N/O ABUNDANCES IN PLANETARY NEBULAE FROM FAR-INFRARED LINE OBSERVATIONS

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ABSTRACT. Measurements of the [O III] 52, 88 μm and [N III] 57 μm fine-structure emission lines have been obtained for nine planetary nebulae, using the facility far-infrared array spectrometer on NASA's Kuiper Airborne Observatory. The N^{++}/O^{++} ratios determined from these observations range by more than an order of magnitude among the sample. Using recent improved values for the atomic parameters, we find that the N^{++}/O^{++} ratios agree fairly well with values of N^{+}/O^{+} determined from optical lines in the same objects. The highest N^{++}/O^{++} values, found for the extreme "Type I" nebulae NGC 2440 and NGC 6302, are approximately unity. These results imply that the synthesis and mixing of nitrogen must be extremely efficient in the progenitor stars of some planetary nebulae, and that these nebulae are significant sources of nitrogen to the interstellar medium. The local electron densities derived from the intensity ratios of the two [O III] lines are generally lower than values in the literature determined from small-beam optical observations of other ions, such as [O II]. This effect can be understood in terms of the presence of clumpy structure in the nebula, since the far-infrared lines have fairly low critical densities for collisional de-excitation and therefore are preferentially emitted from low-density gas.

S. Torres-Peimbert (ed.), Planetary Nebulae, 214.