Overview
Utilizing the diamond nitrogen-vacancy center’s ability to image the strength of a magnetic field across the surface of the diamond, we aim to be able to detect the angle that a magnetic particle is oriented relative to the surface of the diamond. Being able to tell the orientation of a magnetic particle could be useful in biological experiments, where the change in the orientation of a magnetic particle could be related to a rotating of a biological feature.

Magnetic Nanoparticles and Dipole Moment
- Particle’s magnetic field dominated by dipole term
- Field from magnetic dipole is similar to the field from a bar magnet
- Rotating the dipole will change the field inside the diamond

- The dipole magnetic field will create a shift in resonant frequency
- Resonant frequency shifts will affect the amount of light emitted from the diamond
- The variance in brightness across the diamond is related to the strength of the magnetic field at those points.

NV Centers
- Nitrogen vacancy centers, or NV centers, are optically excitable between two energy levels
- In lower energy level there is a “bright” and a ‘dim” state that the NV center can be in
- The light emitted when transitioning from the excited state to the unexcited state is dependent on if it stated in the “bright’ or “dim” state.

- The energy difference between the “bright” and “dim” state is 2.87 GHz in the absence of magnetic fields
- Applying an external magnetic field to the NV center we see a shift in resonant frequency
- By applying a resonant field to the NV center put more NVs into the “dim” state, meaning less light emitted

Simulating Dipole Orientation Measurements
- Simulation created to see what we should expect
- Works by figuring out frequency shift caused by the particle and the affected brightness

Experimental Setup

Future Work
Now that our microscope is finished I will begin my dipole orientation experiment. To orient the particles with various angles, I will apply the particles to the diamond with an angled magnetic field, which their dipole moment will naturally want to align with. I will then collect images of the sample in a weak magnetic field and compare them to the results from my simulation.

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