GRAVITATIONAL LENSES AND VLBI STRUCTURES +

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The double quasar Q0957 + 561 A,B along with bright radio arches and VLBI structures is modelled using a gravitational lens consisting of an elliptical galaxy and a cluster. The effective time-delay between components A and B comes out to be about a year and this enables one to distinguish between intensity fluctuations resulting from intrinsic quasar variations and minilensing by low mass stars.

The double quasar Q0957 + 561 is composed of two components with identical redshifts of 1.41 and a separation of 6.15" (Walsh, Carswell and Weymann, 1979). Young et al (1981) have modelled the lens action produced by the combined gravitational effects of the galaxy and the background cluster at Z = 0.36, to produce the observed separation between the components A,B and their intensity ratio of 1.3. The VLBI observations of the double quasar by Porcas et al (1981) has revealed core-jet type structures with extensions of 46 ± 1 mas and 56 ± 2 mas respectively for the components A, B and the respective position angles of 21° ± 1° and 17° ± 1°. Any lens model must also explain these observations.

We consider the combined gravitational effect of the elliptical galaxy and the background cluster by adopting a density profile $(r_c^2 + r^2)^{-3/2}$ (r_c, core-radius) for both the galaxy and cluster mass distributions. The lens parameters can be so arranged that the second image B1 is about 75% as bright as image A, while the third image B2, which is typically 0.5" from B1 is about 2 magnitudes fainter. For a spherically symmetric distribution of matter the positon angles of the core-jets are expected to be oppositely directed in relation to the line through the images. When we attempt to model the VLBI features, it turns out that the image configuration in which the axes of the core-jets are aligned almost parallel is obtained only for a narrow range of source positions close to the critical curves across which transition from one to three images occurs. The lens parameters are: Core-radius, $r_g = 3$kpc, $r_{c\ell} = 170$ kpc; Velocity dispersion, $\sigma_g = 287$ km/sec, $\sigma_{c\ell} = 1010$ km/sec; Ellipticity, $\varepsilon_g = 0.6$, $\varepsilon_{c\ell} = 0.8$.

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With respect to the centre of the galaxy chosen as the origin, the right ascension and declination of the cluster-centre are respectively -31" and -8.65". This choice of the lens parameters yields average linear amplification ~ 2 and time delay: $t_{B1} - t_A = 1.198$ yrs, $t_{B2} - t_{B1} = 0.0117$ yrs. The lens model implies a linear magnification by a factor of the order 2-3. It is tempting to speculate that future VLBI observations of this object may reveal existence of apparent superluminal motion of components of order $\leq 3c$. The calculated time delay also indicates that image A should show intensity variation ahead of B by 1.198 years, while Young et al. (1981) report the corresponding value of 5.88 years from their calculations. We believe this variance of our calculated time-delays from those of Young et al. is because of an error of sign in their potential time-delay calculation.

During the monitoring period since its discovery, component A has not varied, while component B which was about 70% as bright as component A in early January 1980 has become comparable and in fact, slightly brighter than A since November 1982 (Gott, 1983). Such a behaviour is difficult to explain on the basis of intrinsic variation in the quasar, if the time delay between A and B is indeed of the order of a year, for in that case component A would have shown intensity variation during the past four years. This points to the possibility that the light from the split images of the quasar is influenced by stars passing in front of the beam causing the images to fluctuate on the time-scale of few years (Chang and Refsdal 1979, Gott 1981). The pattern of intensity variation seems to indicate the minilensing events being operative in the case of Q0957 + 561 B. We find that stars in the mass range $10^{-3}M_\odot < M < 10^{-1}M_\odot$ in the lensing galaxy cause fluctuations in the quasar intensity over a time-scale of 1.5 - 15 years assuming a transverse velocity of ~ 300 km/sec for the low-mass star. Observations over a long time-scale will be able to distinguish between the time-variation arising from minilensing and intrinsic quasar variation.

It is thus possible to model the double quasar along with the arched lobe extending from A with complete absence of the structure around B and also the VLBI features associated with A and B.

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