Excerpted from "The Nature of the Physical World" by A. S. EDDINGTON

Objectivity of Becoming

In general we should describe the familiar world as subjective and the scientific world as objective. Take for instance our former example of parallelism, viz. colour in the familiar world and its counterpart electromagnetic wave-length in the scientific world. Here we have little hesitation in describing the waves as objective and the colour as subjective. The wave is the reality—or the nearest we can get to a description of reality; the colour is mere mind-spinning. The beautiful hues which flood our consciousness under stimulation of the waves have no relevance to the objective reality. For a colour-blind person the hues are different; and although persons of normal sight make the same distinctions of colour, we cannot ascertain whether their consciousness of red, blue, etc. is just like our own. Moreover, we recognise that the longer and shorter electromagnetic waves which have no visual effect associated with them are just as real as the coloured waves. In this and other parallelisms we find the objective in the scientific world and the subjective in the familiar world.

But in the parallelism between entropy-gradient and "becoming" the subjective and objective seem to have got on to the wrong sides. Surely "becoming" is a reality—or the nearest we can get to a description of reality. We are convinced that a dynamic character must be attributed to the external world; making all allowance for mental imagery, I do not see how the essence of "becoming" can be much different from what it appears to us to be. On the other side we have entropy which is frankly of a much more subjective nature than most of the ordinary physical qualities. Entropy is an appreciation of arrangement and organisation; it is subjective in the same sense that the constellation Orion is subjective. That which is arranged is objective, so too are the stars composing the constellation; but the association is the contribution of the mind which surveys. If colour is mind-spinning, so also is entropy a mind-spinning—of the statistician. It has about as much objectivity as a batting average.

Whilst the physicist would generally say that the matter of this familiar table is *really* a curvature of space, and its colour is *really* electromagnetic wavelength, I do not think he would say that the familiar moving on of time is *really* an entropy-gradient. I am quoting a rather loose way of speaking; but it reveals that there is a distinct difference in our attitude towards the last parallelism. Having convinced ourselves that the two things are connected, we must conclude that there is something as yet ungrasped behind the notion of entropy—some mystic interpretation, if you like— which is not apparent in the definition by which we introduced it into physics. In short we strive to see that entropy-gradient may *really* be the moving on of time (instead of *vice versa*).

Before passing on I would note that this exceptional appearance of subjective and objective apparently in their wrong worlds gives food for thought. It may prepare us for a view of the scientific world adopted in the later chapters which is much more subjective than that usually held by science.

The more closely we examine the association of entropy with "becoming" the greater do the obstacles appear. If entropy were one of the elementary indefinables of physics there would be no difficulty. Or if the moving on of time were something of which we were made aware through our sense organs there would be no difficulty. But the actual combination which we have to face seems to be unique in its difficulty.

Suppose that we had had to identify "becoming" with electrical potential-gradient instead of with entropy-change. We discover potential through the readings of a voltmeter. The numerical reading stands for something in the condition of the world, but we form no picture of what that something is. In scientific researches we only make use of the numerical value—a code-number attached to a background outside all conception. It would be very interesting if we could relate this mysterious potential to any of our familiar conceptions. Clearly, if we could identify the change of potential with the familiar moving on of time, we should have made a great step towards grasping its intrinsic nature. But turning from supposition to fact, we have to identify potential-gradient with force. Now it is true that we have a familiar conception of force— a sensation of muscular effort. But this does not give us any idea of the intrinsic nature of potential-gradient; the sensation is mere mind-spinning provoked by nervous impulses which have travelled a long way from the seat of the force. That is the way with all physical entities which affect the mind through the sense organs. The interposed nerve-mechanism would prevent any close association of the mental image with the physical cause, even if we were disposed to trust our mental insight when it has a chance of operating directly.

Or suppose that we had had to identify force with entropy-gradient. That would only mean that entropy-gradient is a condition which stimulates a nerve, which thereupon transmits an impulse to the brain, out of which the mind weaves its own peculiar impression of force. No one would feel intuitive objection to the hypothesis that the muscular sensation of force is associated with change of organisation of the molecules of the muscle.

Our trouble is that we have to associate two things, both of which we more or less understand, and, so far as we understand them, they are utterly different. It is absurd to pretend that we are in ignorance of the nature of organisation in the external world in the same way that we are ignorant of the intrinsic nature of potential. It is absurd to pretend that we have no justifiable conception of "becoming" in the external world. That dynamic quality—that significance which makes a development from past to future reasonable and a development from future to past farcical—has to do much more than pull the trigger of a nerve. It is so welded into our consciousness that a moving on of time is a condition of consciousness. We have direct insight into "becoming" which sweeps aside all symbolic knowledge as on an inferior plane. If I grasp the notion of existence because I myself exist, I grasp the notion of becoming because I myself become. It is the innermost Ego of all which *is* and *becomes*.

The incongruity of symbolising this fundamental intuition by a property of arrangement of the microscopic constituents of the world is evident. What this difficulty portends is still very obscure. But it is not irrelevant to certain signs of change which we may discern in responsible scientific opinion with regard to the question of primary and secondary law. The cast-iron determinism of primary law is, I think, still widely accepted but no longer unquestioningly. It now seems clear that we have not yet got hold of *any* primary law—that all those laws at one

time supposed to be primary are in reality statistical. No doubt it will be said that that was only to be expected; we must be prepared for a very long search before we get down to ultimate foundations, and not be disappointed if new discoveries reveal unsuspected depths beneath. But I think it might be said that Nature has been caught using rather unfair dodges to prevent our discovering primary law—that kind of artfulness which frustrated our efforts to discover velocity relative to the aether. I believe that Nature is honest at heart, and that she only resorts to these apparent shifts of concealment when we are looking for something which is not there. It is difficult to see now any justification for the strongly rooted conviction in the ultimate re-establishment of a deterministic scheme of law except a supposed necessity of thought. Thought has grown accustomed to doing without a great many "necessities" in recent years.

One would not be surprised if in the reconstruction of the scheme of physics which the quantum theory is now pressing on us, secondary law becomes the basis and primary law is discarded. In the reconstructed world nothing is impossible though many things are improbable. The effect is much the same, but the kind of machinery that we must conceive is altogether different. We shall have further glimpses of this problem and I will not here pursue it. Entropy, being a quantity introduced in connection with secondary law will now exist, so to speak, in its own right instead of by its current representation as arrangement of the quantities in the abandoned primary scheme; and in that right it may be more easily accepted as the symbol for the dynamic quality of the world. I cannot make my meaning more precise, because I am speaking of a still hypothetical change of ideas which no one has been able to bring about.