OBSERVATIONS OF INFRARED FINE STRUCTURE EMISSION

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A new spectrometer has been built for use in the 10μm atmospheric window which is substantially more sensitive than previous instruments for observations of 10μm emission and absorption features narrower than about .25 cm^{-1}. Measurements have been made of fine structure emission lines in planetary nebulae as well as in galactic and extragalactic H II regions. The spectrometer consists of a liquid Helium cooled grating with a resolution of 1-4 cm^{-1} and a liquid Nitrogen cooled Fabry-Perot spectrometer which is scanned across the grating bandpass, resulting in a resolution of .1 - .2 cm^{-1}. The system NEP is about 4×10^{-14} W/$\sqrt{Hz}$, resulting in a minimum detectable line flux of about 10^{-19} W/cm^2, with a 6" aperture on the Lick 3m telescope.

We have undertaken a survey of the fine structure lines of Ne II, S IV, and Ar III from planetary nebulae. These lines give a measure of the abundance of the ions which is only weakly dependent on temperature and is essentially unaffected by interstellar absorption. Since Ne II and S IV have no visible transitions, the fine structure radiation gives the only measure of their abundances. So far, 19 planetaries have been observed, most of which lie between 0^h - 16^h. At least one line was detected in 7 of these objects. The complete survey will include about 50 of the brightest planetaries. Other programs in progress include studies of the velocity fields in the Ne II line in M82 and the galactic center. The results for the galactic center are especially interesting, showing substantial variations in the strength and Doppler shift of the line on a scale of several arc seconds. This work was supported by NASA Grants Nos. NGR 05-003-452 and NGL 05-003-272.

RADIO SPECTROSCOPY OF PLANETARY NEBULAE

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The H110α radio recombination line has been observed toward the planetary nebulae NGC 7027, IC 418, and NGC 6543 in order to ascertain the physical characteristics of the bulk nebular gas. The observations of NGC 7027 confirm the earlier findings of Chaisson and Malkan (Ap.J., 210, 108, 1976) and Churchwell, Terzian and Walmsley (A&A, 48, 331, 1976)

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who reported evidence for a substantial increase in linewidth with principal quantum number. Attributed to electron-ion impact broadening (Stark Effect), the observations imply an electron density $N_e \simeq 50{,}000/cm^3$. The LTE-derived electron-ion temperature $T_e \simeq 18{,}000°K$ agrees reasonably well with most radio-line analyses, as well as with previous analyses of the radio continuum, of forbidden optical line ratios, and of optical recombination lines and their associated continuum. IC418's H110α line is also wider than radio lines observed at higher frequencies, suggesting a Stark Effect consistent with $N_e \simeq 20{,}000/cm^3$; NGC 6543 shows no appreciable line broadening, providing an upper limit to the density $N_e < 10{,}000/cm^3$. The LTE-derived T_e values for IC 418 and NGC 6543 are approximately 14,000 and 7000°K, reasonably consistent with those found by other techniques. On the basis of this and other recent studies, I suggest that the bulk emission in the Hnα recombination lines observed to date, $77 < n < 111$, can be explained by a simple model of optically thin planetary nebular gas largely homogeneous in temperature and in density, and only slightly removed from LTE.

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