A robust expansion proper motion distance to the extraordinary planetary nebula KjPn 8

P. Boumis[1] and J. Meaburn[2]

[1] IAASARS, National Observatory of Athens, Greece
[2] Jodrell Bank Centre for Astrophysics, University of Manchester, UK

Abstract

Since the discovery by Lopez, Vasquez and Rodriguez of the giant lobes projecting from the otherwise innocuous planetary nebula, KjPn 8, it has been imperative to obtain a robust distance (D) determination. This has now been achieved by comparing an image of the lobes taken in 2011 with the **Greek Aristarchos telescope** with that (POSSI-R) obtained in 1954: the baseline for expansive proper motions has therefore being extended to 57 yr. These proper motions, combined with previous radial velocity measurements and tilt of the most energetic outflow with respect to the sight line, as determined from HST imagery of the nebular core, give **D = 1.8 +/- 0.3 kpc**. This value then lets the kinetic energy **(approx 10^{47} erg)** of the most recent and energetic outflow to be determined. It could be significant that this energy is consistent with an **Intermediate Luminosity Optical Transient (ILOT)** origin of the latest ejection as proposed for other similar objects by Soker and Kashi.

Observations & Results
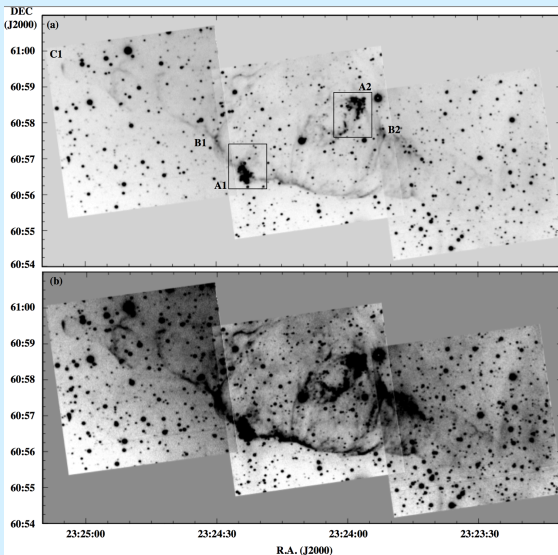
Fig.1 (Left): (a) A light, negative grey-scale presentation of mosaic of Hα + [N II] images of KjPn 8 and its filamentary lobes that were obtained in 2011 with the Aristarchos telescope is shown. The ionized knots A1 and A2, B1 and B2 and C1 are indicated. The two rectangular boxes are the areas whose contours of equal surface brightness are shown in Figs 3 and 4, respectively. (b) A deeper presentation of the mosaic in Fig. 1a reveals many faint features in the extended lobes (Boumis & Meaburn 2013).
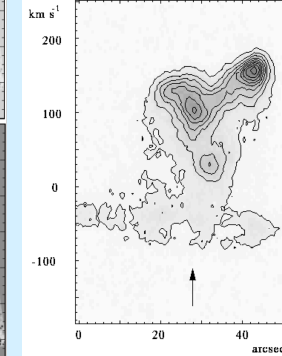

Fig.2 (Left): Contour map of the p-v array of [N II] j6584 profiles. The contour intervals are linear in relative surface brightness. The [N II] j6584 profiles of Galactic origin have been subtracted from this display, and only residuals of this process remain. The radial velocity scale is for Vhel ; note that the systemic radial velocity is Vhel = 44 km/s (Lopez et al. 1997).

Table 1. In column 1 the ionized knots identified in Figs 1(a), 3 and 4 are listed. Their EPMs and position angles (PAs) of their motions since 1954 are given in columns 2 and 3, respectively. The rates of these expansive motions over the 57 yr between observations and their distances from the central star are given in Columns 4 and 5, respectively. These rates and distances are converted into dynamical ages in column 6. The percentage errors listed in column 2 pass through to the values in columns 4 and 6.
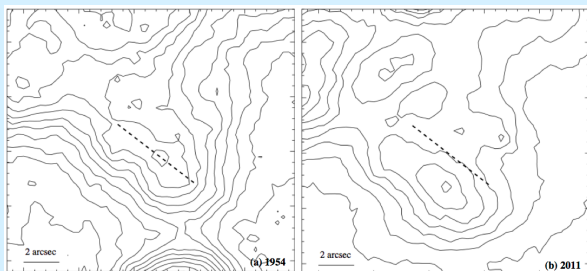
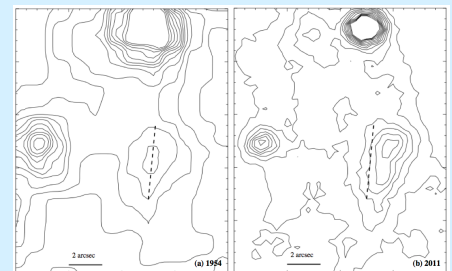| Knot	Knot parameters				
	EPM (arcsec)	PA (°)	EPM rate (mas yr⁻¹)	Separation (arcsec)	Dynamical age (yr)
A1a	2.05 ± 0.3	146	35.9	118	3284
A1b	1.77 ± 0.2	136	31.6	115	3630
A1c	2.85 ± 0.5	147	50.0	106	2116
A2a	2.40 ± 0.5	317	42.1	110	2606
A2b	1.77 ± 0.3	306	30.5	116	3810
A2c	2.13 ± 0.3	306	37.4	114	3035
A2d	2.30 ± 0.3	315	40.4	126	3121
A2e	–			124	–
A2f	1.80 ± 0.3	300	31.6	111	3525
A2g	1.54 ± 0.3	293	27.2	102	3739
A2h	2.96 ± 0.5	10	51.9	78	–
A2i	2.70 ± 0.3	336	47.4	75	1577
B2	1.10 ± 0.3	290	19.3	139	7218
C1	≤0.5	–	–	423	≥5×10⁴
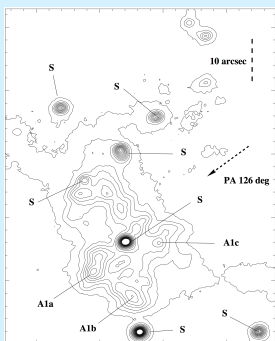
Fig.3 (Left): The features whose expansive proper motion has been measured in the A1 group of knots (Fig. 1) are identified in this contour map of the 2011 Hα + [N II] image by A1a, A1b, etc. The confusing stellar images are marked by an S. The axis of the central elliptically shaped image of KjPn 8 is shown as an arrowed, dashed line. (Boumis & Meaburn 2013).
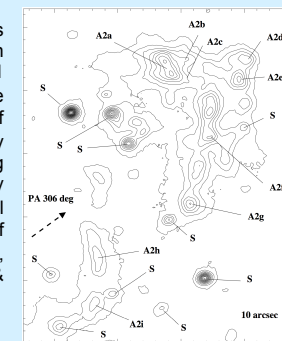
Fig.4 (Left): Same as for Fig. 3 but for the A2 group of knots identified in Fig. 1 (Boumis & Meaburn 2013).

Fig.6 (Below): (a) Contours of the 1954 POSSI-R image from the CCDALIGN pair, of the knot B2. The dashed line indicates the peak of this elongated feature. (b) Contours of the 2011 Hα + [N II] image for the same knot B2. The dashed line is exactly that shown in (a) (Boumis & Meaburn 2013).

Fig.5 (Left): (a) Contours of the 1954 POSSI-R image from the CCDALIGN pair of knot A1b. The dashed line indicates the peak of the ridge of this elongated feature. (b) The 2011 Hα + [N II] contours of the same knot A1b. The dashed line is exactly that shown in (a) (Boumis & Meaburn 2013).

References

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