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High-Resolution (d,p) Reaction Spectroscopy at Near-Zero Degrees for Probing Nuclear Giants

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Some nuclei, such as gadolinium, exhibit exceptionally large neutron capture cross sections—far exceeding typical geometrical cross section of atomic nuclei. This indicates the existence of exotic nuclear structures, such as spatially extended neutron halo states, which remain underexplored, particularly in heavy nuclei. To investigate such states, we are developing a new approach based on high-resolution (d,p) reaction spectroscopy using the AVF cyclotron and the Grand Raiden spectrometer at RCNP. Our setup employs “dispersion matching” to achieve an energy resolution of ~ 20 keV (FWHM). This high resolution is essential for resolving closely spaced excited states.

As a benchmark measurement, we conducted the $^{197}\text{Au}(\text{d},\text{p})^{198}\text{Au}$ reaction. The resulting excitation spectrum confirms the performance of the system and indicates the feasibility of future studies of halo candidates in heavy nuclei with high precision.

Moving forward, we aim to identify spatially extended neutron wave functions by analyzing angular distributions at near-zero degrees.

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