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This week's Citation Classic

Sorokin P P & Lankard J R. Stimulated emission observed from an organic dye, chloro-aluminum phthalocyanine. *IBM J. Res. Develop.* **10**:162-3, 1966. [IBM Research Laboratory, Yorktown Heights, NY]

Stimulated emission was observed when a solution of chloro-aluminum phthalocyanine dissolved in ethyl alcohol was irradiated by the beam from a giant-pulse ruby laser. The wavelength of this stimulated emission was centered at approximately 0.755 μm. Its spectral half-width was observed to be some 5 cm-[1]. [The *SCI*® indicates that this paper has been cited over 130 times since 1966.]

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"The reason for the many citations to this article is that it provided the first real demonstration that stimulated emission (i.e., lasing action) could be induced on the strongly allowed fluorescent transitions of organic molecules. A laser of this type is today known as a dye laser.[1]

"Our original motivation to try the experiment which led to the result described above derived from our having had on hand certain remarkably stable phthalocyanine compounds prepared for a bleachable dye absorber experiment we had previously conducted.[2] The striking aspects of the spectra of these dyes led us to believe that there were other ways in which they could be utilized as elements in quantum electronic devices. One idea was to try to produce stimulated (resonance) Raman scattering from concentrated solutions of the dyes, with the required primary beam being provided by a Q-switched ruby laser. Another thought was to attempt to obtain stimulated emission from the dyes, using a ruby laser as a fast flashlamp. Because the most soluble of the phthalocyanines, chloro-aluminum phthalocyanine, had its maximum absorption peak shifted somewhat from the ruby laser frequency, we initially opted to try the first experiment. When the spectrum of the light emitted from the ruby-laser-irradiated cell was examined, it was apparent that we had instead succeeded with the *second* experiment: we had observed stimulated emission from the dye. The above result immediately led to an intensive investigative effort by our group at the IBM Research Laboratory, Yorktown Heights, New York. The effect was soon seen to be quite general, occurring for many dyes, with laser wavelengths being generated throughout the visible and near IR spectral ranges. Interest in this subject began to spread rapidly, and important results started flowing from other laboratories, most notably that of F.P. Schäfer in Marburg, Federal Republic *of* Germany. (Schäfer, unaware of our work, had independently observed stimulated emission from dyes only a few months after our initial observation.) It was soon demonstrated that dyes could emit powerful pulsed beams of coherent light when flashlamp excitation was substituted for the pump laser. Later, it was also shown that certain dyes could be made to generate continuous wave beams of light.[3]

"Dye lasers today are in wide scientific use, partly because the active dye media can be handled conveniently, but more so because these lasers are capable of producing beams of light with sharply defined frequencies that can be *continuously tuned* throughout the visible, near infrared, and near ultraviolet. This feature permits the selective excitation of various atomic and molecular energy levels, thus forming the basis for the true revolution in spectroscopy that subsequently resulted. Credit for the discovery of the feature of continuous narrowband tunability of dye lasers belongs to B.H. Soffer and B.B. McFarland, who reported their work in 1967.[4]

"For the discovery of the dye laser, I was awarded both the Michaelson Medal by the Franklin Institute in 1974 and the R.W. Wood Prize by the Optical Society of America in 1978."

1. **Schäfcr F P.** Principles of dye laser operation. *Top. Appl. Phys.* **1**:1-85, 1977.
2. **Sorokin P P, Luzzi J J, Lankard J R & Pettit** G **D.** Ruby laser Q-switching elements using phthalocyanine molecules in solution. *IBM J. Res. Develop.* **8**:182-4, 1964.
3. **Peterson O G, Tuccio S A & Snavely B B.** cw operation of an organic dye solution laser. *Appl. Phys. Lett.* **17**:245-7, 1970.
4. **Soffer B H & McFarland B B.** Continuously tunable, narrow-band organic dye lasers. *Appl. Phys. Lett.* **10**:266-7, 1967.