# MIRROR AND TRIPLET ENERGY DIFFERENCES WITHIN DENSITY FUNCTIONAL THEORY

**Paweł Bączyk**
**Institute of Theoretical Physics, Faculty of Physics, University of Warsaw, Warsaw, Poland**

P. Bączyk[1], J. Dobaczewski[1,2,3,4], M. Konieczka[1], T. Nakatsukasa[5,6], K. Sato[7], W. Satuła[1,2],

1 Institute of Theoretical Physics, Faculty of Physics, University of Warsaw, ul. Pasteura 5, PL-02-093 Warsaw, Poland
2 Helsinki Institute of Physics, P.O. Box 64, FI-00014 University of Helsinki, Finland
3 Department of Physics, University of York, Heslington, York YO10 5DD, United Kingdom
4 Department of Physics, P.O. Box 35 (YFL), University of Jyväskylä, FI-40014 Jyväskylä, Finland
5 Center for Computational Sciences, University of Tsukuba, Tsukuba 305-8577, Japan
6 RIKEN Nishina Center, Wako 351-0198, Japan
7 Department of Physics, Osaka City University, Osaka 558-8585, Japan

Isospin symmetry in atomic nuclei is violated predominantly by the Coulomb force. However, there is clear experimental evidence that the strong interaction is also different for the pp, nn, and np pairs, thus breaking both the charge independence (CI) and charge symmetry (CS). Besides the scattering experiments, the isospin-symmetry-breaking (ISB) interactions can be tested by studying properties and structure of nuclei in isobaric multiplets. Since the first work of Nolen and Schiffer [1], the need to include ISB strong forces in theoretical description of nuclei was also concluded by *ab initio* approaches [2] and Shell Model (SM) calculations [3]. Here we use Density Functional Theory (DFT) to describe differences in binding energies, Mirror Displacement Energies (MDE) and Triplet Displacement Energies (TDE), and differences in energies of excited levels, Mirror Energy Differences (MED) and Triplet Energy Differences (TED).

In our recent works [4,5] we successfully derived, implemented, and fitted new isospin-symmetry-breaking terms within the Skyrme DFT approach. With only two parameters, we reproduced the experimental values and staggering patterns of MDEs and TDEs for nuclei within the wide range of masses $A = 10$ - 75.

In this contribution we briefly summarize the results on MDE and TDE to give a feeling how well our approach can describe the ISB effects reflected in binding energies. The main part of the presentation relates to our latest results on MED and TED of the rotational bands in isospin doublets and triplets in the $f_{7/2}$ shell. We compare our predictions with the experimental data and the latest SM calculations [3]. We discuss effects induced by the ISB strong interactions and pairing correlations.

REFERENCES

[1] J.A. Nolen, Jr., and J.P. Shiffer, Annu. Rev. Nucl. Phys. **19**, 471 (1969).
[2] R.B. Wiringa, S. Pastore, S.C. Pieper, and G.A. Miller, Phys. Rev. C 88, 044333 (2013).
[3] M. A. Bentley, S. M. Lenzi, S.A. Simpson, and C. Aa. Diget, *Phys. Rev. C* **92**, 024310 (2015).
[4] P. Bączyk, J. Dobaczewski, M. Konieczka, W. Satuła, *Acta Phys. Pol. Proc. Suppl.* **8**, 540 (2015).
[5] P. Bączyk, K. Sato, J. Dobaczewski, M. Konieczka, T. Nakatsukasa, W. Satuła, in preparation.
[6] W. Satuła, P. Bączyk, J. Dobaczewski, M. Konieczka, arXiv:1601.03593 [nucl-th].