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GLMP 621: A BINARY PLANETARY NEBULA

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RESUMEN

El estudio observacional de GLMP 621 ha permitido su identificación como una nebulosa planetaria de reciente formación. Con el objeto de estudiar el sistema en detalle hemos obtenido imágenes de esta fuente, que se reportan en este trabajo, utilizando el telescopio NOT de 2.5 m con la cámara ALFOSC conjuntamente con un juego de filtros de banda angosta (ver Riera et al. 2003). También se obtuvieron observaciones espectroscópicas de alta dispersión. La complicada geometría y cinemática observada en GLMP 621 se asemeja a la de otras proto-nebulosas planetarias con una estructura multipolar dentro de un halo esférico.

ABSTRACT

The observational study of GLMP 621 have identified it as a newly-formed planetary nebula. In order to observe the system in more detail we have obtained images of this source, reported here, using the 2.5 m NOT Telescope with the ALFOSC camera together with a set of narrow band filters (see Riera et al. 2003). High-dispersion spectroscopic observations were also obtained. The complex geometry and kinematics observed in GLMP 621 resembles that of other Proto-PNe with a multipolar structure within a spherical halo.

Key Words: **PLANETARY NEBULAE — ISM: JETS AND OUTFLOWS**

GLMP 621 (IRAS 17395-0841) was first identified as a possible newly-formed planetary nebula on the basis of its IRAS colours (García-Lario 1992). A few years ago it was confirmed as such through spectroscopic observations where nebular emission lines corresponding to a proto-typical low excitation planetary nebula were detected overimposed on a strong and red continuum corresponding to a star of intermediate spectral type (García-Lario et al. 1997).

The observational study of this planetary nebula was complemented with CCD images taken at various broad and narrow band filters which showed the source is actually a binary system, in which one of the components is the central star of the PN. In order to observe the system in more detail we have obtained images of this source using the 2.5 m NOT Telescope (La Palma, Spain) with the ALFOSC camera together with a set of narrow band filters (see Riera et al. 2003). High-dispersion spectroscopic observations were obtained using the echelle spectrograph UES on the 4.2 m WHT Telescope (La Palma, Spain). The slit was oriented at P.A. = −4° (along the jet-like feature) and at P.A. = 88°. The spectrograph was used in the single-order long-slit mode covering the Hα and [N II] 6548, 6583 Å emission lines.

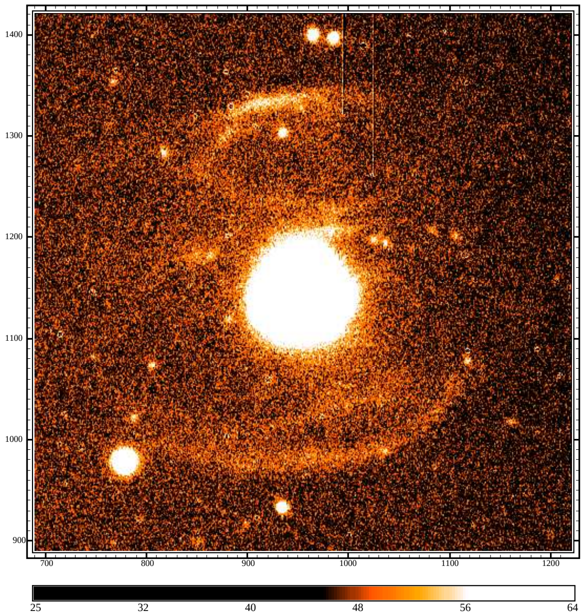

Fig. 1. Hα image obtained with the 2.5 m NOT. The core is saturated on this display to emphasize the various structures observed in the halo. North is at the top, and East is to the left.

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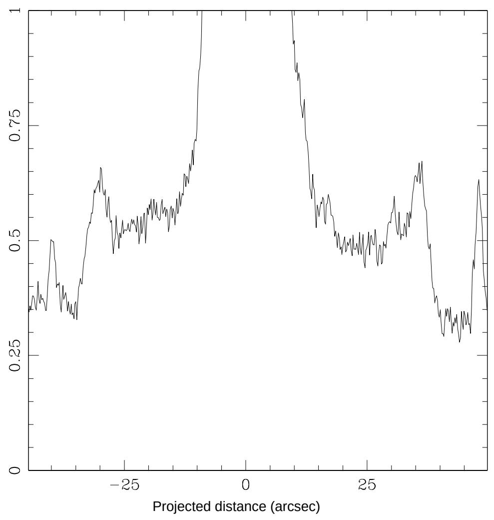

Fig. 2. One dimensional profile along the N-S direction in the line of Hα. Relative intensity is plotted versus projected distances.Several rows of data from the Hα image were averaged to form a one dimensional radial profile along the N-S direction.

The narrow band images clearly show the presence of a central binary system formed by a central star of the PN and a companion star (see Figure 1 of Riera et al. 2003). The companion lies $\sim 1''$ from the central star (equivalent to a distance of d(AU) $\sim$ 100 (D/100 pc), where D is the distance to the object). The probability of finding a companion star at a distance of less than $2''$ of the brightness observed in the case of GLMP 621 not physically associated to the system is less than 1 over 10,000.

The narrow band images show many morphological details, including a bipolar overall structure and a ring of emitting material. The innermost part of the nebula appears as an ellipse with its major axis subtending $\sim 6''$ (see Figure 3). A collimated structure is seen in the N-S direction where individual knots (at least two) can be distinguished (Riera et al. 2003).

A faint extended structure (halo) beyond the bright central nebula is outlined in Hα (Figure 1). This halo is composed by two concentric arcs that surround the nebula. These arcs are seen exclusively in the light of Hα and form part of an incomplete circle of $2\,\mathrm{r} \sim 70''$. The emission observed toward the halo might reasonably be intrinsic or dust scattered line emission from the central core. Several rows of data from the Hα image were averaged to form a one dimensional radial profile along the N-S direction (see Figure 2). Figure 2 shows the increase of the surface brightness at the outer halo and the abrupt decrease of its brightness at the outer edges, which is a pattern also observed in haloes of evolved PNe (Balick et al. 1992). In all those cases the limb-brightening of the outer edges of the haloes suggests that haloes are preassure confined. In addition to the round outer structure the halo shows other features: structures which do not appear to be arc-shaped and have not a particular symmetry with respect to the central nebula. The Hα image shows an additional network of faint irregular features (see Figure 1).

Figure 3 shows the long-slit echelle spectrum (with P.A. = $-4°$) which presents two main features: (i) the line shape produced by an expanding shell with a line splitting of 15 km s^{-1}; (ii) a low-velocity and low-brightness feature which is barely seen connecting the centre of the nebula and the outer edge of the shell with an extension of $\sim 5''$. Interestingly, the brightest emission of the Hα spectra is associated with the region where this feature seems to impact/interact with the shell. However, the identification of the low-velocity feature in the images is not clear. We might be observing the interaction between a high velocity outflow and the inner shell.

The morphology and kinematics of the bright shell can be described as an ellipsoidal shell with a homologous expansion. The best fit is obtained for an inclination angle of $25° \pm 10°$ and an expansion velocity of $\sim$ 30 km s^{-1} (Figure 3).

The complex geometry observed in GLMP 621 is not unique. There are other PNe and Proto-PNe which have bipolar (or multipolar) structures within a spherical (or almost spherical) halo (e.g., Sahai 2000, Trammell and Goodrich 2002). In these nebulae, the transition from spherical to axisymmetric mass-loss occurs soon after the AGB. There is a debate concerning the origin of the axisymmetric mass-loss and the presence of collimated outflows in PNe. Most of the scenarios invoked to produce collimated outflows in PNe require the existence of a central binary system. In this context, Soker (2001) has proposed that wide binary systems can form axisymmetric structures (as jets or multipolar outflows) observed in PNe within spherical haloes. GLMP 621 presents a unique opportunity to study the sharp transition from an outer spherical and faint halo to an inner highly aspherical bright region which are predicted to be the result of wide binary interaction (Soker 2001).

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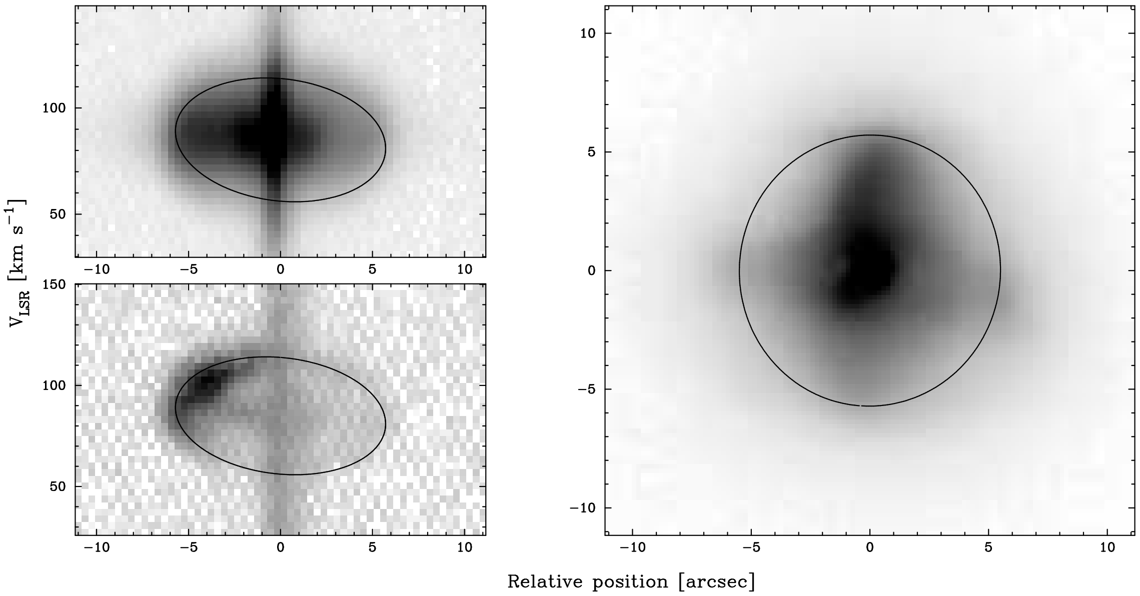

Fig. 3. Long slit echelle spectra obtained using the UES spectrograph at the 4.2 m WHT. Left panels: Hα (top) and [N II] (bottom) emission lines are shown for the slit position at -4°. Right panel: Hα image. The ellipse velocity prediction for the ellipsoidal shell model with homologous expansion are overlaid in this figure.

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