Many radar and sonar applications require evaluation of the field scattered from complex objects. Usually, the monostatic scattered field is of interest for various aspect angles of interest within a certain band of frequencies. In addition, the range of distances to the target is often such that, for the desired frequencies, it is within the target's near field. At high frequencies, where the physical Optics (PO) approximation is valid, the scattered field can be divided into a series of separate contributions, depending on the number of bounces. For concave geometries, accurate computation of the scattered field requires, taking into account at least the first and second order terms in the series, namely, the "single-bounce" (SB) and "double-bounce" (DB) contributions. In terms of the computational complexity (CC), evaluation of the PO integrals associated with the SB and, especially, DB contributions is still too high for many applications.

In this talk, we present fast algorithms for the evaluation of the SB and DB contributions to the PO scattering integrals, over a range of aspect angles, frequencies, and distances, including for near-field scenarios. The algorithms rely on the observation that partial contributions to the backscattered patterns, due to subdomains of the scatterer surface are essentially band-limited functions of the aspect angles, frequency, and distance. Multiplying these contributions by appropriate common phase factors allows for their sampling over coarse grids of source/observation points and frequencies at rates which are dictated by the subsurfaces' linear dimensions. Savings are achieved by directly evaluating the partial contributions due to very small subdomains on coarse grids at a very low computational cost, and then gradually interpolating and aggregating the contributions to obtain the backscattered fields due to large subdomains, in a hierarchical fashion. Such SB and DB fast-PO algorithms achieve significant reduction in the CC.