BOOK REVIEW

Fusion—The Energy of the Universe

Authors G. McCracken and P. Stott

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Reviewer Martin Greenwald

Nuclear fusion is the process that powers the stars and creates the elements of the periodic table. The quest to harness this power as a practical energy source has been one of the great challenges of modern science. Fusion holds out the hope for the development of power plants with unlimited, inexpensive fuel and virtually no adverse environmental effects. However, while significant progress has been made, after 50 yr of research the goal has not yet been achieved but instead remains just out of reach. The reason is that the problem of confining hot plasma has turned out to be much more difficult (and more interesting) than anyone imagined. The threads of the tale entwine the history of astrophysics, the development of nuclear weapons, the cold war, and detente. McCracken and Stott tell this story in a compelling manner and with sufficient technical detail to serve as a introduction to the science and technology for students or nonspecialists. The authors capture moments of high drama—like the 1958 Geneva conference where scientists from both sides of the iron curtain presented results of their newly declassified research and displayed samples of their experimental equipment. It was a rare example of cooperation in a very dangerous time.

Fusion—The Energy of the Universe is part of the Complimentary Science Series from Elsevier whose aim is to cover scientific subjects in a technical but accessible manner. McCracken and Stott succeed admirably. They manage to explain most of the important phenomenology with a physical rather than mathematical approach and provide a good deal of background and context. The latter is missing from most textbooks and much course work, where students learn in great detail how a particular calculation is done but often are never taught why. The authors are well-known researchers in the field and tell their story from the perspective of their long experience at the Culham Laboratory in Britain and their work on the Joint European Tokamak, which is sited nearby. The book outlines the basic approaches to magnetic and inertial confinement, reviews some of the underlying theory, and describes a variety of experimental devices. There is an excellent description of the operation of one of these devices, a kind of "day in the life" for a fusion experiment. The authors also provide a good discussion of engineering and technology issues that will need to be solved for a practical fusion reactor and describe the role that fusion power might play in the context of world energy needs.

In an otherwise excellent book, a few opportunities are missed. The problem of confining plasma is a natural lead-in to discussions of turbulence, nonlinear dynamics, and chaos, subjects of considerable interest especially to young people. Also lacking is a theory analog to their descriptions of experimental apparatus—an introduction in physical terms of the important theoretical ideas would be welcome. Nowhere in the text would a reader learn just how the field of plasmas connects to statistical mechanics or fluid dynamics. Lastly, in retelling the history of the field's development, some mention might have been made of the pioneering role that fusion research took in driving advanced scientific computing. A few mistakes have crept in as well. In their introduction to the fusion reactions, they overstate the ratio of the coulomb to fusion cross sections (though it is still large enough to sustain their point, that practical fusion energy requires the confinement of thermalized plasmas rather than the collision of energetic beams.) And some readers will note that the muon is now understood and classified with the leptons and has lost its historical designation as a meson. But such quibbles are minor; the book is a terrific read and highly recommended to anyone with an interest in this fascinating and complex subject.

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