Computational Lenses

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Computationally retrieving the phase of a diffraction pattern to form an image of a non-crystalline object has been successfully demonstrated, with images of several millions of resolution elements, from objects as complex as biological cells, nanotubes and nanoscale aerogel structures. The challenge of this imaging technique is transferred from optical lenses to the algorithms. Recent advances [1,2] in reconstruction algorithms based on the hybrid-input-output control feedback loop [3] will be discussed. Experimental arrangements of illumination conditions, reference objects, or detector geometries will be discussed in order to simplify the job of the computational methods.

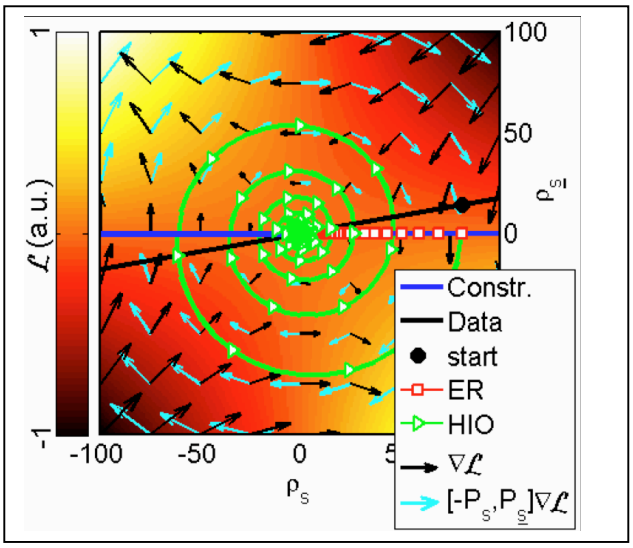

Figure 1: In order to find the intersection of two sets (data and constraints), rather than projecting back and forth between sets, depicted here by straight lines, one seeks the saddle point of the difference of the distances of the current point to each set [2]. That is, we invert the horizontal direction of the gradient.

[1] S. Marchesini, A unified evaluation of iterative projection algorithms for phase retrieval, Review of Scientific Instruments 78, 011301 (2007), arXiv:physics/0603201

[2] S. Marchesini, Phase retrieval and saddle-point optimization, arXiv:physics/0611233.

[3] J. R. Fienup, Phase Retrieval Algorithms: A Comparison, Appl. Opt. 21, 2758 (1982).