Collectivity studies in fully aligned Isomeric states

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The information coming from Coulomb excitation experiments has been fundamental in the development of the nuclear collective model through the accurate measurements of electromagnetic transition probabilities. The investigation of electromagnetic transition matrix elements between nuclear states by this technique has proved to be more useful than any other method based on life time measurements. These studies have been limited for long time to ground state transitions or bands populated by multiple excitation.

The Fragment Separator coupled with the Rising γ-array offers an unique opportunity to study not only transition probabilities in the vicinity of the ground state of exotic nuclei, but also the Coulomb excitation of isomeric beams.

Of particular interest are the isomers corresponding to the maximum aligned state for a given configuration. From a simple point of view states with the maximum alignment should present a reduction of the collectivity since the valence nucleons are fully aligned to generate angular momentum inside the shell. This seems to be the case for many configuration terminating states in nuclei with a reduced number of valence nucleons in the shell. For many isomeric states the statement is less clear and, in fact the relatively high collectivity of the state can be, to large extent, responsible for the presence of the isomer. This is the case of the 12^+ isomer in ^{52}Fe where the collectivity is mantained to the maximum alignment [1].

We propose to use the capability of the GSI Rising setup to study the collective components of the isomer wave functions through the absolute Coulomb excitation cross section. Moreover, spectroscopic studies above the high spin isomeric traps are very difficult. The use of this technique will allowed to identify the presence of collective bands and states connected by electromagnetic transitions with the isomer.

The technique will require delayed coincidences with the decay of the isomer in case of fast decay (see Zs. Podolyák contribution) or the determination of the isomer ratio by radioactivity measurements in case of long lifetimes.

Example case

Coulomb excitation of the 12^+ yrast trap in ^{52}Fe. Large Scale shell model calculations predict that the 46s 12^+ isomer in ^{52}Fe has a substantial degree of collectivity, not present in its cross conjugate ^{44}Ti, which is the cause of the isomer. In Fig.1 the level scheme of the two cross conjugate nuclei ^{44}Ti and ^{52}Fe are shown, Fig. 2 shows that the contribution from the $p_{3/2}$ orbit is not vanishing in the 12+ isomer, in contrast with other N=Z rotors in the $f_{7/2}$ shell.
Rotational bands based on particle-hole excitations inside the *fp*-shell or on the excitation of particles into the intruder orbital $1g_{9/2}$, already identified in the doubly magic nucleus ^{56}Ni [2], are expected above the 12^+ isomer in the nucleus ^{52}Fe.

References

[1] C. A. Ur *et al.*, Phys. Rev. C **58**, 3163 (1998).

[2] D. Rudolph *et al.*, Phys. Rev. Lett. **82**, 3763 (1999).

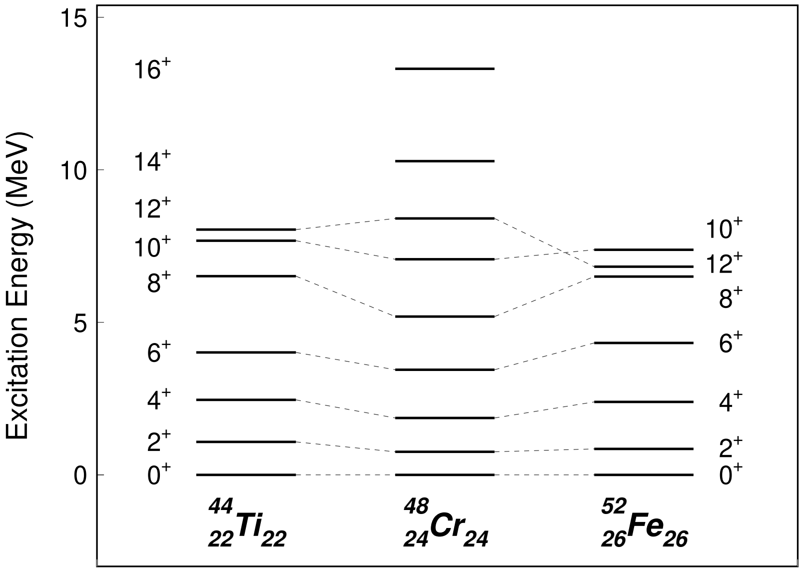

Figure 1: *Spectra of the cross conjugated nuclei* ^{44}*Ti and* ^{52}*Fe. The self-conjugated* ^{48}*Cr has also been added to the figure (from reference [1]).*

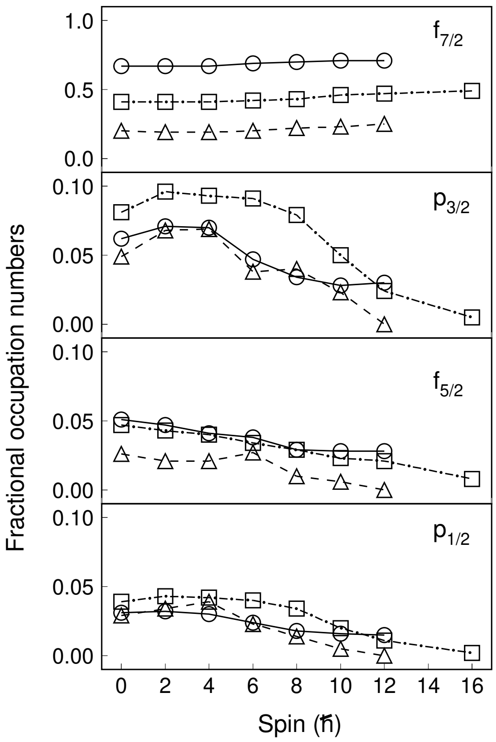

Figure 2: *Calculated LSSM fractional occupancies for ^{44}Ti (△) ^{48}Cr (□) and ^{52}Fe (○) (from reference [1]).*