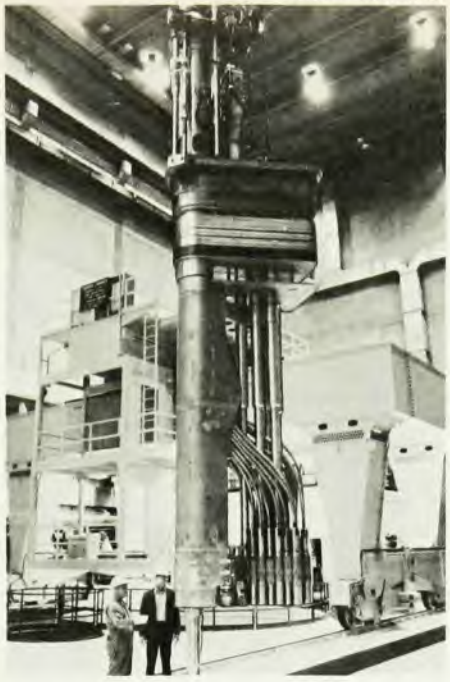
HANFORD LABORATORY

BATTELLE-NORTHWEST



The Fast Flux Test Facility at the AEC's Hanford Project in Richland, Wash. (left) is an important part of that agency's LMFBR program. The instrument tree (right) is a model for trees that will serve as monitors for temperature and flow characteristics in the FFTF reactor vessel.

thousand times shorter than that of U^{235}, so that a particle of insoluble plutonium oxide trapped in the human lung would irradiate its neighborhood that much more intensely. Cochran and Tamplin have recently drawn public attention to the possibility that the irradiation of the lung by radioactively "hot" particles might be orders of magnitude more effective in the production of cancer than the uniform exposure of the lung to the same average dose.[3]

Both of these questions, the explosive potential of the LMFBR and the potential toxicity of plutonium-oxide particles, are important ones, and I believe that Cochran and others deserve great credit in bringing them to public attention. The result has been that much more serious consideration is being given to these problems by the technical community—both inside and outside of the AEC.

It is not clear yet how these questions will ultimately be resolved. The breeder development program might not survive the close scrutiny that it is now receiving; or perhaps a much more defensible program, even another breeder design, will emerge. In any case Cochran and other LMFBR critics appear to have made their case that we are faced with a serious decision with regard to the future direction of our nuclear technology. Equally important is their argument that we should not allow ourselves to be stampeded into backing the LMFBR by dire warnings of a uranium shortage at the end of the century. The prospect appears much less forbidding than that. We have the time to reassess the breeder design thoughtfully and to consider seriously, the alternative futures.

References

1. The AEC issued a four-volume draft *Environmental Statement on the Liquid Metal Fast Breeder Reactor Program* in March, 1974 (Wash-1535). This draft was heavily criticized in extensive written comments from both environmental groups and the Environmental Protection Agency and, in June 1974, the AEC received an indefinite extension in the court deadline for the final draft to allow it to take these criticisms into account.
2. *Report of the Cornell Workshops on the Major Issues of a National Energy Research and Development Program* (Cornell University, College of Engineering, 1973), Chapter IV.
3. Robert Gillette, "Plutonium and the 'Hot Particle Problem': Environmental Group Poses a Draconian Answer," Science **183**, 834 (1974).

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The Special Theory of Relativity

H. Muirhead
163 pp. Halsted, New York, 1973. $12.75

The right undergraduate textbook on special relativity must not only be suitable for classroom instruction, it must also be appropriate for self-study, since the subject is generally not offered as a separate course. The required standards in accuracy and lucidity present, therefore, a goal approached as yet in only a few instances.

How closely does the text under review approach that goal? The question is in order because the book is by Hugh Muirhead of the University of Liverpool, well-known author of two creditable books on elementary-particle physics, the field of his scientific activity, and one in which special relativity is pervasive; and because his preface raises expectations. But a perusal of the text's six chapters reveals, along with commendable features, some nontrivial weaknesses.

The weakest portions are contained in chapters 2 and 3 dealing respectively with basic foundations and kinematic applications of special relativity. Thus, no direct indication is given in the statement of Einstein's first postulate that the coordinate systems in question are *inertial*. But more significant than any such lapses is the author's failure to carry out fully his expressed intention "to follow the spirit of a paper by Minkowski . . ." One may even wonder what he means by that spirit. On page 20 he refers to space–time (that is, Minkowski's "world") as "a fictitious (but mathematically convenient) four-dimensional space," while on page 23 the mere formal introduction of the variable *ict* is declared to "put our notions of space and time on a more equal footing."

A mild caveat cannot be avoided also regarding some aspects of the mathematical formalism. The discussion relating to ordinary vectors is in part superfluous (at least in the US) and in part strange. More importantly, space–time covariance methods are usually handled with undue restraint, as, for example, on pages 108–109 where the derivations are tortuous, and the gratuitous equation that follows is meaningless. Also, despite a section on symmetries in physics and the introduction of ϵ-symbols, pseudo-tensors are never mentioned. But these deficiencies can be corrected in the classroom.

Turning to the pedagogical features of the book, helpful and interesting problems, useful diagrams, and up-to-date references, are abundant, while misprints—though some are of a curious variety—are not excessive. A connection between Lorentz transformations and spherical triangles may interest some readers, and so may a comprehensive discussion "on spin and polarization in relativistic situations . . . *from the high-energy physicist's point of view*" (italics supplied.) But the last point is also a source of weakness for a text that is to be used by as yet uncommitted undergraduates who need a broad introduction to special relativity. This could be remedied by the instructor's making some omissions, while in-

troducing topics such as the Thomas precession, and some *qualitative* indications of the few spectacular successes of relativistic quantum mechanics.

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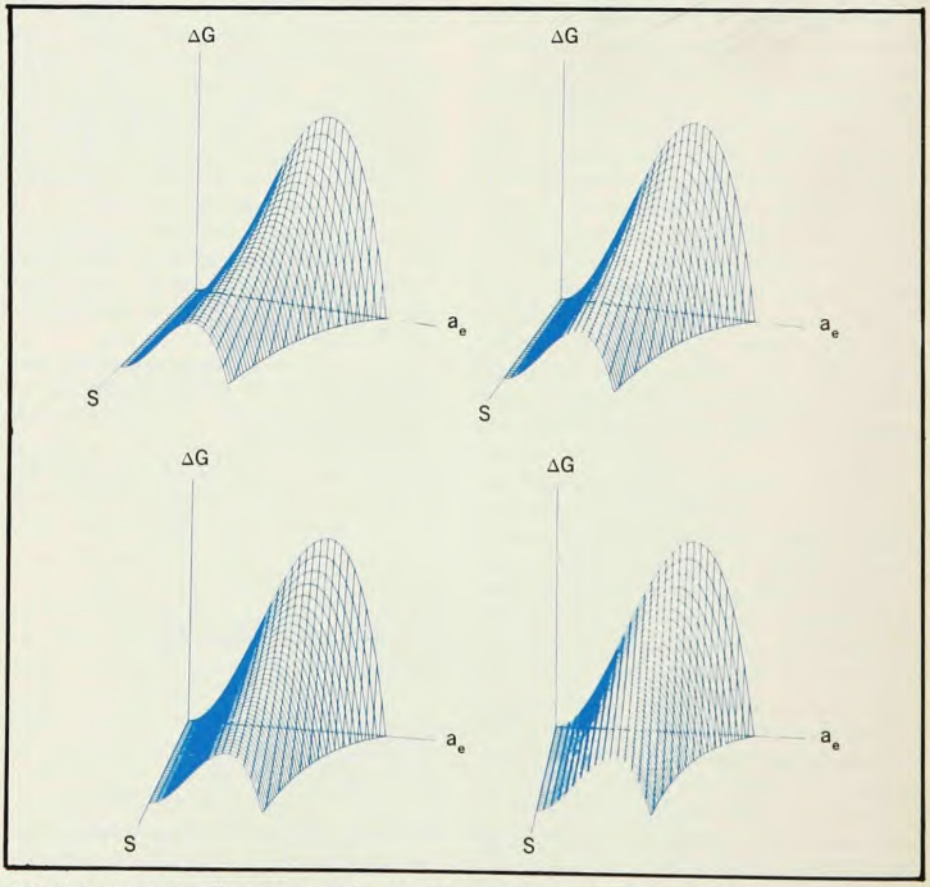
Homogeneous Nucleation Theory

F. F. Abraham
263 pp. Academic, New York, 1974. $23.00

Nucleation has become a major subject for scientific investigation throughout the world. Some of the subfields undergoing vigorous investigation, both theoretically and experimentally include nucleation in the atmosphere (cloud formation and precipitation), from solution, in metals, in semiconductors, in glasses, in void and in bubble formation. The practical importance of nucleation phenomena is shown by the fact that industrial scientists, such as Farid Fadlow Abraham, as well as academic scientists, are important contributors. Phase changes occur with difficulty in homogeneous systems, but they are usually aided by heterogeneities—any housewife who has tried to boil water knows this. The detailed processes by which heterogeneities catalyze phase changes are little understood and remain a major challenge. Yet our understanding of heterogeneous nucleation must ultimately rest on our understanding of homogeneous nucleation. Thus the importance of Abraham's book, even beyond the phase change he describes becomes apparent.

Abraham dwells on the pretransition theory of vapor condensation following the historical order of his own studies. These studies began with the classical thermodynamics of homogeneous nucleation and continued with the statistical mechanics and multistate kinetics of this pretransition phenomenon. The physical cluster model of the imperfect vapor, that the author leads up to, has been the basis for most of Abraham's studies. The cluster model bridges the gap between the important strides that have been recently made in our understanding of both dense gases and condensed matter. The Monte Carlo simulation of physical clusters, which has been a recent contribution of Abraham and his co-workers, has helped to resolve some of the controversies. This is its first presentation in a monograph.

The book concludes with two presen-



"As the supersaturation becomes larger, the critical free-energy barrier decreases and shifts to smaller droplet sizes." These four perspectives show the free-energy surface as a function of supersaturation ratio S (for $2 \leq S \leq 8$) and droplet radius a_e for a vapor–drop system of water at 263.2 K. From F. F. Abraham's monograph *Homogeneous Nucleation Theory.*