The humorous anecdotes on physics before the war convey in this regard a sense of the human side of science; Casimir's essays "Industry and science after the Second World War" and "The science-technology spiral" contain much hard-learned wisdom. One wishes, however, for temporal extensions of both: more about the human side of industrial science after the war, more reflection upon physics and society before and during the war. Casimir apologizes for not fulfilling the first wish: a generation should pass before names are mentioned (or are industrialists less prone to adolescent pranks?). His intriguing chapter on physics in occupied Holland—the only country in which students and faculty struck the universities upon the dismissal of Jewish colleagues—helps to satisfy the second wish. Yet more remains to be known. Passing remarks about Pascual Jordan's Nazi collaboration, about genetics and intelligence, and about "mass murder" weapons (atomic bombs?) are simply too sketchy to allow full comprehension.

Aside from the numerous anecdotes, Casimir actually does write about such informative (and sometimes equally amusing) topics as the nature of the physics profession when he entered it, the pedagogy of his three outstanding teachers, and the expected career opportunities (mainly in secondary school teaching). There are also informative technical appendixes on physics in the '30's as he recalls it. Yet, again, more could be said. There is, for instance, little account of his own research, such as his best-known work on van der Waals forces.

Historians of science will thus desire much more, but physicists and lay readers will nevertheless join them in their immense enjoyment of this personal encounter with a prominent physicist and with the world of physics as he remembers it.

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Neoplasia

Chromosome Mutation and Neoplasia. JAMES GERMAN, Ed. Liss, New York, 1983. xxxiv, 452 pp., illus. $96. The Chromosomes Series.

Chromosome Mutation and Neoplasia is the second volume in the Chromosomes Series. The first volume, *Chromosomes and Cancer* edited by German, was published in 1974 and was a success. The new volume is based on the proceedings of a meeting held in New York in 1980 on chromosome breakage and neoplasia, with material added to give improved coherence to the subject, especially in the light of the enormous advances made in the past two years in understanding oncogenes, their chromosomal localization, and their likely role in chromosome translocations in tumors.

The volume is divided into two sections, the first consisting of a straightforward clinical description of inherited disorders in humans that predispose to cancer. These include Bloom's syndrome, ataxia telangiectasia, xeroderma pigmentosum, and Werner's syndrome. These chapters are quite thorough reviews for newcomers to the field but do not offer any new information. A chapter by B. P. Alter and N. U. Potter on Fanconi's anemia is the exception here. The rest of the section offers useful and comprehensive reviews of both the patterns of neoplasia associated with the chromosomal breakage syndromes and the well-known unusual sensitivities of various disorders to different environmental agents.

The second section tries to describe the importance of genomic change in neoplastic development. There are chapters on the effects of ionizing radiation, various chemicals, and viruses on chromosomes, all subjects that have been well reviewed previously. The remainder of this section attempts to provide continuity with the first section on the subjects of inherited chromosomal disorders and specific chromosomal changes associated with various tumor types. R. Sager, J. German, and R. S. K. Chaganti in separate chapters reiterate various schemes for the origin and progression of malignancy. The various postulated steps to malignancy, including generation of genetic diversity by damage to the genome, the production of specific chromosomal translocations, oncogene activation, and specific target cell involvement all are mentioned. Sager's chapter is more general, being partly a review of other work on transposable elements. German and Chaganti speculate more directly on the significance of the quite different chromosome abnormalities associated with Bloom's syndrome and ataxia telangiectasia respectively. Both chapters are thought-provoking. There is a paucity of comments on the significance of chromosomal changes in Fanconi's anemia, and both xeroderma pigmentosum and Werner's syndrome are lost to view. Of course, these chapters in some ways attempt what at present is impossible, to understand the relation to cancer development of chromosomal changes observed experimentally or clinically.

Clearly there are some irritations in a book like this. The main ones in my view are a degree of repetition throughout, the unequal treatment of the significance of the chromosomal changes in the different disorders, and the fairly superficial homage given, in what must be an added chapter, to recent developments concerning oncogenes and their involvement in chromosomal translocation.

Overall, however, the book is a worthy successor to *Chromosomes and Cancer* and is to be recommended as an attempt to bring together the chromosomal and molecular levels of study. The printers have included their own joke by getting pp. 338 and 339 out of sequence in the chapter on genomic rearrangements.

The subject is advancing rapidly, and it is to be hoped that we do not need to wait a further decade for a third volume. This might include both a review section and a section of recent experimental results by some new contributors.

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Plants and Pollinators

Handbook of Experimental Pollination Biology. C. EUGENE JONES and R. JOHN LITTLE, Eds. Scientific and Academic Editions (Van Nostrand Reinhold), New York, 1983. xviii, 558 pp., illus. $46.50.

Although pollination biology may seem to be a quite circumscribed and specialized subject, its study encompasses an amazing diversity of approaches. Plant-pollinator systems can be used as models for studying problems of plant genetics, plant reproduction, ecological chemistry, foraging behavior, species interactions, coevolution, and community ecology. The last 20 years have seen an explosion of such studies on pollination biology, and, as in any rapidly growing field, some areas have advanced considerably in isolation from others. This *Handbook of Experimental Pollination Biology* provides a timely and valuable compilation of recent research advances in these diverse areas.

Despite what the title implies, the book goes beyond being a manual of methodologies, although techniques for the analysis of color perception, floral pigments, and fragrances are covered. Some of the 29 papers in the volume contain extensive reviews, but others report original research results. Papers on floral rewards and cues review extensive information on such intriguing traits as buzz-pollination (the fastest mechanism of pollen collection), dummy anthers, stigmas as electrostatic pollen collectors, oils as rewards for pollinators, colors as perceived by an insect's eye, and patterns of sugar constituents in nectar (high sucrose in long-tubed flowers and high hexose in open flowers). All mention the lack of information on how different types of rewards or cues influence pollinators. Intraspecific variation in rewards due to genetic or environmental effects emerges as a major topic that remains to be explored.

Pollinator behavior and species interactions are covered mostly in reports of specific research studies. The importance of competition among plants for pollination remains controversial, but an emerging consensus here from studies of natural populations is that it is quality of pollen, more commonly than number of pollinator visits, that limits seed set. Carpenter and Ford both suggest that bird-pollinated plants may seldom be pollinator-limited. Waser presents some exciting new data showing flip-flops in flowering phenologies of two unrelated plant species that share hummingbird pollinators. This is the only good example of character displacement between unrelated species due to pollinator sharing, although Waser's studies also suggest that the phenomenon is due to selection from interspecific pollen transfer and not from competition for pollinator visits. In contrast, in agricultural systems competition among plants for honey bee visits recurs as a major problem for obtaining hybrid seeds in crops. Selection for male sterility in flowers is often accompanied by reduced production of nectar and fragrance, and this is often correlated with changes in floral cues that are discriminated by honey bees. Varieties that provide lower rewards are visited less often and seed set is reduced. The editors have done a great service by including two reviews of the extensive agricultural research on pollination and plant breeding that will bring this information to the attention of other ecologists.

The number of new research studies reported here is a tribute to the growth and vitality of pollination biology. Such studies on natural populations report on pollen tube competition and timing, the maintenance of pollinated flowers to increase pollinator attraction, staggered phenologies that promote intraspecific bee movements within tropical tree species, and possible floral mimicry between two plant species. As one might expect, a major conclusion that arises from reading this book is that plant-pollinator systems are complex with many fascinating but often poorly known components.

Although this book will be of the most direct value to pollination biologists, it should open up the possibilities of using plant-pollinator systems to study many basic problems in ecology and evolution. Its influence will certainly be felt as an influx of information into many different areas of research.

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The Structure of the Universe

Relativistic Astrophysics. Vol. 2, The Structure and Evolution of the Universe. YA. B. ZEL'DOVICH and I. D. NOVIKOV. Gary Steigman, Ed. University of Chicago Press, Chicago, 1983. xxxiv, 718 pp., illus. $65. Translated from the Russian edition (Moscow, 1975) by Leslie Fishbone.

Cosmology is a speculative field. There are few facts on which to base a theory. As one proceeds to probe earlier and earlier epochs of the universe, the data become sparser and sparser. Finally, one is left, almost literally, with hot air.

As it happens, the cooled relic radiation from the fiery beginnings of our universe was discovered in 1965 at microwave frequencies by Arno Penzias and Robert Wilson. They verified one of the great predictions of modern physics, second in cosmology only to the prediction of the expansion of the universe itself. Georges Lemaître deserves much of the credit for this latter idea, but the trail was clearly blazed several years earlier, in 1922, by the Soviet scientist Alexandre Friedman. It was Friedman's discovery of the expanding universe models, due to a much regretted oversight of Einstein's, that heralded the emergence of Soviet cosmology into the mainstream of modern physics.

Ya. B. Zel'dovich and I. D. Novikov are worthy inheritors of this tradition. Both have played major roles in developing the theory of the large-scale structure of the universe. Novikov recognized that the fireball radiation might be measurable a year before its serendipitous discovery. Both authors are well known to Western cosmologists.

Their latest book provides a thorough account of cosmic evolution. Its scope ranges from the earliest instants of the big bang to the formation and clustering of galaxies. Its level is appropriate for beginning graduate students, and it provides a broad introduction to much of modern cosmology. Some knowledge of general relativity is required, but not at a very sophisticated level. Not surprisingly, it highlights contributions by the authors and their Soviet colleagues, but it also gives a fair account of results obtained in the West.

One theme that pervades the book is the need to confront cosmological theories with observation. The microwave background radiation has been a source of continuing employment for aspiring cosmologists. The seed fluctuations from which galaxies emerged must have left telltale traces in the apparently uniform background radiation. Apart from a variation over 180° that is associated with the motion of our galaxy, no trace of anisotropy is seen in the radiation to within one part in 10^4. A race is now under way between forthcoming Soviet and U.S. satellite experiments to measure the radiation fluctuations, which according to the cosmologists must ultimately be detectable.

The Zel'dovich and Novikov book provides a detailed description of how such fluctuations arise. Once there were no stars, no galaxies; matter was everywhere a homogeneous soup. But it could not have been completely uniform, otherwise structure would not have evolved by the present epoch. The gravity field of the seed fluctuations in the matter slightly perturbed the fireball radiation, much as a light ray from a distant star is slightly deflected by close passage to the sun.

Such a history of minuscule deviations from uniformity is a conservative view of our past. A radical view is that the universe originated from an extreme state of chaos and nature provided a suitable filter. Zel'dovich and Novikov tell us how the cosmic background radiation constrains such hypotheses. Exotic possibilities remain for the first second of the universe. One can imagine a universe collapsing in one direction yet expanding in another, rather like a tube of toothpaste when squeezed, only to periodically reverse this behavior. As long as such bizarre behavior eventually dies away, there need be no contradiction with the observable universe.

Gravity waves could be one surviving manifestation of primordial chaos. Such waves manifest themselves by generating a transient acceleration of any object in their path. Cosmological gravity