Contribution ID: **16** Type: **Poster**

Investigation of octupole excitations in ^{207}Tl using $\gamma\gamma$ angular correlations at the ISOLDE Decay Station

Wednesday, 7 December 2016 19:55 (10 minutes)

^{208}Pb is the heaviest stable doubly-magic nucleus and has been studied in great detail. Its first excited state occurs at 2.6 MeV and corresponds to an octupole vibration, resulting from the collective behaviour of a number of $E3$ ($\Delta l = \Delta j = 3$) particle excitations across the closed shell. This octupole transition has been observed in several other nuclei around ^{208}Pb, including the single proton-hole ^{207}Tl[1]. This nucleus has a number of known states; however, unambiguous spin-parity assignments are often missing[2]. It is expected that, given a $\frac{9}{2}^+$ ground state in ^{207}Hg and a Q-value of 4.8 MeV, β decay from ^{207}Hg should populate many of the states consisting of one of these proton-hole states coupled to the octupole 3^- vibration. \\

One experiment took place in 2014 and a second in 2016, both at the ISOLDE Decay Station (IDS) at CERN. Using the resident molten lead target on the General Purpose Separator (GPS), ^{207}Hg was produced at a rate of up to 5×10^4 pps in 2014, and $> 10^5$ pps in 2016. This was then impacted upon the tape at IDS and observed by an array of five HPGe detectors, the data sorted digitally with a Nutaq acquisition system. The first experiment utilised β gating to allow for the reliable observation of new γ transitions in ^{207}Tl, while the second operated at a higher rate un-gated in order to collect the necessary statistics for $\gamma - \gamma$ angular correlations between germanium crystals. \\

A new level scheme, including four new levels and many new transitions, has been established. While several types of spin-parity argument can be employed, the angular distribution of successive gamma rays in a cascade is known to give the most confident result. Here fourteen crystal-crystal angles were identified by modelling the detector arrangement in three dimensions. Single-crystal add-back was also computed. From these calculations the spin of the level at 3273 keV is suggested to be equal to $\frac{7}{2}$. This would be the first successful application of angular correlation analysis at IDS, and an achievement given the limited granularity of the set-up. The aim of the analysis is to determine J^π for all levels observed here, before comparison with state-of-the-art shell model simulations. From this we plan to learn about how the vibration couples: a step towards the characterisation of the lead octupole excitation. \\[8mm]

\begin{footnotesize}
[1] O. Hansen \textit{et al.}, Nucl. Phys. A \textbf{127}, 71 (1969).

[2] B. Jonson \textit{et al.}, CERN 81-09 \textbf{2}, 640 (1981).

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Session Classification: Poster Session