Imaging of biomagnetism using diamond quantum sensors

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Imaging magnetic field signals from biological samples is a groundbreaking technique in fundamental biology, medicine, and clinical settings. One of the leading quantum platforms for magnetic imaging is the diamond's nitrogen-vacancy (NV) center [1]. The NV center carries an electronic spin of one that is addressable via laser and microwave irradiation and stable under ambient conditions. With these unique advantages, researchers have investigated magnetic field signals in numerous systems. In this talk, I will overview recent demonstrations of magnetic field imaging of wide-ranging biological systems, from living cells and neurons to mammalian hearts, with high sensitivity and spatial resolution [2-4].

In particular, magnetocardiography (MCG) is a contactless sensing technique that remotely measures the stray magnetic fields produced by cardiac currents in the heart. Unfortunately, the spatial resolution of MCG deteriorates significantly as the standoff distance between the target and the sensor increases. Commercialized MCG devices usually provide centimeter-scale spatial resolution. As an alternative approach, NV-based magnetic sensing offers a millimeter-scale spatial resolution. Millimeter proximity from the sensor to the heart surface enhances the cardiac magnetic field to be stronger than nanoteslas and allows the mapping of these signals with intra-cardiac resolution. I will also discuss the possibility of further improvements in sensitivity and resolution and the application of this technique to studying the origin and progression of various cardiac arrhythmias, including flutter, fibrillation, and tachycardia.

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