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# Progress in Inductive Detection

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Radio-frequency (rf) atomic magnetometers (AM) can measure oscillating magnetic fields (1 kHz-1 MHz range) with fT/√Hz sensitivity and are 2D sensors. Magnetic induction tomography (MIT) measurements require sensitive magnetometers, e.g., for use in the non-destructive testing of pipework and defect detection. Experimental work, verified with COMSOL simulations, shows how changing rf field polarisations across a sample affect the output of the magnetometer, giving the impression that symmetric samples (with no defect) appear to be asymmetric (defective). This full understanding is necessary as the drive towards commercialising the technology approaches.
Work is also presented on developing the two-photon rf AM, which allows us to operate at low frequencies (<1 kHz). All spectral components of the two-photon process are identified, which result from the non-linear interactions between the rf fields and atoms. For the first time, a method for the retrieval of the two-photon phase information, which is critical for inductive measurements, is also demonstrated. Furthermore, a self-compensation configuration is introduced, whereby high-contrast measurements of defects can be obtained due to its insensitivity to the primary field, including using simplified instrumentation for this configuration by producing two rf fields with a single rf coil.
Statistical methods and machine learning can be used to increased data acquisition rate through data reconstruction for inductive measurements, which is vital for real working environment, e.g. in process and field testing. This work will discuss the advantages and disadvantages of this method for defect detection.
Finally, results from our prototype AM is presented, where the sensor is used for the non-destructive testing of defects in metallic samples.

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