1032-65-63 **Bjorn Engquist** and **Lexing Ying*** (lexing@math.utexas.edu), 1 University Station C1200, Austin, TX 78712. *Fast Directional Multilevel Algorithms for Oscillatory Kernels.* Preliminary report.

This talk introduces a new directional multilevel algorithm for solving N-body or N-point problems with highly oscillatory kernels. These systems often result from the boundary integral formulations of scattering problems and are difficult due to the oscillatory nature of the kernel and the non-uniformity of the particle distribution.

We address the problem by first proving that the interaction between a ball of radius r and a well-separated region has an approximate low rank representation, as long as the well-separated region belongs to a cone with a spanning angle of $O(1/r)$ and is at a distance which is at least $O(r^2)$ away from from the ball. We then propose an efficient and accurate procedure which utilizes random sampling to generate such a separated, low rank representation. Based on the resulting representations, our new algorithm organizes the high frequency far field computation by a multidirectional and multiscale strategy to achieve maximum efficiency.

The algorithm performs well on a large group of highly oscillatory kernels. Our algorithm is proved to have $O(N \log N)$ complexity for any given accuracy when the points are sampled from a two dimensional surface. We also provide numerical results to demonstrate these properties. (Received August 07, 2007)