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Setting a New Standard in the Analysis of Binary Stars
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HST FINE GUIDANCE SENSORS SURVEY FOR BINARIES AMONG THE MASSIVE STARS

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Abstract. We present the results of an all sky survey for binary systems among the massive stars that we made with the HST Fine Guidance Sensors. The sample of 225 stars is comprised mainly of Galactic O- and B-type stars and Luminous Blue Variables, plus a few luminous stars in the LMC. The FGS TRANS mode observations are sensitive to detection of companions with an angular separation of 0.01–1 arcsec and brighter than $\triangle m = 5$ mag. The FGS observations resolved 52 binary and 6 triple star systems and detected partially resolved binaries in 7 additional targets, yielding a companion detection frequency of 29%. We also gathered literature results on the numbers of close spectroscopic binaries and wider astrometric binaries among the sample. These results confirm the high multiplicity fraction. The period distribution is essentially flat in increments of $\log P$, although there remains an observational gap in detections for periods of years and decades.

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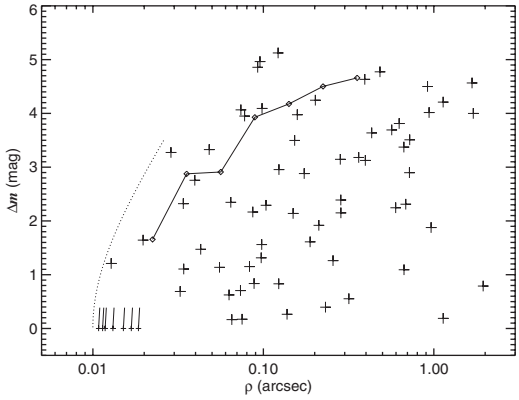

Fig. 1. A plot of the angular separation and magnitude difference for the companions detected with FGS. The plus signs with line segments in the lower left show solutions for blended companions. The solid and dotted lines show the predicted detection limits for resolved and blended companions, respectively, from Caballero-Nieves (2012).

The OB stars are very distant in general, so there exists a gap in our knowledge about binaries that have periods too long to be detected as spectroscopic binaries and are too short to be directly resolved by conventional means (years to centuries). Yet it is important to detect such wider binaries to complete our census of the overall binary frequency distribution, discover and interpret composite spectra, explore dynamics in triples, and find systems for future orbital mass determinations. The Fine Guidance Sensors on the *Hubble Space Telescope* offer us the opportunity to make such high angular resolution observations over a wide range of magnitude, and they have been used successfully in binary surveys of the Carina region (Nelan *et al.* 2004) and Cyg OB2 (Caballero-Nieves 2012).

We used the FGS1r to make TRANS mode scans in two orthogonal directions across each star. The scan shapes are compared to those of single stars to determine the separation and flux ratio of any companion recorded in the scan. Figure 1 shows the separations and magnitude differences of the companions we detected in our survey of OB stars. This shows that FGS can detect brighter companions over the range from 10 mas to 1 arcsec in projected separation. Our derived multiplicity fraction is similar to that detected for Carina and Cyg OB2, and together with the results from spectroscopic investigations and from wider systems listed in the Washington Double Star Catalog, it suggests that the total binary frequency is close to one, *i.e.*, almost all massive stars have a companion.

References

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