Neutrinos after 50 Years

Neutrino Physics and Astrophysics. Papers from a conference, Erice, Italy, June 1980. ETTORE FIORINI, Ed. Plenum, New York, 1982. xii, 422 pp., illus. $49.50. Ettore Majorana International Science Series (Physical Sciences), vol. 12.

In honor of the 50th anniversary of Pauli's neutrino hypothesis, the International Conference on Neutrino Physics and Astrophysics in 1980 set aside its opening session to recollect the early days of the field and review its history. Other sessions were devoted to the latest results from enormous detectors at modern high-energy accelerators, at atomic reactors, and deep underground, but the first set of talks reminded us how it all began as a "desperate remedy" for the conflict between the continuous spectrum of beta rays and the conservation of energy. Particle inflation had not hit physics in those far off days when not even the neutron had been discovered, and it was only with the greatest reluctance that Pauli postulated the existence of a new particle; unlike Bohr, he preferred doing this to giving up one of the fundamental laws of physics.

Pauli was correct, but many ironies lay ahead before the full story emerged. The particle invented to save one conservation law went on to create its own revolution 25 years later by violating another, the law of symmetry under reflections. Whereas Pauli hesitated to postulate even one new particle, the neutrino is now known to come in at least two distinct varieties, and probably three. The particle that interacts so weakly with matter that it cannot harm a single human being required the full panoply of work related to the atomic bomb before it could be detected. Even today, the neutrino is starting off its second 50 years by threatening to break more of the rules it ought to obey.

But this behavior is not without value. The original neutrino hypothesis led to the Fermi theory of beta decay, which over the years has had a great influence on the development of modern theories of all interactions, not only the weak ones. The lack of reflection symmetry brought about a profound clarification of the Fermi theory and of the nature of the neutrino itself. The existence of more than one kind of neutrino paved the way for the drawing of a parallel between leptons and quarks, and neutrino neutral currents confirmed the brilliant predictions of the unified theory of Glashow, Salam, and Weinberg. Every breakdown seems to have opened up another new vista for physics.

All these themes appear in one guise or another throughout the proceedings of the 1980 neutrino conference. The book opens with a delightful account of the early days by Peierls, who takes us from 1930 to 1945. Reines then describes the debate on atomic bombs versus reactors as the better source of neutrinos, and he explains why he and Cowan chose the latter to make the first observation of the neutrino in 1956. Pontecorvo, that wizard of ideas, then tells how he came to propose the ^{37}Cl reaction and how incorrect accounts of the first such experiment carried out by Davis using reactor neutrinos led him to invent the notion of neutrino oscillations. Ten years later, in 1967, he revived the notion as a result of correct accounts of similar experiments by Davis on solar neutrinos.

The decade of the 1970's was the era of accelerator neutrinos, and many papers describe the results of experiments probing the interactions of neutrinos with matter and the structure of matter itself. The confirmation of the Glashow-Salam-Weinberg theory is laid out in great detail, as is the study of nucleon structure functions. About the only thing missing from the book is a good account of neutrinos and modern cosmology. Nevertheless, there is enough material in these proceedings on the physics and the history of the neutrinos.

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Angiosperm Orders and Families

An Integrated System of Classification of Flowering Plants. ARTHUR CRONQUIST. Columbia University Press, New York, 1981. xviii, 2162 pp., illus. $100.

There has been a crying need for a comprehensive handbook covering all the orders and families of flowering plants. John Hutchinson's *Families of Flowering Plants* (ed. 3, 1973) follows a classification that is no longer acceptable to the critical student and is even less so to the professional taxonomist. Nor does it include much information apart from gross morphology. Engler's *Syllabus der Pflanzenfamilien* (ed. 12, by H. Melchior, 1964) is also somewhat out of date and rather limited, although it does present the subdivisions of families and the genera in a skeleton survey.

Thus the publication of Cronquist's new book is welcome. It is the only volume that, within the frame of a modern system of classification, gives comprehensive information on families, including gross morphology, vegetative anatomy, embryology, chemical contents, serology, chromosome numbers, and fossil records. Data of all these kinds are now indispensable for a full understanding of the relationships and biology of the plant groups. Cronquist's book is a veritable mine of information. The extensive references listed in connection with the ordinal descriptions are also well chosen and up to date. There are about 225 plant illustrations of a high standard; as a rule they show the details of one representative species chosen out of the family.

The great number of pages makes the book rather too cumbersome for convenience, however. A somewhat larger format with two-column text would have reduced it to a little more than half the thickness. In addition, the ordinal and familial descriptions, presented in coherent blocks, may prove too massive for the reader.

Apart from this, my impression of the book is nothing but positive. The information is as accurate as could ever be achieved and is presented in a lucid manner. The immensity of Cronquist's own body of knowledge coupled with his connections with botanists all over the world, including the Soviet Union, and the facilities available to him at the library and herbarium of the New York Botanic Garden has resulted in an admirable wealth and precision of information.

The utilization of this information in the construction of Cronquist's system of classification should also be commented on. There is gradually developing a consensus among the few taxonomists working at the highest levels of classification, with the result that the main features of the current classifications are approaching one another. Further cooperation in the future may reduce to an even greater extent certain unnecessary technical and nomenclatural differences. The increasing similarity in the classifications is largely due to new, unequivocal data. Most of Cronquist's constellations and concepts are undoubtedly wise and have a greater public appeal than those of other classifications, in which

the hierarchy is more complicated or the orders and families split into more entities or both. Despite his wealth of knowledge Cronquist seems somewhat hampered by a conservative or even somewhat reactionary attitude. Thus in my opinion the following families are out of place in the orders where they are placed on the basis of superficial resemblance and should be removed from them: Chloranthaceae in Piperales; Nelumbonaceae in Nymphaeales; Coriariaeceae in Ranunculales; Sarraceniaceae and Droseraceae in Nepenthales; Fouquieriaceae, Bixaceae, and Cistaceae in Violales; Gunneraceae in Haloragaceae; Boraginaceae in Lamiales; Hippuridaceae and Hydrostachyaceae in Callitrichales; and Poaceae in Cyperales. These few changes alone would make the classification more convincing. A number of other changes would also improve the classification. Being, as I am, responsible for a different system of classification and having somewhat different evaluations, I feel tempted, of course, to put forward divergent points of view.

Cronquist's conservative approach is most obvious in the case of the Liliiflorae. Instead of acknowledging Alliaceae, Hyacinthaceae, Alstroemeriaceae, and a number of other segregate families on the same level, Cronquist includes these in his Liliaceae. This approach is both radical and practical, although important constellations of genera, representing main interesting evolutionary lines, are relegated to infrafamilial level in Liliaceae. Surprisingly, within the jungle of generic groups Cronquist acknowledges a few, such as Cyanastraceae, Aloëaceae, and Iridaceae.

Some comments should also be included on the basic philosophy behind the treatment of the evolution of the angiosperms. Cronquist claims that the earliest angiosperms were probably shrubs of riparian habitats and had monosulcate pollen grains and leaves with irregular pinnate-reticulate venation. His sequence of orders indicates that he favors the so-called Euanthian theory, with Magnoliales as the most archaic existing order of flowering plants. This is in accordance with the general view held today. The connection between monocotyledons and dicotyledons is more vaguely, and in my opinion less satisfactorily, explained. The close relation between Nymphaeales and monocotyledons is emphasized, and, although Cronquist does not suggest that the Nymphaeales are direct ancestors to the monocotyledons as a whole, he concludes that the premonocotyledonous dicotyledons probably somewhat resembled the modern Nymphaeales. Leaf impressions resembling water lilies from Albian times support this view. In the discussion of the affinities of the Nymphaeales I would have liked to see mentioned sieve tube plastid conditions, occurrence of perisperm (remarkably similar to that in Piperales), and chemical conditions. A note on alternative views would have been appropriate, for example that the monocotyledonous Dioscoreales, such as Trichopus, and various members of the dicotyledonous Magnoliales sensu lato exhibit a number of conspicuous similarities.

The book is not, however, meant to be speculative-philosophical or "evolutionary." It is a highly pragmatic presentation of the present groups of angiosperms and their characteristics. It can be strongly recommended for its wealth of exact information, not to mention its attractive appearance, and is far superior to other handbooks of its kind. It should be present in all libraries attached to the botanical departments of universities and available to botanical gardens and secondary schools all over the world. It certainly also deserves to have a place on the shelves of all taxonomists with a broad range of interests.

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Electrons, Phonons, Magnons. M. I. Kaganov.

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