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INFRARED GENERATION AND WAVE-MIXING STUDIES IN CESIUM

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Abstract

A Nd-YAG pumped dye laser and heat pipe has been used to investigate stimulated infrared production, wave mixing, and ionization in cesium vapor near the one-photon resonant $7P_{1/2,3/2}$ fine structure states.

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Summary

A Nd-YAG laser (Quanta Ray DCR-II) and dye laser (Quanta Ray PDL-I) have been used in combination with a Cs heat-pipe oven (70 cm length, 3 cm diam) to probe tunable infrared generation by stimulated electronic Raman scattering (SERS) and to examine wave-mixing processes in which SERS photons are combined with the input laser frequency. In addition, we have made simultaneous ionization measurements using an insulated collection wire through the heat pipe parallel to the laser beam. Cesium pressures were in the region from 5 to 12 torr; average input power during the ~5 ns laser pulses was 2 x 10^6 W at the dye peak near 460 nm. The region chosen for examination in this study was that surrounding the Cs $7P_{1/2,3/2}$ fine structure states. Previous studies in this region at lower power have been reported by Cotter and Hanna[2] and by Wynne and Sorokin[3].

Figures 1 and 2 show infrared and total red emission intensities, respectively, over the input (blue) pump wavelength range from 445 to 470 nm. In Fig. 1, in addition to the SERS emission which appears on either side of each of the 7P fine structure resonances at 459.4 ($7P_{1/2}$) and 455.7 nm ($7P_{3/2}$), there are a number of other features. These will be discussed in the paper. The total red emission spectrum largely corresponds to wave

mixing of the form $\omega_L - 2\omega_s$, as described by Wynne and Sorokin,[3] where ω_L is the input laser frequency and ω_s is that of the corresponding SERS photon. When the laser is tuned to either of the 7P states, forward directed green emission is observed but not presently understood. Scans of multiphoton ionization intensity over this region show minima at the fine structure resonance positions at low laser power and a transition to broad ionization continua peaking at the resonance positions at high power. The influence of SERS emission on multiphoton ionization will be discussed.

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References

1. Physics Department, Davidson College, Davidson, North Carolina 28036.

2. D. Cotter and D. C. Hanna, J. Phys B 9, 2165 (1976).

3. J. J. Wynne and P. P. Sorokin, "Nonlinear Infrared Generation" (Y-R Shen, Ed.), TOPICS IN APPLIED PHYSICS, 16, 159, Springer Verlag, Berlin and New York (1977).

Figure Captions

Fig. 1. Infrared emission intensity vs pump laser wavelength. The cesium $7P_{1/2}$ fine structure resonance is at 459.4 nm; the $7P_{3/2}$ at 455.7. The major peaks on either side of the 459.4 nm position and the two smaller peaks immediately to either side of the 455.7 nm position are produced through the stimulated electron Raman scattering process.

Fig. 2. Total red emission intensity vs pump laser wavelength.

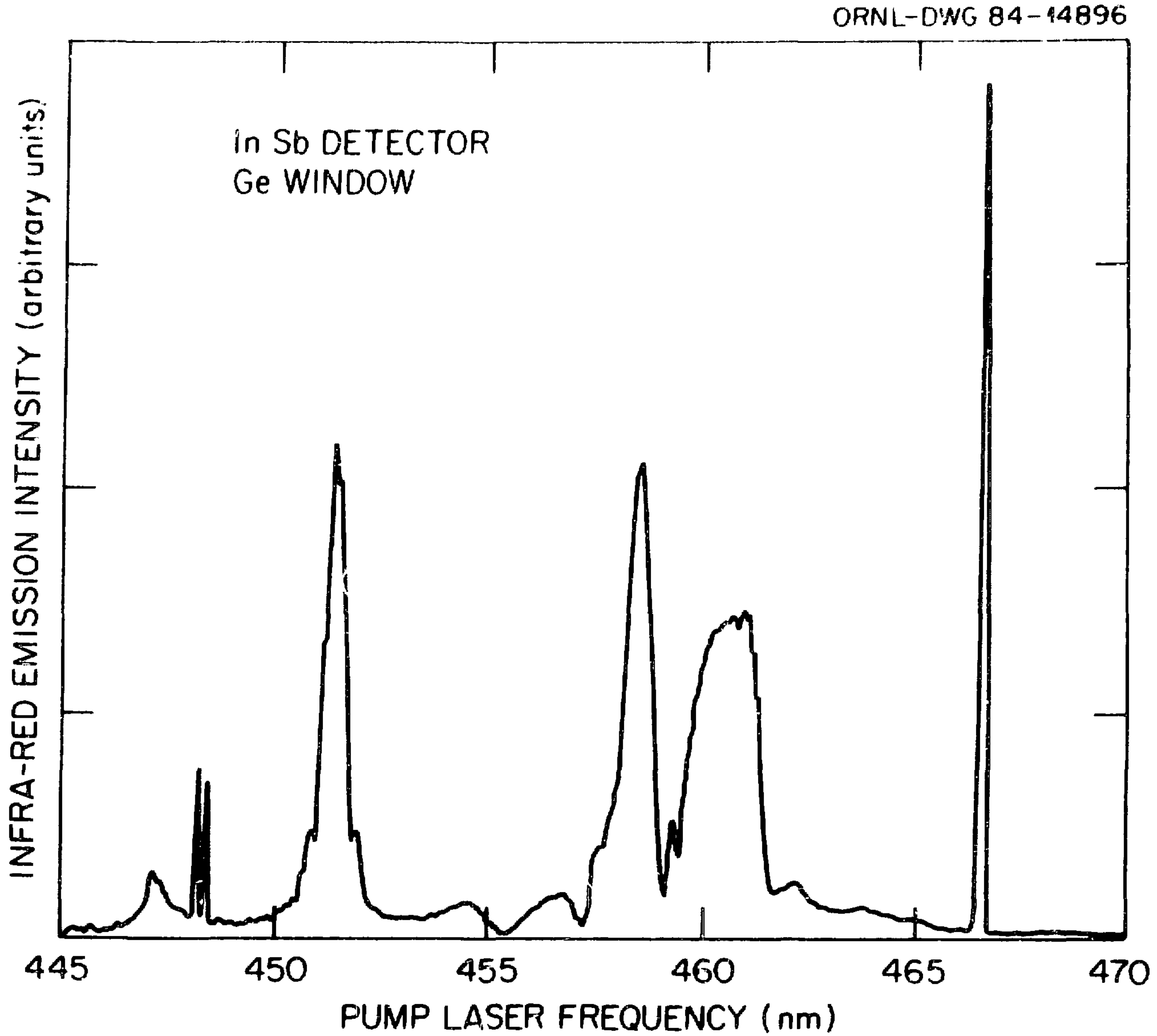

Fig. 1
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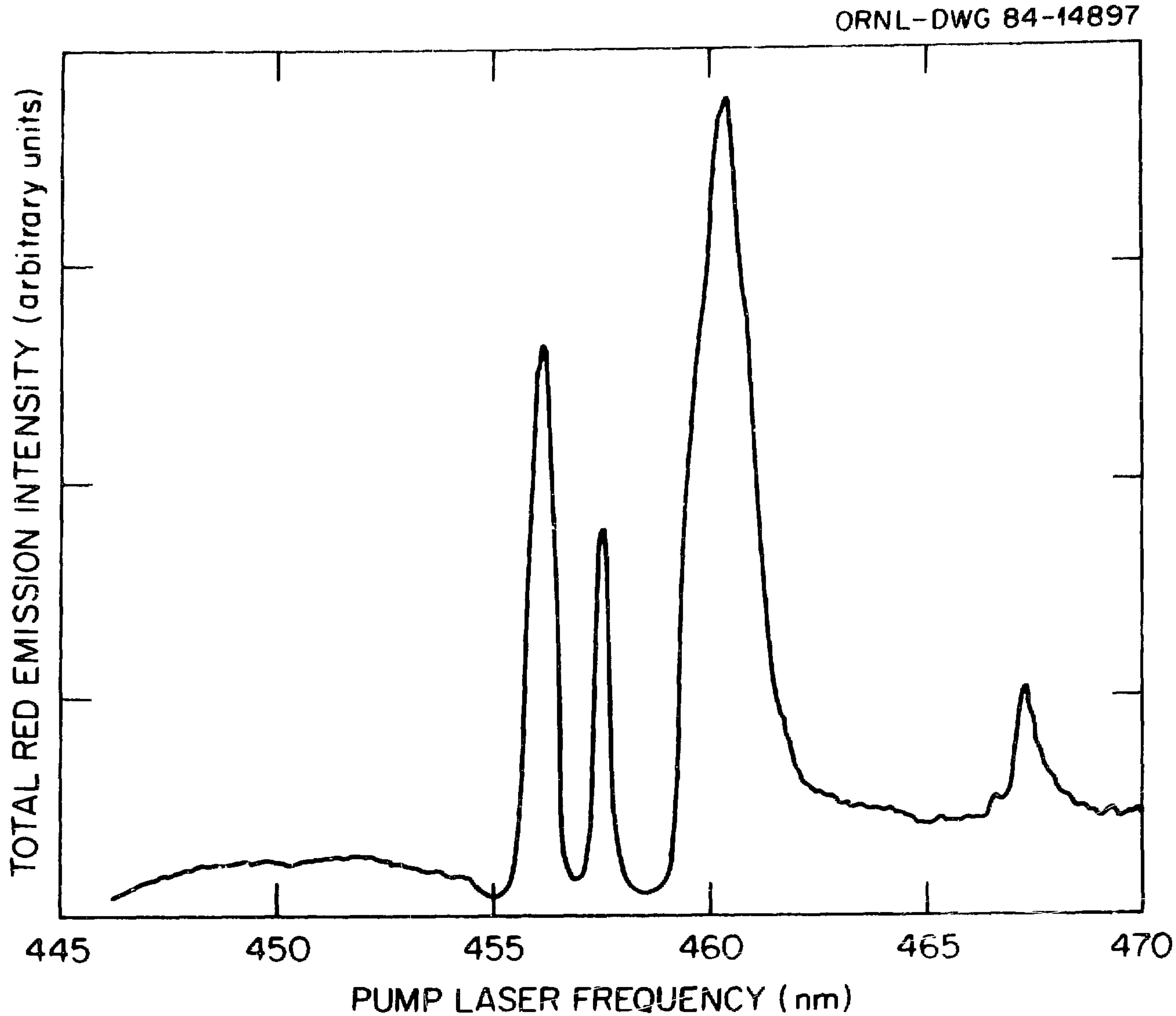

Fig. 2
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