

**NATURAL SCIENCE AND PHILOSOPHICAL HERMENEUTICS:
AN EXPLORATION OF UNDERSTANDING IN THE THOUGHT OF
WERNER HEISENBERG AND HANS GEORG GADAMER**

BY

LISA MADELINE SMITH

**A Thesis
Submitted to the Faculty of Graduate Studies
in Partial Fulfillment of the Requirements
for the Degree of**

DOCTOR OF PHILOSOPHY

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Winnipeg, Manitoba**

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For my husband, Gord Richardson

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ABSTRACT

The late modern view that science and the humanities, including the study of religion, occupy separate territories and pursue different aims persists to this day. The purpose of this work is to add to the growing discussion which seeks to reconnect the natural sciences and the humanities through an exploration of the theories of understanding offered by physicist Werner Heisenberg and philosopher Hans Georg Gadamer. As it is guided by general principles of authentic dialogue, this exploration unfolds important correspondences between those theories with regard to human nature and the nature of the world around us. The significance of this rests on the fact that their respective theories have different points of origin: Heisenberg's theory has its basis in the world of science, and Gadamer's theory isolates itself from any connection to that world. The investigation concludes that the natural sciences and the human sciences share essentially the same scope: both lead to an understanding of that reality and truth which underlies all differentiation of human interest.

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On a more personal note, I would like to thank my family, especially my parents. For years, my mother and father have been unstinting in both emotional and financial support, and I could never express my gratitude deeply enough. My brothers and sisters were always free with their encouragement, which I greatly appreciated. Finally, I must thank my husband, Gord, who has been a tremendous support over the years. During the high points and the low points of my studies, he never lost faith in my abilities. Moreover, he has always shown an enthusiastic interest in my work, even when my own interest occasionally flagged. Certainly I could not have done this without my husband, and the present work is dedicated to him.

INTRODUCTION

The late modern view that science and the humanities, including the study of religion, occupy separate territories and pursue different aims persists to this day. The natural sciences are thought to concern themselves with those appearances given to the senses, the outer reality, while the interest of the human sciences is assumed to be with the direct experience of inner reality. The gap between the two is often seen as unbridgeable, though this is changing through a growing dialogue between the "two cultures." An awareness is growing that the strict separation of the two realities is largely unworkable: reality is not so easily separated into inner and outer, body and soul, objective and subjective, mind and matter. The artificial nature of these distinctions is becoming clearer. Also becoming clearer is the material and spiritual danger of continuing to maintain and integrate them into the larger context of our existence. When our various experiences of the world as a whole do not meet up, when science and religion, for example, have little of value to say to each other, we have reached a hazardous limit of fragmentation. The overarching aim of the present work is to add to that emerging discussion which seeks to reconnect the natural sciences and the humanities. Through a focus on the corresponding ideas of Werner Heisenberg and Hans Georg Gadamer, this effort will show that the natural sciences and the human sciences share essentially the same scope: both lead to an understanding of that reality and truth which crosses all borders of specific human interest.

Heisenberg (1901-1976) was a prominent German physicist, closely involved with the momentous discoveries of the atomic world earlier this century; he received the 1932 Nobel Prize in Physics for his scientific work in this area. Most of his professional career was

associated with the prestigious Max Planck Institute for Physics. Although Heisenberg's contributions to science proper are significant, his contributions to the philosophical interpretation of quantum physics are equally worthy of mention. Many of the fundamental changes in scientific thinking that have unfolded over the course of this century have important roots in that interpretation. Such change was always Heisenberg's interest, and he constantly sought to explore the real human possibilities of science. Indeed, from the very beginning his non-technical writing and addresses show a profound concern for reconciliation of the human and scientific worlds. It is unfortunate that his valuable insights with regard to the worlds of science, philosophy and religion have not found greater circulation in the English-speaking world; hopefully the present work can remedy this to some extent.

Gadamer (1901 -), both a contemporary and countryman of Heisenberg's, is a highly respected and influential philosopher, especially within the hermeneutical discipline. As a doctoral student, Gadamer was an enthusiastic student of Professor Martin Heidegger. Years later, and building on Heidegger's insights concerning language and art, Gadamer achieved tremendous philosophical distinction (and notoriety) with the 1960 publication of his monumental and provocative work, *Warheit und Methode (Truth and Method)*. The ideas expressed within that work, and in those works which followed, have remained at the forefront of the current hermeneutical dialogue; it has been remarked that no one else has done as much to intensify and enliven the hermeneutical discussion since that time.¹

Although they come from two ostensibly distant areas, in fact an immediate connection is established between Gadamer and Heisenberg with regard to their fundamental concern: Gadamer calls it our alienation from being, and Heisenberg refers to it as our loss

of connection to the central order. What they both mean is that we have become separated from our relation to the fullness of truth, insofar as we have become separated from ourselves and our world. They agree that this situation is in a large part due to the immersion of the world into the thinking and goals of modern science, though Heisenberg does not perceive the origins and development of science in the same way as Gadamer does. At a certain point, however, both men agree upon the nature and goal of this science, and also agree that modern science and its method have, at the very least, narrowed the possibilities of our humanity in relation to truth. At the very worst, the misappropriation of science and its method by areas other than the study of nature has created a world where a rediscovery of the meaning of human being in the world has become absolutely necessary. Where science and its method once defined our understanding, it now defines our being. In the view of each man, science has come to dominate the world with frightening power, leading us in machine-like fashion further away from that profoundly human world of understanding in which we deepen our relationship with truth. We are more and more caught up in processes that have less and less relation to our real humanity.

Both believe that a critical aspect of addressing this crisis is a thorough re-evaluation of what it actually means to be human in the world, as well as a re-evaluation of science within that framework. Naturally, this is the point of perhaps their greatest difference. Subscribing to the view that the natural sciences and the humanities have altogether different aims, and thus convinced that the method and goal of natural science is inappropriate to a real understanding of who we are, Gadamer sets aside science in his effort to uncover the fundamental human condition. His consequent discovery paves the way for what he considers

the appropriate decentralization of science and the scientific method within the scope of a more enriching human understanding. On the other hand, Heisenberg explores that fundamental human condition from within the possibilities of science, though not exclusively from there, concluding that science has much potential for the meaningful enrichment of our world.

As a scientist, it is not surprising that Heisenberg's understanding of the limits and possibilities of natural science should in many ways be quite different than Gadamer's. But it is not merely a question of interest and experience. Gadamer is deeply influenced by Heidegger, who was notoriously anti-science. Gadamer shows a certain hostility to natural science in his works, which I think often clouds his ability to see any real possibilities there; indeed, his aversion to it sometimes borders on the irrational. Given this, one might well wonder why Gadamer is included in a discussion which seeks to remove the distance between the natural sciences and humanities, a distance which certainly Heisenberg actively seeks to overcome. Indeed, my initial exposure to Gadamer's perception of natural science dismayed me to no small extent, given my previous work on Heisenberg and his understanding of science as a real avenue of human understanding. However, when one looks beyond Gadamer's view of science to his vision of what it means to be human in the world, one finds his ideas extraordinarily compelling. Moreover, and this is the critical point, that vision corresponds very closely to Heisenberg's, who begins his own investigation from *within* the framework of natural science. In view of the divergent conceptions of science, I found that correspondence both striking and significant - hence the present work.

Naturally, the aim here is not to prop up Gadamer's ideas by introducing similar ideas

held by a scientist. The days of scientific "approval" as the guarantor of philosophical or religious victory have passed. Indeed, considering the opposition to some of Heisenberg's ideas, it might well be claimed that I am using Gadamer to prop up Heisenberg's theories. The real purpose is not to add argumentative weight to one side or the other. That is never the point of thoughtful dialogue, which is precisely what I hope to initiate between the two. The understanding achieved through dialogue, says Gadamer, is like a new light being turned on, expanding the range of what we can take into consideration. That idea captures the present intention: an increase in our range of vision, although a very modest one. I hope to show something quite simple: the two claims to universality, one from the realm of philosophical hermeneutics and one from the realm of science, come together in the most important points. The overarching reality which Gadamer sees from without science is that which Heisenberg sees from within science: humans are understanders, the world is by nature intelligible, and all things can reflect truth.

The decision to view the present work in the spirit of dialogue is not an arbitrary one. The process of discovery which has culminated in the present work has from the beginning been of a dialogic nature. My consideration of Gadamer led me to possibilities I had not explored in my earlier work on Heisenberg, and these possibilities reflected back onto the potential for a more meaningful role for science within Gadamer's thought. Moreover, the content of their respective ideas was very influential here. Although they do not conceive of dialogue in exactly the same way, at least philosophically, they do agree that dialogue is the true ground of understanding, as we will see. A proponent of the dialogic method captures the conditions and qualities that both Heisenberg and Gadamer assign to dialogue: "In a

genuine dialogue, all expect to learn something from one another. This learning is not necessarily based on additional factual information (though this often is an ingredient, too) but on perceiving hitherto unnoticed aspects of an issue, being enlightened about a question in a novel manner, adding to one's understanding of a matter."²

At the outset, and particularly from Gadamer's perspective, the potential for successful dialogue here seems small. Gadamer does not try to hide his intention of establishing the universality of hermeneutics "especially over against the claims of modern science to universality."³ To be sure, he is thinking of those claims more as they derive from the philosophical and social sciences, as well as certain philosophies of science, even though these claims are based on the natural scientific method. At issue again is his notion that natural science has its own specific agenda. Thus, even when he feels most friendly to the natural sciences, the possible contributions of the natural scientist to the areas of human concern are simply brushed aside; Gadamer assures us that "the true natural scientist does not have to be told how very particular is the realm of knowledge of his science in relation to the whole of reality."⁴ This does some injustice to those who consider themselves true natural scientists, yet who believe that their encounter with nature is not isolated from that larger world, that the insights gained through that interaction have a relevance beyond the scope of science. To name merely a few, we can mention Planck, Bohr, Pauli, Schrödinger, Prigogine, Davies, Wheeler, and of course Heisenberg. Pointing to the "universal character of the science of the atom," Heisenberg is adamant: "Anyone who takes it seriously, with all its consequences in philosophy, technology and politics, has no other choice, when reflecting on these implications, than to trespass far beyond the boundaries of physics proper."⁵ Of course,

Heisenberg's understands the character of this science to be very different from that which Gadamer has in mind: "the experience drawn from the development of atomic physics has led almost automatically to a way of thinking, united in its basic suppositions and differing essentially at certain points from earlier scientific thought."⁶

We should add that this "earlier scientific thought" that both Gadamer and Heisenberg feel compelled to challenge has undergone some transformations in the course of the thirty to forty years since they first addressed the issue. The claims of late-twentieth century natural science are different from those made previously. For instance, at the present time one might be hard pressed to find a serious thinker discussing the "objective" world of science and the "subjective" world of the humanities. For the most part, this transformation has been of a very productive nature. For example, many scientists' understanding of nature has changed substantially, and they have been quite successful in communicating these changes to the world at large. Yet to imagine that the influence of this earlier scientific thinking has been fully overcome is perhaps too optimistic. It has been put forward that, in certain cases, the changes might not all be positive ones. For example, Joel Weinsheimer notes that while Gadamer may seem to be fighting shadows in his determination to establish the truth claims of human endeavors against those of science, the shadows may yet be quite substantial. Weinsheimer points out that much of the philosophy of science has simply decided to forfeit its claims to truth in the face of the 20th century discoveries which seem to overturn the foundations of modern science: "In all the talk about models, theories, conjectures, hypotheses, paradigms, and research programs one finds that the rationale for using this kind of language to describe scientific research is precisely to avoid laying claim to truth."⁷ Yet

he goes on to suggest that this forfeiture is not related to intellectual honesty but instead to a fundamental unwillingness to give up the “scientific” criteria of truth, despite the reality that this criteria is such that even science can no longer meet it. In the philosophy of science, he says, positivism has gone underground. Furthermore, one cannot dismiss the continued influence of that earlier science within the context of our daily lives. Gadamer’ and Heisenberg’s shared assessment of the nature of scientized world and the consequences for humans existing within this world remains valid to this day. It is precisely the current situation which necessitates continued dialogue between the worlds of science and humanities, the *Naturwissenschaften* and the *Geisteswissenschaften*. The problems of our time have deep roots, and only real and ongoing communication and mutual enlightenment can effect the changes that are becoming crucial for the survival of human beings.

It is rather ironic that Gadamer never seeks to initiate a real dialogue between natural science and the humanities, given that one of the most important sources of dialogue at the present time is just that field of hermeneutics from which Gadamer emerges, and which his work has to a large extent shaped. A word or two on this area is not out of place here, at least for the purposes of situating ourselves with regard to Gadamer’s philosophical hermeneutics. Generally, hermeneutics refers to interpretation. Although the term hermeneutics has recently come into popular usage, interpretation has always been with us, in such forms as commentary and exegesis. Its origins in the modern west as a distinctive discipline are related to the perceived need for a methodical interpretation, of both texts and for anything else that needed interpreting. This kind of hermeneutics, generally known as hermeneutical theory, is interested in guiding interpretation; it is interested in the rules by

which interpretation should be directed. Obviously, this is not the only type of hermeneutics in existence at present; there are many different types. It is interesting, and perhaps characteristic of the nature of the hermeneutical endeavour, that these types are difficult to pin down. Depending on one's choice of author, one might find the realm of contemporary hermeneutics distinguished into three areas, four areas or even more. Gadamer, following Heidegger, defines his own hermeneutics as philosophical, meaning ontological: "My real concern was and is philosophic: not what we do or what we ought to do, but what happens to us over and above our wanting and doing."⁸ Furthermore, I think we can fairly state that Gadamer's philosophical hermeneutics have played a larger role in the development and variety of hermeneutical types, and types within types; his ideas have proven themselves as rich sources for further dialogue. Certainly his conception of the universality of philosophical hermeneutics, given in the statement "being that can be understood is language,"⁹ acts as such a source.

It is important to recognize that, as a broad ontological statement, that statement actually gathers together a variety of elements, e.g., the nature of our human nature, the nature of the world around us, and the nature of our interaction with the world. In those hermeneutical dialogues which concern themselves with Gadamer's ideas, we can see some aspects of this universality commended, others rejected, and altogether new concerns brought in. For example, Gadamer views an important aspect of that universality to be dialogue, given that language is the medium of our existence. Richard Bernstein points out that the notion of conversation is "vital" not only in the hermeneutical thought of Gadamer, but also in that of Jurgen Habermas and Richard Rorty; however, it is differently conceived by each.¹⁰

Another aspect of that universality holds that, since we exist in language, we also exist in prejudice; hence, the idea of objective knowledge is illusion. Again, we can see a number of thinkers are drawn to this element, though they may not remain exactly with Gadamer's interpretation of prejudice as the pre-understandings with which we approach the world: some see in this the complete relativization of knowledge, others feel that we must work even harder to purge prejudice. In the world of hermeneutics, Gadamer has his supporters and detractors, where sometimes the supporters detract, and the detractors support; this appears to reflect the fact that the field of hermeneutics addresses and embraces a broad range of concerns. Interestingly, Bernstein suggests that a difference of emphasis plays a not insignificant role in the varieties of approaches within the field, though naturally there exist actual and quite substantive differences.¹¹

My concern is not with the varieties of hermeneutical thought, but with a dialogue between Heisenberg's vision and Gadamer's. I will say that if one does not find Gadamer palatable, one will not find Heisenberg so. Generally, any critique of Gadamer will apply to Heisenberg, since their respective theories of understanding - one might even say their respective interpretations of being - correspond closely, though not exactly. One of the greatest differences is found in that one aspect that Gadamer considers so absolutely essential to his philosophy - language as the medium of existence. For Heisenberg, order is that medium, though he is by no means averse to the notion of language as the receptacle of order (which Gadamer could never agree with). Yet this difference is no barrier to the dialogue. Indeed, Heisenberg himself would point out that "It is probably quite true generally that in the history of human thinking the most fruitful developments frequently take place at those points

where two different lines of thought meet."¹² In actuality, the disparity is less than one might initially imagine. In language and in order, each man is concerned with the fundamental intelligibility of the world. One could go so far as to state that Heisenberg is offering an order-based philosophical hermeneutics.

Putting the nature of intelligibility aside, we see that Heisenberg and Gadamer are almost natural dialogue partners, given their shared conviction that dialogue occurs in relation to a real question or problem. As we noted, Gadamer and Heisenberg possess essentially the same primary concern, i.e., our separation from the fullness of truth. They further agree that this situation originates in the engulfing of the world in a science which alienates us from ourselves and our world. The first chapter concerns itself with establishing and expanding this ground of dialogue. The second chapter turns to an examination of Gadamer's philosophical hermeneutics. By leaving aside science and its method, and considering what really happens to us when we understand, Gadamer arrives at a theory of understanding which he believes has universal relevance, given in that statement: "being that can be understood is language." Since Gadamer's work is very well known, this will be a comparatively brief investigation, though a necessary one for the present dialogue. I have attempted to interpret his ideas as "correctly" and as closely to his own emphasis as possible, given the need for integrity in a dialogue. Following this is an inquiry into the relevance of his hermeneutics to natural science, and the reasons for the limitations we find there. The last chapter concerns itself with Heisenberg's theory of understanding, as it begins from the world of atomic physics and moves outward to the larger human world. As we will see, it is no distortion of his thought to state that, for Heisenberg, 'being that can be understood is order.' Given the relative

obscurity of his thought within the English-speaking world, this exploration will be given some depth. What emerges is that, despite the difference with respect to the role of science and the form of the fundamental intelligibility of reality, Heisenberg's and Gadamer's theories of understanding correspond to an amazing degree. The hope is that this can reflect positively back into Gadamer's sphere, and furthermore, that the interplay between the two can add some new light into the larger sphere of our lives.

CHAPTER 1

The following chapter is concerned with an exploration of science, the scientific method and the scientific age from the view of both Gadamer and Heisenberg. On most points there is agreement. For both men, the crisis of the present time, our increasing alienation from ourselves and the world of meaning, is intimately linked to the expansion of scientific thinking from the study of nature into the human world. While Gadamer has been admonished for his assumption that there exists a universal method that is generally recognized, in fact Heisenberg would agree that the scientific attitude that has become incorporated into the larger world possesses just those characteristics outlined by Gadamer. He also agrees that this attitude is generally distinguished by its conviction that there is no truth outside of that scientific method. That is, from Heisenberg's perspective, Gadamer has really understood our current situation. Yet, where Heisenberg might himself admonish Gadamer is his lack of interest in the actual way the natural scientist comes to understand nature, and the reason he wants to understand. Gadamer might have captured what science has become, but he has not understood the foundations of that science as it derives from the study of nature. It is actually quite true that Gadamer pays little attention to natural science. His concern is above all opposing the unreflective scientific attitude that has permeated our human world, which might explain Gadamer's essentially abstract and unhistorical conception of the scientific method. Indeed, Gadamer's answer to the question about what happened in the human world is a short one: science happened. Heisenberg's concern is rather more complicated: how can a science that came out of the world as the search for the divine order have degenerated into a quest for mastery over nature, and how can it have happened that the

world which gave birth to this science plunged headlong into it? Yet they both come together in their recognition that a specific kind of science has pervaded the larger world to a dangerous extent, and that a reconsideration of ourselves and our world has become critical.

Part I - Gadamer

The goal and method of natural science

While he spends much time criticizing the inappropriate use of the scientific method, Gadamer rarely discusses the *development* of modern natural science and its method. As Joel Weinsheimer put it, Gadamer seems to think this method leaped out "full-blown from the heads of Bacon and Descartes and has not altered significantly since then."¹ For Gadamer, the goal of natural science is a simple one: "the knowledge of all the natural sciences is 'knowledge for domination.'"² Bacon is for him the "predecessor of modern science," insofar as his aim is "conquering nature through obedience - the new approach of attacking nature and forcing nature's secrets from it."³ Naturally Bacon is not completely disassociated from the issue of method, since one of Bacon's great achievements is "that he undertakes a comprehensive examination of the prejudices that hold the human mind captive and lead it away from the true knowledge of things."⁴ Descartes is similarly villainous, since his quest for certain knowledge is also characterized by the elimination of all prejudice: "Governing itself by rule, objectivity tries methodically to eliminate bias, prejudice and all the other distortions that go by the name of subjectivity. This Cartesian endeavour assumes that a methodically purified consciousness guarantees certainty."⁵ Modern natural science is led on by "the rule of Cartesian doubt, accepting as certain nothing that can in any way be doubted,

and adopting the method which follows from this rule."⁶ Certitude becomes associated with knowing the thing as it really is, and thus, as Gadamer sees it, the essence of natural science is its methodology, which works through mathematics and reason to a knowledge of what is intelligible in itself.

For Gadamer, scientific certainty is of a distinctive kind. It is, Gadamer states, "the result of a critical method that admits only the validity of what cannot be doubted," and this certainty is altogether distinct from the "immediate living certainty that all ends and values have when they appear in the human consciousness with an absolute claim."⁷ From a scientific view, the beauty and advantage of theoretical knowledge is precisely that it makes no claim upon us. This complete disassociation from what we know is an essential precondition for technological application. Obviously one must know a thing before one can dominate it, but the real trick is attaining a knowledge which is purged of any connection with the human world that might make that knowledge less amenable to technical application. For Gadamer, there is an intimate relation between certitude and domination; when things are assumed to exist "in themselves," the knowledge of those things "is determined as certain knowledge, which permits us to control things."⁸ He continues this idea: "the projected theories themselves are dominated by the idea of construction - i.e., theoretical knowledge is itself conceived in terms of the will to dominate what exists; it is a means and not an end."⁹ Theoretical knowledge makes itself available for purposes. The scientific method thus has a very special purpose: it is designed not only to ensure certainty but also to shape a properly theoretical attitude. Hence the emphasis on induction for the determination of the principles employed by nature. The inductive method, Gadamer points out, is "free from all

metaphysical assumptions and remains perfectly independent of how one conceives of the phenomena that one is observing."¹⁰ Attempting to ascertain causes is not the point, and moreover should be avoided at all costs, at least from the perspective of the scientific agenda. The determination of regularities is quite sufficient.

Science in the humanities

Gadamer's overriding concern is not the use of the method in the natural sciences. It is fair to state that he in fact shows a fundamental disinterest in natural science altogether. Of more interest, and certainly much more disturbing to him is the adoption of this method into the human sciences, particularly by the nineteenth century: "The human sciences...so obviously understand themselves by analogy to the natural sciences that the idealistic echo implied in the idea of Geist ("spirit") and of a science of Geist fades into the background."¹¹ Naturally, Gadamer is not suggesting that the human sciences deliberately set out to dominate their fields of interest. Rather, they found quite persuasive the ideal of "certain" knowledge, which the scientific method seemed to be offering. Yet that certainty is only arrived at through the method of science, which necessitates a translation of the field of interest into a scientifically productive context. The problem for Gadamer is that the use of the method does achieve theoretical knowledge of the "scientific" kind and thus a knowledge that loses its human meaning. For Gadamer, "what is called 'method' in modern science remains the same everywhere and is only displayed in an especially exemplary form in the natural sciences."¹² In this assumption that we all know what the method is, Gadamer does not give us a perfectly coherent description. Yet there are some elements related to that method that not only recur throughout his critique of the human sciences in the modern age, but also have

a bearing on his vision of the current crisis of our age: experimentation, data, objectivity, repeatability of experience for verification, rationality, the prejudice against prejudice, and a degenerated concept of practice. In the human sciences these elements, together with the goal of certain knowledge, have the effect of alienating us from what we are trying to understand.

Gadamer's well-known example of this alienation through the absorption of the scientific attitude is the transformation of the understanding of art and history into what he calls the aesthetic and historical consciousness. Characteristic to both of these consciousnesses is the ideal of withdrawal from the "data" under observation. While the consciousness of art, an awareness of it as an object to be known, is for Gadamer "always secondary to the immediate truth claim that proceeds from the work itself,"¹³ it takes precedence within a scientific approach. The observer of an artwork is asked to stand back, to withdraw himself from the immediate claim which grasps him, and to make a careful judgement of the work. Of course, within a methodical approach, that which is offered for judgement is radically changed. To help the observer judge, all the "subjective" elements of an artwork are disregarded. Gadamer refers to "aesthetic differentiation," which consists of abstracting a work from all its conditions of emergence: "By disregarding everything in which a work is rooted (its original context of life, and the religious or secular function that gave it its significance), it became visible as the 'pure work of art'."¹⁴ This despite the fact that there is always an intention behind every artistic creation. There is a meaning that is trying to be expressed and which the artist wants his audience to understand: "no artist of the religiously vital cultures of the past ever produced his work of art with any other intention

than that his creation should be received in terms of what it says and presents and that it should have its place in the world where men live together."¹⁵ Nevertheless, aesthetic experience (Erlebnis) is directed toward that 'pure work', putting aside all the "elements of content that induce us to take up a moral stance or religious stance towards it."¹⁶ The work loses its place and the world to which it belongs as it is given over to an aesthetic consciousness which strives to break out of its own belongingness to the world and to the work. One is left with an object to be rationally judged - not experienced.

As to the historical consciousness, Gadamer describes it as "the noble and slowly perfected art of holding ourselves at a critical distance in dealing with witnesses to past life."¹⁷ For Gadamer, only by renouncing one's connection with life, by achieving a distance from one's own history, does it become possible for history to become an object, an object to become deciphered and thus known in itself. For example, Gadamer points to Schleiermacher (1768-1834), for whom it was necessary to understand the mindset of the writer of the historical text, and the circumstances surrounding emergence of the text. The reconstruction of the original intention is for him the understanding of the history. Gadamer tells us that Schleiermacher's approach was a reaction against the aesthetic consciousness above, though he also adds that this sort of historical offering is nothing but the handing down of a dead meaning. A conscious distancing of oneself from history removes the possibility of being moved by one's object, despite the fact that the real achievement of historical objectivity, a standing outside the flow of our existence, is pure illusion. But obviously, illusions can be dangerous. We will return to this particular issue presently. Relevant to our discussion is the notion that understanding history is reduced, in the emphasis on knowledge of intentions, to

explaining history. The truth content of the claims of those past witnesses to life is ignored as the interest becomes grasping the motives for making any claims at all: "This kind of understanding thus involves an understanding of the psychological, biographical or historical conditions behind a claim or action as opposed to a substantive understanding of the claim or action itself."¹⁸ Though these elements are not unimportant for Gadamer, when they become the totality, he is sure that something significant is lost. What happens with this type of thinking is that it turns to a concern with "establishing similarities, regularities, and conformities to law which would make it possible to predict individual phenomena and processes."¹⁹ That is, it lends itself more fully to the scientific method, and thus to the scientific goal of domination. Gadamer is clear on this point. When we refuse to allow that which we study to make a claim upon us by distancing ourselves from that object, when we remove it from any meaningful context, it almost naturally falls into the category of that which we can dominate. For Gadamer, we always need only look at the natural sciences for confirmation of this, particularly its view of nature: "modern science does not view nature as an intelligible whole but as a process that has nothing to do with human beings, a process on which science throws a limited, but reliable light, thus making it possible to control it."²⁰

For example, a knowledge of human nature tries to discover typical behaviours in people in order to make predictions about others on the basis of experience; it "seeks to calculate how the other person will behave."²¹ When humans fall under the category of data to be studied by an objective observer, it is too easy to manipulate them. Gadamer is always concerned to show that the scientific method alienates us from that which we try to understand, and that this alienation is the basis for control. On the other hand, authentic

understanding is for Gadamer always an encounter with something that speaks to us: "it is a genuine experience (Erfahrung) -- i.e., an encounter with something that asserts itself as truth"²² A real encounter of I and Thou is characterized by openness, by mutual respect and friendship with another person, where one listens as well as speaks. Scientific knowledge is not understanding, as it makes no room for this encounter; it possesses only data for its study. In terms of coming to know the Thou through method, and not through encounter, the relationship between persons is severed: "by understanding the other, by claiming to know him, one robs his claims of their legitimacy...The claim to understand the other person in advance functions to keep the other person's claim at a distance."²³ And out of this approach can only come domination, whether it is the domination of the slave-owner, or that of the 20th century expert. For Gadamer, however, what is true of the aesthetic consciousness when it tries to 'understand' art is true of a scientific knowledge of the human being. When the integrity of the other is discounted, the understanding of the other is overwhelmingly incomplete: "It is an illusion to see another person as a tool that can be absolutely known and used. Even a slave still has a will to power that turns against his master, as Nietzsche rightly said."²⁴

Science in the human world: the scientific age

Especially from the last example, it is quite clear that Gadamer's concern is not exclusively theoretical. While his concern is in part that the incorporation of the scientific method into the humanities has alienated us from the text, it is more appropriate to say that this textual alienation is merely an illustration of what has happened to the world around us. As he says, "we cannot avoid the question of whether what we are aware of in such

apparently harmless examples as the aesthetic consciousness and the historical consciousness does not represent a problem that is also present in modern natural science and our technological attitude towards the world"²⁵ (though naturally he does not think such alienation in either experience is harmless in the least, since it has helped to set the stage for the present crisis). While Gadamer asserts that the whole of our civilization is founded on modern science, it is only in the twentieth century that we see the ultimate maturity of our scientific/technological civilization - "or, if you will, the crisis of our civilization."²⁶ What is the crisis? Even in the face of our current situation, where a touch of a button can obliterate hundreds of thousands of lives, where the earth is merely a warehouse of resources, where in the wake of human progress extinction of species occurs every day, this crisis is not merely, as one might suppose, the question of the retrieval of values. Rather, the crisis is the complete and utter immersion of every aspect of our lives into the ways and aims of modern science - "the transfer of technical expertise from the mastery of the forces of nature to social life."²⁷ The thinking goes that if science is effective in mastering natural processes, it should be effective for all processes. Gadamer sees in this a new, radicalized faith in science, despite the fact that the mastery of natural processes still involves a relatively small realm of nature. The public is filled with a "mounting expectation that science is ultimately capable of banishing all unpredictability from the life most proper to society by subjecting all spheres of human living to scientific control."²⁸ Yet, it can only achieve this by translating the world into its own terms. Thus, as Gadamer sees it, now *all problems* are to be understood as technical ones dependent on technical solutions. The dream of the eighteenth century of a new future society based upon scientific reason and independent of the forces of tradition in all its forms,

has now become our reality. For Gadamer, it is more nightmare than the expected utopia, simply because the scientific civilization carries with it all the unwholesome characteristics of modern science. *We* have become the data from which science distances itself in order to inspect, manipulate and master:

...with the increasing mastery of nature, the domination of human beings over human beings is not eliminated but... becomes ever greater and threatens freedom from within. A result of technology is that it leads to such a manipulation of human society, of the formation of public opinion, of the life conduct of everyone, of the disposition of each individual's time between job and family, and it takes our breath away.²⁹

We mentioned earlier the ideal of rationality for the scientific method. Reason, freed from the prejudices of tradition, becomes the sole authority in judgement; whatever derives from tradition is viewed as unfounded opinion. This has had what Gadamer sees as a deleterious effect on our more formal quest for understanding through the human sciences, whose true end is the "vital and ongoing shaping of man's knowledge of himself."³⁰ Yet, the theory of science discards the truth claims of such endeavours precisely *because* those endeavours take seriously the human's collective knowledge of itself and the world of its creations in which it has deposited this knowledge: "all this - the truth claim of art as well as the claim of the *Geisteswissenschaften* to serve man's self-understanding - is labelled hybrid, an inadmissible fusion of imagination with the rigor of pure science."³¹ Yet the authority of rationality has infiltrated the larger world, where the claims of religion, philosophy, and art are often viewed with both suspicion and disbelief. Gadamer sees our time as one in which "the passion for philosophy appears altogether like an irresponsible flight into a world of dreams,"³² and where philosophy is discounted as merely one of the "theological relics of a

bygone age." In the scientific age, such human undertakings are indicative only of an immature phase of the human mind, before liberation to its own rationality. The questions and concerns of those endeavours - who and why we are, how we should be - are primitive at best, and are certainly no longer our problems. Of course, they are for Gadamer no longer problems for the scientific age because they are not *technical* problems. Whatever science cannot address, it dismisses. And so it shunts aside not only our questions, but the "grand answers" of the religions, mythologies and artistic creations. For Gadamer, the development of our scientific civilization has effectively severed our relation to the realm of the truly human questions and answers:

Metaphysics and religion seem to have provided a better support for the task of order in human society than the power packed into the modern sciences. But the answers that they claimed to give are for people of today answers to questions one cannot really ask and, as they suppose, do not really need to ask.³³

It should be added in all fairness to the much-maligned Bacon, that Bacon himself would have been aghast at the current situation. For him, scientific knowledge was never meant to "take over" our whole existence: the area of application of scientific and technological knowledge was for Bacon restricted to the material improvement of human life. When he disdained traditional and philosophical ideas, he did so because of their unproductiveness in aiding that improvement. In actual fact, scientific knowledge and its application occurred only as a part of the framework of a religious world, which he not only accepted, but embraced. For him, it was a given that love and compassion for our neighbours could be the only possible justification for the development of new discoveries and powers.³⁴ Now, science itself has become the larger framework. These dimensions of religiosity and

spirituality, from which Bacon speaks with utter seriousness, and which for Gadamer will always be a vital aspect of human existence, are now almost denied to us.

Not only has science denied to us those areas of real human interest, *science mechanically leads us further and further away from the truly human questions*. Under the influence of modern science, we are driven away from ourselves and from our world. Take, for instance, what Gadamer sees as the vicious spiral of the technological ideal. Previously, he notes, the standard for what was to be made was ultimately set by the user. In the present time, those standards are set by the construction itself: "in our civilization, characterized by technological growth, what has been artificially produced sets the new terms."³⁵ As an unmistakable example, he points to the fabrication of a consumer-awakening and need-stimulating industry. Moreover, he adds, it is only by giving oneself over completely to this artificial world that can one enjoy the comforts and wealth the offered by the scientific age. For Gadamer, this "primary renunciation of freedom in relation to one's overall ability to act"³⁶ is an intrinsic demand of the scientific/technological agenda, simply because control and domination are inherent characteristics of that agenda.

Of course, the "domination" and "control" have been transformed into the more palatable "planning" and "social engineering." Call it what you will, for Gadamer, we are being shaped by a way of thinking which has no real connection to our humanity. Rather, we should call it an un-shaping, or de-humanizing, since it does lead us away from ourselves and our world. But this is all one could expect from a science that seeks to control and whose watchwords are 'rationality' and 'objectivity', and this what one can continue to expect. Indeed, even where the notion of objectivity has undergone profound changes, as in atomic

physics, and the model of statistics comes to the fore, "it would still be a mistake to disregard the desire for mastery expressed in these new methods for dominating nature and society."³⁷ Gadamer is clear on this point: "[Science] will continue along its own path with an inner necessity beyond its control, and it will produce more and more breathtaking knowledge and controlling power. It can be no other way."³⁸ It is in the nature of modern science to do this. Of course, Gadamer is not unaware of the very human qualities that might take advantage of science for personal benefit, for the tremendous opportunities for power which can be gained from it. But he sees as more frightening the forward motion it carries within itself, and the power which consumes everything in its path, including ourselves. "In this way ever more areas of our life fall under the compulsory structures of automatic processes, and ever less does humanity know itself and its spirit within the objectifications of the spirit."³⁹ For Gadamer then, the loss of human freedom was inevitable as long as the world embraced modern science, and this loss is at the heart of the present crisis. Contrary to all expectation, people are not more free when 'science' rules - rather, they are re-enslaved through it.

Science, human freedom, and self-understanding

When Gadamer, following Hegel, describes the principle of freedom as "unimpugnable and irrevocable", and claims that "the principle that all are free can never again be shaken,"⁴⁰ he clearly means a freedom that is more than merely an escape from oppressive government. Rather, he means the freedom to choose, the freedom to make decisions. This freedom identifies us as human beings. It is this freedom that the scientific age is challenging in so many ways: "The social order develops forms of such power that the individual is hardly conscious at all any longer of living out of his own decisions, even in the intimate sphere of

his own personal existence."⁴¹ Naturally, the loss of freedom is not just that of decision-making; the loss is ultimately the entire scope associated with it: reflection, deliberation, taking things into consideration and acting. The challenge to freedom comes directly from an all-encompassing science, simply by drawing us further and further into its machinery. This is especially apparent in the existence of the *expert*, who is for Gadamer the ultimately 'scientific' product of the scientific age. Gadamer conceives the ideal of the technocratic society to be the control of society by reason and by more rational social relationships, achieved by calculated planning. To this end, the technocratic society looks to those experts for the discharging of the practical, political, and economic decisions, as opposed to the people of practical wisdom. As Georgia Warnke puts it, "Social decisions are not the result of reasoned discussion in an informed public sphere but instead the decisions of small groups of experts who have mastered a great deal of technical information and therefore claim to be able to act in the name of everyone else."⁴² While Gadamer admits that in the technical mastery of processes, the expert is in fact an indispensable figure, he forcefully asserts that our lives *are not* technical problems amenable to technical solutions. This is something we desperately need to recognize. Too much is demanded of the expert in his substitution for practical and political experience, and the expert, "in the light of a sober and methodical self-appraisal and an honest heightening of awareness" must admit that he cannot substitute for such.⁴³ Yet, the challenge to freedom in the scientific age is a two way street - the freedom that science mechanically seeks to eradicate can only be truly eradicated when we give it up. As he says, we can only enjoy the comforts of the age by renouncing our freedom. But for Gadamer, it is our absolute responsibility to become fully human, and we are only human

when we are free, when we see that it is not an option but an obligation to participate thoughtfully and earnestly in the direction of our lives here together: "The authority of science and experts adds up to relieving that responsibility that should be borne by the one acting."⁴⁴

Gadamer believes that the full dimensions of human freedom are to be achieved through a careful re-consideration of who we are and how we know. That is, self-understanding is the key to freedom from the profound restrictions of the scientific age:

The Delphic demand "Know thyself" meant, "Know that you are a man and no god." It holds true as well for human beings in the age of the sciences, for it stands as a warning before all illusions of mastery and domination. Self-knowledge alone is capable of saving a freedom threatened not only by rulers but much more by the domination and dependence that issue from everything we think we control.⁴⁵

Knowing who we are involves the insight that "we have to accept the limits imposed for finite natures."⁴⁶ Yet, just as the Greek thinkers could not wholly submit themselves to this admonition to humility, "but surrendered themselves to the drive toward questioning for the sake of becoming immortal as far as possible,"⁴⁷ as Aristotle wrote, so Gadamer wants us to focus on our possibilities as well as our limits. For Gadamer, the profound challenge of life can only be met through a truer and richer self than the scientific age, by its very nature, can allow the self to be. The scientific age traps us in a compressed existence, where the actual fullness and possibilities of our understanding are denied to us.

Part II: Heisenberg

I suggested earlier that Heisenberg cannot consider the problem of a scientized world without considering the development and essence of natural science itself. Thus, as we locate

the correspondence between Heisenberg and Gadamer with respect to the problem of alienation in the human world, it is necessary to include his understanding of the development of the scientific method. This sketch of that development is helpful because it reflects on his notion that the larger context has a close relation to how we understand. Additionally for Heisenberg, this history, which cannot be understood apart from philosophical and religious history, contains within it an understanding of both the possibilities and limits of our current science, though it is by no means the exclusive source of such understanding. One of his works in particular, *Das Naturbild der heutigen Physik*, illustrates for us just how important he considers that history to be for the understanding of the nature of science and the nature of its relation to the world. While the work is concerned with the contemporary situation, more than half the work is given over to historical sources. As he says, since serious problems have arisen out of the changes of world-view of science, "these problems endow historical relations with a quite special significance."⁴⁸ Naturally, Heisenberg never purports to offer us a comprehensive "history of science" in any of his works. When he does refer to that history, he focuses on particular aspects which are relevant to our current problems.

Gadamer's characterization of the elements of the scientific method derive from his assumption that science developed out of the desire to dominate nature, that those elements come almost as a "package deal" of that larger aim of compelling nature to our desires. Heisenberg points out that this method did not leap out fully formed from anyone's head. It developed over time and through the study of nature. Certainly after Newton there is a stabilization of approach in the method that was at least *perceived* to be the source of scientific success. This method was generally conceived in this way: the details of nature

must be separated out by means of experiment, and the observation of those details is done in an objective manner; this position of distance enables a rational explanation of nature, as the scientist extracts the laws underlying the details through his observation; the scientist then goes on to formulate interrelations mathematically and thus to arrive at "laws" that hold universally.⁴⁹ Missing here is the overt aim of dominating nature, though Gadamer would argue that it is an implicit aim of the method. However, Heisenberg does not see the mastery of principles for the purpose of application as essentially related to the origins of modern science (though he is aware of this aspect in all our activities), and I am sure that Heisenberg would be very dismayed at Gadamer's discussion of the original aims of science without ever once mentioning Kepler. For Heisenberg, the aim of understanding nature is fused with the aim of extending humanity's material powers only when science becomes dogmatically methodological, especially with regard to rationality and objectivity. Heisenberg learned in connection with his science that it is the theory which decides what we can observe, in the sense that we can only understand through given intelligibilities. Here, one might say that it is the method which determined our vision. If our abilities are limited - and blind adherence to method assures those limitations -, we cannot grasp the larger context. In Heisenberg's view, only when the knowledge achieved by science has no real meaning for us, meaning which can only come from that larger context, is that knowledge turned to practical purposes. With respect to theoretical knowledge, this corresponds almost exactly to Gadamer's view. And for Heisenberg, when "purposiveness" becomes the catchword of both science and the world, there lies chaos.

The context of early modern science

In Heisenberg's reflection upon this history and in particular his discussion of the origins of modern science, it is significant that he rarely refers to the desire to master nature. For him, the origins of science are found in a genuine effort to understand nature, or rather, to understand the divine order as we encounter it in nature. In the seventeenth century, when modern science was being established by Kepler, Galileo and Newton, "nature was thought of as the work of God. It would have seemed senseless to people of the time to ask about the material world apart from its dependence on God."⁵⁰ Yet while these three scientists can be tied together through the idea that they all saw nature as God's creation, they have different notions regarding the level of dependence of nature upon God. For Kepler, there existed an almost immediate dependence: "The complete correspondence between 'things of the senses' -i.e., the works of God - and mathematical and intelligible laws - the 'thoughts' of God - becomes the fundamental concept of the *Harmonices Mundi*."⁵¹ While Galileo was the one to argue that nature was God's "second book," and that it was written in mathematical letters, he moves further away from the divine in nature. Galileo separated out individual processes from their environment, described them mathematically, and thus "explained" them without any recourse to the divine. This continues throughout modern science. With regard to Newton, though his nature has divine origins, "[he] could no longer see the world as the work of God, comprehensible as a whole."⁵² Newton's well-known image, that he felt like a child playing on the seashore, finding prettier things than usual "while the great ocean of truth lay unexplored before him,"⁵³ circumscribes most clearly for Heisenberg Newton's position toward nature. For that scientist, and for those after him, the divine was not "in" the world in the same way it was for Kepler. When God in heaven is viewed as so far removed

from earth, it becomes meaningful to view the world apart from God. Yet it is significant for Heisenberg that Newton's seashore treasures are important to him because they come from the great ocean of truth. Thus what Heisenberg can generally conclude about early modern science is that "Observing [nature] is not an end in itself; rather, its study receives meaning through its relation to the whole."⁵⁴

Heisenberg finds it quite interesting that the close connection between nature and the divine is largely eliminated at the same time as the intimate human connection to the divine order in nature is lost. In Heisenberg's view, Kepler is an important exception here, since he distinguishes himself from the other early moderns by his profound conviction of the integral relation of the study of nature to the whole of our reality. Heisenberg admires Kepler tremendously, to such an extent that he can be said to use Kepler as a model for his own approach to science, though there exist notable differences in their thinking. Obviously, Heisenberg is not suggesting that we try to recreate the exact circumstances surrounding Kepler's science, fully aware that such a recreation is impossible. The very fact that we have been shaped by modern thinking assures that we will never see the world in Kepler's way again. Besides, we must remember the benefit of such thinking: though Heisenberg is concerned with its own turn to narrowness and dogmatism, it was natural science that "brought liberation from a narrow, dogmatic way of thinking handed down from the Middle Ages."⁵⁵ (It is not irrelevant to recall that Kepler, one of the founders of modern science, had to defend his mother against charges of witchcraft.) But in terms of an appropriate context for science, and for the situation of the scientist within that context, Heisenberg feels that Kepler can add much insight.

For Kepler, science is not at all a means to technological progress, but on the contrary, it is a "means of elevating the mind, a way of finding peace and solace in the contemplation of the eternal perfection of the Creation."⁵⁶ The fulfilment that derives from such contemplation naturally comes only to the soul which is seeking its ascent: "astronomy is not food for everybody, without distinction, but only for the aspiring soul."⁵⁷ Of course, Kepler was contemplating the harmony of the world, particularly of the heavens, as it was generated through the pure and eternal archetypes which are derived from God's own essence. Particularly compelling for Heisenberg is that Kepler does not approach this divine order from the stance of strict rationality. For a Platonically minded Kepler, we are only able to understand the geometrical harmony because we are created in God's image. Based on this, Heisenberg reads into Kepler's works a "remarkable disdain of empirical facts."⁵⁸ Experience in Kepler's thought is only that accidental discovery of relations, "that can be understood much better from an insight into *a priori* reasons."⁵⁹ That is, the relations discovered in empirical fact around us are actually better understood through those pre-existing archetypes within, even before they shine forth more vividly through a recognition of the same without. This is not to say that Kepler's science was an exercise in imagination: he did, after all, spend many frustrated years trying to reconcile an anomaly of eight minutes in his astronomical observations. But by pointing out Kepler's disdain, Heisenberg wants to underline Kepler's utter certainty that only our connection to the divine allows us to understand his works.

Naturally, Kepler was not alone in his turn to a Platonically-influenced science. In most of the early moderns Heisenberg sees exemplified the trend in Renaissance and Reformation ideas towards a revival of Platonic mathematical thinking. Indeed, Heisenberg

calls it a misunderstanding to think of the scientific method of early modernity (and of the present time) as empirical. Heisenberg points out that Galileo actually turned away from the descriptive, Aristotelian science of his time to the structural concept of science based on Plato's philosophy. When Galileo championed experience, it was experience illuminated by mathematical constructs: "Galileo as well as Copernicus understood that by going away from immediate experience, by idealizing experience, we may discover mathematical structures in natural phenomena, and thereby gain a new simplicity as a basis for a new understanding."⁶⁰ For Heisenberg, these two abstractions, the recognition of the simple in the multiplicity of phenomena, and the use of mathematics to represent the phenomena, characterize modern science to a large extent, and their use in physics has been tremendously successful, from Newton's time to the present.

Still, for all that a new simplicity became the basis for understanding, for all that Newton's science was as mathematical as Kepler's, Heisenberg points out that there occurs a fundamental change in scientific thought after Kepler. That is, the *human* relation to the study of nature is lost. Heisenberg suggests that the separation of the human element from science can probably be traced to two lines of thought at the time. The first, just mentioned, was that revival of mathematical thinking, which led to an increase of influence of Platonic thinking in philosophy. The second was a spreading insistence on personal religion. "The growing interest in mathematics favoured a philosophical system that started from logical reasoning and tried by this method to arrive at some truth that was as certain as a mathematical conclusion. The insistence on personal religion separated the I and its relation to God from the world."⁶¹ Again, this does not quite apply to Kepler. Certainly Kepler felt

a profoundly personal relation to his God, but clearly believed this relationship could be deepened through a vision of the divine in nature. Moreover, he was unwilling to remain at the level of logical reasoning with regard to that vision. For Kepler, we can understand precisely because we are created in the image of God; this creation allows us to rise above the level of rationality. Not that Kepler dismissed that level, but for him real understanding occurs beyond discursive reasoning, at a level, he says, "which employs no considered method."⁶²

But for the most part after Kepler, the conception of humans as understanders of the divine in nature is tremendously diminished. While Galileo abstracted from God's 'book of nature' its mathematical structures, he does not concede to the scientist the insight or levels of understanding of which Kepler speaks. Our effort to understand nature is for him a plodding affair, based on trial and error: assumptions are put forward, tested, and either rejected or accepted as a natural law based on their empirical validity. For Galileo, that the mind is able to evolve assumptions for the observation of nature which are mathematically and logically valid is no proof of the existence in nature of those relations implied by the assumption; Heisenberg emphasizes that for Galileo "*only when the latter are used as empirical hypotheses and are proven by experiment do they assume the character of natural laws.*"⁶³ Certainly the validity of those unproven assumptions remains, but not as a natural law. But when Heisenberg turns to Newton, he sees that scientist denying any validity to these "unproven" mathematical and logical assumptions. Newton writes:

For anything which is not deduced from phenomena ought to be called a hypothesis, and hypotheses of this kind, whether metaphysical or physical, whether of occult qualities or mechanical, have no place in experimental philosophy. In this philosophy,

propositions are deduced from phenomena, and afterward made general by induction.⁶⁴

For Newton, there is only one way to determine natural law, and that is from the phenomena itself, by a double process of analysis and synthesis, or induction. By means of analysis, the forces of nature and the laws governing them are gleaned from a few well-chosen phenomena; synthesis comes into play when those forces and laws are used to explain the properties of the remaining phenomena. Again, as with Galileo, uncertain assumptions must be subordinated to strict observation and experiment, experiment being performed on those problems thought out to test the validity of the theory. As a scientist, Heisenberg himself does not dispute the necessity of experiment and the empirical validity of hypotheses. Nor is he disturbed by the drawing of a general conclusion from especially those laws: Newton's laws, though originally applied to the solar system, have found many other applications in science, right down to quantum physics, when approached classically. What he finds distressing about Newton's science is the way in which Newton purports to understand nature: "he freed nature from an all-embracing God relatedness, but also from its narrow connection with man."⁶⁵ That is, Newton's science denies that connection between ourselves and nature. This implies that we drag that information from nature, rather than being led there.

Nonetheless, though the nature of understanding was in Heisenberg's view misconceived by Newton, Heisenberg does appreciate the modesty of his science, and indeed the modesty of early modern science in general. Heisenberg attributes this modesty to the fact that there still existed a larger framework in which science was located: natural science "made

statements about strictly limited relations that *are only valid within the framework of these limitations*.⁶⁶ A whole ocean of truth still lay before these scientists, who, for the most part, would never claim that all of reality could be explained through mathematical science.

Fragmentation of the context

Heisenberg is sure that those two trends of thought mentioned above, i.e., the revival of mathematical thinking and the tendency to personal religion, had a real effect on the science of the early moderns. They are also, for Heisenberg, concretely formulated in Descartes' philosophy, as that philosopher attempted to discover order in the world. What Heisenberg finds interesting about this philosophy is its contrast to the more ancient attempts at discovering order. While the ancients had tried to find this order through a fundamental unifying principle, Heisenberg points out that Descartes' attempt to establish this order of things is done through a fundamental *division*, where the starting point is the "triangle" of God-World-I.⁶⁷ For Heisenberg himself, as we shall certainly see, the connection between the three is critical, since some of the essence of a single part is lost when it is considered apart from the others. He is firm that if one uses the concepts of Descartes at all, it is vital to recognize that God is in the world and in the I, and also that the I cannot really be separated from the world. Heisenberg acknowledges that while Descartes naturally was aware of the necessity of the connection, the division and the utter disparity between the three helped to set the stage for things to come, especially as philosophy and natural science after him developed on the basis of that division. Heisenberg is concerned to underline the essential differences between the elements of the triangle, which "simplifies in a dangerous way the basis for further reasoning."⁶⁸ As Heisenberg sees it, the Platonic division between

body and soul is here complete in the separation of God from both the world and from the I: "God is in fact raised so high above the world of men that He finally appears in the philosophy of Descartes only as a common point of reference that establishes the relation between I and the world."⁶⁹ The world is the "res extensa", the extended things, ideas of which can only be expressed mathematically. The I is the "res cogitans," the thinking being that is mind. Thus at the same time that God is moved high above both, the "res cogitans" and the "res extensa" are situated far away from each other. The difference between them is so great that there can really be no connection: "Since, on the one hand, the 'res cogitans' and the 'res extensa' were taken as completely different in their essence, it did not seem possible that they could act upon each other."⁷⁰

Natural science favoured these separations because, with respect to the problems of modern physics, they seemed to achieve tremendous results. First of all, the understanding of the motion of matter is accomplished with relative ease when matter is understood as extended in height, depth and breadth, that is, able to be represented mathematically. Moreover, concerning this motion, though God may well have created nature, he seemed to have wound it up like a clock, and let it run on its own. Of interest were the mechanics of this instrument, and which could obviously be explained without recourse to the divine, as Newton so clearly demonstrated. Heisenberg notes that in some cases an explicit agreement was arrived at in which the name of God or a fundamental cause should not be mentioned in their discussions of nature: "only observed principles should be discussed, not the larger connection to the whole."⁷¹ Nor do we need to bring anything more than our rational faculties to this explanation, or rather, we should be careful *not* to bring anything but our

powers of reasoning to our observations. Especially this latter qualification is problematic for Heisenberg, insofar as it is an illusion. In Heisenberg's eyes, Newton did in fact make an assumption: the laws of nature, whereby different phenomena are gathered together and understood, must be understood through relatively simple mathematical principles. As we will see more clearly later on, it is in this mathematically ordered relation of the many to the one, i.e. beauty, that Heisenberg finds the foundations of exact science. Indeed, Heisenberg attributes the success - the truths - of modern physics not to the separation of ourselves from our study of nature, but to our connection as it is retained through the demand for a beauty. It is a slim, but powerful, connection.

Yet given this assumption that the laws of nature must be understood through relatively simple mathematical principles, it is important to recognize that for the most part Newtonian science can legitimately make use of the Cartesian division. It is possible to "explain" the mechanical processes of nature without recourse to the divine. In addition, the notion that the mind can "observe" without in any way either affecting what it observes, or being affected by what it observes at least appears to be the case in Newtonian physics. Any observer can verify the picture of nature given by Newtonian mechanics. That we do bring structures of understanding to our study of nature (and in doing so bring more than rationality to that study) is not something easily discovered through Newtonian mechanics. At least in the natural macroworld, we are not forcibly confronted by anything that challenges this apparent ability to give a truly "objective" view of nature; the microworld which contests this idea has only recently become accessible. This will presently be discussed in some detail. For the moment we will remain with Newtonian science and the way in which it was perceived

to work.

Most who came into contact with Newton's laws were dazzled, and Heisenberg always contends that they really do shine with the splendour of truth, despite what contemporary philosophers of science might hold. Heisenberg sometimes finds it difficult to criticize harshly the modern world for its separation of the human from the material reality around it, at least as it was modelled on Newtonian physics. If it was thought that scientists really added nothing to their study but what was available to sensory experience or experimental observation, as Newton so vehemently insisted, and then offered the fabulous fruits of this study, who would not be convinced? This is the turning point of modern science. While the early moderns were in a sense "working through" methods, in Newton we are given spectacular results, along with a clear description of the method which achieved them. Heisenberg points out that even Newton was so struck with his results that he wished the rest of nature could be derived from the same kind of reasoning from mechanical principles, and hoped that "the principles here laid down will afford some light to this or some truer method of philosophy."⁷² And so these principles, including the division between the divine, the world and ourselves, were thought to throw light upon many aspects of nature :

...in natural science the partition was for several centuries extremely successful. The mechanics of Newton and all the other parts of classical physics constructed after its model started from the assumption that one can describe the world without speaking of God or ourselves. *This possibility seemed almost a necessary condition for natural science in general* [my emphasis].⁷³

We should add it is quite apparent that Heisenberg is not asserting Descartes' responsibility for the fragmentation of reality or for the development of the scientific method. Clearly, Heisenberg sees the development of a method as a back and forth motion between

articulated understandings and the actual experience of the study of nature. Descartes formulated an understanding, which in light of experience was compelling enough to reflect back positively onto that formulation. However, in a critical way, that reflection fundamentally altered that formulation by refusing to re-unite the division. In terms of the study of nature, there simply appeared no compelling reason to pull them together again. Not only did Newton's laws "work," they worked better than anything had ever offered before (at least with regard to the mechanics of nature). Especially after Newton, success in understanding nature was conceived to *depend* upon this partition, and thus we are given a science that strives to understand a nature not only independent of God, but also independent of ourselves, "so that there is formed the ideal of an 'objective' description of nature."⁷⁴

Truth and method: objectivity, rationality and the meaning of science

To understand the turn in science to the Baconian directive, Heisenberg feels we cannot ignore those elements of objectivity and rationality which gained such significance in the approach to nature, and which, when taken to their extremes, remove the meaning from science. As Heisenberg sees it, the principle of utility can only thrive on a ground that is without meaning, since it is without any intrinsic meaning itself. To Heisenberg, objectivity in terms of especially post-Newtonian science means the total independence of the human factor from that which it is observing; in an important sense, it also refers to the independence of nature from any immediate connection with the divine. In a discussion of Goethe's views of nature and science, Heisenberg finds many insights in Goethe's understanding of both the unity of God-world-I and the dangers of its division, despite the fact that Heisenberg obviously does not share Goethe's vivid distaste for this experimental and mathematical

science.

Heisenberg points out that Goethe's experience of nature "starts directly from man: he and his immediate experience of nature form the center whence the phenomena range themselves in an intelligible order."⁷⁵ Naturally, it is not just nature that Goethe experiences; for Heisenberg, the essential point to keep in mind here is Goethe's conviction that "man is visibly confronted in nature by the divine order." As Heisenberg interprets him, Goethe believes that the divine order which becomes perceivable in the experience of nature makes this claim upon us, that our approach be adequate to what we are trying to understand; we saw something of this in Kepler. For Goethe, our great human task is one of a search for the "God-given structures"⁷⁶ underlying the appearance, and therefore this pursuit requires all that we can humanly bring to it: "Seeing, knowing, sensing, believing and whatever all the feelers may be called, whereby man gropes about in this universe, must then genuinely work together, if we wish to fulfil our important, though difficult, task."⁷⁷ The same amount of effort is just as necessary to our study of nature, an effort that Goethe does not see characterizing the science of Newton, which for him dangerously limits both our organs of understanding and that which we are trying to understand.

One might ask whether the loss of the divine in nature was that the study required so little from us in terms of understanding, or whether rational analysis is simply not adequate to that vision of the divine. For Heisenberg, it seems to be an issue of mutuality. The more distant we become from the divine in what we are trying to understand, the less claim is made upon our abilities; and the less we bring to the effort, the more distant the divine becomes. One acts upon the other. Yet as Goethe views the new science, he understands that it is

already situated far from reality on both sides. Whereas Goethe is certain that the divine order is wholly open to view, "it is, in fact, the greatest evil of the more modern physics, that experiments are, as it were, separated from man himself, and that Nature is recognized only in that which artificial instruments demonstrate - nay, they want to prove and limit her capability by these."⁷⁸ Moreover, his insistence that the search for the divine order in nature demanded more than a rational understanding, that this order should be "immediately discerned, experienced and felt,"⁷⁹ is in the new science completely disregarded. There, as he sees it, only what can be "calculated" has any value.

As Heisenberg points out though, even Goethe was forced to make compromises and admit at least the *correctness* of some modern discoveries, e.g., the Copernican system. Yet, though compelled to accept some of this knowledge, Goethe is disturbed by it all the same. For Heisenberg, this uneasiness has its roots in Goethe's conviction that this new method, by its very nature, should be unable to arrive at any truly worthwhile knowledge. Something was wrong about its success, and "Goethe was not able to rid himself of the fear that the Devil might hereabouts have a hand in the game."⁸⁰ The achievements of a method which so limits nature, the divine and the human simply must be suspect. In fact, Goethe does not see the knowledge of the new science as valuable, precisely because it is only correct: "Goethe's cardinal objection to the post Newtonian methodology of science is thus assuredly directed against the divorce, in this methodology, of the concepts of 'correctness' and 'truth'.⁸¹ It does not follow that what is correct is also true, especially given Goethe's conviction that "truth was inseparable from the value concept."⁸² The true is always bound together with the good. Heisenberg shares completely Goethe's objection against that separation of correctness

and truth, seriously questioning whether correctness is enough in science:

It must be particularly stressed at this point that there is certainly no avoiding the conclusions of modern science, once its methods are accepted; and its methods consist in observation, purified into experiment, and rational analysis, which takes on precise shape in mathematical presentation. If experiment and rational analysis are admitted, the correctness of the results cannot be seriously cast into doubt. But perhaps one can confront them with this question: Is the knowledge so obtained of any value?⁸³

For Heisenberg, the scientific method can only speak of the correctness of its finding as long as it strictly limits itself to rational thinking. Truth is beyond this level of thought. Heisenberg turns to Plato's distinction between two types of knowledge, *episteme* and *dianoia*, to illustrate this. *Episteme* is immediate awareness or intuition, while *dianoia* is the ability for rational or logical deduction. Heisenberg states that "only *episteme*, the first kind of knowledge, furnishes a connection with the true, the essentially real, with the world of values, whereas *dianoia* yields knowledge, indeed, but knowledge merely devoid of values."⁸⁴ Given that both types of knowledge are available to the human, Heisenberg understands that to remain on the level of strict rationality is to alienate ourselves from a much fuller experience. Disregarding the human feelers, particularly those which situate our science in a larger framework and which situate ourselves appropriately within our science, casts us perilously adrift. We lose our grounding when our understanding of ourselves and of our relation to that whole is disregarded. For Heisenberg as much as Goethe, truth is inseparable from the value concept. The 'one, the good and the true,' is the only possible guide for humankind as it tries to find its way in the world.⁸⁵ But a science which "is merely correct, in which the concepts of correctness and truth have separated, and hence where the divine order no longer determines the direction by itself, is too greatly imperiled, is too far exposed...

to the clutch of the Devil."⁸⁶ It is very telling for Heisenberg that Goethe was able to see the "progressive reshaping of the world" by a utility-oriented science. Heisenberg believes that the overwhelming turn to this direction can be traced to the loss of meaning in the world which gave science its context and concerns.

Scientific thinking in the human world

Especially by the nineteenth century, Heisenberg sees that "scientific modesty" of Kepler, Galileo and even Newton has undergone a massive disintegration. Claims began to grow excessive: "Physical knowledge was considered to make assertions about nature as a whole."⁸⁷ While Newtonian science is specifically concerned with the *motion* of matter, the "method of Newtonian mechanics was being applied to ever wider domains of nature." Modifications were necessary, but it boiled down to attempts "to isolate the details of natural processes and to determine their 'laws'."⁸⁸ However, due to its astounding success in explaining the processes of nature, the application of scientific principles soon moved beyond a strict understanding of nature. Heisenberg points out that this urge to arrive at, e.g., philosophical conclusions through science became an important one, and "the demand was voiced from many quarters that all true philosophers must be scientific."⁸⁹ Not only philosophy, of course, but all aspects of existence fell under the scope of scientific thinking: "The general trend of human thinking in the nineteenth century had been towards an increasing confidence in the scientific method and in precise rational terms."⁹⁰

That extreme rationality and objectivity are not adequate to truth Heisenberg sees especially in the fact that wherever the scientific method has been applied outside of science, something important is lost. Heisenberg, like Gadamer, believes that the influence of science

has to a large extent shrunk the world to a single dimension, and a dimension which has a very tenuous link to our humanity. For example, that increasing confidence in the scientific method and rationalism has led to "a general skepticism with regard to those concepts of natural language which do not fit into the closed frame of scientific thought - for instance, those of religion."⁹¹ Heisenberg notes that the language and concepts of science began to be applied to diverse areas, and that application was soon understood not as throwing fresh light on the other areas, but as throwing the only light upon them. Actually, Heisenberg can sympathize with the use of a precise and mathematical language in philosophy: that such language is valued as "the typical example of clarity" tempts people to apply it to the truths of philosophy, "because one senses that these truths are just as binding and irrefutable as those of mathematics."⁹² But one must be aware of those limits, and to recognize that a scientific language based on logic consciously attempts to concentrate on "very special structures, unambiguous connections between premises and conclusions, [and] simple patterns of reasoning."⁹³ For Heisenberg, the language of science can in a way be thought of as an abstraction from natural language, thus not immediately connected with reality in the same way in which natural language is connected to it, natural language being the language of religion, philosophy and art. Heisenberg recognizes that this language is simply not adequate to the contents of religion, philosophy, and art.

For Heisenberg, when that method and that language is applied to our human questions we receive incomplete answers. If we remain with those answers, the requisite fullness is not being met: "if we begin by neglecting many important aspects in favour of the one feature whereby we are able to order the phenomena, we are confining ourselves to the

working out of a basic structure, a sort of skeleton, which only the addition of a great wealth of further details could turn into a genuine picture."⁹⁴ For example, when science takes up the question of the relation of the earth to the universe around it, we of course discover that the earth is not the center of the cosmos; rather, "the earth is only a minute grain of dust in one of the countless galactic systems." On the other hand, "for us it is the center of the universe - it really is the center."⁹⁵ While this may be a simple illustration, it is still meaningful. The challenges of our existence are played out here, in our interaction with the world around us. However, this centering of our world in the universe has no meaning to astronomical science; from a strict astronomical viewpoint, that statement is incorrect. Nevertheless, it is true, states Heisenberg, and is a truth that is not within the scope of that science.

Of course, the problem really begins when the scope of science becomes our only scope, as it does through that increasing confidence in the scientific method. The return of these details to that skeletal framework is no easy matter. There was a time in the not so distant past that it was thought these details could easily be filled in. Heisenberg recalls, for example, Max Planck's understanding of the compatible relationship between science and religion. For Planck, they are compatible because they refer to quite different facets of reality: "Science is, so to speak, the manner in which we confront, in which we argue about, the objective side of reality. Religious faith, on the other hand, is the expression of the subjective decisions that help us choose the standards by which we propose to act and live."⁹⁶ In Heisenberg's view, this careful separation of science and religion characterizes a whole generation. But this tidy separation between science and religion, between the objective and the subjective, is in actuality nothing more than an "emergency measure" for a very limited

time: "In Western culture...we may well reach the point in the not too distant future where the parables and images of the old religions will have lost their persuasive force even for the average person; when that happens, I am afraid that all the old ethics will collapse like a house of cards and that unimaginable horrors will be perpetrated."⁹⁷ The hope that science can be held at bay, so to speak, regarding the essentially human concerns is a futile one. However, the problem will not be that the legitimacy of certain understandings will be attacked; rather the essentially human concerns will be eradicated through a blanket, if generally well-intended, scientific approach which removes us from a meaningful relation to the whole.

Knowledge for power and progress

With this we backtrack somewhat to the consequences of a lack of meaning in science, and the turn to knowledge for power. For Heisenberg, when science no longer aspires to an understanding of the divine order, or even if it loses the knowledge of its relation to that order, the meaning of science is lost. Observing nature becomes an end in itself, and thus the knowledge of nature is in a sense "useless" information, unless we impart some meaning to it. But looking to the larger world for meaning is difficult, especially when that world, e.g., philosophy, has grown out of the more immodest elements of science. Of course, it is critical to keep in mind that a mutual process is occurring between the human and scientific worlds.

That is, science did not give the world a method with which to work out its problems, crawl back into its scientific hole, and later emerge to consult that human world about meaning, only to discover that the world had none to give. Humans living in the human world study nature, so that there is a constant interplay between what science offers and what it takes back into its sphere. One might speak here of a gradual spiral into a lack of meaning, a vacuum,

so to speak, that is just as gradually filled with the principle of utility. Certainly we see this principle earlier than the nineteenth century. Consider, as Heisenberg does, the reason for studying nature, as it is given by the eighteenth-century encyclopedist, D'Alembert. No longer is science food for the aspiring soul. Rather, the study of nature is "prosecuted partly from necessity, and partly for Amusement,"⁹⁸ that necessity being an unmistakably Baconian one. In this line, D'Alembert manages to capture for Heisenberg the essential connection between science and utility. Without a larger context of meaning, science has become a tool to solve problems of our material existence, and Heisenberg can confidently speak in the mid-twentieth century about the complete turn to the Baconian directive:

In the same sense in which every detailed question in science is subordinate to the major task of understanding nature as a whole, so also does the smallest technical advance serve the general goal, that of enlarging the material power of man. The value of this goal is as little questioned as the value of natural knowledge in science, and the two aims coalesce in the banal slogan "Knowledge is Power."⁹⁹

While our abilities to master principles and techniques and to apply them is in Heisenberg's view a natural and enduring feature of humanity, he is convinced that such mastery and application are not the original aims of modern science: "I would doubt whether Kepler and Copernicus really primarily thought about the practical application of science. That knowledge means power was of course already known much earlier, and the motives of science will probably always be mixed up in this."¹⁰⁰ Moreover, from a certain perspective it is not an undesirable thing that science has in a large measure turned to utility: "It is in starting from man's station in this world, from the difficulties that oppress him and the demands which others impose on him, that we shall esteem most highly the possibility of being practically and effectively active in this regard, of being able to help others and in

general to improve the conditions of his life."¹⁰¹ Heisenberg never denies that knowledge *is* power, and points to the power we have been given through modern science to accomplish many wonderful things. Yet he never forgets the horrific things we have been empowered to do. Utility is tied to intentions, and there are good and bad intentions. Thus things can work both ways. Still, when people can recognize that there are good and evil purposes, when "men preserve in themselves a clear power of distinguishing good from bad,"¹⁰² there is still hope for improvement.

It is when the purpose of mastering principles and applying them becomes the *only* purpose, when utility becomes the context for our existence - as it has through the adoption of the ways and ends of science into the human world - that we are lead into real destruction and disorder. As an illustration, Heisenberg points to the ability of modern medicine to eradicate plagues, save lives, and alleviate suffering. At the same time, however, a population explosion due to the advances of modern medicine threatens to end in "frightful catastrophes."¹⁰³ Gadamer often refers to science's goal of dominating the objects under study. This notion is not one that Heisenberg uses very often, I think because it implies some evil intent. In the first place, science in its true role is interested in a real understanding of nature, not in mastering it. Secondly, the most frightening thing about a science and technology aimed at utility is for Heisenberg precisely the lack of intent of any sort, aside from the hazy aim of progress. Utility acquires its meaning from the context around it. When it *becomes* the context, all meaning is lost, and certainly in modernity the "good" is replaced by progress. Heisenberg assures us that "even purposiveness can lead into chaos, if the

purposes are not themselves understood as parts of a larger pattern, a higher order of things."

He continues:

'Purposiveness is the death of humanity.' In saying this at times, it is pointed out that any isolated purpose detached from its context can lead to developments inconsistent with what is truly human, namely the cautious tracing out of connections extending beyond the human sphere. The axiom fails to apply only when the purposes themselves form part of a larger context, which in earlier ages was spoken of as the divine order.¹⁰⁴

Any isolated purpose "can lead to developments inconsistent with" real human understanding.

Though a much fuller discussion of Heisenberg's theory of understanding will be the focus of a later chapter, we can at least suggest what would be consistent with real human understanding: the freedom to explore new connections. The isolated purpose of our time, i.e., knowledge for power, does not allow for those possibilities.

Science, technology and the human condition

The problem for Heisenberg, as it was for Gadamer, is that we are no longer dealing with a world-view from which we can easily retreat. Heisenberg is adamant that in whatever endeavour humans take on, the possibility to be realized influences the course of events. This is definitely the case of a science, of a world, whose aim is knowledge for power and progress. Here, we observe a close similarity between Gadamer and Heisenberg with regard to what Gadamer calls inner movement of science. Heisenberg refers to Goethe's perception of the inevitability of the "machine", which for him signified the complete takeover of modern science: "The growing prevalence of machines distresses and worries me. It is rolling up like a storm, slowly, slowly. But it has taken its course, it will come, and it will strike."¹⁰⁵ For Heisenberg, this storm has fully struck. As he sees it, the principle that "knowledge is power"

directs and influences our endeavours to such an extent that it has become almost a biological feature of our existence:

Probably it is possible to demonstrate in the case of every technical process its subservience to this common goal; it is, on the other hand, characteristic for the whole development that the individual technical process is bound to the common goal in such an indirect way that one can hardly view it as part of a conscientious plan for the accomplishment of this goal. Technology almost ceases to appear at such times as the product of conscious human effort for the spreading of material power. Instead it appears as a biological process on a large scale in which the structures that are part of the human organism are transferred in ever larger measures to man's environment.¹⁰⁶

For Heisenberg, we have almost lost our choice in the matter. As he goes on to say, the human can do what he wills, but he cannot will what he wills.

Modern technological science has become such a part of us that our interaction with the world is governed by the principles of this science. For Heisenberg, it is not only the physical environment which we transform in this particular way, it is also the human world in which we live. That is, it is assumed that a methodical approach, i.e., objective and rational, will lead to the knowledge of the regularities of the human world and thereby enable improvements to that world: "Society is endeavouring so far as possible to eliminate all risks for the individual."¹⁰⁷ Yet in doing so, it forgets the possibility that "the scope of the individual in regard to human relations will then be critically reduced."¹⁰⁸ What are improvement in the eyes of a scientized world may well have nothing to do with what is good for humans. Heisenberg points to the dangerous alienating process of shaping the individual to fit into the world of technical advances and prosperity. Insofar as we can call science and technology the "machine," we can call ourselves cogs in its wheels. Thus, without taking into consideration his real human aspects and needs, the world outfits him "as sort of a spare part,

into the gigantic, rationally programmed machinery of modern society - equipped, of course, with its equally preprogrammed freedoms."¹⁰⁹ When the notion of progress, based on rationalism and objectivism, becomes fully and almost inextricably incorporated into the human world, we have reached a dangerous limit, though it may not be clearly visible. For Heisenberg, a mindset which effectually dehumanizes people through control of them cannot represent a healthy step forward. But if this absolute limit is not recognized, worse will happen: "The dangers are the greater, the more violently the wave of optimism engendered by the belief in progress surges against this limit."¹¹⁰

For Heisenberg, to be human is to possess possibilities, to possess freedom. As with Gadamer, one of our most important freedoms is the ability to make decisions. For Heisenberg as much as for Gadamer, we have a profound obligation to participate in the course of our lives together, and to participate thoughtfully. For this reason, Heisenberg admires the philosophizing of the ancient Greeks, which he sees not as an exercise in intellect, but as the basis for action - what must I do?¹¹¹ Ethics is for Heisenberg the presupposition of life. Gadamer complained about the handing of decisions over to the expert, who may possess a great deal of technical information, but yet cannot in all honesty deal with the whole of our lives. Though Heisenberg never analyzes the expert, he is moving in the same direction as Gadamer, inasmuch as he sees that scientific and technical thinking is being incorporated into our daily lives at the most basically human level. In terms of our present way of life, as we are squeezed into the machine of modern society, this freedom of moral decision is increasingly being taken out of our hands. Certainly, we are still faced with choices, but the standards imposed upon us by science give little room for truly meaningful decisions. The

norms given by a scientific world view "relate to the strictly experienceable pattern of a human community,"¹¹² that is, the pattern which emphasizes rationality and objectivity for human progress in both the material and spiritual realms. To make any valuable decisions, we need valuable standards from which to work, ideals that are related to the divine order, not the superficial world of our creation. The ideals that science imposes on us do not derive from that higher order, and thus a technical/scientific worldview cannot offer a valuable basis for decision-making. Of course, even disregarding the Baconian directive, when science seeks primarily to understand the divine order to nature, science can never by itself have offered ideals by which to live. In this, Heisenberg would fully agree with Gadamer that science must be guided in its own decisions by ideals that do not spring from itself: "The correctness of proven scientific results cannot sensibly be doubted by religious thinkers, and vice versa, the ethical demands which proceed from the heart of religious thinking should not be dissolved by extreme rational arguments from the sphere of science."¹¹³ Continuing to act upon norms that are without real foundation in the divine order assures that catastrophes will follow. Heisenberg is clear on this point, insisting that if ever we really become alienated from the patterns of truth that are necessary to our human lives, "terrible things may happen to mankind, far more terrible than concentration camps and atom bombs."¹¹⁴

Heisenberg is sure that we are on the path to this complete alienation. While he includes in the dangers of a scientized world physical destruction, what is more disturbing to Heisenberg is the real estrangement from our humanity which can occur through this mindset. This issue is becoming less that we are humans caught inside the machine, and more that we are developing into the machine. Heisenberg always insists that we are very much affected

by the world around us. Thus, we cannot remain untouched by the changes to our environment and to our way of life in the technical age, and in fact these changes to our reality have transformed our thinking in the frightening way mentioned earlier, that is, the actual eradication of the human concerns. Heisenberg notes that the possible dangers of a technologized world were recognized a long time ago by Chang Tzi, who told what Heisenberg considers as an insightful parable: A passer-by advises an old man to use a mechanical draw-well to irrigate his vegetable garden, rather than the manual method he was using. It involved, the passerby said, too much work for the meagre results. The old man became angry at this advice, and replied:

I have heard my teacher say that: 'When a man uses a machine he carries on all his business in a machine-like manner. Whoever does his business in the manner of a machine develops a machine heart. Whoever has a machine in his breast loses his simplicity. Whoever loses his simplicity becomes uncertain in the impulses of his spirit. Uncertainty in the impulses of the spirit is something that is incompatible with truth.' Not that I am unfamiliar with such devices: I am ashamed to use them.¹¹⁵

This uncertainty in the impulses of the spirit is for Heisenberg "one of the most telling descriptions we can give to the condition of man in the present crisis."¹¹⁶ Heisenberg is not suggesting that our *use* of technology is at the heart of this uncertainty; where there exists a larger framework of meaning, many things can aid us in our search for meaning. For Heisenberg, the problem is that we are immersing ourselves in the methods and goals of modern science to such an extent that we can no longer see anything beyond them. Thus, when the parables and images of the old religions lose their persuasive powers, it is not just because their language is foreign to us, or that they speak of dimensions which science managed to contract and 'sterilize', so to speak, though these elements played an important

part in bringing us to this point. The problem is now the actual disintegration of those concerns. In this connection, Heisenberg is reminded of Huxley's *Brave New World*: "The possibility of breeding men for their appointed tasks, of rationalizing all life on earth through the cult of utility and thereby rendering it meaningless, is here carried through to absurdity with gruesome consistency."¹¹⁷

As Gadamer thought, so too does Heisenberg believe that self-understanding is necessary to human freedom. A rediscovery of ourselves, both our limits and possibilities, is critical, since "The space in which man as spiritual being is developing has more dimensions than the one in which he has moved forward in the preceding centuries."¹¹⁸ Naturally, the rediscovery of the meaning within ourselves, and the rediscovery of our relation to the order of things, will not be an easy task. As Heisenberg points out, in a world transformed by that particular brand of science above, "we invariably encounter structures created by man, so that in a sense we always meet only ourselves,"¹¹⁹ and for the most part, this self that we confront is that one emptied of meaning, uncertain in its impulses. Yet in another way, the task now comes almost naturally - we have no where else to look but to ourselves. And as we are forced to look directly at ourselves and the world of our creation, we begin to sense that something is amiss, and that perhaps the familiar 'scientific' approach to the world and to our modes of life "somehow no longer quite applies." Heisenberg points out that in a world in which the dominating influence of science and technology has so overstressed the rational, a reaction against this overemphasis is almost inevitable. Heisenberg is aware of a spiritual hunger in people, and he speaks of the "emptiness and suffering" of the world. In all the irrational doings born of a rational world, "there is probably an unconscious expression of

longing for that world in which mind is more than information, love more than sexuality and science more than the collection and analysis of empirical data."¹²⁰ The present time, says Heisenberg, has clearly been given the responsibility of coming to terms with the question of who we really are, and "only when this is accomplished will man be able to regain that 'certainty in the impulses of the spirit' talked of by the Chinese sage."¹²¹ Regaining this certainty does not mean a flash of immediate awareness of what is right and wrong. For our time, self-understanding leads to a discovery of the larger framework of our existence, and re-orientes us to the possibilities of truth in understanding.

CHAPTER 2

We are interested here in exploring Gadamer's concern with human freedom, which he believes we are losing within the totality of a social reality dominated by science, and his solution of regaining it through self-understanding, by coming to know who and how we are in the world. It is clear to him that a re-visioning is absolutely necessary at this time, when what little freedom we have left is being slowly but surely squeezed out of existence. Of course, Gadamer's concern is not in handing out a list of the steps we must take to regain our freedom; rather his concern is with "what happens to us over and above our wanting and doing."¹ Yet this is a crucial foundation for any valuable transformation, since it helps to dispel the harmful illusions of the scientific age about who we are and how we come to know both ourselves and the world around us. Bracketing the assumptions of science that method can achieve certain knowledge, Gadamer looks again at the question of how understanding is possible. Gadamer is not interested in showing what method-related conditions are necessary for this activity. In fact, he thinks that the question springs from a fundamental misunderstanding of ourselves. For Gadamer, understanding is not one of many activities that we choose to do as humans. As Aristotle was convinced, so too Gadamer is sure that humans are first and foremost *understanders*, and that understanding is the original characteristic of human being. For Gadamer, human freedom is the ability to exist within our true possibilities, and human freedom is not possible in the scientific world because scientific knowledge is not understanding in the true sense. Understanding is an integrating experience, as opposed to the naturally alienating experience through scientific method. What gives depth to this vision is the fact, for Gadamer, that the medium of our existence is language, and

language is being that can be understood. That we exist within and through the medium of intelligible being means to Gadamer that our participation in language, the logos, is our participation in truth. Language is speculative in that it reflects truth. Our final focus in this chapter will be the place of the natural sciences within a vision that sees our encounter with truth as one of enrichment as opposed to certitude, since for Gadamer to encounter truth is to be changed by it. Thus what we get from Gadamer is a way both of being and knowing that is fundamentally different from that of science, but is universal in the sense that it comes before all else, within a medium that embraces everything we can understand within it.

The historicity of our being

The ideal of scientific method is objectivity. In terms of understanding who we are, Gadamer sees that this ideal has translated into the notion of a substantial, isolated self, one that strives to remove itself from the world around it. Thus, our self-understanding in the scientific age emerges from this Enlightenment conception of some mysterious substance inhabiting the body, this "I", where purging the extraneous elements from it unveils the truth of what it really is. These ontological assumptions of modernity, especially as they derive from the Cartesian persuasion, are in Gadamer's view dangerously deceptive, compelling as they might be. But little help is to be had from the more formal efforts in modernity to understand who we are, since those efforts are wholly guided by the assumptions of science; when the scientific light is turned on ourselves, one sees merely another illustration of this deception. As Gadamer sees it, in the scientific age, self-understanding has come to denote "objective self-consciousness."² He writes: "The concept of knowledge based on scientific procedures tolerates no restriction on its claim to universality. On the basis of this claim, all

self-understanding is represented as a kind of self-possession that excludes nothing so much as the idea that something that separates it from itself can befall it."³ That is, it is not only necessary, but possible to purify ourselves from all foreign and unessential elements. For Gadamer, the assumption that it is both necessary and possible to purge ourselves of any link with the world around us is just the obstacle that we must overcome in order to achieve a real understanding of who we are. This assumption has no basis in reality: "The claim to be completely free of prejudice is naive whether that naivete be the delusion of an absolute enlightenment or the delusion of an empiricism free of all previous opinions in the traditions of metaphysics or the delusion of getting beyond science through ideological criticism."⁴ We must come to recognize the actuality of our situation, that we are beings in time and the world.

Gadamer insists that someone who reflects himself out of the mutuality of the relationship between the I and Thou changes that relationship and destroys its moral bond. He continues that "*A person who reflects himself out of a living relationship to tradition destroys the true meaning of this tradition in exactly the same way.*"⁵ What we must point out here is that Gadamer conceives the world in which we live, or more precisely, the tradition in which we dwell, to be a Thou in a very compelling sense. It is wrong to consider this tradition extra-human, something that needs to be purged from ourselves in order to see ourselves and the world around us more clearly. The attempt to eliminate the human and historical elements from our being does not result in the ideal of objectivity (always an illusion), but instead succeeds in alienating us from ourselves and our world. For Gadamer, the reality of the case is that tradition does not belong to us; rather, we belong to it: "Long

before we understand ourselves through the process of self-examination, we understand ourselves in a self-evident way in the family, society and state in which we live. The focus of subjectivity is a distorting mirror. The self-awareness of the individual is only a flickering in the closed circuits of historical life."⁶

In the scientific age, we have tried, and to an extent succeeded, in suppressing this self-evident, experiential understanding of ourselves, insofar as we have tried to delete the world from ourselves. When Gadamer talks about our alienation from ourselves, he is referring in a large part to our alienation from tradition. It is in the face of this alienation that Gadamer finds significant Heidegger's temporal interpretation of being. Gadamer wishes to make clear that such an interpretation of being does not mean, as it is so often misunderstood to mean, "that Dasein [being] is radically temporal, so that it can no longer be considered as everlasting or eternal but is understandable only in relation to its own time and future."⁷ Rather, in revealing time as the ground hidden from self-understanding, that understanding "opens itself to a hitherto concealed experience that transcends thinking from the position of subjectivity..."⁸ For Gadamer, this temporal interpretation of being, that being is being-in-the-world, is not actually a choice of interpretation, but is a given existential structure: "Everything that makes possible and limits Dasein's projection ineluctably precedes it."⁹ What this means in terms of a self is that the self has been shaped in a particular way; it has acquired prejudices and tendencies which are a part of its being, and which affect its projection in the world. Of course, Gadamer is famous (and infamous, in some circles) for his rehabilitation of prejudice. Although the term prejudice had before possessed both negative and positive senses, during the Enlightenment it became limited to the negative, in the sense of an

'unfounded judgement', i.e. a judgement not grounded in methodological justification, and hence having no legitimate certainty. For Gadamer, whether or not prejudices are grounded in methodological justification is beside the point. They exist, and they to a large extent shape our own existence. Through Gadamer's assertion that we experience prejudices as conditions of our life, and ones over which we have limited control, Brice Wachterhauser points out that Gadamer makes "a deep claim that our prejudices always constitute, at least in part, who we *are*." He continues that, in Gadamer's view, "To be human is to find oneself in a historical context that always does more to us than determine, say, the particular style of clothes that we wear or the particular grammar and syntax of the language we speak. History goes deeper in that it determines the possibilities of our lives; in short, it influences our ability to experience ourselves and the world in the particular way we do."¹⁰

Furthermore, the radical temporality of the self implies its insubstantiality. Gadamer does not mean insubstantial in the sense that it may not be everlasting or enduring, but that self is not something which possesses itself in its entirety: "The self that we are does not possess itself, one could say that it 'happens.'"¹¹ Gadamer gives a helpful illustration of this in terms of theology, maintaining that this 'happening' of self is what the theologian is actually saying when he asserts that "faith is an event in which a new man is established."¹² The self happens over time as understanding happens over time. That is, every understanding that derives from a pre-understanding becomes itself a pre-understanding. "To be historically means that knowledge of oneself can never be complete."¹³ With this remark, Gadamer declares himself an advocate of the "bad infinite", in which the end keeps on delaying its arrival: "Our understanding of history is not only a question of acquiring knowledge and

familiarity or of the development of the historical sense; it is also a matter of shaping our destiny. That understanding is not so much an act of consciousness as something that one comes up against in which the historical richness of the spirit builds up; that understanding also and above all is a happening and makes history."¹⁴ If understanding makes history, and history always shapes our understanding, then understanding will never be complete, for it is always affecting that which effects us. If we take seriously the possibility of belonging, of being open to the insights of tradition, we become the "new men" who continue to exist, though in heightened richness, and thus to affect with that richness the historical world in which we live.

But it is not simply a matter of history unfolding onto itself. The 'bad infinite' is not a 'vicious circle.' To take seriously our historicity means not only to reclaim our more distant tradition, but also to take seriously the specific historicity of the present, that is, the horizon in which we are living out our lives in the here and now. For Gadamer, we are encountering tradition with specific questions of our own time, in what he calls the fusion of horizons: "In a tradition this process of fusion is continually going on, for there old and new are always combining into something of living value, without either being explicitly foregrounded from each other."¹⁵ The combination produces something unique and valuable, which will in its turn also be re-combined, and so forth. This is then what Gadamer means when he declares that "Self-understanding can no longer be integrally related to a complete self-transparency in the sense of a full presence of ourselves to ourselves. Self-understanding is always on-the-way; it is on a path whose completion is a clear impossibility."¹⁶

The search for, or assumption of, a self that is prejudiceless, an unchanging core of pure reason or being, is an unproductive search and a naive assumption. It simply is not who we are, and such a being can only be an illusion. Gadamer is convinced that, given the historicity of our being, the meaning of self-understanding must now be seen in a completely different light.¹⁷ His insistence on the complete temporality of the self is designed not so much to give us an understanding of the self, as it is understood as interior knowledge, but to 'bring us back to ourselves'. Indeed, for Gadamer, self-understanding as a *problem* only emerges "when there is no powerful tradition present to absorb one's own attitude into itself and when one is aware of confronting an alien tradition to which he has never belonged or one he no longer unquestioningly accepts."¹⁸ With his emphasis on our prejudices, he wants to underline our real belongingness to tradition. Yet he wants more than this. He wants us to see that prejudices or pre-understandings are "enabling" as opposed to disabling, in terms of understanding. Georgia Warnke sums it well by stating that prejudices, for Gadamer, "serve as our orientation to meaning and, hence, as the basis for the possibility of understanding."¹⁹ Prejudice is, for Gadamer, a pre-understanding. With this, our conversation turns in a direction more to Gadamer's liking. To be historically means to be able to understand, and for Gadamer, "understanding is the original characteristic of the being of human life itself."²⁰ Understanding is what is truly appropriate to the human, and thus Gadamer is more interested in discussing our being as understander than our being as being (which means little to him). It is our existence in the world, our existence in pre-understandings, that enables us to understand.

The linguisticity of our being

Here, we must strongly emphasize that in Gadamer's view, *the most fundamental pre-understanding of the human is language itself*. Gadamer is convinced that our basic experience of the world is linguistic in nature: "language is not only an object in our hands, it is the reservoir of tradition and the medium in and through which we exist and perceive our world."²¹ We belong to history through our pre-understandings, and all our pre-understandings are mediated through language. "The verbal world in which we live is not a barrier that prevents knowledge of being-in-itself but fundamentally embraces everything in which our insight can be deepened and enlarged."²² Language itself is that which orients us to meaning and offers possibilities for understanding.

For Gadamer, there is an ontological affinity between language and the universe of meaning that is reminiscent of Plato's theories, and as we shall see, to Heisenberg's, especially in terms of our participation in truth. Gadamer notes that in Plato's thought, the important thing is that the soul participates in true being, that it belongs in the same sphere of being as the ideas (and also notes that for Aristotle too this participation is paramount, for Aristotle's "soul" is in a way everything that exists). What he finds compelling within these views is the denial of an otherworldly spirit, so to speak, which is trying to find its way into worldly being. The self and the world belong originally together, and it is this relationship which is primary. Gadamer can never emphasize this relationship enough in his own work. Of course, he does not find this relationship in the world of ideas, or in soul. For Gadamer, as Brice Wachterhauser points out, the true link between our selves and reality is not "a metaphysical

substance which is divinely attuned to the order of the cosmos."²³ Rather, it is language itself, and it is in language that Gadamer sees the "universal relatedness of being."²⁴

"Whoever has language 'has' the world."²⁵ For Gadamer, we participate in being inasmuch as we participate in language, and for him, we do participate, and so does the world - all things have a language, be it a human language, the language of art, or the language of nature. Being that can be understood is language. We must be aware though that Gadamer does not equate language with being, or reality. Rather, for him, being that can be *understood* is language. This qualification is very illustrative, I think, of his concern for the human problem, and reflects his conviction that we are always beings in the world. We can only talk about what we can understand, and he declares, "With this area of what lies outside the realm of human understanding and human understandings (our world) hermeneutics is not concerned."²⁶ Naturally, Gadamer is not claiming that the belongingness of language and being is some relative thought-construction, a merely intellectual framework from which to view our being within the world. There is an actual ontological affinity between the two. Language is the medium of intelligible reality, and what we attempt to hear and or try to express is that inherent intelligibility. "It is from *language as a medium* that our whole experience of the world, and especially hermeneutical experience, unfolds."²⁷

Gadamer suggests that a very helpful way to understand our existence within the medium of language is through the metaphor of "play." In play, what is important is the primacy of the game over the consciousness or attitude of the player. The real subject of the game is not the player but the game itself, which "holds the player in its spell, draws him into play, and keeps him there is the game itself."²⁸ The player does not draw the game into

himself, but rather the game "draws him into its dominion and fills him with his spirit. The player experiences the game as a reality that surpasses him."²⁹ And this precisely how Gadamer wishes us to see our existence within the medium of language, or better, the "play of language."³⁰ Language is a game in a much more encompassing sense, since it is the "game" of our existence, and like any other game, it is "the game itself that plays, for it draws the players into itself and thus itself becomes the subjectum of the playing."³¹ This will become more important when we turn to dialogue. However, our next concern is with the nature of this reality that both surpasses us, and draws us into it.

The nature of language

Gadamer helps us to understand the nature of language by means of the ancient concept of the beautiful. He begins with Plato's insights here. For Plato, the beautiful was our link between the world of ideas and the world of shadows. It was something we could cling to in order to ascend to the good. Naturally, Gadamer is not interested in the beautiful in terms of substance metaphysics and the metaphysical relationship to the infinite divine mind. But he is very interested in Plato's understanding of the nature of beauty. For Plato, the mode of being of the beautiful was considered characteristic of being in general, as was the good, and the true. Yet, however closely Plato linked the beautiful and the good: "he is still aware of the difference between the two, and this difference involves the *special advantage of the beautiful*."³² One may be misled by impure copies and apparent virtues, but one never mistakes the beautiful, for it is visibly manifest, and possesses its own radiance. "Obviously what distinguishes the beautiful from the good is that the beautiful of itself presents itself, that its being is such that it makes itself immediately evident."³³ Its evidentness

and immediacy is found in its 'radiance', its 'shining', which constitutes the actual being of the beautiful, and Gadamer continues that in classical thought, "Beauty has the mode of being of *light*...The beauty of a beautiful thing appears in it as light, as a radiance."³⁴ James Risser is quite helpful in delineating the meaning of this radiant self-presentation of the beautiful in terms of its mediation between the intelligible and the appearance: it mediates between them "precisely because shining-forth constitutes the being of the beautiful in such a way that *being present* belongs decisively to the being of the beautiful [my emphasis]."³⁵ It is an idea, and therefore rises above the flux of appearances, but is at the same time what shines forth in these appearances. That beauty is immediately evident means that "the beautiful does not simply mediate between the intelligible and the appearance. It collapses the distinction between the difference; it collapses the difference between the illuminated and the illuminating."³⁶

It is with this understanding that Gadamer turns to the notion of "image" with regard to the beautiful: "in regard to beauty the beautiful must always be understood ontologically as an 'image.' It makes no difference whether it 'itself' or its copy appears."³⁷ We can already gather what he means by this term. The image is something that collapses the distance between itself (the illuminating) and what it images (the illuminated). We are helped in our explication by his exploration of the experience of art, since a work of art is for Gadamer always conceived of as image (*Bild*: picture, image). Gadamer is ultimately interested in demonstrating the ontological communion of an image with what it images. He means this in the sense that the image is what it reveals, and what is revealed cannot be disassociated with its image. He starts by noting that the mode of being of a work of art is above all

presentation. Art is only art when it is presented: "it is in the performance and only in it - as we see most clearly in the case of music - that we encounter the work itself, as the divine is encountered in the religious rite."³⁸ But artistic presentation for Gadamer is *representation*. In terms of this representation, it is possible to understand art as imitation; that is, the artist has managed to copy something. Thus Plato sees an "insuperable" ontological difference between the copy and original. Gadamer himself refers us to the Latin *repraesentare*, "to make present,"³⁹ and it is just this that he is trying to get across: the image *makes present* that which it images, and to make it present is to bring it into being, at least being that can be understood. "It expresses something in such a way that what is said is like a discovery, a disclosure of something previously concealed."⁴⁰ One way to understand it, and a way that will have particular relevance for our discussion, is in terms of a mirror image, in which "the entity itself appears in the image so that we have the thing itself in the mirror image."⁴¹ But this model can only be taken so far, since this image is mere appearance and has no real being. The image for Gadamer always shares in the being of what it presents. To get across this critical relationship between the image and what is imaged, Gadamer turns to the metaphor of emanation, the Neoplatonic concept of 'overflow', in which that which flows does not become less - indeed, it becomes more:

That the picture has its own reality means the reverse for what is pictured, namely that it comes to presentation in the representation. It presents itself there. It does not follow that it is dependent on this particular presentation in order to appear. It can also present itself as what it is in other ways. But if it presents itself in this way, this is no longer any incidental event but belongs to its own being. Every such presentation is an ontological event and occupies the same ontological level as what is represented. By being presented it experiences, as it were, *an increase in being*. The content of the picture itself is ontologically defined as an emanation of the original.⁴²

Gadamer works through the notions of beauty and image especially to set the stage for a much richer understanding of language than we presently have at our disposal. Language is the radiance, the evidentness and the imaging of reality. For Gadamer, the metaphysics of light is the basis of the relationship between the shining forth of the beautiful and the evidentness of the understandable. Of particular significance is his connecting of this metaphysics of light to the Christian doctrine of the word, which itself follows the Platonic and Neoplatonic metaphysics of light: "The light that causes everything to emerge in such a way that it is evident and comprehensible in itself is the light of the word."⁴³ Through language, Gadamer is seeking to revive what Wachterhauser refers to as a "modified philosophy of the *logos*,"⁴⁴ that is, the inherent intelligibility of reality. Wachterhauser points out that while Gadamer refers to this element of reality in all language in different ways (e.g., reason, the unfolding of the unity of the spirit, the *logos*), he maintains that there is more than simply a binding connection between language and reason - they are one and the same: "The intelligible reality in language and the language of intelligibility is the *logos*."⁴⁵ Gadamer is himself very clear on this, declaring unambiguously that "Language is the language of reason itself."⁴⁶ He understands two dimensions to the *logos*, or the Word. First is its complete unity, e.g., "theologically, 'the' Word of God."⁴⁷ This is the reality that is utterly whole; it is the center and source of all words and speaking. Yet this is a dimension to which we, as finite beings, are denied complete access. The second dimension of the *logos* is its multiplicity. It is in the second dimension that we participate in the 'universal relatedness of being', and by doing so, actually participate in the unity of the *logos*.

With this we return to the connection with image. A word, says Gadamer, is not a sign, but is something like an image. It has a "mysterious connection with what it images; it belongs to its being."⁴⁸ Moreover, like an image, a word is not a mere imitative illustration: both of them "allow what they present to be for the first time fully what it is."⁴⁹ Again Gadamer looks to the mirror image for elucidation. A mirror relation is the constant substitution of one thing for another. He illustrates this: "when something is reflected in something else, say, the castle in the lake, it means that the lake throws back the image of the castle. The mirror image is essentially connected with the actual sight of the thing through the medium of the observer."⁵⁰ But what is critical to realize here is that language does not "mirror" an original or a particular object. Language is speculative, in the sense of a mirror relation, but it is speculative in a much more universal sense, "as the event of speech, of mediation, of coming to an understanding. Such a realization is speculative in that the finite possibilities of the word are oriented toward the sense intended as towards the infinite." Attempting to flesh out this idea for us, he continues: "Someone who speaks is behaving speculatively when his words do not reflect beings, but express a relation to the whole of being."⁵¹ Language reflects endlessly upon itself, but this is not a massive relativization of language, or a confusing house of mirrors. Language reflects not the multiplicity of the logos, but its unity:

Every word breaks forth as if from a center and is related to a whole, through which it alone is a word. Every word causes the whole of the language to which it belongs to resonate and the whole world-view that underlies it to appear. Thus every word, as the event of a moment, carries with it the unsaid, to which it is related by responding and summoning. The occasionality of human speech is not a casual imperfection of its expressive power; it is, rather, the logical expression of the living viruality of speech that brings a totality of meaning into play, without being able to

express it totally. All human speaking is finite in such a way that there is laid up within it an infinity of meaning to be explicated and laid out.⁵²

The speculative nature of language is a universal ontological structure, "the basic nature of everything toward which understanding can be directed."⁵³ For Gadamer, the universality of the hermeneutical perspective is gathered together in the idea that "being that can be understood is language." He calls Goethe's statement that "Everything is a symbol" the most comprehensive formulation of this idea, reminding us that it means "that everything points to another thing. This 'everything' is not an assertion about each being, indicating what it is, but an assertion as to how it encounters man's understanding."⁵⁴ We are understanders, and since language is what we understand, we are drawn in through language to a world of meaning. Our absolute and fundamental participation in language is the basis of our participation in truth, since that speculative structure is "the coming into language of a totality of meaning."⁵⁵ Thus we much better understand the statement given earlier, i.e., "the verbal world in which we live is not a barrier that prevents knowledge of being-in-itself but fundamentally embraces everything in which our insight can be enlarged and deepened."

Language speaks itself, in the sense that the infinite whole which it is, is laid up in each of the parts. But we do not understand simply because we exist in this medium; our existence in language is the *possibility* for understanding. It has given us orientations and foundations from which to say the unsaid. It may be within language, and thus certainly accessible, but the "unsaid" actually has no intelligible being. Understanding is in fact not some "pure" thought "put into words;" rather "the way understanding occurs...is the coming-into-language of the thing itself."⁵⁶ Thus, while every word carries with it the unsaid, Gadamer is careful

to point out that the unsaid only comes into language through "responding and summoning." By its nature, language is the language of conversation. He means that understanding is achieved always by dialogue, the relation of question and answer. Dialogue is our real entry into the speculative nature of language, since through dialogue "what emerges in its truth is the logos, which is neither mine nor yours..."⁵⁷

The nature of understanding

"Conversation is a process of coming to an understanding."⁵⁸ Earlier we introduced the notion of play with regard to language as the medium of our existence. In terms of dialogue this concept takes on especial brilliance. For Gadamer, a genuine conversation is not one we conduct, but one we "fall into" or become involved with. It is one in which the partners do not lead, but are led, and do not know where they are led, in the sense that they do not know what will "come out" of their conversation. Understanding is like an event that happens to us, as is the failure to understand. All this shows Gadamer that "a conversation has a spirit of its own, and that the language in which it is conducted bears its own truth within it - i.e., that it allows something to 'emerge' which henceforth exists."⁵⁹ The spirit is the truth of the object as it gathers together the partners in conversation: "...in a successful conversation [both partners] come under the influence of the truth of the object and are thus bound to one another in a new community. To reach an understanding in a dialogue is not merely a matter of putting oneself forward and successfully asserting one's own point of view, but being transformed into a communion in which we do not remain what we were."⁶⁰

There are of course conditions for a genuine conversation, the rules of the game, so to speak. One of the first conditions of engaging in dialogue is the admission that one's

knowledge is limited, and that one is thus open to the possible truth of another view. Obviously, this requires that one take seriously the other partner in a conversation: "Thus it belongs to every true conversation that each person opens himself to the other, truly accepts his point of view as valid and transposes himself into the other to such an extent that he understands not the particular individual but what he says."⁶¹ That is, it is not a question of understanding the other person's intentions, how he comes to be saying what he is saying (though this is a part of it). More important is *what* the other partner is saying. Furthermore, it is just as necessary to take seriously our own place in the dialogue, since the goal is a shared understanding where the participants are at one with each other on the subject. The necessity of taking both partners seriously is particularly apparent when the dialogue is between a person and a text, whether that text is a work of art, a historical document, or given in whatever language the thing has. A dialogue between a person and a text is slightly different than a dialogue between persons, since a text is an enduringly fixed expression of life. This means that "one partner in the hermeneutical conversation, the text, speaks only through the other partner, the interpreter. Only through him are the written marks changed back into meaning."⁶² In this, the interpreter has a great responsibility to treat the text as a Thou, and must be very careful not to dominate and impose himself upon the text. The interpreter is obligated to let the text speak. "Nevertheless, in being changed back by understanding, the subject matter of which the text speaks itself finds expression. It is like a real conversation in that the common subject matter is what binds the two partners, the text and the interpreter, to each other."⁶³ Yet understanding the subject matter of the text can never be had without

the contribution of the interpreter, whose own thoughts have gone into re-awakening the text's meaning:

In this the interpreter's own horizon is decisive, yet not as a personal standpoint that he maintains or enforces, but more as an opinion and a possibility that one brings into play and puts at risk, and that helps one truly to make one's own what the text says... We can see now that this is what takes place in conversation, in which something is expressed that is not only mine or my author's, but common.⁶⁴

Gadamer is referring here to that fusion of horizons, the "combination" of old and new into something of living value. This is perhaps the greatest difference between the methods of science and a discipline of dialogue, that the knowledge so gained has value. As opposed to a scientific understanding, which claims certain knowledge of the things as they really are, the hermeneutically enlightened consciousness establishes the higher truth of dialogic translation: "It is higher because it allows the foreign to become one's own, not by destroying it critically or reproducing it uncritically, but by explicating it within one's own horizons with one's own concepts and thus giving it a new validity."⁶⁵ Understanding is interpreting insofar as it is *the integration of truth into our lives*.

From this, we can see to what extent Gadamer's philosophical hermeneutics is at the same time practical philosophy. We do not, as in a technologically-oriented science, understand and then apply. We understand *through* application. Our interest is in the meaningfulness of a text within our horizon. In fact, application is what makes understanding meaningful: "application is neither a subsequent nor merely an occasional part of the phenomena of understanding, but codetermines it as a whole from the beginning."⁶⁶ When the interpreter tries to understand what constitutes the meaning and significance of a text, i.e., what it says, he cannot disregard himself and his situation. The interpreter "must relate the

text to this situation if he wants to understand at all."⁶⁷ Gadamer illustrates this through the model of legal hermeneutics. Universal laws exist, but the understanding of those laws is achieved only in application to a particular situation, an interpretation for the here-and-now. In giving an answer for the present, the legal hermeneuticist has to give an interpretation which remains true to the law, but which is appropriate to the circumstances: "Finding the law means thinking the case together with the law so that what is actually just or the law gets concretized."⁶⁸ In terms of the dialogue, we might call the "law" the truth that guides the conversation, and coming to an understanding of that law is the concretization of it in a specific situation. It is not without significance that for Gadamer, "thinking the law" means not only the consideration of universal laws, but even more a careful consideration of the body of precedents, those decisions already laid down. For the legal systems, the body of precedents "is more crucial...than the universal laws in accord with which the decisions are made."⁶⁹ The legal conversation is led by the universal law, and the expression of those laws in precedents is the basis for further expression of the law.

Here, Gadamer finds quite insightful and relevant to our larger situation Aristotle's observation that the understanding of "natural" truths and "human" truths are two very different things, especially in terms of how we are to act: "Aristotle emphasized that it is impossible for ethics to achieve the extreme exactitude of mathematics. Indeed, to demand this kind of exactitude would be inappropriate."⁷⁰ A blanket application of sociological or economic laws is inappropriate because the human world is one of constantly changing situations. In taking his model of practical knowledge from Aristotle, Gadamer insists that the problem of method has a moral relevance. As Gadamer understands Aristotle, moral

knowledge "is clearly not objective knowledge - i.e., the knower is not standing over against a situation he merely observes; he is directly confronted with what he sees. It is something he has to do."⁷¹ He agrees with him that "knowledge that cannot be applied to the concrete situation remains meaningless and even risks obscuring what the situation calls for."⁷² We should keep in mind that Gadamer does not take up the model of practical knowledge for understanding, and disregard it with respect to the question of action. Understanding a text and ethical action are two faces of the same coin, and certainly when he seeks human freedom, he is seeking both the possibilities of action as well as understanding. It is clear to Gadamer that a natural affinity exists between the two: "understanding, like action, always remains a risk and never leaves room for the simple application of a general knowledge of rules to the statements or texts to be understood."⁷³ Action and understanding, where successful, means a growth in inner awareness, a broadening and deepening of the texture of our experience. The hermeneutical experience is an adventure, simply because it is not merely interested in registering what is there or said there, but leads us back to our guiding interests and questions; in this, the experience has a far lesser degree of *scientific* certainty, but thus is "capable of contributing in a special way to the broadening of our human experiences, our self-knowledge, and our horizon."⁷⁴

While it may not have that scientific certainty, the hermeneutical discipline of questioning and inquiring nonetheless "guarantees truth."⁷⁵ Practical knowledge, that directed toward the concrete situation, is that which imparts the immediate living certainty that science is neither interested in achieving, nor able to achieve, but has covered up with its own claims of certainty. In terms of the Neoplatonic metaphor, coming into language is an

increase in being of the thing. In his own words, the coming into language of something is an event of being, since truth has presented itself more fully - at least from our perspective and understanding, which is all we can really talk about. Moreover, truth cannot be verified; it must be experienced. The experience of truth, in both its captivating self-evidence and transformative quality, is the experience of an "event;" understanding is above all a happening and makes history. There is always an element of surprise in understanding: "what is evident is always something surprising as well, like a new light being turned on, expanding the range of what we can take into consideration."⁷⁶ The reality is that though the experience of truth is always a unique event, truth has a very compelling nature: "when we understand a text, what is meaningful captivates us just as the beautiful captivates us. It has asserted itself and captivated us before we can come to ourselves and be in a position to test the claim to meaning it makes."⁷⁷ Thus it expands our range of consideration precisely because it makes a claim upon us, and sets us a task which we must master ever anew, that is, "the task of integrating it into the whole of one's own orientation to a world and one's own self-understanding."⁷⁸ In the final analysis, understanding as it is reached through dialogue is an "*enrichment*" of ourselves, as our world is enriched by the 'increase in being.'⁷⁹ Though the experience of truth is a unique event, it is never an isolated one. It occurs within the context of our lives, and through its expression there, changes the very context within which it was realized. For Gadamer then, coming to an understanding is "a life process in which a community of life is lived out."⁸⁰ Our whole existence is dialogic, where dialogue is the play of language itself. Language fully realizes itself only in the process of coming to an

understanding, and that process is its play: it plays insofar as it "addresses us, proposes and withdraws, asks and fulfils itself in the answer."⁶¹

Enrichment and the natural sciences: the limits of science

Our question at this point concerns the location of the natural sciences within this universality, which includes our nature above all as understanders, the medium of our existence in language, the inescapability of prejudice, and the necessity of dialogue for understanding. Naturally, since Gadamer is confident of the universal claims of his hermeneutics, it is not for him a question of verification through science. The question we put to Gadamer is thus not whether science is within this universal reality, since for him every human activity is within that reality. Instead we ask: Can natural science play a part in the enrichment of our world by truth? Where does natural science fit in the human and humanizing process of coming to an understanding, where understanding is that life process in which a community of life is lived out? Given the perception of science and the scientific method that we saw earlier, we can anticipate that, in Gadamer's view, science can play only a small role in the hermeneutical enterprise. I hope to show that, notwithstanding his discovery that science has "hermeneutical dimensions," this anticipation is essentially correct. The claim to universality of philosophical hermeneutics is, in the case of natural science, limited. Gadamer would argue that this limitation does not stem from hermeneutics, but from science as it is protected by the philosophy of science. Nonetheless, one cannot ignore the fact that Gadamer has no real interest in natural science, that he generally gives it up for lost, and that this effects his efforts - or lack of them - in that direction. At most, natural science is that which needs to be restrained by the hermeneutical enterprise.

One of the most generous pictures of Gadamer's views on natural science is given by Michael Kelly in "Hermeneutics and Science: Why Hermeneutics is not Antiscience."⁸² It is an interesting picture in its attempt to clarify the position of natural science within especially Gadamer's hermeneutical emphasis and endeavour. Kelly outlines and refutes two minor and one major reason which lead to the assumption that Gadamer's hermeneutics is antiscience: Gadamer's philosophical connection with Heidegger, the supposed antithesis between truth and method, and Gadamer's apparent distinction between the human and natural sciences. The third reason is most relevant to our discussion, especially since his discrediting of this distinction leads to a discussion of the significance of hermeneutics for the natural sciences. Kelly is very positive about the relation of Gadamer's hermeneutics to natural science. Thus, in terms the claim to universality of philosophical hermeneutics, I think we can rely on him to show us the most optimistic extent to which natural science is involved in that universality. For Kelly, this involvement is a restricted one, which in itself is quite telling if one considers that he is sometimes open-minded beyond justification, as we see by considering his refutations of the first two reasons.

With regard to the first reason, Kelly does not deny Gadamer's connection to Heidegger, who appears to be both antiscience and antitechnology. Yet he wants to underline that Gadamer's whole philosophical strategy is much different than Heidegger's. Heidegger challenged the entire tradition of western philosophy, including science, on the grounds of its obsession with presence that is associated with the domination of Being in the thinking of both philosophy and science. While Gadamer also seeks alternatives to modern philosophy, Kelly points out that he tries to do this within the traditions of western philosophy and

science: "He accepts the importance of science within modern society and he never attempts to challenge science on its own turf; that is, he does not object to the use of its methodology in the study of nature."⁸³ The other related reason that people assume Gadamer's hermeneutics is antiscience is the very title of *Truth and Method*, which implies to some an antithesis, an opposition between truth and method. This is simply not the case, argues Kelly. Gadamer is making a philosophical point to other philosophers "who define the concept of truth almost exclusively in terms of the concept of scientific truth."⁸⁴ Gadamer wants to expand the restricted concepts of scientific truth, knowledge and experience to include nonscientific truth, knowledge and experience, but this articulation of these expanded concepts "does not entail a rejection of science, nor even of scientific truth."⁸⁵ Strictly speaking, Gadamer's acceptance of the importance of science within modern society is true, though Kelly has given a very generous spin to this acceptance. As we saw, it is precisely because science has gained such overwhelming and destructive power in the world that he turns to alternatives. That Gadamer never challenges natural science on its own turf, that he concedes to science the use of its method, and that he does not reject scientific truth cannot be denied. However, this is not an occasion for celebration, since it suggests not so much Gadamer's recognition of the integrity of science, but rather his perception of the lack of possibilities of modern science from a hermeneutical perspective. As to the truth of science, it is clear that his concession there is merely a formal one. The above investigation of understanding and truth has clearly shown us that for Gadamer, science has little real connection to truth.

Yet that science, in the form of the philosophy of science, has been rethinking itself certainly interests Gadamer. His discovery, which for the most part came after his writing of *Truth and Method*, that science, or rather - its foundations, are not as "monolithic, homogeneous and fixed"⁸⁶ as Gadamer had assumed facilitates his task of legitimating the truth claims of art, philosophy and history, at least on the intellectual side. Indeed, Gadamer sees some of those reflections as bearing out his own ideas, and he refers enthusiastically to the recent uncovering of the "hermeneutic dimensions" of natural science. He especially highlights in this regard the admission of historicity in science - "in the natural sciences as the dimension of paradigms and of the relevance of one's framework of inquiry."⁸⁷ For Gadamer, these dimensions are a welcome crack in the facade of science. Finally, science is recognized as an historical and not an a-historical enterprise (this is a curious reaction, given his own essentially abstract view of science); it has a communicative side which for Gadamer is ultimately connected to language. However, what is relevant here is that, for Gadamer, this discovery of hermeneutical dimensions applies more to the question of scientific *limits* than to scientific *possibilities*.

This returns us to Kelly's discussion of the third and major reason for the perceived antiscience of Gadamer's philosophical hermeneutics, i.e., the supposition that Gadamer makes a distinction between the human and natural sciences. He argues that in fact Gadamer's philosophical hermeneutics does not assume a sharp distinction between the human and natural sciences, and certainly one cannot disagree with this. For Kelly, insofar as Gadamer's hermeneutics is universal, Gadamer's emphasis is on a theory of understanding which is applicable to both sciences; though in a massive understatement, he admits that

Gadamer discusses the common ontological roots uniting the sciences much more in relation to the human sciences. Nevertheless, Kelly claims that Gadamer "does clarify their relevance for the natural sciences by analyzing two specific limits of the natural sciences... One limit is from below, the other from above."²⁸ The limit from below concerns the recognition of the historicity of science, and from above concerns the question of the value of science.

Let us look at the limit from below. To illustrate this limit with regard to natural science, Kelly takes an example from the modern philosophical situation. There, he notes that hermeneutics has demonstrated that the historicity of philosophy, "i.e. the historical conditionedness of philosophical reflection," does not mean the demise of philosophical reflection. This can also apply to what we might call the historical conditionedness of scientific activity. He uses Gadamer's model of the effective-historical consciousness to argue that our consciousness as rational, critical, and objective may be historically conditioned, but is not invalidated by this conditionedness. Certainly, Kelly is onto something here, since in Gadamer's view, an acknowledgement of history, of limits, does not imply an outright rejection of science, nor does it imply restrictions on the accepted procedures in science. It does show the reality of the case, that is, that science has very human (i.e. historical) foundations. In Gadamer's view, Kuhn's theory of revolution in science "rightly criticizes" the notion of an uninterrupted and linear progression of science. It is significant, as Kelly takes pains to show, that Gadamer insists that hermeneutic dimensions do not make science any less scientific. As Gadamer declares: "science is no less science where it is aware the *humaniora* as its integrative function. Just as little is the scientific character attainable in the natural or the social sciences lost by the reason of the fact that the theory of science

allows them to be aware of their limits."⁸⁹ Interestingly, it is with reference to the hermeneutical dimensions of science that we find Gadamer's single and short reference to Heisenberg. Gadamer sees Heisenberg asking the question of whether "scientific inquiry really is completely independent of the language world in which the scientist lives as a scientist."⁹⁰ Gadamer recognizes that this does not mean the demise of science, but rather indicates that research occurs in a social context. Still, he does not tread too far into the world of natural scientific insight. We therefore hear him insisting that he is not the least interested in changing natural science: "It is a naive misunderstanding ...to fear that the hermeneutic reflection I practice will mean a weakening of scientific objectivity," though he adds that this objectivity is little to be commended.⁹¹ Kelly interprets Gadamer's unwillingness to call for changes in natural science quite positively, concluding that the hermeneutical relevance for science on this limit is this: "because of its historical development and conceptual structure, hermeneutics is in a very good position to contribute to the philosophical understanding of the relationship between science and history."⁹²

For Kelly, Gadamer is not antiscience because he is not interested in changing natural science, or attacking it on its own turf. Certainly this is true. But we might ask both Kelly and Gadamer, *is this enough?* I don't think so, especially if hermeneutical reflection is "universal in its possible application."⁹³ Although it was never Gadamer's intention in *Truth and Method* to "make prescriptions for the sciences or conduct of life, but to try to correct false thinking about what they are,"⁹⁴ it seems quite clear that Gadamer expects an investigation of the philosophical foundations of the human sciences to *affect* those sciences in a meaningful way. A change in perception with regard to the ontological make-up of both

ourselves and our world almost demands a change in our approach to both. For example, knowing ourselves as historical beings makes a quite a difference to the historical sciences, where the "apparent opposition of knowing subject and his object is eliminated."⁹⁵ In the hermeneutically enlightened human sciences, the traditions on which we stand now "offer less an objective field for the scientific mastery of a subject matter or for the extension of our domination by knowledge of the unknown than a mediation of ourselves with our real possibilities engulfing us."⁹⁶ For our larger discussion, this is an important point, since Heisenberg is quite clear that fundamental change is demanded by the discoveries about our limits and possibilities within the study of nature.

On the one hand, I believe that if Gadamer had really demanded such a fundamental change to natural science, he would have subjected himself to the equivalent to a philosophical lynching, at least in his circle of discussion. He is quite aware of this, noting that even his mere suggestions that science must acknowledge the existence of "productive prejudices" brings out accusations that his philosophy is "encouraging people to proceed uncritically and subjectively in science!"⁹⁷ The limits of science are particularly clear to him through his own attempts to dialogue with the philosophy of science. For Gadamer, the method of modern science, protected so fiercely by the philosophers of science, "is characterized from the start by a refusal: namely, to exclude all that which actually eludes its own methodology and procedures."⁹⁸ One senses his frustration in trying to dialogue with those who entangle themselves almost irrationally in the ideals of science, and thereby lose the openness that is essential to dialogue, or at the very least to common sense. He is blunt: "It is in the nature of the case, then, that the dialogue between philosophy and philosophy of

the sciences never really succeeds."⁹⁹ Certainly an important basis for the limited relevance of hermeneutics to natural science is for Gadamer based upon the inability and lack of desire in the philosophy of science to change its objectives.

I think he is quite mistaken to see the philosophy of science as the "ambassador" of natural science. His occasional brushes with the ideas of natural scientists suggests that he is aware that the defenders of science in the social sphere are somewhat off-track with regard to the real experience of natural science. But that he does not dialogue more fully with natural science demonstrates his underlying conviction that it really has not much to offer the larger scope of human existence, despite occasional reflection upon its foundations, which in any case are quickly appropriated by Gadamer for his own agenda. On the whole, Gadamer never relinquishes the view that modern empirical science purchased "certitude and controllability of their knowledge and the secure path of their progress" by forsaking comprehensive knowledge in what he calls "the grand Aristotelian style."¹⁰⁰ He continues:

What the old science, crowned by metaphysics, had provided was a whole orientation to the world, which brought the natural experience of the world and its linguistically mediated interpretation of the world to a unified conclusion. Modern science could not provide this. Just as man no longer considers himself the center of his universe, so too his knowledge is no longer the natural expansion of his experience of the world. Instead it is an independent setup, indeed an attack upon nature, which it subjects to a new but only partial mastery.¹⁰¹

For Gadamer, the universality of the hermeneutical perspective is discovered in the idea that "being that can be understood is language." This is no metaphysical assertion, he notes, but describes "from the medium of understanding, the unrestricted scope possessed by the hermeneutical perspective." He continues by noting "it would be easy to show that all historical experience satisfies this proposition, *as does the experience of nature* [my

emphasis]."¹⁰² That our experience of nature unfolds into a larger experience of reality is what the ancient Greeks understood; for Gadamer, this is what modern science has relinquished, and is not interested in understanding. Natural science as it comes out of modernity simply cannot offer that sort of comprehensive knowledge, but only a never-ending mastery of nature. The experience of nature, which would always be a dialogue with nature, would require such a fundamental shift of viewpoint with regard to nature, ourselves and the nature of reality that to Gadamer it seems beyond the possibilities of modern natural science. Asking whether modern natural science "could even pose the questions that unceasingly stir our desire to know, questions that truly spring from wonder," Gadamer decidedly responds in the negative. In his view, the possibilities that exist in the human sciences have no place in the natural. By its objectives and methods, that science has situated itself far from the larger human concerns: "it cannot be denied that science always has and always will come up against a claim of comprehension (*Begreifens*) in the face of which it must fail - and indeed it should forgo."¹⁰³ Thus, the best that can be done at this point is to simply make the attempt to restrain science, to limit it as far as possible.

For Gadamer, then, the recognition of the historicity and human dimensions of science only provide a path for science to step back from its own claims of universality. Here we are concerned with the Kelly's limit from above, which refers to the values by which science is directed, and its place in the world. In this regard, hermeneutics as practical philosophy has relevance for the problem of how to assimilate scientific knowledge with practical, ethical life. Clearly, Gadamer is not claiming moral superiority for his hermeneutics, nor is he interested in suggesting any particular criteria for the choices about the values and purpose of science.

Still, though his focus is more on the model of reflection through which decisions can be arrived at, it is telling that natural science has no real connection to this model. In that limit from above, hermeneutics supplies a philosophical foundation from which to speak about both the ethical questions raised by science and the matter of its appropriate place in society, a foundation that Gadamer feels is wholly absent in natural science. Thus the relation of natural science to the universality of hermeneutics is ultimately found in its subordination to it:

...the claim to universality on the part of hermeneutics consists of integrating all the sciences, of perceiving the opportunities of knowledge on the part of every scientific method wherever they may be applicable to given objects, and of deploying them in all their possibilities...[Hermeneutics] has to bring everything knowable by the sciences into the context of mutual agreement in which we ourselves exist...[It] not only accounts for the procedures applied by science but also gives an account of the questions that are prior to the application of every science...These are the questions that are determinative for all human knowing and doing, the greatest of questions, that are decisive for human beings as human and their choice of the good.¹⁰⁴

So we see that when Gadamer asks the question of "how man can understand himself within the totality of a social reality dominated by science,"¹⁰⁵ his answer is the necessary restriction of the scope of science, alongside a renewal of human possibility and freedom. Since science by its very nature removes the possibility for a serious consideration of our belongingness to the world, it is clear that science can only participate in the larger process of enrichment by backing off and making room for the truths of the human endeavours. In the end, Gadamer appeals to science for the realization of the actual structure of understanding that exists before all methodologies, and that it not deprecate the legitimacy of other forms of knowing in light of their own: "In a time when science penetrates further and further into social practise, science can fulfil its social function only when it acknowledges

its own limits and the conditions placed on its freedom to manoeuvre. Philosophy must make this clear to an age credulous about science to the point of superstition."¹⁰⁶

CHAPTER 3

In *Truth and Method*, Gadamer asks the question: "Does not the experience of art contain a claim to truth which is certainly different from that of science, but just as certainly not inferior to it?"¹ The underlying assumption of that work is the necessity of legitimating the truth claims of the experience of philosophy, art and history against the truth claims of science. For Gadamer, this legitimation can only be provided by a deeper investigation of the phenomena of understanding, which is exactly what *Truth and Method* goes about doing. However, I suggested earlier that his concession to scientific truth in *Truth and Method* and elsewhere is more formal than otherwise. Clearly for Gadamer, in view of what 'really happens' in the experience of art and history, whatever science has been claiming, it is *not* truth. For Gadamer, coming under the influence of truth changes us in a very real and profound way. Through truth, we come more to ourselves and to our world. From his viewpoint, a science which grounds itself in illusions, which dominates and controls, which alienates us from that which we are trying to understand, can never make a genuine claim to truth, however impolitic it might be to announce this aloud. In his own work, Heisenberg might be asking a similar question: Does not the real experience of nature contain a claim to truth that is different than that of objective, rational science? Indeed, it is quite interesting that Heisenberg in some scientific and philosophical circles finds himself in a similar position to Gadamer - how to legitimate the truth of a science that is no longer "scientifically objective." But it is ultimately for Heisenberg not a question of mere epistemological interest. Heisenberg's concern above all is the living out of our lives, and the experience and integration of truth into life, whatever the source of that experience.

In the following, we are concerned with offering Heisenberg's vision of who and how we really are in the world, and especially what part science plays in this vision. We will begin by looking at the radical changes to scientific thought earlier this century, changes with which Heisenberg was closely involved. This focus gives us an idea of the limits of science, limits which are particularly confining if one remains within the demands of a rational, objective science. That is, if one cannot talk about the larger context, even those radical changes are meaningless. From here, we will turn to the broader framework of Heisenberg's thought, where the fuller possibilities of science can be discovered. That there are many affinities between his scientific discoveries and his vision of human being might suggest to some that he is in some danger of contradicting his statement that it is "impossible to base articles of belief that are to be binding for one's bearing in life on scientific knowledge alone."² There is no doubt that the discovery of the limitations of science profoundly affected him; on the other hand, certainly his larger vision affected his scientific discoveries. There is definitely an interplay between the two, and for Heisenberg, this is how it should be. When we encounter something of ultimate importance, this thing "will suddenly begin to shine in its own light, first dimly and vaguely, then ever more brightly, until finally it will glow through our entire mind, spill over to other subjects and eventually become an important part of our own life."³ For Heisenberg, the encounter with the divine order is like this, whether one encounters it in nature, art, or in human relationships. The divine order within art "spills" into that within science, and science into life, just as life "spills" into science and art. For Heisenberg this order is the ground of our existence, or in Gadamerian terms, the medium of our life. And while Gadamer holds that language is being that can be understood, for Heisenberg, *order* is

that which can be understood. What we will see is a fascinating correspondence between their thoughts, but one in which science comes to life as an integral aspect of that speculative nature of order.

Quantum mechanics and the scientific experience

For Gadamer, natural science could only become an enriching and humanizing activity through fundamental changes of viewpoint. Heisenberg insists these fundamental changes have occurred through the discoveries of atomic physics, discoveries which were as much about ourselves as they were about nature. For the physicist, quantum mechanics and in particular the Copenhagen interpretation of quantum mechanics is a turning point in human understanding, at least with regard to modern scientific thinking. In brief, the Copenhagen interpretation states we must do away with the notion that science comes to know nature in itself, that what we can observe is limited by our concepts, and that this limitation is a basic and unalterable feature of our situation in science. Thus, it is impossible to explain atomic phenomena in any more detail, and quantum theory can make the claim to completeness. In practical terms, this means that we necessarily change the processes we are observing through our observations, that in the microworld "every process of observation causes a major disturbance," and thus must be factored in to the picture of nature. It boils down to the fact that we are no longer dealing with a picture of nature as it really is, "but rather a picture of our relation to nature."⁴

As Heisenberg describes it, the Copenhagen interpretation is actually a partnership of different contributions which arose from the consideration of different angles of the problem. For example, Niels Bohr's contribution, the principle of complementarity, arises from the

practical necessity of describing the wave/particle duality of an, e.g., electron. Complementarity refers to the fact that both pictures, though mutually exclusive, are necessary to a full understanding of the electron. Heisenberg's contribution arises from a consideration of the problem of the description of the mechanics of quantum problem, from which he developed his famous uncertainty relations. The two notions do not contradict each other, since the uncertainty to each of the pictures above "is expressed by the uncertainty relation, which is sufficient for avoiding a logical contradiction between the different pictures."⁵ It is helpful to give some brief detail to this interpretation, at least to somehow get across its startling implications from a scientific perspective. As Heisenberg recalls Bohr saying, "Those who are not shocked when they first come across quantum theory cannot possibly have understood it"⁶ (though, to be sure, we are much less shocked a half-century later). Although complementarity plays a role in Heisenberg's thinking, the following is particularly concerned with the development of Heisenberg's contribution, because his description of that development and his contribution, as well as his interpretation of that interpretation, reflects in many ways his larger framework of thought.

That there are various contributors to the Copenhagen interpretation, and not only those whose names are formally associated with it, is indicative of the larger scientific experience. Heisenberg's participation in the world of science taught him that the creative processes of science are never the product of individual and isolated effort. Individual and isolated genius is as much a myth for Heisenberg as it is for Gadamer. For Heisenberg, it is impossible to escape the fact that science is a human activity, done in the world and within a community, since our understanding rests on community. Thus, Heisenberg insists that

though the natural sciences may rest on experiments, its results are based in the dialogue of those who work in them, who discuss the meaning of their experiments. Naturally, this is not an insight that comes out of quantum physics, but his own experience of science. All knowledge, he insists, is grounded in dialogue, scientific no less than any other kind.⁷ The real creative processes of science rest upon cooperation and dialogue within the community, where goodwill and a genuine desire to understand form essential preconditions. For Heisenberg, that much must be said of the creative processes of life. At this point, it is very interesting to recall Gadamer's understanding of dialogue as "a life process in which a community of life is lived out."⁸ Heisenberg's *Der Teil und das Ganze* is the presentation of his life in the form of dialogue with an immense variety of people and ranging over an immense variety of concerns. For Heisenberg, these discussions necessarily move beyond the scope of strict scientific problems, because science is done in the context of life. Thus, the discussions just as often extend to the larger human, philosophical or political questions, and in this way introduce both the larger tradition into science and science into the larger tradition. His aim is to show how little natural science can be separated from these more general questions. In Heisenberg's view, science is a human activity, whether it is natural science or human science, and the truly human inclination is to search for the broad connections. Furthermore, the natural sciences have now more than ever a crucial place in that search, since their results took them far beyond that strict sphere of science: "Modern atomic physics has presented for discussion fundamental philosophical, ethical, and political problems in renewed form, and the largest possible circle of people should participate in that discussion."⁹ For the moment, however, we will restrict ourselves to the scientific dialogue.

While Heisenberg would include a number of conversations that helped him to an understanding of quantum mechanics, he tells us that the main insight from which he worked to develop his uncertainty relations came from a discussion he had once had with Einstein, who had told him that "it is the theory which decides what we can observe."¹⁰ It is helpful to consider that conversation and its larger context, as it is recalled by Heisenberg. Although young Heisenberg was drawn to physics in the hope of taking part in this exciting new area, in which basic scientific and philosophical attitudes were being questioned, he did not blaze in with novel ontological or epistemological theories. Entering the field and trying to be a conscientious scientist, he took quite seriously the method by which science was supposed to work. His work was fruitful, and Heisenberg at one point gave a lecture on the new quantum mechanics that he had played a part in developing, a coherent mathematical framework that promised to embrace all the multi-faceted aspects of atomic activity. It was after this lecture that he and Einstein pursued some ideas relating to quantum mechanics. Einstein's attention was caught by both Heisenberg's assumption of the existence of an electron inside the atom and his simultaneous refusal to consider its orbit, even though it was possible to see electron tracks in a cloud chamber. Heisenberg defended himself by pointing out "even in the older physics wave numbers and amplitudes could be considered substitutes for electron orbits."¹¹ Thus, he explained to Einstein, he had felt it necessary to restrict himself only to the radiation emitted from the electron, because "a good theory must be based on directly observable magnitudes."¹² Einstein immediately protested: "But you don't seriously believe...that none but observable magnitudes must go into a physical theory?"¹³ Heisenberg wondered aloud at this, asking whether this was not precisely what Einstein had

done with relativity. Certainly, Einstein's remark is worthy of emphasis, insofar as it might suggest to Gadamer that even scientists can come to an insight of "what really happens," despite their wanting and doing: "Possibly I did use this kind of reasoning,' Einstein admitted, 'but it is nonsense all the same...It is the theory which decides what we can observe.'"¹⁴

By theory, Einstein is referring to an assumption of natural laws which enable our observation. Einstein tried to make Heisenberg to see that the bare datum of experience alone is unable to provide a basis for theories of natural laws. In fact, the theory comes first: knowledge of natural laws determines what can be seen and understood of the phenomena.

Heisenberg remembers Einstein's argument:

Only theory, that is, knowledge of natural laws, enables us to deduce the underlying phenomena from our sense impression. When we claim that we can observe something new, we ought really to be saying that, although we are about to formulate new natural laws that do not agree with the old ones, we nevertheless assume that the existing laws - covering the whole path from the phenomena to our consciousness - function in such a way that we can rely upon them and hence speak of 'observations.'¹⁵

At the same time as it enables observation, it also *constrains* that observation. With regard to these two aspects, Einstein points to Heisenberg's work, underlining the fact that he himself did not work with only observable magnitudes, but assumed that things work according to established laws: "You are, in fact, assuming that your theory does not clash with the old description of radiation phenomena in the essential points,"¹⁶ which Heisenberg had to admit was quite true.

Some time after this conversation, a wave mechanics was developed which, though an improvement in terms of mathematical clarity and simplicity over the efforts in which Heisenberg had been involved, ignored aspects of atomic activity like quantum jumps, which

suggested the existence of discrete electrons.¹⁷ However, on the basis of this improvement, it was assumed by many that all the difficulties would be resolved soon enough. But Heisenberg remained uneasy, unable to forget the cloud chamber experiments. Thinking further about the matter, he forced himself to consider what really was observed, noting that physicists, himself included, "had always said so glibly that the path of the electron in the cloud chamber could be observed."¹⁸ It was possible that the observation was merely of a series of discrete and ill-defined spots through which the electron had passed, and in fact "all we do see in the cloud chamber are individual water droplets, which must certainly be much larger than the electron." Here Einstein's remark came back to him, that the theory decides what we can observe. If this is the case, and what we actually do observe is much less than assumed, may it be true, perhaps, "that only such experimental situations can arise in nature as can be expressed in the mathematical formalism?"¹⁹ That is, if only so much can be expressed by the classical formalism in terms of trajectories and orbits, only so much will be observed, since any experiment in physics is described by classical concepts. It occurred to Heisenberg that the real question should thus be: "Can quantum mechanics represent the fact that an electron finds itself approximately in a given place and that it moves approximately with a given velocity, and can we make these approximations so close that they do not cause experimental difficulty?"²⁰

With this he went to work on the uncertainty relations, which did in fact establish the necessary connection between the cloud chamber experiments and the mathematics of quantum mechanics: "It was discovered that it was impossible to describe simultaneously both the position and the velocity of an atomic particle with any prescribed degree of

accuracy. We can either measure the position very accurately - when the action of the instrument used for the observation obscures our knowledge of the velocity, or we can make accurate measurements of the velocity and forego knowledge of the position. The product of the two uncertainties can never be less than Planck's constant."²¹ Quantum theory had to be accepted, because it was both possible to represent it mathematically and because *in every case*, "we could say clearly and without danger of logical contradiction how the result of an experiment would turn out."²² Although the concepts of classical mechanics are being used within a situation where the phenomena do not act classically, a coherent and logical understanding of them is nonetheless possible. One can predict, within a range of probabilities, the "position" and "velocity" of a particle.

It is helpful to illustrate this with regard to an experimental situation. For example, if one were to try and determine path of an electron, it would be necessary to observe it with light. This observation necessarily changes the situation, since in the microworld, even a single light photon is sufficient to knock an electron from its path. We change nature through our observation of it. Of course, quantum theory gives us a definite range of possibilities about where the electron will re-appear after this initial observation, and herein lies its success. But can we really speak of a "path" that the electron followed? Heisenberg notes that it is tempting to assume that there existed some path between the two points, even though it might be impossible to discover it. To overcome this temptation he leads us to a different experiment. Light is known to act both as a particle and a wave. If light is radiated between two holes onto a photographic plate, one observes the expected interference pattern typical of waves. If one radiates only a single photon towards the two holes, one would

expect that it would choose a hole to go through and be absorbed by the plate somewhere within the probability distribution of light as wave. What we should get, after many trials, is two different probability distributions, depending on whether the light quanta went through the first or second hole. In fact, one observes the same interference pattern as before. Therefore, the statement that a light quantum goes through either the first hole or the second is problematic and leads to contradictions, i.e. the single light quantum went through both holes at the same time, which is impossible. "This example shows clearly that the concept of the probability function does not allow a description of what happens between the two observations. Any attempt to find such a description would lead to contradictions; this must mean that the term 'happens' is restricted to the observation."²³

Implications for modern science

For Heisenberg, the Copenhagen interpretation certainly places real limits on the self-understanding of classical science. Nevertheless, it is strictly "scientific" in the sense that there are no "subjective" elements related to it: "quantum theory does not contain any subjective features, it does not introduce the mind of the physicist as part of the event."²⁴ Indeed, quantum theory corresponds to the ideal of objectivity as far as possible. For Heisenberg, that it does comply as far as possible to the ideals of modern science is what makes it so compelling. In its interplay with that science, nature itself forces us to admit the limitations of our classical assumptions and method. In view of this, we need to abandon the idea that science comes to know nature as such, realize that our observations are limited by our pre-understandings, and also that these are fundamental features of the scientific situation.

Heisenberg claims that we can only observe in terms of given understanding: "Any experiment in physics, whether it refers to the phenomena of daily life or to atomic events, is to be described in the terms of classical physics. The concepts of classical physics form the language by which we describe the arrangements of our experiments and state the results."²⁵ What we achieve through this approach is not an "objective" picture of nature, but *a response from nature to our form of questioning*. He is absolutely clear on this: "we have to remember that what we observe is not nature but nature exposed to our method of questioning. Our scientific work in physics consists in asking questions about nature in the language that we possess and trying to get an answer from experiment by the means that are at our disposal."²⁶ Nature "in itself" is beyond the range of scientific intelligibility; rather, it does not exist for science, since the question of what nature is doing when we are not observing cannot be allowed, since it does lead to contradictions. For Heisenberg, this re-evaluation of our relationship to nature, especially as that relationship has been defined in Cartesian terms, is perhaps one of the most compelling realizations to come out of his science. This division evaporates from the point of view of atomic physics. In the most obvious sense, it is clear that there is no longer an "I" who is able to purify himself of subjective elements that detract from an objective picture of nature or anything else the "I" wishes to consider. "The old compartmentalization of the world into an objective process in space and time, on the one hand, and the soul in which this process is mirrored, on the other - that is the Cartesian differentiation of *res cogitans* and *res extensa* - is no longer suitable for the understanding of modern science."²⁷ When we want to get a picture of the elementary particles, we cannot ignore the physical processes by which we obtain our information about them, processes that

are determined by our pre-understanding of nature. "The scientific method of separating, explaining and arranging becomes conscious of its limits, set by the fact that the employment of this procedure changes and transforms the object; the procedure can no longer keep its distance from the object."²⁸

While this is very obvious in the microworld, this has in fact always been the case in science, though it certainly did not hurt science to be reminded in so startling a fashion. That we "transform" what we observe through our questions is seen, in the clearest instance, through the fact that when we approach nature with *mechanical* questions and concepts, "we simultaneously forgo all those features in the phenomena which cannot be captured by means of these concepts."²⁹ He takes another such example from biology: "whenever we treat living organisms as physiochemical systems, they must necessarily act as such."³⁰ That is, if one uses the concepts of physics and chemistry as the framework of one's inquiry, the only answers which make sense are those that respond within that framework. Heisenberg also finds a parallel here in the notion of a theoretical framework which determines the experimental structure, as it does in quantum physics. If one looks at a living cell in terms of a physiochemical system, a complete knowledge of this structure "could possibly be achieved only by operations that destroy the life of the cell."³¹ To understand thoroughly the physiochemical system, we must disregard the cell as a living being. Heisenberg states that understanding life may well preclude a complete determination of underlying physiochemical structures. This is naturally an extreme example, but one which lends itself to Heisenberg's aim of showing to what extent science gives us a picture of our relation to nature, as opposed to a description of nature "as such."

Science has come to recognize itself as part of the interplay between man and nature, where that objective picture of nature has been transformed into a picture of our relation to nature. What we learn through the field of view of quantum physics is that "there appears above all the network of relations between man and nature, of the connections through which we as physical beings are dependent parts of nature and at the same time, as human beings, make them the object of our thought and action."³² Let us look at this more closely with regard to quantum physics. Heisenberg is aware of what is almost an immediate reaction to the fact that we must use classical concepts in our physical experiments, whether those experiments refer to the phenomena of the macroworld or the microworld. This reaction concerns the possibility of leaving off with the classical concepts altogether for the microworld, and developing radically new concepts with which to describe experiments, thus taking us back to "a nonstatistical, completely objective description of nature."³³ Heisenberg says this is impossible, and rests upon a misunderstanding of our human situation: "The concepts of classical physics are just a refinement of the concepts of daily life and are an essential part of the language which forms the basis of all natural science. Our actual situation is such that we *do* use the classical concepts for the description of the experiments, and it was the problem of quantum theory to find theoretical interpretation of the experiments on this basis. There is no use discussing what could be done if we were other beings than we are." We are what we are, because the world is what it is. Thus he continues "At this point we have to realize...that 'Nature is earlier than man, but man is earlier than natural science.' The first part of the sentence justifies classical physics, with its ideal of complete objectivity. The second part tells us why we cannot escape the paradox of quantum theory, namely, the

necessity of using the classical concepts."³⁴ Our limitations come from our human nature, which is a part of nature itself. Yet in Heisenberg's view, these are only limitations from the perspective of an objective science.

Responses to the Copenhagen Interpretation

Quantum theory "works." It allows us a coherent mathematical representation of the phenomena which consequently enables us to predict the results of any experiment. However, this does not make the surrounding interpretation palatable to everyone. In particular, the notions that we can never achieve an objective picture of nature, and that quantum theory is the final solution to the problem of understanding the microworld, have by no means gone uncriticized, both by other scientists and by philosophers. In his writings, Heisenberg shows himself aware of this criticism. For Heisenberg, the criticisms from both ends, so to speak, derive from the requirement that any form of natural description must correspond with the earlier ideal of scientific truth. This ideal is objective truth, i.e., an objective picture of nature, where the human being and its interference in nature played no part in it whatsoever. In fact, Heisenberg can even sympathize with this unwillingness to accept the idea that the mathematical forms no longer represent nature, but our knowledge of nature, given that when the Copenhagen interpretation came into being, the old ideals were seen as the obvious goal of exact science.

As the criticism comes out of philosophy proper, Heisenberg does not appear overly distressed, given that much of the philosophy of the time was of a positivist nature. Heisenberg considers this a "pointless philosophy,"³⁵ insofar as it adds little to our efforts to find our way through life, and Heisenberg often remarks on his frustration with this narrow-

minded philosophy. He recalls reading a monograph by a certain positivist, in which the term "metaphysics' is a synonym for 'loose thinking,' and hence a term of abuse,"³⁶ a position far from Heisenberg's own. Moreover, positivists seem to base their ideas on a science which, though they might disagree has changed, Heisenberg feels they have never understood at all. For Heisenberg, there is something very important about the actual experience which initiates a change in perception and understanding. For example, he recognizes that it is quite possible to speak confidently, and from a safe intellectual distance, about the assumed methods and abilities of natural science. Yet, these assumptions might not hold up "under fire," so to speak. Thus when Heisenberg responds to a claim that rationalism and its modern positivistic-rationalistic forms are the sole basis for science, Heisenberg acknowledges that his criticism of this view must at first appear unsatisfactory, given that these claims have gained much credence in the past. But he turns to the realities of the scientific experience for justification: "To this I can only say that my own experiences of scientific work in the course of decades has indicated to me the limits of this rationalistic-pragmatic method...but I can also understand that someone who has not so directly experienced these limits would know nothing of them."³⁷ For Heisenberg, it is not a question of a layperson's ability to understand the limits or possibilities of science; rather, the thoughtful scientist has these limits and possibilities presented to him in again and again in actuality, so that they deeply influence the way he thinks about nature and his science. To this point, one should recall Heisenberg's significant remarks when he described his early exposure to Einstein's theory, "You might even say that I have grasped the theory with my brain, but not yet with my heart."³⁸ It is this understanding "with the heart" that legitimates the interpretation of science from within.

Naturally he is not insisting that only scientists can have a valuable understanding of science. Science has much to learn from other fields, and he always holds that on its own, isolated from all human questions and concerns, science is absolutely without meaning.

Yet, given this need for an actual understanding of science, Heisenberg is much more inclined (and as a scientist naturally compelled) to respond thoughtfully to the varied criticisms from within science. As he sees it, these criticisms concern themselves with the possibility that, at least in its present form, quantum theory may not be the final formulation of our understanding of the microworld. He distinguishes three broad groups: the first wants to change the philosophy without changing the physics, e.g., introducing "hidden parameters" which escape observation but which "determine the outcome of the experiment in the normal causal way;"³⁹ the second wants to change the theory in order to arrive at a different philosophical interpretation; and the third group simply expresses general dissatisfaction without making any counterproposals. His refutations are of a complex physical nature, which is beyond the scope of this paper, but it is significant to Heisenberg that they all agree on one point: "It would, in their view, be desirable to return to the reality concept of classical physics or, to use a more general philosophic terms, to the ontology of materialism. They would prefer to come back to the idea of an objective real world whose smallest parts exist objectively in the same sense as stones or trees exist, independently of whether or not we observe them."⁴⁰

As it happens, this desire to return to the framework of classical physics is something with which Heisenberg can wholly sympathize, if not condone. If, as it happened in modernity, "all known experimental facts agree with the results mathematically derived from

the [natural] law, it becomes extraordinarily difficult to doubt its general validity. It is therefore intelligible that Newton's principia should have dominated science for more than two centuries."⁴¹ The validity of Newtonian mechanics is compelling *especially* to physicists, who, before entry into the microworld, had never seen a contradiction between the mechanics of matter and Newton's laws. When Heisenberg talks about the events leading up to quantum physics, the unexpected difficulties that arose here and there, he points out that physicists were not especially worried, aware that "the edifice of classical physics was so firmly fashioned, so securely anchored together by thousands of experiments,"⁴² that the solutions were somehow bound to be discovered within that classical framework. The unassailability of those laws had been presented to them so often, and in so wide a range of experience, that when the solutions were not found to be within that framework, some scientists proved highly resistant. But Heisenberg does not want quantum mechanics to be seen as an attack on the truth of Newton's laws. In their framework of application, Newton's laws *are* unassailable; Heisenberg is adamant that those laws are true, and will always remain so. What he finds problematic in many of the critics of the Copenhagen interpretation is their retention of the mistaken assumptions of modern science, i.e., that science is not only capable of, but has achieved a genuinely objective picture of nature. He sees their reformulations of both the theory and the phenomena of the microworld as wishful and almost unscientific efforts to arrive at a "picture" of nature that accords with that classical one. Nonetheless, the equation of truth with certainty about the thing in itself is an illusion that we simply must give up. But giving up this certainty does not mean giving up an understanding of nature: "Quantum theory

is in itself an example for the possibility of explaining nature by means of simple mathematical laws without this basis."⁴³

Certainly Heisenberg can understand some unwillingness to accept the Copenhagen interpretation. Yet a response he finds even more disturbing is one which accepts it on the basis of a "rash" conclusion that "Newtonian mechanics had finally been disproved."⁴⁴ A main characteristic of this pragmatic attitude is the belief that quantum mechanics, or Maxwell's equations, or the mechanics of relativity theory, are "improvements" over what has been shown to be quite inadequate. But for Heisenberg, a pragmatic attitude in science, one willing to cull whatever seems useful for a "better" description of nature, is one that not only retains that objective view, but one which has completely given itself over to that vague notion of progress. It thinks of understanding in science in terms of a constant process of correction to previous approximations or inaccuracies, where "the result is a more reliable blueprint, and everyone is happy about it."⁴⁵ A better explanation is the goal, as opposed to a deepened understanding. For Heisenberg, a real development of this thinking "would weaken, or rather soften, physics to such an extent that we could hardly continue to call it an exact science."⁴⁶ By elevating the notion of continuous progress in science,

we should have to give up asking about the wider connections, and there would be very little chance of our advancing to the very simple relationships which, to mention just one example, distinguish Newtonian mechanics from Ptolemy's astronomy. In other words, we would lose the most important truth criterion of physics, namely, the ultimate simplicity of all physical laws.⁴⁷

For Heisenberg, there is an immense difference between an "accurate description of observed facts," and an "understanding" of them. That comparison between Newton's mechanics and Ptolemy's astronomy is a favourite illustration of his in this respect. Although it had been

theorized by Aristarchus that the sun was the centre of the planetary system, Ptolemy held the earth in that position, and treated the orbits of the planets as superimposed cycles and epicycles. Though an astoundingly complex astronomical picture, Ptolemy's amazingly accurate predictions of solar and lunar eclipses nevertheless guaranteed the validity of his theory for fifteen hundred years. But Heisenberg asks who really understood the planetary system: "Was it not Newton who, knowing the law of inertia, and introducing force as the cause of changes of momentum, was the first to give a proper explanation of planetary motions in terms of gravitation? Was he not the first to have really understood this type of motion?"⁴⁸ Another example of his concern for understanding in science is seen with respect to his hope that "some eternal law of motion for matter"⁴⁹ might be discovered through the study of elementary particles. Heisenberg notes with extensive dismay the existence of pessimists among particle physicists, "who believe that there simply is no such law of nature defining the dynamic properties of matter. With such a view I confess that I can make no headway at all."⁵⁰ For Heisenberg, such pessimism would merely result in a grand tabulation of the maximum stationary states of matter, "and thus a compilation in which there is nothing more to understand, and which therefore, no doubt, would no longer be read by anyone."⁵¹ Pure empiricism - "endless tabulation without inner connection"⁵² - is not science. Science fulfils itself when it comes to an understanding, where understanding is not of things, but of connections or relationships.

Understanding science

For Heisenberg, if quantum mechanics has taught scientists anything at all, it is that they must be more scientific, that is, they must think clearly and with all their abilities of

reasoning. This is particularly the case in understanding the nature of Newtonian mechanics, and the nature of its relationship to other areas of physics. Heisenberg explains: Newtonian mechanics deals with an idealization of nature, and "the idealization comes about through the fact that we approach reality with certain concepts, which have proved themselves in the description of the phenomena and which thereby give the latter a certain aspect."⁵³ For Heisenberg, an idealization is not distinct from reality, it is an abstraction from reality initiated by certain pre-understandings. By abstraction he means that it deals with a very focused aspect of reality. As we mentioned, our interplay with nature within a framework of mechanical questions and concepts will lose us a great many features not found within that framework. Naturally, this is much more obvious now than it was a hundred years ago, but let us remember just how obscure an insight it was. But from its approach, from asking the appropriate questions and setting appropriate limits, Newtonian science was able to achieve an understanding of nature that was dazzling in the extreme. Heisenberg is concerned for us to understand that Newtonian mechanics, which embodies for him an awesome simplicity and wholeness of relationship, is a closed-off system or subarea of science. That the framework of Newtonian physics is essential to its validity demonstrates to Heisenberg that Newtonian science is not a picture of nature "in itself." Naturally, in its particular framework of definitions and axioms which establish the fundamental concepts and their interrelations, Newtonian physics is a profound understanding of nature, embracing within that axiom system a very wide set of relations - *but only in that framework*.⁵⁴ Where phenomena can be described by Newtonian concepts, his laws are authentic ones: "Newton's laws hold quite rigorously, and nothing in this will be changed for the next hundred thousand years."⁵⁵

Naturally, even classical physicists knew that there were limits to the accuracy with which the phenomenon can be described by these concepts: it is humanly impossible to achieve a perfect degree of accuracy in measurement. Yet, "it is enough to assert that, inasmuch as it is possible to make accurate measurements of this kind at all, Newtonian mechanics is fully valid now and will remain so in the future."⁵⁶ Heisenberg is absolutely convinced that there is a qualitative difference between predicative ability and understanding, as we saw in his comparison of Ptolemaic astronomy and Newtonian mechanics. Yet while there is a difference, that ability does play a very important role in determining the value of a theory. With regard to Newtonian mechanics, Heisenberg insists that, although even one disagreement between theory and experiment could refute the theory, this disagreement has never occurred within its appropriate framework. Furthermore, to imagine that it can be improved is a grave misunderstanding. In its world, Newtonian mechanics has always proven itself abundantly sufficient: "There are no experiments to force [improvements] upon us. And this is why we can grant that Newtonian physics has an absolute validity; in its particular sphere of application it cannot be improved by small changes."⁵⁷

In terms of the relation of Newtonian mechanics to other areas of physics, Heisenberg insists upon the critical recognition of *difference* between those areas. Quantum mechanics is not an "improvement" over Newtonian mechanics: it is "essentially different" from it.⁵⁸ The sphere of application of quantum mechanics may incorporate those concepts, but within an entirely different framework of questions; for Heisenberg, concepts are sharply defined with regard to their connections, but not in their relation to nature. Heisenberg outlines four closed areas in physics: Newtonian mechanics, statistical thermodynamics, quantum

mechanics, and special relativity theory. He maintains that for each of these four closed systems, "there is a precisely formulated system of concepts and axioms, whose propositions are strictly valid within the particular realm of experience they describe."⁵⁹ Certainly there are connections between these different areas. For example, Newtonian mechanics is contained as the limiting case in the system of special relativity, where the velocity of light can be considered as infinitely large, and as the limiting case in quantum theory, where Planck's quantum of action can be considered infinitely small. As we have discussed, it also belongs to quantum theory as a priori for the description of the experiments: "most experiments by which fields are measured are based upon Newtonian mechanics."⁶⁰ However, what is important is that each closed area, within its framework, gives simple laws that embrace a broad range of experience, and describes that experience accurately.

Heisenberg fully recognizes that the "bare datum of experience, in the sense that we normally know and recognize it, does not make clear why there should be very simple basic laws - laws that we can describe with a couple of simple mathematical concepts in spite of the fact that they determine an immense profusion of particular experiences."⁶¹ In one instance he finds himself defending to a pragmatic scientist the ultimate simplicity of all physical laws as the most important truth criterion in physics. Heisenberg is aware that he is on shaky "scientific" ground: "you may, of course, object that this insistence on simplicity is nothing but a hidden thirst for the absolute, devoid of the least logical justification. Why should physical laws be simple, why should wide realms of experience be susceptible to simple representation?"⁶² Nevertheless, Heisenberg insists that simplicity is not one we *impose* upon nature in this hidden thirst; these laws are not merely the conscious reduction of complicated

sense impressions into a simple mathematical theories. For Heisenberg, these laws which are represented by simple mathematical concepts really exist. And he has no "logical justification" for this, at least in terms of the logic of modern science. He can only turn to the experience of understanding, which tells us that it is so. Thus he makes a distinction between a constructed relationship and a purely self-evident one: "If, as we must always do as a first step in theoretical physics, we combine the results of experiments and formulae and arrive at a phenomenological description of the processes involved, we gain the impression that we have invented the formulae ourselves."⁶³ But should we, through continuing effort, encounter "one of those very simple, wide relationships that must later be incorporated into the axiom system, then things look quite different. Then we are brought face to face with a relationship that has always existed, and that was quite obviously not invented by us or by anyone else,"⁶⁴ where these relationships are "the real content of our science." Heisenberg is firm that one can actually claim to understand science only when one has fully absorbed the existence and meaning of such relationships.

The reaction of the other scientist in this particular conversation is telling: "He did not contradict me, but I had the distinct impression that my way of thinking was rather alien to him."⁶⁵ In terms of late modern science, Heisenberg's line of thought is alien. What he is getting at can only be grasped by moving beyond the boundaries, so to speak, of science in its most rationalized and narrow perspective, that is, into the realm of the *intelligible*, a realm always associated by Heisenberg with the beautiful. Of course, Heisenberg is fully aware that his introduction of the beautiful may be opposed as unscientific: "You may object that by speaking of simplicity and beauty I am introducing aesthetic criteria of truth."⁶⁶ Nonetheless,

Heisenberg insists that he is drawn to these notions because they are precisely what nature itself offers to our understanding: "I frankly admit that I am strongly attracted by the simplicity and beauty of the mathematical schemes with which nature presents us."⁶⁷ For Heisenberg, the experience of beauty is closely tied to the experience of those relationships, or the order of nature. Our next task is to take up the question of the existence and meaning of such order within that context of beauty.

Beauty, order and intelligibility

As we observed, Heisenberg is convinced that there is a qualitative difference in science between understanding and predicative ability. He insists that understanding is what makes science meaningful. For Heisenberg, this also applies to any of our human endeavours, insofar as understanding is what makes human existence meaningful. Understanding is what identifies us as human beings: "the ability to reach beyond the immediate sensory given, the recognition of wider interrelations" distinguishes us "above all living creatures."⁶⁸ It is with regard to understanding that science rejoins the fundamentally human world, since Heisenberg is sure that understanding is the *primary* characteristic of our being, as Gadamer is similarly convinced. Moreover, Heisenberg is sure that our own nature is closely related to the real nature of the world around us. Above all the world is intelligible - that is the primary characteristic of the world. Unlike Gadamer, however, who believes that the world is intelligible because it is linguistic in nature, Heisenberg relates its intelligibility to its orderliness. Hence, as it comes to recognize those relationships or connections in nature, which he generally refers to as a recognition of order, science is an expression of the universal experience of understanding. For Heisenberg, we understand order when we understand at

all, whether that order is associated with nature, or art or human relationships, and we understand order because the world is ordered.

It is quite interesting that, in this regard, Heisenberg also turns to the concept of beauty, and he does so for the same reasons as Gadamer - beauty has traditionally been closely associated with intelligibility: "The significance of the beautiful for the discovery of the true has at all times been recognized and emphasized."⁶⁹ Again, there is no logical justification for this significance; the experience of beauty is the justification, something that Gadamer also wished to get across. It is telling, then, that in a discussion of the meaning of beauty in the exact sciences, Heisenberg begins not with a philosophical analysis of the concept, but with that experience of beauty. To this end, he recalls his early introduction into the world of mathematics, and the deep impression made upon him by the wonderful interrelation within that world. At that time, he had not yet become conscious of the questions and issues associated with that particular experience of beauty. For example, he never addressed the question whether whole numbers and geometrical forms "really exist," that is, "whether they are there outside the human mind or whether they have merely been created by this mind as instruments for understanding the world."⁷⁰ Too young to consider these problems, what remained in the foreground for Heisenberg was the initial experience of beauty: "The impression of something very beautiful was, however, perfectly direct; it required no justification or explanation."⁷¹ It is the experience which convinces. For the moment, we will also leave aside that same question of what is "real" and what is "created," in order to focus more closely upon that experience, that is, as Heisenberg asks, "what was beautiful here?"

When approaching the beautiful with a more analytical attitude, Heisenberg obviously conceives of it in different, and much more structured, terms than Gadamer. He finds very compelling the classical definition of beauty as "the proper conformity of the parts to one another, and to the whole."⁷² It is just this kind of beauty that describes the mathematical axiom system underlying arithmetic and Euclidean geometry: "We perceive that the individual parts fit together, that as parts they do indeed belong to the whole, and without any reflection we feel the completeness and simplicity of this axiom system to be beautiful."⁷³ Heisenberg points out that in this one can see that the involvement of beauty with the ancient problem of the one and the many, which is itself related to the question of being and becoming. As Heisenberg sees it, the basic concern of Greek philosophy was how to understand the colourful variety of phenomena in terms of a basic principle. He finds appealing the resolution made within the Pythagorean school, where the notion originated that "the mathematical order was the basic principle whereby the multiplicity of phenomena could be accounted for."⁷⁴ He is particularly drawn to the Pythagoreans' "momentous discovery" that mathematical principles are the source of beauty in music, a discovery that influenced them to expand this notion to the entire world: "Understanding of the colourful multiplicity of the phenomena was thus to come about by recognizing in them unitary principles of form."⁷⁵ That is, to understand something was to grasp the very connection which was the source of beauty. Here Heisenberg sees the establishment of the close connection between the intelligible and the beautiful: "if the beautiful is conceived as a conformity of the parts to one another and to the whole, and if, on the other hand, all understanding is first made possible by means of this formal connection, the experience of the beautiful becomes virtually identical

with the experience of connections either understood or at least guessed at."⁷⁶ For Heisenberg, this relation between the intelligible and the beautiful is the most important element of the Pythagoreans' philosophy, as it is of Plato's.

Yet Heisenberg is quick to connect this more formal conception with the experience of the beautiful. In this regard, Heisenberg turns to another definition of beauty, one related to the radiance and the shining forth of the beautiful, which is the one Gadamer emphasizes. In this definition, as he finds it in Plotinus, no longer do we hear of parts, but of the whole: "Beauty is the translucence, through the material phenomena, of the eternal splendour of the one."⁷⁷ From this same line of thinking is derived the notion of the radiance of beauty, its shining quality, and Heisenberg repeats the Latin motto, "Pulchritudo splendour veritatis" - "Beauty is the splendour of truth."⁷⁸ Truth is recognized by the way it shines forth in beauty, or order. What captivates him in this second definition is the immediacy of the experience, which he is sure is a real human possibility: "it cannot be doubted that there actually is this perfectly immediate recognition, this shuddering before the beautiful, of which Plato speaks in the Phaedrus."⁷⁹ Implicit in his understanding of the immediacy and evidentness of the experience, which for Heisenberg is found in the sense of simplicity that accompanies the experience of truth. When Heisenberg refers us to that criterion of truth, "the simple is the seal of the true,"⁸⁰ he is also referring us to that experience of evidentness. In a critical connection, whereby the many are unified into a whole, we are confronted with a beautiful simplicity, an obviousness of the connection.

While Heisenberg points out that these two definitions - the conformity of the parts to one another and to the whole, and the translucence, through the material phenomena, of

the eternal splendour of the one - have always been perceived to stand in a certain opposition to each other, he insists that "in actual fact the two definitions are not so very widely removed from one another."⁸¹ Rather, they are two elements of the same experience. Basically, the first refers to what we understand, and the second to how we understand it. It is the second definition that stands as the real criterion of truth. That shining forth, that experience of enlightenment, is evidence of the truth of an understanding. Without doubt he includes the truths of science here as well as the truths of art; he asserts that the scientist "first recognizes truth by this splendour, by the way it shines forth."⁸² Understanding is something that "happens" to us; it precedes our exploration of it, so to speak. As Gadamer was convinced, so is Heisenberg that a real understanding makes an immediate impact upon us, and this because the recognition of order is not a process of rational thought. Real understanding is not the consequence of discursive thinking. Heisenberg is certain that a connection becomes recognizable "even before it is understood in detail and before it can be rationally demonstrated."⁸³ It is of interest to us that Heisenberg describes his own experience of understanding in these terms. Speaking of his discovery of the mathematical formulation for quantum mechanics, he writes: "At first I was deeply alarmed. I had the feeling that, through the surface of the atomic phenomena, I was looking at a strangely beautiful interior, and felt almost giddy at the thought that I now had to probe this wealth of mathematical structures nature had so generously spread before me."⁸⁴ 'Probing' that wealth, or rationally analyzing it, only follows the experience of understanding it. For Heisenberg, this is a feature of all human understanding, whether that understanding is in art or in science. It might even pleasantly surprise Gadamer to find that Heisenberg considers rational thinking and careful

measurement simply as instruments of the scientist, just as the sculptor uses a hammer and chisel: "But in both cases, they are merely the tools and not the content of the work."⁸⁵ In exact science as well as in the arts, that experience of understanding order or beauty, "is the most important source of illumination and clarity."⁸⁶

Obviously, Heisenberg is moving far beyond the notion of understanding as it is perceived in a rational, objective science. Furthermore, though Heisenberg sees the universe as a cosmos, which means beauty as well as order, he does not equate all order with that susceptible to mathematical representation. He insists that we must discard the notion of a "single" way to understand. The contemporary study of nature has made it particularly clear, at least to Heisenberg, that the "concept of scientific truth basic to natural science can bear many kinds of natural understanding."⁸⁷ He adds that science proper is only "a link in the endless chain of discussions of man with nature."⁸⁸ And while art uses different forms than science for its expression of the intelligible, he is adamant that "all art, all poetry in some way mediate understanding." He turns to Plato for insight here: after attempting to approach as close as possible to the One through precise scientific language, Plato turns to poetry, "which evokes in the hearer images conveying understanding of an altogether different kind."⁸⁹ Yet the experience of understanding in art is just that which justifies its legitimacy: "every art would be worthless if it was no longer able to move men, no longer able to illumine for them the meaning of existence."⁹⁰ Indeed, art is one of the most important modes of understanding. The relationships it tries to make intelligible are those that are most closely related to our lives; we are always a part of the order that art makes understandable. It is not surprising then, that Heisenberg closely relates art and religion. In this, he sees it is crucial to recognize

that "the fact that religions through the ages have spoken in images, parables, and paradoxes means simply that there are no other ways of grasping the reality to which they refer. But that does not mean that it is not a genuine reality. And splitting this reality into an objective and a subjective side won't get us very far."⁹¹ What is called for is an openness to understand the orders made intelligible there, an openness he is sure is just as necessary in science.

Order as the medium of our existence

Much earlier, we pointed out Heisenberg's belief that humans were in great danger of losing that 'certainty in the strivings of their hearts,' or that fundamental human attitude. In his view, regaining this certainty depends upon the possibility of enlarging the scope of our understanding. With regard to this, the division of reality into an objective and subjective side poses a large problem, especially with regard to non-scientific endeavours. For example, to a scientized world thinking out of that Cartesian perspective, works of art are "rather arbitrary products of the human mind,"⁹² deriving from a subjective as opposed to an objective world. But Heisenberg is firm that we cannot be misled by the Cartesian partition, that we need to move beyond subjective and objective, beyond mental and material realities - and not only in art, but in science too. Heisenberg is generally very uncomfortable arguing the objective reality of intangible "things" in which art, religion and philosophy are interested. For Heisenberg, this is the wrong way to go about legitimating the truths therein. Recall that the question of whether the forms of mathematics were real or whether they are created by the human mind for the purpose of understanding did not occur to a young Heisenberg. The impression of beauty had the most impact. However, his serious consideration of that question when he is older still places that experience in the foreground. The experience of

understanding, of the beautiful, is that which truly moves a person: in Platonic terms, it is in the beautiful that "the divine becomes visible and at sight of which the wings of the soul begin to grow."⁹³ Thus with regard to the meaning of a work of art, for example, whether it is something we create in order to impose order on the world, or whether it really represents an aspect of reality, Heisenberg tends to subordinate the question to the experience of understanding. Or better, that issue is resolved in relation to the reality of the experience.

Given that "understanding can never mean anything more than the perception of connections,"⁹⁴ he urges us to see that the world is not divided into different groups of objects, "but into different groups of connections."⁹⁵ Furthermore, there is a tremendous and inherent richness within these connections; in Heisenberg's view, the world in its entirety presents itself to us "as a complicated tissue of events, in which connections of different kinds alternate or overlap or combine and thereby determine the texture of the whole."⁹⁶ The significance here is that this perception of connections is transformed into a perception of reality. For Heisenberg, reality is not associated with the material, or immaterial, existence of a thing, but *primarily with its intelligibility*. It is relevant to our discussion that Heisenberg conceives the issue of the "objective reality" of elementary particles to dissolve of itself with regard to our understanding of them: "The conception of the objective reality of the elementary particles has thus evaporated in a curious way, not into the fog of some new, obscure, or not yet understood reality concept, but into the transparent clarity of a mathematics that represents no longer the behaviour of the elementary particles but rather our knowledge of this behaviour."⁹⁷ By focusing on the "transparent clarity" of our understanding, the question of their objective reality becomes a non-issue.

In Heisenberg's view, this is not merely a convenient perspective. For instance, Heisenberg tells us that when the scientist tries to understand nature, from the very beginning he stands in the center of the ongoing interplay between humans and nature, an interplay in which "science is, of course, only a part." In this center, "the familiar classification of the world into subject and object, inner and outer world, body and soul, somehow no longer applies, and indeed leads to difficulties."⁹⁸ As science does, so also art, religion and philosophy derive their being "from the interplay between the world and ourselves."⁹⁹ This interplay crosses the borders of modern scientific ontology in every sense. Of course, this is no crime, given that the division of the world into objective and subjective is "arbitrary and historically a direct consequence of our scientific method."¹⁰⁰ Heisenberg suggests that if we want to think in terms of this division, we might say that understanding begins at a point between the one extreme of "the idea of an objective world, pursuing its regular course in space and time, independently of any observing subject" and the other extreme of "the idea of a subject, mystically experiencing the unity of the world and no longer confronted by an object or by any objective world."¹⁰¹ However, much more appropriate to the actual nature of our situation is to state that understanding is an experience that is "beyond the question of objective and subjective."¹⁰²

Understanding is such an experience because it reflects the intelligible nature of the world. He insists the structures of intelligibility "must be of such a kind that it can no longer be determined whether they belong to what we think of as the objective world or to the human soul, since they form the presuppositions for both."¹⁰³ Order is the real medium of the world, a world that always includes ourselves. In terms of our understanding of nature he

states: "Nature was made so that we are able to understand it. Or perhaps it is better said the other way around: our reasoning power is made to understand nature....The same organizing forces that have shaped nature in all its forms, and which are responsible for the structure of our souls, are also responsible for that reasoning power."¹⁰⁴ Obviously Heisenberg is not thinking here of a sharp demarcation between us and nature, a Platonic 'separate but equal' situation, where in the course of our encounter with nature our innate understanding of it is dragged out from some hidden corner of our soul. For Heisenberg, there is no hidden corner to our soul. He is sure that we understand the world in all its aspects, not only because we share the same order, but also because we are immersed in that order. The scientist, and naturally the artist, only understands because he is at the center of a larger interplay of order.

Here we have an interesting line to follow. Heisenberg speaks of a reasoning power that accords with the intelligible nature of the world, for certainly he means that all aspects of the world are intelligible, not only those amenable to scientific understanding. On the other hand, we saw much earlier with respect to quantum mechanics that understanding is grounded in pre-understandings, and this is the case for any area of human understanding. What we see, then, is that this reasoning power includes our pre-understandings. That is, tradition is an essential aspect of our understanding. Heisenberg cannot emphasize enough that our understanding is utterly dependent upon what we have previously understood, and the way in which we have understood it. This was clearly demonstrated in his realization that the theory decides what we can observe, but we should reiterate this. In a discussion about tradition in science, i.e., "whether it has filled the minds of the scientists with prejudices or preconceptions, the removal of which was the most important condition for progress,"

Heisenberg underlines the fact science is possible *only through tradition*.¹⁰⁵ To study phenomena properly, "we need a language, we need words, and the words are the verbal expressions of concepts. In the beginning of the investigations, we cannot avoid connecting the words with the old concepts; the new concepts do not exist yet. Therefore these so-called prejudices are a necessary part of our language and cannot simply be eliminated."¹⁰⁶ These prejudices and preconceptions are not subjective elements which need to be purged from our minds that we may be able to understand. Such a purge would be impossible anyway. As he says of the traditional concepts with which we work: "they may even be inherited..."¹⁰⁷ He does not really mean that they are genetically passed on; rather, he wants to get across idea that they are an absolutely integral part of our being, as it is being in the world. Actually, the intelligible structures of tradition might as well be a genetic feature of our being, insofar as our being is grounded in that intelligible world.

When Heisenberg, then, talks about the scientist at the center of a much larger interplay, he means that the scientist comes into a world already intelligible in a particular way. Nor is the particularity an arbitrary one that can be shaken off. The structures of intelligibility brought into being by the human world through continual interplay are, from the perspective of human understanding, as much a feature of that overarching medium of order as any other. Thus, when Heisenberg talks about the order of the world, he refers to an order that always includes the past and present human order. To say that we are immersed in order is to say not only that order is what we understand, but also that we understand order through order. In this, Heisenberg sees tradition as the living reservoir of intelligibility. It enables us to understand precisely because it opens the world to an ever-increasing view. Yet to fully

grasp this it is necessary to explore in some depth the actual nature of intelligible structures with which we are in constant interplay.

The nature of order

At the outset, it is critical to keep in mind that Heisenberg sees all intelligible structures as fundamentally related, a relation grounded in what Heisenberg calls the *central order*. Clearly, in view of his conception of the nature of understanding, his use of this term is intended to stress the inherent intelligibility of reality, though he additionally refers to it as "the one, the good and the true," the "divine order," or the "One." In the realm of understanding, the realm in which humans are always situated, the central order is "a connection of the whole that gives meaning to the particular event."¹⁰⁸ For Heisenberg, no order is without this relation to the center. This central order is the source of all order, it embraces all order, and is the center of *each* order. Thus, all orders must reflect the whole, which necessarily includes all other orders. We observe this in Heisenberg's declaration that, wherever that splendour of understanding occurs, there is a new world opened up to us: "this shining forth of the great connection [is] the crucial signal for a significant advance."¹⁰⁹ Gadamer's reference to understanding in terms of a light being turned on, extending the range of what we can see, is thoroughly applicable in Heisenberg's case. Although Heisenberg does not use the term "speculative" with regard to order, in Heisenberg's notion of the actuality and possibility of order, of the intelligible structures of reality, we find something that corresponds very closely to it.

In coming to his understanding of the nature of order, it is clear that Heisenberg is relying in part on Plato, as we remember Gadamer did. Indeed, much of Heisenberg's

thinking is grounded in some key elements of Plato's philosophy. Basically, Heisenberg agrees with Plato that we need to aspire to a higher order with respect to the living out of our lives, that this higher order is found in the intelligible structures, and that our participation in those structures enables us to understand them. Yet, for all that Heisenberg relies on Plato's insights, he does not replicate that philosophy in his own works, for the simple reason that Plato tries to remove us from this shadow world into the 'real world' of mind. For Heisenberg, Aristotle goes a long way in providing a balance to this picture, in the sense that Aristotle would have us fully grounded in this world. Heisenberg cannot help sympathizing with Aristotle's complaints about the Pythagoreans and Platonists, that they tried to accommodate facts to fit the theories, rather than seeking theories to account for observed facts, and "were thus setting up, one might say, as joint organizers of the universe."¹¹⁰ Just as Heisenberg understands the "correct" representation of natural phenomena in modern science to have evolved from the interplay between the "the wealth of facts and the mathematical forms that may possibly be appropriate to them," so he feels that both Plato and Aristotle have much to add to our understanding of reality. Of course, he is not interested in setting out a definitive middle ground between the two; rather, he uses them to point beyond the modern vision of reality.

As Heisenberg understands him, Plato sees the world around us as an imperfect and less real reproduction of the world of the Ideas: "Material things are the copies, the shadow images, of the ideal shapes in reality."¹¹¹ There is a sharp demarcation in Plato's philosophy between a corporeal being accessible to our senses and a purely ideal being accessible only through acts of mind. In terms of our participation in being, we are only able to know the

Ideas because they are part of us: "As their name already indicates, the apprehension of Ideas by the human mind is more an artistic intuiting, a half-conscious imitation, than a knowledge conveyed by the understanding. It is a reminiscence of forms that were already implanted in this soul before its existence on earth."¹¹² Certainly for Plato, it is only because we are in the sensible world that truth is accessible, that we can ever understand the structures within. Yet, while Plato states that we begin our movement to the good in the world, which stimulates reflection on the forms, he would have us quickly leave the world, to leave the visible embodiment of the form, and consider it only in the mind. For example, he suggests that in astronomy and geometry, "we should employ problems, and let the heavens alone if we would approach the subject in the right way and so make the natural gift of reason to be of any real use."¹¹³ A purer, more ideal beauty is found in the mind than in the world, and it is this beauty that helps lead one upwards.

While Heisenberg feels Plato offers tremendous insight with regard to the experience of beauty, he cannot remain with Plato when it comes to departing from the world. For Heisenberg, when we turn away from the given world, we turn away from reality, which must be our grounding from first to last. Unlike Plato, Heisenberg does not require that we escape from the world. Indeed, he is more concerned with our remaining in the world, in the given realm of order and intelligibility. Heisenberg remarks that humans sometimes tend to look at the reality around us with frustration, that we see the facts of the world, including both the insights of art and science as well as the real situations around us, as "a sort of constraint, as an oppression, which we submit to reluctantly." He continues

We think that freedom is given only when we are able to withdraw from this constraint into the realm of fantasy and dreams, into the intoxication of surrender to utopia. There we hope, at long last, to realize the absolute which we intuit and which time and again spurs us on to the highest achievements, for instance in art. But we fail to appreciate what 'realization' means. Its very basis is reality; it can only be attained through the combination of facts or thoughts in accordance with the laws of nature.¹¹⁴

As Plato is drawn to leave the shadows for an ideal world, Heisenberg conceives his philosophy to veer precariously towards illusion. Thus what Heisenberg appreciates in Aristotle is his recognition of the reality of our situation - humans understand in and through the world. Aristotle rejects Plato's Ideas on the basis that they are simply too completely separate from the world in which we are wholly immersed to be knowable by us. Yet, it is not simply a matter for Aristotle of their unknowability; their complete separation from the world makes it impossible that they should be the causes of the things around us. Aristotle cannot see how a separately existing universal could be the cause of the many individual concrete things that we experience. This is no shadow world; the things here are eminently *real*. What we are, what we know, and what we desire occur in the context of this world. So for Aristotle, when we aim at our natural excellence, i.e., understanding, we aim to understand the things of this world. Of course, in his four causes (the material, the formal, the efficient, and the final), Aristotle offers a definite checklist of understanding that accounts for the whole of a thing: its substance, its coming-into-being, its changes, and its purpose. Heisenberg finds genuine merit in these causes, as he finds merit in much of Aristotle's philosophy. Although our purpose here is not to order Heisenberg's thought in terms of Aristotle's philosophy, we can generally state that Heisenberg is drawn to the living picture of the world given by Aristotle.

On the one hand, then, the intelligible structures of reality - "the order of things and events" to which Heisenberg often refers -, certainly have their basis in Plato's Ideas. Heisenberg generally prefers the term "structure" to "Idea" for the simple reason that "the word 'Idea' has acquired a rather too subjective taint."¹¹⁵ That they are real, and that we participate in them, Heisenberg is quite convinced: "we all know that our own reality depends on the structure of our consciousness; we can objectify no more than a small part of our world. But even when we try to probe into the subjective realm, we cannot ignore the central order or look upon the forms peopling this realm as mere phantoms or accidents."¹¹⁶ On the other hand, he deliberately associates these structures with Aristotle's formal cause: "what was called the 'formal cause' one would today perhaps designate as the structure or the intellectual content of a thing."¹¹⁷ By intellectual content, and in view of our earlier discussion, Heisenberg means simply that which is intelligible. And while Heisenberg is quite conscious that for Plato, material things are the shadow images of the ideal shapes in reality, he does not accept precisely this conception, but turns to the notion of Aristotle's formal cause: "moreover, as we should be tempted to continue today, these ideal shapes are actual [*wirklich*] because and insofar as they become 'act'-ive [*'wirk'sam*] in material events."¹¹⁸

Of course, Aristotle spoke about the formal cause in connection with the material cause. The material is that out of which a thing comes to be and which persists. Matter is not some brute stuff, but is potential. It has a nature such that things which possess it are capable of being, and not being. Thus, where matter is the potentiality, form is the *actuality*: "Actuality means the existence of the thing, not in the way which we express by 'potentially'; we say that potentially, for instance, a statue of Hermes is in the block of wood...."¹¹⁹

Actuality is the specific form which allows that statue to be. It is of some interest that Heisenberg uses this notion with regard to an understanding of matter. In physics, of course, the notion of an objective existence of a thing has been radically questioned. The smallest bits of matter are not solid or immutable objects. Heisenberg points out that accelerator experiments have demonstrated the complete mutability of matter: at sufficiently high energies, elementary particles can be transmuted into other particles, or can simply be created from kinetic energy and can be annihilated into energy. In terms of a qualitative description of the fundamental structure of matter, Heisenberg offers energy as that basic feature of matter which persists under all apparent changes, or as he refers to it, "universal matter."¹²⁰ All elementary particles are made of the same substance, which can be called energy or universal matter: those elementary particles are "just different forms in which matter can appear."¹²¹ He goes on to describe it precisely in terms of Aristotelian thought: "the matter of Aristotle, which is mere 'potentia', should be compared to our concept of energy, which gets into 'actuality' by means of the form, when the elementary particle is created."¹²² But physics is not satisfied with this qualitative description; it wants "a mathematical formulation of those natural laws that determine the 'forms' of matter, the elementary particles and their forces."¹²³

Of even more interest is that Heisenberg does not restrict the concept of potentia to matter, but uses it in connection with those forms of matter, which he refers to in terms of the *possibilities* of the structures of reality. Let us keep for the moment to the world of physics. He says that if we want to describe an elementary particle accurately, the best we can do is write down a probability function. Since the mathematical formalisms of our science do not

allow questions of nature or quality, but of motion, the most accurate description of an elementary particle given to us is a statistical probability, within a definite range, of the location a particle will materialize with observation. For Heisenberg, the mathematical forms symbolizing elementary particles can be described as "the ideas of the elementary particles on which the actual particles are modelled."¹²⁴ Certainly, the idea - the intelligible - is the real, in the sense that it is that upon which the particles are modelled, and without the idea there would be no particles. But what makes a structure actual for Heisenberg is precisely its ability to actualize in the world. Thus Heisenberg is adamant that "not even the quality of being (if that may be called a 'quality') belongs to what is described. It is a possibility for being or a tendency for being."¹²⁵ By "being," he simply means an actualization into the world. For Heisenberg, as a tendency for being, a structure or idea is absolutely related to the world. It is understood as a structure in itself, to be sure, but at the same time in terms of its possibilities. This is an important point to consider. That is, its intelligibility is tied to both the actual and the possible.

To elaborate upon this, he draws upon Goethe's understanding of the structures of reality, which Heisenberg interprets from an ostensibly Platonic perspective (keeping in mind Heisenberg's "slight" modification of that perspective). Specifically, Heisenberg finds quite insightful his vision of the *Urphänomen*, the "ground phenomenon." As Heisenberg describes it, "This ground phenomenon was not to be a fundamental principle, from which the various phenomena had to be deduced, but a basic appearance within which the manifold was to be discerned."¹²⁶ What is significant to Heisenberg is that the discovery of this ground phenomenon is not a reduction of the many to the one, but of vision of the many "in" the one:

it is an uncovering of possibilities. With regard to what Goethe called the archetypal plant, this ground phenomenon "is the primordial form, the basic structure, the shaping principle of plants, which need not be constructed by the understanding but can also come directly to our awareness in intuition."¹²⁷ To remain with this context, this ground phenomenon would be the key by which we could invent plants *ad infinitum*. When Heisenberg speaks of intelligible structures, he means this kind of ground phenomenon. Thus, in his hope that physics would achieve an understanding of that idea of all forms of matter, i.e., a simple and easily understandable mathematical structure (relatively speaking), he has in mind less a formula from which all forms are to be deduced, than an appearance, so to speak, of possibilities.

Heisenberg is sure that the dimensions of actuality and possibility within the intelligible structures are closely related. That is, that vision of the many in the one works both ways, since we can get to the one through the many. Certainly, understanding is always of order, the proper conformity of the part to each other and the whole. But for Heisenberg, the parts reflect the whole; each part carries the whole within it. All order has that center, so to speak, and thus all order can reflect the central order. As he writes, should we seize upon given reality with all our powers of understanding, "this reality will then also reflect the essence of things, the 'one, the good and the true.'"¹²⁸ Naturally, this is as true of the intelligible structures that we encounter in our scientific study of nature as of those we encounter in art: "the very broad connections become apparent in the basic structures, in the Platonic Ideas that thereby manifest themselves; and since these Ideas give tidings of the underlying total order, they may also, perhaps, be picked up by other areas of the human psyche than merely that of ratio - areas which themselves in turn stand in immediate relation

to that total order, and hence also to the world of values."¹²⁹ Of course, one of the clearest examples of the part participating in the whole is ourselves. We see Heisenberg's understanding of this in his response to a question concerning his belief in a "personal God." Heisenberg asks to rephrase the question: "Can you, or anyone else, reach the central order of things or events, as directly as you can reach the soul of another human being?" To this, he answers yes. Questioned on his use here of the word "soul" rather than "people", Heisenberg explains that the word "soul" signifies precisely "the central order, the centre of a being, which in its outer manifestations might be very diverse and complex."¹³⁰ In our centre, we participate in the central order, just as all order participates in the center.

In terms of our understanding, this means that the intelligible structures both encompass order, and are encompassed by order. There is always a larger order associated with any given order, a possibility that stands above it, so to speak, to which the actual order is intimately related and to which it points. Again, though, it is a mistake to think of that larger order as something from some distant and ideal world. Rather, it is a real possibility in this world. We see this in his insistence that *the aim to be reached, the possibility to be realized, influences the course of events.*¹³¹ Recall that he sees structures as actual 'because and insofar as they become active in the world.' They are actual as the possibility to be realized. Heisenberg gives us an image of this in one of his discussions of beauty: "when a great cathedral was to be built in the Middle Ages, many master masons and craftsmen were employed. They were imbued with the idea of beauty posited in the original forms, and were compelled by their task to carry out exact and meticulous work in accordance with these forms."¹³² The possibility guides the realization. Though this illustration through a pre-given

structure may be thought of as somewhat artificial, this is actually not the case. The idea of the cathedral itself is an aspect of something much larger - the effort to illuminate our relationship to the divine, and the understanding of that relationship guides the architectural forms of the cathedral. For example, the medieval stone masons who endeavoured to reproduce the folds of garments as accurately as possible did not conceive of the solution to that problem as an end in itself; rather, "the solution of their special problem was necessary because the folds of the garments of the saints were part of the large religious relationship that was the real aim."¹³³

In fact, and perhaps more importantly, the possibility to be reached influences the course of events even when we are initially unaware of the larger possibility. Heisenberg offers an illustration of this from the concept of a "style" of architecture. Pointing to the basic forms of certain styles of architecture, Heisenberg remarks through the course of history there emerges

new, more complicated and also altered forms, which yet can still in some way be regarded as variations on the same theme; and from the basic structures there emerge a new manner, a new style of building. We have the feeling, nonetheless, the possibilities of development were already perceivable in these original forms, even at the outset; otherwise it would be scarcely comprehensible that many gifted artists should have so quickly resolved to pursue these new possibilities.¹³⁴

At the outset, we might not even be fully alive to all the possibilities. But even when a "part" come into being, the larger possibility, or the "whole," is actualized at the same time. As he notes: "the development of the style is therefore more a matter of unfolding than of new creation."¹³⁵ For Heisenberg, with an actualization of order, there is at the same time an introduction of a larger possibility.

That the larger possibility shapes the form of the understanding is quite significant. Heisenberg is convinced that in the attempt to make an order intelligible, the artist "is led to the forms of the style in which he works."¹³⁶ He is quite clear that in art "one cannot invent such basic forms but only discover them."¹³⁷ The basic forms possess a genuine reality. The forms are in fact determined by the larger possibility; hence it is a true understanding. Here again we see the affinity between Heisenberg and Gadamer. Recall that for Gadamer, with regard to beauty, the beautiful must always be understood ontologically as an 'image', meaning that it makes no difference whether it or its copy appears; the important thing about an image is that it shares the being with what it images. For Heisenberg, a work of art is an actualization of a possibility of a larger connection; it has an intimate relation to that larger possibility. The goal of art, as the goal of all understanding, is precisely to illuminate the world. With regard to this goal, Heisenberg concludes that "Under fortunate circumstances one may discover that there are forms which do this, but one cannot simply construct them."¹³⁸ Of course, the experience of understanding is the only "proof" of this truth. For Heisenberg, it almost goes without saying that something like Newtonian science is a true understanding of nature with regard to the particular framework of approach. Nothing could replace it, simply because Newtonian theory is the inherently appropriate form in which we come to understand our relation to that aspect of nature. From this perspective, there is no difference between a work of art and a scientific theory.

The notion that the larger possibility influences its actualization in the world certainly means that truth is associated with our efforts to understand the whole, but also has a further implication. In Heisenberg's view, humans understand not only because understanding is

natural to us, but also because the intelligible guides our efforts in understanding. The world strives to be intelligible. In other words, there is a real interplay and relationship between our efforts to understand and that which we try to understand. Heisenberg sees this clearly with regard to nature. It is very indicative that Heisenberg considers our relationship to nature as one of real dialogue, as opposed to one of interrogation and manipulation. Heisenberg is clear that nature is interacting with us in science as much as we interact with it, and it is only through this interplay that we come to any understanding. The structures or wide connections that are the real content of science emerge only through genuine effort to dialogue with nature, a dialogue in which nature responds. Heisenberg speaks of nature "revealing" its structures to us: "the mere fact that we could never have arrived at these forms by ourselves, that they were revealed to us by nature, suggests strongly that they must be a part of reality, not just of our thoughts about reality."¹³⁹ Elsewhere, Heisenberg refers to the simple and beautiful mathematical schemes which "nature presents us," and of the "almost frightening simplicity and wholeness of the relationships *which nature suddenly spreads out before us* and for which none of us is prepared [emphasis added]."¹⁴⁰ For the physicist, it is precisely because we are in dialogue with nature that we come to any true understanding: "If nature leads us to mathematical forms of great simplicity and beauty - by forms I am referring to coherent systems of hypotheses, axioms, etc.- to forms that no one has previously encountered, we cannot help thinking that they are 'true', that they reveal a genuine feature of nature."¹⁴¹ Naturally, Heisenberg believes that concepts like "dialogue" or "intention" are most appropriate to the human world, and "can at most serve as metaphors when applied to

nature."¹⁴² His emphasis here is that there is a genuine interplay within the larger medium of order, that what we try to understand in a sense moves forward to meet us.

The intelligible world of concepts

Perhaps the best illustration of the nature of the intelligible structures, and thus the intelligible world, is found in Heisenberg's understanding of concepts. In this connection, we can learn something from Heisenberg's discussion with regard to his friend Wolfgang Pauli's philosophical outlook. Like Heisenberg, Pauli is unhappy with the "purely empiricist view whereby natural laws can be drawn solely from the data of experience."¹⁴³ Pauli, postulating an underlying order of the cosmos of a Platonic type, thinks that the bridge from the unordered world of experience and the world of Ideas is found in "certain primeval images preexisting in the soul, the archetypes discussed by Kepler and also by modern [Jungian] psychology."¹⁴⁴ In Pauli's thinking, understanding is just that recognition of agreement between the inner images and the outer world: "the preexisting images fall into congruence with the behaviour of external objects."¹⁴⁵ In this Pauli agrees with Kepler, and they both further agree that it is "naturally characteristic of these primal images that they cannot be rationally or even intuitively described."¹⁴⁶ Heisenberg points out that there are in fact differences in the nature of the archetypes conceived Platonically by Kepler and in Jungian terms by Pauli. The archetypes of Jungian psychology can be regarded as "slowly variable and relative to a given cognitive situation," whereas for Plato the primary images exist "unchangeably and independent of the human soul." What draws them together is that "the archetypes are consequences or evidences of a general order of the cosmos, embracing matter and spirit alike."¹⁴⁷

When Heisenberg thinks of concepts, he thinks of them somewhat along the lines of these kinds of archetypes. The most important connection between them is found in Heisenberg's notion that, since order is the medium of our existence, we only understand order through order. Of course, archetypes conceived as bridges between the sense perceptions and the Ideas in the soul do not play a significant part in Heisenberg's own larger philosophical outlook. Certainly he agrees that understanding is a process that occurs at levels beyond the rational, and he does speak of understanding in terms of recognition, but Heisenberg does not think we need to dig deep within ourselves to some hidden level of archetypes. The intelligible structures are the ground of the whole, and we are in constant interplay with them. In a sense, the process of understanding occurs "on the surface," though this does not mean it is a superficial process. Concepts are at our fingertips - life, mind, God. But when we use a concept in earnest, when we try to understand through a concept, we are led from it into a network of wider structures.¹⁴⁸ Concepts are also intelligible structures, embracing both possibility and actuality. They are structures of order, yet at the same time they are ordering structures. Indeed, Heisenberg states that we can describe a concept "as sort of a 'ground phenomenon,'" ¹⁴⁹ though he admits that Goethe would not have used the term in this context. It is especially in his understanding of concepts that we see how strong is Heisenberg's conviction that order is the medium of our existence: the orders with which humans are in interplay neither belong exclusively to the world "out there" nor to humans "in here," but are rather shared between them.

In Heisenberg's view, concept formation is a natural characteristic of human beings. It is not without interest that Gadamer himself refers to the process of concept formation as

a natural process, though one through language. For Heisenberg, it is a natural process through our larger and collective interplay with the order of the world. That is, concepts emerge from tradition. As he writes, "the influence of tradition is perhaps strongest in shaping or passing on the concepts" by which we try to understand.¹⁵⁰ If understanding is the perception of connections, then concepts are in a sense the foundation for understanding; they give us orders with which to understand the world. A concept is an abstraction from the world, and depends on our ability to consider an object or group of objects "under *one* viewpoint while disregarding all other properties of the object." He continues: "The essence of abstraction consists of singling out one feature, which, in contrast to all other properties, is considered to be particularly important in this connection... all concept formation depends on this process of abstraction, since concept formation presupposes the ability to recognize similarities."¹⁵¹ For Heisenberg, concepts need not be rationally constructed, and indeed rarely are: "concepts are acquired gradually without critical analysis."¹⁵² That is, concepts are acquired by our living and thus understanding in the world. The most significant concepts are just those that emerge from that immediate interplay with the world. In fact, he views the concepts of the human world, such as mind, or soul, or life, as *primary*: "the concepts of natural language are formed by the immediate connection with reality; they represent reality."¹⁵³ Moreover, Heisenberg emphasizes that many of the concepts so significant in Newtonian science, such as "time" and "space," derive from what we might call these "human concepts." Instead of lessening their meaningfulness, this indicates their connection with reality, where "the existence of such a connection is an indispensable precondition for the abstraction still to convey any understanding of the world at all."¹⁵⁴

He thinks that this is an important recollection for the scientific age, which tends to see scientific concepts as the primary ones, and which reacts with scepticism towards the human concepts. The concepts of science are well-defined, to be sure, at least with respect to their connections, where the human concepts seem to have less definition, even with respect to their connections. Given this lack of precise definition, these concepts may "undergo changes in the courses of the centuries." Nevertheless, Heisenberg is quick to add that despite these changes, "they never lose their immediate connection with reality."¹⁵⁵ Naturally, one might choose to see the changes in terms of contradictions, but he points out that the concepts of science cannot escape contradictions, even in its most precise parts: "It is well known that the concept of infinity leads to contradictions that have been analyzed, but it would be practically impossible to construct the main parts of mathematics without this concept."¹⁵⁶ For Heisenberg, vaguely defined as human concepts may be, in fact they are "more stable in the expansion of knowledge than the precise terms of scientific language."¹⁵⁷ That is, scientific concepts are so well-defined, and so specialized, that their applicability is largely confined to very limited aspects of reality; they are unstable because we must occasionally abandon concepts altogether as we move to other aspects of the world. The concept of the complete independence of space and time, which is a fundamental assumption of Newtonian physics, is radically changed in the theory of relativity. But the concepts of the human world are rarely abandoned; they are always fruitful. This is not to dismiss the fruitfulness of scientific concepts. As long as they are connected to reality, they share the nature of human concepts.

For Heisenberg, a concept is always much more than it appears, particularly because it is a sort of ground phenomenon. From its formation through a specific connection in the world, a concept opens the door into a network of intelligible structures. That is, once a concept is brought into actuality, tremendous possibilities are brought into being as well. Heisenberg understands a concept to be closely, and intrinsically, related to what he call the unfolding of abstract structures: "the concept formed by way of abstraction takes on a life of its own; it allows for the generation of an unexpected wealth of forms or ordering structures, which can later prove valuable in some way."¹⁵⁸ By forms he means a specific understanding, like a work of art or science. That our own efforts play only a part in the unfolding of structures from within it is quite fascinating, but tremendously characteristic of Heisenberg's larger understanding of the medium of order, and the real interplay that occurs here. Concepts are in a sense independent of our understanding, or rather, while we at one point seem to have "created" a concept, that creation turns around and "re-creates" us, in terms of what is given to our understanding and how we understand it:

The concepts initially formed by abstraction from particular situations or experiential complexes acquire a life of their own. They prove to be far more abundant and fruitful than we can initially perceive them to be. In later developments they display an independent ordering power - in promoting the creation of new forms and concepts, in providing insight into their connection and also in somehow demonstrating their own value....¹⁵⁹

Once we grasp a "part" of a concept, we can somehow get into the whole of it. As to what "all of it" might mean is unknown. As mentioned, though concepts are precisely defined with respect to their particular connections (e.g., the concepts within the system of Newtonian mechanics), concepts are never precisely defined with respect to their meaning -

"that is to say, we do not know exactly how far they will help us in finding our way in the world. We often know that they can be applied to a wide range of inner and outer experience, but we practically never know precisely the limits of their applicability."¹⁶⁰ This is true for concepts of science, but even more true with regard to natural concepts. These are not well defined, but for Heisenberg this is precisely because of their immediate connection with reality: the less definition a concept possesses is almost an indication of its greater richness. Of course, the initial formation of a concept may suggest possibilities, but the range of those possibilities are beyond that initial conception. From our perspective in the world, there is nothing inevitable whatsoever about a concept. Concepts can surprise us, because they can lead us to the unexpected or unforeseen. In addition, concepts can also surprise us by showing limitations where we most expect them to succeed.

For Heisenberg both the limitations and the possibilities of concepts are tied to the reality that we are beings in the world, and that this is where our real interest is centred, where the "world" means our relationship with all the possibilities associated with order. Indeed, given all the possibilities of order, the most obvious limitation of a concept is that a single concept is never enough. A concept is an abstraction from the world, and when we abstract, we necessarily lose aspects of the world. As abstractions, concepts "cover always only a very limited part of reality, and the other part that has not yet been understood is infinite."¹⁶¹ Hence that necessity for as many concepts as possible. It is for this reason that Heisenberg agrees with Bohr that "only fullness leads to clarity, and truth dwells in the deeps.' Fullness here is not only a wealth of experience, but an abundance of concepts, of approaches, with which to discuss our problems and phenomena in general."¹⁶² Thus, when we try to

understand a relationship or a connection, we bring a variety of concepts to the problem, "lighting this relationship up from all sides."¹⁶³ Naturally, we must remember that for Heisenberg, this call to fullness applies to all aspects of our understanding. No single work of art, nor a single scientific theory will ever illuminate the whole for us. Certainly a work of beauty, scientific or artistic, can shine with that splendour of the whole, but the consequence of such a work is precisely the opening up of new worlds to us, and thus new understandings.

Heisenberg's understanding of concepts adds to his vision of the almost living intelligibility of the world. We come to the world already understanding it, insofar as we come into a world of concepts. Despite their nature as abstractions, concepts are not vague or bare formations; rather, they are replete with possibilities. They acquire this richness *through* their connections with tradition. Nor can concepts be severed from their connections; by its nature, each concept brings with it the world from which it emerged, whether or not we are aware of it: "Traditional concepts form our way of thinking about the problems and determine our questions."¹⁶⁴ Thus we are already "in" the world given by traditional concepts; our range of view is determined by those concepts. In Gadamer's terms, we might call it a horizon, and for Heisenberg, we are constrained to the possibilities of this horizon. An illustration from the world of science is helpful here: "Scientists are bound up with the historical process, and their choices seem to be restricted to deciding whether or not to participate in a development which will take place with or without them. If Albert Einstein, for example, had lived in the 12th century, he would have had very little chance of becoming a good scientist."¹⁶⁵ That is, he would have had little chance if he were interested in relativity - which he could not have been. Quantum leaps are not given to humans - for example, we

cannot move from Archimedes' lever laws to Einstein's relativity in a single bound. Many questions had to be asked and many aspects of the world opened to view before Einstein's theories could come into being.

Of course, the point for Heisenberg is to extend our range of vision within the possibilities of our horizon. Fortunately, any given horizon is very broad; we have many concepts with which to light up what we are trying to understand. For example, the concept of an elementary particle, in atomistic terms of small, solid object, proved very productive in early chemistry, at least with the respect to the stability of the chemical elements. It was the original conception in atomic physics, and in fact brought physics a long way in an understanding of atomic processes. Yet at a certain point, traditional concepts can lead us astray, especially when they cloud our vision to the reality in front of us (here we might recall Heisenberg's question of what "exactly" it is we see in a cloud chamber experiment - the notion of the elementary particle grounded the assumption that the water droplets observed at intervals showed the particle's "path"). The questions to which the concept of the atom leads us, such as the location and orbit of an electron, are not the correct questions with which to approach nature in that particular realm; certainly, "to realize that such questions have no meaning is a very difficult and painful process."¹⁶⁶ On the other hand, a conception of elementary particles that has remained in the background, such as Plato's mathematical forms, suddenly takes on new brilliance. For Heisenberg, it is this concept, in a rather radically renewed form of fundamental symmetries, that is appropriate to the microworld. It is with this change of concepts that we move from the fog of some strange reality to that transparent clarity of the beautiful. All this goes to underline not only the possibilities of our

horizon, but the fact that we are unaware of these possibilities until we are compelled to explore them.

Insofar as we exist in a world of given concepts, we exist within the possibilities of tradition. Of course, order of any kind possesses possibilities, concepts no less than others. Yet order is only potentially thus; it is not inevitable that the concept actualize its possibilities. Thus, while Heisenberg underlines that independent ordering power of a concept, he is quick to add that creation of forms is not some spontaneous action on the part of a concept: the meaning and possibilities of a concept can only be discovered through our interplay with it in the world. For Heisenberg, it is highly unreasonable to think that we should - or *can* - destroy all the old forms and concepts, and wait for the new to emerge by themselves. With this sort of rule we would never achieve any understanding: "first, without the old forms we could never have found the new; secondly nothing ever happens, in science or in art, of its own accord - we have to shape the new ourselves."¹⁶⁷ What we have to recognize is that for Heisenberg, understanding is not a connection we make and then apply to the problem in from of us. Heisenberg here is very close to Gadamer: we understand *through* application. It is only when we ask genuine questions that we unfold the richness of understanding. In terms of the human world, we create or actualize the forms or concepts within the concept, given that concept and the world around us.

Application and understanding

Heisenberg is firm that all understanding "arises from the fact that men continue to ask questions, and that such questioning is the form in which they come to grips with the world about them, in order to perceive its unitary connection and in order to live within it."¹⁶⁸

Moreover, our questions are not arbitrary: "a fruitful period is characterized by the fact that the problems are given, that we need not invent them."¹⁶⁹ That questions naturally present themselves to us by no means diminishes their importance; rather, it heightens it. We do not spend our time aimlessly casting about for things to understand. We are compelled by connections; something about a certain feature of the world grasps us, and makes us look more closely at it. Or again, it may be an apparent lack of connection that strikes our attention, that stops us and forces us to look for some kind of order. Yet whatever the case may be, all understanding begins with genuine questions. For Heisenberg, genuine questions almost assure authentic interest, and successful understanding demands that authentic interest.

One of Heisenberg's examples in this regard is Planck's discovery of the quantum of action. In Heisenberg's view, there are two significant aspects to this illustration that reflect on the larger situation of human understanding. The first is that Planck was working on a specific problem, that is, a real and unanswered question in the world of physics. The second is that Planck felt himself compelled, through that interplay between the given laws and the given phenomena, to move into an entirely new understanding, which itself was the basis for a much broader understanding of nature. In this connection, Heisenberg occasionally takes up the issue of how to make a "revolution" in thought patterns, no doubt spurred on by Kuhn's notion of scientific revolutions. Heisenberg continuously asserts that in science, "never in its history has there been a desire for any radical reconstruction of the edifice of physics."¹⁷⁰ Indeed, he cannot emphasize this enough, pointing especially to quantum physics: "at no time during this history of quantum theory was there a physicist or group of physicists seeking to bring about an overthrow of physics"¹⁷¹ - Planck least of all. At the turn of the

century, Planck decided to go into physics despite being told that almost all work in the field was complete. He concentrated his interest upon one of the "last" remaining problems, that of blackbody radiation. Although energy was classically understood as moving continuously, Planck "finally discovered to his horror that in order to interpret blackbody radiation, he was obliged to frame a hypothesis which did not fit into the framework of classical physics and which, from the standpoint of this older physics, seemed completely insane."¹⁷² His discovery was that energy moved discretely, in packets that he termed "quanta." While "horror" is not normally the experience of understanding that Heisenberg wishes to emphasize, his point is that there never existed any desire to radically revolutionize physics. What was given simply, and rightly, commanded tremendous respect.

Thus, when Heisenberg considers the question of how a revolution in understanding is made, he answers: "By trying to change as little as possible; by concentrating all efforts on the solution of a special and obviously still unsolved problem, and proceeding as conservatively as possible in doing so. For only when the novel is forced on upon us by the problem itself, where it comes in a sense from outside and not from ourselves, does it later have the power to transform."¹⁷³ Only those who try to shed as much light as possible upon the question with proven insights can achieve real understanding, because instead of dealing in illusions, they merely make evident what the facts compel: "The small changes he eventually shows to be absolutely necessary may afterward, in the course of years or decades, enforce a change in the pattern of thought, and hence a shifting of foundations."¹⁷⁴ Naturally, Heisenberg does not confine this insight to science alone: "I suspect that even historically the most durable and beneficial revolutions have been the ones designed to serve clearly defined

goals and problems and which left the rest strictly alone... So let me repeat: what matters is to confine oneself to a single, important objective and to change the rest as little as possible. The small part we have to change may well have so great a transforming force that it may affect all forms of life without any further effort on our part."¹⁷⁵

This is much less a call to conservatism than it is a recognition of the truth value of the insights upon which we rest. In Heisenberg's view, humans are not only natural understanders, they are *successful* understanders, and have always been so. Our natural inclination to understand, together with what Heisenberg regards as the natural inclination of the world to be understood, have from the beginning combined to bring the intelligible structures and all the possibilities associated with them into actuality. It is with this in mind that Heisenberg can state the following: "We wish that, despite all outer confusion, our youth will grow up in the spiritual climate of the West, and so draw upon those sources of vitality which have sustained our continent for more than two thousand years."¹⁷⁶ To Heisenberg it is clear that if there were no truth to these sources, they would not have proven so fruitful in terms of the understanding we achieve in science, art, religion and philosophy. Gadamer once asked, "Does what has always supported us need to be grounded?"¹⁷⁷ Heisenberg can be understood as saying something very similar. Truth sustains us. We do not need to "ground" truth. Truth grounds itself through the playing out of our human existence, in art, in science, and in the ideals which guide our actions. Thus we do not need to dig deep from within ourselves to understand, nor do we need to reach far beyond ourselves. In Heisenberg's view, insofar as we are in the world and necessarily in tradition, we are in constant interplay with the depth and breadth associated with the intelligible.

Still, the fact remains that in our interplay with the given intelligible structures, we are dealing with answers to specific questions, where the answers are inherently appropriate to the question. That is, all our understandings are unique and historically situated. Newtonian physics is Heisenberg's great example of this. Gadamer disparages the understanding of modern science because it demands the repeatability of events. While verification and repeatability are critical to the demonstration of the validity of scientific theories (and for Heisenberg science has this advantage over art, that its claims can be "tested," though whether this test can move a person is a different matter), they are only effective within carefully defined systems. But the closed world of Newtonian physics is itself a unique and historical phenomenon. Newton's laws only "fit" within the framework of classical concepts and connections. They are not as successful when moved to a different context, i.e., from the macroworld to the microworld. In this sense, a scientific theory is like a work of art. In one place Heisenberg compares such a theory to the artistic ribbon decorations of an Arab mosque, where those decorations express "the spirit of the religion from which they have arisen". He notes of these decorations that "so many symmetries are realized all at once that it would be impossible to alter a single leaf without crucially disturbing the connection of the whole."¹⁷⁸

In a very real way, Heisenberg and Gadamer share the problem of interpretation. Recall that Gadamer comes out of a hermeneutical tradition which perceived the understanding of a text to be the "reconstruction" of the intention and world of the author, which Gadamer is convinced is not only unhelpful, but impossible. Heisenberg agrees with the impossibility of a successful reconstruction of a context in which a unique understanding

can be re-experienced. Science might appear to give some difficulty here, since Newtonian mechanics, which is for Heisenberg very much a shining forth of a great connection, always remains true in the macroworld. Yet we can never again fully recapture that Newtonian context with its framework of unlimited applicability. A genuine understanding of Newton's laws includes an acknowledgement of their limits. Indeed, as we saw, it was quite necessary to interpret Newtonian physics within the wider scope of new scientific insights. It is quite significant that, as Gadamer does, Heisenberg also picks up on legal interpretation to illustrate both the uniqueness of our understandings and the lack of finality in any area of understanding: "certain philosophies of justice assume that justice always exists but that, in general, in every new legal case justice must be found anew, that at all events the written law always covers only limited areas of life and therefore cannot be everywhere binding."¹⁷⁹ Yet it is critical to recognize that, in Heisenberg's view, we only have access to Law (for which we can substitute the term the logos, or the intelligible) through the written laws, that is, through the works and concepts of art, science, philosophy and religion that form the medium of our world, and every new interpretation of law must ground itself in those the precedents. From science, he points out, "one may learn above all things here that freedom is possible only through acknowledgement of laws."¹⁸⁰ He is using the term "law" rather literally here, underscoring his conviction that not only the laws of nature have that quality of self-evident authority, but what we have come to discover through art, religion and philosophy. We saw this earlier in his opinion that one cannot invent intelligible structures, but only discover them.

Moreover, we also saw how possibilities are always associated with these structures. Heisenberg is adamant that the possibilities are absolutely tied to the structures. Only through

serious regard for these understandings are we able to achieve freedom of understanding, which for Heisenberg includes both the freedom "from" and the freedom "to". It is a freedom from "prejudices, from dogmatic ties, from suggestive influences, from an imposed point of view," and the freedom to "think new thoughts, to look at known facts with fresh eyes, to follow the thoughts of others, even if they do not at first illuminate, and to go beyond them."¹⁸¹ Heisenberg adds that science also teaches us something else of great importance, a lesson applicable in any area of human understanding, namely, that freedom is not easy: "To perceive new connections amid the inexorable laws of nature, to explore new possibilities, to think in unaccustomed ways, can be achieved only by the utmost effort. But anyone who finds it too difficult should not be led astray into simply ignoring the existing laws. Nothing whatever would come of that."¹⁸²

For Heisenberg, we cannot underestimate the firmness of the foundations of philosophy, religion, and art, since they have sustained us for so very long; to diminish their truth based on their historical conditionedness is to do them a great injustice. As he writes, "it would certainly be a mistake were we to detract from scientific or philosophical knowledge with the phrase, 'Every age has its own truth.'" Nevertheless, the fact remains that "the very structure of human thought changes in the course of historical development."¹⁸³ That structure changes precisely because we are in constant interplay with given understandings, bringing them to bear time and again upon the questions and problems facing us in life, and bringing into being altogether new intelligible structures. That is, as understanders, we exist in constantly changing situations, with new questions. For the answers, we have nowhere to turn but the intelligible structures already given to us. If they could not offer anything to us,

we would have little interest in them. It is thus very characteristic of Heisenberg's thought that what we might call the interpretability of a given understanding is for him a measure of its greatness. In terms of art, "Perhaps men like Bach or Mozart are kings of music only because, for two long centuries, they have offered so many lesser musicians the chance of re-interpreting their thoughts with love and a conscientious attention to detail. And even the audience participates in this careful work as it hears the message of the great musicians."¹⁸⁴

Our continual interpretation, our effort to move beyond specific connections, is "ultimately based upon the necessity to go on asking questions, upon the striving for a unitary understanding,"¹⁸⁵ where that understanding must be meaningful for our here-and-now lives.

In terms of art, for example, the focus of an artist in a particular question or feature of the world is determined by his real interest in that question, where "the word 'interest' means: to be with something, to take part in a process of life."¹⁸⁶ In this, Heisenberg almost naively assumes what Gadamer, in terms of the hermeneutical enterprise, must argue again and again - what we encounter in tradition has a meaning, and the importance of understanding it lies not as a historical point of interest, but in light of its relevance for our questions of today. When we understand, asserts Heisenberg, we must try to do so "in accordance with the spirit of our times."¹⁸⁷ It is impossible to emphasize enough that Heisenberg's main concern is our current situation, individually and collectively. It is the interest in the world around us, in the questions that have emerged through this world, which themselves initiate that interplay of order.

Of course, Heisenberg is not only interested in the integration of the intelligible structures of the past. Just as important in his view is the interpretation that occurs from new

structures of intelligibility; this relates back to his notion of revolution-making, where a single insight can have a huge transformative effect. As we saw, he believes that truth has a very compelling quality, where the possibilities can be sensed even from a single specific actuality. For example, "In the 18th century, Hayden tried in his string quartets to express emotions that had appeared in the literature of his time, in the works of Rousseau and in Goethe's *Werther*, and then, the musicians of the younger generation - Mozart, Beethoven, Schubert - gathered in Vienna to compete in the solution of this problem."¹⁸⁸ The actualization of something real and compelling causes an outward diffusion, underlining the actual collective interplay of human understanding. Human understandings reflect upon one another. However, these reflections need not be so obviously harmonious. Romanticism deals with "problems" that emerge from a world already transforming itself by rationalism, science and technology into a world of facts and practical preconditions for outward life. The art of the time looked to explore the "proper scope for the personality in its wholeness, its wishes and hopes and woes."¹⁸⁹ Yet we see that the inward turn in art is intimately related to the outward turn in science. Though we come to distinctive understandings, these are always related to one another through their relation to the whole.

Lastly, we need to stress Heisenberg's perception of the adventure quality of understanding that occurs through questioning and interplay, which is nothing more than dialogue. The old saying, "I believe that I may understand," is insufficient for Heisenberg. He approved of the introduction of an intermediate term, so that it reads as follows: "I believe that I may act; I act so that I may understand."¹⁹⁰ Heisenberg points to the initial voyage of Christopher Columbus as an example of this. While others before him had believed that the

earth was round and small enough to be circumnavigated, Columbus' remarkable achievement was his "decision to leave the known regions of the world and to sail westward, far beyond the point from which his provisions could have got him back home again."¹⁹¹ This is his metaphor for understanding. Though it begins with the known, with the familiar, it is not real understanding until it has taken us beyond this realm. All understanding is an adventure, because as we move forward through that crucial question or problem, we are taken somewhere new and unfamiliar. And yet, the new territory is not unrelated to the familiar. To take this image a bit further, we might say that Columbus might never have made his voyage without all that which the known could offer. It was not a blind leap into the unknown; rather, he carefully researched the voyage, taking advantage of all the available navigation tools of the time. Nonetheless, in pushing off from familiar shores, Columbus was putting his life at risk; instead of remaining within the theoretical realm of such a journey, "he staked his whole existence on it."¹⁹² And this is what we do when we go forward to understand - we stake our lives upon it, simply because we cannot understand without being changed by it, and only by being changed have we understood.

We are changed because our world is changed by understanding. For Gadamer, understanding as it is achieved through dialogue, was the coming-into-language of the thing itself. In like manner, Heisenberg speaks of understanding in terms of a dynamic interrelationship between given orders from which a new order emerges. As he writes: "the old mystics used to associate the number 3 with the divine principle. Or if you dislike mysticism, you could think of the Hegelian triplet: thesis-antithesis-synthesis. Synthesis need not be a mixture; it can prove extremely fruitful, but only when thesis and antithesis combine

to produce something qualitatively new."¹⁹³ For Heisenberg, the world is always intelligible; the possibility of relation overarches any as-yet unrelated orders, and coming to an understanding is the "real"-ization of that possibility. Given that Columbus did not reach the land he expected to reach, an entire continent being in the way, we might also use this metaphor to emphasize another aspect of Heisenberg's thinking, that element of surprise in understanding. For Heisenberg, and like Gadamer, real understanding is an event because it brings something new into the realm of intelligibility. However much we may be prepared for this event, Heisenberg is sure that we are not in fact "in charge" of understanding. The understanding that emerges through a real interest in the question and which is based on the dialogue or interplay between people, ideas or concepts is in the end something that we find wholly unexpected. "Whenever we proceed from the known into the unknown we may hope to understand, but we may have to learn at the same time a new meaning of the word 'understanding.'"¹⁹⁴ The possibilities associated with the intelligible are always greater than we can imagine. Questions and problems are given to us; the paths we must follow are clear. But where we are led is a different matter entirely, which we can only discover by going forward along the path.

As we saw earlier, Heisenberg does not ask us to rest upon, but to "draw upon" the sources of vitality within our larger human tradition. For Heisenberg, the serious consideration of those sources of vitality always leads to further vitality, further avenues of exploration. For Gadamer, the pre-understandings determine our understanding, which in turn becomes another pre-understanding. This is why understanding is always on-the-way. This is Heisenberg's thinking entirely. For Heisenberg, human understanding is not carved

in stone. It is precisely by engaging in dialogue with the world around us, a dialogue in which we have always been engaged, that the search for truth is discovered to be both an abundant and endless one. With regard to this, Heisenberg recalls a particular moment of clarity during a recital at which Beethoven's D Major Senerade was being played: "[the work] brims over with vital force and joy; faith in the central order keeps casting out faint-heartedness and weariness. As I listened, I grew firm in the conviction that, measured on the human time scale, life, music, and science would always go on, even though we ourselves are no more than transient visitors or, in Niels' words, both spectators and actors on the great drama of life."¹⁹⁵ The reality in which we exist is always enriched by understanding, by that wider and deeper interplay of order that we both shape and are shaped by, which brings the intelligible into being, and opens up possibilities through actualities. And it is truly a grand adventure, for although the world is by nature intelligible, Heisenberg always reiterates that we must learn "over and over again what the word 'understanding' may mean."¹⁹⁶

Understanding and science

The question we put to Gadamer, after the exploration of his thought, concerned the role of natural science in the enrichment of the world by truth: does science have a part to play in the human and humanizing process of coming to an understanding? In Gadamer's view and with regard to modern natural science, the role was a very limited one. On the other hand, the "old science" that Gadamer reflected upon, a science crowned by metaphysics and providing a whole orientation to the world, comes alive again in Heisenberg's vision. From the very beginning our investigation of that vision has shown Heisenberg's deep conviction that science can be a real part of the universal experience of understanding. In trying to

illuminate the intelligible, it is an endeavour no different than art. When it is approached as the intelligible, it can effect a real experience of understanding, an experience that points through the particular to the whole. Of course, all order has that center, and thus all order has that potential. Yet for Heisenberg, science has a special place at the present time, because of the nature of the contemporary world. The one reality of our age that we cannot ignore or escape is our immersion in scientific and technological thinking. Heisenberg fully realizes to what extent the world has both interiorized and exteriorized the goals and method of the science which developed in modernity. Since the whole development of science and the scientific age "has for a long time passed far beyond any control by human forces, we have to accept it as one of the most essential features of our time."¹⁹⁷ We can call it the "natural fact" in accordance with which all our understanding must be made. We see Heisenberg's awareness of this even in his choice of terms, e.g., the 'central order' for the divine or the logos, or 'structures' for Ideas. The world is very comfortable with the words and concepts of science, and he is writing to be understood; certainly Gadamer, for whom every real artist speaks to his world and for his world, would appreciate Heisenberg's effort to be understood by his world. Heisenberg is interested in bringing out the possibilities of this science within and through the world around us, as they can emerge from a return to the centre.

All order has that centre to it, which connects it to the whole. We have observed time and again Heisenberg's conviction that all orders are related, that "life on earth represents a unity." That all orders are intimately related to each other means, in the most negative sense, "that damage at one point can have effects everywhere else."¹⁹⁸ In this expression lies the whole of modern western history for Heisenberg, as it developed on the basis of a science

which separated nature from its relationship to the human and the divine, and the divine from the human, consequently losing sight of the real center. There is a certain order to the scientific age, but Heisenberg would call it a partial order, broken off from the central order, but erected as the centre. Orders of this type are dangerous: "they might not have lost their creative force, but they [are] no longer directed to a unifying center."¹⁹⁹ Thus we see that though interplay and dialogue is critical, all interplay must from the beginning include that orientation to the center if one is to achieve a valuable understanding. Yet the situation is not completely hopeless. All order is related to the central, and all order can reflect that center, even that order in which we are presently lost. Heisenberg is a firm believer in natural law, and for him, there is no law greater or more natural than that of order. If damage at one point has so much power, so too can enrichment at any point affect the whole. He is sure that science can be a real source of enrichment, though not unless material interest is removed from its foreground, and the real possibilities for understanding are drawn to the surface. Of course, Heisenberg is sure that in this century science has come to some very important insights which can go a long way to realizing the tremendous potential within science, and thus for the world so closely connected with science: "If we raise the question whether science and technology in our life today are producing forces of order that may shape life on earth as did the great ideals of the past, we must surely think in the first place of those broad connections which have become visible to us in these most recent developments."²⁰⁰ To be sure, he says, these orders can for the time being only become known to the narrow circle of those who work in the field. Nevertheless, "even from this circle it is possible for influences to spread into human thought generally."²⁰¹

Yet there are conditions to this possibility. Heisenberg is positive that science can never shape life as the great ideals have without its own return to the center. Even in science it is possible to miss the meaning of what one encounters - as much of modern science has demonstrated. Although Heisenberg is sure that we have lighted upon critical understandings in science, he is not interested in a replay of modern history. Even at its best, when science was an activity in relation to the divine, i.e., when its understanding was the immediate perception of the workings of the God in nature, it was too easy to ignore the distance between this God and that "to whom we can relate our life."²⁰² When attention is directed entirely to one aspect of the divine activity, there will always arise "the danger of losing sight of the totality, the interconnected unity of the whole."²⁰³ For Heisenberg, that interconnected unity can only be kept in view by a constant interplay between the various forms of human understanding, especially where that interplay is directed to an understanding of our relation to the central order. It is helpful here to recall Gadamer's point that a person behaves speculatively when his words do not reflect beings, but the whole of being. Heisenberg is thinking along just these lines. An understanding of any order is most valuable when it points beyond itself to our relationship to the whole of order. But in this regard, the individual (and the individual discipline) must rely upon his relationship with the human community, for it is only within that broad context is there access to the larger vision.

Here, it is of particular interest and relevance that we are dialogic beings. It is fundamental to Heisenberg's thought that understanding is very much a continuous and collective effort. Though it is quite obvious from our exploration above, Heisenberg wants to make it clear that our understanding only develops in relation to a community: "man can

develop his mental and spiritual powers only in relation to a human society;" the understanding of any individual depends upon "his being lodged in a community of speaking and thinking beings."²⁰⁴ As we have seen, dialogue does not make for better understanding; it makes for *all* valuable understanding. Furthermore, Heisenberg is utterly convinced that as a community engages in dialogue, it becomes something more than a collection of individuals. While individuals seek understanding, which is always an understanding of order deriving from specific questions, when individuals come together in community this drive to understand almost naturally evolves into a much broader scope. Communities tend to seek the wider connections, for the interconnected unity of the whole, and are only successful *as* a community. That is, they incline to an understanding of our relation to the central order. Heisenberg calls this the spiritual pattern of a community, "the relation of a meaningful connection to the whole, beyond what can be immediately seen and experienced."²⁰⁵ He also refers to it as the religion of a community, though by the concept of "religion" Heisenberg is trying to convey something much broader than what is generally meant: "It is intended to cover the spiritual content of many cultures and different periods, even in the places where the very idea of God is absent."²⁰⁶ It is only where the transcendent is completely excluded does he doubt the term religion is meaningfully applied. Heisenberg refers to the development of this pattern as the "*fundamental human attitude*."²⁰⁷

This communal inclination to discover a meaningful connection of the whole, a whole that always includes ourselves, has "almost always played the deciding role" in all our human efforts. It brings into being meaningful orders of existence, and in doing so, makes real human life possible: "It is only within this spiritual pattern, the ethos prevailing in the

community, that man acquires the points of view whereby he can also shape his own conduct wherever it involves more than a mere reaction to external situations; it is here that the question of values is first decided. Not only ethics, however, but the whole cultural life of the community is governed by this spiritual pattern."²⁰⁸ He goes on to assure us that it is only within the sphere of the spiritual pattern that "the close connection first become visible between the good, the beautiful and the true." This is the case because that pattern makes the wider connections, and it is only through these wider connections that one can discover the centre. Thus, for science to become a real source for a much larger order, which Heisenberg believes it has the potential to do, it must regain that fundamental human attitude. It must move beyond its narrow borders and engage in the larger interplay of the world. Naturally, a scientized world must do the same.

Yet this fundamental human attitude, this overarching concern for the unity of the whole, is nothing less than that 'certainty in the strivings of the heart' that we are in danger of losing. At this point it is absolutely critical that we come to recognize the unity of our existence. It was just by a conscious rejection of unity that we have been brought to this juncture. As he says, damage at one point can affect the whole, whether or not we admit the whole. We must "bend all our efforts to reuniting ourselves...in a common human outlook."²⁰⁹ Naturally he does not mean by this common human outlook an identical vision of the world. Nothing would be so unfruitful as this. Heisenberg asserts with Niels Bohr that "The opposite of a correct statement is a false statement, but the opposite of a profound truth may well be another profound truth."²¹⁰ That various traditions formulate and express our relatedness to the central order in different ways always demonstrates for Heisenberg the

expanse and depth of the central order and our connection to it: despite the fact that they are distinctive understandings, each spiritual pattern is needed to "convey the rich possibilities flowing from man's relationship with the central order."²¹¹ Indeed, the richness within any one spiritual pattern demonstrates the tremendous possibilities that are associated with any particular connection. Rather, he means coming together in terms of human solidarity, understanding that "we are jointly responsible for the ordering of life upon this our earth."²¹² This means that renewing the connection between the human and the natural sciences is not an intellectual game, but a real human obligation, both to ourselves and to the whole. We are not fully ourselves without that real interplay with the larger human community, and the community is not what it should be if it is so fragmented, if the individuals within it exist in a real isolation, as they do through the machinations of a scientized and technologized society. Such a society is not a community in the true sense.

Heisenberg feels that this is where science can play an especially important role, though not a dramatic one, given that of all the insights natural science has achieved in this century, the sense of unity is perhaps the most evident. For example, in terms of physics, "the lucid region we spoke of earlier...which Goethe was able to discern throughout all nature, has also become visible in modern science, at the point where it yields intimations of the mighty unity in the ordering of the world."²¹³ Indeed, throughout science this unity is becoming plain: physics, chemistry, biology are all discovering relations with each other. And not least of all is that re-discovery of the fundamental relationship between ourselves and nature. Yet Heisenberg would be the first to point out that larger meaning of this unity cannot be discovered from within the restrictions of a rationalistic, pragmatic and objectivized science.

If these insights are to be diffused into the larger sphere of our existence, they must be compelling, and only science can make them compelling; as he writes, the insights of science would be insufficient "if science were not also to arouse a feeling for those larger interconnections in which the order of our world is expressed."²¹⁴ Of course, it can only arouse this feeling for the larger interconnections when it has first integrated them into its field. As ever, it comes down to dialogue, though this is only to be expected. As we saw, Heisenberg is sure that dialogue is an integral part of the scientific experience, as it is of any area of understanding, whether the dialogue is one with the world around or with figures, concepts and ideas of tradition. Therefore, science, and the world around it, must make a commitment to dialogue, in which the true possibilities of understanding are unfolded.

However, science cannot integrate the wider framework into its sphere if it remains within the bonds of strict rationality, pragmatism and an idealized objectivity. Here, Heisenberg urges science, and the world grown out of science, to become more scientific, to accept what the facts compel - although for Heisenberg, the facts compel a great deal. Physics has led us to the inherent difficulties of that Cartesian partition in our efforts to understand, and for Heisenberg, it is critical to realize just how misleading are the separations between subject and object, inner and outer world, body and soul. It is only with this realization that science as a whole can begin its transformation from an explanatory and technical effort to that concerned with understanding. With the eradication of these false boundaries, our entire understanding can come into play. Though we have seen Heisenberg's conviction that understanding is what we do first, and then analyze, in fact understanding is made much more difficult by a conscious rejection of our abilities, by the idealization of

objectivity and rationality (just as understanding is made more difficult by the conscious rejection of tradition). Heisenberg reminds us of Antoine de Saint-Exupery's little prince, who had to learn from the fox that it is only with the heart that one can see rightly; what is essential is invisible to the eye.²¹⁵ Heisenberg encourages this possibility of "seeing with the heart:" "Even today we can still learn from Goethe that we should not let everything atrophy in favor of the one organ of rational analysis; that it is a matter, rather, of seizing on reality with all the organs that are given to us, and trusting that this reality will then also reflect the essence of things, the 'one, the good and the true.'²¹⁶ Speaking here of the basic forms of matter, he is adamant: "That these basic structures are intimately connected with the order of the macrocosm as a whole is surely almost beyond dispute. But it remains up to us whether we wish merely to seize upon the one narrow, rationally apprehensible segment from this immense system of connection."²¹⁷ What Heisenberg is asking for here is a real openness to the possibilities of understanding, the experience that truly enlightens.

Naturally, the integration of the larger whole into science has ethical implications for technology. In terms of the relation between science and technology, and at the very least, this means that "we should...no longer do everything that we are technically able to do."²¹⁸ Certainly Heisenberg is not denying opportunities of knowledge to science, and insists that "there must be fundamental and applied research in many different areas, because all new knowledge can do good if it is properly employed."²¹⁹ Nevertheless, he continues, restraining technology is an urgent task. This restraint can begin with science insofar as it returns to its true roots of understanding, and free itself from the overarching influence of possible technical application, which drives us to do everything that we are able. He is not interested in cutting

science off from the possibility of providing material benefit to the world; yet no stretch of the imagination could see benefit in the profound destruction of an atom bomb. Nor is Heisenberg suggesting that the scientist, with respect to technological application, should retreat into a distant ivory tower. Freedom comes through the acknowledgement of laws, moral as well as natural. For Heisenberg, these laws must come together in science; the natural scientist must very seriously consider the aspects of technical application, including all the possibilities for misuse; the social scientist must consider real human necessities. We might even say that Heisenberg is thinking of the incorporation of the wider connections as a real aspect of scientific method: "the individual tackling a scientific or technical task, however important, must nevertheless try to think of the broader issues. And, indeed, if he did not, why did he exert himself in the first place? Moreover, he will more easily arrive at the right decision if he bears in mind the wider connections."²²⁰ Heisenberg is suggesting a real relation between scientific knowledge and moral, that working within the scope of values in fact has an intimate connection to understanding in science, where understanding is more closely aligned with truth than with correctness.

In regard to the crisis of our time, that 'uncertainty in the strivings of the heart' that derives from the fragmentation of the larger context, Heisenberg is sure that we have a real obligation "to overcome the isolation which threatens the individual in a world dominated by technical expediency." Direct action is the key here: "It will be a matter of reanimating in daily life the values grounded in the spiritual pattern of the community, of endowing them with such brilliance that the life of the individual is again automatically directed toward them."²²¹ By values he does not mean norms of ethical behaviour, but a real sense of that

relation of a meaningful connection to the whole, with all that this sense implies. Heisenberg thinks that natural science can be the source of such light. Yet he is positive that unless it takes very seriously the insights to which it has come, unless it is changed by those insights, it cannot be an enriching source. At this point, one cannot help recall Gadamer's complaints that he was being accused of urging science to proceed subjectively when he merely mentioned productive prejudices. Of course, Heisenberg goes far beyond the mere mention of productive prejudices, and he urges a great deal upon natural science and all endeavours which strive to be scientific: seeing with the heart, re-kindling the fundamental human attitude, understanding that integrates wider insights. Yet Heisenberg would absolutely deny that he was encouraging a "subjective" science, or rather, encouraging a science that is not guided by the appropriate orders, and which has proven so fruitful. Indeed, he is not asking that science abandon anything that is truly its own, but to reflect more carefully upon what *is* truly its own. He is clear on this: "It is a question, here, not of obliterating the clear outlines of earlier scientific thinking but of a more subtle approach to the possibilities initially concealed in that thought."²²² He is not at all asking that we become less scientific, but that we enlarge our vision and enrich our world. For Heisenberg, the issue for science, and naturally for the scientized world, is getting beyond the subjective and objective, beyond pragmatism, to real understanding. It is in this "beyond," which is nothing more than the world to which we really belong, that we can bring the totality of ourselves to our interplay with the world around us, where that totality is not only the fullness of our individual cognitive abilities, but also the wider interrelations that come from a real connection to the whole.

CONCLUSION

The present work began with the assumption of the persistence of the view that the natural sciences and the humanities concern themselves with two different worlds. The broad aim of this work was to add to the emerging discussion which seeks to bridge the perceived distance between these worlds by initiating a dialogue between Gadamer and Heisenberg. As it seeks to work in the spirit of dialogue, then, this work is concerned with more than a mere correspondence of their thought, though this ingredient is certainly important to the dialogue. The overarching spirit of the work is captured in Gadamer's conviction that the understanding achieved through dialogue is like a new light being turned on, expanding the range of what we can take into consideration. Hopefully this work has provided such light, though of admittedly modest proportions. In drawing together the worlds of natural science and philosophy as they are represented by Gadamer and Heisenberg, an entirely new one unfolds before us. In this particular world, it is not the philosopher with his strictly "philosophical" concerns or the scientist with only "scientific" issues who stands at the center, but human being and human concerns in the framework of an all-encompassing reality.

Of course, the modesty of the claim here derives from the fact that in their individual works, each thinker does strive to move beyond such restricted frames of inquiry, though naturally Gadamer is not as inclusive as Heisenberg. The physicist stands firmly in that center, ranging across disciplines in the confidence that the variety of our interests are drawn together through our basic humanity, which provides the real connection between all endeavours of human understanding. This mirrors Gadamer's own perception of the situation; underlying all differentiation of interest and questions of method within the human sciences is the human

as understander. But where Heisenberg conceives of a true universality of the experience of understanding, e.g., one that is the same in art as in natural science, the claims to universality coming out of Gadamer's philosophical hermeneutics essentially stop short at the natural sciences. For Gadamer, real human understanding is alien to the basic nature of that science and those human sciences which have modelled themselves upon it. From first to last Gadamer shows a fundamental disinterest in natural science intimately connected to his supposition that the world of natural science, including its methods and goals, is inherently foreign to the world of truly human concerns, wherein his own interest lies. His conviction of its foreignness is above all observed in his conviction that a valuable assessment of what it means to be human in the world can only be made when the assumptions and methods of natural science are set aside.

Given this conviction, it is highly significant that Gadamer and Heisenberg are led to corresponding conclusions, despite the their respective re-evaluations of our human nature and the nature of the world around us begin from what Gadamer would see as incompatible positions, one from outside the framework of natural science and the other from within it. In broad terms, these conclusions hold that understanding is the primary characteristic of what it means to be human in the world, intelligibility is the primary characteristic of the world, and everything within this world can reflect truth. That Heisenberg can begin from within science and yet arrive at a perspective so close to Gadamer's own points to a much greater compatibility between the sciences and humanities than Gadamer himself can conceive. Furthermore, that both men offer very compelling visions from such seemingly distant points of departure suggests real substance to those visions.

Manifestly obvious at this point is that the natural science to which Gadamer generally shows disinterest or hostility bears little resemblance to that science as it is understood by Heisenberg. In Gadamer's mind, natural science always remains nothing more than the quest for "certain" knowledge of a thing, as it is achieved through the ideals of objectivity and rationality, for the real purpose of dominating it. As we observed, Heisenberg is sure that this is not the true nature of science. For him, the real foundations of modern natural science are grounded in the understanding of truth, in terms of understanding the divine order in nature. Yet Heisenberg recognizes that as science became dogmatically methodological, and thus distanced itself from the larger context of human meaning, including the realms of art, religion and philosophy, that original goal was lost. In this way, the study of nature became an end in itself, creating a vacuum of meaning that was soon filled by the principle of utility. No longer was the driving force behind that study of nature the understanding and deepening of our relationship with the divine, but rather the mastery of the principles of nature in order to make use of them. Thus, in respect to its late modern form, Heisenberg does not disagree with Gadamer's characterization of natural science.

Nor does he disagree with Gadamer's criticism of that science. Indeed, the elements of that science to which Gadamer most strongly objects are the same elements to which Heisenberg objects. Heisenberg finds very problematic in natural science the ideals of strict rationality and uncompromising objectivity, as well as the fundamental unwillingness to seek the broader connections. Furthermore, Heisenberg shares Gadamer's distress at widened sphere of influence of this science, and the consequence thereof, which Gadamer refers to as the alienation from being, and Heisenberg as the loss of connection to the central order. They

both mean the deterioration of our relation to the fullness of truth through the alienation from ourselves and our world. For both, the science in which the world has immersed itself cuts at the roots of our belongingness to the world of meaning, which we access through genuine interaction with the human world around us.

Both men are convinced that the scientized world is one which alienates us from the ground of meaning. They underline the fact that the adoption of the specialized concepts of science into the larger human sphere and the general idealization of the perceived elements of scientific method has created a world of infinitely reduced dimensions. In terms of the mastery of principles, they each point out that, since scientific knowledge is limited to that which is accessible by its method, the principles it does master are of the least meaningful kind. Gadamer is especially concerned by this translation of the human world into scientifically productive terms. For him, as our problems and concerns become technical ones, they necessarily disappear as human concerns. Because it distances itself from the fuller dimensions of human life and the meaningful orientations which derive from a genuine relation to those dimensions, science cannot capture within its scope the truly human concerns. Hence we are forced to exist in a world of scientific construction. Heisenberg sees the contemporary world ordered in terms of a hazy notion of progress, where scientific and technological ability are expected to tremendously improve all aspects of our lives. Yet in line with Gadamer's thinking, Heisenberg is sure that this utility-oriented science has little relation to real human needs and concerns, since it has lost touch with the world of human meaning; for Heisenberg, this orientation to utility is itself a result and symptom of that loss. Moreover, both are convinced of an intrinsic inner movement to this scientized world that works to further lead

us from the ground of meaning. That is, more and more is being built upon the foundations and illusions of this particular science, making it ever more difficult to access that ground. Gadamer calls us prisoners of a world we think we control, which Heisenberg echoes in his description of ourselves as cogs in the gigantic, rationally programmed machinery of modern society.

Heisenberg and Gadamer are convinced that the basis for freedom from this captivity is in a re-orientation to that world of meaning, which is the world of authentic human understanding. While understanding is the primary characteristic of human being, a key assumption for both men is that we only understand in and through the world. As Heisenberg would put it, we are only truly ourselves when we exist and understand within a much larger framework. Indeed, almost every aspect of their respective philosophies seeks to relocate us within this context: the rehabilitation of prejudice, the affirmation of tradition, the concept of logos, the necessity of dialogue for true understanding, and a vision of truth as that which we bring into the world and integrate into our lives. In general terms, we can state that as the pervasive scientific attitude tends to remove us from the world and from possibilities of understanding, their philosophies are directly concerned with our re-integration into the world and thus into the possibilities for understanding. And as we saw, not only do both philosophies provide a real challenge to that scientific attitude, they challenge it with similar insights. Of course, the interesting point is that those insights are drawn from two "different" worlds, at least as Gadamer would see the situation.

As pre-understandings, prejudices are not foreign elements which need to be eliminated from our efforts to understand. When Gadamer states that the world does not

belong to us, but that we belong to it, he means that we come into a world already understood and meaningful in a particular way, and that this understanding is already a part of our being. In this sense, prejudice is our orientation to meaning, and provides us with possibilities for further and deepened understanding. Heisenberg also insists that prejudice should be viewed less as an obstacle to understanding than that which enables understanding. Natural science is no exception here; as we observed, it was precisely through his scientific work that Heisenberg came to the realization that strict induction was largely an illusion, and that pre-understandings were a critical - and unavoidable - element of any new natural discovery. The way in which humans have previously understood the world is by no means irrelevant for us; it shapes and guides our own understanding. In their thinking, prejudice and tradition are transformed from that which must be overcome into the larger and ongoing link with the human community and thus the reservoir of meaning.

It is in the notion of language and order as the medium of understanding that Gadamer and Heisenberg ground the inherent meaningfulness of the world and fully establish our participation in that meaningfulness. Of course, though Gadamer uses the term much more often, they are both relying here on the concept of logos, which has always been associated with order as well as language. Thus, though they formulate the nature of intelligible reality differently, those differences are actually minimal in terms of the source, and especially in terms of the larger perspective. That is, when Gadamer states that we understand language, he does not mean merely spoken or written language, but whatever language things have - and for him all things have a language. Similarly, though in Heisenberg's view it is order that we understand, it is not only mathematical and scientific order, but also orders of value - all

things participate in the central order. What is important to both is the intelligibility of the world. All things participate in the unity of the logos, and all things reflect that unity - thus there is in principle nothing that is not accessible to our understanding, and nothing which lacks meaning.

In addition, the differences in formulation are further minimized by their agreement that this intelligibility emerges through the *experience of understanding*. The experience is of primary importance for both. It is an event, a happening that makes history, insofar as understanding is always something that must be incorporated into the given horizon, and thus that which changes the horizon. This is an especially challenging concept for a scientized world. Truth is not a statement or formula that we can take out or put away at will. Recall that Heisenberg was careful to make the distinction between the concepts of correctness and truth. The understanding of truth is an experience of living value. It makes an immediate claim upon us, compelling us to integrate it into our lives. For both Gadamer and Heisenberg, the point is never to *know* more truth, but to *live* more truth.

Moreover, the discovery of truth never occurs in isolation from the world. It occurs through a genuine interest in the world, through concern for real questions and issues. For both men, "disinterested" knowledge is of the least valuable kind. It is only authentic interest which enables one to approach the world as a Thou, and thus engage in true dialogue. It is particularly in the notion of dialogue that both thinkers emphasize not only our participation in truth on the largest possible scale, but also on the scale of daily existence. Gadamer states that conversation is the true nature of language, the logos, and that successful dialogue is emergence of truth into the world. Yet he also calls dialogue a life process in which a

community of life is lived out, meaning simply that our human situation is truly one in the world and in the community. These levels reflect those in Heisenberg's own thinking. He insists that the possibility and actuality of order can only unfold through a real interplay with order in the world, and also that we in fact are in constant interplay with the world around us. Of course, not just any interplay or conversation leads to the unfolding of truth in the world. Indeed, without that orientation to the center of order, or to the whole of being, such interplay becomes more dangerous than pointless.

Again, what is particularly fascinating here is that it is through natural science that Heisenberg comes to those insights which correspond to Gadamer's, though for Heisenberg this science is intimately connected to the human world. Heisenberg offers a tremendously compelling vision of natural science as a ground of real human understanding, and hence as a source of the coming-into-being and integration of truth into the world, even as art, religion and philosophy act as such sources. It is, I think, a vision to which even Gadamer would be drawn. Certainly it is relevant to the claims to universality of Gadamer's hermeneutics, and thus to a real enrichment of his philosophy. Aside from Gadamer's view of natural science, his own vision of what it is to be human in the world is quite compelling. The lack of real dialogue with the natural sciences is the single greatest flaw there, though it is one that cannot be overlooked. Heisenberg rightly notes that, at the present time, natural science is essential to any discussions which concern themselves with human questions and problems. First, it does offer valuable insights. Second, the concepts and ideas of science and technology have become integral parts of our existence in the world. As Heisenberg would point out, we cannot achieve genuine understanding in isolation from the reality around us. In this sense,

Gadamer's understanding lacks something important. By setting aside natural science in his assessment of the human condition, and by ultimately subordinating that science to more hermeneutically enlightened disciplines, Gadamer does not speak to his world as effectively as he might, or as he hopes to, especially in view of the current crisis.

Yet the barrier to a dialogue with natural science is found more in Gadamer's attitude and emphasis than in his hermeneutics proper. Gadamer's concern is for a theory of understanding applicable to all areas of human inquiry, and he succeeds in uncovering the common ontological roots uniting those areas. Certainly there is nothing in that theory which inherently excludes the study of nature, and a consistent approach there would have to include natural science as an integral part of the larger hermeneutical discussion. However, the point of dialogue is precisely to learn from one another, to become enlightened about a thing in a novel manner. In this, there is no doubt that Heisenberg's ideas can shed real light onto the possibilities within Gadamer's ideas. This is quite significant, given Gadamer's very legitimate importance and influence in the contemporary hermeneutical dialogue.

The extension of our range of vision certainly includes the enrichment of Gadamer's philosophy, and also of Heisenberg's: there is no doubt that Gadamer's depth of thought and insight lends itself to an enhanced understanding of Heisenberg's thinking. The difference, I think, is that Heisenberg would never have to be coaxed into a real dialogue between the scientific and human worlds. For him, it is always human beings who study nature, humans who are very much a part of the world around him. It would be well for Gadamer to be reminded of this basic truth, i.e., scientists share the same nature of understanding as philosophers, a nature Gadamer so carefully outlines for us; moreover, scientists exist within

the same the possibilities of truth in which artists exist, given the universal ground of being. But while the ideas of each thinker can reflect fruitfully on the other's, it is in a real interplay between them that a fuller vision unfolds for us. As those ideas come together in critical points, they do help to bridge the distance between the two worlds of the natural science and the humanities, at the very least in an intellectual sense. Yet we cannot forget that both their ideas derive from that genuine concern for human being. That is, they have both sought to offer real understanding, and real understanding always has a claim upon us. Thus, in a more specific sense, the compelling vision of our human nature and its immediate relation to the world of truth - a vision which not only emerges from the interplay between their ideas, but which also owes its true universality and added depth to that interplay - is one that demands an authentic integration into the world around us.

NOTES TO THE TEXT

Abbreviations for major and frequently used works:

Werner Heisenberg

- AF* *Across the Frontiers*. Translated by Peter Heath. New York: Harper & Row, 1974.
- NHP* *Das Naturbild der heutigen Physik*. Hamburg: Rowohlt, 1955.
- PB* *Physics and Beyond*. Translated by Peter Heath. New York: Harper & Row, 1971.
- PCN* *The Physicist's Conception of Nature*. Translated by Arnold J. Pomerans. London: Hutchinson, 1958.
- PP* *Physics and Philosophy*. New York: Harper & Brothers Publishers, 1958.
- SG* *Schritte über Grenzen*. Munich: Piper, 1985 (original edition 1971).
- TG* *Der Teil und das Ganze*. Munich: R. Piper & Co, 1971.
- TS* *Tradition in Science*. Selected chapters translated by Peter Heath. New York: The Seabury Press, 1983.

Hans Georg Gadamer

- PH* *Philosophical Hermeneutics*. Translated and Edited by David E. Linge. Berkeley: University of California Press, 1976.
- RS* *Reason in the Age of Science*. Translated by Frederick G. Lawrence. Cambridge: The MIT Press, 1981.
- TM* *Truth and Method*. Second revised edition. Revised and Translated by Joel Weinsheimer and Donald G. Marshall. New York: The Crossroad Publishing Company, 1980.

Notes to Introduction

1. David Klemm, *Hermeneutical Inquiry. Volume I: The Interpretation of Texts* (Atlanta: Georgia Press, 1986), p. 173.
2. Klaus Klostermaier, "Interreligious Dialogue as a Method for the Study of Religion," *Journal of Ecumenical Studies*, 21:4, Fall 1984, p. 756.
3. *PH*, p. 37.
4. *PH*, p. 36.
5. *AF*, p. xxi; *SG*, p. 9.
6. *AF*, p. xxii; *SG*, p. 10.
7. Joel Weinsheimer, *Gadamer's Hermeneutics: A Reading of Truth and Method* (New Haven and London: Yale University Press, 1985), p. 17.
8. *TM*, p. xxvii.
9. *PH*, p. 103.
10. Richard Bernstein, "What is the Difference that Makes a Difference?" in *Hermeneutics and Modern Philosophy*, ed. Brice Wachterhauser (New York: State University of New York Press), p. 369.
11. "What is the Difference that makes a Difference?" p. 346.
12. *PP*, p. 187.

Notes to Chapter 1

1. Joel Weinsheimer, *Gadamer's Hermeneutics: A Reading of Truth and Method* (New Haven and London: Yale University Press: 1985), p. 2.

2. *TM*, p. 451.

3. *TM*, p. 349.

4. *TM.*, p. 349.

5. Joel Weinsheimer, *Philosophical Hermeneutics and Literary Theory* (New Haven and London: Yale University Press: 1991), p. 13.

6. *TM*, p. 271.

7. *TM*, p. 238.

8. *TM*, p. 450.

9. *TM*, p. 454.

10. *TM*, p. 4.

11. *TM*, p. 3.

12. *TM*, p. 7.

13. *PH*, p. 5.

14. *TM*, p. 85.

15. *PH*, pp. 4-5.

16. *TM*, p. 85.

17. *PH*, p. 5.

18. Georgia Warnke, *Gadamer: Hermeneutics, Tradition and Reason* (Stanford, California: Stanford University Press, 1987), p. 8.

19. *TM*, p. 4.

20. *TM*, p. 239.

21. *TM*, p. 359.

22. *TM*, p. 489.

23. *TM*, p. 360.

24. *TM*, p. 359.

25. *PH*, p. 10.

26. *RS*, p. 72.

27. *RS*, p. 72.

28. *RS*, p. 147.

29. *RS*, p. 3.

30. *RS*, p. 146.

31. *RS*, p. 146.

32. *RS*, p. 140.

33. *RS*, p. 3.

34. "I would address one general admonition to all, that they consider what are the true ends of knowledge, and that they seek it not either for pleasure of the mind, or for contention, or for superiority to others, or for profit, or fame, or power, or any of these inferior things, but for the benefit and use of life; and that they perfect and govern it in charity. For it was from lust of power that the angels fell, from lust of knowledge that man fell; but of charity there can be no excess, neither did angel nor man ever come in danger by it." Francis Bacon, *The Great Instauration*, in *Francis Bacon: A Selection of his Works*, ed. Sidney Warhaft (Toronto: Macmillan of Canada, 1965), 310. Warhaft tells us the text and translations are essentially those of Spedding, Ellis and Heath (*Works*, 7 vols., London, 1857-59).

35. *RS*, p. 71.

36. *RS*, p. 71.

37. *RS*, p. 14.

38. *PH*, p. 10.

39. *RS*, p. 15.

40. *RS*, p. 37.

41.*PH*, p. 111.

42.*Gadamer: Hermeneutics, Tradition and Reason*, p. 163.

43.*RS*, p. 72.

44.*RS*, p. 148.

45.*RS*, p. 150.

46.*RS*, p. 52.

47.*RS*, p. 52.

48.*PCN*, p. 71; *NHP*, p. 49.

49. Werner Heisenberg, "The Representation of Nature in Contemporary Physics," trans. by O.T. Benfrey, in *Symbolism in Religion and Literature*, ed. Rollo May (New York, George Braziller, 1961), p. 217; *NHP*, 9. In fact, this is the first chapter of *Das Naturbild der Heutigen Physik*; however, I find it is a much better translation of it than that given by Arnold Pomerans in *The Physicist's Conception of Nature*. I might also add that Pomerans' translation of *Der Teil und das Ganze* is sometimes disappointing.

50. "The Representation of Nature in Contemporary Physics," p. 217; *NHP*, p. 9.

51.*PCN*, p. 84; *NHP*, p. 59.

52. "The Representation of Nature in Contemporary Physics," p. 217; *NHP*, p. 8.

53. "The Representation of Nature in Contemporary Physics," p. 217; *NHP*, p. 8.

54. "The Representation of Nature in Contemporary Physics," p. 217; *NHP*, p. 8.

55.*AF*, p. 209; *SG*, p. 295.

56.*PCN*, p. 84; *NHP*, p. 58.

57.*PCN*, p. 76; *NHP*, p. 52.

58.*PCN*, p. 84; *NHP*, p. 58.

59.*PCN*, p. 84; *NHP*, pp. 58-59.

60.*TS*, "Tradition in Science" p. 8; chapter written in English.

61.*PP*, p. 79.

62.*AF*, p. 178; *SG*, p. 264.

63.*PCN*, p. 86; *NHP*, p. 60.

64. Newton, Letter to Cotes, in *Newton's Philosophy of Nature: Selections from his Writings*, ed. H.S. Thayer (New York: Hafner Press, 1953), p. 7.

65.*PCN*, p. 111; *NHP*, p. 79.

66.*PCN*, p. 180; *NHP*, p. 132.

67.*PP*, p. 78.

68.*PP*, p. 78.

69.*PP*, p. 78.

70.*PP*, p. 80.

71.*AF*, p. 216; *SG*, p. 302.

72. Newton, *Principia*, cited by Heisenberg in *PCN*, p. 114; *NHP*, p. 81.

73.*PP*, pp. 80-81.

74. "The Representation of Nature in Contemporary Physics," p. 217; *NHP*, p. 8.

75.*AF*, p. 133; *SG*, pp. 217-218.

76.*AF*, p. 133; *SG*, p. 218.

77. Goethe, letter to C. D. von Buttel, May, 1827, cited in *AF*, p. 133; *SG*, p. 218.

78. *Goethe's Letters to Zelter*, ed. and tr. A.D. Coleridge, 1887; No. 47, p. 62, cited in *AF*, p. 127; *SG*, pp. 211-212 .

79.*AF*, p. 133; *SG*, p. 218.

80.*AF*, p. 129; *SG*, p. 214.

81.*AF*, pp. 131-132; *SG*, p. 216.

82.*AF*, p. 132; *SG*, p. 216.

83.*AF*, p. 129; *SG*, p. 214.

84.*AF*, p. 137; *SG*, p. 222.

- 85.*AF*, pp. 131-132; *SG*, p. 216.
- 86.*AF*, p. 132; *SG*, p. 217.
- 87.*PCN*, p. 180; *NHP*, p. 132.
- 88.*PCN*, p. 121; *NHP*, p. 86.
- 89.*PCN*, p. 180; *NHP*, p. 132.
- 90.*PP*, p. 201.
- 91.*PP*, p. 201.
- 92.Letter to Eberhard Cold, 4 April 195? (date obscured), my translation.
- 93.*PP*, p. 170.
- 94.*AF*, p. 85; *SG*, p. 166.
- 95.*AF*, p. 226; *SG*, p. 312.
- 96.*PB*, p. 83; *TG*, pp. 116-117.
- 97.*PB*, p. 84; *TG*, p. 118.
- 98.D'Alembert, Preface to the French Encyclopaedia, cited in *PCN*, p. 130; *NHP*, p. 92.
- 99."The Representation of Nature in Contemporary Physics," p. 224; *NHP*, p. 14.
- 100.Heisenberg, Letter to Dr. W. Gerlach, 11 Feb 1974 (unpublished).
- 101.*AF*, p. 129; *SG*, p. 214.
- 102.*AF*, p. 219; *SG*, p. 305.
- 103.*AF*, p. 131; *SG*, p. 216.*Ibid.*
- 104.*AF*, p. 64-65; *SG*, p. 146-147.
- 105.*AF*, p. 130; *SG*, p. 215.
- 106."The Representation of Nature in Contemporary Physics," p. 224; *NHP*, p. 15.
- 107.*AF*, p. 203; *SG*, p. 289.
- 108.*AF*, p. 203; *SG*, p. 289.

109.*AF*, p. 205; *SG*, p. 291.

110. "The Representation of Nature in Contemporary Physics," p. 231; *NHP*, p. 22.

111. In this, Heisenberg turns more often to Plato, while Gadamer, though a Plato scholar, turns to Aristotle. Gadamer does this, it seems to me, because of Aristotle's perhaps more vocal insistence on the obligation of involvement in the polis, and his in-depth considerations regarding the practical reasoning on which that involvement is based. Naturally, Gadamer does not ignore the fact that in Aristotle, the fulfilment of our natures as ethical beings is a second-best fulfilment, the best being contemplators of the divine. But he uses Aristotle only as a model, and not as a prophet. Heisenberg, who is no scholar of ancient philosophy, finds that philosophizing as a basis for action well enough in Plato.

112.*AF*, p. 219; *SG*, p. 306.

113.*AF*, p. 227; *SG*, p. 315.

114.*PB*, p. 217; *TG*, p. 295.

115. "The Representation of Nature in Contemporary Physics," p. 225; *NHP*, p. 16.

116. "The Representation of Nature in Contemporary Physics," p. 225; *NHP*, p. 16.

117.*AF*, p. 131; *SG*, p. 216.

118. "The Representation of Nature in Contemporary Physics," p. 232; *NHP*, p. 23.

119. "The Representation of Nature in Contemporary Physics," p. 227; *NHP*, p. 18.

120.*AF*, pp. 211-212; *SG*, p. 298.

121. "The Representation of Nature in Contemporary Physics," p. 227; *NHP*, p. 18.

Notes to Chapter 2

1. *TM*, p. xxvii.
2. *RS*, p. 105.
3. *PH*, p. 54.
4. *PH*, p. 94.
5. *TM*, p. 360.
6. *TM*, p. 276.
7. *TM*, p. 99.
8. *TM*, pp. 99-100.
9. *TM*, p. 264.
10. Brice Wachterhauser, "Prejudice, Reason and Force," *Philosophy* 63, 1988, p. 237.
11. *PH*, p. 55.
12. *PH*, p. 55.
13. *TM*, p. 302.
14. *RS*, p. 41.
15. *TM*, p. 306.
16. *RS*, p. 103.
17. *RS*, p. 103.
18. *PH*, p. 46.
19. *Gadamer: Hermeneutics, Tradition and Reason*, p. 82.
20. *TM*, p. 259.
21. *PH*, p. 29.
22. *TM*, p. 447.

23. Brice Wachterhauser, "Gadamer's Realism: The 'Belongingness' of Word and Reality," in *Hermeneutics and Truth*, ed. Brice Wachterhauser (New York: State University of New York Press), p. 162.

24. *PH*, p. 103.

25. *TM*, p. 453.

26. *PH*, p. 31.

27. *TM*, p. 457.

28. *TM*, p. 106.

29. *TM*, p. 109.

30. *TM*, p. 490.

31. *TM*, p. 491.

32. *TM*, p. 480.

33. *TM*, p. 481.

34. *TM*, p. 482

35. James Risser, "The Remembrance of Truth," in *Hermeneutics and Truth*, ed. Brice Wachterhauser (New York: State University of New York Press), p. 126.

36. "The Remembrance of Truth," p. 126.

37. *TM*, p. 487.

38. *TM*, p. 116.

39. *TM*, p. 141, note 250.

40. *PH*, p. 101.

41. *TM*, p. 138.

42. *TM*, p. 140.

43. *TM*, p. 483.

44. "Gadamer's Realism: The 'Belongingness' of Word and Reality," p. 163.

45. "Gadamer's Realism: The 'Belongingness' of Word and Reality," p. 164.
46. *TM*, p. 401.
47. *TM*, p. 458.
48. *TM*, p. 416.
49. *TM*, p. 143.
50. *TM*, p. 466.
51. *TM*, p. 469.
52. *TM*, p. 458.
53. *TM*, p. 474.
54. *PH*, p. 103.
55. *TM*, p. 474.
56. *TM*, p. 378.
57. *TM*, p. 368.
58. *TM*, p. 385.
59. *TM*, p. 383.
60. *TM*, p. 379.
61. *TM*, p. 383.
62. *TM*, p. 388.
63. *TM*, p. 388.
64. *TM*, p. 388.
65. *PH*, p. 94.
66. *TM*, p. 324.
67. *TM*, p. 324.
68. *RS*, p. 82.

69.*RS*, p. 82.

70.*TM*, p. 313.

71.*TM*, p. 314.

72.*TM*, p. 313.

73.*RS*, p. 109.

74.*RS*, p. 110.

75.*TM*, p. 491.

76.*TM*, p. 486.

77.*TM*, p. 490.

78.*PH*, pp. 101-102.

79.*PH*, p. 57.

80.*TM*, p. 446.

81.*TM*, p. 491.

82. Michael Kelly, "Hermeneutics and Science: Why Hermeneutics is not Anti-Science," in *The Southern Journal of Philosophy* (1987) Vol. XXV, No. 4.

83. "Hermeneutics and Science: Why Hermeneutics is not Anti-Science," p. 483.

84. "Hermeneutics and Science: Why Hermeneutics is not Anti-Science," p. 484.

85. "Hermeneutics and Science: Why Hermeneutics is not Anti-Science," p. 484.

86. *Gadamer's Hermeneutics: A Reading of Truth and Method*, p.2

87.*RS*, p. 166.

88. "Hermeneutics and Science: Why Hermeneutics is not Anti-Science," p. 488.

89.*RS*, p. 167.

90.*TM*, p. 560.

91.*TM*, p. 555.

92. "Hermeneutics and Science: Why Hermeneutics is not Anti-Science," p. 494.

93. *PH*, p. 93.

94. *TM*, p. xxiii.

95. *RS*, p. 166.

96. *RS*, p. 166.

97. *TM*, p. 558.

98. *PH*, p. 93.

99. *TM*, p. 554.

100. *RS*, p. 144.

101. *RS*, p. 144.

102. *PH*, p. 103.

103. *RS*, p. 12.

104. *RS*, p. 137.

105. *RS*, p. 111.

106. *TM*, p. 552.

Notes to Chapter 3

1. *TM*, p. 97.
2. "The Representation of Nature in Contemporary Physics," p. 230; *NHP*, p. 20.
3. *PCN*, p. 56; *NHP*, p. 39.
4. "The Representation of Nature in Contemporary Physics," p. 230; *NHP*, p. 20.
5. *PCN*, p. 41; *NHP*, p. 29.
6. *PB*, p. 206; *TG*, p. 280.
7. *PB*, p. xvii, revised translation; *TG*, p. 9.
8. *TM*, p. 446.
9. *PB*, p. xviii, revised translation; *TG*, p. 10.
10. *PB*, p. 63; *TG*, p. 92.
11. *PB*, p. 63; *TG*, p. 91.
12. *PB*, p. 63; *TG*, p. 91.
13. *PB*, p. 63; *TG*, p. 91.
14. *PB*, p. 63; *TG*, pp. 91-92.
15. *PB*, p. 64; *TG*, p. 92.
16. *PB*, p. 64; *TG*, p. 93.
17. In fact, Schrödinger developed this waves mechanics, and although he was thinking in terms of material waves, they came to be understood as waves of probability.
18. *PB*, p. 78; *TG*, p. 111.
19. *PP*, p. 42.
20. *PB*, p. 78; *TG*, pp. 111-112.
21. *PCN*, p. 40; *NHP*, pp. 28-29.
22. "The Representation of Nature in Contemporary Physics," p. 228; *NHP*, p. 18.

23.*PP*, p. 52.

24.*PP*, p. 55.

25.*PP*, p. 44.

26.*PP*, p. 58.

27. "The Representation of Nature in Contemporary Physics," p. 231; *NHP*, p. 21.

28. "The Representation of Nature in Contemporary Physics," p. 231; *NHP*, p. 21.

29.*AF*, p. 185; *SG*, p. 271.

30.*PP*, p. 104.

31.*PP*, p. 105.

32. "The Representation of Nature in Contemporary Physics," p. 231; *NHP*, p. 21.

33.*PP*, p. 56.

34.*PP*, p. 56.

35.*PB*, p. 213; *TG*, p. 290.

36.*PB*, p. 209; *TG*, p. 284.

37. Letter to Karl Hufbauer, 22 October 1971, my translation.

38.*PB*, p. 29; *TG*, p. 48.

39.*PP*, p. 130.

40.*PP*, p. 129.

41.*AF*, p. ; *SG*, p. 196.

42.*AF*, p. 158; *SG*, p. 244.

43.*PP*, p. 82.

44.*PP*, p. 96.

45.*PB*, p. 95; *TG*, p. 133.

46.*PB*, p. 98; *TG*, p. 138.

47.*PB*, p. 98; *TG*, p. 138.

48.*PB*, p. 31; *TG*, p. 50.

49.*PP*, p. 72.

50. "What is an Elementary Particle?" translated by Peter Heath, *TS*, p. 79.

51. "What is an Elementary Particle?" translated by Peter Heath, *TS*, p. 79.

52.*AF*, p. 172; *SG*, p. 258.

53.*AF*, p. 185; *SG*, p. 271.

54.*PB*, pp. 98-99; *TG*, pp. 138-139.

55.*PB*, p. 96; *TG*, p. 135.

56.*PB*, p. 96; *TG*, p. 135.

57.*PB*, p. 97; *TG*, p. 136.

58.*PP*, p. 97.

59.*PP*, p. 98.

60.*PP*, p. 97.

61. C.F. von Weizsäcker, "Platonic Natural Science," p. 4.

62.*PB*, p. 99; *TG*, p. 138.

63.*PB*, p. 99; *TG*, p. 139.

64.*PB*, p. 99; *TG*, p. 139.

65.*PB*, p. 99; *TG*, p. 139.

66.*PB*, pp. 69-69; *TG*, p. 99.

67.*PB*, p. 69; *TG*, p. 99.

68.*AF*, p. 218; *SG*, p. 304.

69.*AF*, p. 174; *SG*, p. 260.

70.*AF*, p. 167; *SG*, p. 253.

- 71.*AF*, p. 167; *SG*, p. 253.
- 72.*AF*, p. 167; *SG*, p. 253.
- 73.*AF*, p. 168; *SG*, pp. 253-254.
- 74.*AF*, p. 169; *SG*, p. 255.
- 75.*AF*, p. 170; *SG*, p. 256.
- 76.*AF*, p. 170; *SG*, p. 256.
- 77.*AF*, p. 182; *SG*, p. 269.
- 78.*AF*, p. 174; *SG*, p. 261.
- 79.*AF*, p. 177; *SG*, p. 264.
- 80.*AF*, p. 174; *SG*, p. 261.
- 81.*AF*, p. 183; *SG*, p. 269.
- 82.*AF*, p. 174; *SG*, p. 261.
- 83.*AF*, p. 175; *SG*, p. 261.
- 84.*PB*, p. 61; *TG*, p. 89.
- 85.*AF*, p. 182; *SG*, p. 268.
- 86.*AF*, p. 183; *SG*, p. 269.
- 87."The Representation of Nature in Contemporary Physics," p. 230; *NHP*, p. 21.
- 88."The Representation of Nature in Contemporary Physics," p. 221; *NHP*, p. 12.
- 89.*AF*, p. 121; *SG*, p. 205.
- 90.*AF*, p. 88; *SG*, p. 169.
- 91.*PB*, p. 88; *TG*, p. 123.
- 92.*PP*, p. 109.
- 93.*AF*, p. 171; *SG*, p. 257.
- 94.*AF*, p. 168; *SG*, p. 254.

95.*PP*, p. 107.

96.*PP*, p. 107.

97. "The Representation of Nature in Contemporary Physics," p. 221; *NHP*, p. 12.

98. "The Representation of Nature in Contemporary Physics," p. 227; *NHP*, p. 18.

99.*PP*, p. 109.

100.*PP*, p. 55.

101.*AF*, p. 227; *SG*, p. 313.

102. Letter to Arnold Pomerans, 1 April 1970, my translation.

103.*AF*, pp. 133-34; *SG*, p. 218.

104.*PB*, p. 101, revised translation; *TG*, p. 142.

105. "Tradition in Science," in *TS*, p. 15.

106. "Tradition in Science," in *TS*, p. 15.

107.*PP*, p. 92.

108.*PB*, p. 241, revised translation; *TG*, p. 327.

109.*AF*, p. 174; *SG*, p. 261.

110.*AF*, p. 172; *SG*, p. 258.

111.*AF*, pp. 170-171; *SG*, p. 257.

112.*AF*, p. 170; *SG*, p. 257.

113. *Republic* 530, in *The Dialogues of Plato, 2 Vols.*, trans. by B. Jowett (New York: Random House, sixteenth printing, 1937).

114.*PB*, p. 186, revised translation; *TG*, p. 253.

115.*AF*, p. 136; *SG*, p. 221.

116.*PB*, p. 214; *TG*, p. 291.

117.*SG*, p. 115, my translation.

118.*AF*, pp. 170-171; *SG*, p. 257.

119.*Metaphysica*, θ .9, 1048a30-32, in *The Works of Aristotle*, translated under the editorship of J.A. Smith and W.D. Ross (Oxford: Clarendon Press, 1908).

120.*PP*, p. 160.

121.*PP*, p. 160.

122.*PP*, p. 160.

123.*PP*, p. 160.

124.*PB*, p. 245; *TG*, p. 332.

125.*PP*, p. 70.

126.*AF*, p. 136; *SG*, p. 221.

127.*AF*, pp. 136-137; *SG*, p. 221.

128.*AF*, p. 141; *SG*, p. 226.

129.*AF*, p. 139; *SG*, p. 224.

130.*PB*, pp. 215-216, revised translation; *TG*, p. 293.

131.*PB*, pp. 242-243; *TG*, p. 328.

132.*AF*, p. 176; *SG*, p. 262.

133. "The Representation of Nature in Contemporary Physics," p. 229; *NHP*, p. 19.

134.*AF*, p. 176; *SG*, p. 262.

135.*AF*, p. 86; *SG*, p. 168.

136.*PP*, p. 109.

137.*AF*, p. 86; *SG*, p. 168.

138.*AF*, p. 87; *SG*, p. 168.

139.*PB*, p. 68; *TG*, p. 98.

140.*PB*, p. 69; *TG*, p. 99.

- 141.*PB*, p. 68; *TG*, pp. 98-99.
- 142.*PB*, p. 212; *TG*, p. 288.
- 143.*AF*, p. 31; *SG*, p. 44.
- 144.*AF*, p. 32; *SG*, p. 45.
- 145.*AF*, p. 32; *SG*, p. 45.
- 146.*AF*, p. 180; *SG*, p. 267.
- 147.*AF*, pp. 36-37; *SG*, p. 50.
- 148.*AF*, p. 72; *SG*, p. 153.
- 149.*AF*, p. 72; *SG*, p. 153.
150. "Tradition in Science", in *TS*, p. 12.
151. *AF*, p. 71; *SG*, p. 152.
- 152.*PP*, p. 168.
- 153.*PP*, p. 200.
- 154.*AF*, p. 86; *SG*, p. 168.
- 155.*PP*, p. 200.
- 156.*PP*, p. 200.
- 157.*PP*, p. 200.
- 158.*AF*, p. 73; *SG*, p. 154.
- 159.*AF*, p. 72; *SG*, p. 153.
- 160.*PP*, p. 92.
- 161.*PP*, p. 201.
- 162.*PB*, p. 209; *TG*, p. 284.
- 163.*PB*, p. 209; *TG*, p. 285.
164. "Tradition in Science," in *TS*, p. 15.

165. "Tradition in Science," in *TS*, p. 3.
166. "Tradition in Science," in *TS*, p. 15.
167. *AF*, p. 152; *SG*, p. 237.
168. *AF*, p. 88; *SG*, p. 170.
169. "Tradition in Science," in *TS*, p. 3.
170. *AF*, p. 163; *SG*, p. 249.
171. *AF*, p. 160; *SG*, p. 245.
172. *AF*, p. 159; *SG*, p. 244.
173. *AF*, p. 152; *SG*, p. 237.
174. *AF*, p. 165; *SG*, p. 250.
175. *PB*, p. 148; *TG*, p. 204.
176. *PCN*, p. 67; *NHP*, p. 46.
177. *TM*, p. xxxvii.
178. *AF*, p. 28; *SG*, p. 41.
179. "The Representation of Nature in Contemporary Physics," p. 230; *NHP*, p. 20.
180. *AF*, p. 210; *SG*, p. 297.
181. *AF*, p. 210; *SG*, pp. 296-297.
182. *AF*, pp. 210-211; *SG*, p. 297.
183. *PB*, p. 124; *TG*, p. 173.
184. *PB*, p. 23; *TG*, p. 40.
185. *AF*, p. 85; *SG*, p. 167.
186. *PP*, p. 108.
187. *AF*, p. 129; *SG*, p. 214.
188. "Tradition in Science," in *TS*, p. 3.

- 189.*AF*, p. 134; *SG*, p. 219.
- 190.*PCN*, p. 66; *NHP*, p. 45.
- 191.*PB*, p. 70; *TG*, p. 101.
- 192.*PCN*, p. 65; *NHP*, p. 45.
- 193.*PB*, p. 245; *TG*, p. 331.
- 194.*PP*, p. 201.
- 195.*PB*, pp. 246-247; *TG*, p. 334.
- 196.*PB*, p. 124; *TG*, p. 173.
- 197.*PP*, p. 203.
- 198.*AF*, p. 68; *SG*, p. 149.
- 199.*PB*, p. 10; *TG*, pp. 23-24.
- 200.*AF*, p. 69; *SG*, p. 150.
- 201.*AF*, p. 68; *SG*, p. 149.
- 202.*AF*, p. 215; *SG*, p. 302.
- 203.*AF*, p. 215; *SG*, p. 302.
- 204.*AF*, p. 218; *SG*, p. 304.
- 205.*AF*, p. 218; *SG*, p. 304.
- 206.*AF*, p. 218; *SG*, p. 305.
- 207.*AF*, p. 229; *SG*, p. 315.
- 208.*AF*, p. 218; *SG*, p. 304.
- 209.*AF*, p. 229; *SG*, p. 315.
- 210.*PB*, p. 102; *TG*, p. 143.
- 211.*PB*, p. 89; *TG*, p. 125.
- 212.*AF*, p. 68; *SG*, p. 149.

213.*AF*, p. 141; *SG*, p. 226.

214.*AF*, p. 66; *SG*, p. 147.

215.*AF*, p. 69; *SG*, p. 150.

216.*AF*, p. 141; *SG*, p. 226.

217.*AF*, p. 140; *SG*, p. 225.

218.*AF*, p. 203; *SG*, p. 290.

219.*AF*, p. 204; *SG*, p. 290.

220.*PB*, p. 199; *TG*, p. 272.

221.*AF*, p. 228; *SG*, p. 315.

222.*AF*, p. xxii; *SG*, p. 10.

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