THE ASTROPHYSICAL JOURNAL, 498:L59–L60, 1998 May 1

ON THE EXISTENCE OF JETS IN THE RECURRENT NOVA T PYXIDIS[1]

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Received 1997 December 15; accepted 1998 February 25; published 1998 April 7

ABSTRACT

Recently, it has been claimed that the recurrent nova T Pyxidis 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 that lie on 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 center of the shell of about 500 km s^{-1}.

Subject headings: circumstellar matter — novae, cataclysmic variables

1. INTRODUCTION

T Pyxidis 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 that has been investigated extensively by Shara et al. (1989, 1997). Recently, Shahbaz et al. (1997, hereafter S97) have presented optical spectroscopy of T Pyx in which they identify emission components redward and blueward of Hα (S^+ and S^-, respectively, in their Fig. 1), which they interpret as red- and blueshifted 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}.

2. OBSERVATIONS AND DISCUSSION

On the night of 1997 November 21/22, we obtained several spectra of T Pyx with the Low Resolution Imaging Spectrograph (LRIS) (Oke et al. 1995) on the Keck II telescope in Hawaii. Two 400 s 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$''\!.$5 matching the seeing. The pixel scale was 0$''\!.$2, and the spectral resolution 8.8 Å.

Figure 1 shows a gray-scale representation of the two-dimensional spectrum from position angle 30°, clearly revealing the presence of an expanding shell emitting in [N II] and Hα with a signal-to-noise ratio 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 the 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 redshifted component of [N II] λ6583 and the blueshifted component of [N II] λ6548.

Furthermore, by extracting the stellar continuum from our two-dimensional 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 Fig. 2). In this spectrum, we have indicated the rest wavelengths of Hα and the two [N II] lines, together with the positions of the blue- and redshifted 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 blueshifted [N II] λ6583 and redshifted Hα) is clearly visible in the spectrum in Figure 1 of S97, while the 6555 Å component (from redshifted [N II] λ6548 and blueshifted 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 [N II], the shell is clumpy and incomplete. The velocity of 530 km s^{-1} is derived from the wavelength 6595 Å of the redshifted [N II] λ6583 line at the point where it crosses the stellar continuum. This corresponds to the expansion velocity along a line of sight through the center of the shell and hence will be independent of the 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 Figure 2 peaks shortward of 6595 Å because this particular feature is dominated by emission from a bright part of the shell 2$''$–3$''$ below the star (see Fig. 1), which is at lower radial velocities.

In conclusion, we suggest that there is little evidence to support the existence of collimated jets in T Pyx. However, the data are consistent with the presence of a shell expanding at about 500 km s^{-1} and emitting more strongly in [N II] than in Hα; this is in broad agreement with the findings of Shara et al. (1989). However, a more detailed modeling 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).

We are grateful to M. Shara and C. Gill for useful discussions and to an anonymous referee for helpful comments on the

[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.

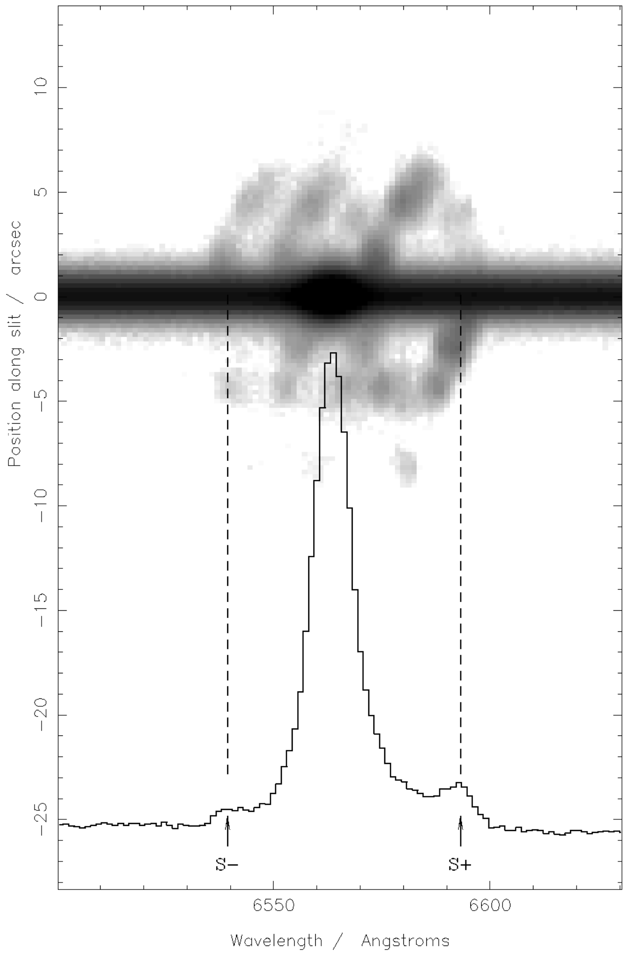

FIG. 1.—The two-dimensional spectrum of T Pyx plotted as a logarithmic gray scale. Below it is the one-dimensional spectrum obtained by summing in the spatial direction. The features referred to by Shahbaz et al. (1997) as S^+ and S^- are also indicated (at the wavelengths taken from their paper), as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

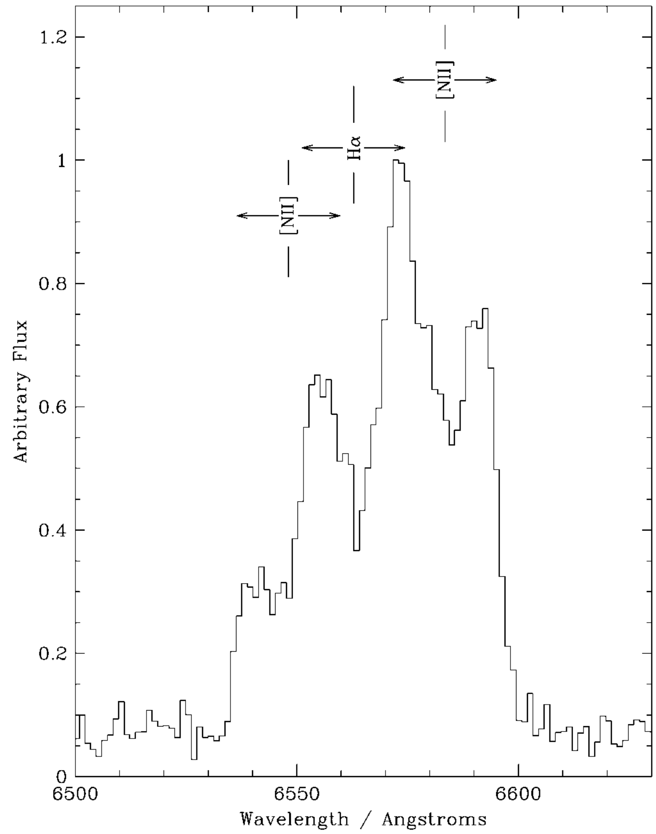

FIG. 2.—The spectrum of the shell obtained by subtracting the stellar contribution from the original data shown in Fig. 1. The rest wavelengths of Hα and the two [N II] lines are indicated, as are the wavelengths to which these lines would be red- and blueshifted by an expansion along the line of sight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

original version of this Letter. The entire Keck/LRIS user community owes a huge debt to Jerry Nelson, Gerry Smith, Bev Oke, and many other people who have worked to make the Keck telescope and LRIS a reality. We are grateful to the W. M. Keck Foundation, and particularly its late president, Howard Keck, for the vision to fund the construction of the W. M. Keck Observatory.

REFERENCES

Oke, J. B., et al. 1995, PASP, 107, 375
Shahbaz, T., Livio, M., Southwell, K. A., & Charles, P. A. 1997, ApJ, 484, L59 (S97)
Shara, M. M., Moffat, A. F. J., Williams, R. E., & Cohen, J. G. 1989, ApJ, 337, 720
Shara, M. M., Zurek, D. R., Williams, R. E., Prialnik, D., & Gilmozzi, R. 1997, AJ, 114, 258
Webbink, R. F., Livio, M., Truran, J. W., & Orio, M. 1987, ApJ, 314, 653