Physics Letters B 710 (2012) 587–593

Contents lists available at SciVerse ScienceDirect

Physics Letters B

www.elsevier.com/locate/physletb

Emergence of principal axis rotation in ^{110}Ag

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ARTICLE INFO

Article history:
Received 28 November 2011
Received in revised form 15 March 2012
Accepted 15 March 2012
Available online 16 March 2012
Editor: D.F. Geesaman

ABSTRACT

The negative-parity yrast band of ^{110}Ag has been extended significantly and the lifetimes of the high spin levels of this band have been measured. The experimentally observed level scheme and measured electromagnetic transition rates have been compared with the theoretical predictions of a model with two quasiparticles coupled to a triaxially deformed core. This calculation successfully reproduces the energy spectra and electromagnetic transition rates beyond $I^\pi = 12^-\hbar$. These observations indicate that the principal axis of rotation is responsible for the generation of high angular momentum states along the yrast cascade in ^{110}Ag. In all the other lighter isotopes, these states are generated through titled axis rotation. Thus, ^{110}Ag is the first nucleus where the boundary between tilted and principal axis rotation could be established.

In the last two decades, a large number of bands arising from Tilted Axis Rotation (TAR) [1,2] have been identified [3–14] in the $A \sim 200$, 140, 110 and 80 regions of the periodic table. In this mode of excitation, the angular momenta of the valence nucleons are along the rotational axis (low Ω orbitals) and the symmetry axis (high Ω orbitals) only and the contribution of the rotational angular momentum is small (low to moderate deformation). In this situation, the total angular momentum becomes tilted with respect to the rotational axis. Thus, the π-rotational symmetry is broken and the signature is no longer a good quantum number. So, the staggering in the magnetic transition rates ($B(\mathrm{M1})$), observed in cases of Principal Axis Rotation (PAR), are absent in TAR. In this case, the $B(\mathrm{M1})$ transition rates show a decrease with increasing angular momentum.

Among the different mass regions, $A \sim 110$ has a unique feature that the neutrons are in the low-Ω shape driving orbitals while in all other mass regions the protons occupy these orbitals. Thus, it is possible to gradually increase the deformation in the $A \sim 110$ region by increasing the number of neutrons in the low-Ω orbitals of $h_{11/2}$ parentage. This opens up the possibility to study the competition between PAR and TAR in the heavier isotopes of a nucleus of this mass region through the measurements of level lifetimes.

Such a systematic study has been initiated for the yrast bands of the Ag isotopes [11,15]. The detailed measurement of level lifetimes along the yrast band of ^{109}Ag has established that the high spin levels, after the neutron alignment, originate due to TAR [15]. The similarities of the high spin level structure ($2I \geqslant 25\hbar$) and the observed $B(\mathrm{M1})/B(\mathrm{E2})$ rates in the yrast bands of ^{105,107}Ag with that of ^{109}Ag, indicate a common origin for these states. In odd–odd Ag isotopes, no signature staggering has been reported in the yrast bands till ^{108}Ag and the lifetime measurements of the high spin states ($2I \geqslant 26\hbar$) in ^{104}Ag exhibit a smooth fall in $B(\mathrm{M1})$ rates with increasing angular momentum [11]. Thus, the existing systematics tend to indicate that the high spin yrast levels ($2I \geqslant 25\hbar$) of Ag isotopes till ^{109}Ag, originate due to TAR. The quadrupole deformation (β_2) in these isotopes increases from $\beta_2 \sim 0.13$ in ^{104}Ag to $\beta_2 \sim 0.17$ in ^{109}Ag as deduced from the observed transition rates [11,15]. It is, therefore, interesting to explore the competition between PAR and TAR in ^{110}Ag, for which $\beta_2 \sim 0.2$ has been predicted by a Total Routhian Surface (TRS) calculation.

In the previous study, ^{110}Ag was investigated by M.-G. Porquet et al. [16] through fission induced spectroscopy. The level scheme

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0370-2693/$ – see front matter
http://dx.doi.org/10.1016/j.physletb.2012.03.035