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This Week's Citation Classic

Kuo T T S & Brown G E. Structure of finite nuclei and the free nucleon-nucleon interaction: an application to ^{18}O and ^{18}F. *Nuclear Phys.* **85**:40-86, 1966. [Palmer Physical Laboratory, Princeton University, Princeton, NJ]

This is a nuclear physics paper concerned with the theory of nuclear structure. Evidence is given that many basic properties of atomic nuclei can be explained, with a fairly good accuracy, by quantum mechanics using an internucleon interaction deduced from low energy two-nucleon scattering experiments. [The *SCI*® indicates that this paper has been cited over 545 times since 1966.]

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"A goal of many nuclear physicists has been to formulate a microscopic nuclear structure theory where detailed nuclear properties like nuclear energy levels, decaying probabilities, shapes, and so forth, can be predicted starting from the dynamic interactions among the nucleons — protons and neutrons —which constitute the nucleus. Indeed, many nuclear physicists have worked very hard toward this in the past 10 or 20 years, including the authors of the above paper—G.E. Brown (now at Stony Brook) and myself. We have not succeeded in reaching this goal. Instead, our work is just a small beginning step in this direction. We owe a great deal to our colleagues and host institute for the completion of this work, and this I should like to particularly emphasize. We carried out this work around the years 1964 to 1966. Few would dispute that Princeton University is a rather stimulating place for physics. At that time, G.E. Brown, the senior author of this work, had just joined the Princeton faculty from Copenhagen. And with him came a group of then young and supposedly highly devoted postdoctoral fellows, myself being one of them. We were really having a very good time together, from playing tennis to doing physics. We also worked hard, of course. For example, we benefited a lot from discussions with Chun-Wa Wong, now at UCLA. These discussions generally took place in the quiet evenings, as Wong's working schedule, at that time, was routinely from 8 p.m. to 11 a.m., almost exactly twelve hours out of phase from mine.

"What are the uses of such a microscopic nuclear structure theory? Motion of celestial objects can be understood and predicted starting from the gravitational interactions acting among them. This has had far-reaching effects. Atomic structure can be understood in terms of the Coulomb interactions acting on the atomic electrons. This has paved the foundation for many things including television and computers. Thus if we have a fundamental nuclear structure theory with which we can not only understand known nuclear properties but also predict new nuclear properties, it can indeed be very useful. We are still quite far from this ambitious goal. The tangible contribution of the Kuo-Brown paper is probably in providing some evidences and hopes for such a theory. Using quantum mechanics and an internucleon interaction based on two-nucleon scattering experiments, we found that the calculated nuclear properties of nuclei ^{18}O and ^{18}F were in unexpectedly good agreement with experiments. It is probably the first major nuclear structure calculation where one does *not* treat the effective internucleon interactions as free parameters and adjust them so as to give good results. The application of this theory to many other nuclei yielded equally encouraging results.[1] Nevertheless, our approach is by no means free from defects. It employed a number of approximations. Unlike the Coulomb and gravitational interactions which are weak, the nucleon-nucleon interactions are strong and our knowledge about them and how to handle them in many-body theories is still rather preliminary. Much has been done since this paper, and much more remains to be done. Let us hope that physicists will keep on working in this direction and complete before long what we were not able to complete."

1. **Brown G E**. *Unified theory of nuclear models and forces.* New York: North-Holland, 1967. 259 p.