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Short note

Yrare bands of ^{121}Xe

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Abstract. High-spin states in ^{121}Xe have been studied via the ^{109}Ag (16O, p3n) ^{121}Xe reaction at a beam energy of 80 MeV. Several rotational bands based on one- and three-quasiparticle excitations have been established. Among them, an unfavoured yrare rotational band with unfavoured signature has been newly identified.

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In some even-even xenon and barium nuclei, low-lying γ-vibrational bands have been observed that show a pronounced energy staggering between odd and even spin states. This has been interpreted in terms of a gamma-soft nuclear potential in their low-lying states. In the odd-A Xe isotopes, the unique-negative parity $h_{11/2}$ neutron orbital forms the yrast rotational band. Since the positive parity neutron orbitals, such as $d_{3/2}$, $d_{5/2}$, and $g_{7/2}$ lie near Fermi surface, a series of positive parity rotational bands based on these configurations have also been observed. Thus their lowest bands are based on one-quasiparticle excitation, which can be described by cranking calculations. Features of the odd-A Xe isotopes have also been described in terms of the rigid triaxial plus particle (RTRP) model where an odd particle in a deformed single particle orbital is coupled to a rigid triaxial core [1-3], although alternative descriptions are provided by boson models [4, 5]. In the RTRP model the nuclear shape is characterized by constant values of the deformation parameters β and γ. Calculations of triaxial deformation in the odd-A Xe and Ba nuclei have been quite successful by using this model [2, 3] and the properties of the negative yrare states in ^{125}Xe have been nicely described [1]. With these features in mind, although high-spin states in ^{121}Xe have been studied previously in heavy-ion induced reactions [6–8], we tried to investigate excited states of ^{121}Xe and report on the new observation of the yrare states in this nucleus.

Excited states of ^{121}Xe were populated with the ^{109}Ag (^{16}O, p3n) ^{121}Xe reaction at a beam energy of 80 MeV. The beam was provided by the 12UD tandem accelerator at the University of Tsukuba. The target was a self-supporting foil of ^{109}Ag 4 mg/cm^2 with the Pb backing 5 mg/cm^2 in thickness. The γ-ray spectra were taken with 7 high-purity (HP) Ge detectors with BGO anti-Compton shields. Data were written onto 8-mm tapes (EXABYTE) for events in which two or more HP Ge detectors registered in prompt coincidence. Approximately 98 million events were collected. The level scheme of ^{121}Xe deduced from the present work is shown in Fig. 1.

Band 1 was already identified in the earlier work [8] and confirmed in the present work. In [8], however, an 849 keV transition feeding the $23/2^-$ state in band 1 was observed, but was not found in the present experiment. Instead an 854 keV transition was observed. Band 2 that turned out to be a signature partner of band 1 was newly identified in the present work. This band consists of stretched E2 cascades decaying to the yrast band 3 via several M1/E2 transitions. Bands 1 and 2 are called as the yrare states with favoured and unfavoured signatures, respectively. We could establish the spins up to $27/2^-$ in band 1 and $29/2^-$ states in band 2, respectively. Observation of such high-spin states in yrare bands in the odd-A Xe isotopes are rare although similar bands were observed in heavier isotopes of ^{125}Xe [9] and very recently ^{123}Xe [10]. In contrast to the behaviour of the yrast states in which the favoured signature states should be energetically favoured, i.e., signature splitting is positive, the yrare favoured states as labelled 1 are seen to be energetically unfavoured. This signature inversion in the yrare states, as shown in Fig. 2, seems to be quite general in the odd-A Xe isotopes. Such signature inversion in the yrare bands of ^{125}Xe has been interpreted as being caused by the large contribution from the core γ–band [1]. According to [1], the components from the odd spin member of the γ–band are strong in the unfavoured yrare states, while in the

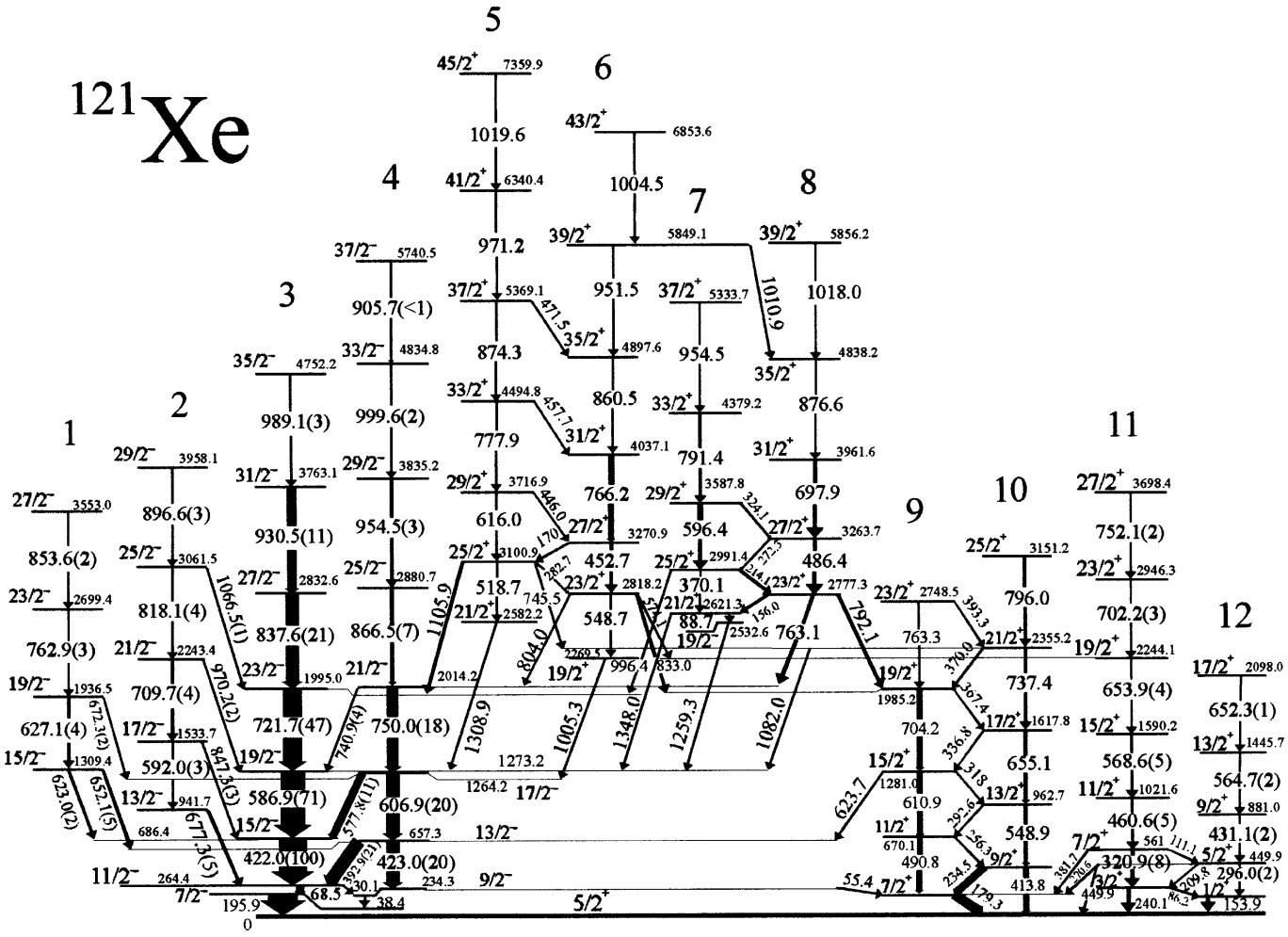

Fig. 1. Level scheme of ^{121}Xe deduced from the present experiment. Transition and excitation energies are given in keV. A number in parenthesis of transition energy is the relative intensity to the 422 transition

favoured yrare states the contribution of the even spin γ–band is large only at low spin and practically disappears at high spin. Instead, the ground-band contribution to the favoured yrare states increases steadily with angular momentum. Consequently, the signature inversion observed in ^{125}Xe can be attributed to the different contribution of the γ–band to a neutron in the $h_{11/2}$ orbital.

To date, however, have any useful experimental data for showing clearly favoured and unfavoured yrare states up to high spins in ^{125}Xe not appeared. So it will be of interest to compare the present experimental results for the yrare bands in ^{121}Xe and also the yrare bands in ^{123}Xe [10] with the RTRP model calculations.

Band 3, favoured yrast states, built on the $11/2^-$ state and its signature partner band 4, unfavoured yrast states, were already known in the previous works [6–8]. These yrast states are characterized by the near degeneracy of the favoured and unfavoured states, namely the large signature splitting, in the odd-A Xe isotopes as shown in Fig. 2.

Band 11 built on the $3/2^+$ state could be more extended up to higher spins than those obtained in the previous works. It shows a typical decoupled band that transition energies are close those in the ground band of neighboring ^{122}Xe and ^{120}Xe isotopes. In addition, we found a new decoupled band corresponding to its signature partner, which is band 12. They exhibit a strong signature splitting contrary to bands 9 and 10.

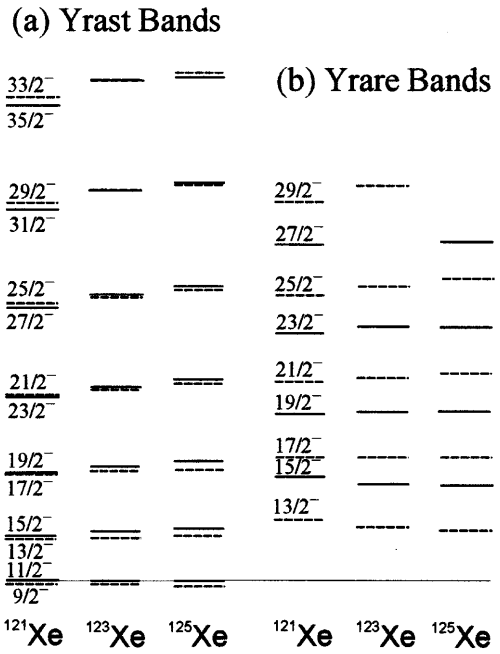

Fig. 2. Systematic of the yrast bands (a) and the yrare bands (b) of negative parity observed in ^{121}Xe, ^{123}Xe [10], and ^{125}Xe [9] nuclei. In (b), favoured and unfavoured states of ^{123}Xe correspond to those labelled as H1 and F in [10], respectively. The $15/2^-$ state in the favoured yrare band of ^{125}Xe corresponds to the 1310 keV state labelled as G and the other favoured states those labelled as H2 in [9]. It is noted that, however, the spin-parity assignments of the states H2 in [9] have not been clear. Unfavoured states in ^{125}Xe correspond to those labelled as H1 in [9]

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