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INTRINSICALLY-VARIABLE B STARS IN ECLIPSING BINARY SYSTEMS

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As part of an ongoing series of projects to use the *Hipparcos* database of epoch photometry for variable star research, we have examined the short-term variability of several B0-B3 stars. The ultimate goal was to search for intrinsic short-term variability in B0-B3 stars in EA-type eclipsing systems with well-determined masses. This would enable us to determine accurate pulsation constants (Q-values), and pulsation modes. First, we examined several B0-B3 stars with known or suspected intrinsic short-term variability.

The *Hipparcos* epoch photometry consists of "clusters" of measurements taken within a day or two. We used these to investigate the short-term variability. The clusters are usually separated by many days or weeks. The photometric system is wide-band; it covers most of the visible spectrum. Autocorrelation analysis (Percy et al. 1993) was used to search for characteristic short-term time scales in the measurements obtained out of eclipse. In an autocorrelation diagram (AD), there are minima at multiples of the characteristic time scale, with maxima in between. The accuracy of individual *Hipparcos* measurements is a function of magnitude, and is typically a few millimagnitudes. The accuracy of points in the autocorrelation diagram (Figures 1 and 2) is greater, because each point is the average of ten or more delta mags. Because of the short datasets in the clusters, and the long intervals between the clusters, Fourier analysis was not practical - but autocorrelation analysis is ideal.

γ Peg (HIP 1067, $V = 2.83$) is a B2IV β Cephei star with a period of 0.15 day. The AD showed shallow but clear minima at $\Delta t = 0.15$, 0.30, and 0.45 day, consistent with the known period and the amplitude of 0.01 magnitude published in the *Hipparcos* catalogue (Perryman et al. 1997).

53 Ari (HIP 14514, $V = 6.13$) is a B1.5V β Cephei star with a period of 0.15 day. The AD shows only a weak minimum at $\Delta t = 0.26$ day; this and other maxima and minima are ≤ 0.002 magnitude. Either the star is not variable, or the variability lacks any characteristic time scale. The star is constant according to the *Hipparcos* catalogue.

23 Sex (HIP 50684, $V = 6.66$, B2.5IV) and **53 Psc** (HIP 2903, $V = 5.89$, B2.5IV) are both suspected β Cephei stars which are now regarded as constant to better than 0.01 magnitude. The AD's are sparse, but there are no conspicuous maxima or minima ≥ 0.002 out to $\Delta t = 0.15$ day for either star. This suggests that both are constant.

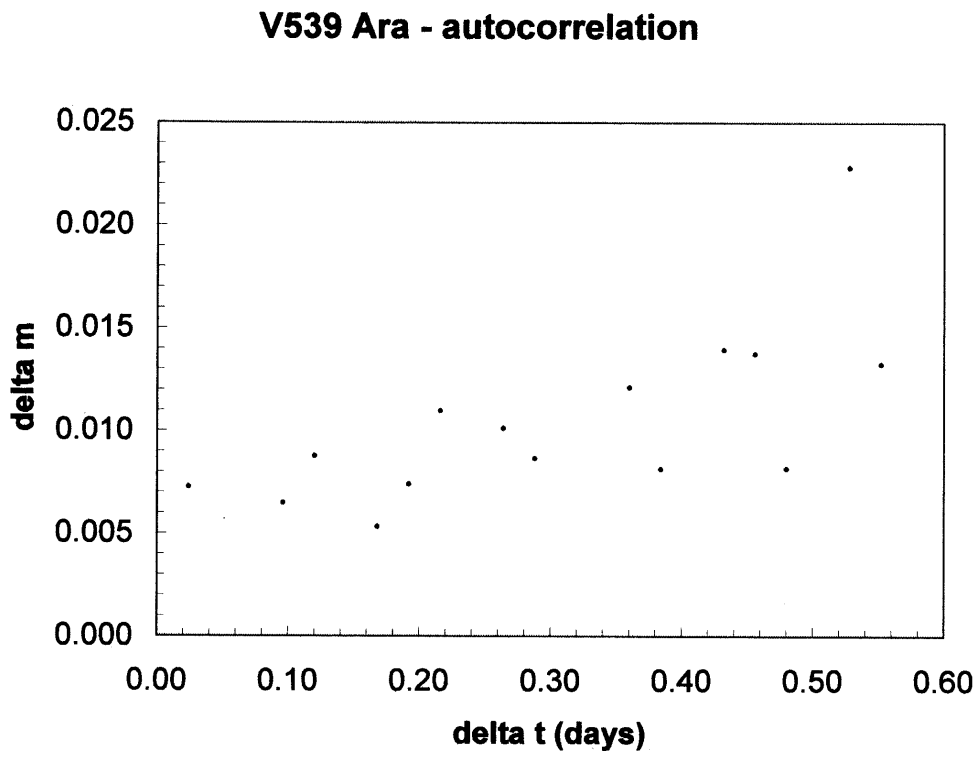

Figure 1.

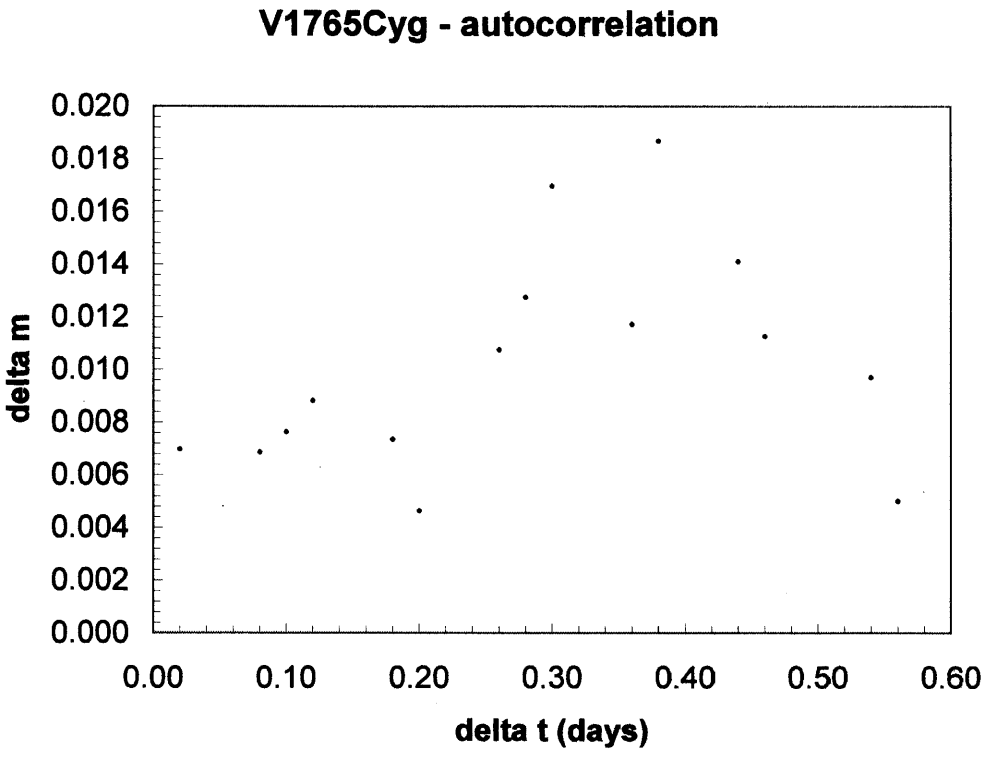

Figure 2.

OX Cas (HIP 5391, $V = 9.99$) is a faint B1V + (?) system in a 2.489-day eclipsing binary. The AD is flat (at a level of 0.03 to 0.05 magnitude, a result of the faintness of the star) to $\Delta t = 0.8$ day. This suggests that there is no short-term variability, larger than a few hundredths of a magnitude, on time scales $\geq$ one day.

V436 Per (HIP 8704, $V = 5.53$) is a B1.5V + (?) system in a 25.9366-day eclipsing binary. The AD slowly rises from $\Delta t = 0.0$ to 0.6 day; there is a weak minimum at 0.7 day. This suggests that the time scale of the short-term variations, if any, is greater than 0.6 day. According to the light curve in the *Hipparcos* catalogue, the scatter at eclipse maximum is very small. Harmanec et al. (1997) have observed line-profile variations in this system, with a time scale of a few hours.

AN Dor (HIP 22663, $V = 7.68$) is a B2 + B3V system in a 2.0328-day eclipsing binary. The AD is very sparse; it is flat to 0.1 day, but there is a weak minimum (defined by one point) at $\Delta t = 0.17$ day. The short-term variability is therefore uncertain.

CV Vel (HIP 44245, $V = 6.70$) is a B2V + B2V system in a 6.889-day eclipsing binary. The AD is sparse, but there is a maximum at $\Delta t = 0.12$ day and a minimum at $\Delta t = 0.25$ day. This suggests that this system may vary with a total range of 0.02 magnitude on a time scale of 0.25 day.

QX Car (HIP 48589, $V = 6.64$) is a B3V + B3V system in a 4.478-day eclipsing binary. The AD is sparse, but is flat to ≤ 0.002 magnitude, out to 0.2 day. This suggests that there are no short-term variations, ≥ 0.01 magnitude, on time scales less than 0.4 day.

V539 Ara (HIP 87314, $V = 5.68$) is a B2V + B3V system in a 3.169-day eclipsing binary; one of the components is a Slowly-Pulsating B (SPB) star with a period of 1.36 days. The AD rises steadily from $\Delta t = 0.0$ to 0.6 day (Figure 1). This suggests that any short-term variability occurs on a time scale ≥ 1.2 days. This is consistent with the known period of the SPB star.

V1765 Cyg (HIP 97485, $V = 6.42$) is a B0Ib + B1V system in a 13.3738-day eclipsing binary, and is interesting because of the presence of the supergiant component. Percy & Khaja (1995) suspected that there were variations on a time scale of 1.5 or 3.0–3.5 days, in addition to the eclipses. These may be intrinsic, or tidally-induced. The AD shows a weak minimum at $\Delta t = 0.2$ day, a maximum at 0.3–0.4 day, and another minimum at 0.6 day (Figure 2). These results suggest that may be small, short-term intrinsic variations in this star. It should be monitored photoelectrically, preferably from multi-longitude sites.

We conclude that autocorrelation analysis is a useful tool for investigating short-term variability in *Hipparcos* stars, given the time distribution of the data.

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