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Peter G Casazza* (casazzap@missouri.edu), Department of Mathematics, University of Missouri, Columbia, MO 65211. *Phase Retrieval*.

Over the 100 year history of phase retrieval, it has had broad application to x-ray crystallography, electron microscopy, diffractive imaging, DNA, x-ray tomography and much more. Phase retrieval will even be needed to align the mirrors of the new James Webb Space Telescope scheduled for launch in 2018. We will start with the fundamentals of phase retrieval and its applications which have garnered a dozen Nobel Prizes over the years. Only recently have mathematicians entered this area to give a solid mathematical foundation to phase retrieval. In the second half of this talk we will look at recent advances in the mathematics of phase retrieval. Phase retrieval is a class of highly non-linear problems. (Received January 23, 2015)