Triaxial shape in ^{129}Ce*

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Abstract The high spin states of ^{129}Ce have been populated via heavy-ion fusion evaporation reaction ^{96}Mo (^{37}Cl, 1p3n) ^{129}Ce. The comparison between the signature- and B(M1)-staggering defined by Hagemann and Hamamoto have been showed in the negative-parity band of ^{129}Ce. The lifetimes and quadrupole moments Q_t of the high spin states of ^{129}Ce have been extracted from the line shape analyses using Doppler shift attenuation method (DSAM). The deformation parameters extracted through the solution of equations for quadrupole transition moments Q_t and collective moments of inertia J_{RR} .

Key words triaxiality, lifetime measurement, signature splitting

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1 Introduction

In recent years there has been of great interest in the signature splitting and inversion. For this behavior, there are several explanations but no common understanding. The signature splittings in ^{129}Ce are previously discussed in terms of the cranked shell model and interpreted successfully using the triaxial-rotor-plus- particle model, i.e. the signature splitting in the one-quasi -neutron bands of ^{129}Ce arises from the effects of triaxiality[1]. The purpose of present thesis work is to measure the lifetimes of the high spin states in ^{129}Ce and deduce the quadrupole moments Q_t, so that provide experimental evidence of γ-deformation for the signature splitting.

2 Experiment

The experiment was carried out at the HI-13 tandem accelerator in the China Institute of Atomic Energy. The excited states in ^{129}Ce have been populated via heavy-ion fusion evaporation reaction ^{96}Mo(^{37}Cl, 1p3n)^{129}Ce at a beam energy of approximately 155 MeV. The target ^{96}Mo was a thickness 1.0mg/cm^2 ^{96}Mo foil, evaporated on a 19mg/cm^2 Pb backing. An array of fourteen High-Pure Germanium detectors with BGO anti-Compton suppressor was used to record γ-γ coincidence data. Under this condition, a total of about 246 million two- or higher-fold γ-γ coincidence events were recorded. The lifetimes and quadrupole moments Q_t of the high spin states of ^{129}Ce have been extracted from the line shape analyses using Doppler shift attenuation method (DSAM).

3 Data and results

The lifetimes and quadrupole moments Q_t have been extracted from the lineshape analyses using

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DSAM. Fig. 1 shows fitted line shapes for the 579 keV and 739 keV transitions in ^{129}Ce. Both display the backward angle spectra. The solid line display the total fitted line shape.

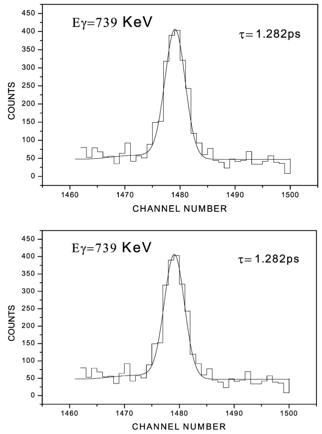

Fig. 1. Fitted line shapes for the 579 keV and 739 keV transitions in ^{129}Ce.

At very high spin and for member states of a rotational band the quadrupole transition moments depend only on the deformation parameters β and γ as[2]

$$Q_{\mathrm{t}}=3\sqrt{\frac{1}{5\pi}}\ Ze\ R_0^2\ \beta\ \cos\ (30^{\circ}+\gamma)/\cos\ 30^{\circ},$$

with the nuclear charge Z and the mean nuclear radius R_0,which is assumed to have a mass dependence of $R_0=1.2A^{1/3}$. Deformation should also be reflected in a variation of the collective moments of inertia, which depend on the quadrupole deformation parameters β and γ as[2]

$$J_{\mathrm{RR}}=\frac{2}{5}\ M\ R_0^2\left(1+\sqrt{\frac{4}{5\pi}}\ \beta\ \sin(30^{\circ}+\gamma)\right).$$

Where, M stands for the mass of the nucleus, and J_{RR} rigid-rotor moments of inertia the momentum of inertia of the system. The deformation of the negative band of ^{129}Ce was extracted from the Q_{t} and J_{RR}. It is concluded that the γ deformation is about 0 degree and β is 0.27 after the back bending with J_{RR}= 51.02 MeV$^{-1}\hbar^2$ and Q_{t}=4.13eb (show as the Fig. 2).

On the other side, The comparison between the signature- and B(M1)- staggering defined by Hagemann and Hamamoto indicates that the γ deformation became to zero from negative value with increases of spin in the negative-parity band of ^{129}Ce. The relations of them are shown in Figs. 3 and 4.

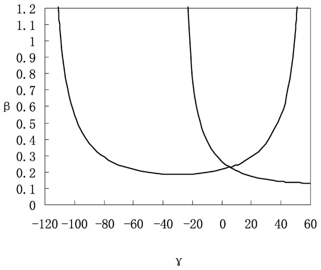

Fig. 2. The deformation of the negative band of ^{129}Ce.

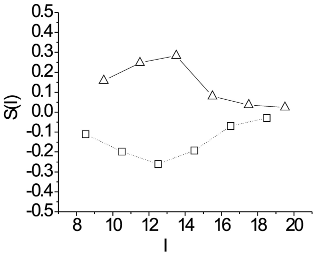

Fig. 3. Signature splitting in $\nu_{7/2^-}$[523] band. And, $\alpha=-1/2$; $\alpha=+1/2 S(I)=E(I)-E(I-1)-[E(I+1)-E(I)+E(1)-E(I-2)]/2$.

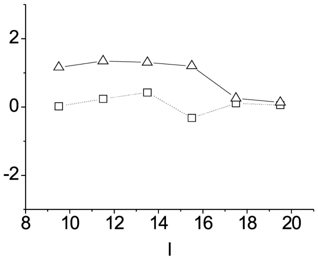

Fig. 4. The comparison between the signature- and B(M1)-staggering defined by Hagemann and Hamamoto. And □: $\frac{\Delta B(M1;I\rightarrow I-1)}{<B(M1;I\rightarrow I-1)>}$; △: $\frac{4(\Delta e'/\hbar\omega)}{1+(\Delta e'/\hbar\omega)^2}$.

The two figures show that while the signature splitting are decreasing closed to zero, its energy splitting($\Delta e'$) are gradually equal to the signature splitting. The γ deformation became to zero from negative determined on the method given by Hagemann and Hamamoto[3]. We propose that the signature splitting in $\nu_{7/2^-}$[523] rotational band of ^{129}Ce arises from the γ deformation.

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