IS THE FLAT SPECTRUM DOUBLE 1830-211 A RESULT OF GRAVITATIONAL LENSING?

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ABSTRACT. In this paper we present recent observational data on the flat spectrum double (1 arcsec.) radio source 1830-211 (Rao and Subrahmanyan, 1988, MNRAS, **231**, 229) and discuss why gravitational imaging appears to be the most plausible explanation for its unique nature.

Fig. 1 shows the VLA 1.3 cm image of 1830-211 made with a beam of 0.101 arcsec x 0.075 arcsec at 27° PA. The sub-components marked A and B have 88% of the total flux density; the secondary sub-components C and D, and residual extended emission contain the balance. The overall structure shows inversion symmetry. Components A and B are 1-3% linearly polarized whereas components C and D are ~21-24% polarized. The total spectrum (Fig. 2) is flat between 1 GHz and 15 GHz ($\alpha = 0.26$, $S\alpha f^{-\alpha}$), steepens above 15 GHz ($\alpha = 0.6$) and $\alpha = 0.8$ beyond 90 GHz. The individual sub-components A and B are also flat at $\lesssim$ 10 GHz and steepen above 15 GHz to ~0.7. Components A and B have angular sizes ~14 milli-arc-sec (mas) as inferred from the 1.3 cm VLA image as well as 6 cm EVN observations. Optical CCD imaging in the I band using the AAT shows a faint object ($19.6 < m < 21.6$; inclusive of 1.2 magnitudes extinction for $l = 12\overset{\circ}{.}2$ and $b = -5\overset{\circ}{.}7$ for the source) at the radio source position, but no object is seen in the V band ($m > 20.3$; assuming 2.7 mag. extinction).

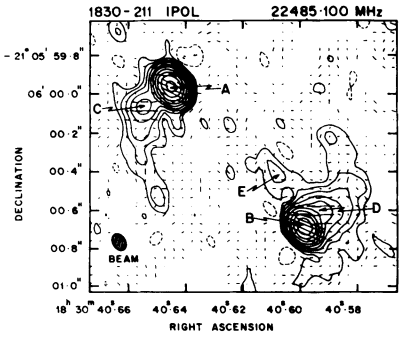

FIG.1 POL LINE 1 ARCSEC = 2·2222E-01 Jy/BEAM
PEAK FLUX = 2578 mJy/BEAM
LEVS = -8,-4,4,8,16,32,64,128,256,512,1024
2048 mJy

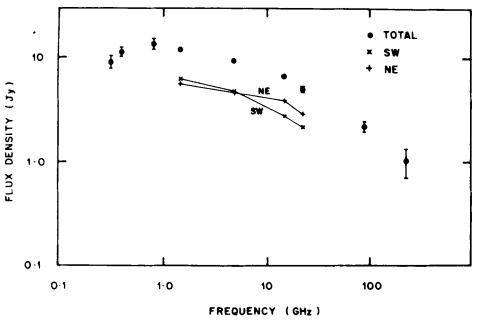

FIG. 2 SPECTRUM OF 1830 - 211

D. E. Osterbrock and J. S. Miller (eds.), Active Galactic Nuclei, 265–266.

The 1 arsec separation of 1830-211 and its peaked spectrum could indicate a Compact Steep Spectrum (Fanti et al., 1984, IAU Symp. **110**, p 57) classification. Adopting a linear separation of 4 kpc, typical of CSS sources, implies a redshift of 0.18 and a luminosity ~10^{-27} W Hz^{-1}. Assuming equipartition, components A and B have energy densities ~10^{-5} ergs cm^{-3} which could be ram pressure confined by an external medium with n_{ext}~0.05 cm^{-3} for an expansion velocity of 0.3c, similar to a typical CSS source. But the spectral turnover at ~1 GHz is much higher than in CSS sources and favours a Compact Double class (Philips and Mutel, 1982, A&A, **106**, 21), although the latter are ~100 mas across. However, the observed ~10% variability in both the flux density and polarization position angle of 1830-211 is uncharacteristic of the lobes of extended and sub-galactic double radio sources. Further, the flatness of the spectrum (<0.4) over a decade in frequency (1-10 GHz) clearly requires that the sub-components A and B be composed of multiple components with a spread in their turnover frequencies, incompatible with both the CD and CSS classes of sources. A synchrotron self-absorption turnover at ~1 GHz indicates sub-component sizes of ~3 mas for a reasonable B ~10^{-4} Gauss.

The above difficulties disappear if the NE and SW components of 1830-211 are viewed as being gravitationally lensed images of a compact flat spectrum source having a core-jet-knot structure. We model the background object at z ≃ 0.2 comprising of (a) core of ~20 mas size dominating the flux, (b) knot of ~20 mas size having 10% luminosity of core and separated by 70 mas from it (c) jet of ~200 mas linear extent emanating from the core and containing the knot. The lensing elliptical galaxy at z = 0.1 with central mass 3.2 x 10^{10} $M_{\odot}$ is taken to be of Shuster form. The resulting images, convolved to a resolution of 50 mas x 30 mas at 0° PA is shown in Fig. 3. The two images of opposite polarity reproduce sub-components A through D as well as the extended emission, the third image close to the lens centre produces component E. The predicted magnifications of ~3 for components A and B implies a few arcsec size core. The observed polarization properties, variability, evidence for multiple component core, morphology are all typical of radio cores of AGNs. The extensions of the NE and SW images along South and North directions respectively could indicate transition from five to three images configuration of the source. The non-identical nature of spectral and polarization properties of the corresponding components of the NE and SW images could be owing to differences in the magnifications of the multiple sub-components as well as a combined effect of variability in the AGN differential propagation time delay between the two images. Hence, it seems quite likely that 1830-211 is a gravitationally lensed source.

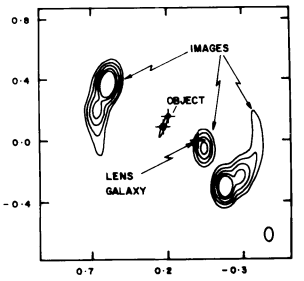

Fig. 3 Contours: 1·5, 4·4, 14·6, 44, 146 mJy/beam
Gravitational Lens Model

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