原子磁强计多层磁屏蔽中磁场噪声的耦合

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Coupling of Magnetic Field Noise in Multilayer Magnetic Shields for Atomic Magnetometer

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Abstract—Ferrite materials are used as magnetic shielding to reduce ultra-low magnetic field noise and interference in ultra-high precision magnetic measurement instruments, including atomic magnetometers. However, there was a shielding coupling between the inner and outer layer of magnetic shields, which affected the shielding effect of the magnetic shields. This study analyzed the magnetic field noise coupling between magnetic shields, and measured the residual magnetic field. Then, after demagnetizing and compensating the coil to remove residual magnetic field, a spin-exchange relaxation-free magnetometer was used to study the coupling magnetic field noise on ferrite. A thermal magnetic noise of $210 f^{-1/2} \cdot fT$ had a significant impact on the magnetic field noise of Mn-Zn ferrite shield. The sensitivity decreased from $0.737 fT/Hz^{1/2}$ to $9.223 fT/Hz^{1/2} @ 30Hz$, and the magnetic field noise raised to $70.05 f^{-1/2} \cdot fT$. The study indicated that the secondary outer layer has a significant impact on the coupling magnetic field noise and magnetic shielding performance of ferrite, while the impact of thermal magnetic noise on the magnetic field noise of ferrite is related to frequency and bandwidth. The research provides a reference for the application of ferrite magnetic shields in atomic magnetometers and the development of shielding devices with wide-frequency electromagnetic shields.

Index Terms—Ferrite Magnetic Shields, Magnetic Field Noise, Noise Coupling, Atomic Magnetometer.