Stellar Rotation
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Post Main-Sequence Changes in Rotational Velocities

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Abstract. From recent measurements of the rotational velocities of 1100 B stars and 1700 A stars, we determined the maximum periods of binaries with fully circularized orbits. Combined with published data, we derived the relation of period (days) = 0.001 age$^{0.42}$ (yr). We were able to reproduce the rotational velocities of giants from $v \sin i$ of dwarfs only if rigid body rotation applies to both. However for evolutionary expansions greater than 5 the angular momentum is conserved in shells, which is reasonable physically.

1. 1. Introduction

New projected rotational velocities, $v \sin i$, were derived for about 1100 B stars by Abt, Levato, & Grosso (2002) and for 1700 A stars by Abt & Morrell (1995). Those showed that for stars in binaries, all the B primaries with periods <2.4 days are fully synchronized and for A primaries with periods <4.9 days. These are consistent with the theoretical results of Zahn (1977). Further, all B stars with periods <1.5 have circular orbits and all A stars with periods <2.5 days are circular. Combining these data for Hyades & Praesepe and old disk stars (Duquennoy & Mayor 1991), M67 (Mathieu & Mazeh 1988), and halo stars (Latham et al. 1988), we find the linear relation circularized P (days) = 0.001 age$^{0.42}$ (yr).

1.1. 2. Post Main-Sequence Rotational Velocities

Using the mean projected rotational velocities of 1377 B and A dwarfs (normal and peculiar), we attempt to explain the mean rotational velocities of 381 B and A giants. We assumed evolutionary models of Bertelli et al. (1986) and assumed a mean MS age for the dwarfs of 30×10^6 yr. The data do not allow any significant loss of angular momentum with either extreme transfer method. The extreme transfer methods are a free transfer of angular momentum, i.e. continuous rigid body rotation, or no transfer of angular momentum, i.e. conservation in shells. Conservation in shells does not fit the data but a free transfer of angular momentum within the stars fit within the measuring errors of (15 km s^{-1}. This confirms the results of Oke & Greenstein (1954) and Sandage (1955) for late-type giants that have expanded by less than a factor of about 5 from the main sequence. However, Abt (1957, 1958) found that the rotational velocities of bright giants and supergiants that have expanded by factors of 4-10 from dwarfs can be understood only with conservation in shells. Thus conservation in rigid-body rotation applies for expansions <5 and in shells for expansions of 5-10. This conclusion seems reasonable in view of the gradual density gradients in

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dwarfs but in supergiants the interior structure consists of a small high-density core and a very tenuous envelope. We would not expect much coupling of envelope and core in the latter case. Another example is the atmosphere of the K bright giant in zeta Aurigae. Wilson & Abt (1954) could explain why the UV radiation of the B stars did not ionize the atmosphere of the K star only if the atmosphere of the K stars consisted of high density condensations (sheets, clumps, or prominences) of order 10^3 km. The rotational motions of such condensations are unlikely to be coupled with the stellar core.

References

Abt, H. A. 1957, ApJ 126, 503

Abt, H. A. 1958. ApJ 127, 658

Abt, H. A., Levato, H., & Grosso, M. 2002, ApJ 573, 359

Abt, H. A., & Morrell, N. I. 1995, ApJS, 99, 135

Bertelli, G., Bressan, A., Chiosi, C., & Angerer, K. 1986, A&A 66, 191

Duquennoy, A., & Mayor, M. 1991, A&A 248, 485

Latham, D. W., Mazeh, T., Carney, B. W., McCrosky, R. E., Stefanik, R. P., & Davis, R. J. 1988, 567

Mathieu, R. D., & Mazeh, T. 1988, ApJ 326, 256

Oke, J. B., & Greenstein, J. L. 1954, ApJ 120, 384

Sandage, A. 1955, ApJ 122, 263

Wilson, O. C., & Abt, H. A. 1954, ApJS 1, 1

Zahn, J. P. 1977, A&A 57, 383

Jean Zorec and Helmut Abt discussing about maybe rotation.

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