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A RELATION BETWEEN X-RAY SURFACE FLUXES AND U-BAND "TIME SIGNATURES" IN dMe STARS

Utilizing the MAC technique (Andrews 1988a) for analyses of photometric data in the Johnson U-band, we now have "time signatures" for seven dMe stars, which describe their brightness fluctuations in terms of rapid quasi-periodic oscillations. We have previously suggested that these time signatures (TS) are possibly related to the X-ray luminosities of the stars (Andrews 1988b). There are usually several TS's per star in the range investigated, from about 6 seconds to a few minutes, depending to some extent on the sampling times (usually continuous 1-second integrations collected over 10 to 20 minutes). When several TS's are present, the lower TS's may be harmonics, and, of course, are limited by the sampling Nyquist frequency, so we have examined the relationship of the maximum TS detected for each star with the X-ray luminosity. In Fig.1, we give a plot of $log\ L_X$ against $log\ (1/TS_{max})$, the logarithm of the maximum frequency of oscillations (in Hertz). We are presently looking for a connection with either non-radial oscillations or a possible link with the Ionson-Mullan hypothesis that convective motions in the presence of strong magnetic fields may contribute to coronal heating (Ionson 1984, Mullan 1984). Temporal and spatial coherence in a large coronal loop may allow detection of oscillations against the low surface brightness of a dMe star. There are no predicted values for asteroseismological p-mode oscillations in dMe stars. However, for comparison, we include in the plot the observed 10-minute "p-mode feature" for the K2 dwarf, epsilon Eridani, discovered in the variation of the strength of the CaII H and K lines (Noyes et al. 1984) This departs from the 4-minute asteroseismological period predicted for a K2 star by Christensen-Dalsgaard and Frandsen (1983). A value of $log\ L_X = 28.29$ for epsilon Eridani (= Gliese 144) is listed by Bookbinder (1985), and values for the dMe stars are available from Bookbinder (1985) and Pallavicini (1988). N.B. There is an error in $log(L_X)$ quoted previously for V1054 Oph (Andrews 1988b), where Gliese 644C was used instead of 644AB, and should be 29.08.

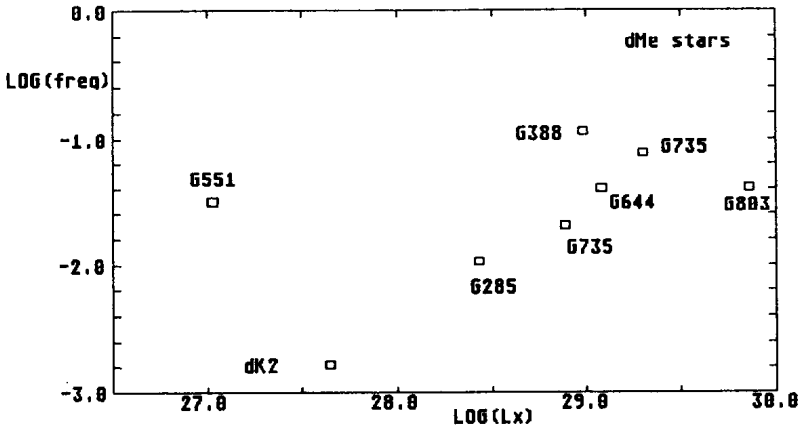

Figure 1

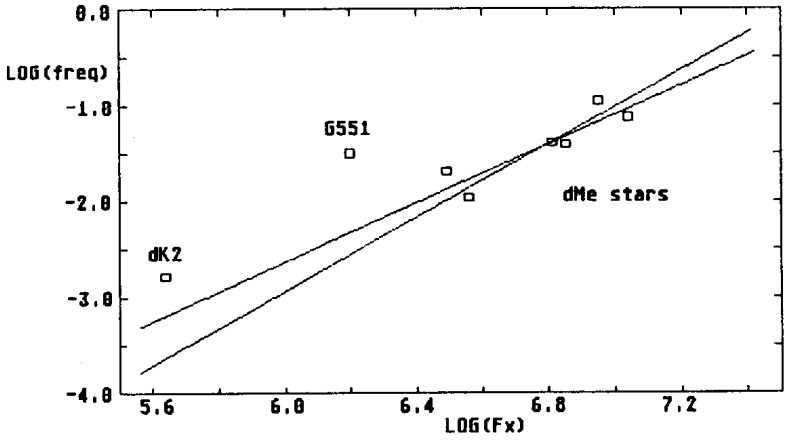

Figure 2

In the $log\ L_X$ versus $log\ (1/TS_{max})$ diagram we find considerable scatter, and V645 Cen (Gliese 551) which has a low X-ray luminosity destroys any relation if it exists. We have therefore examined the possible relation with the X-ray surface flux, F_X, (see Figure 2). V645 Cen (Prox Cen) is appreciably shifted in relation to the other stars due to its relatively small radius compared with those of the other dMe stars, but V645 Cen still stands out and may possess a larger TS. In Figure 2, we show two linear fits obtained by minimizing the square deviations in ordinate and abscissa. Excluding the dK2 star and V645 Cen, an approximate mean relation is found which is valid over $log\ F_X = 6.4\ to\ 7.0 : log(1/TS_{max}) = 1.75\ log\ F_X - 13.32$,

where the time signature is in seconds, and the X-ray surface flux is in ergs per sq.cm per second. For the six stars the correlation coefficient is 0.89, and we have the power law : $frequency(Hz) \sim (F_X)^{1.75}$, for the U-band oscillations. We predict an X-ray surface flux of 6.0 for epsilon Eridani compared with 5.64 deduced from Bookbinder's (1985) observations. We urge flare star observers to examine especially their U-band monitoring for low X-ray emitters. Amongst the dMe stars, EZ Aqr= Gliese 866 ($log\ F_X = 5.66$), has a predicted modulation, TS_{max}, of 43 minutes in the U-band. The dM1.5 star, AX Mic (Gliese 825) is a good southern hemisphere candidate for a search due to its brightness ($V = 6.7\ mag$) and very low X-ray flux ($log\ L_X = 27.28$, $log\ F_X = 4.76$), which is predicted to modulate with an unlikely 27.1 hour period according to the above power law. This may be explicable by the fact that AX Mic is not a dMe star (no Balmer emission). We tentatively point out that the small-amplitude photometric oscillations of 5 to 30 hours in some K-type Pleiades members (van Leeuwen 1983) are possibly a phenomenon related to that suspected in the solar neighbourhood dMe stars.

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