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Planetary magnetic field sensing via electrical readout of quantum centers in SiC

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Abstract

The most widely used magnetometers for scientific missions to space are fluxgate and optically-pumped atomic-gas instruments due to their high sensitivity, reliability, and proven performance. Fluxgates are simple and robust while the atomic-gas designs are highly accurate and stable. However, it is very difficult to include all of these desired specifications in a single package with adequate size and power constraints for smaller scientific missions that involve cubesats. This opens the door for infusion of next-generation magnetometer technologies. In this work, we report on the development of a silicon carbide magnetometer, promising to be a low complexity, lightweight, low power, and inexpensive alternative to these heritage technologies. It measures magnetic field induced changes in spin dependent recombination (SDR) current within a pn junction. The change in SDR current arises from the interaction of external magnetic fields with the atomic-scale defects in the SiC semiconductor. This change in current can be detected electrically via magnetoresistance caused by zero-field level crossings or low-field electrically-detected magnetic resonance, thereby giving the instrument the ability to self-calibrate, a significant advantage in the remoteness of space. The material properties of SiC, namely radiation and temperature hardness, are also very attractive for space applications in harsh environments.