Workshop on New Approaches to the Phase Problem for Non-Periodic Objects

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Phase retrieval and zero information

M. A. Fiddy and M. Testorf
University of Massachusetts
Michael_fiddy@uml.edu

Many years ago it was fashionable to analyze the Fourier phase retrieval problem in terms of the distribution of that function's complex zeros. This proved insightful for 1D problems and also in 2D, because of the complexity and likely irreducibility of the function describing a zero. It appeared that uniqueness might be favored, in some sense, in phase retrieval problems in 2D. Of course limited data restricted the usefulness of this analytical statement and the slightest amount of noise also rendered the supposedly factorisable intensity irreducible in practice. Recently, efforts have moved away from locating 2D zeros to understanding what influences the real (point) zero crossings and their frequency of occurrence. This has importance in phase unwrapping and adaptive optics, and has also spawned at least one phase retrieval method [1]. Based on this background we revisited the irreducible nature of 2D spectra and considered whether it would be possible to approximate an irreducible function arbitrarily closely by a factorizable one. While we do not expect factorizability in principle, with limited measurements we cannot really ignore this possibility, We show that quite different objects can be reconstructed from factorizable data consistent with the intensity measurements. The significance of this is that we still need to use an independent criterion to select one of them as the solution, just as we do in most spectral estimation methods, and minimizing some cost function.

[1] Liao C-W, M. A. Fiddy and C. L. Byrne, "Imaging of targets from intensity data," J. Opt. Soc. Amer. A 14, pp3155-3161, 1997.).