

So this is a route whereby not merely complex structures such as life come to arise in a natural way, but the laws of physics themselves also become adapted to make possible this existence of complex structures.

The case is argued with skill and sophistication. The book is carefully written for the nonspecialist and is a pleasure to read, with many excellent descriptions of modern scientific ideas that will convey the excitement of science to the nonscientist. Because the book aims to deal with the 'big questions' of fundamental importance, it considers issues in science, metaphysics and religion.

The book deals with a vast spectrum of science. What is proposed is highly speculative, but then that holds true for much of present-day theoretical physics. The central mechanism envisaged is conceivable but incomplete: we do not yet have a well-developed proposal as to how collapse to a black hole can be reversed to expansion into a new region. The final sections on relational approaches to fundamental physics are somewhat vague. But this is all fine because, in contrast to many recent popularizations of science, this book makes clear what is well-established theory and what is speculative, with one important exception: it is not demonstrated that the physics that would lead to maximal star formation would also necessarily allow the complex molecular chemistry of life. This is assumed rather than argued; it certainly needs further justification. But overall the science is interesting, reasonably plausible if not proved, and well argued.

The underlying metaphysics is much less satisfactory. Again, it is very helpful that, unlike many writers, Smolin makes

explicit his metaphysical aims. But his hope of attaining coherent laws of physics from pure chaos or from nothing is illusory, as has been pointed out by Paul Davies. Smolin seems unaware of the body of literature in cosmology. He does not refer, for instance, to Dirac, Bondi, Sciama, Wheeler and Feynman, Brans and Dicke, or Hoyle and Narlikar.

This literature makes clear that all one can sensibly achieve in following this route is to replace some constancy in present-day physics (for example, the value of the gravitational constant) by a variability that is itself controlled by another law which is constant and unchanging; for, without this, there is nothing one can say. In the end, all one can do is replace specific physical laws by higher-level laws; the fundamental metaphysical situation is unaltered. The author's proposals are no exception. Even if he does not acknowledge it, they are underpinned by assuming continued validity of physical ideas that can remain true only if they reflect continuing unchanged physical behaviour that can be described by unchanging (higher-level) physical laws — which is what he is trying to avoid.

His final metaphysical proposal — to derive physics that cannot be interpreted as a whole by an observer "outside of the world" — is in my view unnecessary and uninteresting (although it does show that most attempts at a fundamental physical theory do not satisfy his proposed principle). His motivation comes from a desire to exclude a concept of God from his metaphysical picture. This is where his book is weakest.

It is not necessary to refer to religious

issues in considering the fascinating physical ideas that are the main burden of this book. However, if one chooses to do so (and the author does — there is a chapter entitled "Philosophy, Religion, and Cosmology") then one has an obligation to do so properly. In a number of recent writings by scientists, there is a catastrophic decline in academic rigour and quality of argument when referring to these issues. Smolin is more sophisticated than many, but nevertheless does not follow the basic principles one would expect of anyone wishing to make a serious contribution to thought in the science-religion debate.

Moving to a new area of science, one would expect a researcher to be aware of the current debate and in touch with recent relevant literature (for example, *Religion and Science: History, Method, Dialogue* edited by M. Richardson and W. Wildman, Routledge, 1996, and references therein); to follow the basic principles of critical thought, such as looking seriously at the evidence supporting opposing views; and to respond to the best available thought in the opposing camp, and not to some ersatz argument that no sensible person would support. When it comes to the science-religion issue, Smolin does none of these things. He does not, for example, refer to Torrance, Ian Barbour, Soskice, Peacocke, Polkinghorne, Murphy, Bowker or Ward.

So the comments made in this area are disappointing, and not at the same level as the rest of the book. This reflects a broader theme: if scientists wish to enter effectively the debate about the ultimate meaning of cosmology and its relation to human life, they need to take humanity seriously as well as taking scientific data seriously. The evidence they consider needs to refer to the deepest aspects of human life — pain and joy, love and war, morality and ethics — and not merely to the fact that we are made of carbon-based molecules organized in complex ways.

The approach presented in this book in the end does not take such data seriously — when theorizing about ultimate meaning, only the physical data and theories are taken as significant. This is surprising in view of many vignettes in the book showing a much wider appreciation of life than can be encompassed in the theoretical physicist's highly simplified physical models of reality which largely ignore emergent order and meaning.

Despite this criticism, this thought-provoking book is much more broad-ranging and considered than most of those that tackle fundamental issues of cosmology. It is well worth reading, and is highly recommended to scientists and nonscientists. □

George Ellis is in the Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosh 7701, South Africa.

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