Scientific Justification *Be sure to include overall significance to astronomy; limit text to one page with figures, captions and references on no more than two additional pages.*

A number of studies of molecular hydrogen and its excitation in galaxies have been made over the last decade (e.g. Joseph et al. 1984; Puxley, Hawarden & Mountain 1988, 1990; Moorwood & Oliva 1990; Kawara & Taniguchi 1993; van der Werf et al. 1993). Early indications from low spatial and spectral resolution H_2 line ratios that the gas was always shock excited were challenged by parallel theoretical developments showing that in dense, warm photo-dissociation regions heated by UV-photons the low-lying (and brightest) transitions could be thermalised. Moreover, Puxley et al. (1990) argued that given the observed Br-γ recombination line emission, the copious non-ionizing UV photons would be expected to produce substantial H_2 emission when absorbed by molecular gas. Indeed, the different dependences of H and H_2 emission on incident UV flux provided a diagnostic of the relative spatial distributions of exciting stars and gas. Despite these arguments, however, it remains widespread in the current literature that H_2 in galaxies is shock excited (by supernova remnants and stellar outflows), although these studies are invariably without detection or reliable analysis of the critical higher level line fluxes.

One of the principal difficulties in determining accurate fluxes for H_2 lines above the lowest v=1-0 transitions is the strength of the underlying stellar continuum and the presence of metal absorption features in the cool stellar atmospheres. Even with very high S/N data, local variations in stellar population and element abundance produces systematic features after subtraction of empirical or theoretical stellar templates. This restricts the detectability in galaxies with strong continua to transitions brighter than those required to definitively determine the H_2 excitation.

The wider astrophysical context for studying H_2 emission from galaxies is in understanding the interaction between massive stars and their environment (e.g. the relative importance of the excitation mechanisms, the effect of the formation of massive star clusters on the local ISM and its feedback into the star-formation process), the distribution of stars and interstellar material and the subsequent evolution of the starburst. Paradoxically, within our own galaxy it can be difficult to establish, say, the H and H_2 emission and excitation mechanisms for a single star-forming complex. For example, although the peak H_2 flux from shocks is 100 times that from the diffuse component in Orion, only by integrating over a 7×9 arcmin^2 region is it revealed that the shocked and UV-excited luminosities are equal (Burton & Puxley 1990; Usuda et al. 1996). Observation of a galaxy provides such a census of the entire emission in a single measurement.

During an IR spectroscopic study of several Wolf-Rayet galaxies, four lines of H_2 were serendipitously detected in the nearby dwarf galaxy NGC5253 (Lumsden, Puxley & Doherty 1994) : 1-0 S(1), 1-0 S(0) and marginally 3-2 S(3) and 2-1 S(1). This observation represented the first suggestive evidence for the dominance of UV-photon excitation of H_2 in at least some galaxies, now strongly supported by the spectrum of NGC5461 in M101 (Fig. 1).

The NGC5253 and NGC5461 observations raise several interesting questions: Is UV-excitation of H_2 actually a general phenomenon in galaxies? What are the relative fractions of UV- and thermally-excited gas? What does the UV-excited component and hydrogen recombination line emission imply about the physical relationship of sources in the emitting region e.g. are they consistent with the models described by Puxley, Hawarden & Mountain (1988, 1990)?

To address these questions we require measurements of the H_2 line excitations sufficient to determine the contributions from UV irradiated low and high density gas, and from shocks. We propose observations of weak continuum, dwarf galaxies. All have been detected in the 1-0 S(1) H_2 transition (Doherty, Puxley, Lumsden & Doyon 1995). The weakness of the continua provides two benefits (i) a relatively large H_2-to-continuum ratio and (ii) weak underlying stellar absorption features.

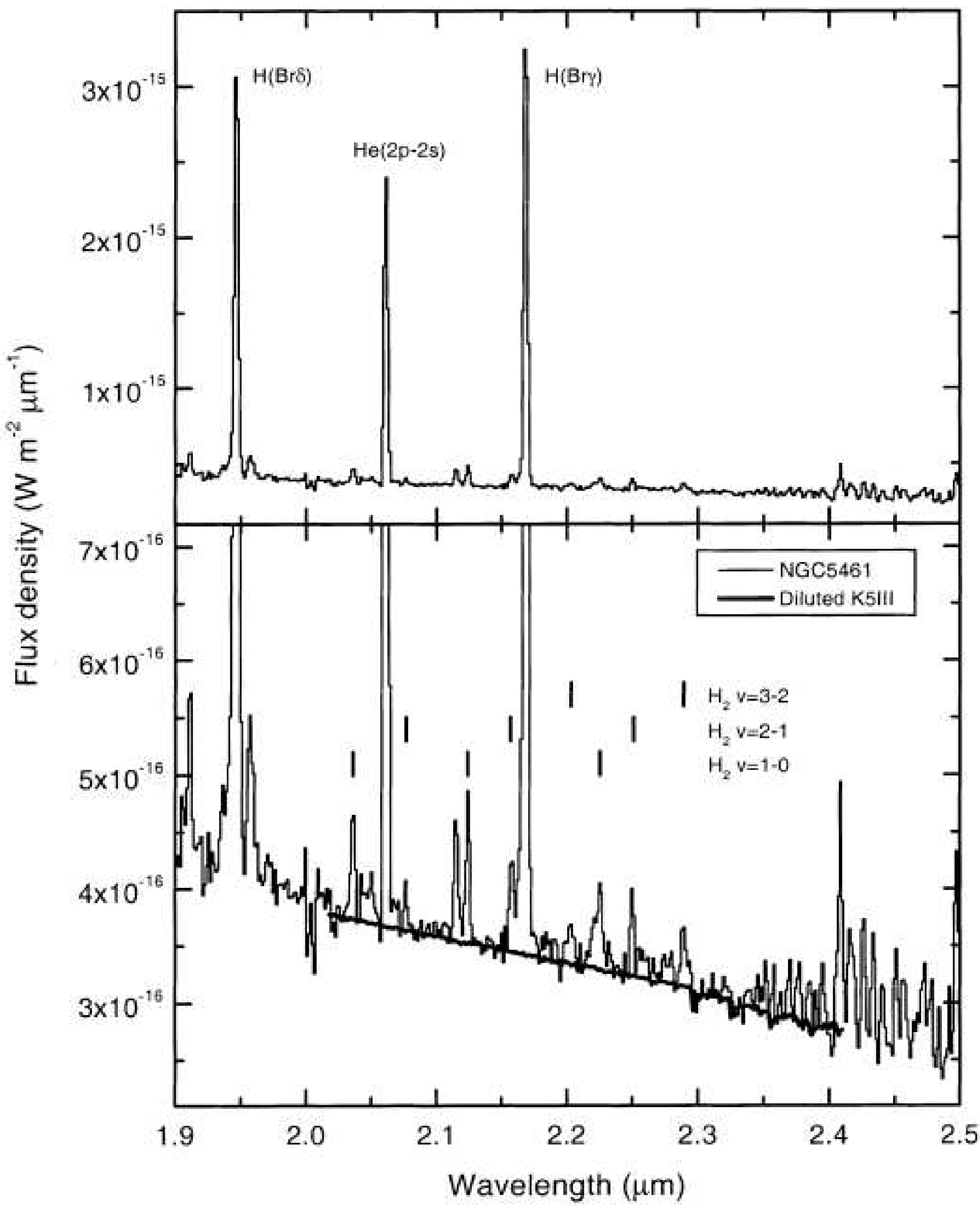

Figure 1: Spectrum of NGC5461 from Puxley et al. (2000).

Technical Description *Justify the instrument configuration, the exposure times and the constraints requested (seeing, cloud cover, sky brightness and, if appropriate, water vapor and elevation). Limit text to one page with no additional figures or references.*

Images with NIRI f/6 camera are requested of four weak-continuum, blue compact dwarf galaxies (NGC5253, Haro2, Haro3, IIZw40). The giant HII region NGC5461 (in M101) previously observed provides a 'bridge' between studies of the starburst nuclei of galaxies and Orion-like complexes in our own Galaxy.

The expected continuum flux density in NGC5253 is 0.5×10^{-15} W/m^2/μm (K $\sim$ 14.7) assuming approximately uniform surface brightness in scaling from our previous $3x3$ arcsec^2 measurement.

Similar previous observations of the rest of the sample gives expected continuum flux densities of $0.5 - 2 \times 10^{-15}$ W/m^2/μm (K $\sim$ 13.3-14.8) and 1-0 S(1) line/continuum ratios of $0.5 - 1.0$. The galaxies with weaker continua have larger line/continuum ratios and thus we expect similar integration times.

The total request to observe the four targets, allowing 1 hour per target for calibration and acquisition, and 75% efficiency on long integrations is 15 hours.

Band 3 Plan *If applying for queue time and it is acceptable for the program to be scheduled in Band 3, describe the changes to be made to the proposal to allow it to be successful in Band 3 (limit text to half a page).*

If we are allocated time in Band 3 we will either require twice the time allocation to observe all the targets or we will only observe the brightest half of the sample and double the integration time per object.

Classical Backup Program *If applying for classically scheduled time, describe the program you will pursue should the weather be worse than the requested observing conditions (limit text to half a page).*

Scheduling Constraints *If there are scheduling constraints for your program, describe them here.*

Justify Target Duplications *If your targets have been previously observed by Gemini using similar setups to those proposed here, justify the duplication below.*

Publications *Enter a list of publications written by the PI and Co-Is that support this proposal.*

Puxley, Doyon & Ward (1996). The spatial distribution of stellar CO absorption in M83, ApJ, 476, 120.
Puxley (1997). "Multi-wavelength hydrogen recombination lines in the compact HII region K3-50a" , Star-formation with ISO, in press."
Harrison, Puxley, Brand & Russel. "Molecular hydrogen and the ortho/para ration in NGC253", MNRAS, in press.
Puxley & Skinner (1996). "Search for IR positronium emission from the great annihilator", CTIO/ESO conf. on the Galactic Centre, in press.
Lumsden & Puxley (1996). "Near IR spectroscopy of the ultracompact HII region G45.12". MNRAS, 281, 493.

Use of Other Facilities or Resources *List any applications to non-Gemini facilities that are related to this proposal.*

Previous Use of Gemini *List allocations of telescope time on Gemini to the PI during the last 2 years, together with the current status of the data.*

Reference	Allocation	% Useful	Status of previous data
UKIRT97A	2 nights	100%	Data shown in text, paper in preparation.
GN-2009B-Q-13	12 hours	80%	Reductions in progress