

XI. QUANTUM OPTICS AND ELECTRONICS

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1. PICOSECOND DYE LASER OPTICS

Joint Services Electronics Program (Contract DAAG29-78-C-0020)

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Michael M. Salour, Stanley R. Rotman, Richard Bebelaar

We have developed a new method of pulsewidth stabilization of a synchronously pumped dye laser. Our work represents the first attempt to stabilize the pulses by measuring the pulsewidth and maintaining it at a minimum using analog and digital feedback acting, respectively, on the mode-locking frequency and the cavity length of a synchronously pumped mode-locked dye laser. In this way, we have been able to counterbalance the undesirable effects, such as the plasma instabilities in the Ar^+ laser, thermal drift in the cavity length of the dye laser, and the electronic noise in the oscillator that provides the signal for the acousto-optic mode locking of the crystal, which when combined produce fluctuations both in the amplitude and pulsewidth of the picosecond pulses. In this way, we have been able to reproducibly generate pulses as short as 0.7 picosecond.

We have also achieved larger interpulse separation and more energy per pulse by both cavity-dumping and amplifying selected pulses from the cavity dumper in

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synchronism with the frequency-doubled output of an amplified Q-switched Nd:YAG laser. Four stages of amplification are used. We are currently obtaining powers of the order of 3 gigawatts at the repetition rate of 10 Hz with pulses as short as 0.8 picosecond. In addition, we have been able to reproducibly generate sub-picosecond continuums by focusing the output of the last amplifier stage in water.

Publications

- Rotman, S.R., C.B. Roxlo, R. Bebelaar, and M.M. Salour, "Stabilization of Picosecond Pulses from a Synchronously Pumped Dye Laser," Appl. Phys. Lett., to appear June 1980.
- Rotman, S.R., C.B. Roxlo, R. Bebelaar, and M.M. Salour, "Pulsewidth Stabilization of a Synchronously Pumped Dye Laser," Proceedings of the International Conference on Picosecond Phenomena, Falmouth, MA, June 1980.

2. NONLINEAR SPECTROSCOPY OF ATOMS AND MOLECULES

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National Science Foundation (Grant ENG79-08031)

Michael M. Salour, Guillaume M.A. Petite, Bartley C. Johnson,
Wulfhard K.H. Lange

We have made the first observation of unidirectional gain in a sodium vapor induced by velocity-dependent light shifts. Our observation was based on creating unidirectional amplified spontaneous emission (ASE) light through Doppler compensation. We have demonstrated that the ASE light intensity depends strongly on the total gain of the medium, $\exp(g \cdot \ell)$, where g is the gain per unit length and ℓ the length. In addition, due to the exponential dependence, we have demonstrated that even a small change of the gain curve width and height will give rise to a dramatic forward/backward (in relation to the compensating laser direction) gain asymmetry, resulting in unidirectional ASE. Our work has also introduced a novel kind of light-induced light switching where the switching is brought about by the rapid relaxation of the population inversion under high forward-gain conditions, and accompanied by a burst of ASE light.