Observations of the scintillation's correlation of two nearby stars

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The commonly accepted view treats scintillations of two nearby stars as coherent within a very small angle about of a few arcseconds (Dravins at al., 1997). We show that the temporal behaviour of two nearby stars exhibits the significant correlation of both their brightnesses and total scintillation powers with some little time's delay. The latter lies in the range of seconds for stars separated at several tens of arcminutes. The common properties of the high-frequency brightness variations were investigated using a high-speed two-channel photometer (Zhilyaev et al., 1992) with the 60 cm telescope at Peak Terskol (North Caucasus, 3100 m a.s.l.). The temporal changes in scintillation strength were evaluated using the second order normalized factorial moment (Klauder & Sudarshan, 1968)

$$H_2 = \frac{< m(m-1) >}{< m >^2} = \frac{\sigma^2 - < m >}{< m >^2} + 1, \tag{1}$$

where $< m >$ and σ^2 are the sample mean and the variance for photometric readings. The quantity

$$\varepsilon = \frac{\sigma^2 - < m >}{< m >^2} = H_2 - 1, \tag{2}$$

specifies the relative power of fluctuations in the frequency range $\Delta f = \frac{1}{2\Delta t} - \frac{1}{n\Delta t}$, where Δt is the sampling time, n is the length of data segment. Finite-time averaged powers shown in Fig. 1 reflect the temporal changes in signal strength in the range from 1 to 5 Hz with 1 s resolution time.

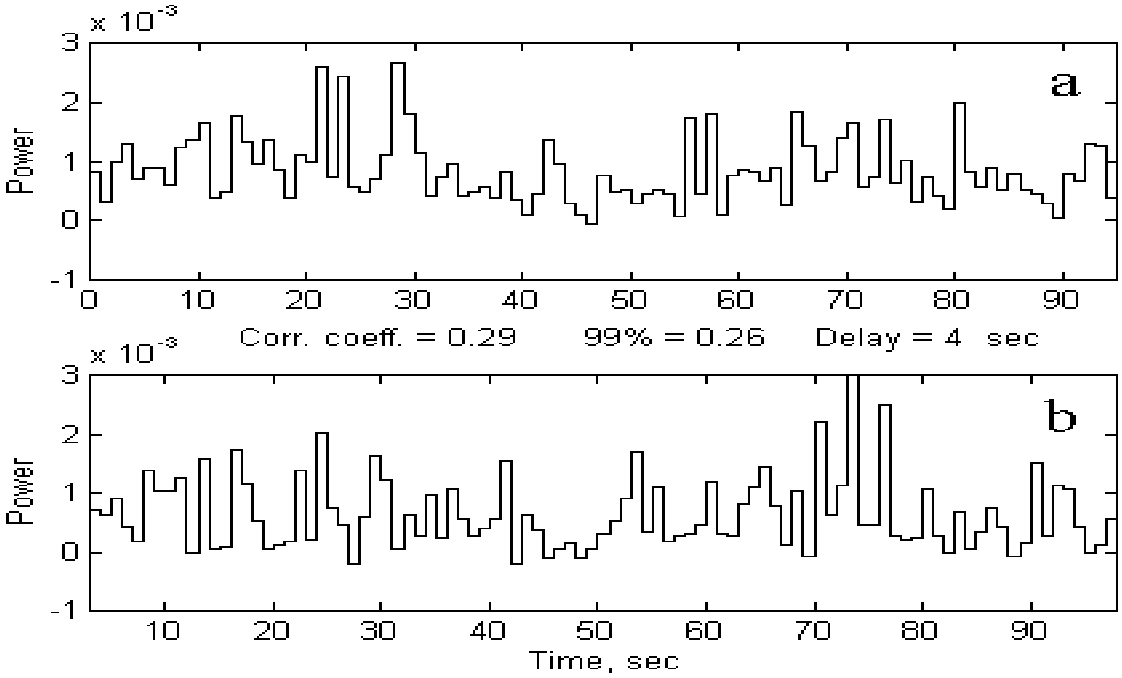

Figure 1: Relative power of fluctuations. The 60 cm telescope, U - band, Peak Terskol, July 21, 1995, 20:16 UT. a - R CrB, b - reference star.

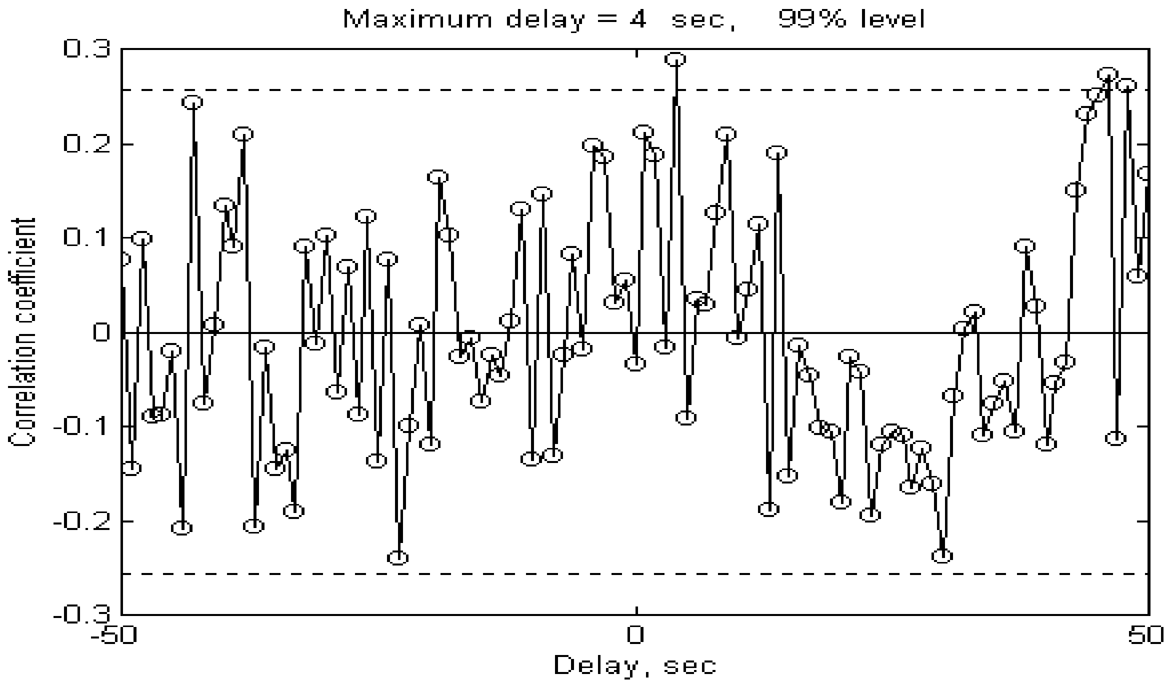

Figure 2: Correlation between power curves of R CrB and its reference star distanced at 20 arcmin.

These power curves result from the sets of data in the U band for R CrB (upper panel) and its reference star (lower panel) separated at distance of 20 arcmin. Although R CrB is usually recognized as the variable, its light curve was found in quiescence for definite periods. A pulse width is ranged from 1 to 6 s and a rate is of order of 10 per min. The correlation between power curves is significant with probability $> 99\%$. Of prime importance that the cross-correlation function shown in Fig. 2 demonstrates a time delay of 4 s between their power curves. A scale of phase coherence exceeds at least of several minutes. Also the light curves (not shown) from the same data fluctuate correlatively with a time lag of 4 s. Moreover, the total scintillation power curves show often significant periodicity in the range of several tens of seconds. This fact was first mentioned by Stecklum (1985). One clearly sees in Fig. 2 that the flashe activity is modulated with a period about of 44 s. This example is a typical demonstration. Note that a similar effect had been observed in a few other pairs with time's delay depending on the separation between stars. To check the devices and algorithms we used artificial light sources like luminophor and lamp and the numerically simulated time series with the relevant variances and mean count rates. The result of the experiments revealed that both the light and power curves indicate the properties inherent in uncorrelated stochastic processes and failed to give the detectable effect as in the case of natural stars.

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References

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