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Becchetti F D, Jr. & Greenlees G W. Nucleon-nucleus optical-model parameters, $A > 40$, $E < 50$ MeV. *Phys Rev* **182**:1190-209, 1969.
[School of Physics, University of Minnesota, Minneapolis, MN]

This paper presented a universal set of optical-model parameters that could be used to describe the scattering of nucleons (protons and neutrons) by nuclei These parameters were obtained by simultaneously fitting a large range of experimental data as a function of bombarding energy and target mass [The *SCI*® indicates that this paper has been cited in over 1,200 publications since 1969]

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In the late 1960s, I was a new physics graduate student at the University of Minnesota working under the supervision of George Greenlees. Although I was an experimentalist, Greenlees gave me a challenging quasi-theoretical master's thesis project.

Usually, proton-nucleus and neutron-nucleus elastic scattering are analyzed using the nuclear optical model. This model treats the nucleus as an optical medium with a complex index of refraction, the latter to account for absorption processes. The complex index of refraction, in turn, can be described by a complex interaction potential, viz., V(r) + iW(r) These potentials can be parameterized in terms of incident particle (proton or neutron, i.e., z), bombarding energy (E), and target nucleus (mass, A, shape, and charge, Z).

In 1963, F.G. Perey[1] at Oak Ridge had analyzed individually a large number of nucleon-nucleus scattering-data sets and found systematic dependencies on z, E, Z, and A.

Since the Perey analysis, much new data had been published Also, the University of Minnesota had just obtained a state-of-the-art CDC-1604 computer. Greenlees thought it would be feasible to analyze the available nucleon-nucleus data *simultaneously* as a function of z, E, Z, and A, using the new computer.

We originally thought that we could just modify some of the existing programs, but these ran too slowly and I therefore wrote a new, very fast optical-model program. Eventually, Gil Pyle (a research associate) and I became trained CDC-1604 computer operators and spent many nights running it together, mostly trying to prevent the card readers from eating our card decks. It was a sound and light show when the computer was running, and one soon knew which parts of a program were executing and if a search was converging just by the sound generated by the processor unit. Later, the university obtained a CDC-6600. Parameter searches then took only a few minutes, and the project began to converge rapidly. A consistent "best-fit" set of parameters emerged and I finished my MS thesis in 1968. Greenlees and I submitted a comprehensive paper on the analysis in late 1968.

The paper has been widely quoted because it provides a model that gives a good description over a wide range of bombarding energies and targets of one of the basic nuclear processes, viz., the elastic scattering of nucleons by nuclei. Much of our knowledge about nuclei (energy levels, moments, and so on) is obtained from analyses of nuclear reactions. Our "global" parameters allow one to derive this information in a systematic way, using nuclear reaction theories such as the Born approximation, and have become the de facto standard optical-model parameter set.

In addition, one can relate the parameters to the basic nucleon-nucleon interaction and nuclear-matter distributions (e.g., via the folding model). This was described in another classic paper[2] by Greenlees, Pyle, and Tang.

1 **Perey F G.** Optical-model analysis of proton elastic scattering in the range of 9 to 22 MeV *Phys Rev* **131** 745-63, 1963 [See also **Perey F G.** Citation Classic *Current Contents/Physical Chemical & Earth Sciences* **20**(27) 10, 7 July 1980]
2 **Greenlees G W, Pyle G J & Tang Y C** Nuclear-matter radii from a reformulated optical model *Phys Rev* **171** 1115-36, 1968 (Cited 340 times)

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