Study of the ^{131}Ba and ^{133}BaNuclei by One-Neutron Transfer Reactions

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The Barium isotopes around mass number 132 are interesting for their transitional character. By analogy with the Platinum isotopes, it was proposed that nuclei in this region are γ-soft nuclei, therefore described in the frame of the interacting boson model (IBM) as close to the dynamical symmetry O(6) [1]. Otherwise, the ^{134}Ba nucleus is a good candidate for the E(5) symmetry, therefore being close to the critical point of the transition between vibrational (U(5)) nuclei, and γ-unstable (O(6)) nuclei [2]. It is little studied how these specific symmetries reflect themselves in the odd-mass Ba isotopes from the same region. Thus, in principle, due to the vicinity of the "E(5)" nucleus ^{134}Ba, and the available neutron orbitals, one may meet characteristics of a supersymmetric coupling scheme, such as E(5/4) [3], or E(5/12) [4]. The possibility of an E(5/4) scheme has been so far investigated in ^{135}Ba [5], while an investigation of ^{130}Ba via the (p,t) reaction revealed its closeness to the O(6) symmetry [6].

In this work we present studies of the odd-mass isotopes ^{131}Ba and ^{133}Ba by direct one-neutron transfer reactions, aiming at a better characterization of both the quantum numbers and microscopic structure of the low-lying states in these nuclei.

The experiments were performed with a 24 MeV polarized deuterium beam delivered by the Munich MP Tandem and the Stern-Gerlach polarized ion source. We used a ^{132}Ba target of 60 μg/cm^2 on a 40 μg/cm^2 carbon backing, prepared at the Orsay isotope separator from $BaCO_3$ material with 11.9% enrichment in ^{132}Ba. Using the Q3D spectrograph and the focal plane detector with cathode strip readout, two reactions were studied on this target: the $(\vec{d},p)^{133}$Ba and $(\vec{d},t)^{131}$Ba. Angular distributions and asymmetries were measured at 10 angles between 5° and 40°. For each angle, two magnetic settings for the spectrograph were used to cover excitation energies up to about 2.3 MeV. Spectra were taken both for spin "up" and spin "down".

Unfortunately, due to the presence of chlorine isotopes as impurities in the target (from the CCl_4 used to reduce the original isotopic material), many peaks of our reactions were obscured at some angles by impurity peaks. Thus, the outcome of our study is not only the number of observed and characterized levels in the final nuclei, but also the unambiguous assignment of spin and parity of the states which could be measured for a sufficient number of angles, since for many of such states this information was missing.

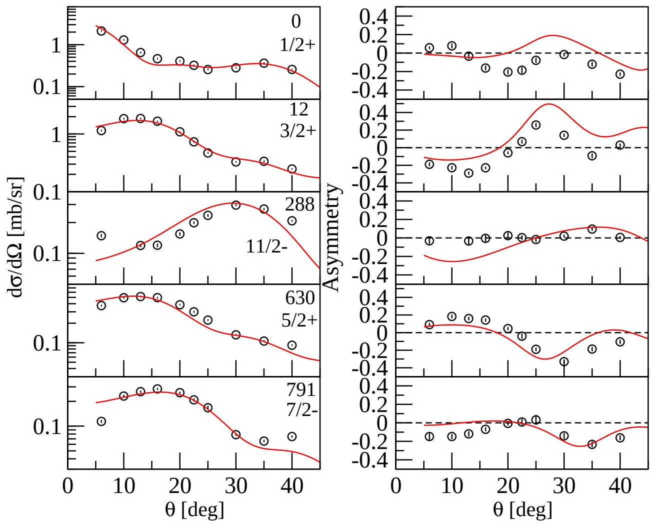

Fig. 1: Angular distributions and asymmetries representative for different transfers in the ^{132}Ba$(\vec{d},p)^{133}$Ba reaction at 25 MeV. The curves are DWBA calculations. Numbers are energy in keV and assigned spin and parity values.

Figure 1 shows an example of measurements for the ^{132}Ba$(\vec{d},p)^{133}$Ba reaction. It illustrates different angular momentum transfers ℓ, as well as the spin ($J = \ell \pm 1/2$) assignments for the final state, made possible by the use of the polarized beam. One should note, e.g., the mirror-like distinction between the $2d_{3/2}$ and $2d_{5/2}$ transfers in the figure.

For ^{133}Ba, calculations are in progress with the shell model and with the interacting boson-fermion model.

The processing of the data for the ^{132}Ba$(\vec{d},t)^{131}$Ba is under development.

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