to understand the initial terror Baltimore, Berg and others felt at the prospect of recombinant DNA experiments.

Crotty's retelling of the Imanishi-Kari affair also benefits from this clear detailing of the science. With the precisely focused lens of hindsight, and in enormous detail, Daniel Kelves' book *The Baltimore Case: A Trial of Politics, Science, and Character* (Norton, 1998) demonstrated the great injustice done to Imanishi-Kari and Baltimore. Crotty tells a more human story. The facts were not so clear at the time, and in the fog of misinformation Baltimore changed his own story more than once. This infuriated many who thought he went too far in attacking his critics, especially John Dingell, the bombastic Detroit congressman who chaired the congressional committee investigating the case. Although science itself was never on trial, as Baltimore and others alleged, Baltimore's ultimate exoneration was critically important for science because it restored one of its greatest practitioners to his deserved status. Crotty's book brilliantly illuminates this pillar of molecular biology, and should be read by anyone, whether scientist or not, who cares about the modern research enterprise and the politics that drive it. ■

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What every woman knows

Athena Unbound: The Advancement of Women in Science and Technology
by Henry Etzkowitz, Carol Kemelgor & Brian Uzzi
Cambridge University Press: 2000. 282 pp. £12.95, $19.95

The Gender and Science Reader
edited by Muriel Lederman & Ingrid Bartsch
Routledge: 2001. 505 pp. £55, $90 (hbk), £18.99, $29.95 (pbk)

Sylvie Coyaud

In spite of its subtitle, *Athena Unbound* has little 'advancement' to report in the lives of the American women scientists interviewed by the authors. Only the most determined were able to overcome early stereotypes of what girls should be like at home, at school or in society, as well as later prejudices. Girls tend to leave college with higher exam results than boys and with reasonable self-assurance. Then, from university onwards, they are made to feel out of place in labs, pubs and the other meeting places where gossip and information are swapped and where men receive their informal training in career-long networking.

The book contains few in-depth interviews, but the scientists selected have perceptive things to say about their own and other women's failures. Their testimony often contradicts prevailing assumptions and policies. For instance, they say that the impact of role models — older women in top jobs who function as beacons for young students — has been overrated. The poor 'models' have to struggle so hard to stay on top and are so obviously exhausted that only masochists would emulate them. The 'critical mass' theory, according to which a sufficiently large number of women researchers in a field would lead to a change in the power structure, doesn't stand the test either. This naive idea goes against experience: in some areas of the life sciences women are in the majority, but are kept firmly on the lower rungs, where a large and not too skilled labour force is needed. The same thing happened in medicine in European countries, and in road building in the Soviet Union.

The authors, two sociologists and a psychotherapist, want to dispel clichés about the inability of women to survive in a harsh environment. Not that they need to sell this argument — the large numbers of women raising a family as single mothers on a part-time salary are proof enough of their resilience. And although the authors' quantitative analysis method is respectable, job and pay statistics already tell the whole story. The book, though slim, feels over-long, because its unstartling conclusions are hammered home by the American habit of summarizing a chapter's contents at the end of that same chapter, as if readers were memory-impaired.

The Gender and Science Reader covers the same ground from the point of view of the feminist critique of science. It is a collection of essays and book extracts from the best English-language authors, from well-known feminist writers such as Donna Haraway, Evelyn Fox Keller, Hilary Rose and Carolyn Merchant, to newer entrants such as biologists Christine Wennerås and Agnes Wold, who discovered the 2.6 factor (they showed that women had to publish 2.6 times more than men in order to obtain the same quality scores for postdoctoral fellowship applications submitted to the Swedish Medical Council; see *Nature* **386,** 341–343; 1997).

The book starts with a survey of (mainly US) data on the low status of women scientists. This is followed by a critique of scientific methods and values and of the underlying ideas about 'nature'. The editors nicely balance the different schools of feminist theory. For example, Sarah Harding's essay "Is science multicultural?" is followed by Helen Longino's "Subject, power, and knowledge", a review of feminist epistemological strategies. Longino herself favours "the inclusion of cognitive diversity", whether gendered or cultural, within the scientific community "as a resource for criticism of the received wisdom", but doesn't believe "that every alternative view is equally deserving of attention".

Longino is in turn followed by John Lukacs, a "historian of twentieth-century European culture who brings a strongly religious perspective to his discussion of … quantum mechanics". Lukacs treads less cautiously than the other two men who contribute to this anthology. One suspects his essay on "Heisenberg's recognitions", which discusses the "historicity of reality as something which is prior to its mathematicability" in relation to human nature, has been included to underscore the rationality of feminist authors. Comic relief is provided by chapters on "Gender practice" and "Science and identity", which tell how past research in the life sciences proceeded apparently unaware that human organisms, unlike bacteria, come in two versions, or

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blinded by an eagerness to assign inferior quality to female cells, genes or brains.

The book's final section asks the question: will feminist scientists change science? Well, in some areas of science they already have, for instance in animal behaviour studies, Earth sciences and medical research. Hilary Rose, who has been chosen to provide an uplifting epilogue, sees "harbingers of hope". I agree. An increasing number of men love science enough not to deprive it of the "brilliance of women" (Rose). In the United States, where women complain more loudly than in most other countries, equal-opportunities policies have improved their lot in publicly funded research. But in Europe, according to "Women and Science", a report published last year by the European Technology Assessment Network, even countries committed by European treaties to fight discrimination in the work-place are reluctant to interfere with scientific bodies. If they don't interfere with teamsters' unions or soccer fans, who cares? But scientists take pride in their objectivity, yet don't notice that their sexist bias makes them look like the Victorians who preached family values to the underclass during the day and patronized brothels at night. No wonder so many women still think, with Virginia Woolf, that science "is a man, a father, and infected too". ■

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Nothing to it!

The Book of Nothing
by John D. Barrow
Pantheon: 2001. 370 pp. $27.50

John O'Connor

It must have been all those noughts at the end of last year's date that started people writing about zero. In 1999 we had Robert Kaplan's *The Nothing That Is: A Natural History of Zero* (Penguin), in 2000 we had Charles Seife's *Zero: The Biography of a Dangerous Idea* (Souvenir), and now we have John Barrow's *The Book of Nothing*. It's like standing at a bus stop. For 1,000 years nothing arrives and then you get three books on zero coming along together.

Kaplan's book was content to examine the history of zero and its position in a mathematical framework. The other two take the exploration of the idea out of the domain of pure mathematics and into the modelling of the physical Universe. This makes for a livelier story and expands the interest of the topic away from the purely arithmetic. Of these two, Barrow's book is the more authoritative and tells the story more persuasively. As with all popular books on modern physics, the approach is of necessity non-mathematical, and many of the arguments proceed by analogy. In these cases it is Barrow's arguments that are the more convincing.

All three books tell the story of how zero was invented several times, finally impinging on Western mathematics from its incarnation in Indian and Islamic culture in time to spark the Renaissance. We can only join Pierre-Simon Laplace in acknowledging: "The ingenious method of expressing every possible number using a set of 10 symbols (each symbol having a place value and an absolute value) emerged in India. The idea seems so simple nowadays that its significance and profound importance are no longer appreciated. Its simplicity lies in the way it facilitated calculation and placed arithmetic foremost among useful inventions. The importance of this invention is more readily appreciated when one considers that it was beyond two of the greatest men of Antiquity: Archimedes and Apollonius."

Barrow includes an account of the parallel development of zero by the Mayan civilization of Central America and numbers his chapters with Mayan 'glyphs' (gargoyle-like stylistic faces used as numerical symbols).

The connection between zero and the nothingness at the heart of Barrow's book is made by way of that most slippery of concepts, the empty set. Nineteenth-century mathematicians were able to use some cunning tricks to make this most humble of sets the basis for their arithmetic. It is a curious fact that although we may worship different deities, we are all forced to use the same empty set. It is the true universal concept. No wonder that this idea, which mathematicians now accept with equanimity, caused much debate and heart-searching down the centuries among philosophers and theologians.

Early scientists, despite the reservations of the philosophers, pursued the vacuum increasingly successfully with their barometers and pumps, and the idea of an empty space seemed eminently satisfactory. But then the necessity of finding a medium to allow the propagation of various electromagnetic waves meant that theoreticians were led to fill it up again with a presumed 'ether' — an invisible, inviscid fluid permeating all space. Physicists played intricate games with this new toy. Lord Kelvin and Peter Tait knotted ethereal vortices; Simon Newcomb and John Gore invoked its properties to explain the darkness of the night sky. Theologians likened it to "The Rudder of the Universe, the Rod ... in the Hand of the Almighty".

With the benefit of hindsight, we can see that by the end of the nineteenth century the theory was running into trouble. This was the beginning of big-money science, and it was the first telecom magnate, Alexander Graham Bell, who financed the experiments that laid the ether to rest. Albert Michelson and Edward Morley found strong evidence for its non-existence, and eventually the man-in-the-street's favourite eccentric genius, Albert Einstein, devised a theory that allowed it to be dispensed with altogether and so restored the status quo for an empty vacuum. It was a pity he had to use mathematics that the man-in-the-street could not possibly understand.

Nature may not always abhor a vacuum, but theoretical physicists seem unable to leave it alone. Only a short time after Einstein had restored empty space as a concept that one could believe in, the invention of quantum mechanics made it something that was too simple to satisfy the new theories. In the most persuasive model, any so-called empty box contains innumerable pairs of virtual particles which switch themselves in and out of existence, and which contribute to the energy of that apparently empty hole. This is the zero-point or vacuum energy. Even the experimentalists joined in, and measured the tiny forces involved in the Casimir effect, one of its consequences. Barrow brings this firmly into the realms of credibility by outlining results on a nautical phenomenon noticed in the nineteenth century, when two ships wallowing near each other in a choppy sea were moved towards each other by the wave action. It turns out that this involves the same theory, albeit on a much greater scale.

Such is the way that modern physics is interconnected that these effects noticed in the 'quantum vacuum' turn out to have wide-ranging consequences even at the truly astronomical scale. Cosmologists now have to take account of this new version of empty