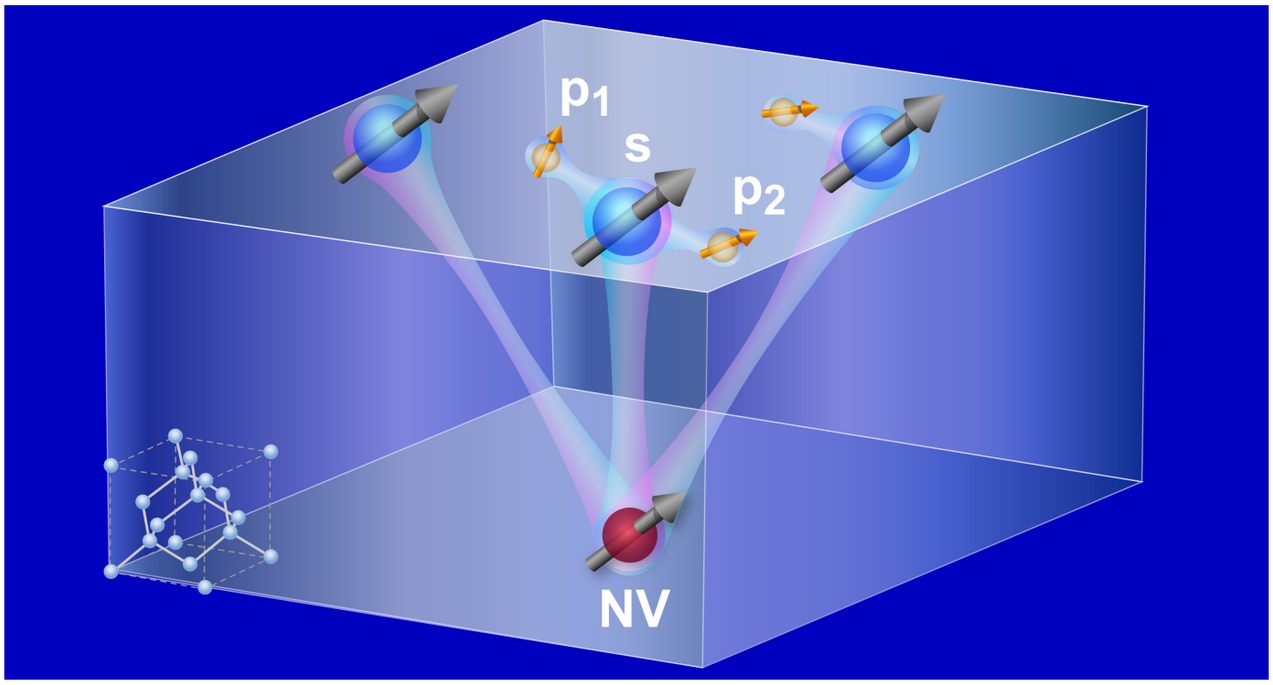
Boston University **Physics Colloquium**



Quantum physics in the laboratory: From magnetic imaging of single atoms to searching for dark matter

The field of quantum science and engineering was originally stimulated by ideas from information theory showing that quantum mechanical machines can perform certain informational processing tasks much faster than any classical computer. While it is still unknown if and how truly large-scale quantum machines can be built, these concepts have already spurred new fields of science and inspired novel applications. I will talk about the development of new quantum tools for precision measurements and about how these tools can be used to address key problems in fundamental and applied science. I will focus on nanoscale magnetic sensing, and describe how we used nitrogen-vacancy (NV) centers in diamond to achieve magnetic sensing and imaging of individual proton nuclear spins, as well as NMR spectroscopy of individual protein molecules, under ambient conditions. In the future, nanoscale sensing with NV centers in diamond may enable experiments testing of one of the central assumptions of statistical mechanics, the establishment of local equilibrium due to interactions, which was recently shown to fail in a class of strongly-disordered interacting systems, for which there exists a many-body localized (MBL) phase, with no transport or thermalization. The tools developed in the field of precision magnetic sensing can also be used to address one of the most important open problems in modern physics - the nature of dark matter. Specifically, I will describe the experimental approach to searching for axion dark matter using magnetic resonance, which has the potential to detect axion-like dark matter with coupling strength many orders of magnitude beyond the current astrophysical and laboratory limits, and all the way down to the Quantum Chromodynamics (QCD) axion.

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3:30 - 4:30 PM
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