powerful than the usual methods of finding a stationary value of a function of several variables. It takes a little while to program, but so will any iterative method which has second-order convergence near a stationary value and which will converge from a poor approximation to the stationary value.

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Book reviews

A Fortran Program for Elastic Scattering Analyses with the Nuclear Optical Model, by MICHAEL A. MELKANOFF, DAVID S. SAXON, JOHN S. NODVIK and DAVID G. CANTOR, 1961; 116 pp. (Berkeley, and Los Angeles: *University of California Press*, $4.50; London: *Cambridge University Press*, 34s. 0d.)

To quote from the introduction, "the purpose of the present report is to describe in complete detail a FORTRAN code named Program SCAT 4 written by the UCLA group in order to analyze elastic scattering of various particles against complex nuclei by means of the diffuse surface optical model of the nucleus." The publication is similar to, but more elaborate than, the many technical reports which come from the large scientific institutions such as the Atomic Energy laboratories, aircraft companies and defence research establishments, especially in America where people seem to be particularly good at writing up work. There is a full account of the mathematical basis of the calculation; a description of the program, first in general terms, then in detail, routine by routine; a listing of the program which occupies 40 pages and runs to 21 routines totalling nearly 2,000 FORTRAN statements; the input data and output listing of a simple calculation, the scattering of 9·75 MeV protons by copper; and a bibliography of related calculations. There is also an offer to send the program card deck to anyone who is willing to pay the mailing charges.

The essence of the calculation is the numerical integration of the Schrödinger equation for the system, reduced to a set of ordinary differential equations in a single radial variable by a process of expansion in eigen-functions, followed by a matching of the numerical solution to an asymptotic solution expressed in terms of Coulomb wave functions. The matching process leads to the determination of some important parameters called *phase shifts* which, together with the computed solution, enable one to calculate the cross-section for the reaction in question. A very practical consequence is that one can compute from basic nuclear data the values of certain physical quantities which are needed, for example, in the design of nuclear reactors; in fact, this kind of computational procedure is already beginning to supplement programmes of experimental work, and is quite likely later on to replace a good deal of this.

The attention to detail in the report is very impressive. It is written for the man who wants to use the program and who may wish to extend or modify it, and the impression one gets is that every point has been considered. The mathematical section (33 pages) is concentrated and is certainly not for the uninitiated, but it does give a complete account of the analyses so that one can find out just what has been put into the program; in addition to the mathematical physical arguments, it goes into detail about the numerical processes, including a full account of the special Runge–Kutta process used for the numerical integration of the differential equations. The description of the program itself is equally complete, giving full details of the structure and operation of every routine and of its relations with whatever others it calls or is called by. The writing is terse but very clear, and the publication fulfils admirably its purpose of providing a technical reference manual to a specialized and complicated piece of work.

The corresponding reports issued by industrial and government laboratories are mostly circulated privately, although some, especially those coming from the UKAEA in England and the AEC in America, can be bought by anyone who knows of their existence. Open publication, as in this case, seems to me to be a move to be welcomed; a very large amount of thought, effort and experience has gone into the construction of a computer program of the size and complexity of one such as SCAT 4, and it is all to the good that as many people as possible should be able to take advantage of it. There is quite literally a universal interest in the calculation described here, and because the program language FORTRAN is now used on many of the larger machines, the program itself can be used quite widely just as it stands with enormous saving in scientific effort. Clearly, the value of a publication of this kind is very greatly increased if a more widely accepted language is used; the actual value for money represented by this manual at a price of around £2 is quite remarkable.

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