This Week's Citation Classic

Satchler G R. The distorted-waves theory of direct nuclear reactions with spin-orbit effects. *Nucl. Phys.* 55:1-33, 1964.
[Oak Ridge National Laboratory, TN]

A general formulation was given of the distorted-waves theory of direct nuclear reactions which displayed the universal structure underlying such a description of these reactions. This formulation was especially suited for the construction of flexible computer programs. [The *SCI*® indicates that this paper has been cited in over 475 publications since 1964.]

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"My graduate work on direct nuclear reactions started at Oxford in 1952, almost immediately following the discovery of these important reactions.[1] Their importance arises because they are fast reactions between two nuclei, accompanied by a minimum of rearrangement of either nucleus. Thus, they are particularly suited to give (excuse the pun) direct information about nuclear structure. The earliest theoretical models essentially made use of the first (or 'plane wave') Born approximation, but it was soon realized that this was inadequate. Elastic scattering of the two nuclei before and after the nonelastic event is always important and must be taken into account. This was done by introducing elastically scattered, or 'distorted,' waves and calculating nonelastic transitions between these distorted-wave states. (A more complete discussion can be found in my recent book.[1] It is interesting to note that this distorted-waves method was already well known to theorists working on *atomic* collisions more than two decades earlier.[2])

"This particular paper of mine described an attempt to provide a formulation of the distorted-waves theory which exhibited its basic structure in as transparent a way as possible. On the one hand, this structure consisted of a universal scheme for coupling the various angular momenta involved, one that was independent of the particular type of reaction being considered. On the other hand, it displayed the simple factorization of the integrand of the transition amplitude into one part that depended only upon the dynamics of the initial and final elastic scattering, and another part, the nuclear matrix element, that described the particular nonelastic event. This latter embodied the angular momentum and parity selection rules, as well as the other nuclear structure information which was expressed in terms of characteristic radial form factors and spectroscopic strengths.

"Although this was far from being the first paper to present a distorted-waves theory for direct nuclear reactions, I would like to think that it has been cited frequently because of the care I took in not making the formulation specific to one particular type of reaction. This feature was of especial importance in facilitating the construction of flexible computer programs which, through incorporation of a variety of options for the radial form factors, could be used for the calculation of different kinds of direct reactions. The wealth of experimental data becoming available in the late 1950s and early 1960s was creating a need for such programs. It was a fortunate coincidence that computing facilities adequate for these calculations became available just at the time that the need arose. The vigorous application of these techniques and the associated computer programs[3] at Oak Ridge led to my being awarded the T.W. Bonner Prize in Nuclear Physics of the American Physical Society in 1977. This work would not have been possible without the active support of many colleagues, especially R.H. Bassel and R.M. Drisko."

1. **Satchler G R.** *Direct nuclear reactions*. Oxford: Clarendon Press, 1983. 833 p.
2. **Mott N F & Massey H S W.** *The theory of atomic collisions*. Oxford: Clarendon Press, 1933. 293 p.
3. **Bassel R H, Drisko R M & Satchler G R.** *The distorted-wave theory of direct nuclear reactions*. Oak Ridge, TN: Oak Ridge National Laboratory, 1962. 95 p. ORNL-3240.