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A metrology technique for phosphorus-donor clusters in silicon based on hyperfine splittings YU WANG, Purdue Univ, HOLGER BUCH, University of New South Wales, LLOYD HOLLENBERG, University of Melbourne, GERHARD KLIMECK, Purdue Univ, MICHELLE SIMMONS, University of New South Wales, RAJIB RAHMAN, Purdue Univ — The spin states of electrons at phosphorus-donors in silicon are promising candidates for solid-state qubits. A single phosphorus atom in silicon can act as an electron-spin qubit, which shows long relaxation time. However, even with atomically precise fabrication techniques, it is challenging to precisely control the number of phosphorus atoms implanted in silicon. A phosphorus-donor cluster in silicon is an experimentally less demanding alternative for a qubit. Recently, single-shot spin-readout measurements have been performed on phosphorus-donor clusters and show long relaxation time ($\sim$ 2s). However, there is uncertainty in the number of donors, number of electrons and donor locations of a donor cluster, which is difficult to characterize directly in experiments. Since the hyperfine couplings between electron and nuclear spins in a donor cluster are sensitive to variations on an atomic scale, characterization techniques can be devised to extract the configurations of donor clusters based on electron spin resonance, which is useful to design qubit control parameters needed for scaled-up devices. In this work, we propose a unique metrology technique based on large-scale atomistic electronic structure calculations for donor clusters in silicon.

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