

KINEMATIC EVIDENCE FOR FUNDAMENTAL MODE PULSATION IN THE
SHORT-PERIOD CLASSICAL CEPHEID SU CASSIOPEIAE

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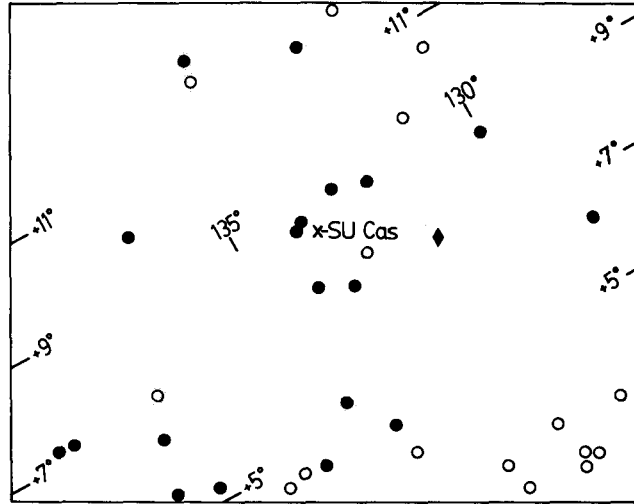
The short period and small amplitude of pulsation for the 1^d.95 Cepheid SU Cas make it an excellent candidate for pulsation in a purely excited mode, and, as summarized by Gieren (1982), there is some evidence from recent radius determinations for this variable which suggests that it is indeed an overtone pulsator. This conclusion considers only the Cepheid's observed characteristics, however, and ignores 3 important additional pieces of information:

1. SU Cas illuminates reflection nebulosity from a nearby dust cloud, whose distance of 258 pc (Turner & Evans 1984) is consistent with fundamental mode pulsation for the Cepheid.
2. One previous radius determination by Milone (1971), making use of data independent of that used in the other studies quoted by Gieren, yields a radius for SU Cas consistent with fundamental mode pulsation.
3. The radial velocity of $-6 \pm 1 \text{ km s}^{-1}$ quoted by Gieren (1976) for SU Cas is kinematically consistent with fundamental mode pulsation.

This last result is based upon an unpublished study by Havlen, the data from which have recently been reanalyzed by us with the addition of new photometric observations for B stars in the field of SU Cas. Havlen's original purpose for this study was to search for possible members, by now mostly main-sequence stars of spectral type B8 or later, of the cluster or association in which SU Cas originated. The search included all stars in the HD Catalogue brighter than 9th magnitude, of spectral type B9 or earlier, and lying within $\sim 5^\circ$ of SU Cas, in order to ensure possible detection of such companions out to and beyond the expected distance of SU Cas. A few early A stars near the Cepheid were added by Turner & Evans (1984). The distribution of program stars on the plane of the sky is illustrated in Fig. 1, where filled circles denote stars comparable in age to SU Cas, open circles denote stars much younger than SU Cas, and a filled diamond symbol denotes the one star judged to be older than the Cepheid. Identical symbols are used in Figs. 2 & 3.

Age discrimination was based upon the location of each star in the H-R diagram of Fig. 2, in conjunction with an estimated age for SU Cas (embracing the possibilities of fundamental mode, F, and first harmonic, 1H, pulsation), assuming it to be in the first or higher crossing of the instability strip. The luminosity of SU Cas was derived from the PL relation of van den Bergh (1977), which is consistent with the B star

Figure 1.



luminosity scale used here. Individual data for the stars in Fig. 2 were derived from broad band UBV photometry, Strömgren and $H\beta$ photometry, and up to 3 blue spectra at a dispersion of 63 \AA mm^{-1} for each star. Radial velocities were obtained from Abt & Biggs (1972), Turner & Evans (1984), and/or from radial velocity measures derived from the original plate material of Havlen. The resulting heliocentric velocities are plotted as a function of distance modulus for each star in Fig. 3, where the shaded region denotes the velocity of SU Cas. The main features of Figs. 1 & 3 which pertain to the pulsation mode of SU Cas are summarized below:

1. The majority of stars younger than SU Cas are located within 5° of the galactic plane, which is typical of a group of young field objects unrelated to the Cepheid. Stars comparable in age to SU Cas predominate

Figure 2.

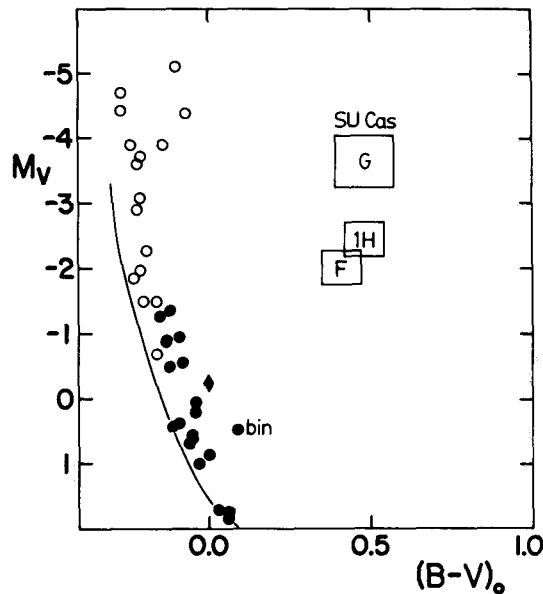
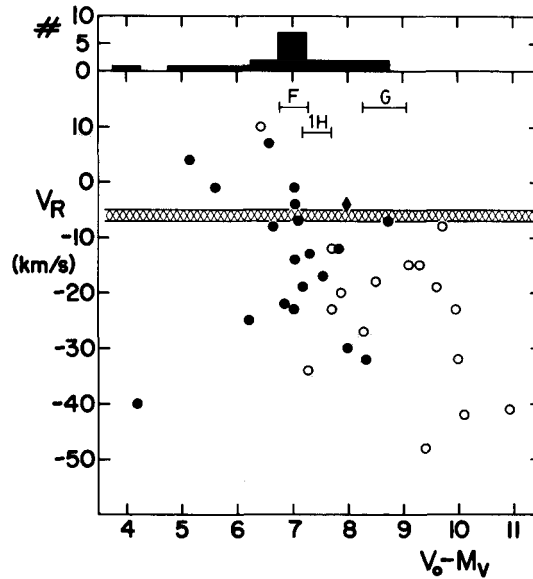


Figure 3.



at galactic latitudes similar to that of the Cepheid ($+8^{\circ}.5$).

2. As noted in the upper part of Fig. 3, stars comparable in age to SU Cas peak in number at a distance modulus of 7.0, which coincides in distance with the SU Cas BA association discovered by Turner & Evans (1984). This is also the distance at which most of the stars of comparable velocity to SU Cas are found.
3. There is only one star of comparable velocity and age to SU Cas at the distance indicated by the results of Gieren (1982; G in Figs. 2 & 3). However, this star (HD 19856) is almost 6° distant from SU Cas and lies near the edge of the field of Fig. 1.
4. If SU Cas is an overtone pulsator, then it has no nearby companions of similar age and radial velocity.

In general, the kinematic evidence supports the conclusions of Turner & Evans that SU Cas lies at a distance consistent with fundamental mode pulsation. It should be emphasized that this conclusion also rests upon the morphological evidence that SU Cas illuminates reflection nebulosity from the same dust cloud in which are embedded two other members of the association containing the Cepheid. It seems impossible to reconcile all of these arguments with anything other than fundamental mode pulsation for SU Cas, and the suggestion that this Cepheid is an overtone pulsator must therefore be considered untenable.

References.

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