

A is for atom

John Durant

Science Matters: Achieving Scientific Literacy. By Robert M. Hazen and James Trefil. *Doubleday: 1991. Pp.294. \$19.95.*

IN the midst of the Gulf War, US President George Bush took time out to greet the American Association for the Advancement of Science (AAAS), gathered in Washington for its annual meeting. Having pointed out that the US budget included substantial funding increases for mathematics and science education, President Bush added that "All sectors of society must recognize the importance of scientific literacy and strive to achieve it".

Scientific literacy is a buzz phrase in American educational circles. It stands for what the general public ought to know about science, and its widespread use reflects concern about the performance of the American educational system. In 1987, the English Professor E. D. Hirsch Jr captured this concern in his best-selling book: *Cultural Literacy: What Every American needs to Know* (Random House, 1987). Hirsch argued that the unity of American culture depended upon a common stock of generally shared knowledge, which he listed in the form of some 5,000 essential names, phrases, dates and concepts covering the entire world of learning.

In drawing up his list, Hirsch called upon the services of the physicist James Trefil. Trefil took advice from colleagues about the key concepts and facts that were "truly essential to a broad grasp of a major science". The result was several hundred items, ranging from 'absolute zero', through 'mutation', 'nuclear fission' and (amazingly) 'ontogeny recapitulates phylogeny', to 'Y chromosome'. In 1988, the list was expanded into a *Dictionary of Cultural Literacy* (Houghton-Mifflin, 1988). Starting out from the same concern "to provide only the constellations of basic facts and concepts that you need to understand the scientific issues of the day", Trefil and Earth scientist Robert Hazen attempt to review the world of science in 18 synoptic chapters. The first chapter is entitled 'Knowing', and deals with the idea that the universe is regular and predictable. Then come chapters on everything from energy and electricity to evolution and ecosystems.

Reviewing all of the natural sciences between one set of covers is a daunting task, but Hazen and Trefil approach it with relish. Throughout, they concentrate on key ideas and principles and avoid technical details. They use clearly headed sections to organize their material, and from time to time they highlight fundamental principles in large bold print. For example, chapter 5 on quantum mechanics is introduced with the

emboldened statement that, "Everything — particles, energy, the rate of electron spin — comes in discrete units, and you can't measure anything without changing it".

I share Hazen's and Trefil's enthusiasm for equipping the general public to make sense of the scientific issues of the day, I admire their synoptic grasp of the natural sciences, and I recognize their considerable skill in conveying the broad outlines of science in clear, nontechnical prose. Nevertheless, I have two major reservations about *Science Matters*. First, the book reflects its authors' disciplinary backgrounds in being too heavily weighted in favour of the physical sciences (14 chapters) and against the life sciences (four chapters). Even worse, it contains virtually nothing about the single area of science that is unquestionably of most direct relevance to the public: medical science.

Second, *Science Matters* is almost entirely taken up with a summary of the well-established findings of science. It devotes just one page to the scientific method, and just three pages to scientists. The account of scientific method is woefully inadequate, whereas the discussion of scientists is largely taken up with bizarre caricatures of the people who work in different disciplines. Thus, "For some reason many physicists, particularly those in universities, seem to enjoy appear-

ing sloppy and disheveled — always the ones without ties at faculty meetings"; whereas biologists are "the only group of scientists who routinely wear white lab coats".

Caricatures such as these do nothing to assist the general public in coming to terms with science; on the contrary, they merely perpetuate the myth that scientists are very peculiar people. But more serious even than this is the fact that Hazen and Trefil present science as a vast edifice of unproblematic knowledge built up by the routine application of 'the scientific method'. This view ignores the methodological diversity of science, as well as the difficulties that arise from scientific ignorance, uncertainty and controversy.

Science Matters is supposed to enable nonscientists to make sense of the scientific issues of the day. But the scientific issues of the day are real-life questions in which real-life people debate matters that are technically and/or socially controversial. Because it ignores this real world of scientific practice, *Science Matters* provides only a part of what nonscientists need to achieve scientific literacy. □

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Articles of faith

George Marsden

Can Scientists Believe? Some Examples of the Attitude of Scientists to Religion. By Sir Nevill Mott. *James and James: 1991 Pp. 182. £21, \$40.*

FOR about a century in western civilization, roughly from the 1860s to the 1960s, the belief became widely held that scientific thinking was at odds with Christianity. Although, as a number of the authors of *Can Scientists Believe?* point out, this notion rested on a dogmatic conception of scientific knowledge that is now generally considered passé, the idea of an inherent conflict between science and religion has persisted.

In fact, of course, many scientists believe in Christianity and other religions. In the West this is particularly true in the highly religious United States, where over a fourth of scientists are active in churches and half describe themselves as religious. These percentages are not as high for the American public generally; but contrary to some popular belief, scientists are considerably more likely to be religious than are social scientists or humanist academics. So, even though rates of religious practice are much lower in most other western nations, the title question of this collection *Can Scientists Believe?* has an empirical answer.

Nonetheless, interest persists in this volume's main theme of how believing scientists relate their faith. Sir Nevill Mott's own resolu-

tion of the issue arose from being reassured by a vicar that one could be active in the Anglican Church without literally believing its creeds. But only a few of the other 14 contributors to this volume share the Cambridge physicist's strategy of resolving the problem by broadening the definitions of Christianity. Rather, most reflect on the implications of their scientific knowledge for a rather traditional faith, Protestant, Catholic or in one case Jewish. V. Ya. Frenkel, Professor of the History of Science, Leningrad, is the one contributor who takes a very dim, virtually comtean, view of religion. He remarks that he only ever met one highly intelligent man, a mathematician, who was religious. (The contrast to the number of religious scientists in the United States suggests the degree to which such issues are not decided merely on an intellectual basis.)

Wide diversity of opinion is the most striking general feature of the essays by believing scientists. No reader could be happy with all the contributions because a number contradict each other (as on whether the anthropic principle is of merit). Also a few are little more than impressionistic personal testimonies. Nonetheless, many others are valuable reflections on the relation of science to faith. So almost any reader interested in the topic is likely to find enough to make this a worthwhile volume.

One recurring theme is that science and theology represent two complementary ways of looking at reality. As Richard Bube of Stanford puts it, theology asks "who?" and science asks "why?" Several also note that scientific knowledge is nonetheless a lot

more like theological knowledge than is commonly recognized. For instance, C. W. Francis Everitt, also of Stanford, points out the similarities in being dependent on a community and dealing with insoluble mysteries. A number of authors argue that scientific truths are too often revised to provide dogmatic refutations to religious claims. For instance, Christopher Moss points out that recognition of the subjective elements of science, conditioned by social circumstances have tended to desecralize science. Knowledge of God, Moss adds positively, has the moral seriousness of justice at its core.

Arguments for free will versus a materialistic determinism provide the most recurrent theme. Several authors suggest (though one dissents) that indeterminacy in quantum mechanics has a bearing on the question of free will. Statistician, D. J. Bartholomew, in summarizing his study, 'The God of

Chance', provides some ingenious additional arguments. For instance, he suggests that randomness is not incompatible with design because there are still highly probable aggregates. Moreover, a 'random search' may be an efficient way for a mind to operate, although allowing room for the free will. Sir John Eccles argues that demonstrable influences of minds on brains substantiates free will.

Books on the beliefs of scientists constitute a venerable genre to which this one is a worthy contribution. The essential message of this volume is that science is not legitimately an obstacle to religious belief. Perhaps now we need a sequel, *Can Humanists Believe?* □

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Heroines of science

Janet Browne

The Scientific Lady: A Social History of Women's Scientific Interests, 1520-1918. By Patricia Phillips. *Weidenfeld and Nicolson: 1990. Pp.279. £25, \$35.*

THE presence — or more usually, the absence — of women in science has been the focus of much concern during the last decade or so. Academics and teachers go out of their way to encourage female pupils to consider a career in the subject, perhaps explaining that equal opportunities, though not perfect, have never been better: Victorian mores, they say, have passed at last. *The Scientific Lady* will therefore come as something of a surprise. The central theme of Patricia Phillips's book is that women's scientific activities were at their zenith during the eighteenth and nineteenth centuries and have steadily deteriorated since. Science, it is claimed, has not opened its doors willingly to women since the Taunton Commission of 1864-8.

According to Phillips, the first recognizably modern science as formulated in the seventeenth century was a low-status activity: natural philosophers were thought to be little more than artisans, their experiments requiring mechanical skills, their theories depending on physical demonstrations of effects. By contrast, the study of classics and the ancients were the highest point of intellectual life. Where women would only rarely aspire to studying Latin and Greek at that time (although some discussed by Phillips plainly did), the low status of science made it more permeable to female enthusiasts. Women like Mary Astell, Marie de Gournay and Margaret Cavendish (Duchess of Newcastle) found it possible to create a niche for themselves and worked hard in the field.

With the great social changes of the eighteenth century there came a popularization of science among the European gentry which further stimulated female participation in scientific activities. This was the age in which Caroline Herschel studied astronomy, women wrote children's textbooks, and Aphra Behn translated Fontanelle's influential conversations into English.

"Pray Sir," said one of Fontanelle's heroines, "leave Adorers alone, and let us speak of the Sun." The way women took over the media of science is an important aspect of the wider cultural context of the eighteenth century and is well laid out here. In particular, one little-known facet of the diffusion of science among women is brought to light by Phillips: printed diaries of the period seem to have sometimes included scientific questions expressly intended for female readers (perhaps a precursor to the Christmas quiz). The answers were promised in the next year's issue. A series of manuscript letters to the publishers conveying the answers well in advance shows just how educated some of these ordinary, otherwise unknown women were.

By the nineteenth century, women had carved a capacious niche for themselves, although Phillips seems rather to overstate the case with headlines like "The female science student was a familiar sight." Nevertheless, she is right to emphasize the diverse and often ignored functions taken up during that period. It is good to have attention drawn to the great numbers of women who listened to Humphry Davy and Michael Faraday lecture on their researches at the Royal Institution: fashionable occasions though these were, the audience was primarily there to learn.

Equally welcome are the (too brief) discussions of the careers of significant figures like Augusta Ada Lovelace, Mary Somerville and Elizabeth Garrett Anderson. The thrust of these later chapters is the proposal that as science became more prestigious — and as emphasis on a classical education waned — men pushed women out of their former niche. Once science was transformed into an important profession women's participation dramatically decreased.

Phillips's argument is a powerful one that bears careful attention, although some of her sweeping judgements may seem unlikely to professional historians of science and a few aspects surely overemphasized for effect. It is hard to think of Sir Isaac Newton as a rude mechanical, for example, although this could apply to Robert Hooke. More could have been said about French salons in which intellectual women reigned supreme. How odd not to find Florence Nightingale somewhere in the text: her impact on nineteenth century women and on culture at large cannot just be ignored. The analysis is furthermore predominantly confined to European ladies of high social standing. Chapters dance about through the centuries and on two or three occasions appear to contradict themselves. Sloppiness is seemingly only just kept at bay,



The great reformer — Elizabeth Garrett Anderson and her husband in 1870.

ready to break out at any moment: the attractive dust-jacket, for instance, reads differently to the title page. But what this book misses in weight is balanced by a breezy, readable overview of the topic. Patricia Phillips is an anecdotal author with considerable style. It is social history with few pretensions and can be recommended to any general reader. □

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