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H_2 infrared line emission from S140: a warm PDR *

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Abstract. ISO SWS spectra of H_2 pure rotational and ro-vibrational transitions, as well as [FeII], and [SiII] fine structure lines were obtained for one position on the photodissociation region (PDR) adjacent to the bright rim of the S140 HII region. The gas density is $\approx 10^4\ \mathrm{cm}^{-3}$ and the incident UV flux $\chi \approx 400$ at the location of the ionization front. Our PDR model analysis shows that the relative H_2 line intensities are characteristic of low-density fluorescent emission and that the gas temperature is $T > 500$K in the partially dissociated gas. A comparison of predicted and observed fine structure line intensities permits an estimate of the abundances of Fe and Si.

Key words: ISM: individual: S140 – reflection nebulae – molecules – abundances – HII regions – infrared: ISM: lines and bands

1. Introduction

Among the first objects examined with the ISO short wavelength (2.4–45μm) spectrometer (SWS) within our program to study the physics of warm, dense molecular gas is the photodissociation region adjacent to the prominent bright rim (Blair et al. 1978) of the S140 HII region. Here a dense clump in the L1202/L1204 molecular cloud (Minchin et al. 1995) is exposed to ionizing and dissociating radiation from a nearby B0.5V star, resulting in strong emission of rotational and ro-vibrational lines of H_2 and of ionic fine structure lines. ISO has extended the wavelength range within which H_2 line emission can be observed to include many prominent near and mid IR lines, in particular those arising from transitions within the vibrational ground state. Observations that include those as well as ro-vibrational transitions from higher v yield important clues to the physical state of the gas, and the dissociation, excitation and formation properties of H_2.

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2. Observation

Our pointing, $22^{\rm h}17^{\rm m}35^{\rm s}.0$, $+63°03'01''$ (1950), coincides with the inner edge of the Hα (Hayashi et al. 1985) and radio continuum (Schwartz 1985) peak emission, and with the outer edge of the CO (Hayashi et al. 1987) emission and the [CI]609μm (White & Padman 1991) emission ridge (Fig. 1). Recent [CII]158μm observations by Schneider et al. (1992) locate our pointing on the peak of the [CII] emission ridge, which runs parallel in between the ionized gas rim and the [CI] emission rim. Since the H_2 emission in PDRs originates from the gas in between the hydrogen ionization front and the warm CI layer behind the CO dissociation front, our observing position appears to cover the expected location of the H_2 dissociation front. Our pointing also coincides with a steep rise in the CO excitation temperature to about 250K (Minchin et al. 1993: Fig. 13, offset position 63″). The clear separation between the apparently limb-brightened emission ridges of [CI], [CII], and Hα suggests a near edge-on view of a thin and slightly curved PDR.