Complete Spectroscopy of Negative Parity States in $^{208}\text{Pb}$ with $E_x < 6012$ keV


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The study of the doubly magic nucleus $^{208}\text{Pb}$ is of key interest as more and more doubly magic nuclei come into the reach of modern experiments. The schematic shell model without residual interaction (SSM [1]) predicts 70 particle-hole states with negative parity for $E_{SSM} < 6361$ keV (Fig. 1 left, neutron and proton configurations are marked by solid and dotted lines, respectively). Recent experiments [1] revealed new identifications, spin and parity assignments for many states (Fig. 1 right; more states at $E_x > 6012$ keV are known [2]). The inelastic proton scattering on $^{208}\text{Pb}$ via isobaric analog resonances (IAR) in $^{209}\text{Bi}$ yields the main information. Additional data is known [2], especially for the $^{207}\text{Pb}(d,p)$ reaction. The excitation of the states by these two reactions is highly selective; they excite only certain neutron particle-hole configurations in each state. Experiments have been performed with the Q3D magnetic spectrograph of the Maier-Leibnitz-Laboratorium (München) at an energy resolution of 1.5 keV HWHM [1]. The $^{208}\text{Pb}(p,p')$ reaction via an IAR in $^{209}\text{Bi}$ is equivalent to the neutron pickup reaction on a target of $^{209}\text{Pb}$ in an excited state $LJ$. In each state of $^{208}\text{Pb}$, it excites the components $LJ^{+}\nu \otimes lj^{-}\nu$ with neutron particle $LJ$ and neutron hole $lj^{-}$; $^{207}\text{Pb}(d,p)$ excites $LJ^{+}\nu \otimes p_{1/2}^{-}\nu$. The sum rules for 64 out of 70 particle-hole configurations with spins $0^{-}$ to $8^{-}$ are thus found to be complete within 10%; the completeness of six configurations which are not directly detectable ($f^{+}\pi_{5/2} \otimes lj^{-}\pi$) is deduced. The large gap in the SSM space at $6033 \leq E_{SSM} < 6361$ keV together with the determination of the configuration mixing in all 70 states allows to deduce matrix elements of the residual interaction [3].

Figure 1: (left) SSM configurations, (right) identified states with spins $0^{-}$ to $8^{-}$ and $2600 < E_x < 6012$ keV.