

THE PHOTON SHEDS LIGHT ON THE QUANTUM:

Fluctuations and correlations tell the story

Marlan O. Scully

Texas A&M University and Princeton University

The study of fluctuations and correlations has historically been a royal road into quantum mechanics. Planck fit the spectrum of thermal light by focusing on its entropy. Einstein used Planck's entropy to calculate the fluctuations of thermal radiation and discovered the particle nature of light.

From one point of view, quantum optics began with the photon-photon correlation interferometry experiment of Hanbury-Brown and Twiss which involves thermal light. The quantum eraser combines entangled light with photon-photon correlations yielding the first entanglement interferometer. In particular, we shall discuss how the availability and/or erasure of information in one point in space-time affects how we interpret data in another. In the words of Aharonov and Zurek:

“The quantum eraser effect dramatically underscores the difference between our classical conceptions of time and how quantum processes can unfold in time. Such eyebrow-raising features of time in quantum mechanics have been labeled ‘the fallacy of delayed choice and quantum eraser’ on the one hand and described ‘as one of the most intriguing effects in quantum mechanics’ on the other.”

BIOGRAPHY

Marlan O. Scully presently holds a joint professorial appointment between Texas A&M and Princeton Universities. He has been involved in many aspects of laser science and quantum optics. These include: the first quantum theory of the laser yielding the laser photon statistics and line width with Willis Lamb, the first demonstration of lasing without inversion, the first utilization of coherence effects to generate ultraslow light in hot gases, and the use of quantum coherence to detect anthrax and poison gas at a distance. Furthermore Scully's work on quantum coherence and correlation effects has shed new light on the foundations of quantum mechanics, e.g., the quantum eraser.

He has been elected to the National Academy of Sciences, the American Academy of Arts and Sciences, the Academia Europaea, and the Max Planck Society and has received numerous awards including the Arthur Schawlow prize of the APS, the Charles H. Townes Award of the OSA, the Quantum Electronics Award of IEEE, the Elliott Cresson Medal of the Franklin Institute, the Adolph E. Lomb Medal of the OSA, a Guggenheim Fellowship, and the Alexander von Humboldt Distinguished Faculty Prize. Also he has recently been selected to be a Loeb Lecturer at Harvard.