"coming of age" in physics during the interwar years resulted from two symbiotic sets of circumstances: a concatenation of social, economic, and institutional conditions that made for opportunity and growth in the environment of professional physics; and the entrance into the discipline of many talented people who were drawn by the excitement and challenge of the rapidly developing quantum theory. Both in overall interpretation and in substance, Sopka covers much ground that, while comparatively fresh in 1976, is now rather familiar. Her contribution consists in the detailed attention she gives to the development of the American corps of theoretical physicists.

Circa 1920 there were few American theorists, and by 1935 there were many more. What spurred the growth over that period, Sopka argues reasonably, was the ascendancy of quantum physics. She fleshes out the argument with estimates of the number of American theorists and dissertations in theory at five-year intervals. She also demonstrates that a small but able cadre of Americans, not all of whom were theorists, collectively contributed to quantum theoretical physics in the early 1920s, before the intensive European migration to the United States. The contributions included the work on band spectra of Edwin S. Kemble and Robert S. Mulliken, John Van Vleck's extension of the correspondence principle and William S. Duane's quantization of momentum transfer. Some of this effort caught the attention of Europeans, a number of whom, like Arnold Sommerfeld, visited the United States after World War I and carried home the word that American physics was growing up.

Sopka spotlights the generally unrecognized importance, for the development of theory in America, of Kemble at Harvard University. Between 1920 and 1935, 85 theoretical theses were produced at American universities; 26 of them were directed by Kemble or his former students, notably Van Vleck. Yet while the acquisition of theorists was indubitably essential to America's coming of age in physics, one wishes that Sopka had given more attention to the actual role of theorists in the work of the community, particularly their importance to experimentalists. There is a certain confusion in this study between the significance to the discipline of theorists on the one hand and, knowledge of theory on the other. Hardly all experimentalists of the period would concede that it was quite so critically important as Sopka suggests to have theorists around; relying on their own knowledge of quantum mechanics, experimentalists like I. I. Rabi did excellent physics. One also wishes that Sopka's dissertation had been available to scholars through the normal—and much lower priced—channels when it was originally completed. But, even if this expensively, better late than never.

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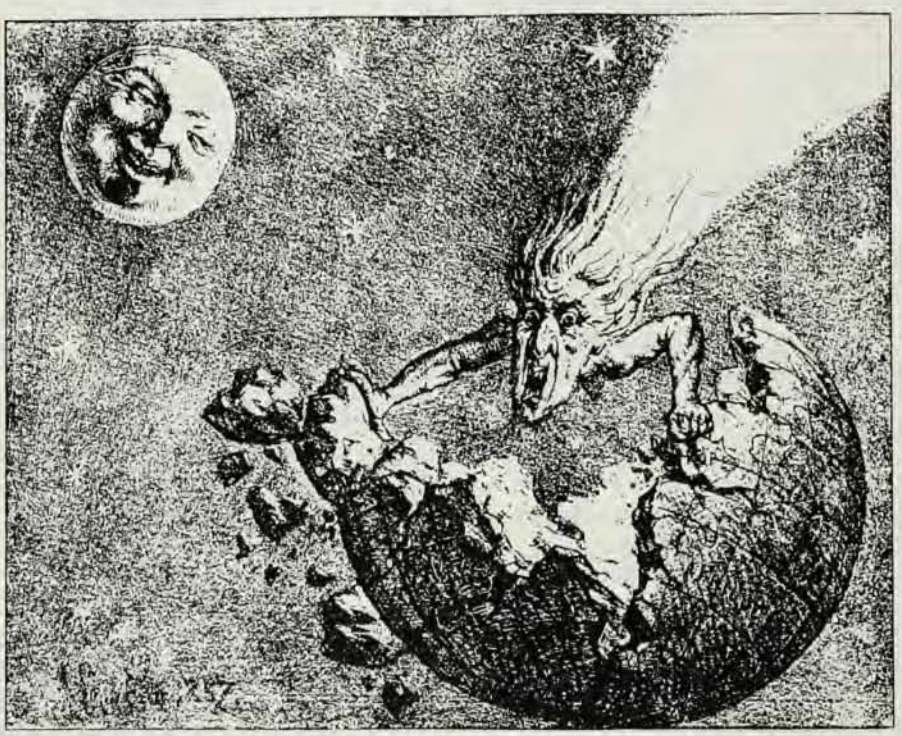

In 1857 this caricature of a comet smashing into the Earth was published in France. It appears as one of many illustrations in Nigel Calder's *The Comet is Coming* (160 pp. Viking, New York, 1981. $12.95). Anticipating the return of Halley's comet in 1985–86, Calder describes the history of sightings and the popular and scientific speculations they have provoked over hundreds of years. Courtesy American Museum of Natural History.

Introduction to Quantum Theory. Gauge Fields

L. D. Faddeev, A. A. Slavnov
246 pp. Benjamin/Cummings, Reading, Mass., 1980. $28.50

In 1971, Gerard 't Hooft solved a problem that had totally befuddled the leading lights of particle physics. The subject was gauge fields, which provide a geometrical and group theoretic foundation for fundamental forces. They generalize the concepts of connection and covariant derivative that underlie electromagnetism and general relativity. 't Hooft's particular contribution concerned the renormalization of perturbation theory, which involves the taking of subtle limits to get physically significant predictions. With these issues clarified after over a decade of confusion and contradictory claims, people finally took seriously Steven Weinberg's 1967 gauge theory of weak and electromagnetic interactions. Experimental support was there for the asking in the form of neutrino-induced interactions that had hitherto been thrown out as neutron background events. Soon thereafter, the detailed calculations made possible by 't Hooft's analysis revealed that gauge fields were also ideally and even uniquely suited for the description of the strong forces that hold quarks together into nucleons. So by 1974, gauge fields formed the basis for all known fundamental interactions.

Ludwig Faddeev and Andrei Slavnov wrote their monograph, *Gauge Fields: Introduction to Quantum Theory*, in 1977. Faddeev had pioneered the study of quantized gauge fields, but this work, too, had gone largely unnoticed and was translated into English only after 't Hooft had rekindled widespread interest in the subject. Slavnov's contributions in this area came soon on the heels of 't Hooft's publications and offered a more traditional analysis to substantiate 't Hooft's very original and occasionally idiosyncratic treatment.

Gauge Fields provides a reasonably complete and concise description of the quantization and renormalization of gauge theories as appropriate for weak-coupling calculations. It stresses those aspects that are particular to gauge interactions, arising from the presence of variables that do not represent true dynamical degrees of freedom. It describes techniques developed specifically for these problems, such as analytic continuation in the number of spatial dimensions, as well as older techniques,

Galaxies of the Sc I luminosity class, which have well-defined spiral patterns, appear in *A Revised Shapley-Ames Catalog of Bright Galaxies*, by A. Sandage and G. A. Tammann (157 pp. Carnegie Institution of Washington, 1981. $29.00). The book describes magnitudes, types and redshifts of galaxies in the original Harvard survey, updated to Summer 1980 and provides both a selection of photographs that illustrate the luminosity classification and a list of additional galaxies that satisfy the magnitude limit of the original catalog. Data for 1246 galaxies are included.

such as functional integrals (including fermions), which are particularly suitable for understanding gauge theories.

There certainly continues to exist a demand in the high energy community for a good reference work on the fundamentals of gauge theories. A 1973 review article on the subject by Benjamin Lee and Ernst Abers remains by far *Physics Reports*' most popular reprint. On purely formal questions, this monograph by Faddeev and Slavnov is somewhat more complete, though its description of actual physics situations is rather spare. But it has probably outlived most of its usefulness. It assumes the reader is perfectly well versed in state-of-the-art quantum field theory *circa* 1971, and the presentation is so terse and linear that little distinction is made between points that are subtle, fundamental or trivial. I suspect that those with sufficient background to follow the presentation are by now as familiar with the subject as they wish to be. Also, the point of view is narrowly confined to the perturbative approach, which is totally inadequate for confronting the basic problems of gauge theory today. Further, for those current applications of gauge theory which use perturbative calculations, *Gauge Fields* is both overly formal and too incomplete to serve as an introduction.

For people wishing to learn the subject, it is absurd, though woefully common, to require that they progress systematically through the full historical development. What is needed is to incorporate the gauge theory perspective into some new textbooks on relativistic quantum mechanics.

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Nuclear Reactions with Heavy Ions

R. Bass
418 pp. Springer, New York, 1980. $48.40

Until a few years ago, advanced graduate students and specialists in other areas could rapidly acquire a broad working knowledge of heavy-ion nuclear science by studying topical conference proceedings and following the current literature. With the explosive growth of the field in diverse directions over the last decade, new researchers now face a formidable task in gaining a comparable orientation, and students, in particular, often fail to perceive the underlying unity of the subject.

In *Nuclear Reactions with Heavy Ions*, Reiner Bass provides a very useful introduction to a substantial portion of the field. Written for the readers described above, the book contains relatively thorough, critical surveys of five major areas of current research interest: resonances and related phenomena in light systems; quasi-elastic scattering and transfer reactions in heavier systems; deep-inelastic processes; complete fusion reactions; and compound nucleus decay. In each of these areas, data drawn from a variety of representative experiments are presented and discussed in terms of straightforward models that help bring out the underlying physics. Controversial or tentative interpretations are labeled as such, and in many cases, several alternative viewpoints are outlined and contrasted. The treatment tends to be phenomenological, and developments along