PHYSICS AND ASTRONOMY
COLLOQUIUM

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"Highly Enriched ^{28}Si: From a New Kilogram to Quantum Computing"

Abstract

Our investigation of the optical properties of highly enriched ^{28}Si over the past 10 years has revealed remarkable improvements in the linewidths of diverse optical transitions (which are already very sharp in natural Si). This in turn has revealed many new and surprising results and effects, and I will focus on several of the latest.

Luminescence associated with deep defects in Si has been studied over the past 30 years, and some of the 'brightest' of these lines are considered to be optical signatures of various important metallic contaminants such as Fe, Cu, Ag, Au etc. The remarkable spectral resolution achievable in ^{28}Si allows us to see not only isotope shifts associated the defect constituents, but "isotopic fingerprints" revealing not simply the presence of specific elements, but also the number of atoms of each. Remarkably, none of these supposedly well-studied centers is what it was thought to be.

We have also observed well-resolved hyperfine transitions for the ^{31}P bound exciton in ^{28}Si, which allow for the optical measurement of the electronic and nuclear spin of this prime candidate for Si-based quantum computing. More recently, the same transitions have been used to achieve rapid electronic and nuclear spin hyperpolarizations of the ^{31}P by dynamic pumping. This removes one of the major roadblocks for Si-based quantum computation: the lack of a viable scheme for initializing the nuclear spin states. I will also show preliminary results using a combination of optical spin hyperpolarization and readout to perform NMR on dilute ^{31}P in ^{28}Si in a regime which is inaccessible to other methods. Record coherence times are obtained for the ^{31}P nuclear spin.

Wednesday, September 28, 2011
3:30 p.m.
Bob Wright Centre
Room A104