Part I **Roberto Mangabeira Unger**

1 The science of the one universe in time

THE SINGULAR EXISTENCE OF THE UNIVERSE

This book develops three connected ideas about the nature of the universe and of our relation to it. The first idea is that there is only one universe at a time. The second idea is that time is real and inclusive. Nothing, including the laws of nature, stands outside time. The third idea is that mathematics has this one real, time-drenched world as its subject matter, from a vantage point abstracting from both time and phenomenal particularity.

On the view defined by these three ideas, the universe is all that exists. That there is only one universe at a time justifies using the terms universe and world interchangeably. If there were a plurality of universes, the world would be that plurality. The singular universe must, however, be distinguished from the observable universe, for our universe may be much larger than the part of it that we can observe. In this book, we use the words cosmology and cosmological to designate what pertains to the universe as a whole, not just to its observable portion. Observational astronomy has continued, in recent decades, to make remarkable discoveries about the observable universe. Cosmology, however, risks losing its way. The arguments of this work are cosmological: they concern the whole of the universe and the way to think about it.

Each of the three central ideas developed in this book has implications for how we interpret what science, especially in physics and cosmology, has already discovered about the world and for how we view what science can and should do next. It has consequences as well for our view of the place of these scientific discoveries in our self-understanding.

The first idea is the solitary existence of the universe. We have reason to believe in the existence of only one universe at a time, the universe in which we find ourselves. Nothing science has discovered up to now justifies the belief that our universe is only one of many, although the universe may well have predecessors. The multiplication of universes in contemporary cosmology has not resulted from any empirical discovery or inference from observation; it has been the outcome of an attempt to convert, through this fabrication, an explanatory failure into an explanatory success. The explanatory failure is the compatibility of a prevalent view of how nature works at the level of its elementary constituents with many states of nature other than the one that we observe. (Today, in the early twenty-first century, string theory, with its prodigious surfeit of alternative consistent versions, almost all of them not realized in the observed universe, provides the most striking example of such underdetermination of phenomena by prevailing theories.) The conversion of failure into success proceeds by the simple expedient of supposing that for each version or interpretation of the theory in favor there is a corresponding universe in which what it says is true.

If these unobserved universes were held to be merely possible, the question would arise why only one of the possible universes in fact exists. Therefore, the most radical form of the conversion of failure into success consists in claiming that these other universes are more than merely possible; they are actual, even though we have no evidence of their existence (the multiverse idea).

The most widely accepted causal hypothesis today to explain the genesis of such a multiverse is "eternal inflation," postulating the creation of an infinite number of universes formed as bubbles from phase transitions on an eternally inflating medium. Within string theory, it is plausible to believe that such bubble universes are described by laws, chosen by a stochastic process from the immense range of theories that are compatible with the string-theoretical approach. The retrospective teleology of the "strong anthropic principle," according to which the criterion of selection of the laws in our universe is that they make possible our human life and consciousness, closes the circle of prestidigitation.

The sleight of hand represented by this combination of ideas amounts to an ominous turn in the history of science. It is a turn away from some of the methods, standards, and presuppositions that have guided and disciplined science until relatively recently.

Although the opposing idea, of the singular existence of the universe, may appear self-evident to some scientists and to many non-scientists, it raises a problem of the first order. Individual being, wrote Aristotle, is ineffable. We can provide law-like explanations of recurrent phenomena in parts of the universe. But how can there be a law-like explanation of the universe as a whole if the universe is one of a kind? How can we offer such an account if we are not entitled to represent and to explain our world as one of many possible or even actual worlds? The theory of the universe would have to be the theory of an individual entity. For such a theory the history of science offers no model.

THE INCLUSIVE REALITY OF TIME

The second idea defended and developed in this book is that time is inclusively real. According to this thesis, nothing in this singular universe of ours remains outside time.

The reality of time may seem an empty truism. In fact, it is a revolutionary proposition. It contradicts not only certain speculative doctrines that openly affirm the illusory character of time, but also ideas about causation and scientific explanation that may seem beyond reproach and doubt.

When the idea of the reality of time is combined with the idea of the unique existence of the observed universe, it results in the view that this one world of ours and every piece of it have a history. Everything changes sooner or later.

Recognition of the reality of time gives rise to a philosophical conundrum about causation. If time were not real, there could be no causal relations for the reason that there would be no before (the cause) and after (the effect). Causes and consequences would be simultaneous. They would therefore be unreal or mean something different from what we take them to mean. Nothing would distinguish causal connections, which are time-bound, from logical or mathematical relations of implication, which stand outside time. What we, in causal language, call causes and effects would in fact be aspects of a relational grid in a timeless reality.

If, however, everything is time-bound, that principle must apply as well to the laws, symmetries, and constants of nature. There are then no timeless regularities capable of underwriting our causal judgments. Change changes. It is not just the phenomena that change; so do the regularities: the laws, symmetries, and supposed constants of nature.

Our conventional picture of causation must be confused. For we seem to believe, on the evidence of the way in which we use our causal language, outside science as well as within it, that time is real, but not too real. It must be somewhat real; otherwise there would be no causal connections at all. It must not, however, be so real that our causal judgments are all adrift on a sea of changing laws.

In this book we argue that the evidence of science – the deliverances of the science of today, viewed in the light of its recent history – does not entitle us to circumscribe the reality or the reach of time. Our causal judgments cannot indeed be anchored in immutable laws and symmetries. That need not mean, however, that we stand condemned to explanatory impotence. Causal explanation, properly reinterpreted and redirected, can survive the overcoming of our equivocations about the reality of time. It can make peace with the view that time is real and that nothing remains beyond its reach.

This intellectual program brings us face to face with a further riddle, a puzzle that comes into sight when we begin to take seriously the notion that the laws of nature, as well as its other regularities – symmetries and supposed constants – are within time, and therefore susceptible to change, rather than outside time, and therefore changeless. We seem faced with an unacceptable choice between two troubling positions.

One position is that higher-order or meta-laws govern the change of the laws and other regularities of nature. In this event, however, the problem presented by the time dependence of the laws is simply pushed to the next level. Either such higher-order laws are themselves within time and liable to change, or they are timeless and changeless. Nothing fundamental would have shifted in the structure of the problem.

The other possibility is that no such higher-order laws exist. Then our causal judgments would remain bereft of any apparent basis. The change of laws would seem an enigma for which no adequate explanation can exist: change requires causal explanation, and causal explanation must in turn be warranted, or so it is traditionally believed, by laws and symmetries of nature.

We consider ways out of this dilemma. One of them plays an especially large role in our argument, as it has in the development of the life and earth sciences and of social and historical study, although not of physics. According to this view, the laws, symmetries, and supposed constants change together with the phenomena. Causal connections are, on this view, a primitive feature of nature. In our cooled-down universe, they recur over a discriminate structure of natural phenomena, which is to say that they exhibit law-like form. In other, extreme states of nature, however, those that occurred in the very early history of the universe, they may be, or have been, lawless.

The idea that the laws of nature are susceptible to change and that the laws may develop coevally with the phenomena that we take them to govern may be puzzling: for the reasons that I have suggested, it renders unstable the laws of nature that we habitually take as warrants of causal explanation. However, it is neither nonsensical nor unprecedented. We are accustomed to invoke it in the life sciences as well as in social and historical study. It saves us from needing to appeal to speculative metaphysical conjectures, such as the notion of a multitude of unobservable worlds.

The conjecture of the mutability of the laws of nature seems to give rise to insuperable paradoxes. The impression of paradox, however, begins to dissolve once we turn on its head the conventional picture of the relation between laws and causal connections, and recognize that the former may derive from the latter rather than the other way around. This idea may lead us to think in a new light of a broad range of familiar and intractable facts. Among these facts are the unexplained values of the universal constants of nature, especially of those constants that we do not and cannot use as conventional units of measurement and that are, for this reason, conventionally called dimensionless. Their seemingly arbitrary values may be the result of earlier states of the universe and of the operation of laws or symmetries different from those that now hold. They may be vestigial forms of a suppressed and forgotten history: testimonials to a vanished world – the one real world earlier on.

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A simple way to grasp what is at stake for science in the idea of the inclusive reality of time and of its corollary, the conjecture of the mutability of the laws, symmetries, and supposed constants of nature, is to ask the question: Where do these regularities come from? Because the laws and symmetries of nature, as we now understand them, fail to account uniquely for the initial conditions of the universe, we need to ask as well a second question: Where do these initial conditions come from? (The mysterious constants of nature help describe these conditions. They do not explain them. On the contrary, they require explanation, which the established laws and symmetries fail to provide. Thus, even though we can count the constants, together with the laws and symmetries, as regularities, we cannot expect them to help explain the initial conditions of the universe. They form, from the outset, part of the problem rather than part of the solution.)

There are, broadly, three ways to approach these questions.

A first approach is to say that the laws and symmetries comprise an immutable framework of natural events. They are what they are. If they fail to apply to the very earliest moments of the universe or to explain its initial conditions that must be only because our knowledge of the laws and symmetries remains incipient and incomplete. It is this first approach that, at least until recently, has been ascendant in the