EVIDENCE FOR DISK LOCKING FROM DEBRIS DISKS IN OPEN CLUSTERS.

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A number of theoretical models predict that magnetic fields should couple the rotation rate of young, PMS stars to the rotation rate of the inner portion of their circumstellar disks as long as those disks are actively accreting. Such models naturally predict that PMS stars with long-lived disks should be slow-rotators, whereas PMS stars with short-lived disks should be relatively rapid rotators. This theoretical expectation has been used to explain an apparent bimodal distribution of rotational periods in the Orion Nebula Cluster, and as a contributor to the explanation of the observed distribution of rotational velocities in young open clusters like the Pleiades and Alpha Persei clusters. Detailed comparisons of observations to model predictions have often met with difficulties, however. In particular, in order to explain the slowest rotators in young open clusters, it has usually been necessary to invoke very long PMS disk lifetimes. We have attempted to find a direct link between circumstellar disks and rotation in low mass open cluster stars. We first assume that long-lived PMS disks are more likely to be more massive and more likely to form planetesimals. If so, the long-lived primordial disks are more likely to also have more massive debris disks. If these assumptions are valid, then the PMS disk-locking model would lead to a correlation for low mass stars whereby the slow rotators should have mid-IR excesses detectable at 24 or 70 microns with Spitzer.

We have combined data from the FEPS Legacy program (stars in the Pleiades, Alpha Per, and IC2602 clusters) and a GTO program for the Pleiades in order to search for such a correlation. The result is shown in Figure 1 - which does indeed suggest that there is a strong link between the ZAMS rotation rate and mid-IR excess for this sample of ~100 Myr old F and G dwarfs. This could be evidence for disk-locking during PMS evolution. However, a similar correlation would result from a wind-scouring model, such as that proposed by Chen et al. 2005 (ApJ, 623, 493) to explain a correlation between IR-excess and X-ray flux that they observed for a sample of Sco-Cen low mass members.

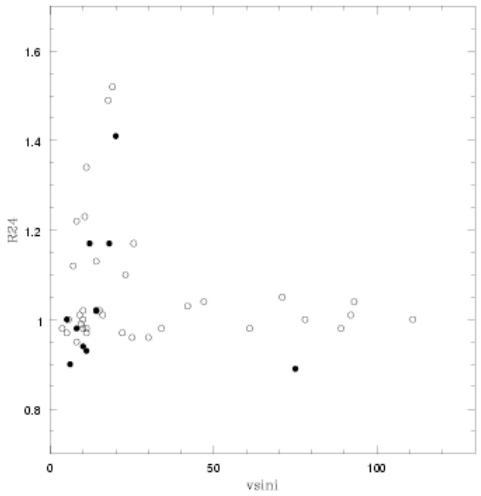

Figure 1: Ratio of observed to photospheric 24 micron flux vs. spectroscopic rotational velocity (in km/s) for stars from the FEPS Legacy program (open circles) and the GTO Pleiades program (filled dots).