Origins in heat and dust

David W. Hughes

The Solar System: Chemistry as a Key to its Origin. Edited by S.K. Runcorn, G. Turner and M.M. Woolfson. *The Royal Society, London: 1988. Pp.251. £50, $90.50.*

THE Solar System that we observe today is about 4,570,000,000 years old and the mass is now a mere 1/750 that of the central Sun. Four things are clear about it. First, most of this mass is confined to a thin disk-like region that has a radius 30 times greater than the radius of the orbit of Earth. Secondly, the size of the planetary orbits has changed little with time. Thirdly, the flattened, doughnut-shaped nebula cloud of gas and dust was initially hundreds of times more massive than the planets that formed from it. And finally, chemistry played a large part during the condensation and accretion processes that resulted in the planets.

Most cosmogonists (those who study planetary formation processes) believe that the nebula was produced by the condensation of interstellar material, material similar to that from which the Sun was produced. This material can be crudely divided by mass into 1 part of metal and rock, 2.2 parts of ices (H_2O, CO_2, CH_4 and NH_3) and 200 parts of gas (H and He). In the hot inner regions of the nebula only the rock and metal could condense. Moving out beyond the asteroid belt, ices and gases condensed onto the rocky/metal nucleation centres and giant planets like Jupiter were eventually formed.

The Discussion Meeting at the Royal Society, held on 15 and 16 July 1987, was timely and brought together many of the world's foremost astrochemists. The papers presented at that meeting have been brought together to form this impressive book.

The timeliness was because a number of clues, together giving insight into the chemistry of the pre-planetary nebula and the present Solar System, had become available over the preceding years. For example, the Moon rock that was returned to Earth in the early 1970s had been carefully analysed; here we have an extraterrestrial sample of material formed at about 1 astronomical unit from the Sun. In 1969, a primitive carbonaceous chondrite meteorite fell to Earth at Allende in Mexico, providing a sample from the asteroid belt. And 1986 saw a spacecraft fly-by of a mass of primitive outer-Solar-System dust and snow in the form of the nucleus of Halley's Comet. The chemical evidence, and particularly the abundances of the elements and isotopes, obtained from these sources were taken as the starting point for the meeting.

The first section of *The Solar System* concentrates on the nucleosynthetic processes responsible for the chemical composition of interstellar gas clouds and the Sun, while the next two deal largely with meteorites; the fact that these can be picked up, taken into laboratories and analysed in detail means that much is known. The book then returns to the more uncharted reaches of the subject — the chemistry of comets, the atmospheres of the Jovian planets and the environments of the planets at the time when the first traces of life started to evolve.

Altogether, this is an enormous topic, and one crying out for more data. It is also clear that there are many problems that will be hard to overcome. We can foresee, in the near future, space-borne instrumentation orbiting and landing on other planets and satellites. But we cannot go back in time to those early days of dust, gas and planetesimals, when accretion and fragmentation were vying with each other and when radioactive, solar and kinetic energy heat sources were more dominant. It will be many years before we stop being embarrassed by the fact that we are still mystified by many of the processes that helped produce our planet and its companions.

The value of the book lies not only in the plethora of excellent, authoritative contributions summarizing the state of chemical cosmogony, but also in the well-documented discussion sections. Here we can savour in full the scientific excitement to be had in the subject, and can appreciate the host of new ideas that are waiting to be tested. □

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Believe it or not

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A Physicist's Guide to Skepticism. By Milton A. Rothman. *Prometheus: 1988. Pp. 247. $19.95, £14.95.*

ALTHOUGH we live in a so-called scientific age, many people do not share the scientist's view of reality. Opinion polls suggest that belief in psychic phenomena, unidentified flying objects, astrology and other bizarre ideas is widespread. The curious thing about many of these beliefs is that although they fail to meet the exacting standards of scientific rigour they are frequently discussed in a superficially scientific manner. Thus arises the concept of pseudoscience.

The pseudoscientist makes much use of scientific terminology. There is talk of fields, black holes, energy flows, vibrations and quantum waves. To the layman this sort of jargon can make pseudoscientists seem erudite and their claims convincing. As a result there has been an explosion of commercially successful books on a whole range of dubious topics, from time travel to telepathy, couched in the bastardized language of pseudoscience. Indeed, so numerous are these texts that genuine scientific books are often subsumed under 'The Occult' in book stores. As most science popularizers know to their chagrin, a considerable amount of apparent interest in science actually stems from a fascination with pseudoscience. Thus many people want to find out about quantum mechanics not in order to better understand the workings of the atom, but out of a wild belief that it will somehow explain precognition or life after death. In my experience, even casual conversation about physics with ordinary folk is soon steered away from the real thing and turns to topics such as ghosts or UFOs.

Milton Rothman is not the first scientist to strike back. His book is a brave attempt to tackle the insidious advance of pseudoscience by carefully explaining in non-specialist terms the aims and procedures of genuine science, and comparing the nature of scientific claims with those of the pseudoscientist. This is not an easy task. The question of what makes a scientific claim, such as the link between smoking and cancer, reliable, and the assertion that astrology can foretell the future unreliable, is a subtle one.

Much of the book is devoted to surveying basic physics and explaining such things as the law of conservation of energy and the second law of thermodynamics. There is an instructive study of the history of perpetual motion machines, and why they cannot work, as an illustration of the use of scientific reasoning. There follows a philosophical discussion of the laws of physics, and the deep issue of verification and falsification of hypotheses.

Those readers who expect a systematic put-down of pseudoscientific topics will be disappointed. The author is more concerned to dwell on general methodology and mythology than to debunk specific claims. He is probably right in this. The committed believer will never accept rational argument against his or her pet belief anyway. The best that can be achieved in a book of this sort is that tender readers will acquire a modicum of scepticism to set against the outpourings of pseudoscientific propaganda to which they are regularly subjected. □

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