MPV⊗Particle States in ^{143}Nd Studied with the (p,t) Reaction

A. M. Oros [a,b], P. v. Brentano [a], L. Trache [b,c], Gh. Cata-Danil [b], B. D. Valnion, A. Gollwitzer, and G. Graw
[a] Institute of Nuclear Physics, University of Cologne, Germany
[b] Institute of Atomic Physics, Bucharest, Romania
[c] Cyclotron Institute, Texas A&M University, College Station, TX 77843, USA

In the frame of a systematic study of the Monopole Pairing Vibration (MPV) in the neighborhood of closed shells, the (p,t) reaction was investigated in the N=83 nucleus ^{143}Nd.

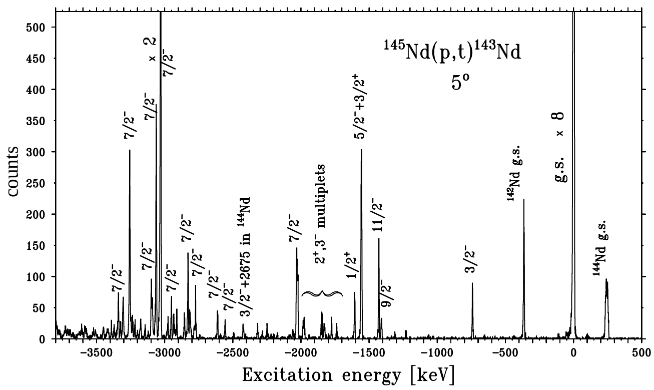

Fig. 1: Spectrum at 5° measured in the ^{145}Nd(p,t)^{143}Nd experiment.

The experiment has been performed at the Tandem accelerator and Q3D magnet spectrometer of the University of Munich, at 26 MeV beam energy, on 105(15) μg/cm^2 thin targets of neodymium oxyde (80(8)μg/cm^2 Nd). Fig. 1 shows a sample ^{145}Nd(p,t)^{143}Nd spectrum measured at 5°. The high selectivity of the reaction is easily seen - only a couple of states besides the ground state are populated with a significant cross-section. The increased sensitivity of the present experiment, reduced background and the ∼5 keV energy resolution of the spectra allowed us to resolve and analyze around 90 states, the weaker ones with cross sections as low as 1 μb/sr. We have measured angular distributions at 8 points between 5° and 45°; fig. 2 shows the characteristic pattern for the L=0, J$^\pi$=7/2$^-$ states. It is to be noticed that the L=0 angular distributions show the characteristic pattern even for the weak states, allowing reliable J$^\pi$=7/2$^-$ spin assignments. A careful impurity check has been performed, and the ground state to ground state transitions due to the heavy impurities present in the target were identified. A previous (p,t) experiment described in ref. [1] reported only three excited 7/2$^-$ states with considerable cross-section. The higher two states were interpreted as sharing the MPV⊗particle strength [1,2]. As many as 24 excited 7/2$^-$ states were identified in the present experiment by their L=0 angular distribution, ten or more of them are new. Besides the previously known two states already mentioned, only one strong state with a L=0 characteristic angular distribution shows up in the higher energy part of the spectrum (∼ 3 MeV). Most of the L=0 states have cross sections of the order of 10 μb/sr, representing around 5% or less of the g.s. cross-section (which ammounts to 541±50 μb/sr at 10°).

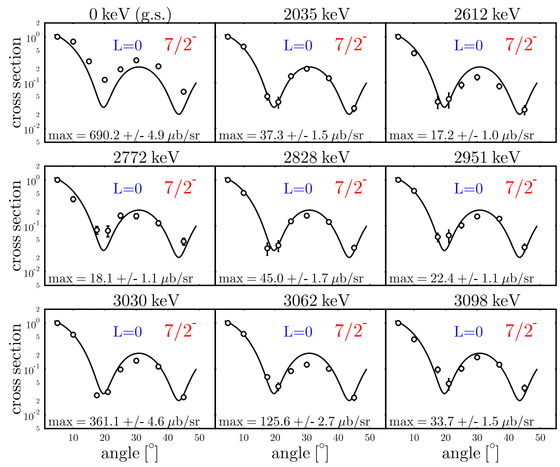

Fig. 2: Sample angular distributions of the L=0 states in ^{143}Nd. The cross sections are normalized to unity and the value at maximum (5°) is given for each state. The curves are drawn to guide the eye.

The results of the present experiment prove once again the usefulness of the (p,t) reaction as a spectroscopic tool. Though very selective, it allows for the population and analysis of a large number of states, many of them difficult to study in other reactions. A convincing example are the 24 excited 7/2$^-$ states seen in this experiment below 3.4 MeV, a result unequalled even by non-selective $\gamma-$spectroscopic experiments like (n,n'γ).

The interpretation of the L=0 states in terms of the MPV⊗particle configuration is discussed in refs. [3,4].

References

[1] L. Trache, C. Wesselborg, P. von Brentano, J. Wrzesinski, and G. P. A. Berg, Nucl. Phys. **A540** (1992) 66
[2] L. Trache, A. M. Oros, Gh. Cata-Danil, K. O. Zell, P. v. Brentano, G. Graw, D. Hofer, and E. Müller-Zanotti, Phys. Rev. **C49** (1994) R1742
[3] A. M. Oros *et al.*, this report, p. 27
[4] A. M. Oros, Ph.D. thesis, Univ. of Cologne, 1996