S6-4 A Narrowband Dye Laser System with Injection-Seeding for a Mesospheric Na Temperature Lidar

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1. Introduction

The temperature and wind profiles of the mesopause region can be obtained by actively probing the mesospheric neutral Na layers located between 80 and 110km. This idea was first applied by Gibson et al.(1), who were able to deduce the temperature by the way that the laser output was scanned over a relatively wide frequency range to adequately cover the Na fluorescence spectrum. She et al. (2) succeeded to measure the Na temperature more efficiently by tuning the laser alternately between the frequencies at the Na D2a peak and a fixed location near the valley between the two peaks of the Na fluorescence spectrum. This technique requires precise, repeatable laser tuning as well as pulse-to-pulse stability. For achieving this tuning precisely, they used an actively stabilized single-mode cw ring laser, followed by a pulsed dye amplifier to pulse-amplify the cw ring laser beam.

We develop the injection seeded dye laser instead of the single amplifier dye laser for observing the temperature structure in the mesopause region. This paper describes the characteristics of the pulsed dye laser system injection-seeded by the single-mode cw ring laser. This laser system can provide precise and repeatable laser tuning with the narrow laser spectrum, and moreover, it can obtain higher pulse-energy than the single amplifier system.

2. Experimental Setup

Figure 1 shows a block diagram of the injection-seeded dye laser system. The ring oscillator is optically pumped by a frequency-doubled cw Nd:YAG laser. The bandwidth of this cw ring laser is about 500KHz rms and it is used as an injection seeder for a followed pulse dye laser. The pulsed dye laser is pumped by an injection-seeded frequency-doubled pulse Nd:YAG laser. This pulse dye laser consists of an oscillator and an amplifier. The reflectivity of the rear mirror of the dye laser oscillator is 90% and that of the output coupler is 30%. The longitudinal mode of the oscillator must be coincided with the frequency of the ring laser.

3. Experimental Results

Figure 2(a) shows the Fabry-Perot interference fringe pattern of the pulse dye laser (pulse length: ～4ns) without injection seeding, and Figure 2(b) shows the fringe pattern of the pulse dye laser with injection seeding. The free spectral range (FSR) of the Fabry-Perot etalon used with measurement is 1.5GHz. Though this laser system is not achieved to the optimum design, the output energy of 90mJ/pulse at 10 repetition rate is obtained from the injection-seeded pulse dye laser system. And, then the resulting laser line-shape is nearly Fourier transform limited.

4. Conclusion

In this paper, we show that injection seeding provides efficiently higher pulse energy and the resulting laser line-shape is maintained with narrowband. This laser system is expected to be applied usefully to the Na resonance scattering lidar for temperature measurement in the mesospheric region.

References

(1) A. Gibson et al., Nature, Vol. 281, pp.131-132, 1979

(2) C. Y. She et al., Geophys. Res. Letts, Vol. 17, pp. 929-932, 1990.

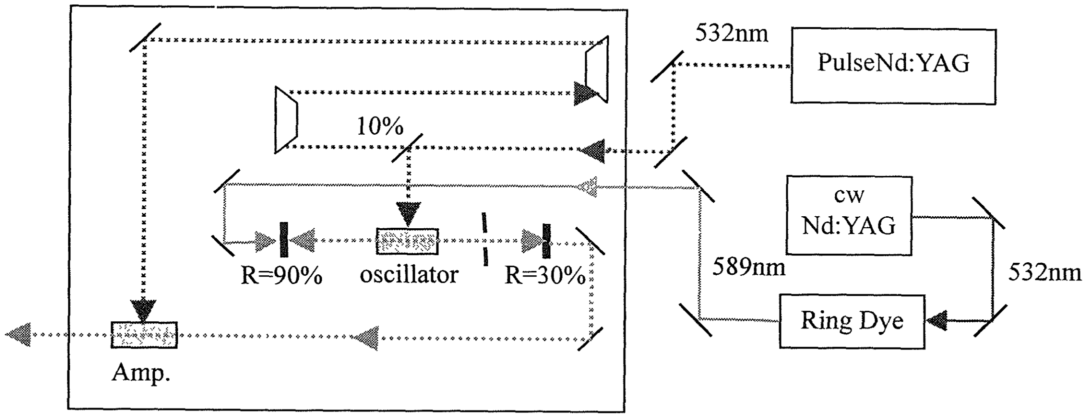
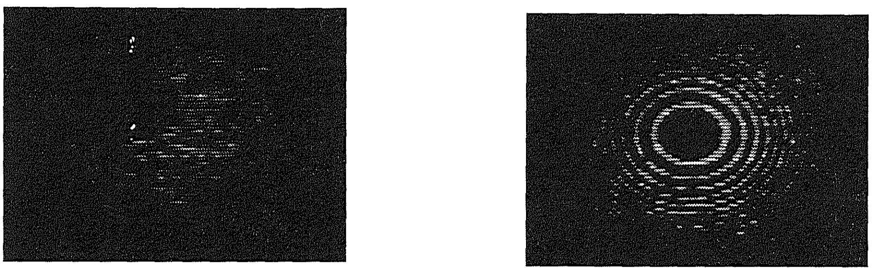


Figure 1 The block diagram of the injection-seeded dye laser system.



(a) (b)

Figure 2 The Fabry-Perot interference fringe pattern of the pulse dye laser. (FSR=1.5GHz)
(a) without injection seeding (b) with injection seeding