THE SPATIAL DISTRIBUTION OF SPECTROSCOPIC BINARIES AND BLUE STRAGGLERS IN M 67

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Mathieu et al. (1986) have completed an extensive radial-velocity survey of over 100 late-type stars in M 67 with V < 12.8. The spatial distributions of the spectroscopic binaries and single stars (i.e. those stars without detected radial-velocity variation; many of these are undoubtedly binaries, albeit with lower secondary masses) are shown in Fig. 1. The distribution of the binaries is notably more centrally concentrated than the single stars. The two observed distributions derive from distinct parent distributions at the 98% confidence level. The projected half-mass radius of the binaries is 0.9 pc; the half-mass radius of the single stars is 2.4 pc. Indeed, 77% of the binaries lie within the single-star half-mass radius.

A reasonable explanation for the central concentration of an ensemble of stars in a stellar system is that 1) the stars are more massive than typical cluster members and 2) relaxation processes have produced a velocity distribution approaching energy equipartition and consequently mass segregation in the cluster. In order to test the viability of this explanation for the central concentration of the binaries, we have fit multi-mass isotropic equipartition King models to the entire cluster, including a 2 $M_\odot$ component to model the binaries. The value of 2 $M_\odot$ was chosen *a priori* to be consistent with binaries that are somewhat less than twice the main-sequence-turnoff mass of 1.2 $M_\odot$. The cumulative distribution of this component is also shown in Fig. 1. The agreement of the model with the binary distribution is quite good. Thus the central concentration of the binaries is entirely consistent with them being more massive objects in a relaxed cluster. The relaxation time of M 67 derived from the average conditions inside the half-mass radius is 1×10^8 yr, short relative to the cluster age of 5×10^9 yr, so that indeed the cluster is expected to be well relaxed.

The central concentration of the blue stragglers is equally striking in Fig. 1. All of the blue stragglers lie within 3.2 pc of the cluster center; the half-mass radius is 1.1 pc. The blue straggler distribution is distinct from that of the single stars at better than the 99% confidence level. The central concentration of the blue stragglers is strong evidence that the blue stragglers do not comprise a relaxed population of objects with masses comparable to those of the single stars; the reasonable fit of the 2 $M_\odot$ component argues for the

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blue stragglers being substantially more massive than the main-sequence-turnoff stars. This argument is entirely independent of any assumptions concerning the internal physical state of the blue stragglers. An alternative explanation for the central concentration might be that the blue stragglers are not a more massive relaxed population but rather that they are preferentially formed in the cluster core. For this to be the case, the blue straggler lifetimes must be short, of order 10^8 yr or less.

The blue straggler distribution is notably similar to that of the binaries, in appealing concord with the hypothesis that some population of binaries are the progenitors of the blue stragglers. We note that the data presented here do not require the binarity of the blue stragglers themselves, an issue that remains controversial. The data require only that in the process of evolving from a binary system with normal cluster-member components to a blue straggler, whether through mass transfer, coalescence or some other mechanism, little mass is lost from the system. Indeed, even this requirement can be relaxed if the blue straggler lifetimes are short. On the other hand, the blue stragglers are more centrally concentrated than would be expected given masses derived from the mixed-stellar-interiors models computed by Saio and Wheeler (1980) for the blue stragglers of NGC 7789. However, without detailed models for the M 67 blue stragglers a definitive test of the extended lifetime scenario cannot be made.

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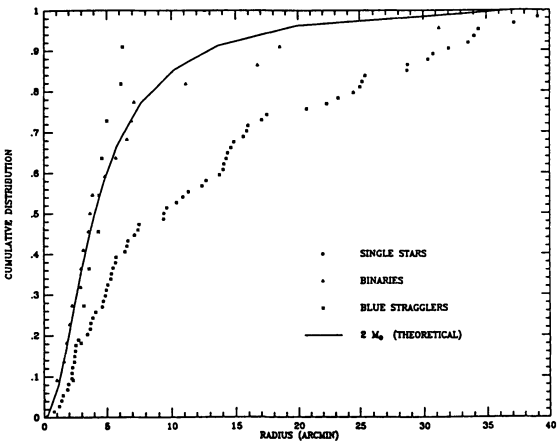

Fig. 1. Cumulative radial distributions of the 1.2 $M_\odot$ single stars, the spectroscopic binaries, the blue stragglers and a theoretical 2 $M_\odot$ component in equipartition.

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