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Structure of ^{50,52,53,54}Cr from inelastic neutron scattering: Implications for shape coexistence and E0 strengths

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Nuclear shape coexistence occurs when an atomic nucleus exhibits low-lying excited states with dramatically different shapes than the ground state [1]. Electric monopole (E0) transitions are a particularly sensitive probe of shape coexistence with the E0 transition strength directly related to the change in the mean square charge radius and degree of mixing between two states.

Shape coexistence in the N=28 region is poorly studied from the perspective of E0 transitions [2], but it is expected in ^{52}Cr from neutron 2p-2h excitation across the N=28 shell gap. The first E0 spectroscopy on the Cr isotopes was performed at the Australian National University [3], but insights were hampered by missing and imprecise data on the key spectroscopic quantities for the determination of the E0 transition strengths, such as level lifetimes and transition mixing ratios.

To address these deficiencies, the low-lying states in ^{50,52,53,54}Cr were investigated at the University of Kentucky Accelerator Laboratory with inelastic neutron scattering. Gamma-ray spectroscopic measurements were carried out following the scattering of quasi-monoenergetic neutrons from a natural chromium rod target. Neutron energies of 2.9 and 3.4 MeV were used to determine level lifetimes via the Doppler-shift attenuation method (DSAM), and gamma-ray angular distributions yielded transition mixing ratios and information on transition multipolarities. Excitation functions were recorded for neutron energies from 2.6 to 4.5 MeV.

We present level lifetimes, transition multipolarities, and spin-parity assignments for states in ^{50,52,53,54}Cr, along with their implications for E0 transition strengths and shape coexistence in these nuclides and this region of the nuclear chart.

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