Exotic modes of excitation and weak interaction rates at finite temperature *

N. Paar[1], T. Marketin[1], D. Vretenar[1], Y. F. Niu[2], J. Meng[2,3], G. Colò[4], E. Khan[5]
[1] Physics Department, Faculty of Science, University of Zagreb, Croatia
[2] State Key Laboratory for Nuclear Physics and Technology, School of Physics, Peking University, Beijing 100871, People's Republic of China
[3] School of Physics and Nuclear Energy Engineering, Beihang University, Beijing 100191, People's Republic of China
[4] Dipartimento di Fisica dell'Università degli Studi and INFN, Sezione di Milano, via Celoria 16, 20133 Milano, Italy
[5]Institut de Physique Nucléaire, IN_2P_3-CNRS/Université Paris-Sud, 91406 Orsay, France

The interplay of isospin asymmetry and finite temperature in nuclei plays an important role in their exotic structure properties and nuclear weak interaction rates in stellar environment[1]. Recently a fully self-consistent microscopic framework, based on Skyrme energy density functionals, has been introduced for description of exotic excitations and weak-interaction rates at finite temperature [2]. The single-nucleon basis and the corresponding thermal occupation factors of the initial nuclear state are determined in the finite-temperature Hartree-Fock model, and charge-exchange transitions to excited states are obtained using the finite-temperature random phase approximation. On the other side, self-consistent framework involving nuclei at finite temperature has also been developed within relativistic mean field theory using effective Lagrangians with density dependent meson-nucleon vertex functions. Nuclear excitations are studied using finite temperature random phase approximation[2,3] for the range of temperatures T=0-2 MeV, as well as in nuclei far from stability. In the focus of research are the structure properties of exotic modes of excitation (e.g. pygmy dipole resonances) and charge-exchange modes (e.g. Gamow-Teller resonances and forbidden transitions). It is shown that finite temperature effects include novel low-energy multipole excitations and modifications of the Gamow-Teller transition spectra[2-4]. Using a representative set of Skyrme functionals, as well as covariant energy density functional with DD-ME2 parameterization, both theory frameworks have been applied in calculations of electron-capture cross sections and respective rates relevant in the stage of supernova precollapse. Recent self-consistent studies of weak interaction in nuclei also include description of neutrino-nucleus cross sections[5] and muon capture rates[6].

*This work was supported by UKF Grant No. 17/08, MZOS project No. 1191005-1010, Croatian National Foundation for Science, NSFC under Grant Nos. 10775004, 10875157, and 10975008, the Major State 973 Program 2007CB815000 of China.

[1] N. Paar, J. Phys. G: Nucl. Part. Phys. **37**, 064014 (2010).
[2] N. Paar, G. Colò, E. Khan, and D. Vretenar, Phys. Rev. **C 80**, 055801 (2009).
[3] Y. F. Niu, N. Paar, D. Vretenar, and J. Meng, Phys. Lett. **B 681**, 315 (2009).
[4] N. Paar, Y. F. Niu, D. Vretenar, and J. Meng, Phys. Rev. Lett. **103**, 032502 (2009).
[5] N. Paar, D. Vretenar, T. Marketin, and P. Ring, Phys. Rev. **C 77**, 024608 (2008).
[6] T. Marketin, N. Paar, T. Niksic, and D. Vretenar, Phys. Rev. **C 79**, 054323 (2009).