# Nucleon knockout from high-spin isomeric states

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Nucleon knockout reactions with secondary radioactive beams are a key tool for spectroscopy in very exotic nuclei, but the maximum spin populated is limited by the single-nucleon states near the Fermi surface. However, projectile fragmentation reactions, which are used to produce secondary radioactive beams at fast fragmentation facilities, are known to populate high-spin isomeric states (e.g., $^{208}$Pb+$^{9}$Be [1], $^{238}$U+$^{9}$Be [2]). Nuclear reactions with isomeric beams have long been considered a potentially powerful method for studying nuclear structure (see [3] and references therein), offering the chance to push further from stability and to higher spin.

Here we will discuss examples of nucleon knockout from isomeric states. In particular, we consider the case of neutron knockout from the $19/2^-$ isomer in $^{53}$Co, recently measured at the National Superconducting Cyclotron Laboratory [4]. The reaction populates two distinct groups of states in the $^{52}$Co daughter, via knockout from the $^{52}$Co ground state ($J^\pi_f = 0^+ - 7^+$), and the isomer ($J^\pi_f = 6^+ - 11^+$). The relative cross sections to the states are well reproduced using an eikonal reaction model and *fp*-shell shell model spectroscopic factors, assuming an isomeric ratio of 27%. This has resulted in a new level scheme for $^{52}$Co, up to the band-terminating $11^+$ state, providing new insights into isospin symmetry in the $f_{7/2}$ shell. Two-neutron knockout from the high-spin isomers in $^{52}$Fe ($12^+$) and $^{54}$Fe ($10^+$) will also be considered.

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