scientific ideas and the ideas that form the basic motivations for our thoughts and actions, including religious ideas, but it is easy to make the connection seem more inevitable than it really is.

To take one of the most salient examples from the book: does the relativistic view of time as simply one dimension of a four-dimensional Universe have any bearing on our attitude to our own death? For many the fear of death is the fear of non-existence, as expressed by Unamuno when he wrote:

For myself I can say that as a youth and even as a child I remained unmoved when shown the most moving pictures of hell, for even then nothing appeared quite so horrible to me as nothingness ["Del Sentimento Tragico de la Vida", quoted by R. Sorabji in *Time, Creation and the Continuum* (Duckworth, 1983)].

As argued by Sorabji in that book, this fear depends on a particular view of time in which there is some absolute distinction between past and future; for we were just as non-existent before we were born as we shall be when we are dead, and yet there are a great many who are indifferent to or intrigued by the former but appalled by the latter. In relativity, according to the most usual metaphysical gloss on the subject, not only is there symmetry between the future and the past of any event (so that a horror evoked exclusively by future non-existence is shown to be irrational) but it is not even possible to say that "at time t I was/will be non-existent", because there is no absolute meaning to "time t": the statement that I shall not exist (anywhere) in the year 2060 is metaphysically equivalent to the statement that I did not/shall not exist (anytime) in Mongolia, except for the first being more certain to be true. Every part of the space-time universe is equally tenselessly existent.

Rudy Rucker writes in this book that

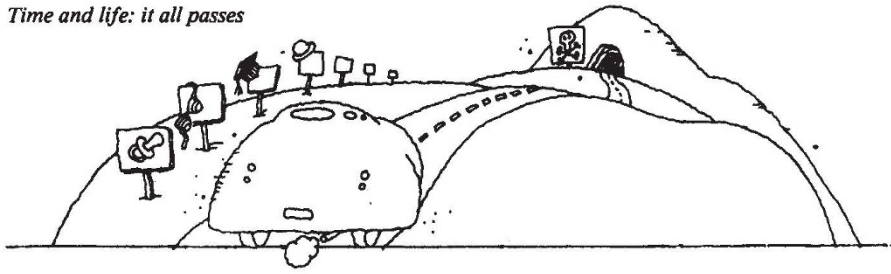
Instead of thinking of myself as a decaying bag of meat, I can think of myself as a part of eternal spacetime. This is a way to cheat death. Instead of identifying myself with my specific body pattern, I identify myself with the block universe as a whole [p.147]

and because of the impossibility of defining a "now", a "time t", in which to localize existence

The idea of the block universe is, thus, more than an attractive metaphysical theory. It is a well-established scientific fact . . . Spacetime is a single unified whole, and the passage of time is just an illusion [pp. 149, 155].

True, it is a valuable insight that one's life has worth as a whole, and as part of a greater whole; that "I am, as it were, an eye that the cosmos uses to look at itself" (p. 147). This insight seems to fit naturally with relativity. But we should be conscious of the presupposed philosophical realism that seems to underlie this particular argument. Is the space-time, the paracompact Hausdorff manifold, that parametrizes the motion of fast particles actually the same thing as the space and time in which we develop our lives? Or is the manifold more "real" than the time of our experience just because it relates best to physics? I plead guilty to being a confirmed realist myself; but the times when I have been most aware of reality bursting through delusion have been in human, rather than mathematical, experience. □

Time and life: it all passes



From *The 4th Dimension*.

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Law, and prophecy

David R. Rosseinsky

The Second Law. By P.W. Atkins. *Scientific American Library: 1984. Pp.230. $21.95, £16.50. (Members of the Library only.)*

A PRECEPT for both admirers and critics of Atkins's book could well be "Thou shalt not make unto thee any graven image". *The Second Law* encompasses, in essentially non-mathematical form, the rigorous to the reflective, but Atkins firmly imputes mechanism to every process. C.P. Snow's contemporary Renaissance Man would know both Shakespeare and the Second Law, and even a popular entertainment by Flanders and Swan some time ago properly enunciated the Lex Secunda, before mangling it in the chant, "Heat is work and work is heat". Correctly, work may all be simply converted into heat, but heat cannot all be simply converted into work. The complexity of fuel plus machine necessary to have work done contrasts with the ready processes available for squandering energy as mere heat.

In explanations of great clarity, Atkins relates spontaneous macro processes to particulate systems where energy becomes dispersed over localized sites (which, in Atkins's exposition, have only a ground and an excited state — that is, OFF and ON, except that ON may be both organized and unorganized). The simplicity ensuing from contemplation of only two states is notable, extensions to greater complexity being straightforward. For me, such analysis resolved apparent conflicts between savants as to whether or not crystallization from supersaturated solution establishes a correspondence between entropy and randomness (you must specify your knowledge of the system); at less subtle levels, the book will lift the hex on entropy traditionally suffered by tyros.

Here, engines of various nomination are unexceptionably cycled in commendably clear applications of the model of energy dispersion. Chemistry is shown to be controlled by free energy (though whether Gibbs's or Helmholtz's is relegated to the thermodynamics appendix). The emergence of complex biological systems (Life itself?) as a result of greater chaos elsewhere, is cogently argued. The so-called "Life Game" is outlined and there are several computer programs appended to play this and other exercises masquerading as games, a nice didactic ploy (also available, note, on discs).

Purists, however, will find much to baulk at in the philosophical implications thus laid before them. For example the validity of contemplating the entropy of the Universe is severely questioned in current correspondence in *Chemistry in Britain*, and indeed has been over the years by many cognoscenti. Atkins's equating of entropy with randomness or chaos is justified by his meticulously numerical definition of randomness, but his use, as synonyms for energy dissipation, of such emotive terms as corruption, chaos and decay — perhaps in a striving to soften the austerity of traditional scientific prose — is questionable. And introducing "Jack" and "Jill" as engine operators mistakes the mental age of the reader, who must distinguish Atkins's "universe" (a large enough region encompassing observable change) from his "Universe", the Whole Thing; unluckily the illustrator has got the capitals wrong in the accompanying diagram (and elsewhere has colour-coded the fluctuations diagram incorrectly).

But this is still a lovely book, beautifully illustrated and presented, and clearly commensurate with its companion volumes in the Scientific American Library. It should engender affection as a sophisticated latterday Hogben, complete with the social allusions implicit in the call to conserve, not energy, but entropy, and to use the virtuous entropy-conserving heat pump rather than crude and profligate combustion. If, for the purist, the net is cast too wide, it may nevertheless capture minds otherwise intent on escaping the chill waters of pure thermodynamics. □

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