This Week's Citation Classic

Forrester A T. Photoelectric mixing as a spectroscopic tool.
J. Opt. Soc. Amer. **51**:253-9, 1961.
[Electro-Optical Systems, Inc., Pasadena, CA]

Equations by which the Fourier spectrum of a photocurrent can be used to obtain the shape of an optical line are developed. The use of lasers as local oscillators in optical heterodyne receivers is shown to be a promising tool. [The *SCI*® indicates that this paper has been cited in over 110 publications since 1961.]

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"It is impossible to describe the genesis of the cited paper without some ancient history. In 1946, William E. Parkins and I were colleagues at the University of Southern California. We had both received our PhDs from Cornell in 1942, had worked together separating uranium isotopes in Berkeley and Oak Ridge in the World War II years, and then set out to launch our research careers. With a brashness based on inexperience we asked not what we could do well, but what was the most important thing in physics to do. We decided that the penetration of the then broad, inaccessible region between one centimeter wavelength microwaves and the near infrared should be attempted. Among the ideas which grew out of our wild brainstorming was that of beating light waves.[1] We soon convinced ourselves that signals generated this way (in pre-laser days) would be terribly weak,[2] but we encountered a widespread, fallacious belief among many physicists that an observation of beats between incoherent light waves would be impossible for fundamental reasons, not merely difficult. I found the challenge to prove them wrong irresistible and set out to do the experiment, fortunately with the assistance of an extraordinary graduate student, Richard A. Gudmundsen. The light source, the photosurface, the microwave receiver, the phase sensitive detection scheme, and other features as well, all had to be pushed beyond the then existing state of the art and it was eight years before our efforts culminated in success.[3]

"Before this effort reached this point, I was persuaded that this work was becoming an obsession and scheduled a sabbatical leave which carried me into other fields. In 1960, when the first Rochester Conference on Coherence Properties of Electromagnetic Radiation featuring my earlier work and that of Brown and Twiss[4] was scheduled, I was far separated from thoughts of optical coherence. At this conference it became clear that lasers were imminent and there was even a rumor that Maiman had already made a ruby laser. It was clear to me that photoelectric mixing would no longer be a very difficult laboratory observation but would, in fact, become a useful tool for obtaining optical line shapes. The material of the cited 1961 paper was largely contained in notes which had been worked and reworked in the 1946-1954 period and, inspired by discussions at the Rochester conference, I very largely wrote the paper on the plane back to Los Angeles.

"The importance of line shapes for diagnosing various phenomena is probably responsible for the wide use of this technique and, therefore, the large number of citations. For example, the spectrum of laser radiation scattered in opalescence, in Rayleigh, Brillouin, or Thomson scattering, contains valuable information about the phenomena and is most easily observed by using some of the unscattered radiation as the local oscillator of a heterodyne receiver."

1. **Forrester A T, Parkins W E & Gerjuoy E.** On the possibility of observing beat frequencies between lines in the visible spectrum. *Phys. Rev.* **72**:728, 1947.
2. **Gerjuoy E, Forrester A T & Parkins W E.** Letter to editor. (Signal-to-noise ratio in photoelectrically observed beats.) *Phys. Rev.* **73**:922-3, 1948.
3. **Forrester A T, Gudmundsen R A & Johnson P O.** Photoelectric mixing of incoherent light. *Phys. Rev.* **99**:1691-700, 1955.
4. **Brown R H & Twiss R Q.** Correlation between photons in two coherent beams of light. *Nature* **177**:27-9, 1956.