SUPERLUMINAL VELOCITIES OF COMPACT RADIO SOURCES: A GRAVITATIONAL LENS EFFECT

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An intervening galaxy acting as a gravitational lens produces usually from a compact radio source two or four enlarged "crescent" shaped virtual images, which have the same surface brightness as the object, but look brighter, due to the lens caused enlargement of the object area in the image. Velocities between elements of a source being vector quantities, will also be seen enlarged, occasionally to superluminal velocities (Fig.1). It is as simple as that. (Barnothy and Barnothy 1971; Barnothy 1976.)

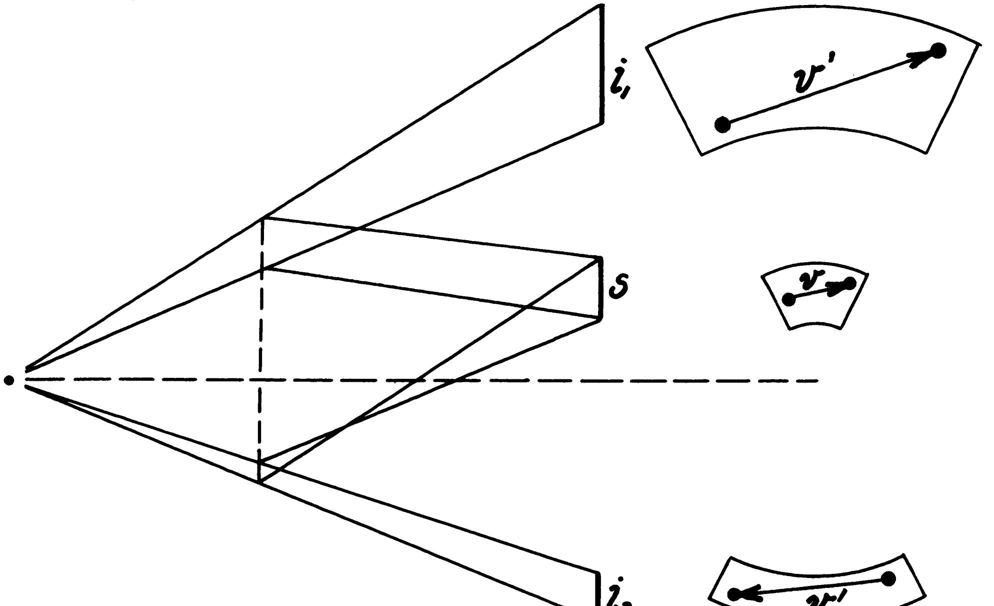

Figure 1. Path of light rays in a distributed mass lens; in a flat space. (Sketch is not to scale.)

D. S. Heeschen and C. M. Wade (eds.), Extragalactic Radio Sources, 463–464.

The tangential enlargement of the image, the scale factor s_t, is inversely proportional to the distance of the optical axis of the lens from the object; its value may be very large (10^8). The radial enlargement, the scale factor s_r depends from the mass distribution of the lens galaxy and from the impact parameter $\varkappa$, at which the focused rays pass from the gravitational center of the lens. Its value is usually small (<5), albeit in some mass distributions and within a short range of $\varkappa$, its value may be very large. (Barnothy & Barnothy 1973).

The total intensification of the brightness of a source is for one crescent $I = s_t \times s_r$. The probability of a proper alignment of object and lens is inversely proportional to the square of s_t, while the chance to observe the radio source increases as the 6th power of its brightness; hence compact radio sources will be mostly observed when s_t is not too large and s_r not too small; meaning that $s_t \sim s_r$. Since the value of $\varkappa$ is different for each crescent (image), it is likely that some of the crescents are so faint that due to the small dynamical range of VLBI's, only one of the images will be visible.

The virtual images will faithfully reproduce the details of the source. Should the object, say, the nucleus of a Seyfert galaxy contain several compact radio sources, aligned in a string like manner in the radial direction, then the virtual image may look like a one-sided, or two-sided jet. It is not a true physical phenomenon, merely a fata morgana.

It is noteworthy that superluminal velocities were so far observed only in quasars. The lens which produces the radio structure and the superluminal phenomenon, will also intensify the optical object, the Seyfert galaxy nucleus. At a lens mass of $10^{11} M_\odot$, and the lens axis passing at a distance of 0.1 kpc from the source, the intensification should be 5 - 6 magnitudes, sufficient to raise the brightness of a Seyfert galaxy nucleus to that of a quasar, as I have proposed this 16 years ago (1965).

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