Investigation of 0^+ Excitations in a Deformed Nucleus: ^{168}Er

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The observation of a large number of 0^+ states (13) up to 3.1 MeV excitation in a deformed nucleus, ^{158}Gd [1], has stirred a lot of interest in the nature of this type of excitations. Such states are easily observed in the (p,t) reaction, and therefore, following a similar study in actinide nuclei [2], 16 nuclei in the rare earth region between ^{152}Gd and ^{202}Hg have been studied with the same reaction in a recent experiment [3]. The purpose is to map out as many 0^+ states as possible, observe the systematics of these excitation modes, and try to understand their nature. The 0^+ excitations can appear indeed in many ways, such as pair excitations, multi-quasiparticle excitations, 2 phonon excitations (e.g., $\gamma-\gamma$ or octupole-octupole modes), shape coexistence, etc. and the somewhat unexpected abundancy of 0^+ states experimentally observed represents a great challenge for the nuclear structure models.

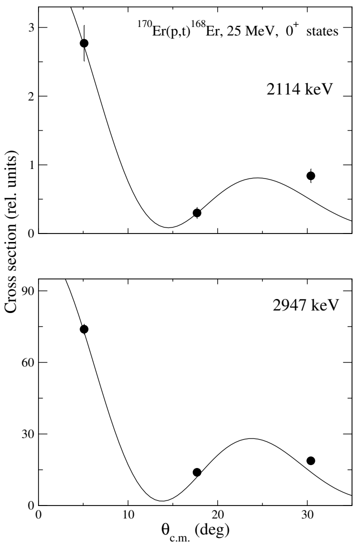

Fig. 1: Examples of DWBA description of the angular distribution for two 0^+ states.

Here we present preliminary results for ^{168}Er, obtained from the ^{170}Er(p,t) reaction at 25.0 MeV, performed at the Münich tandem accelerator with the Q3D spectrometer. In a first experiment, a three-angle angular distribution has been measured (5°, 17.5°, and 30°); the strong forward peaking of the ℓ=0 transfer makes it easy to observe the 0^+ states. Fig. 1 shows typical DWBA assignments. 10 excited 0^+ states have been observed up to 2.95 MeV excitation. In a subsequent experiment, 7 angles between 5° and 37.5° have been measured, and some additional 11 such states have been observed in the 3 to 4 MeV excitation range. Fig. 2 shows that the 0^+ states can be easily identifed among the positive peaks in a difference between the spectra measured at 5° and 17.5°. The analysis of this latter experiment is in progress.

Only three 0^+ excited states were known before in ^{168}Er, at 1217, 1422, and 1833 keV, respectively. Particularly interesting for the newly observed states is the bunch of strongly excited states in the 2.6 - 3.0 MeV region, probably two quasiparticle excitations. ^{168}Er has been recently proposed as a good candidate for the Y(5) symmetry [4]; the weakly excited 0^+ state at 2114 keV is close to the double-γ state, predicted at 2053 keV, and which is not expected to be excited in a (p,t) reaction. One may also assume that the states at 1217 and 2366 keV represent the β and double-β nearly harmonic vibrations, respectively. Detailed comparisons of the large number of 0^+ states observed in this nucleus are expected with predictions of different model calculations: projected shell model, quasiparticle-phonon model, spdf-interacting boson model.

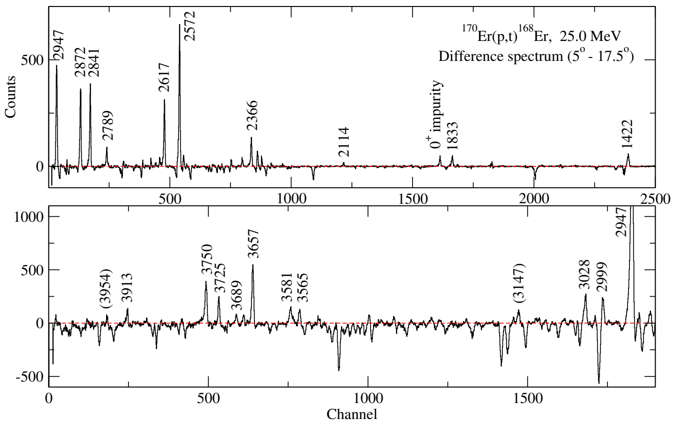

Fig. 2: Difference of the 5° and 17.5° spectra. 0^+ states occur as positive peaks, and are marked with their excitation energy.

References

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