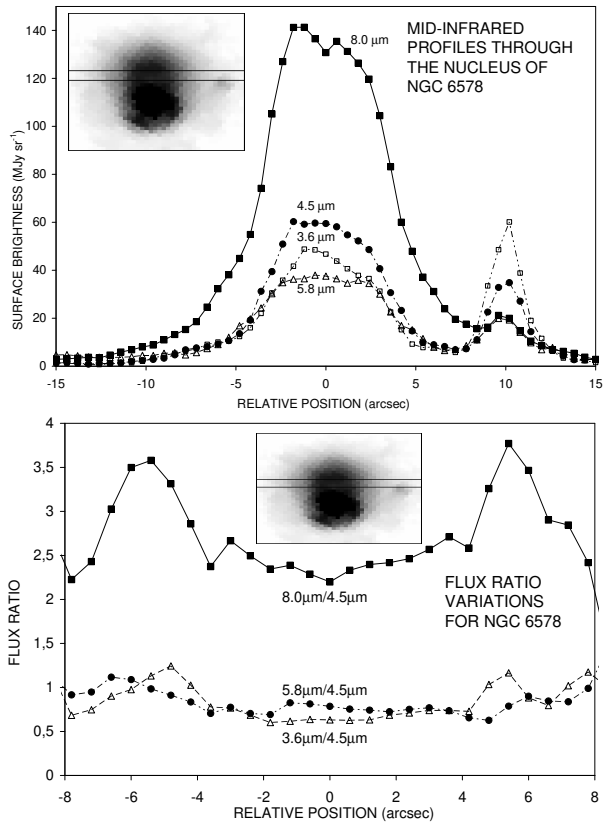

Fig. 10. As for Figure 3, but for the case of NGC 6578. The profiles avoid the region of contamination by the MIR point source. Note the increase in 5.8 μm/4.5 μm and 8.0 μm/4.5 μm close to the limits of the bright interior shell.

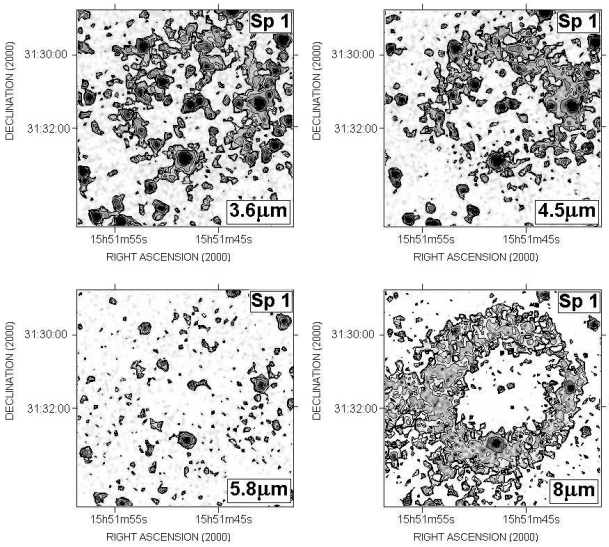

Fig. 11. Mapping of Sp 1 in the four IRAC bands, where the contour parameters [A, B, C] are given by [1.18, 0.74, 0.1119] at 3.6 μm, [1, −0.05, 0.0939] at 4.5 μm, [6, 3.89, 0.0442] at 5.8 μm, and [19, 17.33, 0.0048] at 8.0 μm. This source is close to the limits of detection for the GLIMPSE 3D survey, and levels of S/N are extremely low. Most of the fragmentary appearance can be attributed to noise. The apparent extension of the 8.0 μm shell to the east results from contamination by background emission.

So, the halo surface brightness in the MIR, when compared to peak values in the nucleus, is > 10 times greater than observed in the visual. This unusual behaviour appears typical of many PNe (see e.g., Phillips et al. 2009; Ramos-Larios & Phillips 2009), and may presumably arise due to H_2 emission, PAH emission bands, or as a result of exceptionally strong low excitation transitions such as [ArII] λ6.985 μm or [ArIII] λ8.991 μm. Much depends, in this interpretation, on whether the halo is ionised or neutral, or perhaps even composed of a mixture of the two, and it is still far from clear what the primary emission mechanisms might be.

3.4. *Sp 1*

Sp 1 is one of the most interesting of the sources to fall within the limits of the GLIMPSE 3D survey. The nebula has a closely circular structure with diameter ∼120 arcsec (e.g., Miszalski et al. 2009); a large [OIII] expansion velocity of ∼60 km s^{-1} (Meatheringham, Wood, & Faulkner 1988); and moderate H and HeII Zanstra temperatures of ∼32.5 and 82.0 kK (Phillips 2003). The difference between these values may indicate the escape of H ionising photons, and a nebular structure which is density bound. An image of the source (taken by D. Malin) is available at `http://www.aao.gov.au/images/captions/aat095.html`.

By far the most interesting characteristic of this angularly large PN, however, is that it appears to be centred on a close binary system with period 2.91 days, having an amplitude variation of 0.1 mag in B (e.g., Bond & Livio 1990). Although the binary is a non-eclipsing system, it may be exhibiting radiation effects (e.g., Mendez et al. 1988).

It has popularly been supposed that close binary systems result in bipolar outflows, and Sp 1 would therefore appear to be in conflict with this presumption; a problem which also occurs for SuWt 2 and WeBo 1 (Bond, Ciardullo, & Webbink 1996), both of which are non-bipolar sources centred upon close binary systems. One way out of this predicament has been to suppose that Sp 1 may be being viewed head-on, and that the ring corresponds to the toroidal waist of the bipolar PN (Bond & Livio 1990). Similar hypotheses have also been proposed