Magnetometry Based on Quantum Interference

S&T Campaign: Materials Research
Photonics
Quantum Information Science

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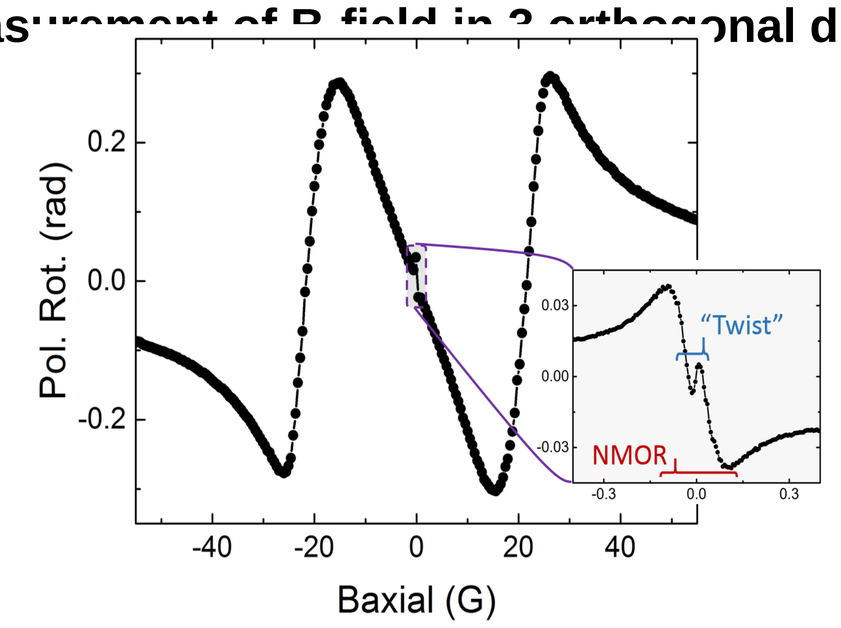
Research Objective

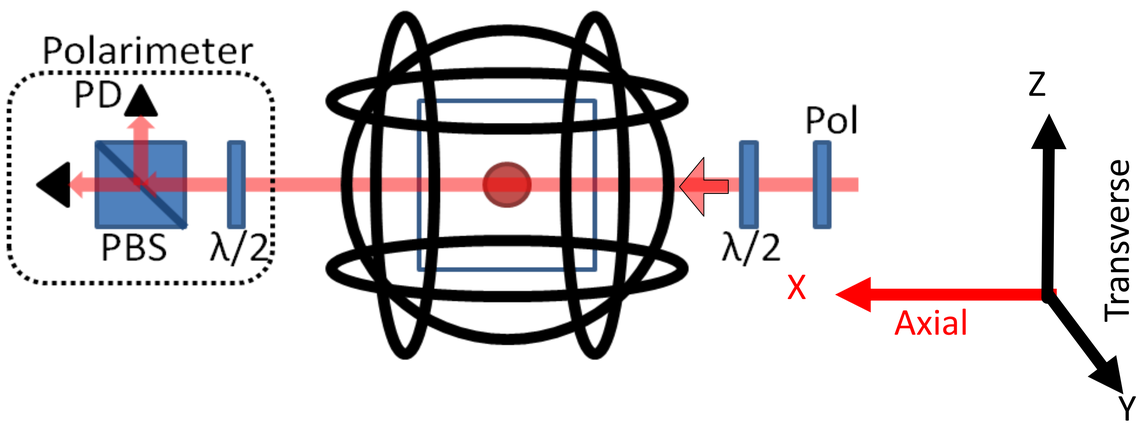
- **We investigate the underlying mechanism behind a novel quantum interference feature, called the "twist", that has applications in magnetometry.**
- **This twist feature enables simultaneous measurement of B-field in 3 orthogonal directions.**



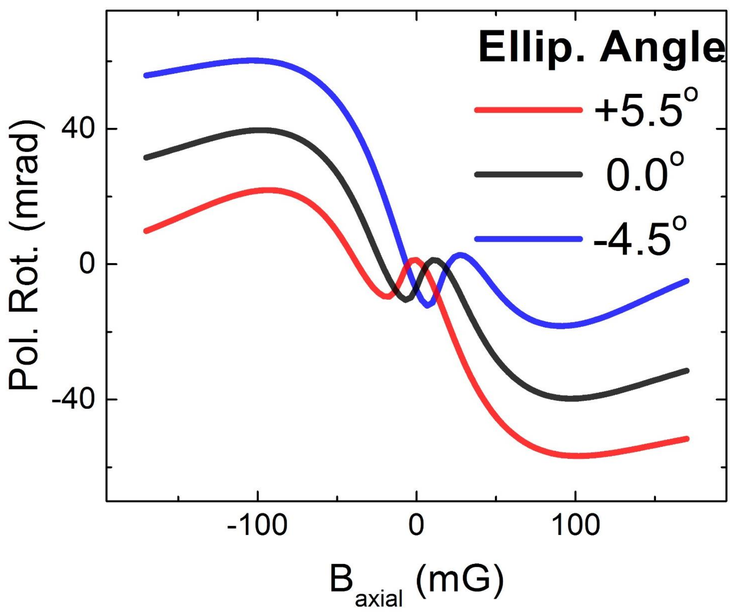
We measure the magnetic field by observing the polarization rotation imparted on a probe laser by the magnetically sensitive atoms.

Challenges

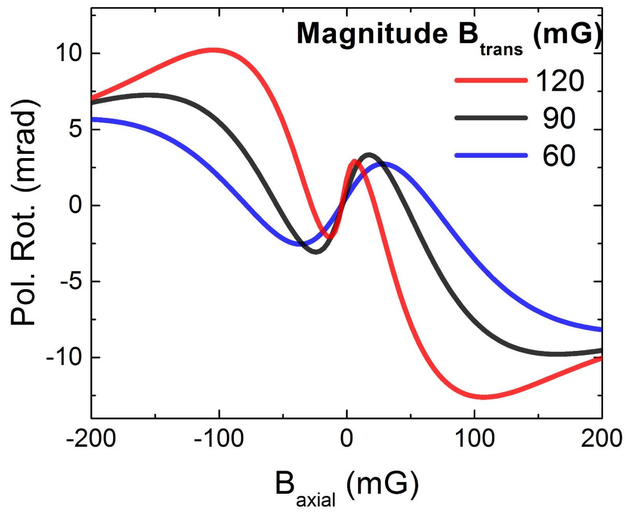
- **Though using warm vapor is *experimentally* simpler, we use laser-cooled vapor to clarify the underlying physical maechanisms.**

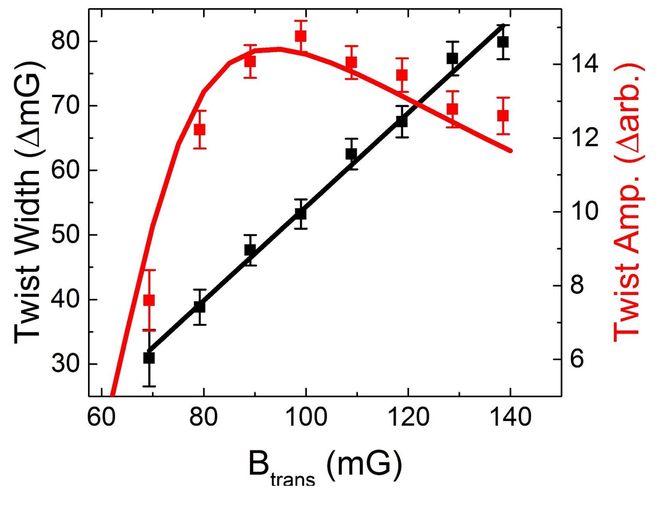


- **Elliptical polarization on the input light can appear as a fictitious magnetic field, thus care must be taken in preparing this light.**



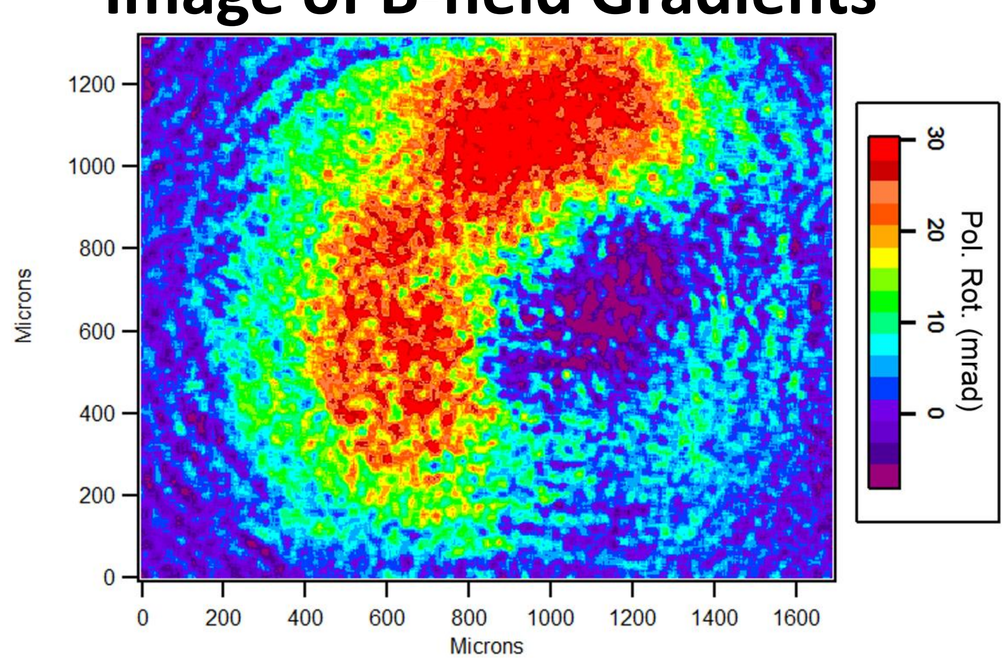
- **Discovered that the twist width scales linearly with magnitude of the B-field component oriented along the light's polarization vector.**





- **By imaging the cold atomic cloud, and using the twist feature we can view magnetic field gradients rapidly in real time.**

Image of B-field Gradients



ARL Facilities and Capabilities Available to Support Collaborative Research

- **Expertise in laser cooling and trapping.**
- **Use of Rydberg atoms as precision sensors and quantum memories.**

Complementary Expertise / Facilities / Capabilities Sought in Collaboration

- **We will be starting new experiments researching neutral atom based quantum repeaters – would love to meet you if you work in this field!**
- **Expertise in compact / chip-scale ultra-high vacuum technology.**
- **Capabilities for custom anodic bonding and optical contacting.**
- **Expertise in optical cavity design and fabrication.**