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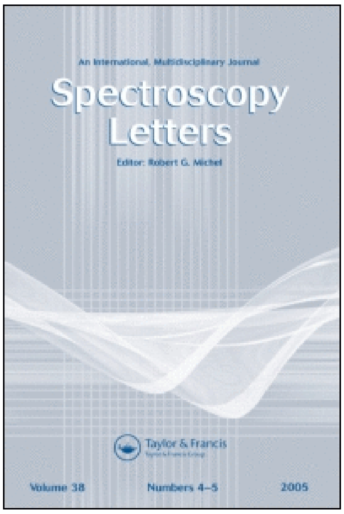

Spectroscopy Letters
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713597299

Polychromatic Pulsed Dye Laser

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To cite this Article Nakashima, Masato and Sousa, John A.(1974) 'Polychromatic Pulsed Dye Laser', Spectroscopy Letters, 7: 1, 15 — 17
To link to this Article: DOI: 10.1080/00387017408067214
URL: http://dx.doi.org/10.1080/00387017408067214

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SPECTROSCOPY LETTERS, 7(1), 15-17 (1974)

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POLYCHROMATIC PULSED DYE LASER

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One of us had previously reported an instrument that produces pulsed laser beams with multiple colors.[1] A pulsed nitrogen laser was focused on a 1 cm fluorometer cell mounted on a circular rotating table. As the table was rotated by a motor, the nitrogen laser was triggered synchronously as another cell moved into the focal point, and the dye laser output was obtained as a spacially superimposed beam. By filling the cells with various laser dye solutions, it was possible to tune to a number of wavelengths.

We now wish to report a device that generates a laser pulse with a number of wavelengths not only spacially superimposed but simultaneously. The idea for this device was conceived in the course of our study of the efficiency of laser dye solutions. We found that only a fraction of energy from a single pulse of a 100 kw nitrogen laser was necessary to pump a dye laser effectively. A fluorometer dye cell 1 cm wide showed laser action when it was exposed to a linearly focused nitrogen laser, 5.5 cm wide. This observation suggested use of a number of such cells to produce laser beams with many colors from a single pulse of the nitrogen laser, since many efficient laser dyes are now known.

The device consisted of an AVCO Model 5000 100 kw nitrogen laser, a quartz cylindrical lens, and four standard 1 cm square fluorometer cells. The size of the cells was chosen merely for its availability. The four cells

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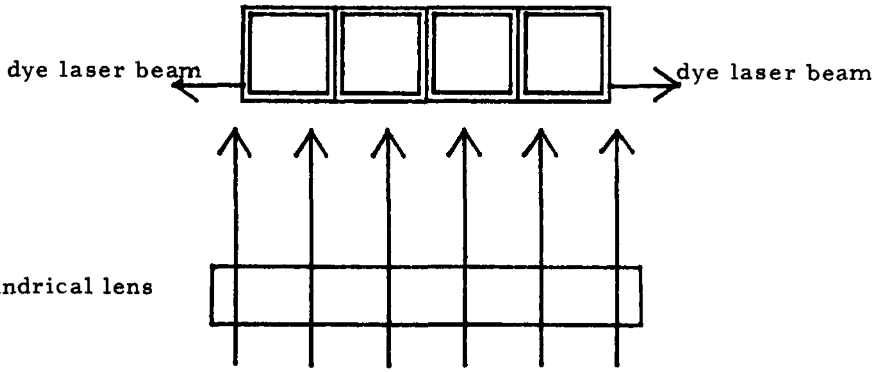
containing various dye solutions were arranged in tandem. The pumping nitrogen laser was focused on the cells by the lens. The following figure shows the experimental arrangement.



The wavelengths could be selected by a choice of dye solutions, concentration, and acidity. For instance, when we used 4-methylumbelliferone (4MU), a coumarin dye, in concentrated acid, the same dye in dilute acid, rhodamine 6G in basic ethanol, and rhodamine B in basic ethanol, blue, green, yellow and red beams were obtained from the respective dyes. Any combination of these colors can be obtained simply by blocking a portion of pumping laser. The cells were lined up in the sequence mentioned, the coumarin cells being closer to an output end. If a rhodamine cell was in front of a coumarin cell, the laser beam from the latter was completely absorbed by the former before it could reach the output end. Usually, a shorter wavelength emitter must be placed closer to the output end. However, in the case of 4 MU in dilute acid (λ_{laser} 490 nm), absorbance of the solution is very small down to 400 nm, and any wavelength longer than 400 nm can pass through the solution.[2] Therefore, it does not matter whether the cell containing 4MU in concentrated acid (λ_{laser} 410 nm) is placed in front or back of the other 4 MU cell.

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When the cells are critically aligned, a good superposition of colors in the output beam is observed, and pumping of one dye cell by both the nitrogen laser and another dye laser takes place. This dual pumping was proved by the following experiment. When two 1 cm cells, one containing ethanol solution of rhodamine 6G and another containing 4MU in dilute acid were held together, laser emission from both cells took place upon pumping by the nitrogen laser. The output from 4 MU impinging on the rhodamine cell was completely absorbed. A block was placed in the path of the nitrogen laser impinging on the coumarin cell, and an increasing portion of the nitrogen laser beam to the rhodamine cell was blocked until the dye laser action ceased completely. At this time, the block was removed from the coumarin cell, and the laser actions from both cells were resumed.

In conjunction with the polychromatic laser, we wish to note that a two color laser beam can be produced from two layers of solution in a single cell cavity also. This was demonstrated by pumping a vertically held 6 cm dye cell with the focused nitrogen laser vertically oriented. The cell was carefully filled through a neck in the center first with 4 MU in concentrated acid, and then with the same dye in dilute acid. The delivery of the solutions was accomplished by the use of a syringe fitted with a Teflon needle to minimize the mixing of the two solutions. The cell was let stand for a few minutes to reach stability. When the cell was pumped by the nitrogen laser, both blue and green laser emissions were observed. This dye has a particular advantage in that a small extent of mixing of the two solutions does not interfere with the laser action.

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Received December 7, 1973
Accepted December 14, 1973