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Differential phase shift spectroscopy in a thallium atomic beam[1]

PROTIK MAJUMDER, DAVID BUTTS, RALPH UHL, PHYSICS DEPT., WILLIAMS COLLEGE TEAM — We have developed a new differential phase shift spectroscopy system capable of detecting atom-induced optical cavity shifts at the microradian level. An in-vacuum three-mirror ring cavity is oriented normal to the propagation of an atomic beam. The frequencies of two counter-propagating optical beams are offset by exactly one cavity free spectral range. By locking the transmission signal of one laser beam to the steep slope of a cavity transmission fringe, we detect relative transmission changes in the two beams. While taking advantage of a high degree of common mode noise rejection, we remain sensitive to small phase shifts induced by the atoms as they interact with one laser beam at a time. We plan to measure the Stark shift and Stark-induced amplitude in the E1-forbidden $6P_{1/2} \rightarrow 6P_{3/2}$ 1283 nm transition in thallium, providing important atomic structure information in an atomic system for which high-precision parity nonconservation results exist. Current results will be presented. Using common-frequency counterpropagating beams, the identical apparatus will also be used to search for a long-range Time-reversal-violating force in thallium which would again manifest itself as a differential optical cavity phase shift, now correlated with the direction of a static electric field.

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