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Study of neutron hole states in the N=83 nuclei ^{147}Gd, ^{145}Sm and ^{143}Nd via the ($\vec{d}$,t) Reaction+)

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To study the interaction of 2-p, 1-h states with single particle-excited core configurations[1] (e.g. the 2+ and 3⁻ states in the N = 82 nuclei) we measured the ^{148}Gd(d,t)^{147}Gd, ^{146}Sm(d,t)^{145}Sm and the ^{144}Nd(d,t)^{143}Nd reactions with the polarized deuteron-beam of the Munich tandem accelerator and the magnetic spectrograph Q3D. For the ^{148}Gd and ^{146}Sm experiments we had a 28 cm long focal plane detector, the overall energy resolution was 8 keV. The ^{148}Gd and ^{146}Sm targets are radioactive. They had been produced in Livermore from the Los Alamos beam stop material. A small spot of material on a carbon backing had a thickness near 30 µg/cm². For the ^{148}Gd(d,t)^{147}Gd reaction we took angular distributions of cross-section and analyzing power from 1o° to 50° up to 1900 keV excitation energy and at one angle (θ = 20°) up to 4000 keV.

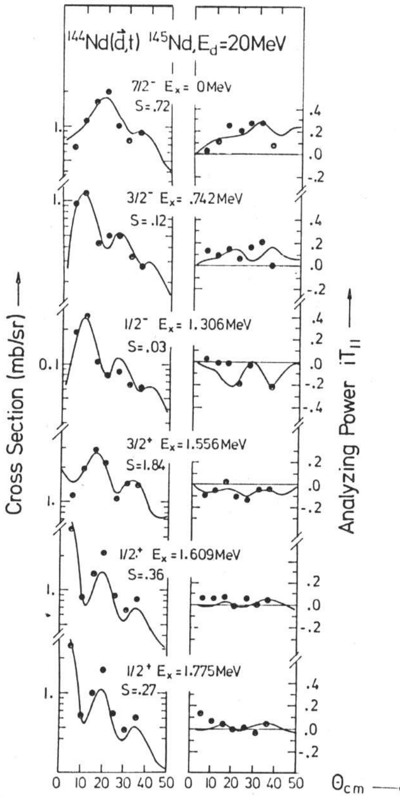


Fig. 1. Strong transitions to ^{143}Nd with DWBA curves

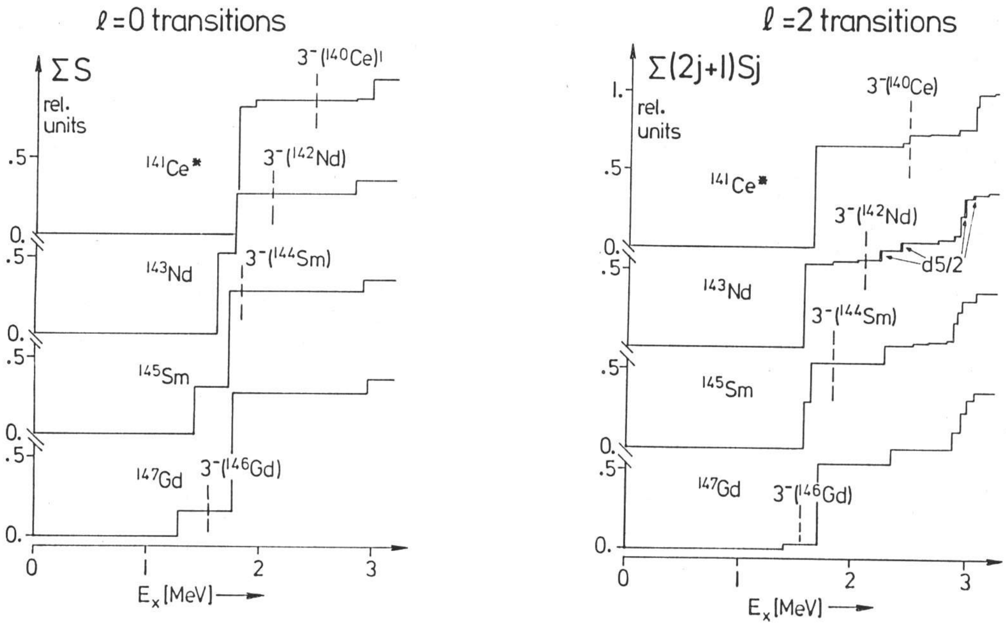
The ^{146}Sm target was partly damaged. We have relative cross sections only for scattering angles 10°, 20° and 30°.

The ^{144}Nd(d,t)^{143}Nd data have been taken with the beam of the new polarized ion source at a deuteron energy of 20 MeV, using an 80 cm single wire proportional counter with particle identification, providing an overall energy resolution of 12 keV. The target was 100 µg/cm² Nd_2O_3 on a carbon backing.

Fig. 1 shows some of the measured angular distributions for the excitation of the negative parity states 7/2⁻, 3/2⁻ and 1/2⁻ and the strong positive parity states with l=0 and l=2 in ^{143}Nd. The theoretical curves are DWBA-calculations with global optical potentials (the triton-potential of ^{143}Nd has been modified to get a better reproduction of the 7/2⁻ transitions).

For the s and d transitions we display the distribution of the measured spectroscopic factors, that is of the neutron hole strength, in figs. 2 and 3. For ^{141}Ce we enclude data of J.R. Lien[2] for completeness.

For ^{147}Gd the l-assignments for the states above 1900 keV are tentative deduced from the behaviour of ^{145}Sm and ^{143}Nd. Definite spin assignments j = l± 1/2 have been made for ^{143}Nd and few low lying levels of ^{147}Gd only.



Figs. 2 and 3. Observed spectroscopic strength for s and d transitions. Indicated are - by thick lines - the identified $5/2^+$ transitions in ^{143}Nd and the position of the 3^- core states.

The spreading of the single particle strength results from the coupling to core vibrational states. Remarkable is a Z independent localisation of s strength at E_x = 1.7 MeV and 2.9 MeV and of d strength at E_x = 1.6 MeV, 2.4 MeV and 3.0 MeV. In addition we observe the crossing of a weak transition: with increasing proton number a weakly excited $1/2^+$ state at excitation energies decreasing from 1.94 MeV to 1.35 MeV and a weakly excited $3/2^+$ state with excitation energies decreasing from 2.4 MeV to 1.4 MeV. The crossing with a strong transition of the same quantum number takes place in ^{143}Nd for the $1/2^+$ states and in ^{145}Sm for the $3/2^+$states. The level crossing is obvious from the observed strong mixing, that are two nearby states with about the same strength. The Z-dependence originates from the significant decrease of the 3^- excitation energy in the region of the Z = 64 subshell, whereas the energy of the positive parity core states remain nearly constant.

To conclude we observe level crossing of the s1/2 and d3/2 hole states with the (f7/2 $\otimes$ 3^-) configuration. This accomplishes the observation of Trache et al.[3] in ^{143}Nd(p,p'), Meyer et al.[1] and Piiparinen et al.[4] from Gamma spectroscopic studies.

+) supported by BMFT

References

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2) J.R. Lien et al., Nucl.Phys. A324 (1979) 141
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