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A Good Phase: Solving the Near-field Phase Retrieval Inverse Problem Quantitatively Using ForwardNET

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In near-field imaging, accurate phase retrieval is crucial for reconstructing complex wavefronts, with applications in optics, microscopy, and X-ray imaging. The beamlines at PETRA III, DESY, like many advanced imaging facilities, involve various inverse problems, including computed tomography, phase retrieval, and image deblurring. Among these, phase retrieval stands out as a non-linear, ill-posed inverse problem that is essential for accurate wavefront reconstruction prior to tomographic analysis. Traditional methods for phase retrieval often lack robustness, particularly under noisy or limited-data conditions. Here, we introduce ForwardNET, a family of generative neural networks specifically designed to address these challenges by learning a forward model that describes the propagation process without needing ground truth data for training. By leveraging this model-driven framework, ForwardNET enables quantitative phase retrieval with high precision. Experimental results demonstrate ForwardNET's superior accuracy and robustness across diverse imaging scenarios, underscoring its potential to significantly enhance phase retrieval and image quality in X-ray imaging and beyond.

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