relation between real and imaginary parts of the index of refraction of an optical medium led to interesting results in the quantum theory of scattering. Specifically, it was noticed that the real part of the amplitude describing the scattering of light by a target (an atom, a nucleus, a proton) evaluated in the forward direction (scattering through zero degrees) could be expressed as an integral over the imaginary part of the amplitude. The latter, in turn, is directly related to the total probability (called the cross-section) for removal of the light from a beam, an experimentally measured quantity. This relation between real and imaginary parts of a function is well known in mathematics as a Hilbert transform and exists whenever one is dealing with an analytic function with certain boundedness properties; hence the initial enchantment with complex variable theory of a rather elementary kind.

It was soon found that these relations, known in the trade as dispersion relations, could be generalized to describe not only light scattering but also scattering of particles with mass, such as pi-mesons and nucleons. They provided presumably exact conditions on scattering amplitudes and were directly related to experimentally measured quantities. There were several reasons for the popularity of dispersion theory: First, the quantum field theory from which it was derived has proved so resistant to explicit quantitative calculations in the regime of strongly interacting particles (mesons and nucleons) that it was gratifying to prove general consequences of the theory without being able to solve it explicitly. Second, dispersion relations, dealing as they do with measurable quantities, lend themselves to useful ways of thinking about theoretical questions and suggest reasonable approximations and relations between various processes in a phenomenological sense. Third, from the very beginning there appeared the possibility that the whole of relativistic quantum mechanics could be studied independent of quantum field theory, some of its diseases and complications being thereby avoided.

It is this third aspect that forms the basis of the present book. If one imagines a giant matrix, called *S*, with the rows and columns labeled by all possible particles in all possible configurations (momenta, spin, and so on), then the probability of a reaction column label → row label is proportional, essentially, to the absolute square of the corresponding element of the matrix. One hopes to study these matrix elements regarding them as analytic functions of the variables describing a given process. For example, in a two-particle scattering process these variables might be the total energy of the system and the momentum transferred from the projectile to the target.

The authors of this book make no pretense at a presentation of an axiomatic *S*-matrix theory. They utilize fully the laboratory of the perturbation expansion of quantum field theory as a guide to the sort of analytic behavior that can be rationally expected in order to eventually develop axioms. This type of "experimental physics" is a highly developed mathematical art and is very clearly presented. One is concerned here with the analytic properties of multiple integrals as a function of several complex variables, and one is led to questions frequently studied by very sophisticated mathematics (topology, homology theory), although the methods used here are well within the grasp of most theoretical physicists. A very complete analysis of the singularity structure of *S*-matrix elements in perturbation theory is given.

The high-energy behavior of scattering amplitudes is studied by means of the analysis of perturbation theory just described, and the connection to singularities in the complex angular momentum plane is brought out.

The final portion of the book is concerned with an exposition of the analytic structure of *S*-matrix elements that can be deduced from some simple assumptions (based on the knowledge gained from perturbation theory) and the exploitation of the so-called connectedness structure of the theory and the principle of unitarity, a consequence of probability conservation. This portion of the book is too technical to describe here. It deals with rather deep questions such as the role of unstable particles and the concept of causality in an *S*-matrix theory.

This book, although intended for a rather specialized audience, is well and carefully written and should be very useful to serious mathematical physicists.

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Nonmetals

The Chemistry of the Non-Metals. WILLIAM L. JOLLY. Prentice-Hall, Englewood Cliffs, N.J., 1966. 159 pp., illus. Cloth, $5.50; paper, $2.50.

This book is written for use with beginning students. As the author writes in the preface, it is "an introduction to, and a compendium of, the chemical compounds of the non-metals," by which the author means hydrogen, boron, carbon, silicon, germanium, nitrogen, phosphorus, arsenic, antimony, the chalcogens, the halogens, and the noble gases, 24 elements in all. The most striking feature of the book is its success in the inclusion of a "compendium" in such a small number of pages. This success is due in no small part to the author's emphasis on the most recent (post-World-War-II) chemistry of the elements, to the virtual neglect of the more classical chemical properties. One can almost hear the groans of industrial chemists reading this book and assuming, erroneously, that this is all that their successors will know about the nonmetals. For example, the only mention of the ability of hydrogen to reduce metal oxides is as a means for analytical determination of hydrogen gas by weighing the water produced by its reaction with copper(II) oxide. As a second example, the chapter on boron devotes ten pages to hydrides and derivatives, covering the remainder of boron chemistry in four pages.

For those who entertain the idea of using the book with beginning students, one small obstacle should be mentioned. The author presumes a familiarity with the language of chemists which is not universally achieved by students at the end of their third year of chemistry. Understanding of hydrogen bonding, of Gillespie's delightful electron-pair repulsion theory for predicting stereochemistry, of the significance of nuclear equations—${}_3\mathrm{Li}^6(n, \alpha)_1\mathrm{T}^3$, for example—and of how to use oxidation potential diagrams are all prerequisites for the use of this book. The student is obviously presumed to have had a fairly sophisticated introduction to "the chemical bond" prior to using this book. Thus for beginning students of sophisticated background, this book is certainly to be recommended highly.

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