Microscopic nature of 0^+ states populated in large abundance in deformed nuclei

N. Lo Iudice[1], A. V. Sushkov[2], N. Yu. Shirikova[2]
[1] Dipartimento di Scienze Fisiche, Università di Napoli Federico II,
and Istituto Nazionale di Fisica Nucleare,
Complesso Universitario di Monte S. Angelo, Via Cintia, I-80126 Napoli, Italy.
[2] Bogoliubov Laboratory of Theoretical Physics, Joint Institute for Nuclear Research, 141980 Dubna, Russia.

We have adopted the microscopic quasiparticle-phonon model to carry out a systematic study of the low-lying excited 0^+ states populated in large abundance in several deformed nuclei by high-resolution (p,t) transfer reaction experiments performed at the Tandem accelerator of the Meyer Leibnitz Laboratory of the University and Technical University in Munich [1-4].

We have computed energy levels, E0 and E2 transition probabilities, and two-nucleon transfer spectroscopic factors and compare all these quantities with the experimental data. This comparative analysis, complemented with a detailed investigation of the phonon content and shell structure of the wave functions, has enabled us to get a deep insight into the nature of these 0^+ states and to single the properties shared by all nuclei from the ones induced by the peculiar shell structure of each system.

The calculation fully accounts for the observed large abundance of the 0^+ excitations. Moreover, it shows that most of the observed 0^+ excitations, at energies below 3 MeV, correspond to one-phonon states built out of pairing correlated two-quasiparticle components. These pairwise configurations, however, add coherently only in one state. Only this 0^+ is pairing collective and is strongly populated in (p,t) two-nucleon transfer reactions, in agreement with the experimental data.

The energy distribution and magnitude of the two-nucleon transfer strength collected by these low-lying 0^+ is affected considerably, especially in some nucleus, by the coupling with the two-phonon configurations. These represent the main ingredients of the high-energy 0^+ states (above 3 MeV). Because of their multiphonon nature, these high-energy states are populated at a very low rate in the (p,t) reactions, consistently with experiments.

[1] S. R. Lesher *et al.*, Phys. Rev. C **66**, 051305(R) (2002).

[2] H.-F. Wirth *et al.*, Phys. Rev. C **69**, 044310 (2004).

[3] D. Bucurescu *et al*, Phys. Rev. C **73**, 064309 (2006).

[4] D. A. Meyer *et al.*, Phys. Rev. C **74**, 044309 (2006).