Induction imaging with radio-frequency atomic magnetometers

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Non-invasively mapping the electric conductivity and the structure of specimens is an open challenge in many fields, from material characterisation to biomedical imaging. Recently, we have demonstrated that radio-frequency (RF) atomic magnetometers operating in magnetic induction tomography modality can provide conductivity maps across several orders of magnitude of conductivities [1-3]. In this configuration, the RF magnetic field driving the magnetometer also induces eddy currents in a sample of interest, probing its characteristics. The response of the object – at the same frequency of the RF field – is detected by the RF atomic magnetometer, and mapped in space. In this talk, we will report on our latest results, and on the on-going work for improving spatial resolution [4]. Recent upgrades brought the sensitivity of our imaging platform to $50\,\mathrm{fT}/\sqrt{\mathrm{Hz}}$, with a single atomic magnetometer in an unshielded environment. We will present experimental demonstrations of imaging and sensing for: security screening [5], active remote and underwater surveillance [6], non-destructive evaluation and corrosion under insulation monitoring [7], and characterisation of materials – such as dopant levels in the bulk of semiconductors [3]. Applications to biomedical imaging, in particular perspectives for the diagnosis of atrial fibrillation [8], will be also discussed. The superior performance in terms of sensitivity and tunability, and the novel functionalities of this technique allow one to envisage a quick transition to real-life applications of a new generation of quantum devices, with potential for relevant impact from security to healthcare.

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