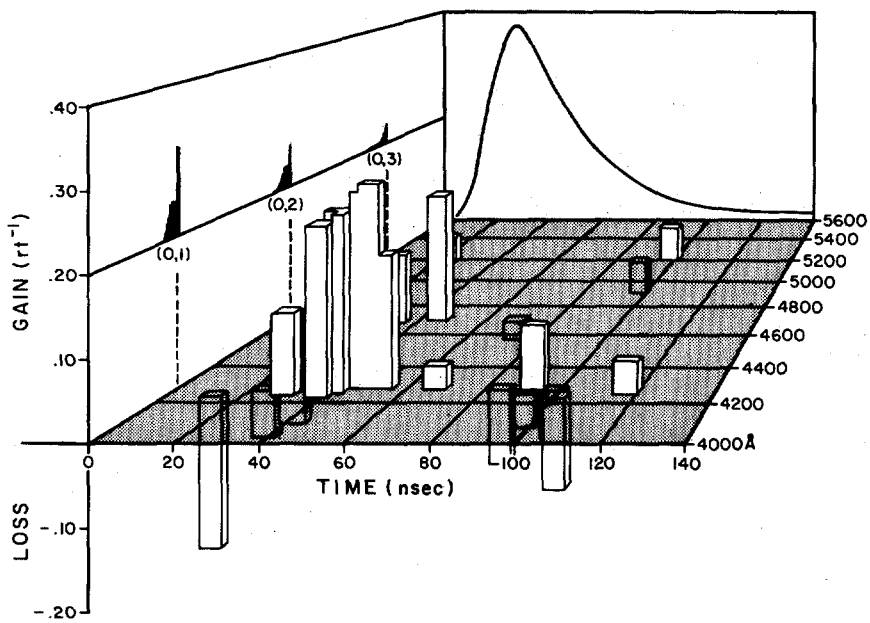

Fig. 2. Fractional gain per roundtrip as a function of wavelength and time of the afterglow of a three atmosphere helium and 1 Torr nitrogen discharge. Three members of the First negative Band System are shown at 4278 Å (0,1), 4709 Å (0,2), and 5228 Å (0,3). Regions of stimulated emission lie above the x,y plane; abosrption, below. Across the x,z plane to the rear of the data has been plotted the time dependence of the spontaneous emission and on the plane to the left edge are shown the normal emission spectrum outline of the three features.

action at pressures as high as 42 atm. In the absence of CO_2, the optically pumped N_2O laser cannot oscillate at pressures above 7.5 atm.

The high density of active molecules and the high degree of population inversion in optically pumped high pressure lasers gives rise to very high optical gain. In fact, a resonator as short as 1 mm is sufficient to provide enough gain for oscillation. Such a short cavity provides a favorable condition for continuous tuning over a large spectral range without mode-hopping. In addition, the high gain and broad continuous bandwidth give rise to output pulses of only 2 to 10 nsec duration and may make possible the generation of picosecond pulses by mode-locking.

S.8 The Effect of "Radial Radiation Transport" on the Interpretation of Laser Saturation Parameter Measurements, G. J. Ernst and W. J. Witteman, *Twente University of Technology, Enschede, The Netherlands.*

It has been remarkable that published data on laser saturation parameters show a large spread, even for measurements done with the same amplifier. Usually the interpretation of the measurements have been done on the simple basis of considering the amplified radiation as gained from a medium bounded by an effective beam diameter, i.e. the width of a Gaussian beam. In this way it is found that the saturation parameter depends strongly on the beam diameter. This behaviour can sometimes partly be understood by considering also the diffusion of excited particles. There is however another very important mechanism that has to be included.

Since the measurements are done in a saturated medium, usually with a Gaussian beam, the medium is at the centre of this beam more saturated than aside of it. This causes a gain profile having increasing gain with the distance from the centre. One might expect at first glance that this profile would tend to broaden the beam. This, however, is practically not the case as we pointed out previously,[1] because due to these gain variations the wave front converges and the beam width is not changed substantially by the medium. The experimental observation that the amplified beam is practically not broadened by the induced gain profile might have suggested in the past that this profile is unimportant for saturation parameter measurements. On the contrary, from our analysis and measurements with a CO_2 amplifier it is shown that this profile can play a dominant role.

An importance consequence of the induced convergence of the wave front is the radial radiation transport which we described earlier.[2] It turns out that this transport is comparable with and sometimes even more than the radiation gained directly from the medium. Because this radiation transport increases with the gain variations it is obvious that the medium seems to be more difficult to saturate when the beam is smaller in diameter. This means that not taking into account this radial radiation transport an error of a factor two or more in the saturation parameter results. This phenomenon must be included in the deduction of saturation parameters from measurements in both homogeneously and inhomogeneously broadened media.

The measurements with a CO_2 amplifier show a strong dependence of the "apparent saturation parameter" on the beam diameter. A quantitative analysis of this phenomenon will be presented. The medium parameters can be approximated by quadratic terms because a serial expansion of propagation constants in terms of radial distance from the axis shows that the main term near the axis, where the field is strongest, is quadratic. It will be shown by numerical calculations that if the above mentioned effects are taken into account the beam diameter dependence can be fully understood and the saturation can be expressed by just one medium parameter independent of beam width.

[1] G. J. Ernst and W. J. Witteman, *IEEE J. of Quantum Electronics*, vol. QE-9, p. 911, 1973.

[2] G. J. Ernst and W. J. Witteman, *IEEE J. of Quantum Electronics*, Jan. 1974.

S.9 A Continuous Positive-Column He-I^+ Laser Using a Sealed-Off Tube, Shuzo Hattori, Hiroyuki Kano and Toshio Goto, *Department of Electronics, Nagoya University, Nagoya, Japan.*

Continuous He-Cd^+ and He-Se^+ lasers are known as practical lasers in the visible spectral region. On the other hand, although pulsed I^+ laser oscillation was got in 1964, continuous laser oscillation in a positive column discharge has not been realized until recently, perhaps on account of the difficulty in controlling iodine pressure and large iodine pressure gradient coming up in a laser tube by a cataphoresis effect. We reduced the two difficulties by the use of molecular sieves and have obtained cw laser oscillation for five visible lines in the positive-column He-I_2 discharge.[1] In this work, we removed those problems by the more improvement of the new method to use the molecular sieves and constructed a sealed-off I^+ laser of a total power around 40 mW at maximum for the five lines and life of few hundreds hours.

A laser tube was 3.5 mm in diameter and 123 cm in length and had a hot cathode of tungsten. Two concave mirrors of a 100% reflectivity were used and a laser power was taken out with a coupling plate inserted in a resonator. Two pockets containing molecular sieves with and without iodine were placed near an anode and a cathode, respectively. This tube was sealed off after helium gas was filled. The optimum iodine pressure for laser action was obtained by warming up the molecular sieves near the anode up to 130°C corresponding to 2×10^{-2} Torr, which was determined from a voltage between electrodes of the tube. Iodine particles ionized in the positive column helium discharge were carried to the cathode by the cataphoresis effect and were eliminated by the molecular sieves near the cathode. Thus iodine pressure in a capillary was always kept uniform and continuous I^+ laser oscillation could be maintained.

In Fig. 1, the characteristics of the laser powers of the five lines are shown as functions of

[1] S. Hattori, H. Kano, et al., to be published.