Fast timing studies in the Mg island of inversion

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Nuclei in the island of inversion around N=20 have recently been subject of experimental and theoretical studies in an attempt to understand the disappearance of the neutron shell closure and the dominance of intruder configurations [1,2,3]. The Mg isotopes are at the border of the island of inversion, and ^{30}Mg and ^{31}Mg in particular are expected to show the coexistence of the spherical sd and intruder pf configurations [4]. In spite of the experimental efforts to tackle these exotic nuclei, the identification of the excited states as members of either configuration has not been yet fully achieved.

In several recent experiment performed at ISOLDE-CERN we have used the Advanced Time Delayed $\beta\gamma\gamma(t)$ Method [5] to study ^{30,31,32}Mg populated in the beta decay of ^{30,31,32}Na. This study is part of an extensive experimental program at ISOLDE aimed at the investigation of the structure of exotic Mg nuclei, which also includes Coulex measurements at REX-ISOLDE [6] and hyperfine interaction studies [7]. The data analysis of our fast timing experiment has yielded several important results. New states have been identified in ^{30}Mg and ^{31}Mg and several level lifetimes have been measured for the first time in these nuclei.

In the light of the new data the characterization of the excited states in ^{31}Mg and the identification of a candidate for the intruder 0^+ state in ^{30}Mg will be discussed. Concerning ^{32}Mg, there exist strong indications of the vanishing of the N=20 shell closure and the domination of the intruder configurations. The measurement of the $(E2; 0^+_{g.s} \rightarrow 2^+_1)$ provides key information on the collectivity of the E2 transition. The ATD $\beta\gamma\gamma(t)$(t) method offers an independent way to determine this transition probability by the measurement of the half-life of the first excited 2^+ state. The B(E2) rate found in our experiment will be discussed in comparison with the values obtained in studies using Coulomb excitations at intermediate energies.

[1] E. Caurier et al., Nucl. Phys. A693 (2001) 374.
[2] T. Otsuka et al., EPJA 15 (2002) 151.
[3] R. Rodriguez-Guzman et al., NPA 709 (2002) 201.
[4] G. Klotz et al., Phys. Rev. C47 (1993) 2502.
[5] H. Mach et al., Nucl. Phys. A523 (1991) 197, and references therein.
[6] O. Niedermaier, Phys. Rev. Lett. 94 (2005) 172501.
[7] G. Neyens, M. Kowalska et al., Phys. Rev. Lett. 94 (2005) 022501.

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