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## Abstract:

We report the discovery of new structures in a series of planetary nebulae found with Wide-Field Infrared Survey Explorer (WISE) imaging. The data presented here reveal the dust emission distribution and unexpected features. Such structures are not seen in the available visible or near-infrared (NIR) images, but can be related to some of the mid-infrared Spitzer images.

## WISE

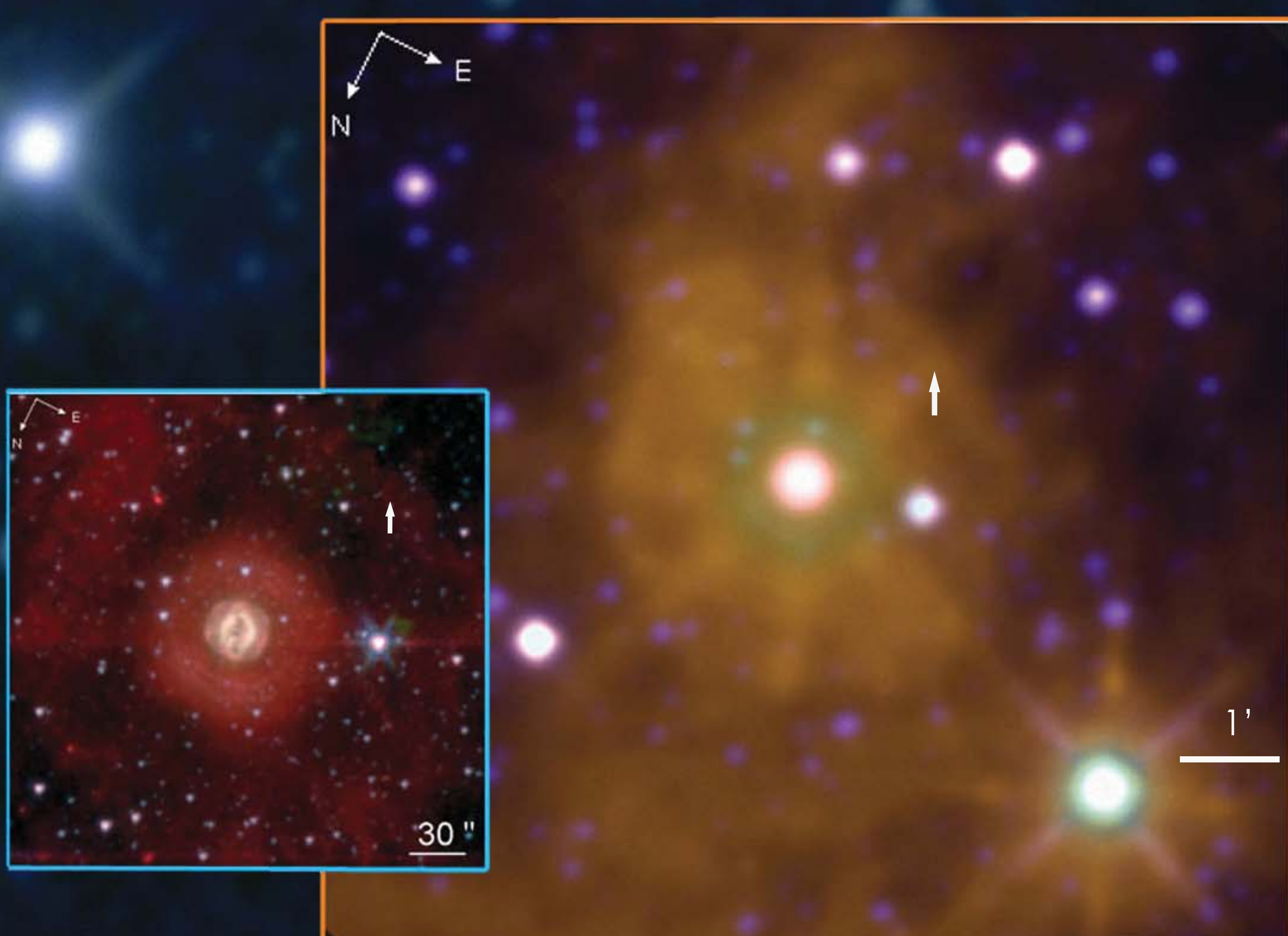
The Wide-field Infrared Survey Explorer (WISE; Wright et al. 2010) is a NASA mission that make a survey of the entire sky at wavelengths of 3.4, 4.6, 12, and 22  $\mu\text{m}$  (W1 through W4, respectively). To study the IR morphology of these nebulae, we use the W2 band ( $\lambda=4.6 \mu\text{m}$ ), which traces the continuum emission from small grains and the stellar background component (see Flagey et al. 2011), the W3 band ( $\lambda=12 \mu\text{m}$ ), which reveals either cold gas through PAH emission features or low ionization material, and the W4 ( $\lambda=22 \mu\text{m}$ ) band, which shows the dust component emission and which can be compared to Spitzer MIPS 24  $\mu\text{m}$  images (see, e.g., Gvaramadze et al. 2010; Wachter et al. 2010).

## NGC 7354

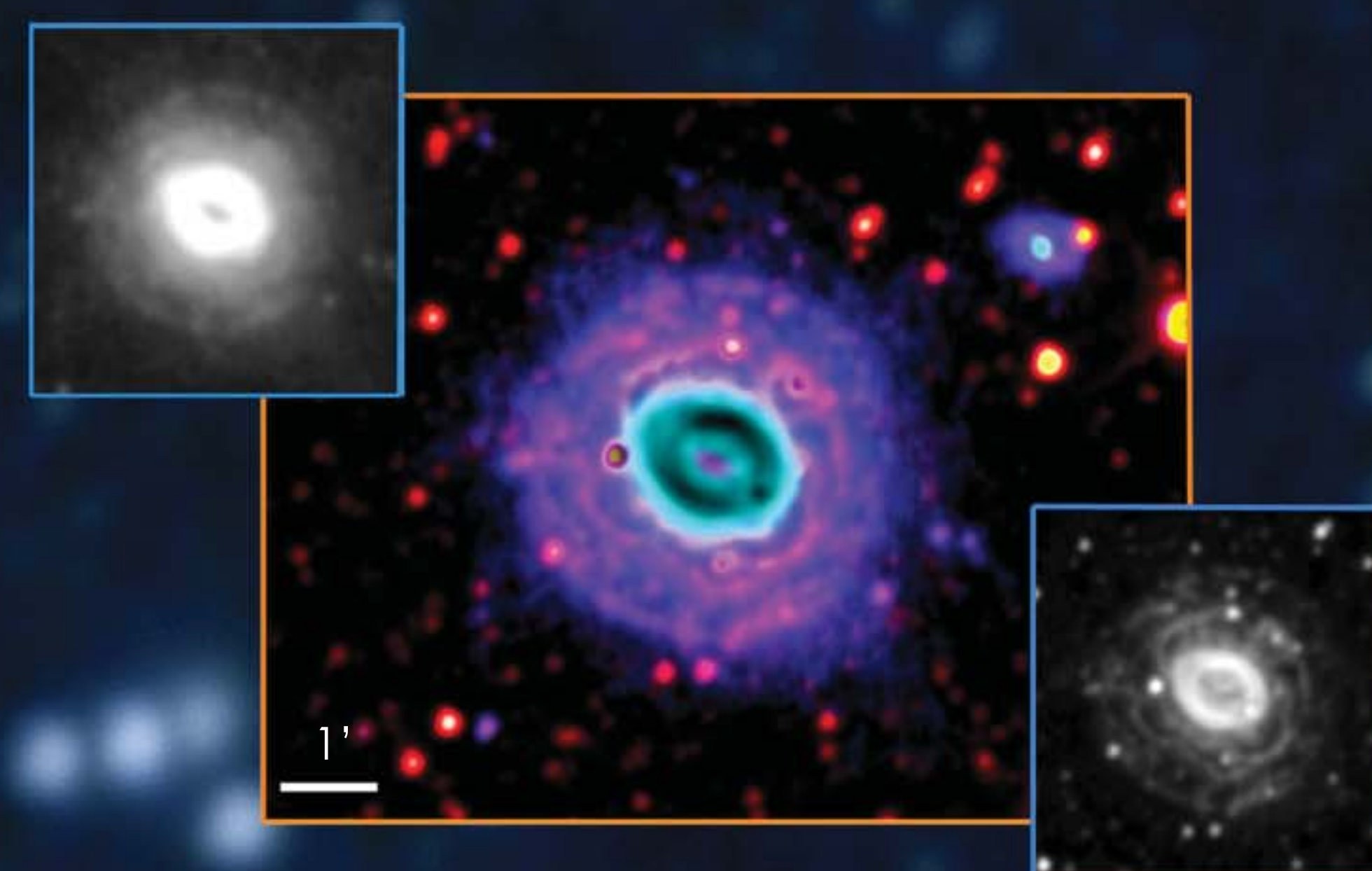
Visual observations of the bright central nucleus of NGC 7354 reveal an ellipsoidal morphology. The PN is composed of an inner rim with a major axis length of  $\sim 30$  arcsec, and a fainter outer quasi-circular shell with a major axis of  $\sim 33$  arcsec. A further characteristic of interest appearing in the Spitzer imaging of this source (Phillips et al. 2009) is the red colouration of the halo, outside of the bright (and more elliptical) inner rim. This arises due to an enhanced 5.8 and 8.0  $\mu\text{m}$  emission, as discussed in our more detailed analysis below, and may indicate the presence of small PAH emitting dust particles.

## Extended outer emission in NGC 7354

A large scale image of the source is illustrated in the image below (right-figure) where we combined W3 and W2 WISE imaging bands to show the larger and more diffuse shell with diameter  $\sim 250$  arcsec. The latter structure is seen very faintly and partially at 5.8  $\mu\text{m}$ , but its clearest (and strongest) at 8.0  $\mu\text{m}$  in the colour-coded IRAC bands (left-figure), as described in Phillips et al. 2009. We also processed both results using unsharp masking techniques. We observe that the bright central shell is surrounded by a much fainter and circular halo. This halo has a diameter of  $\sim 110$  arcsec (which contains at least three inner ring structures) and it is also visible in the WISE imaging (confirming the structure).



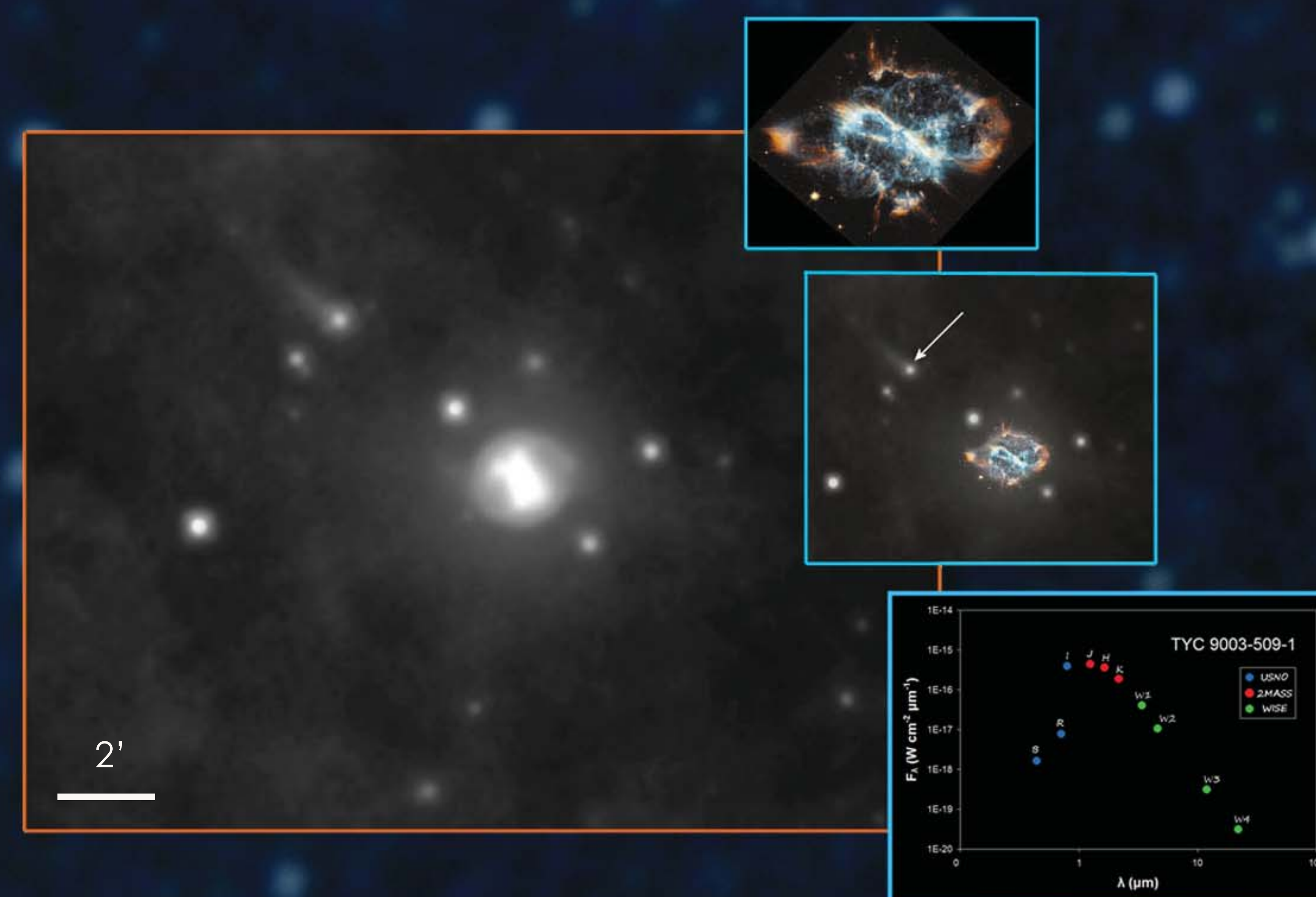
## NGC 6720



NGC 6720 displays multiple features such as a bright internal optical ring and "arc-like" filamentary structures mostly seen in the infrared. The latter are shown in the lower right corner in the WISE W2 band which will trace the H<sub>2</sub> v 0-0 S(8) and S(9) transitions. WISE also allowed us to identify a totally new plain structure at 12  $\mu\text{m}$  (W3 band, upper left corner) which perfectly encloses the clumpy area seen at 4.6  $\mu\text{m}$  (W2 band). The center image is a composition of the W3 (blue) and W2 (red) bands. This could indicate the presence of cold gas through PAH emission. In all images North is up and East to the left.

## NGC 5189

The nebula shows an extremely knotty and filamentary morphology. Sabin et al. (2012) have shown the presence of two nested bipolar structures (one of which was exclusively seen at infrared wavelengths with WISE). Such quadrupolar geometry could be explained by the presence of a binary companion. However, NGC 5189 is not known to be in a binary system.



The WISE W4 band shows a new unexpected "cometary-like" feature located at 4.8 arcmin on the North-East of NGC 5189 (white-arrow) and which is well aligned with the optical twisted torus. Whether there is a connection between both objects or not is still unclear. Indeed, a search on the nature of the compact stellar structure (TYC 9003-509-1) did not return any useful information. Its SED does not show any dust excess which could have been carried away by the PN flux radiation or outflows. A more detailed investigation is needed to see if this new structure is linked to the nearby planetary nebula. In all images North is up and East to the left. Unexpected structures probably will be found in deeper analysis of PNe WISE imaging.