

atomic bomb, since the critical state, once reached, tends to turn itself off. The very heat generated by the onset of an uncontrolled chain reaction tends to liquefy the dense and compact solid substance dispersing it, perforce eliminating the concentrated condition so essential for the onset and continuity of the critical state within a mass of fissile material.

Only if a chain reaction can be achieved and executed nearly instantaneously by intentionally overcoming the barriers nature has set can the 'atomic-bomb' effect be realized. The concentration of fissionable material in a nuclear reactor is not appropriate for this effect. In so-called thermal reactors using the isotope U-235, fissile to *slow* neutrons (neutrons of relatively low energy which have been 'moderated' to 'thermal' velocities), the chain reaction of the nearly instantaneous type required for the 'atomic-bomb' effect simply cannot occur. For the same reason, an atomic bomb consisting solely of the rare isotope U-235 would only fizzle. It is

natural uranium, U-238, which provides the main contribution to the 'atomic-bomb' effect, since it can be fissioned with neutrons which are *fast* enough to yield a chain reaction having the required celerity. Once these and other consequences of nature's inherent control mechanisms become better known, there will be less public obsession with the alleged dangerous proliferation in the supply of U-235 and allied (*slow*-neutron) fissile substances like plutonium.

Yet, to have expected the present work to deal with the totality of our misunderstanding about radioactivity and its nuclear progeny would be unreasonable. The scales can be removed from the public perception only in gradual stages. That Badash has taken us a significant step forward is perhaps a sufficient achievement.

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Astronomical oddities

Paul Murdin

Monsters in the Sky. By Paolo Maffei. Translated by Mirella and Riccardo Giacconi. Pp.241. (MIT: Cambridge, Massachusetts, and London, UK, 1980.) \$15.

THE monsters in the title of this book are not constellation figures, inhabitants of UFOs, dragons or other overtly mythical creatures. Monsters is used in the same sense as in the section of the *Thesaurus* called Unconformity, where it is associated with wonder, curiosity, missing link and queer fish. The "monsters in the sky" are thus unusual astronomical objects. They are the objects, says Paolo Maffei, which were better left out of his previous book, *Beyond the Moon*, on the more straightforward parts of astronomy, because they were so unusual that they were confusing. The present book assumes the elementary knowledge of astronomy contained in the previous one and builds on it to give accounts of black holes, quasars and active galaxies, the missing mass, novae and supernovae, Vulcan and transplutonian planets, and comets (a little surprisingly this, since comets are not as unusual as all that). Each chapter is written in a fair amount of detail, with the stages laid out logically by which astronomers came to their occasionally monstrous conclusions. The chapter on Eta Carinae is the most detailed in this respect, starting with its historical light curve, laying out just how Eta Carinae differs from other superficially similar kinds of stars,

discussing its infrared properties and Gratton's model of the star and concluding with its possible link with the Hubble-Sandage Variables.

The book would be enjoyed by an amateur astronomer who is ready to get to grips with some detail in astronomy. The accounts of the history of the subjects with which it deals make it a book which, say, graduate students would find it profitable to read, so that their thesis on the subjects in which they may be researching might then reference more than the last couple of years' *Astrophysical Journal*. The bibliography to each chapter gives enough references, typically to review articles of the kind that appear in *Nature*, for an easy entry into the literature dating before 1976 when the first edition of the book appeared. This, incidentally, is a translation of the second Italian edition (1979). I can pay the translation the highest compliment of all, that if it was not for a few footnotes accredited to the translators, one would scarcely notice that the book was translated.

Maffei's style is engagingly informal, although always scientific. The effects of close encounters of an astronaut with the tidal forces and event horizon of a black hole, for instance, are described with enough realism to make the image specific but not overplayed in the repellently sensational, even mystical, way which characterizes many journalistic accounts. On the contrary, this is a book which is written by an astronomer who knows the astronomical literature and has considerable skill in interpreting it at a popular level. □

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The AI saga

Donald Michie

Machines Who Think. By P. McCorduck. Pp.375. (Freeman: Oxford, 1979.) £7.80.

THE task of the scientific referee is a well known contradiction. If he is himself a part of that particular action, then he cannot be impartial. If he is not, then how can he be technically competent in his task? The writing of scientific history is in similar case. It is therefore the more remarkable that Pamela McCorduck's gossipy saga on artificial intelligence, aspiring neither to impartiality nor to technical competence, has scored an undoubted overall success.

Her partiality is to the American part of the story, especially to Pittsburgh. Her saving gift is vitality, which carries her eagerly into previously unexplored catacombs of AI's pre-history. Using gold as the construction material the lame Greek god Hephaistos fashioned female attendants to help him walk. These robots not only walked, but also gave utterance from the promptings of inbuilt intelligence. A bronze android named Talos, Zeus' love-gift to Europa, patrolled the shores of Crete three times a day and hurled rocks at invaders. On catching any, he would heat himself up and fry the victim in a fiery embrace. Pandora, another female android from Hephaistos' shop, was developed under contract from Zeus to punish mankind for accepting Prometheus' gift of fire.

Joseph Golem was the artefact of the 16th century Loew, chief rabbi of Prague and friend of Johannes Kepler. The Golem's use was to spy on Gentiles. In reporting on his missions he was somewhat hampered by being mute.

Mary Shelley's tale is brought hauntingly to life, with Dr Frankenstein's creation driven half-mad with loneliness and his maker's evident physical repugnance for him. "Misery makes me a fiend!" says the 8-ft monster, and begs his master to fashion a soul-mate for him. Frankenstein, having promised this, abandons the task, with devastating effect on the creature's subsequent behaviour.

McCorduck's shrewdest move is to have gathered lengthy oral histories from numerous tape-recorded interviews for later interweaving with pre-existing records. It is startling to read Marvin Minsky's words of 1956:

The important result that would be looked for would be that the machine would tend to build up within itself an abstract model of the environment in which it is placed. If it were given a problem, it could first explore solutions within the internal abstract model of the environment and then attempt external experiments. Because of this preliminary internal study, these external experiments would appear to be rather clever, and the behaviour would have to be regarded as rather 'imaginative'.

The subsequent role of heuristically guided processes of search and inference performed on internally stored world-models has been central to AI. So too has the development of special forms of computer language in which to express what the machine knows about its world. It is therefore illuminating to read John McCarthy, saying at this same formative Dartmouth Conference that it was desirable "to attempt to construct an artificial language which a computer can be programmed to use on problems requiring conjecture and self-reference . . .".

Occasional flashes of this kind give welcome relief from the human-interest magazine style. But the latter also has its moments, not least when McCorduck permits herself to write directly from her own resources of wit and perception. On intellectual fashion:

No sooner do hemlines go down with

enormous fanfare than they go up again, the provinces growing dizzy with trying to keep pace . . . MIT thinks itself stylish, but outsiders have been known to call it faddish. Carnegie-Mellon, on the contrary, represents old-world craftsmanship, attending to detail and using the finest materials . . . But classic can be stodgy: if Queen Elizabeth of England bought artificial intelligence, she'd surely buy at Carnegie-Mellon.

For those not already members of the AI subculture, the parade of personalities, their doings and sayings, is liable to pall. Chapter after chapter is devoted to attacks by American polemicists of whom the general scientific world has never heard, aimed at targets whose names are scarcely better known, concerning philosophical issues about which few readers will excite themselves one way or the other. Yet during the same period a world-renowned British physical scientist published a concretely phrased indictment of robotics-

oriented AI activity in Britain, and this led to its almost total dismantling and dispersal. McCorduck passes over the consequential event with a brief mention: hardly excusable in a serious history.

But McCorduck's book is not offered as a serious history, any more than Aubrey's *Brief Lives* is a serious history of Oxford, or David Niven's *Bring on the Empty Horses* is a serious history of Hollywood. The reader should not come to Pamela McCorduck's whimsically titled book for instruction, or for any deep insight. But by stretching his limbs for a while in her brightly peopled landscape he can assuredly acquire, along with much enjoyment, a feel for the adventures, and the adventurers, of a scientific story at its beginning. □

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Natural illustrations

R.D. Meikle

Nature into Art. By H. Buchanan. Pp.220. (Weidenfeld and Nicolson: London, UK, 1979.) £15.

THE title neatly indicates the scope and object of this handsome volume. It is a concise survey of natural history books with fine, coloured illustrations, for the most part published between 1700 and the middle of the succeeding century. The accompanying text is concerned not so much with the scientific importance of the publications or the scientific exactitude of the plates as with their artistic merit and technical excellence.

To deal with such a vast subject within the compass of 220 pages means, of course, that even the finest illustrators are represented by only a very few examples of their work, while many of the less distinguished must be passed by, sometimes without as much as honourable mention. Selections seldom please everyone, but few are better qualified than Handasyde Buchanan, with forty years' experience of such splendid literature, to judge what must be included, and to decide — a more invidious task — what may be omitted. His choice is well balanced, without being too detached, just as his text is concise without becoming a bare catalogue of facts. The notes on printing techniques will be particularly welcome to those who have puzzled over *del.*, *dir.*, *sculp. imp.* and *pinx.*, or who have failed to grasp the distinctions between copper and stipple engravings, mezzotints and aquatints. An appendix of book prices

Plate from Johann Leonhard Frisch's *Vorstellung der Vögel in Teutschland*, Berlin 1733-63.

