Student Research Talks (StReeTs)

George Mason University

Data Assimilation for Quantum NV Diamond Spectroscopy

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Abstract

Abstract: Nitrogen-vacancy (NV) defect centers in diamond have generated much interest for their uses in quantum information and sensing. Negatively charged centers (NV−) are used for high spatial-resolution sensing (magnetometry, electrometry, thermometry, and barometry) and for quantum information (with a scalable quantum computer as the eventual goal). Despite the rapid NV applications development, our grasp of basic NV properties is incomplete, which is important to understand to fully exploit potential uses. In this work we construct a statistical model for NV spectroscopy and use it in synthetic experiments to solve inverse problems. Our principal application is to develop a primary sensor based on the NV diamond quantum optical properties. This is a significant challenge because the NV diamond structure is sensitive to temperature and pressure as well as magnetic and electric fields, including electromagnetic fields of nearby atoms and molecules. First, using the Hamiltonian for the effects of local strain and the environmental variables, we identify the observable components based on the invertibility of various observation systems. Next, we observe the influence of temperature and pressure on the NV center by solving the Schrödinger Equation and computing the theoretical spectroscopy curve. We assume that the observed photon counts are Poisson random variables with rates proportional to the theoretical spectroscopy. Then, using the Maximum Likelihood Estimation we find the parameter values that maximize the likelihood. Last but not the least we determine the robustness of the model using sensitivity analysis.

Date: Friday, November 4^{th}
Time: 2:30pm–3:20pm
Place: Exploratory Hall 4106 and Zoom (Meeting ID: 978 7872 4201)

Pizza will be served at the presentation.

For further information or for special accommodations (including dietary restrictions), please contact Michael Merkle or Aleyah Dawkins via email at `mmerkle@gmu.edu or adawkin@gmu.edu` by Thursday.