

# Observations of Gas and Dust in Compact Planetary Nebulae by Imaging and Long Slit Spectroscopy at $\lambda \approx 10\mu m$

H.U. Käuffl<sup>1</sup> and L. Stanghellini<sup>2</sup>

<sup>1</sup>European Southern Observatory; <sup>2</sup>Osservatorio Astronomico di Bologna

**ABSTRACT:** A variety of compact nebulae was observed to retrieve the morphology in the light of infrared recombination lines ([SIV] at  $\lambda = 10.5\mu m$  and [NeII] at  $\lambda = 12.8\mu m$ ) using TIMMI, ESO's focal reducer for the thermal infrared at the 3.6m telescope (Käuffl et al. 1994). Compared to optical images in some cases striking differences are found. It should be noted that the dust in nearly all PNs is transparent at  $\lambda \approx 10\mu m$  even if there is substantial extinction in the optical ( $\lambda \leq 1\mu m$ ). As compared to space based infrared platforms (IRAS and ISO) our observations have lower sensitivity but sub-arcsec spatial resolution. In some cases the data allow also to assess the relative spatial distribution of dust and gas.

**EXAMPLES:** For NGC 7009 we find a completely unexpected morphology in the light of the [SIV] line at  $\lambda = 10.5\mu m$  (ionisation potential 34.8eV) as compared to optical observations. Isophotes were detected up to a diameter of  $\approx 30$  arcsec whereby there are strong asymmetries. In the *equatorial* plane two strong condensations are apparent whereby the one to the East is much brighter than the one to the West. If at all the overall structure we find has some resemblance with H $\alpha$  plates but not with other optical images ([NII], [OIII], HeII).

IC 418 was imaged in the light of the [NeII] line at  $\lambda = 12.8\mu m$  (ionisation potential 21.6eV) and a longslit spectrum was taken for the wavelength range from 8-13.2 $\mu m$ . The spectrograph slit was aligned N/S with the optical centre of the nebula. The [NeII] image shows the object to have a somewhat bipolar donut shape. This shape is not apparent in reference optical images. The longslit spectrum shows apart from [NeII] no other emission lines. No solid state features be it silicate or polyaromatic hydrocarbonates are apparent. The shape of the dust continuum suggests a dust temperature of  $\approx 300K$ . Averaging of the spectra in the dispersion direction allows to yield a dust over gas ratio along the slit with  $\approx 1$  arcsec spatial resolution. Most notable here is that the dust is overabundant with respect to [NeII] at the very center of the object and in the North. In both the gas and the dust emission the nebula shows some limb brightening.

An atlas and a comprehensive summary of our observations on more than 15 objects is in preparation (Käuffl and Stanghellini, 1997).

## REFERENCES

- Käuffl H.U. et al., 1994, *Infrared Phys. Technol.* **35**, 203.  
 Käuffl H.U. and Stanghellini L., 1997, in preparation