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On the existence of jets in the recurrent nova T Pyxidis [1]

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ABSTRACT

Recently, it has been claimed that the recurrent nova T Pyx exhibits oppositely directed jets of ejecta apparent in features seen in Hα emission. Here we demonstrate that these features are in fact emission in the [N II] lines which lie either side of Hα and arise from the expanding shell associated with this object rather than from collimated jets. We estimate an expansion velocity along a line of sight through the centre of the shell of about 500 km s^{-1}.

Subject headings: circumstellar matter – novae, cataclysmic variables

1. Introduction

T Pyx is a recurrent nova with recorded outbursts in 1890, 1902, 1920, 1944 and 1966 (Webbink et al. 1987). It is notable for possessing a bright nebular shell extensively investigated by Shara et al. (1989) and Shara et al. (1997). Recently, Shahbaz et al. (1997 – hereafter S97) have presented optical spectroscopy of T Pyx in which they identify emission components to the red and blue of Hα (S^+ and S^- respectively in their Figure 1) which they interpret as red- and blue-shifted Hα emission from oppositely directed jets. These features occur at 6593 and 6539 Å respectively implying line-of-sight velocities of 1380 and −1082 km s^{-1}.

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[1] Based on observations obtained at the W. M. Keck Observatory, which is operated jointly by the California Institute of Technology and the University of California.

2. Observations and discussion

On the night of November 21-22 1997 we obtained several spectra of T Pyx with LRIS (the Low Resolution Imaging Spectrograph, Oke et al. 1995) on the Keck II telescope on Hawaii. Two 400 second exposures were made at slit position angles of 30° and 120°. The 600 grooves mm^{-1} grating was used with a slit width of 1.5 arcsec matching the seeing. The pixel scale was 0.2 arcsec and the spectral resolution 8.8 Å.

Figure 1 shows a greyscale representation of the 2-dimensional spectrum from position angle 30° clearly revealing the presence of an expanding shell emitting in [NII] and Hα with signal to noise ranging from 10 to 70. The spectrum from position angle 120° is similar although because the shell is not spherically symmetric (see Shara et al. 1997) there are detailed differences. In order to relate these data to the spectra presented by S97, Figure 1 also includes the spectrum obtained by summing along the slit. Although the spectral resolution is lower than that of S97 it is still obvious that their features S^+ and S^- are in fact, respectively, the red-shifted component of [NII] 6583 and the blue-shifted component of [NII] 6548.

Further to this, by extracting the stellar continuum from our 2D spectrum using Horne's optimal extraction method available in the software package Figaro, and then subtracting this from the total spectrum shown in Figure 1, we obtain a reasonable approximation to the shell-only summed spectrum – see Figure 2. In this spectrum we have indicated the rest wavelengths of Hα and the two [NII] lines together with the positions of the blue- and red-shifted components arising from the front and back of a shell expanding at a velocity of 530 km s^{-1}. It is worth noting that the component at about 6573 Å (arising from a combination of blue-shifted [NII] 6583 and red-shifted Hα) is clearly visible in the spectrum in Figure 1 of S97, whilst the 6555 Å component (from red-shifted [NII] 6548 and blue-shifted Hα) is blended into the blue wing of Hα in their Figure 1. It is difficult to estimate the expansion velocity from these spectra. Apart from the problems of contamination between Hα and [NII], the shell is clumpy and incomplete. The velocity of 530 km s^{-1} is derived from the wavelength 6595 Å of the red-shifted [NII] 6583 line at the point where it crosses the stellar continuum. This corresponds to the expansion velocity along a line of sight through the centre of the shell and hence will be independent of slit position angle. We estimate an uncertainty of ± 2 Å on this wavelength, equivalent to ± 90 km s^{-1}, as a result of the contamination by the stellar continuum and of the spectral resolution. A better estimate would require more kinematical data at higher resolution across the whole shell and a plausible model for its structure. Note that the summed spectrum shown in Fig. 2 peaks shortward of 6595 Å because this particular feature is dominated by emission from a bright part of the shell 2-3 arcsec below the star (see Fig. 1) which is at lower radial velocities.

In conclusion we suggest there is little evidence to support the existence of collimated jets in T Pyx. The data are however consistent with the presence of a shell expanding at about 500 km s^{-1} and emitting more strongly in [NII] than in Hα – this is in broad agreement with the findings of Shara et al. (1989). However, more detailed modelling of the structure of the shell and further higher spectral resolution observations are required in order to reconcile this line-of-sight expansion velocity with the upper limit on the velocity in the plane of the sky of 40 km s^{-1} derived from Hubble Space Telescope observations of the proper motion of knots in the nebular shell (Shara et al. 1997).

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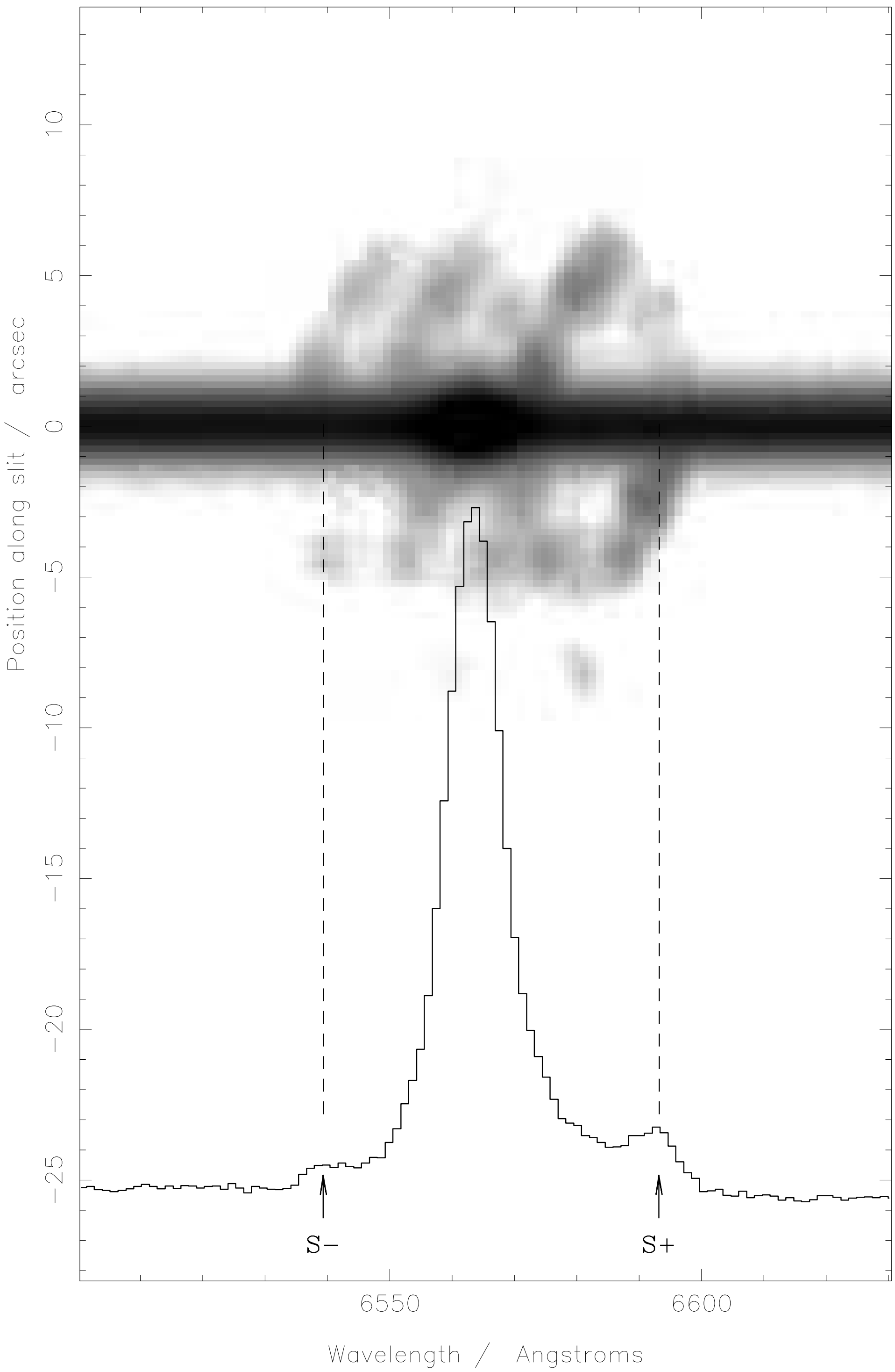

Fig. 1.— The two-dimensional spectrum of T Pyx plotted as a logarithmic grey-scale. Below it is the one-dimensional spectrum obtained by summing in the spatial direction. The features referred to by Shahbaz et al. (1997) as S^+ and S^- are also indicated (at the wavelengths taken from their paper) as is their origin in the [N II] lines from the expanding shell.

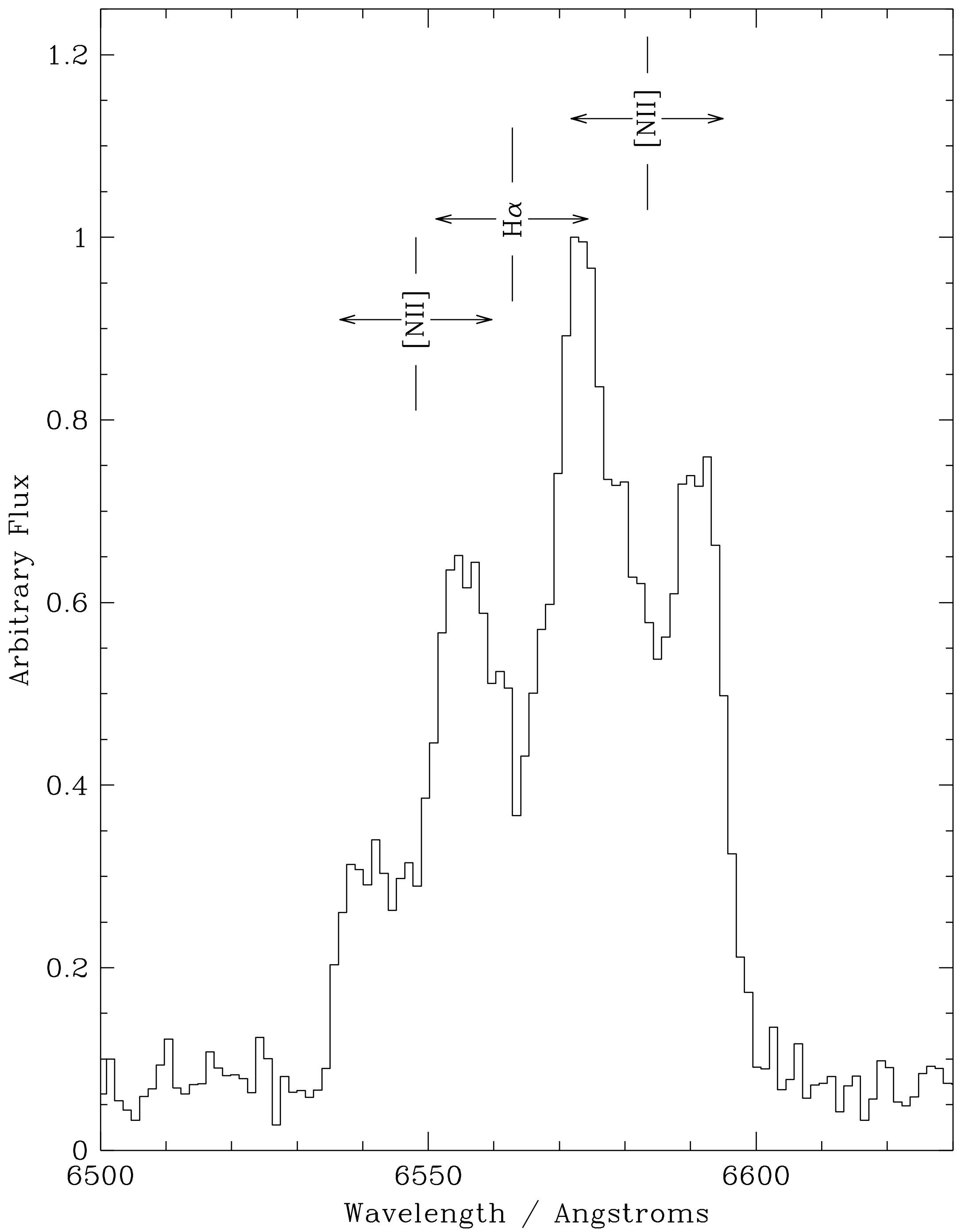

Fig. 2.— The spectrum of the shell obtained by subtracting the stellar contribution from the original data shown in Figure 1. The rest wavelengths of Hα and the two [NII] lines are indicated as are the wavelengths to which these lines would be red- and blue-shifted by an expansion along the line of sight of 530 km s^{-1}.