Spectroscopy of Two-Quasiparticle Excitations in ^{208}Pb ◇

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In the ^{207}Pb(d,pγ)^{208}Pb study of M. Schramm [1] nearly all of the particle - hole multiplets $|\ \nu n_p l_p j_p 3\mathrm{p}_{1/2}^{-1}; \mathrm{J}^\pi\rangle$ in ^{208}Pb up to the excitation energy of 5 MeV had been determined [2]. In the range above uncertainties remained in the determination of the particle-multiplets $|\ n_p l_p j_p\rangle = |3\mathrm{d}_{5/2}\rangle$, $|4\mathrm{s}_{1/2}\rangle$, $|2\mathrm{g}_{7/2}\rangle$ and $|3\mathrm{d}_{3/2}\rangle$. To investigate the fragmentations of these configurations we did unpolarized (d,p) and vector polarized ($\vec{\mathrm{d}}$,p) experiments of high energy resolution at an incident energy of E_d = 22 MeV, using the Q3D magnetic spectrograph and the 1.6 m active length position sensitive detector in magnetic settings of E_x = 5.5 MeV and E_x = 6 MeV, respectively. Self-supporting targets of 291 μg/cm^2 of 99.8% highly enriched metallic ^{207}Pb were used. In ($\vec{\mathrm{d}}$,p) we observed 112 levels in the excitation energy range between 4698 keV to 7388 keV with line widths down to 5.4 keV FWHM. The relative accuracy in the determination of the energy calibration depends on counting statistics. For strongly excited states in this range the agreement with the (p,p') experiment of ref. [6] is about 1 keV or better. For most of the observed levels angular distributions of differential cross section $\sigma(\theta_{lab})$, have been obtained for θ_{lab} from 12.5° to 37.5° in 2.5° steps from (d,p) and from 16° to 34° in 3° steps from ($\vec{\mathrm{d}}$,p), and for the latter angles also for the vector analyzing power iT(θ_{lab}).

The experimental angular distributions (see fig.1) are compared with DWBA calculations. For single-nucleon transfer reaction on $\mathrm{J}_t^\pi = 1/2^-$ targets one may have two values of transferred particle angular momentum j. The amplitudes of the two transfers j, $j_> = l+s$ and $j_< = l-s$, add incoherently to differential cross sections $\sigma(\theta)$ [3]

$$\sigma(\theta) = \mathrm{G}_{lj_>}\sigma_>(\theta) + \mathrm{G}_{lj_<}\sigma_<(\theta).$$

In the notation they are expanded in DWBA cross sections weighted with their spectroscopic factors $\mathrm{G}_{lj_>}$ and $\mathrm{G}_{lj_<}$, respectively. Correspondingly the vector analyzing power $\mathrm{iT}_{11}(\theta)$ results from the analyzing powers $\mathrm{iT}_{11_>}(\theta)$ and $\mathrm{iT}_{11_<}(\theta)$, of pure transitions, weighted with their cross sections [3]

$$\mathrm{iT}_{11}(\theta) = \{\mathrm{G}_{lj_>}\sigma_>(\theta)\mathrm{iT}_{11_>}(\theta) + \mathrm{G}_{lj_<}\sigma_<(\theta)\mathrm{iT}_{11_<}(\theta)\}/\sigma(\theta),$$

The spectroscopic factors G_{lj},

$$\mathrm{G}_{lj} = \mathrm{S}_{lj}(2\mathrm{J}+1)/(2\mathrm{J}_t+1),$$

include weighting by the angular momentum of the target $\mathrm{J}_t = 1/2$ and the residual state J and S_{lj}, following the normalization convention $\mathrm{S}_{lj} = 1$ for transfer to a pure single-particle state in an empty subshell. The theoretical values of $\sigma_>(\theta)$, $\sigma_<(\theta)$, $\mathrm{iT}_{11_>}(\theta)$ and $\mathrm{iT}_{11_<}(\theta)$ have been calculated with the code DWUCK4 [4]. The optical parameters have been taken from ref. [5] without any adjustment.

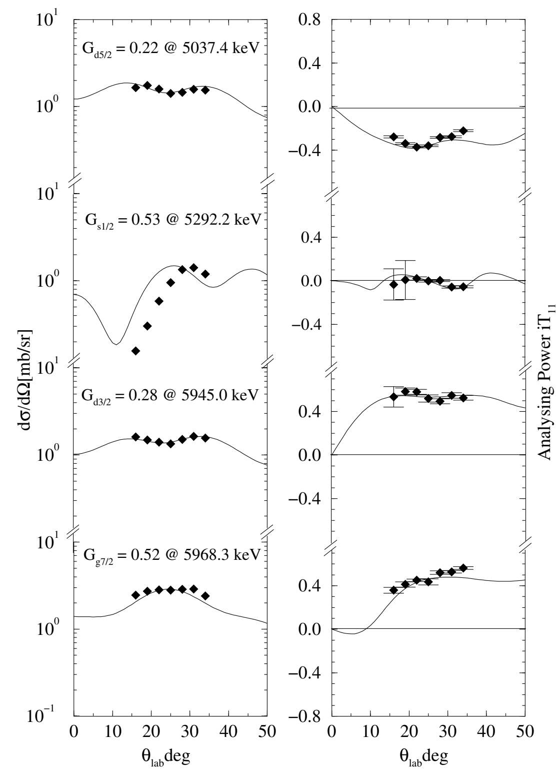

Fig. 1: Cross sections $\sigma(\theta)$ and vector analyzing powers $\mathrm{iT}_{11}(\theta)$ of strongly excited pure lj - transfers $\mathrm{d}_{5/2}$, $\mathrm{s}_{1/2}$, $\mathrm{d}_{3/2}$ and $\mathrm{g}_{7/2}$ in comparison with DWBA calculations. Excitation energies and obtained spectroscopic factors G_{lj} are indicated.

Data of apparently pure lj - transfers derived from the ($\vec{\mathrm{d}}$,p) experiment are depicted in fig. 1. Combining experimental cross sections from ($\vec{\mathrm{d}}$,p) and (d,p) in the forward angle range enables to distinguish uniquely between $l = 2$ and $l = 4$ transfers. A preliminary analysis shows that the derived spectroscopic factors G_{lj} are in agreement with those of ref. [2]. We also observe final states strongly mixed in lj - transfer. The evaluation of the data is in progress.

References

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