^{208}Pb(p,p') via Isobaric Analog Resonances in ^{209}Bi $^\diamond$

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Low resolution semiconductor experiments detected the proton decay of IAR into particle-hole states for the case of low angular momenta of the outgoing protons [1]. From the angular distribution of the decay protons the configuration mixing can be determined without much knowledge from other (e.g. stripping) experiments. Yet the identification of the states and the spin assignment are crucial for such an analysis. An early attempt to describe the lowest negative parity particle-hole states in ^{208}Pb by a subset of shell model particle-hole configurations demonstrated the capacity of the method [2].

In the meantime little work has been done in this field due to the high density of the states in ^{208}Pb. Recently a new focal plane detector has been attached to the Q3D magnetic spectrograph at the MLL accelerator. Together with the excellent stability of the Tandem Van de Graaff accelerator and fine targets we achieved a resolution of $2 \cdot 10^{-4}$ and a peak-to-valley ratio of better than 300 while measuring proton spectra from the reaction ^{208}Pb(p,p') on all IAR in ^{209}Bi between $E_p = 14.9$ and 17.8 MeV and scattering angles from $20° - 115°$.

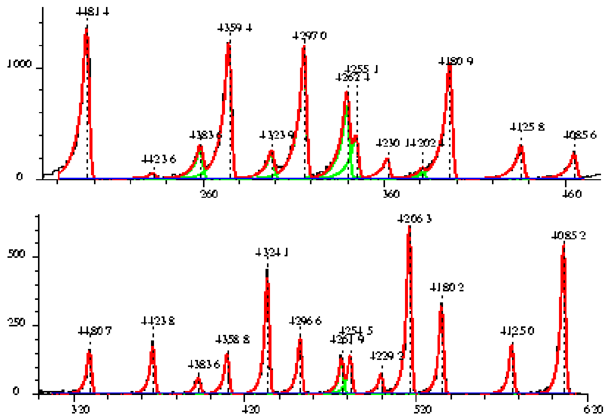

Fig. 1: Spectrum of ^{208}Pb(p,p') for $E_x = 4.07$-4.50 MeV taken on the $g_{9/2}$ IAR in ^{209}Bi *(top)* and on the $i_{11/2}$ IAR *(bottom)*.

Fig. 1 shows spectra taken on the $g_{9/2}$ and $i_{11/2}$ IAR in ^{209}Bi. Weak states besides strongly excited states are clearly resolved, especially a 7 keV doublet. It demonstrates that the energies can be determined with a precision in the order of 100 eV, better than most previous measurements [3].

By comparison of the spectrum taken on the $i_{11/2}$ IAR (Fig. 2 *top*) to spectra taken on other IAR three states with distances 18 below and 10 and 13 keV above the 3^- state at 4.698 MeV are seen to resonate on the $i_{11/2}$ IAR, whereas the 3^- state itself is only weakly excited. This finding contrasts to the statement by Ref. [1] which could not resolve this quadruplet with a resolution of 35 keV.

The two other parts of Fig. 2 show a close group of lines within 20 keV; different states from the multiplet at $E_x \approx$ 5.08 MeV are excited by different IAR. The state at $E_x =$ 5.080 MeV is strongly excited by the $i_{11/2}$ IAR only *(middle)*, whereas the highest member at $E_x = 5.093$ MeV is excited by the $j_{15/2}$ IAR only *(bottom)*.

Because of the high resolution and high statistics, each line has a fine structure in the tail starting at 14 keV distance from the peak. Especially at backward angles and with thicker targets, this is clearly seen at all strong lines, see the lower parts of Fig. 1 and Fig. 2. It is due to the ionisation of the atomic L-shell (13.06, 15.20, 15.86 keV); in some cases even the influence of the K-shell (88.01 keV) is visible. This atomic effect complicates the evaluation since the secondary tail contains up to 10% depending on the scattering angle. For instance in Fig. 2 (*bottom*) the lines at $E_x = 5053$, 5067, 5144 keV are ghost peaks produced by that atomic effect.

The goal to find weakly excited states besides the strong peaks in the spectrum, to determine their excitation energy and the angular distribution of the scattered protons is of considerable interest. Namely thus the contribution of outgoing protons with high angular momentum ($l = 5, 7$) can be derived and hence the particle-hole configuration space enlarged, in effect leading to a more valuable matrix of the residual interaction as shown by Ref. [2].

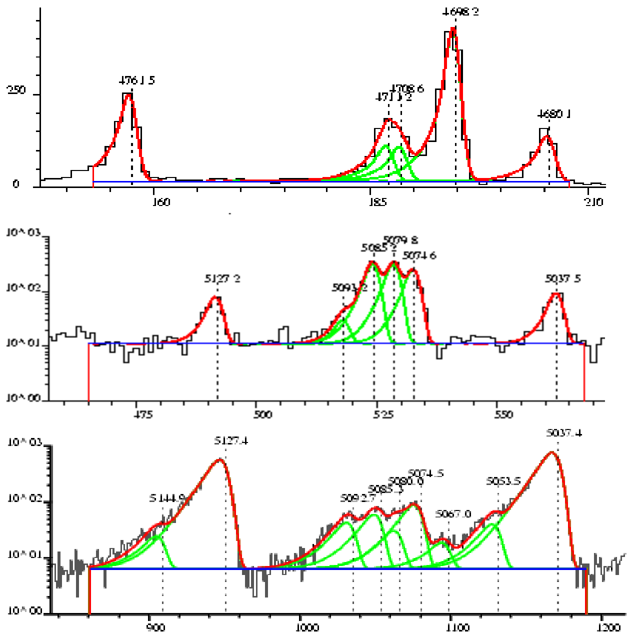

Fig. 2: Spectra taken with a thin target on the $i_{11/2}$ IAR for the region around $E_x = 4.7$ and 5.08 MeV *(top and middle)*; the same region around $E_x = 5.08$ MeV is also shown taken on the $j_{15/2}$ IAR taken with a thicker target *(bottom)*.

References

[1] S. A. A. Zaidi et al., P.R. 165 (1968) 1312.
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[3] M. J. Schramm, Nucl. Data Sheets 47, 797 (1986).

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