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Spin-based quantum sensing and its applications

Quantum sensing has greatly improved the measurement accuracy of physical quantities such as electromagnetic fields, rotation, time, and gravity, which has brought revolutionary means to many frontier sciences such as verifying basic physical laws. My talk first introduces our developed spin-based metrology for ultrasensitive weak magnetic field measurement. The quantum sensing system is based on alkali metal and noble gas atoms, and both atomic systems achieve sensitivity at the fT level. In addition, I will also describe how to apply the developed magnetic-field measurement technology to zero-field nuclear magnetic resonance and dark matter searches. The developed zero-field nuclear magnetic resonance technology does not require any superconducting magnets and achieves high-resolution zero-field signals for dozens of chemicals, providing new means for material structure measurement. The direct evidence of dark matter existence can give us a better understanding of the composition and origin of cosmic matter, and may lead to a series of major breakthroughs in basic science. We have achieved the search for ultra-light dark matter particles (including axions and dark photons) with a mass range of 1-1000 feV, surpassing the currently recognized most stringent limit in astrophysics.

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