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Inelastic studies of Th and ThO collisions below 1 K COLIN CONNOLLY, YAT SHAN AU, Harvard University, WOLFGANG KETTERLE, Massachusetts Institute of Technology, JOHN DOYLE, Harvard University — The actinide series is among very few parts of the periodic table that is virtually unexplored at low temperatures. We present the first experimental investigations of cold collisions of actinide atoms and actinide-containing molecules below 1 K. Using atomic thorium (Th), we measure Zeeman relaxation due to collisions with ^{3}He. Although ground-state Th has "submerged shell" structure—with a spherical outer valence electron shell—these collisions proceed about 100 times faster than those of the lanthanide series, while still about 100 times slower than anisotropic open-shell atoms. In contrast, we find that the first excited state ($^3P_0$) is collisionally stable (no quenching observed within $> 10^6$ collisions with ^{3}He) and has a long radiative lifetime exceeding 200 ms. We also investigate collisions of the molecule ThO (ground state and metastable H-state[1]) with ^{3}He. No quenching of the metastable H-state is observed within $> 3 \times 10^4$ collisions, allowing for a new measurement of the ThO(H) radiative lifetime. Evidence is presented for formation of ThO-He van der Waals molecules.

[1]ThO(H) is used in the ACME search for the electron EDM (Vutha, A. C. *et al. Journal of Physics B* **43**, 074007 (2010))

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