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letters

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sume that their statement was made because I failed to mention that our experimental knowledge of what is termed "photon statistics" is represented by measurements of *photoelectron* counting statistics. As is shown, for example, in the review article by L. Mandel,[1] the latter *can* be derived with no other use of quantum theory than is required to show that the probability per second of photoelectron emission is proportional to the average square of the electric field. This is, of course, the photoelectric effect, which Scully and Sargent included among the phenomena *not* requiring the use of quantum electrodynamics for their explanation. I agree that one does not obtain the "particle" term from a calculation of the energy-density fluctuations of a classical field alone; the presence of the added stochastic element involved in electron emission is essential. But if one chooses to say that the counting of a photoelectron implies the counting of a photon, one is simply demanding the microscopic conservation of energy, which I discussed in my letter, and which Scully and Sargent regard as part of "a turbulent sea of philosophical argument" that is better avoided by concentrating on the comparison of theory with experiment. I agree with them, and it is the experimental comparison of photoelectron counting statistics with the predictions of semiclassical theory that shows that fluctuation in the blackbody spectrum is also not a phenomenon requiring a quantum-electrodynamical explanation.

Reference

1. L. Mandel, "Fluctuations of Light Beams," in *Progress in Optics*, ed. E. Wolf, Vol. II, North-Holland Publishing Company (Amsterdam) 1963.

FORREST C. STROME, JR
Eastman Kodak Company
Rochester, New York

THE AUTHORS COMMENT: We appreciate Forrest Strome's letter clarifying his previous comments on fluctuations in blackbody radiation. We objected to the implication that the "intensity fluctuations in a light beam" can be completely understood with a classical field. In his present letter he pointed out that in practice photoelectrons are what we observe and the fluctuations associated with the photoelectron distribution have both wave and particle contributions, whether calculated by a semiclassical or a fully quantized theory. This point is well taken. [Note however that this is true even when the quantum efficiency (probability of photoemission) is unity (Scully and Lamb, Phys. Rev. **179**, 368, 1969).] In principle, however, we can measure the total (macroscopic) energy in each member of an ensemble of cavities prepared in thermal equilibrium. (A discussion along these lines will be given elsewhere by Chao and Scully.) We could then reduce our data to find the average energy, $\langle E \rangle \propto n_T$, and the fluctuations ΔE. Semiclassical theory for these measurements predicts $\Delta E = n_T^2$, while the fully quantized theory predicts $\Delta E = n_T^2 + n_T$. It is this difference that we regard as providing another vote for a fully quantized over a semiclassical radiation theory.

MARLAN O. SCULLY
MURRAY SARGENT III
University of Arizona
Tucson

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Correction

October, page 64—The most recent edition of *Graduate Programs in Physics and Astronomy and Related Fields* is that of October 1971. It is available for $7.50 prepaid, $8.50 otherwise, as described in the October 1972 issue. Order from AIP, 335 East 45th St., New York, N.Y. 10017. □