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Cepheid Binaries: Frequency and Mass Ratios [1]

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Abstract. Ultraviolet spectroscopy with the IUE satellite has been used to survey all Cepheids brighter than 8^{th} magnitude to identify blue companions. The derived binary frequency is 21% with blue companions which implies that 34% would have been found from a large radial velocity survey. A second study has used deep IUE exposures of Cepheids showing orbital motion to determine the distribution of mass ratios in Cepheid binaries. Low mass companions are strongly preferred, especially when corrections for incompleteness are included.

1. Introduction

Accurate identification of Cepheids with blue companions is difficult from the ground for all but the brightest companions. This has hindered the comparison of the Cepheid binary frequency with that of B stars, and also the investigation of any effects a companion might have on pulsation (amplitude, period variation). It has also proved extremely difficult to extract information about the distribution of mass ratios for binary systems from, for instance, even very large samples of single-lined spectroscopic binaries. Since many cool Cepheids have hot companions, the use of ultraviolet spectroscopy allows us to make a detailed study of the companions. Using this approach, we obtain fresh insight into both these problems.

2. Binary frequency

In order to confidently identify blue companions, we have used the International Ultraviolet Explorer (IUE) satellite to observe all Cepheids brighter than 8.0 magnitude from 2000 to 3200 Å (Evans, 1992)

We find that 21% of the 76 Cepheids have blue companions. When stars known to have companions from other techniques such as orbital motion are included, the percentage rises to 29%. Tables have been provided to identify Cepheids with and without blue companions. If we make a statistical correction to derive the percentage of stars which would be found to be binary if extensive radial velocities were available, the percentage becomes 34%. This is actually larger than the fraction of B star binaries (corrected to include only stars with

[1]IUE Guest Observer

orbital periods longer than a year), but we attribute this to more complete detection of Cepheid systems.

3. Mass ratios

We have similarly obtained a deep IUE exposure from 1200 to 2000 Å for Cepheids with orbital motion (Evans 1995). A mass can be inferred from the spectral types from these spectra. This mass can be combined with a mass for the Cepheid from a mass-luminosity relation to provide the distribution of mass ratios for 20 binary systems. Low mass companions are strongly preferred. Using the distributions of orbital period, velocity amplitude, and eccentricity, we have derived corrections for incompleteness in the sample. These corrections increase the frequency of low mass companions. We stress that we have been particularly careful that all the stars in the sample clearly have orbital motion, so that the preference for low mass companions cannot be attributed to single stars inadvertently included.

The distribution of mass ratios is important observational information for comparison with star formation calculations. In the case of the Cepheid sample, the results refer to intermediate mass primaries with binary periods longer than a year. This is, of course, a spectroscopic rather than a dynamic determination of mass ratios, however, the technique is powerful and mass ratios M_2 / M_1 as small as 0.26 have been found.

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References

Evans, N. R. 1992, ApJ, 384, 220
Evans, N. R. 1995, ApJ, May, in press