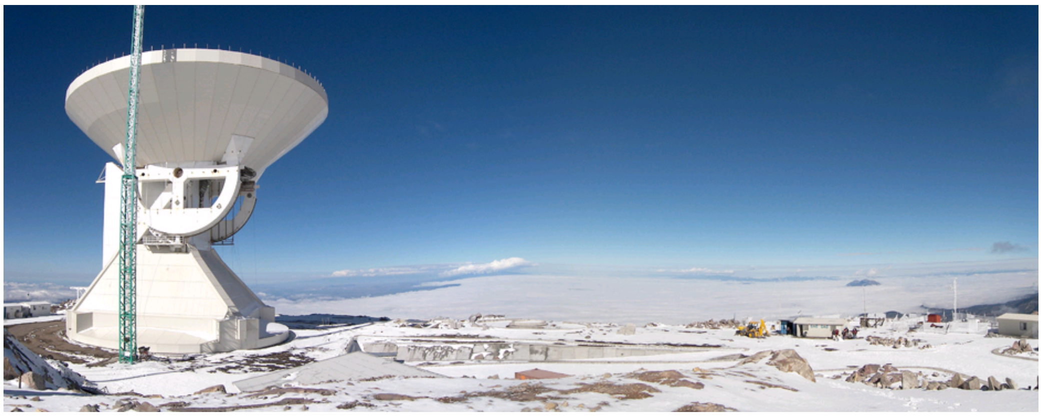

Astronomy Department Faculty Publication Series

Warm molecular hydrogen in the Spitzer SINGS galaxy sample

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Abstract

Results on the properties of warm molecular hydrogen in 57 normal galaxies are derived from measurements of H_2 rotational transitions, obtained as part of SINGS. This study extends previous extragalactic surveys of emission lines of H_2 to fainter and more common systems (LFIR = 107-6 × 1010 L). The 17 μm S(1) transition is securely detected in the nuclear regions of 86% of galaxies with stellar masses above 109.5 M.

The derived column densities of warm H2 (T ≥ 100 K), although averaged over kiloparsec-scale areas, are commensurate with values observed in resolved photodissociation regions. They amount to between 1% and >30% of the total H2. The power emitted in the three lowest energy transitions is on average 30% of the power of the bright [Si II] cooling line (34.8 μm) and about 4 × 10-4 of the total infrared power for star-forming galaxies, which is consistent with excitation in PDRs. The fact that the H2 line intensities scale tightly with the aromatic band emission, even though the average radiation field intensity varies by a factor of 10, can also be understood if both tracers originate predominantly in PDRs, either dense or diffuse. Many of the 25 LINER/Seyfert targets strongly depart from the rest of the sample, in having warmer excited H2 and excess H2 rotational power with respect to the dust emission. We propose a threshold in H2-to-aromatic band power ratios, allowing the identification of low-luminosity AGNs by an excess H2 excitation. A dominant contribution from shock heating is favored in these objects. Finally, we detect in nearly half the star-forming targets nonequilibrium ortho-to-para ratios, consistent with the effects of FUV pumping combined with incomplete ortho-para thermalization, or possibly nonequilibrium photodissociation fronts.

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