Department of Mathematics and Statistics
Colloquium Lecture Series

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New two-dimensional basis set: the circularly symmetric basis, with application to the Hubble Space Telescope point spread function

Acquiring space data via a telescope complicates any cosmological estimation or modeling, as this data collection process introduces systematic error: The image we observe via a telescope is the convolution of the "true" image in outer space, and the Point Spread Function (PSF) of the telescope. In order to draw inference from telescope data, the telescope PSF first needs to be estimated and then accounted for (for example, via deconvolution). Here I propose a new model for the PSF, where it is modeled via a two-dimensional, binary, orthonormal circularly-symmetric basis set—which turns out to be applicable to a wide range of other applications such as resonators of lasers, optical fibers, nebula gas, and defense. I derive the properties of the newly developed circularly-symmetric basis set, and draw the mathematical connection between our model and two parametric models, as well as between circularly symmetric matrices and other special matrices. I then generalize the proposed basis set into an elliptically-symmetric basis set via a shear term. I demonstrate that our model outperforms the leading contemporary approach of modeling the PSF via principal component analysis on simulated data as well as data collected by the Hubble Space Telescope (HST), and that the proposed Poisson-plus-Gaussian statistical model for the noise is supported by the HST data.

Thursday, February 12, 2015
Chapman 106
1:00 – 1:50 pm
Refreshments after the talk in Chapman 101A