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**Electrical tuning of single-photon emission in diamond devices**[1]

LEE C. BASSETT[2], Center for Spintronics and Quantum Computation, University of California, Santa Barbara, CA 93106

For quantum information applications, nitrogen-vacancy (NV) centers in diamond combine many of the advantages of atomic systems (optical access, millisecond spin-coherence times) with the engineering flexibility of solid-state devices. Recent demonstrations of coherent coupling between photons and individual NV-center spins [1,2] provide a route to integrating NV-center qubits within photonic networks and for on-demand generation of entangled single-spin/single-photon pairs. Such applications require the ability to tune the NV-center zero-phonon optical transitions, to compensate for natural sample inhomogeneities which perturb the electronic orbital states. Here we demonstrate the ability to electrically control the orbitals of individual NV centers by applying voltages to micron-scale surface gates [3]. Surprisingly, the local electric field experienced by an NV center is significantly enhanced by a photoinduced space charge resulting from photoionization of deep donor impurities within the diamond, even in high-purity single-crystal material ($<$ 5 ppb nitrogen content). Since the photoinduced electric fields are reproducible as a function of gate voltage and are predominantly directed perpendicular to the diamond surface, we can harness them to obtain three-dimensional control of the local electric field vector with surface gates alone. To demonstrate this technique, we tune the excited-state orbital doublet of a strained NV center to degeneracy, as required for some spin-photon entanglement protocols [2], and then adjust the optical transition frequency, showing that we can tune multiple NV centers to have the same degenerate transition energy. This method should enable the coherent coupling of multiple NV center spins to indistinguishable photons within a scalable photonic network.

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[2] E. Togan *et al.*, *Nature* **466**, 730 (2010).
[3] L. C. Bassett, F. J. Heremans, C. G. Yale, B. B. Buckley, and D. D. Awschalom, *Phys. Rev. Lett.* (in press).

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