

ISO Observations of Atomic Fine-Structure Lines From Proto-Planetary Nebulae

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We present ISO observations of atomic fine-structure lines in the far-infrared (FIR) from protoplanetary nebulae (PPNe). The sample is composed of 24 sources, mostly PPNe but also including a few planetary nebulae and AGB stars for comparison. Data on FIR lines of O^0 , C^+ , N^+ , Si^0 , Si^+ , S^0 , Fe^0 , and Fe^+ were obtained. PPNe are found to emit in these low-excitation atomic transitions only when the central star is hotter than ~ 10000 K. This result suggests that such lines predominantly arise from Photo-Dissociation Regions (PDRs). Our results are also in reasonable agreement with predictions from PDR emission models, allowing the estimation of the density of the emitting layers from comparison with the model parameters. However, Fabry-Perot ISO observations suggest in some cases a contribution from shocked regions, in spite of their poor sensitivity and spectral resolution. The intensity of the line [C II] $158 \mu\text{m}$ has been used to measure the amount of low-excitation atomic mass in PPNe, since this transition has been found to be a useful model-independent probe to estimate the total mass of this atomic gas.