Lidar Orbital Angular Momentum Sensor (LOAMS)

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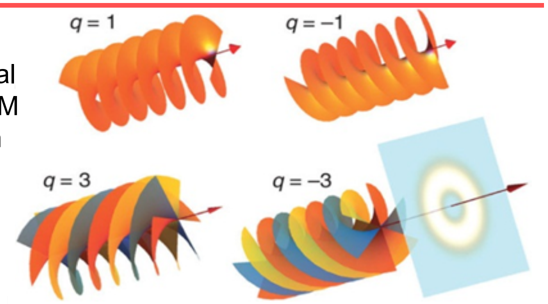
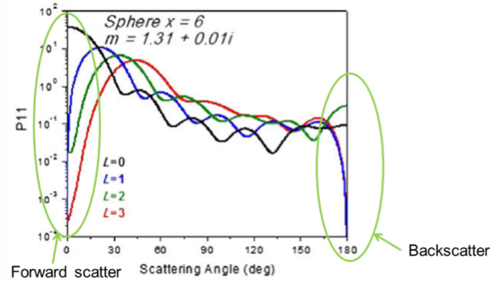
Objective

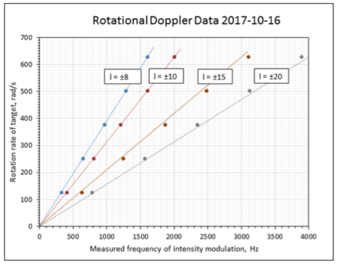
- Investigate how lidars used to study the Earth can be significantly enhanced by using the information encoded in the orbital angular momentum (OAM) of light to provide new measurement capabilities including
  - Rejection of solar background
  - Separation of single and multiple scattering
  - Detection of atmospheric and oceanic turbulence
- Enable higher precision aerosol measurements through the interaction of a laser beam with the atmosphere by using different OAM beam configurations

Vortex beams have helical wavefronts that carry OAM and can code information



Model of Mie Scattering of vortex beam





Accomplishments

- Set-up laboratory capability for creating, manipulating, and detecting light that carries orbital angular momentum in the spatial wavefront in order to study effects relevant to lidar remote sensing of the environment
- Created and adapted wavefront modeling tools to be able to simulate beam propagation and interactions to better understand and extend laboratory results. This included the tools to create vortices using a spatial light modulator, and analyze wavefronts using Shack-Hartmann wavefront sensor and Mach-Zender interferometer. Performed simulations of beam stability showing breakdown of high order OAM states
- Performed Finite Difference Time Domain electromagnetic modeling of the unique interactions between beams carrying OAM and single particles in the Mie and Rayleigh scattering regimes, and interaction with dielectrics surfaces.
- Modeled and tested the breakdown of high order vortices by rough surfaces as an analog to atmospheric Mie scattering
- Modeled and tested how different configurations of spatial coherency filter could be used to separate laser scattering from sunlight (improved SNR), which had been shown to eliminate range bias from multiple scattering
- Demonstrated and characterized the frequency content and amplitude of the rotational Doppler shift due to the non-planar wavefront

Co-Is/Partners: Yong Hu, Wenbo Sun, NASA LaRC

TRL_{in} = 2 TRL_{out} = 3