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ASTRONOMY AND ASTROPHYSICS

The optical counterpart of PKS 1301-19

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Abstract. Optical spectrophotometry and infrared photometry of the counterpart of PKS 1301–19 proposed by Peterson et al (1973), currently classified as a BL Lacertae object, are presented. The spectral flux distribution is close to that of a black body, differing markedly from that expected for a BL Lac object. New measurements of the position of the optical object, compared with the Molonglo position of the radio-source indicate that the Peterson et al candidate is a very unlikely optical counterpart of the radio-source. The optical field of PKS 1301-19 is empty down to magnitude V $\simeq$ 23.

Key words: BL Lacertae objects – PKS 1301–19

1. Introduction

The Parkes radio source PKS 1301-192 ($F_{2700MHz}$ = 0.46 Jy, $F_{5000MHz}$ = 0.28 Jy; Bolton et al 1975) was tentatively identified with a star–like object of $m_p \simeq 18$ on grounds of positional coincidence (Peterson et al 1973). On the basis of a mild ultraviolet excess and of a flat radio spectrum the source was first classified as a quasi stellar object. Optical spectroscopy obtained by Jauncey et al (1978) and Savage et al (1976) showed a spectrum without emission/absorption features greater than 0.2 with respect to the continuum. The featureless optical spectrum suggested a BL Lac nature of the object and in fact it is reported in many lists of BL Lac objects (see e.g. Ledden and O'Dell 1985, Burbidge and Hewitt 1987, Véron–Cetty and Véron 1989).

In the course of a monitoring program of a sample of BL Lac objects, aimed at studying the IR-optical spectral flux distribution (see Tanzi et al 1989), we obtained optical spectrophotometry and near infrared photometry of the Peterson et al (1973) candidate (hereinafter P-object).

The spectral flux distribution, which deviates markedly from the average distribution of BL Lac objects, questions the validity of the proposed identification.

* Based on observations collected at the European Southern Observatory, La Silla (Chile)

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2. Observations

Optical spectrophotometry of the P-object was obtained on 1989 February 12 and 14 with the Boller and Chivens spectrograph attached at the 1.5m European Southern Observatory (ESO) telescope, at a dispersion of 225 Å/mm using a CCD detector (RCA with 1024x300 pixels). Standard reduction techniques were applied for flat field correction, sky subtraction and absolute flux calibration. An optimal extraction procedure was adopted following the method described by Horne (1986) in order to improve the signal to noise ratio favoring the detection of possible emission/absorption features. The photometric accuracy, as derived from several observations of standard stars from the list of Stone (1977), is better than 10%. No variability between the two exposures was detected, and the average spectrum is reported in Fig. 1a.

In the infrared we obtained broad band J, H and K photometry with the InSb detector attached at the ESO–MPI 2.2m telescope on 1988 February 14 and 16. No significative differences of magnitude are present between the two nights. The average magnitudes are: J = 15.5 ± 0.1, H = 15.1 ± 0.1 and K = 15.1 ± 0.2. Conversion to flux density was performed using the zero–magnitude fluxes given in Falomo et al. (1988). The average spectral flux distribution in the optical and near IR region is reported in Fig. 2.

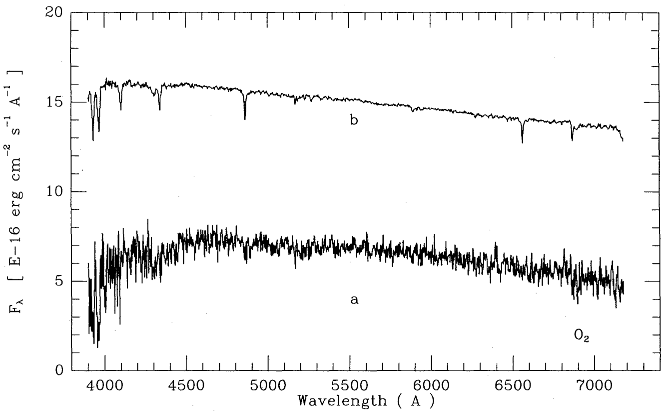

Fig. 1. a) The average spectrum of the P-object; combination of two spectra for a total exposure time of 80 minutes. b) spectrum of the white dwarf LTT 3864 divided by a factor 40.

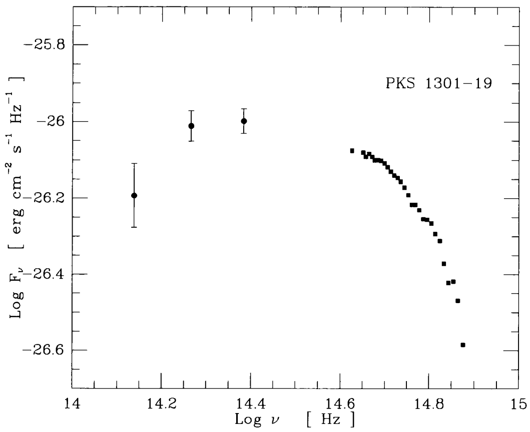

Fig. 2. Optical and near infrared spectral flux distribution of the P–object.

3. Discussion

The IR to optical spectral flux distribution of the source, as derived from our observations is shown in Fig. 2. The infrared fluxes are increasing with frequency, while the optical ones are decreasing. The maximum of the distribution is probably between 1.6×10^{14} and 3.2×10^{14}. A fit with a black body distribution gives a temperature of 5500 K with a mild infrared excess.

The optical spectrum (see Fig. 1a) does not exhibit prominent emission or absorption features, however, comparing with the spectrum of the white dwarf LTT 3864 used as spectrophotometric standard star for the calibration (see Fig. 1b), some similarities can be recognized, which represent some evidence of weak Balmer absorption lines.

The comparison of optical photometry of the P-object reported by Adam (1985) V=16.66, U–B = +0.04 and B–V = +0.71, with magnitudes derived from monochromatic fluxes of our spectrophotometry (V= 16.8 ; B = 17.4) and with $m_p = 18 \pm 0.5$ given by Peterson et al (1973) do not show significative variability either in flux or in the colors.

BL Lac objects are characterized by power law energy distribution in the optical and infrared (see e.g. Tanzi et al, 1989), and large variability. Therefore the indication is that the object under examination is not a BL Lac, but rather a star. This would be definitively assessed if our tentative identification of the weak absorptions with Balmer lines were confirmed.

We are therefore led to question the validity of the proposed optical identification. The position of the Parkes source is (1950) $\alpha = 13^h\ 01^m\ 54^s.0$, $\delta = -19° \ 16' \ 40''$ (Bolton et al, 1975; Savage et al, 1977), with a quoted rms uncertainty for the survey objects of 7 arcsec in both coordinates. A better radio position was obtained from the 408 MHz survey of Molonglo (Large *et al* 1981): $\alpha = 13^h\ 01^m\ 53^s.7 \pm 0^s.2$, $\delta = -19° \ 16' \ 46'' \pm 3''$.

The optical position of the P–object as derived from measurements made on a copy of the ESO B plate using a PDS microdensitometer is: $\alpha = 13^h\ 01^m\ 54^s.60 \pm 0^s.05$, $\delta = -19° \ 16^s \ 40''.5 \pm 0''.7$ Quoted errors are rms of residuals obtained from 18 SAO stars, distributed around the P–object, used as reference. This position is close to the one reported by Peterson et al (1983), $\alpha = 13^h\ 01^m\ 55^s.2$, $\delta = -19° \ 16^s \ 40''$ (accuracy $\sim 6''$), but the error is substantially reduced. The position of the radio source at 408 MHz is reported with a cross over an enlargement of the ESO J plate in Fig. 3 .

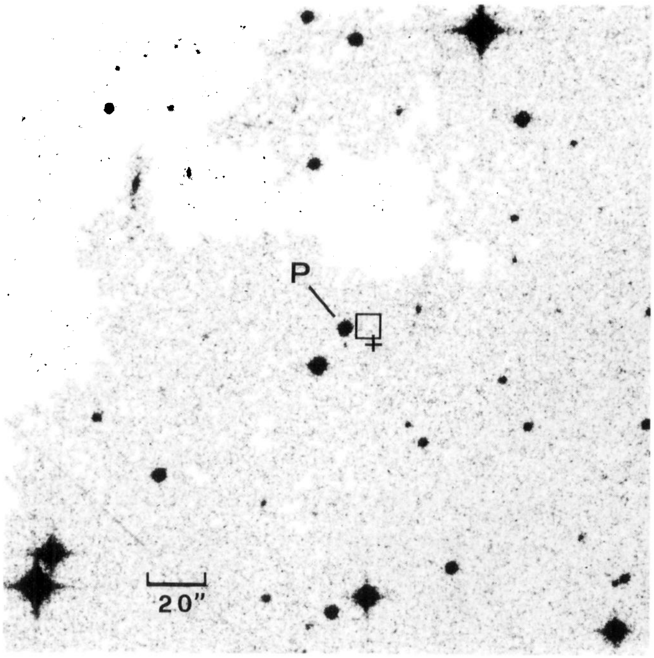

Fig. 3. Enlargement of ESO J plate showing the P–object (see text). Molonglo radio position of PKS 1301–19 is marked with a cross; the square is the error box from Parkes. Field is 4 arcmin and north-east is at top left–hand corner.

It is apparent that the P-object is close to the Parkes the radio boxes, but rather far from the Molonglo one.

On the basis of the position it is therefore unlikely that the P-object is the optical counterpart of PKS 1301-19.

As apparent from Figure 3 within the radio positions there is no optical candidate on the ESO J plate. A CCD image of the source, obtained at the ESO–MPI 2.2 telescope (15 min in the V filter), confirms the emptiness of the field down to a limit of 23 magnitude.

The occurrence of *empty* optical fields in correspondence of radio-sources is not infrequent (see e.g. Peacock 1981; Lilly 1989), and is generally interpreted as due to a radio-source associated to a large redshift elliptical galaxy. This is probably the case of PKS 1301-19.

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