TIME-ODD FIELDS IN THE RELATIVISTIC MEAN FIELD THEORY*

A. V. Afanasjev and S. Frauendorf
University of Notre Dame, Notre Dame, IN 46556

The description of exotic nuclear systems and phenomena requires a detailed and thorough understanding of all components of effective forces. The role of the time-odd mean fields, their evidence in experiment, and an accurate description of these fields are subject of current interest. Recent studies [1,2] advanced the understanding of these fields in the self-consistent non-relativistic mean field approaches based on the Skyrme force. In the relativistic mean field (RMF) theory they are related to nuclear magnetism [3]: time-odd mean fields arise from the space-like parts of the vector mesons and Lorentz invariance requires that their coupling strength is identical to that of the time-like parts. This is is an advantage as compared to non-relativistic theories where the components of the effective interaction generating the time-odd fields are not related to the well known time-even fields.

A number of studies of the effects of time-odd mean fields on the rotational properties of nuclei have been performed in the RMF theory [4,5,6]. These fields modify the moments of inertia, effective alignments, alignment gains at the band crossings and other physical observables in rotating nuclei. Our contribution reviews these results, and extends them to the nuclei at (or near) the proton- and neutron-drip lines. In particular, the question whether the time-odd mean fields are related to the isoscalar proton-neutron pairing [7] is studied. The time-odd mean fields also reveal themselves in non-rotating odd and odd-odd nuclei (broken time-reversal symmetry). Their impact on the binding energies [8], odd-even mass differences, the structure of such nuclei along the neutron- and proton-drip lines is discussed. Magnetic properties of deformed nuclei and the impact of time-odd mean fields on such properties, the study of which is in progress, will be covered.

Whenever it is possible the results of the RMF studies will be compared with the ones obtained in the Hartree+Fock+(Bogoliubov) approaches based on the Skyrme interaction. Similarities and differences between these approaches will be outlined.

* This work was supported in part by U.S. Department of Energy, Grant No. DE-FG02-95ER40934.

[1] M. Bender, J. Dobaczewski, J. Engel, W. Nazarewicz, Phys. Rev. C 65, 054322 (2002).
[2] T. Duguet, P. Bonche, P.-H. Heenen, and J. Meyer, Phys. Rev. C 65, 014311 (2002).
[3] W. Koepf and P. Ring, Nucl. Phys. A511, 279 (1990).
[4] A. V. Afanasjev and P. Ring, Phys. Rev. C62, 031302(R) (2000).
[5] A. V. Afanasjev, P. Ring and I. Ragnarsson, *Proc. Int. Workshop PINGST2000 "Selected topics on $N = Z$ nuclei"*, Lund, Sweden, 2000, p. 183.
[6] A. V. Afanasjev, S. G. Frauendorf and P. Ring, *Proc. of the NATO Advanced Research Workshop on "The Nuclear Many-Body Problem 2001"*, Brijuni, Croatia, 2001, NATO Science Series II - Mathematics, Physics and Chemistry (Kluwer Academic Publishers) v. 53 (2002) p. 103.
[7] J. Dobaczewski, J. Dudek, and R. Wyss, Phys. Rev. 67 (2003) 034308.
[8] A. V. Afanasjev, T. L. Khoo, S. Frauendorf, G. A. Lalazissis, and I. Ahmad, Phys. Rev. C 67, 024309 (2003).