Contribution ID: **10** Type: **Poster**

Constraints on a Spin-dependent Exotic Interaction between Electrons with Single Electron Spin Quantum Sensors

Recently, single NV center in diamond as a quantum sensor has been proposed and utilized to explore electron-nucleon monopole-dipole interaction, which sets a constraint for the electron–nucleon coupling, g_s^N g_p^e, with the force range 0.1–23 μm.(1) A new laboratory bound on the axial-vector mediated interaction between electron spins at micrometer scale is established with single nitrogen-vacancy centers in diamond. A single crystal of p-terphenyl doped pentancene-d14 under laser pumping provides the source of polarized electron spins. Based on the measurement of polarization signal via nitrogen-vacancy centers, we set a constraint for the exotic electron-electron coupling, g_A^e g_A^e, within the force range from 10 to 900 μm. The obtained upper bound of the coupling at 500 μm is|(g_A^e g_A^e)/4$\pi\hbar$c|≤ 5.7 × 10−19, which is one order of magnitude more stringent than previous experiment. Our result shows that the NV center can be a promising platform for searching for new particles predicted by theories beyond the standard model.

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Track Classification: Fundamental Symmetries and Spin Physics Beyond the Standard Model