OPTICAL-RADIO TIME DELAYS IN Q0957+561

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ABSTRACT. Applying a specific cross-correlation method, we obtained evidence that changes in the radio flux appear to lag behind the optical variations of the quasar by about 6.4 years. Our analysis of rapid continuum variations gave some constraints on the sizes and on the differences between locations of radio and optical sources. In particular, it appears that the compact radio source may be so small that it can be affected by microlensing.

Key words: Galaxies - quasars; Cosmology - gravitational lensing

Introduction

Since the first gravitationally lensed quasar was detected (Walsh et al. 1979), the interest of astronomers in objects of this kind has been increasing every year. The reasons are not only an ordinary curiosity to a new exotic phenomenon, but also the hope to realize the determination of the Hubble constant via the time delay. Till now the first gravitational lens has remained the most attractive object for the time delay measurement (e.g. Beskin & Oknyanskij 1992, hereafter Paper I).

Several attempts have been made to determine the time delay τ_o in Q0957+561 (see references in Paper I). Using a special new method, in Paper I we obtained the value of the time delay $\tau_o \approx 1.45\ yr$ on the base of optical monitoring data. The purpose of present work was to use the radio monitoring data (Lehar et al. 1992) for determination the time delay beween A and B images variations and for investigations the optical-radio correlatons.

Time delays from the radio monitoring data

The radio data of the VLA monitoring Lehar et al. (1992) provides an additional opportunity to check the reality of the obtained value for the time delay. We reanalysed the data of Lehar et al. by the methods described in Paper I and obtained $\tau_o = 540 \pm 30$ days.

The radio and optical variabilities of some quasars are known to be correlated with time delays of about years (see, for example, Hufnagel & Breman 1992). We tried to see whether such a correlation may be present in Q0957+561, and (if possible) to estimate the value of the optical-to-radio time delay τ_{otr}. Essentially, we have four "eyes" through which we observe the same object: two at radio and two at optical wavelengths. Given the gravitational/geometrical time delay between the images A and B, we can combine these four data sets into two more complete sets, one optical and one radio. Then we can use the cross-correlation method of Peterson & Gaskell (1978) to search for a possible time shift between the radio and optical light curves. To decrease the noise from interpolations we add an improvement to their method: we take into account only such points of the interpolated data which are close enough to the real ones. The influence of the gaps in the combined light curves on the cross-correlation function is small because τ_o is about 1.5 years.

The radio and optical variations are strongly correlated (max of CCF is about 0.86) with a delay of $\tau_{otr} = 2340 \pm 30$ days.

To estimate the significance level of this correlation we applied the same Monte-Carlo method as in Paper I and found that the significance is better than 99%. That is there would be a very small chance to obtain the same high correlation if the light curves were really independent. Consequently we can conclude that the radio and optical fluxes have common origin of variability.

We predict that microlensing can occur at radio wavelengths, but the microlensing variations in radio and optical ranges are not necessarily correlated with each other. We shall discuss elsewhere possible physical models which can account for optical-radio correlations.

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EVOLUTION OF THE CRAB NEBULA RADIO EMISSION

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ABSTRACT. In 1977–1992 the flux density of the Crab Nebula in respect to Orion Nebula was measured at the frequency of 927 MHz with the same 10–m radio telescope. According to these measurements a mean rate of the Crab Nebula radio emission decline, (0.44 ± 0.16)% per year, was determined. This value is considerably more than the value (0.18 ± 0.01)% per year obtained for the previous fifteen years 1962–1977 (Vinyajkin E.N., Razin V.A.: 1979, *Austral. J. of Physics,* **32**, 93). It is possible that in addition to the steady secular decline of the Crab Nebula radio emission flux there are the flux fluctuations responsible for the variability of the mean radio emission flux decline rate determined with the use of $\approx$ 15–year periods observational data. The most probable cause of these fluctuations is a discreteness of the Crab Nebula radio structure.

Key words: Radio emission, Crab Nebula