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# Measurement of Transient Magnetic Fields Using a Free- Induction-Decay Atomic Magnetometer

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The Transient Electromagnetic Method (TEM) has attracted significant interest because of its non-destructive evaluation, rapid response, and environmentally adaptable. In traditional TEM systems, the signal acquisition module generally utilizes multi-turn induction coils. Based on Faraday's law of electromagnetic induction, these coils detect the secondary eddy currents induced by the primary magnetic field to identify metallic conductors. Nevertheless, it is difficult to measure the small electromotive force induced by a weak low-frequency magnetic field using such method. This constraint limits the potential for sensitivity enhancement and applications of TEM systems.

In this work, we present an alternative technique for measuring transient magnetic fields. It employs a free-induction-decay (FID) atomic magnetometer as the core sensor, replacing conventional induction coils to enhance the capability of extraction of weak signals. Furthermore, an optically-pump-enhanced scheme is utilized [1], which employs the primary pulse to increase the polarization of the atomic ensemble. This enhancement amplifies the FID signal amplitude, thereby improving the measurement sensitivity. The instantaneous-phase retrieval method [2] is applied to reconstruct the eddy-current fields. Experimental results show the successful measurement of the eddy-current fields of copper, aluminum, zinc, and lead. This work exhibits considerable potential for advancing high-precision TEM systems.

References

[1] D. Hunter et al., J. Opt. Soc. Am. B 40, 2664 (2023).

[2] N. Wilson et al., Phys. Rev. Res. 2, 013213 (2020).

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