The nature of reality has been the subject of extensive, deeply searching philosophical thought, discussion, and argument throughout the ages. In our own age the issue is still far from resolved, and arouses undiminished fervor. As science has developed from, say, the 1600s to the present, it has taught humankind objective facts about reality that thinkers cannot afford to ignore. And especially in our own centuries, the implications of the attainments of science, as expressed in relativity and quantum theories, are crucial for our understanding of reality. So much so, I feel strongly that any educational curriculum worthy of its name must assure some minimal elementary understanding of these theories.

Even so, I repeat my assertion that considerations about reality are philosophical considerations, even metaphysical, in the sense described in Science and Metaphysics, chapter 4, since they bear strongly on science. Science can constrain metaphysical speculations about reality, but it cannot totally replace them. Science can go only so far in telling us about reality; reality’s ultimate nature is beyond the domain of science. Yet it seems to me that science, although it cannot force one to adopt any particular worldview, strongly hints in a certain direction. If we’re willing to let science guide us, we will be led to a particular worldview.

Metaphysical Positions

First, let’s reconsider the metaphysical position of realism, presented in Realism and Idealism, chapter 6. There, realism was presented as the position that the order and laws of nature are inherent to the
The world we observe, and are independent of observers. I opposed realism to idealism, in which the order and laws of nature exist wholly in the mind of the observer. I then proposed a hybrid position, that nature does possess objective order, whereas laws are a human device.

Realism, in a more fundamental sense of the term, is the metaphysical position that there is an objective, observer-independent underlying reality that we discover and study through our physical senses (and through our measuring and observing instruments as extensions of our senses). Realism claims that there is a real world “out there” existing independently of us. The assumption of realism in this sense, made in chapter 1, pervades the presentation in this book, simply because my own worldview is basically realist, as is that of almost all scientists. Realism in this sense is usually placed in opposition to positivism, which is the metaphysical position that only our sense data, derived from measurements and observations, are fundamental. Positivist science is thus expressed solely in terms of measurements and observations, solely in terms of the phenomena themselves. It refrains from considerations of any reality that underlies the phenomena, any reality that would not be directly accessible by our physical senses and their extensions.

Realists and positivists both agree that our measurements and observations are the source of our scientific knowledge of nature. Positivists claim that it is meaningless to go beyond these, that nothing significant can be said about whatever might be underlying the phenomena. Realism goes beyond positivism by assuming that an objective reality underlies natural phenomena, and is the ultimate source of the results of our measurements and observations. Thus, according to the realist view, our measurements and observations, as interesting as they might be in themselves, tell us something about objective underlying reality.

As an example of the difference between realist science and positivist science, consider a hypothetical investigation of a sample of some radioactive material. Assume that one gram of the material is placed two centimeters away from the window of a Geiger counter.
The counter responds with a continual irregular series of clicks, while a pointer indicates the average number of clicks per minute, the count rate. (The technical details aren’t important, but I give them to make the procedure sound authentic.)

Both realist and positivist scientists would be interested in the dependence of the count rate on the distance between the sample and the counter window, as well as its dependence on the thickness and kind of material placed between the sample and the counter window. Both scientists would be interested, as well, in the dependence of the count rate on time. Both would make many measurements of many kinds, analyze the results, and look for order.

Positivist scientists would not go much beyond that. They would be happy to find interesting order among the measurement results, and would be satisfied with that. Realist scientists would be happy with that as well, but would not be satisfied. They would look for an underlying reality that brings about the Geiger counter clicks and the dependence of the count rate on distance, intervening material, and time. They would reach an understanding in terms of the sample’s consisting of atoms with unstable nuclei, nuclei that spontaneously and unpredictably “decay” and emit particles. Realists would picture the emitted particles entering the counter window and causing the counter to click, one click per particle. They would understand that intervening material absorbs the particles, so that fewer of them would reach the counter window. They would understand that the count rate decreases in time because there remain in the material fewer and fewer undecayed nuclei. They would even suggest new experiments and attempt to predict the results in order to confirm their understanding.

Positivism carried to the extreme leads to solipsism, which, in its extreme, is the metaphysical position that nothing is real except the self. In other words, starting with “cogito ergo sum” (I think, therefore I exist), I’m assured only of my own existence; the rest is my imagination (including this book and you readers). It must be admitted, it seems to me, that from a purely logical standpoint, solipsism is the only compelling metaphysical position among them all.
Indeed, the reality to me of everything beyond my own existence is based on arbitrary assumptions that I choose to make.

For example, it is an assumption—perhaps reasonable, maybe not, but nevertheless arbitrary—that my self is somehow intrinsically attached to a body. It is a further assumption that my body is equipped with sense organs and that certain sensations I’m aware of result from the activity of these organs. It is also an assumption that the activity of my sense organs is a result of stimulation by some reality external to my body. And so on and so forth. (Am I just imagining I’m hitting imagined keys that bring these imagined words into imagined existence on an imagined monitor screen? Refer to Objective and Subjective, chapter 1.)

Objective Reality

Let’s now proceed step by step to see how science leads us to a particular metaphysical position in regard to reality, which, as you can readily predict from the preceding paragraphs, is going to be a version of realism. My arguments and justifications will be based on common sense, on our understanding of nature, and on reasonableness, utility, motivation, and conceptual economy (or parsimony, i.e., thrift in the use of concepts).

To start off, it seems to me that science is urging us to be realists, that we’re being encouraged to believe there is an objective reality, an observer-independent underlying reality that is the same reality for electrons, for galaxies, for tadpoles, and for people. One argument here is based on motivation. If one doesn’t believe there exists an objective reality, there is no motivation to discover and investigate it. Yet the existence of science demonstrates that there are many people who are strongly motivated to discover and investigate objective reality. Since science is so successful in accomplishing its goals, it seems that our motivation to do science is well justified. Thus we’re encouraged to believe in an underlying reality. This argument is good for the existence of an underlying reality, but does not address its objectivity.
However, it is most reasonable to believe in the objectivity of underlying reality, that it is observer-independent and is the same underlying reality for neutrons, for stars, for carrots, and for humans. Science goes to much trouble and effort to maximize objectivity by confining itself to the reproducible aspects of nature (Reproducibility, chapter 2). Then science finds that nature possesses such aspects, and moreover, that there is no lack of raw material for science to process. And finally, almost all this raw material is well comprehended by science and fits together beautifully, meshing into a most elegant conceptual fabric, the whole wonderful world of science. So if it looks, sounds, and smells like objective reality, is it not most reasonable and conceptually economical to believe that this is just what we have?

Furthermore, it is useful to believe there is an objective reality, because, motivated to investigate it, we do investigate it, and, through technological application, we obtain useful results, such as fertilizers, vitamins, telephones, and word processors.

Now that we’re convinced to believe in an objective reality, we note that we gain scientific knowledge of it through our physical senses: sight, hearing, smell, taste, touch (pressure), temperature, and others. (Any “knowledge” of reality gained through other, non-physical channels is of no concern to science.) Information from our senses is processed by our nervous system, where it interacts with innate and acquired structures, finally emerging in our consciousness. Thus our knowledge of reality involves interaction with the world external to our bodies, filtering through our senses, neural processing, and conscious awareness of the results of all this.

That seems obvious. The crucial implication is that scientific knowledge of objective reality is indirect knowledge. Direct knowledge, in contrast, somehow passes directly from the object of the knowledge into our consciousness. We might call it intuition or belief or feeling. But by its character, science confines us to our physical senses in our observations of nature.

Here intuition, belief, and feeling are forbidden. “Data” gained by intuiting the reading of a gauge, instead of actually reading it, or
by believing a length is such and such, rather than actually measuring it, or by feeling a solution has a certain color, instead of actually seeing it, have no part in science. Thus science dooms itself to merely indirect knowledge of the reality it tries to comprehend.

This puts off some people, who prefer direct knowledge of reality through nonscientific modes of comprehension, in preference to the indirect knowledge of science. Thus they might attempt to know reality by means of meditation, prayer, feeling, intuition, inspiration, awareness, or pure thought, possibly with the help of “awareness-enhancing” or “mind-expanding” drugs. Who but the subject himself or herself can judge whether any knowledge is thus gained at all? And who, including the subject, can judge whether such knowledge has anything whatsoever to do with reality? What can be stated with certainty, though, is that any knowledge thus gained is among the most subjective knowledge imaginable.

Yet scientists, too, indulge in intuition, inspiration, feeling, and pure thought, as we saw in chapter 3, dealing with theories in science. And not only in their devising and judging of theories do scientists act (and must act) with some degree of irrationality, but intuition, inspiration, and taste can also guide the choice of what aspect of nature to investigate, how to go about it, and what experiments to perform, for example. It is to a large extent by their superior intuition and inspiration that the greatest scientists achieve their stature in the science community. But at the level of observational data, no scientist will ever accept “direct knowledge” in lieu of knowledge gained via the physical senses, however indirect the latter admittedly is.

Perceived Reality

What we do become aware of via our senses and our neural processing might be termed perceived reality. It is perceived reality that is the actual subject of science, although we might hope to gain some understanding of objective reality through an understanding of perceived reality.
We are the result of evolutionary adaptation, according to our understanding of nature, and have been managing to survive in our ecological niche for millennia. Thus it is reasonable to believe that perceived reality cannot be much out of tune with objective reality, at least with those aspects of reality that strongly and frequently affect our survival as individuals and as a species. When we perceive food at a certain location at a certain time and strive to get hold of it, we succeed in nourishing ourselves often enough to survive. Or, most of us manage to avoid the attacks of tigers (as well as of their spiritual descendants, motor vehicles). Those of us for whom that is not true don’t live to pass on their genes.

So, in the absence of any direct scientific knowledge of objective reality, we should not throw up our hands in despair, but rather should take our perceptions and concepts seriously and let them guide us toward an understanding of objective reality. The argument here is one of motivation and utility: If we have no hope of approaching objective reality, we might as well give up believing in it. It is reasonable and conceptually economical to believe that our perceptions and concepts even give us a literal picture of objective reality, at least as long as this belief is tenable.

Even so, we cannot presume that our perceptions and concepts of reality necessarily give us a literal description of, or even remain faithful guides to, aspects of reality that do not affect us strongly or frequently, such as for submicroscopic phenomena or for astronomical and larger-scale phenomena. The reason is that the argument based on evolutionary adaptation then loses its validity. It does not much matter whether we are adapted to aspects of reality that affect us only weakly or rarely; in any case, those aspects do not significantly affect our survival.

So when dealing with such aspects of reality, it is reasonable to let our belief in our ability to describe objective reality literally through our understanding of perceived reality be contingent on its not leading to undue difficulty. We should be prepared to drop our belief in literal description if and whenever it proves to cause more trouble than it is worth.
And it turns out that, when we deal with the quantum aspect of nature, our belief in a literal description of objective reality causes tremendous trouble. Perceived reality at the submicroscopic level of nature, which is well described by quantum theory, is simply unacceptable as a literal description of objective reality. The technicalities of the problem are beyond the scope of this book. (They are presented in other books, some of which are listed in the bibliography at the end of the chapter.) But the cardinal point can be stated without going into technicality. It is that in quantum theory there is too much dependence on the observer to allow perceived reality to be a literal description of objective reality, which is assumed to be independent of observers.

Let’s try to clarify that. Quantum theory is formulated in terms of possible happenings and their probabilities of occurring, rather than in strictly deterministic terms of what will occur. For example, for some situations quantum theory might tell us that a particle can be in a certain range of positions (rather than specifying its exact location). If we make an observation of its position, we’ll find it at some location within the allowed range. But only then, according to quantum theory, are we allowed to think of the particle as actually being located. Prior to the observation the particle must not be thought of as being located at all. It then possesses only potentiality for location. The act of observation realizes the potentiality and endows the particle with the property of position.

It’s not as if, prior to the observation, the particle had a location that we didn’t know, but which the observation revealed. Quantum theory clearly rules this out and affirms that it is the act of observation itself that bestows the property of position upon the particle, which previously did not possess the property. The intrinsic dependence of the perceived reality of properties, such as position, on the activities of observers demonstrates that the perceived reality of the quantum aspects of nature cannot be a literal description of an observer-independent, objective reality.

That might seem to make little sense, probably even no sense at all. In fact, it might appear to be downright crazy. Yet that’s the way
things are. The astounding, mind-boggling quantum aspects of nature are counterintuitive. But they are no less part of perceived reality for all that.

The trouble lies with our limited intuition, which developed in the environment of ordinary-size phenomena that affect us strongly and often. At this scale, quantum effects, though valid, are negligible. So we have no intuition for them. Nevertheless, their implications for reality are so crucial that no thinker can afford to ignore them. Thus I repeat my claim (at the beginning of this chapter) that no educational curriculum worthy of its name can do without some minimal exposure to quantum theory (as well as relativity theory). If you’re not familiar with the ideas of quantum theory, I strongly urge you to make use of the bibliography entries at the end of the chapter.

Partially Hidden Reality

Thus we know that even if certain aspects of perceived reality can be assumed to give a literal description of objective reality, there are other aspects that do not. We know that science does not give us full comprehension and understanding of objective reality. Whether science ever will do that is a moot issue at present, but the way things are developing does not offer much hope. So the objective reality that science has led us to believe in is partially hidden from us, as a veiled, clouded, fogged reality. Science allows us clear glimpses of parts of it, as well as provocative hints about more of it. Most of objective reality, however, will very likely remain inaccessible to mankind via science.

It seems to be human nature to want what we don’t have, and to desire especially what we can’t have. And so with objective reality. The simply fascinating questions about it are those we can’t answer at present, whereas the profound ones will most probably never be answered by science. Questions such as: What can be deduced from quantum theory about objective reality? Are space and time, as we perceive them, fundamental aspects of objective reality? (There
appear to be indications to the negative.) And if not, how do they link to it? To what extent is our perception of nature in terms of localized objects valid for objective reality? (Not very, it seems.) What relation does mind bear to objective reality? And the profoundest questions of all are most likely far beyond human mental ability even to formulate.

Since science does not, and most probably cannot, give us anything near full comprehension and understanding of objective reality, some claim that there seems to be no reason why other, non-scientific modes of comprehension and understanding should not afford us hints and clues to this reality. It’s claimed that as long as objective reality, which science guides us to believe in, itself lies beyond the domain of science, we should not shut ourselves off from the possibility that we might possess other channels to it. Indeed, it is claimed, why shouldn’t intuition, belief, feeling, art, music, and poetry be allowed to contribute whatever insight they might offer? Such modes of comprehension, it is claimed, as irrational and subjective as they are, and perhaps even because of their irrationality and subjectivity, might complement, and thus strengthen, the contribution of science to our quest for objective reality.

Might or might not, I reply. I try to remain open-minded, but am skeptical. After all, objective is objective, and it’s hard to see how the subjective and irrational can contribute to an understanding of the objective.

Let’s summarize. Using arguments and justifications based on common sense, on our understanding of nature, and on reasonableness, utility, conceptual economy, and motivation, we have seen how science leads us to a belief in an objective reality. Our scientific knowledge of this reality is indirect. But science should nevertheless give us a literal description of objective reality, at least for those aspects of it that strongly and frequently affect our survival as individuals and as a species. Yet quantum theory, the best theory we presently possess, cannot be a literal description of this reality. Thus objective reality is partially, very likely mostly, hidden from us.
Transcendent Reality

In earlier chapters we made much of the concept of nature. How does nature accord with reality? Recall that nature is, for our purpose, the material universe with which we can, or can conceivably, interact. That’s a close match with perceived reality. Science, we recall, is our attempt to understand objectively the reproducible and predictable aspects of nature, and thus of perceived reality. (In Perceived Reality, this chapter, I pointed out that science is concerned with perceived reality.) Both nature and perceived reality are phenomena of objective reality—which transcends and subsumes nature.

Earlier in the book (in Transcendence and Nontranscendence, chapter 4), I declared that I hold a nontranscendent worldview, one that makes do without any nature-transcending reality. In the present chapter we saw how science guides us to a worldview of partially hidden objective reality, and as might be guessed, I subscribe to this worldview. Since objective reality transcends nature, have I then run into a contradiction? Yes, I have. At the stage of our investigation that we discussed in Transcendence and Nontranscendence, chapter 4, I wanted to hold as simple a worldview as seemed warranted by science, thus a nontranscendent one. I assumed, as do many scientists, that we would thereby find the objectivity we strive for through science. Transcendence was felt to smack too much of subjectivity.

But it turns out, as we just saw, that science, in its study of nature, cannot fulfill all of our demands for objectivity. The quantum aspect of nature involves observers too much for that. So any objective reality must be “farther” from us than nature, “more distant” from us than perceived reality. It must transcend them. Thus I’m led to the belief in a partially hidden objective reality, a reality transcending nature, a reality most likely surpassing human understanding. But nonetheless an objective reality! An observer-independent underlying reality that is the same reality for protons, for planets, for peanuts, and for people.
Is there room in it for God? Deities? Omniscience? Omnipotence? Supernatural powers? Grand designs? Perhaps for some of that, since once Pandora’s box of transcendence is opened, it’s hard to say what exactly is allowed and what is not. After all, we are talking about a metaphysical position (Science and Metaphysics, chapter 4), albeit a “scientific” one, so we are free to assume whatever we want, as long as consistency with science is maintained. And, let me emphasize, as long as objectivity is maintained; as long as one’s assumptions do not contradict observer independence, or the idea that it is the same underlying reality for helium, for helicopters, for hyacinths, and for all humans. If objectivity were to be abandoned, there would be no point in the whole metaphysical construct we have developed in this chapter. And self-consistency? As one likes, since we don’t really expect to fully understand objective reality anyhow.

Using arguments and justifications based on common sense, on our understanding of nature, and on reasonableness, utility, conceptual economy, and motivation, we’re led by science to a belief in an objective reality. Our scientific knowledge of this reality, however, is gathered indirectly. But science should nevertheless give us a literal description of objective reality, at least for those aspects of it that strongly and frequently affect our survival as individuals and as a species. Yet quantum theory cannot be a literal description of objective reality. Thus objective reality is partially, very likely mostly, hidden from us. Since this reality transcends nature, we are thus led to a transcendent worldview.

Bibliography

The principal references for this chapter are:


———, In Search of Reality (Springer-Verlag, New York, 1983).
Neither of these is easy reading, the 1989 book harder than the 1983 one. This chapter is in essence an adaptation, with twists of my own, of d’Espagnat’s ideas concerning what he aptly calls “veiled objective reality.” That will become obvious upon reading his book(s). For more books dealing in various ways with reality, see


Some suggested books on metaphysics are


For adaptive biological evolution, see

Also Lorenz, and Eigen and Winkler, in the lists above.

For the observer dependence of quantum reality, see

———, *Other Worlds: A Portrait of Nature in Rebellion; Space, Superspace and the Quantum Universe* (Simon and Schuster, New York, 1980).


See also Adair, and Rae, in the lists above.