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Constraints on exotic dipole-dipole couplings between electrons at the micron scale[1] SHLOMI KOTLER, National Institute of Standards and Technology, 325 Broadway Street, Boulder, Colorado 80305-3328, USA, ROEE OZERI, Department of Physics of Complex Systems, Weizmann Institute of Science, P. O. Box 26, Rehovot 76100, Israel, DEREK JACKSON KIMBALL, Department of Physics, California State University - East Bay, Hayward, California 94542-3084, USA — Until recently, the magnetic dipole-dipole coupling between electrons had not been directly observed experimentally. This is because at the atomic scale dipole-dipole coupling is dominated by the exchange interaction and at larger distances the dipole-dipole coupling is overwhelmed by ambient magnetic field noise. In spite of these challenges, the magnetic dipole-dipole interaction between two electron spins separated by 2.4 microns was recently measured using the valence electrons of trapped Strontium ions [S. Kotler, N. Akerman, N. Navon, Y. Glickman, and R. Ozeri, Nature **510**, 376 (2014)]. We have used this measurement to directly constrain exotic dipole-dipole interactions between electrons at the micron scale. For light bosons (mass $\lesssim 0.1$ eV), we find that coupling constants describing pseudoscalar and axial-vector mediated interactions must be $|\frac{g_P^e g_P^e}{4\pi\hbar c}| \leq 1.5 \times 10^{-3}$ and $|\frac{g_A^e g_A^e}{4\pi\hbar c}| \leq 1.2 \times 10^{-17}$, respectively, at the 90% confidence level. These bounds significantly improve on previous constraints in this mass range: for example, the constraints on axial-vector interactions are six orders of magnitude stronger than electron-positron constraints based on positronium spectroscopy.

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