

## Doctoral Dissertation Defense

# “Regularization Methods for Ill-Posed Poisson Imaging Problems: Mathematical Theory”

by

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The noise contained in images collected by a charge coupled device (CCD) camera is predominantly of Poisson type. This motivates the use of the negative logarithm of the Poisson likelihood functional in place of the ubiquitous least squares fit-to-data functional. However, if the underlying mathematical model is assumed to have the form  $z = Au$ , where  $A$  is a linear, compact operator, the problem of minimizing the negative-log of the Poisson likelihood functional is ill-posed, and hence some form of regularization is required. For us, this involves solving a variational problem of the form

$$u_\alpha \stackrel{\text{def}}{=} \arg \min_{u \geq 0} \ell(Au; z) + \alpha J(u),$$

where  $\ell$  is the negative-log of the Poisson likelihood functional, and  $J$  is a regularization functional. The main result of this thesis is a theoretical analysis of this variational problem for three different regularization functionals. However, we also present an efficient computational method for its solution and we demonstrate the effectiveness of the approach in practice by applying the algorithm to simulated astronomical imaging data corrupted by typical CCD camera noise.

Thursday, May 1, 2008  
12:30 – 2:00 pm in Math 108