Study of the high spin states in stable nucleus ^{84}Sr

KANG XuZhong & SHEN ShuiFa

Key Laboratory of Nuclear Resources and Environment, East China Institute of Technology, Nanchang 330013, China

The School of Nuclear Engineering and Technology at the East China Institute of Technology cooperated with the China Institute of Atomic Energy to investigate the high spin states of ^{84}Sr . The study is reported in Volume 53 (October, 2010) of the *SCIENCE CHINA Physics, Mechanics & Astronomy* because of its significant research value.

Nuclei with $Z \approx 40$ and $N \approx 45$ lie in a transitional region between deformed nuclei and spherical nuclei. There are collective bands in some isotopes of nuclei of such elements as Sr, Zr and Mo, where the structures have single-particle features. ^{84}Sr , which has four neutron holes lying in the $1g_{9/2}$, $2p_{1/2}$, and $1f_{5/2}$ subshells, displays both collective and quasiparticle excitations, and thus, its structure is complex. However, there has been little research on the high spin states in the stable nucleus ^{84}Sr over the past 10 years.

In this work, the high spin states of ^{84}Sr were populated through the reaction $^{70}\text{Zn}(^{18}\text{O}, 4n)^{84}\text{Sr}$ at a projectile energy of 75 MeV. The ^{18}O beam was provided by the HI-13 Tandem Accelerator at the China Institute of Atomic Energy. The excitation function, γ - γ coincidences, directional correlation from oriented state ratios and γ -transition intensities were measured using eight anticompton HPGe detectors and one planar HPGe detector. From the measurement results, a new energy-level scheme of ^{84}Sr was established in which 12 new states and nearly 30 new γ -transitions were identified.

The positive-parity states of the energy-level scheme were calculated in the framework of the projected shell model. The calculation results roughly agree with the experimental data. Owing to the use of the simple Bardeen-Cooper-Schrieffer vacuum, which only has the properties of the ground-state rotational band and not those of collective vibrations, the calculated levels are higher than the experimental values. The negative-parity states were extended to an energy of 10487 keV ($I^\pi=19^-$). The states exhibited a very good collective vibration-like nature when the spins and parities of states are above 11^- . In addition, we found that above the 14^- state, the γ -transition energies show signature staggering. The negative-parity band levels are in good agreement with deformed configuration-mixing shell model calculations.

One journal reviewer said: "This is a systematic work in which new levels and γ -transitions were obtained through a nuclear structure experiment. The positive-parity bands were calculated using the projected shell model and compared with experimental data. The properties of ^{84}Sr were discussed. This paper is valuable to nuclear structure research."

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