Pramāṇa – J. Phys., Vol. 30, No. 4, April 1988, pp. 309–317. © Printed in India.

On the non-Boltzmann A-X emission in Na_2 following laser excitation of the B state

A SHARMA, G L BHALE, M A N RAZVI and M N DIXIT
Spectroscopy Division, Bhabha Atomic Research Centre, Trombay, Bombay 400 085, India

MS received 12 August 1987; revised 16 January 1988

Abstract. $A^1\Sigma_u^+$-$X^1\Sigma_g^+$ emission in Na_2 is observed following excitation of $B^1\pi_u$ by various lines of an argon ion laser. The excitation energy of $B^1\pi_u$ is collisionally transferred to the $(2)^1\Sigma_g^+$ which then radiatively populates the $A^1\Sigma_u^+$ state. The Na vapour is contained in a stainless steel crossed heat pipe with Ar buffer gas and temperature around 600°C. For all laser lines except 4579 Å, the coarse features of A-X emission are independent of the laser wavelength. However, at high resolution the finer differences between different laser line excitation are explained. Various v'-v'' transitions in this emission are identified. Computer simulation is presented to help explain some features of this emission.

Keywords. Na_2; energy transfer; argon ion laser.

PACS No. 34·50

1. Introduction

Extensive studies have been made of the excitation energy transfer in alkali dimers induced by collisions with other atoms. The energy transfer could be within the rovibrational manifold of the same electronic state (Bergmann and Demtroeder 1974; Bruner *et al* 1979; Ottinger and Schroeder 1980) or to a neighbouring electronic state (Kraulinya *et al* 1976; Lam *et al* 1978; Ennen and Ottinger 1982; Arrowsmith *et al* 1983). If the excitation of molecules is close to the dissociation continuum, the colliding atom could very efficiently dissociate the molecule (Ennen and Ottinger 1979a, b). The cross-sections for all these processes could be quite significant. Ottinger and Schroeder (1980) found that only 5 torr of argon can cause extensive rotational mixing in the $A^1\Sigma_u^+$ state of Li_2. Similar results were obtained for the $B^1\pi_u$ state of Na_2 wherein Bruner *et al* (1979) reported changes in rotational quantum number of the order of $\Delta J \approx 30$ using 10 torr of Xe as the buffer gas. In the examples cited above rotational mixing occurs in the rovibrational levels of the electronic state which is directly pumped by the laser radiation. There are instances where alkali dimers after having been pumped to a given electronic state collisionally transfer their energy, and one observes a broad emission from an electronic state other than the pumped one. Among examples of this kind, is the work by Ennen and Ottinger (1982) who observed the broad B-X and A-X emissions in Li_2 after exciting it to its C and B states respectively. Similarly Huennekens *et al* (1984) obtained the A-X emission in Na_2 and K_2 after laser excitation to their respective B states. Their study has resulted in the observations of the lowest triplet transitions in Na_2 and K_2. In a recent work on Na_2, Astill *et al* (1986)