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Spectroscopic Binaries in the Halo

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ABSTRACT: **For almost 1500 stars in the Carney–Latham survey of proper-motion stars we have accumulated about 20,000 precise radial velocities. Already we have orbital solutions for more than 150 spectroscopic binaries in this sample, and about 100 additional binary candidates with variable velocity. We find that among the metal-poor halo field stars in this sample the frequency of short-period spectroscopic binaries is indistinguishable from that of the disk. The distribution of eccentricity versus period shows evidence for tidal circularization on the main sequence. For the binaries more metal poor than [m/H] = -1.6 there is a clean transition from circular to elliptical orbits at a period of about 19 days. For longer periods the distribution of eccentricity is the same as for stars in the disk of the Galaxy.**

Mathieu & Mazeh (1988) proposed that the orbital period at which there is a transition from circular to eccentric orbits can be used as a kind of clock to date the relative ages of coeval samples of low-mass main-sequence binaries. The basic idea is that all the short-period binaries have had their orbits circularized by tidal mechanisms (cf. see Zahn 1977, Mathieu & Mazeh 1988, Mathieu *et al.* 1992), and the transition between circular and eccentric orbits moves to longer periods as a coeval sample of binaries grows older.

Unfortunately, there is not yet good agreement on the details of the theory of tidal circularization. Thus, it is premature to attempt to derive an age of

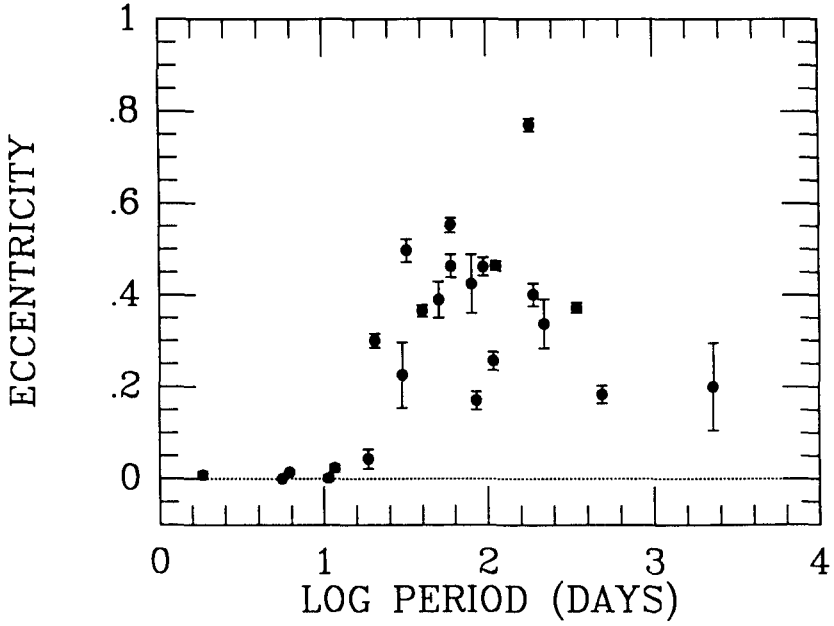

FIGURE 1. Eccentricity *versus* log period for halo binaries with [m/H] < -1.6.

the Galaxy from the transition period observed for the oldest stars. Instead, we need observations to test the competing versions of the theory; we need orbital solutions for rich populations of short–period binaries in several different coeval samples covering a wide range of ages.

To study the orbital characteristics of the binaries in the old, metal–poor, slowly–rotating halo population of our galaxy, we turn to the nearby halo field stars, which just happen to be passing through the solar neighborhood. The Carney & Latham (1986) proper–motion sample has proven to be a rich source of halo binaries. The radial velocities of the original sample of almost 1000 stars have now been monitored for more for more than a decade, supplemented more recently by an additional sample of nearly 500 stars. Orbital solutions have already been published for 80 of these stars (Latham *et al.* 1988, Latham *et al.* 1992), with many more than this number of orbits yet to come.

The eccentricity versus log period for all the halo binaries more metal poor than [m/H] = -1.6 is plotted in Figure 1. According to Morrison *et al.* (1990) this metallicity marks the extreme end of the disk population. Thus, there should be little danger that the binaries plotted in Figure 1 are contaminated by disk stars. All of these orbits are from the CfA data, except for HD 89499 (Ardeberg & Lindgren 1991).

It is impressive to see how clean the transition is from circular to eccentric orbits; all the orbits with periods shorter than 19 days are circular, while all

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the orbits with periods longer than 19 days are eccentric. This provides some reassurance that we have managed to choose a coeval sample; if there were a spread of ages then we might expect to find an interval of periods with both circular and eccentric orbits. However, for this to become a strong argument we will need many more orbits. It will be interesting to see if the transition remains this clean as more orbits get solved and are added to the diagram.

The halo binaries plotted in Figure 1 with periods longer than 19 days show a wide spread of eccentricities, with a mean of 0.38 ± 0.04. This is consistent with the mean eccentricity of 0.43 ± 0.04 found for 36 Hyades binaries with periods longer than 10 days (Stefanik & Latham 1992), and of 0.42 ± 0.03 for a sample of 44 binaries with period longer than 14 days found among 164 nearby solar-type field dwarfs (Duquennoy & Mayor 1991). We conclude that the initial distribution of eccentricities for main sequence binaries must have been very much the same for the halo as for the disk, despite significant differences in the chemical composition and kinematics between these two populations.

The frequency of short-period halo spectroscopic binaries in the Carney-Latham sample is about 20% and is indistinguishable from the frequency of solar-type binaries in the disk (Torres 1991).

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