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Laser Beam Characterization using Gaussian Functions

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In the Attosecond Condensed Matter experiment group, we view light-matter interactions on the attosecond (1 as = 10^{-18} s) timescale using ultrafast lasers. Since lasers are such an important aspect of the research, it is important to characterize them, and understand how effective they are in their functions during experiments. My project is to analyze spatial and spectral characteristics of the lasers we use in the lab by designing opto-mechanical devices and developing a program for a CCD camera that will calculate and display these certain characteristics.

The ideal beam shape is Gaussian, meaning that it is represented by a Gaussian function - or ‘bell curve’ so to speak – for its intensity profile. This type of beam has its highest intensity point at its center, and gradually decreases radially outward from that point, which causes this distribution. Most laser beams, however, are not ideal and cannot be defined by a single Gaussian function, but rather a linear combination of orthogonal functions to compensate for the laser profile variance.

My project uses this concept to compare the quality of a laser with an ideal Gaussian beam. I designed and implemented a program using Python coding language to characterize the intensity profiles in the defined axes of the laser beam, and attribute them to a combination of Gaussian functions that will help identify qualities of that beam. Since beam profiling technology can get quite expensive, we are engineering these laser characterizing devices as a low-risk method to support leading-edge laser technologies.