

now a part of history, and then to the confession: "For me it has been a wonderful time to be alive and to be an astronomer. And so I try to share this experience with you".

To analyse the success of this book I must, like the author, branch out from astronomy into the larger realm of human experience. A landscape is interpreted as a partly subjective human experience, with the human at its centre. Its objective, in an artistic sense, is not the description of the separate parts of the scenery, but rather a description of the act of perceiving it. Rowan-Robinson has not idly chosen a catchy title; he has chosen it specifically to his artistic purpose. The ponderous structure of separate voyages in different wavelength bands succeeds because his purpose is not to explain our understanding of the objects in the landscapes, but rather the human act of perceiving them. He evokes, perhaps unintentionally, the experience of the child in its crib, looking out at baubles hanging above him and wondering at the meaning of a perception he cannot touch. It is a powerful undercurrent that gives

force, by its repetition, to these cosmic voyages. The reader glimpses the human race in its infancy, reaching out.

I cannot say that Rowan-Robinson intended all of this, but I believe that he did. As someone who has also attempted to enlarge the genre of scientific writing, I can only admire his effort. It falls short of greatness because the author was not sufficiently single-minded in this task. The pedagogical explanations weigh down the poetic experience. We have here the artist painting his landscape and, at the same time, explaining to us how we know that the water in the creek flows downhill rather than up. On the positive side of that coin, however, there is fascinating astronomical and physical knowledge interestingly described on each page. So it is also a book from which to learn about astronomy. For a skilful blend of these objectives, the author earns grade A. I remain fascinated with the partially fulfilled opportunities of this book as a poetic and artistic experience. I can best share this fascination by the following poem, which this book inspired me to write:

On His Reading *Cosmic Landscape*

Hanging there on strings, tiny baubles above my crib,
 What would I name you if I, like they, knew words?
 Jupiter, Venus, pulsar, quasi-stellar objects of my gaze,
 Abstaining from warm flesh from which I grew,
 You surely breathe and eat and cry like I.
 For what can I now know of death, of that passage
 That will one day threaten the incomprehensible world?
 Silently they hang above me, beyond my reach, unreal . . .
 Unreal at least except for eyes, mystical extensions,
 Touch without fingers, motion without impact, something there,
 But maybe not important, milkless, without warmth.
 Still, you must have a name, a kind of category,
 Something that can let me live at peace with you.
 Could I but sense you in my way, some measure perhaps,
 Could I but bridge the gulf that lies between,
 Maybe I would do so, but how? what do I need?
 A name is fine, but will it shore up liberty
 From ignorance, from lack of touch, from measurement?
 From measurement! What new idea now swarms within me?
 Perhaps a mathematics, calculations from untouchables
 Can clarify your orbit, predicting perigee perhaps or self collapse.
 Unending accusations drain this dream: worthless metaphysics,
 Not a method to trust, yet my heart does beat to it.
 Have ancient genes bestowed on me this thrill,
 Forgotten values to mankind accrued to permanence in me?
 Urging explorations, voyages from this nursery,
 They inflame my nerves where comfort never can.
 Rattlesnakes see infrared and suffer no abject demise,
 Bats somehow hear a soundless noise, compressibilities,
 But all the same to me, here, not knowing, ignorant,
 Wondering simply what it means to see beyond,
 And if this oh-so-childish room will stand the test
 Of time, when I no longer am its nexus.

D.D. Clayton, 1980

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An optimist's selection of nightmares

Peter J. Smith

A Choice of Catastrophes. By I. Asimov. Pp. 377. (Simon and Schuster: New York, 1979.) \$11.95.

IMAGINE a small black hole about the size of the average asteroid and with a mass of, say, a millionth of that of the Earth. Suppose then that this remarkable object were to enter the Solar System and score a direct hit on the Earth. What would the result be? The "mini-black hole" would tunnel its way into the planet, absorbing matter and thus growing as it went. If it had sufficient momentum to begin with, it would burn a path right through the Earth, causing enormous explosions where it entered and left. At the points of entry and departure life would stand little chance of survival, although the Earth itself would probably heal and go on as before.

But what if this mini-black hole had too low a velocity to enable it to pass through the Earth and instead became trapped in the terrestrial gravity field? It would then fall towards the planet's centre, overshoot, fall back, overshoot again, fall back again, and so on. Because of the Earth's rotation, however, the oscillation would not be along a single line but along a series of linked tracks. The mini-black hole would therefore carve out an irregular volume from the Earth's interior, growing larger as it did so and absorbing more matter with each sweep. Thus hollowed out, the Earth would probably collapse into the black hole with a diameter of 2 cm and a mass and gravitational field identical to that of the planet it had destroyed.

Fantasy? Possibility? Probability? No, yes, no — in that order. As it happens, mini-black holes, black holes of less than stellar size, have not yet been detected, although they were postulated on theoretical grounds by Stephen Hawking in 1974 and to that extent are a serious scientific possibility. The chance of one of them colliding with the Earth must be regarded as remote, however, if only because if such hole-planet collisions were common there would be far fewer bodies in space than there actually are. On the other hand, annihilation of the Earth by a mini-black hole is only one of a bewildering variety of possible catastrophes, many of them less bizarre than that, through which the human species might meet its end.

Indeed, there are so many possibilities here that in his book about them Asimov has had to design a five-fold classification system in order to make the overall picture intellectually assimilable. To begin with, then, we have "Catastrophes of the First Class", defined as changes such as to

render the whole Universe uninhabitable. One of these — the so-called heat death, by which all non-thermal forms of energy are reduced to heat, and entropy reaches its maximum — is inevitable, although it will not occur for at least a thousand billion years. Equally inevitable, though on an even less certain time-scale, is the contraction of all stellar bodies to black holes and the ultimate coalescence of the whole Universe into a single, huge black hole. And finally there is the possibility that the Universe will contract to the sort of 'cosmic egg' from which it developed via the big bang, although this depends on whether the Universe is open or closed (possibly oscillating).

Inevitable or not, however, all First Class death threats are too far ahead to worry about; they are intellectually interesting but of no practical concern. The same could be said about most "Catastrophes of the Second Class", namely, those able to destroy life on Earth by killing the Sun, leaving the rest of the Universe intact. Ultimately — in billions of years time — the Sun will develop into a red giant and then white dwarf, ending its role as supporter of life on Earth. Moreover, in the shorter (but still very long) term the Sun could be annihilated by collision with a star, a 'normal' black hole or a large body of antimatter (which may or may not exist), all of which in any case should give plenty of warning.

With "Catastrophes of the Third Class", on the other hand, a new factor enters — the possibility (but improbability) of immediate death. An undetected mini-black hole of the type mentioned earlier could even now be about to enter the Earth's atmosphere, interaction with which would give a three-minute warning of the planet's annihilation. But if that sounds alarming, it has to be admitted that most other Third Class changes, defined as those potentially able to destroy all terrestrial life by disturbing the Earth itself, are unlikely actually to do anything of the sort. Collision with extraterrestrial objects (asteroids, meteors etc.), interaction with the Moon, earthquakes, volcanoes, moving plates, glaciation and a disappearing geomagnetic field all can, and do, give rise to local disaster, and some (especially glaciation) could conceivably destroy modern Western civilization; but only in very exceptional circumstances could they obliterate all life, or even all human life.

Which brings us to "Catastrophes of the Fourth Class", or those capable of destroying all human life but not most other life forms. This category includes being overrun by insects or rodents, war, the spread of infectious disease and attack by superior extraterrestrial intelligence, although war (especially thermonuclear) and a hitherto unknown disease (perhaps man-made) seem to be the only two worth worrying about. Perhaps of rather more concern, however, are those activities and

events unlikely to destroy all human life but able, nevertheless, to ruin civilization as we know it — "Catastrophes of the Fifth Class". War again, depletion of natural resources (including energy) and pollution are the chief contenders here.

Asimov is an optimist, evidently believing that those catastrophes possible in the short term are avoidable with intelligent handling, although he warns that success in overcoming them could lead to new dangers such as overpopulation and starvation. Be that as it may, he has left us in the meantime with a remarkable survey of the possible dangers, ranging from the

fascinatingly bizarre to the frighteningly realistic. His book, though by no means short, manages to pack an astonishing number of explanatory asides (on entropy, quasars, red giants, supernovae, DNA, cosmic rays etc.) into a story covering an equally remarkable number of primary disciplines (cosmology, geology, biology, technology etc.). I could quibble a bit over points of presentation, but there is no denying Asimov's explanatory powers. □

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Theology after Darwin

A.J. Cain

The Post-Darwinian Controversies. By J.R. Moore. Pp.205. (Cambridge University Press: Cambridge, 1979.) £18.

THE subtitle of this book is "A Study of the Protestant Struggle to Come to Terms with Darwin in Great Britain and America 1870-1900", and indicates its nature far better than the main title. As such, it is not in one sense a book to review in a scientific journal, although *Nature* did publish an exchange of letters between Asa Gray and G.J. Romanes on the religious implications of evolution, in 1883. In another sense, as a study of the intellectual forces resisting, modifying, or encouraging the spread of a particular complex of ideas, it is of interest to everyone.

An idea or complex of ideas is introduced into so heavily structured a space, and engenders such complex reactions, that any account of its spread can only be made, as yet, historically, philosophically or bibliographically. I once consulted a professor of plasma physics on the mathematics necessary for modelling the spread of an idea; he dismissed the subject out of hand as "too hopelessly complicated". And as any historian, philosopher or bibliographer has himself a mind already structured, his account will necessarily be slanted to some extent. Slight slanting is insidious; blatant slanting usually produces a rival account, useful or merely eristic.

James Moore is particularly concerned to do away with the old metaphor of warfare between ideas — the victorious army of the Darwinians, the forces of obscurantism in full flight, the signal victory of Huxley over Wilberforce, and so on. It cannot be denied that there were plenty of people who belonged to neither 'army'; they accepted doctrines of both

camp, and struggled to reconcile them. Two chapters of the book are entitled "Warfare's toll in historical interpretation" and "Towards a non-violent history". These are in Part I, "Historians and Historiography", in which Moore points out the evils of such a schematic representation of extremely complex events. He blames John William Draper (*History of the Conflict between Religion and Science*, 1874) and Andrew Dickson White (*A History of the Warfare of Science with Theology in Christendom*, 1896) particularly for the prevalence of the metaphor in the evolutionary context, giving very useful sketches of their careers and intellectual conflicts to explain both the nature of their books, and the wide difference in scholarship between them. In Chapter 4, "Towards a non-violent history", he brings out his own approach, deploring the use of the military metaphor as showing "the absence of any deep moral aversion from war". Yet he himself allows (as any man of sense must) that "Christians in the late nineteenth century were beset with spiritual disorders and intellectual strife". The metaphor of armies of individuals fighting may be unsatisfactory; at this point the reader might think him about to take up that of gladiatorial combat between ideas within a single individual, which at first sight is nearer the truth. But it is far more useful, as Moore shows, to take a less superficial view. He uses Festinger's theory of the structure of cognitive conflict to show how the individual (merely the arena in a gladiatorial metaphor) is active in reducing the dissonance between incompatible ideas, either by altering one or other idea, or by introducing new ones that reduce the dissonance. He illustrates the point pleasantly by a flat-earther confronted by an extra-terrestrial photograph of the Earth, and more seriously by the example of that unfortunate man St. George Jackson Mivart. Violence, then, is replaced by the reduction of dissonance — an undoubted gain, but one cannot help feeling that a real baby (incompatibility of ideas leading to real distress) was nearly