Near-IR Emission Line Imaging of PN

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Spatial studies of the emission line regions in planetary nebulae (PN) can provide insight into the physical and chemical environments across the nebulae. In a collaborative effort by the coauthors, a *K*-band Fabry-Perot etalon has been coupled with an advanced 256×256 InSb focal plane array at the Wyoming Infrared Observatory 2.3m telescope. This system permits us to obtain spatially resolved, 0.24″/pixel, moderate spectral resolution (R ≈ 800), flux-density IR emission line images of astronomical sources. We obtained continuum-subtracted images of Br γ, HeI 2.06 μm, the 2-μm UIR features, and the 3.3 μm PAH dust feature in the PN NGC 6572, NGC 7027, and NGC 7662. One objective was to determine the spatial morphology of two unidentified emission lines, UIR1 – 2.199 μm, and UIR2 – 2.287 μm (Geballe et al. 1991). These UIR lines appear in the spectra of many PN (Hora et al. 1997) and in the Orion Nebula (Luhman & Rieke 1996). Geballe et al. suggested that the UIR lines are most likely forbidden transitions and showed that the parent ion ionization potential is $\approx 30 - 40$ eV, while the ionization potential for the ions themselves is $40 - 60$ eV. Here we directly compare the distribution of the UIR emitters to that of the gas (H^+,He^+) and dust (PAHs).

The UIR lines in these PN lie in a narrow shell on the outer edge of the H II region, interior to the PAH-emitting region. The UIR shells are thinner in spatial extent than the limb-brightened Brγ shells. The UIR images of NGC 7027 are similar in morphology to the [N II] images (Robberto et al. 1995), supporting the idea that the UIR lines are atomic in origin. Spatially-extracted longslit spectra of the nebulae show the UIR lines to be similar in spatial extent to Brγ and significantly more extended than the He II emission. The He I emission tends to peak at positions where the UIR emission is at a minimum. Echelle spectroscopy of NGC 7027 shows clear similarities in the kinematic signatures of the two UIR features and differences compared to H_2 and He I (Kelly et al. 1997).

Our current hypothesis is that the UIR lines are forbidden transitions in a two or three times ionized complex metal – possibly even fine structure transitions in the ground term of such an ion (*c.f.* Hodge et al. 1997). This work has been supported in part by NSF grant AST94-53354.

REFERENCES

Geballe, T.R., Burton, M.G., & Isaacman, R. 1991, MNRAS, 253, 75.
Hodge, T.M., et al. 1997, in preparation.
Hora, J.L., Latter, W.B., & Deutsch, L.K. 1997, in preparation.
Kelly, D.M., Woodward, C.E., & Latter, W.B. 1997, in preparation.
Luhman, K., & Rieke, G.H. 1996, Astrophys. J., 461, 298.
Robberto, M., et al. 1993, Astron. & Astrophys. 280, 241.