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Afshar's Non-Complementarity Claim Challenged at O&P 2005

oemagazine reported in January 2005 on an experiment by Shahriar S. Afshar in which he claims to have found a violation of Bohr's Complementarity Principle that the particle and the wave nature of light cannot be measured simultaneously in the same experiment.

Afshar published and presented the same claim in the Proceedings of the "The Nature of Light: What is a Photon" conference ([paper 5866-40](#)) at the recent SPIE Optics and Photonics annual meeting in San Diego. That same week, Drs. Neil J. Gunther (a physicist with Performance Dynamics Consulting) and Giordano B. Beretta (an imaging researcher at HP Laboratories in Palo Alto, CA) presented a theoretical rebuttal of Afshar's experiment at the "Quantum Communications and Quantum Imaging III" conference, [paper 5893-32](#).

Gunther and Beretta point out that the error lies not with the measurements but their interpretation. In the course of a very careful quantum-theoretical analysis of the Afshar interferometer, they discovered that coherent light behaves differently in the lens from that which would be expected for a camera. Interference is indeed present (as Afshar demonstrates) but the fringes are not visible. Regions of interference maxima, however, support photons going straight through the lens as if it had no refractive index at all, while photons passing in between interference maxima and minima refract in the usual way. The result is that photons from each of the two pinholes arrive at both image spots consistent with Bohr's principle---the photon path information is lost in the presence of interference. Experimental tests are planned to confirm this prediction.

Gunther concludes that although Afshar's original claim is very likely wrong, he may have inadvertently put his finger on some new physics that could have important implications for quantum imaging.

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