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This Week's Citation Classic

Hänsch T W. Repetitively pulsed tunable dye laser for high resolution spectroscopy.
Appl.Optics **11:**859-8, 1972.
[Depatment of Physics, Stanford University, Stanford, CA]

A pulsed tunable dye laser has been described which can generate intense, highly monochromatic, tunable radiation throughout the visible spectrum. Pumped by a nitrogen laser, it achieves bandwidths of less than 0.004 Angstroms with the help of a diffraction grating in Littrow mount together with an intracavity beam expanding telescope and a tilted Fabry Perot interferometer. [The *SCI*® indicates that this paper has been cited over 240 times since 1972.]

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"In May of 1970 I came to Stanford as a NATO Fellow on leave from the University of Heidelberg, to work with Professor Arthur Schawlow.

"On my way I had visited Herb Kogelnik and coworkers at Bell Laboratories. They were experimenting with a pulsed dye laser, excited by a nitrogen laser, a particularly effective pump source for many dyes. Using a thick holographic grating as a wavelength selective cavity reflector they had produced widely tunable radiation with line widths down to 0.4 Angstroms, considerably more monochromatic than had been achieved before with nitrogen-pumped dye lasers.[1]

"I was intrigued by these results, and I felt that it should somehow be possible to obtain still much higher spectral purity. Such a dye laser would be a very powerful tool for spectroscopy. I was hoping to isolate one single axial resonator mode in a nitrogen-pumped dye laser by combining a holographic grating with a Lyot filter. Art Schawlow found my suggestions interesting, and since research funds were still relatively plentiful, he agreed to purchase a nitrogen laser. Soon after delivery I obtained some encouraging preliminary results, and I submitted an Abstract for the APS Meeting at Stanford in December.[2] Unfortunately, it proved difficult to generate monochromatic light reliably in the envisioned way. One of the main problems was the short pulse duration, which permitted only a few round trips of the light in the resonator.

"After many weeks of frustration, I decided to try and follow an unusual alternative approach. The very high gain of nitrogen-pumped dyes made it seem feasible to place an extremely narrow band and hence very lossy wavelength selective filter inside the resonator. It should still be possible for a single spontaneously emitted photon to be amplified to substantial pulse energy in just a few round trips. By using an 'unstable' cavity geometry, the output beam should be nearly diffraction limited.

"The first laser according to this approach[3] worked well beyond expectations, and in time for the 1970 APS Meeting. Line widths of 0.004 A were readily produced with high peak power, the wavelength could be tuned conveniently and reproducibly, and further line narrowing could be accomplished with a filter interferometer outside the cavity. The laser design described in detail in the 1972 paper was soon adopted as a standard in many laboratories, and it has made possible numerous pioneering experiments in laser spectroscopy. It has also been incorporated into more sophisticated laser systems, and it has inspired several modified designs."

1. **Kogelnik H, Shank C V, Sosnowski T P & Dienes A.** Hologram wavelength selector for dye lasers. *Appl. Phys. Lett.* **16**:499-501, 1970.
2. **Hänsch T W & Schawlow A L.** Single mode operation of repetitively pulsed organic dye lasers. *Bull. Amer. Phys Soc.* **15**:1638, 1970.
3. **Hänsch T W. Shahin I S & Schawlor A L.** High-resolution saturation spectroscopy of the sodium *D* lines with a pulsed tunable dye laser. *Phys. Rev. Lett.* **27**:707-10, 1971.