1086-VL-2405 **Adrianna M Gillman*** (adrianna.gillman@dartmouth.edu), Department of Mathematics, 6188 Kemeny Hall, Hanover, NH 03755. *Fast direct solvers for elliptic boundary value problems.*

Often elliptic boundary value problems can be reformulated as integral equations. Upon discretization, one is left with the task of solving a large dense linear system that can be solved via an iterative solver (e.g GMRES) coupled with a fast matrix vector multiplication scheme such as the fast multipole method (FMM). Unfortunately, when the system is ill-conditioned (as often happens for complicated geometries) the method can take hundreds of iterations to converge. Additionally iterative methods are not able to efficiently solve problems with multiple right hand sides that frequently arise in design applications. In contrast, the methods we present in this talk are "direct" in the sense that they construct an approximation to the inverse of the matrix. Such direct solvers tend to be more robust, versatile, and stable than iterative methods. This talk will demonstrate that in important environments it is possible to construct an approximate inverse with a computational cost that scales linearly with the number of discretization points. Once constructed, the approximate inverse can be applied with linear computational cost, making direct solvers ideal in situations where the same coefficient matrix is used in sequence of problems. (Received September 25, 2012)