Vector Magnetometry Using Nitrogen-vacancy Centers in Diamond

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Magnetometry based on the nitrogen-vacancy (NV) center in diamond is a promising solid-state platform offering sensitivities rapidly approaching other state-of-the-art technologies, such as vapor cell, superconducting quantum interference devices (SQUIDs), and fluxgate magnetometers. By monitoring the red fluorescence emitted by the NV center, the external magnetic field measured is related to fundamental constants of nature via the Zeeman splitting of the NV spin state's quantized energy levels [1]. In an ensemble, the NV centers are orientated along all four tetrahedral diamond axes, enabling inherent vector magnetic field sensing capabilities from a single diamond detector free of dead zones and heading errors [2]. It is expected that NV magnetometers will play a pivotal role in a wide range of magnetometry applications, ranging from navigation to geomagnetic surveying to mineral exploration.

In this work, we present our approach toward the establishment of a full vector magnetometer using NV ensembles in diamond. The NV centers orientated along all four tetrahedral diamond axes are experimentally addressed simultaneously to achieve near real-time vector magnetic field sensing. Technical challenges of the NV magnetometer technology from long term drifts in the sensor output due to phenomenological variations like optical pump and microwave power are discussed and addressed by implementing a closed-loop feedback scheme for each axis [3].

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