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Investigation of the E2 and E3 matrix elements in ^{200}Hg using direct nuclear reactions

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A nuclear-structure campaign has been initiated to investigate the isotopes of Hg around mass 199. To date, ^{199}Hg provides the most stringent limit on an atomic electric dipole moment (EDM) [1]. The observation of a permanent EDM would represent a clear signal of CP violation from new physics beyond the Standard Model. Theoretical nuclear-structure calculations for ^{199}Hg are challenging, and give varied predictions for the excited-state spectrum. Understanding the E2 and E3 strengths in ^{199}Hg will make it possible to develop a nuclear structure model for the Schiff strength based on these matrix elements, and thereby constrain present models that predict the contribution of octupole collectivity to the Schiff moment of the nucleus.

One of the most direct ways of measuring the matrix elements connecting the ground state to excited states is through inelastic hadron scattering. The high level density of a heavy odd-A nucleus like ^{199}Hg makes a measurement extremely challenging. Complementary information can, however, be determined for states in the neighbouring even-even isotopes of ^{198}Hg and ^{200}Hg, and single-nucleon transfer reactions on targets of even-even isotopes of Hg can yield important information on the single-particle nature of ^{199}Hg.

The work presented here comprises two experiments which use a 22 MeV deuteron beam incident on an isotopically enriched target of ^{200}Hg^{32}S. The first experiment was an inelastic deuteron scattering experiment, ^{200}Hg(d,d')^{200}Hg, and included 20 angles ranging from 10° to 115° up to an excitation energy of $\sim$ 6 MeV. The second experiment was a single-nucleon transfer reaction into ^{199}Hg, ^{200}Hg(d,t)^{199}Hg, and included 10 angles from 5° to 50° up to an excitation energy of $\sim$ 3 MeV. These experiments were performed using the Q3D magnetic spectrograph at the Maier-Leibnitz Laboratory. Results from these experiments will be presented.

[1] W. C. Griffith et al., Phys. Rev. Lett. 102, 101601 (2009).

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