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Constraints on the muon spin force from co-magnetometer experiments

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There are many New Physics scenarios that may affect the current discrepancy between the measurement and the prediction of the muon anomalous magnetic moment. One such possibility is a long-range force created by ordinary atoms acting on the muon spin. If the muon $g-2$ discrepancy is attributed to such a force, it would imply a tiny, $\mathcal{O}(10^{-13})$ eV spin energy splitting between muon state polarized in the vertical direction. However, the absence of nuclear spin coupling to a vertical direction has been tested with $\mathcal{O}(10^{-21})$ eV accuracy in ^{199}Hg/^{201}Hg and ^{129}Xe/^{131}Xe systems. We analyze the radiative transfer of the muon spin coupling to nuclear spin coupling. Despite significant nuclear uncertainties, we show that experiments with ordinary atoms set indirect constraints on the exotic muon spin coupling at a factor of a few more stringent than suggested by the muon $g-2$.

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