A Novel Method for Simulating Diffracted Light

Lorio, Mary (School: Saint Joseph's Academy)

There is a limitation in the ability to simulate a high-resolution image of diffracted light. Diffraction occurs when light passes through an aperture. An aperture is a common component of an optical device, such as a telescope, microscope, or camera. This research project proposes a new method for finding the intensity pattern of diffracted light. In this project, an incoming light beam is decomposed into Hermite-Gaussian (HG) modes of light. First, the intensity profiles of HG modes with various indices—two numbers that determine the intensity profiles along the x and y-axes—were simulated from lower-order to higher-order. Next, using the field amplitude of HG modes, the orthonormal condition was derived analytically and verified computationally. After deriving the orthonormal condition, the coefficient of each HG mode was calculated. These coefficients were used to simulate the diffraction pattern of the laser beam after it propagates through an aperture. This theory is tested with a rectangular aperture; however, the method can be applied to any aperture. In this simulation, the resulting intensity profiles depict near field, intermediate field, and far field diffraction patterns by changing the distance of a display screen from an aperture. The far field results (Fraunhofer diffraction) calculated via Kirchoff's diffraction formula are consistent with the results of this research project; thus, this novel method is validated.

Awards Won:

Fourth Award of $500