

Sparsity in Optical Imaging: Bandwidth Extrapolation, Phase Retrieval, and Nonlinearities

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We consider applications of sparse modeling and compressed sensing to a variety of problems in optical imaging, including subwavelength imaging, coherent diffractive imaging (CDI), and superresolution spectroscopy. We show that many interesting problems in optics reduce to solving a sparse retrieval problem from nonlinear measurements. One particular case of interest is that of phase retrieval, where only the magnitude of the Fourier transform of the image is given. This is the case, for example, in CDI. To treat these problems we develop a general framework for recovery of sparse vectors from nonlinear measurements, and then specialize the results to phase retrieval. We propose an efficient algorithm for phase retrieval and prove certain optimality properties of the proposed method. We also consider conditions on the number of measurements needed for stable phase retrieval and show that surprisingly the results coincide with those obtained in the linear measurement setting (up to constants). We demonstrate our algorithms and results on a variety of problems in optical imaging.