Photoelectricity and Quantum Optics: putting the records straight.

Albert Einstein, the great pioneer of modern physics, was awarded the Nobel prize for his explanation of the photoelectric effect in 1905. While recently writing a book on basic concepts in physics, I was struck by the fact that almost all physics textbooks cited Einstein's work as providing a proof for the concept of photons as the discrete energy units of electromagnetic radiation.

In reality, the experimental features of photoelectric effect explained by Einstein in terms of the photon concept are all explained adequately by what is termed the *semi-classical theory* of photoelectric emission where the radiation is treated *classically*, making use of Maxwell's equations, while the atomic electrons are treated as quantum mechanical entities, possessing discrete energy levels.

Ironically, definitive conclusions relating to the quantum nature of radiation could be arrived at only after a series of theoretical and experimental investigations initiated as late as the mid-sixties and early seventies of the last century. In concrete terms, the quantum nature of radiation is revealed by two specific features, namely sub-Poissonian photon-count statistics, and photon anti-bunching, both of which were observed only after the mid-seventies.

Much of the credit for the theoretical description of the quantum features of radiation attaches to Roy J. Glauber, who was awarded the Nobel prize in the year 2005. However, the history of the development of the subject of quantum optics is a complex one. On the theoretical side, pioneers like Emil Wolf, Leonard Mandel, and E. C. George Sudarshan, played a great role in this process, which involved a number of interweaving contributions from several leading stalwarts. The assignment of personal credit to just one individual may not have been commensurate with the complexities inherent in the history of quantum optics.

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