Accretion disks in Algols: progenitors and evolution

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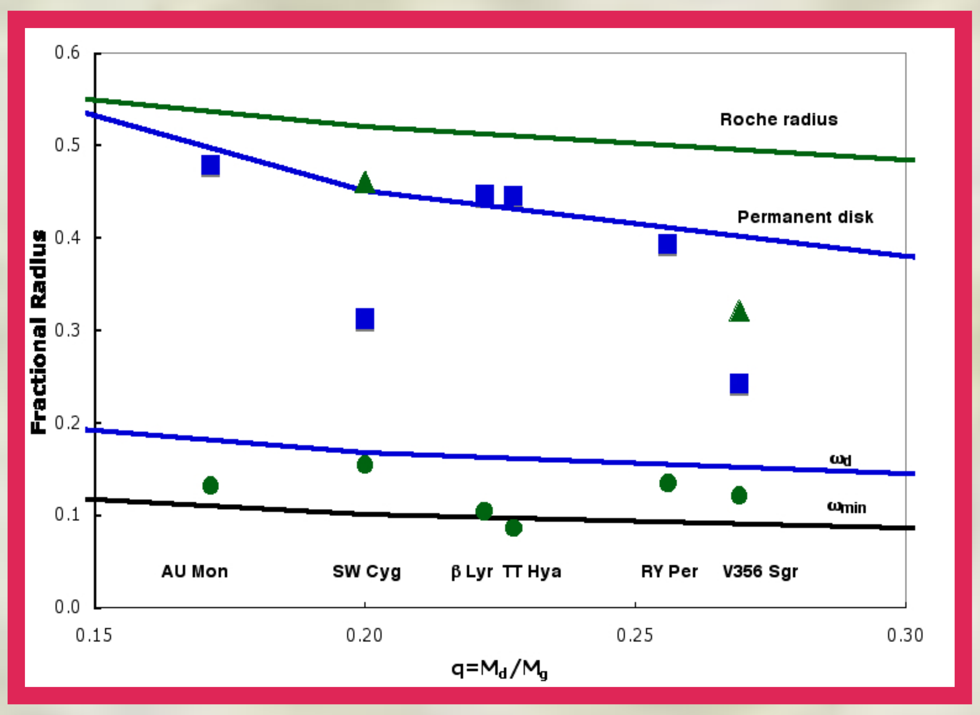
The initially most massive star in a binary starts with Roche Lobe Over Flow (RLOF) towards the initially less massive star

The mass stream through the first Lagrangian point comes from donor (subscript „d") to gainer (subscript „g"')

If during RLOF so much mass has been transferred that:

The less massive (initially most massive) star fills its Roche Lobe (RL)
The most massive (initially less massive) star does not fill its RL and is still on the main sequence
The less massive (initially most massive) star is the cooler, the fainter and the larger

The binary is an ALGOL

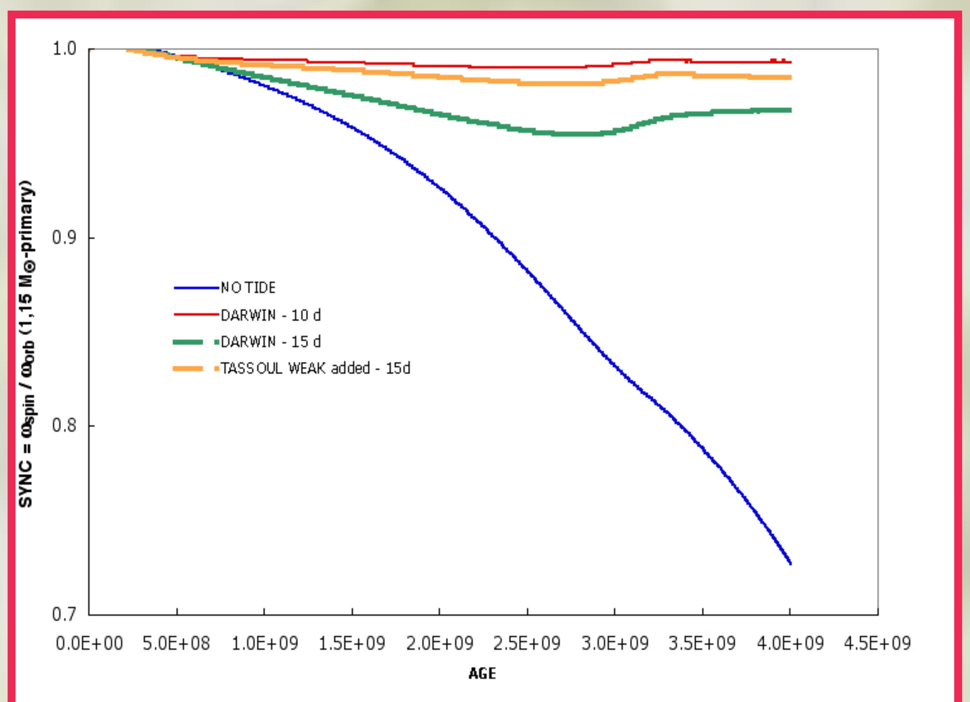


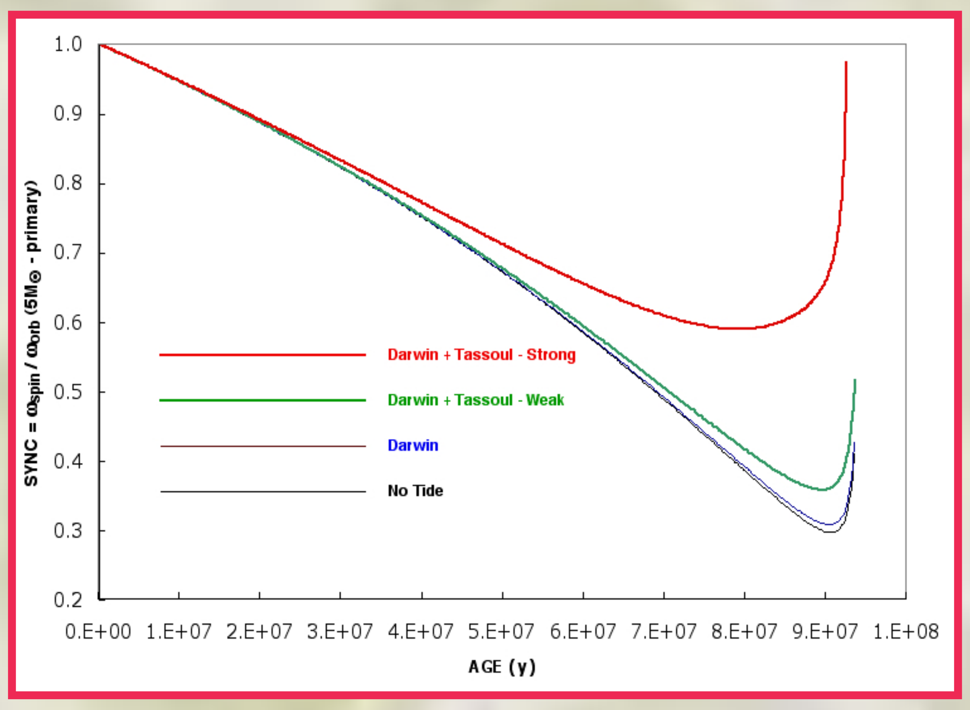
System	P (d)	$M_d(M_\odot)$	$M_g(M_\odot)$	$R_d(R_\odot)$	$R_g(R_\odot)$	Log $T_{eff,d}$	Log $T_{eff,g}$	dM/dt	<T_{disk}>	R_{disk}
β Lyr	12,91378	2.88	12.97	14.7	6.1	4.114	4.447	2.03E-5	9000	0.91
AU Mon	11.11304	1.20	7.00	10.0	5.6	3.760	4.230	2.59E-6	5190	1.00
V356 Sgr	8.89611	2.80	10.40	11.7	5.2	3.954	4.362	1.90E-6	7000	0.65
TT Hya	6.95343	0.63	2.77	5.98	1.99	3.680	3.990	6.85E-8	7000	0.95
RY Per	6.68356	1.60	6.25	8.10	4.06	3.802	4.259			0.85
SW Cyg	4.57302	0.50	2.50	4.30	2.60	3.690	3.956	2.11E-7		0.95

Observed parameters. Stars and accretion disk around the gainer. Subscript "d" for donor and "g" for gainer. The mass transfer rate dM/dt is in $M_\odot$/y. The radius of the disk is divided its Roche radius.

Six ALGOLS with an accretion disk around the gainer need a large distance between the stars:
Criterium of Lubow and Shu (Fractional radius = radius / semi major axis):
Gainers with radii below lowest curve : permanent disks (TT Hya)
Gainers with radii between two lowest curves : transient disks (AU Mon, SW Cyg, ß Lyr (almost permanent), RY Per, V356 Sgr) - Six dots
Calculated six disk radii : Six squares
Two observed disk radii : Two triangles (the large radius of the disk in SW Cyg is hard to believe)
The radii of permanent disks are shown by a blue line
The position of the Roche radius of the gainer is the green line

New in the Brussels binary evolutionary code: tidal interaction needs binaries to be synchronized up to periods = 10d

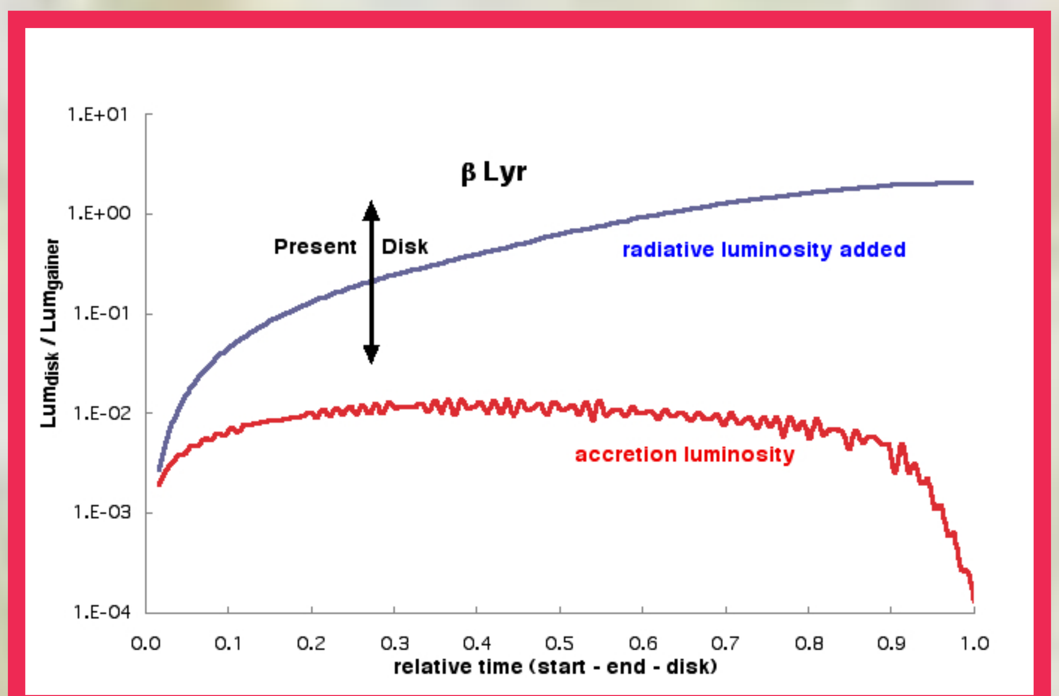




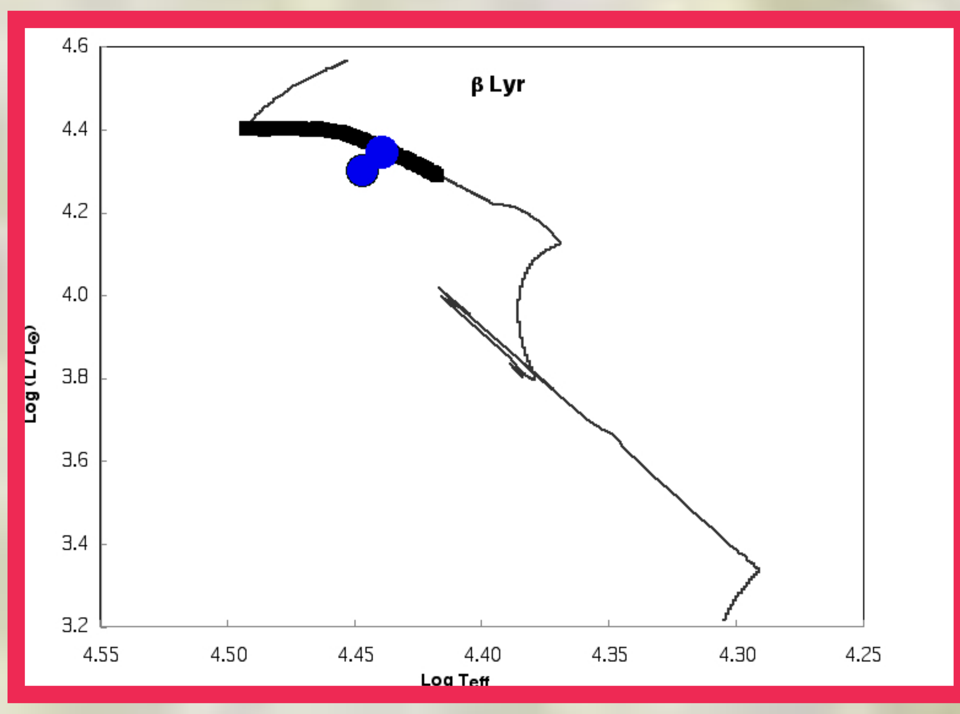
Stars with a convective envelope: Old Darwin theory (quantified by Piet Hut) keeps stars synchronized up to periods of 10 days due to tidal friction. A weak contribution of meridional circulation (Tassoul) contributes to a synchronization of orbital periods up to 15 days.

Stars with a radiativeve envelope: Old Darwin theory (quantified by Jean Paul Zahn) does not keep stars synchronized up to periods of 10 days due to the tidal torque mechanism. A strong contribution of meridional circulation (Tassoul) achieves the observed synchronization.

Results: Evolution of ß Lyr (shown below as an example) and V356 Sgr is liberal (~ 2 $M_\odot$ lost) - The evolution of the four other systems is conservative. Progenitors are found for six Algols. Matching present data on stars and accretion disk narrows the range for possible masses and orbital period for the initial binary.



Evolution with time of the luminosity of the accretion disk in ß Lyr. Accretion from the donor and radiation from the gainer construct the luminosity of a disk. Accretion prevails for disks around WDs and NSs. Radiation dominates for disks in Algols



The path through the HRD of the gainer. The era of disk presence is outlined by a thick part of the evolutionary track with a bullet for the calculated present position. The observed position is shifted a little bit towards the lower left.