CAN ALL QUASARS BE GRAVITATIONALLY LENSED SY's NUCLEI ?

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There has been a good deal of discussion in recent literature about the hypothesis, first put forward by Barnothy and Barnothy (1968), that quasars could be gravitationally lensed nuclei of Seyfert's galaxies (Turner, 1980; Tyson, 1981). Large amplifications (> 3-4 magnitudes) are needed to account for the widespread distribution in the intrinsic optical luminosities of quasars. A direct verification of this hypothesis is difficult to achieve due to the limited angular resolution of ground based telescopes. However, this hypothesis may be tested in a global sense by referring to radiation properties of Sy 1 nuclei which must be preserved, or must change in any predictable way, through the lensing process.

One such test is already provided by the X-ray emission properties of Sy 1 nuclei and quasars. It is known that the X-ray to optical emission ratio for radio quiet quasars depends on their intrinsic optical luminosity and that Sy 1 type nuclei ($M_B > -23.8$) are relatively stronger X-ray emitters than "true" quasars. This in itself already tells us that not all quasars can be magnified Sy 1 nuclei. To make the argument more quantitative we have considered a sample of 70 optically selected quasi stellar objects and Seyfert 1 nuclei ($M_B \lesssim -20$) for which Zamorani (1982) has derived a best fit line

$$\alpha_{ox} = 0.129 \, \mathrm{Log}\, L_{2500} - 2.427 \qquad (1)$$

where α_{ox} is the nominal spectral index between the optical (2500Å) and the X-ray (2keV) emissions, and L_{2500} is the intrinsic luminosity at 2500 A° in units of erg s^{-1} Hz^{-1}. In this sample there are no objects such that $\Delta\alpha = \alpha_{ox}$ (best fit line) - α_{ox} (observed) > 0.395, which according to Poisson statistics implies that at most 3 objects with $\Delta\alpha > 0.395$ could have been found at a 95% confidence level. This finding can be used to set an upper limit to the fraction of gravitationally lensed objects since, according to the relationship (1), one would expect that large amplifications would result in larger $\Delta\alpha$'s. By adopting a power law dist-

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ribution of the amplification factors with an exponent in the range 2-3 in agreement with the quasar source counts (Peacock, 1982; Canizares, 1982), we find that no more than 20% of the objects in the sample could result from amplifications larger than $\sim$2.5 magnitudes.

In this derivation we have tacitly assumed in agreement with present observational and theoretical knowledge that the X-ray photons are produced within the same region from which the optical continuum radiation is emitted.

Our upper limit is consistent with the results of Canizares (1982) for a flux limited sample and adds further evidence to the exclusion of the existence of a closure density of compact objects with masses $\gtrsim 1\ M_\odot$ if the radiation is emitted within 10^{-3} pc.

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Discussion

Rees: These limits are interesting because they constrain the amount of lensing due to individual compact masses (which may contribute $\Omega \simeq 0.01$). Canizares has used the equivalent width of QSO emission lines in a similar way: the continuum source of quasars may be lensed, but the line-emitting region may be too large to be affected, so the effect of lensing would be to introduce too large a spread in the equivalent widths.

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