

Binary Stars

Binary Star **Albireo** in Cygnus

A visual & detached binary

Period --- 1000's of years



It's the Rule...

(NOT the exception)

A sky photo by Scott McNeill of Rhode Island
Image includes Antares, Rho Ophiuchus Cloud,
And Saturn (upper right)



Half of all Stars in Multi-Star Systems

The sun is most likely a “sole” star...

Formation of Binary Systems

Mechanism --- A star forms from disk of gas and dust, whirling around a young star, when the disk fragments, forming a second star which orbits the first one.

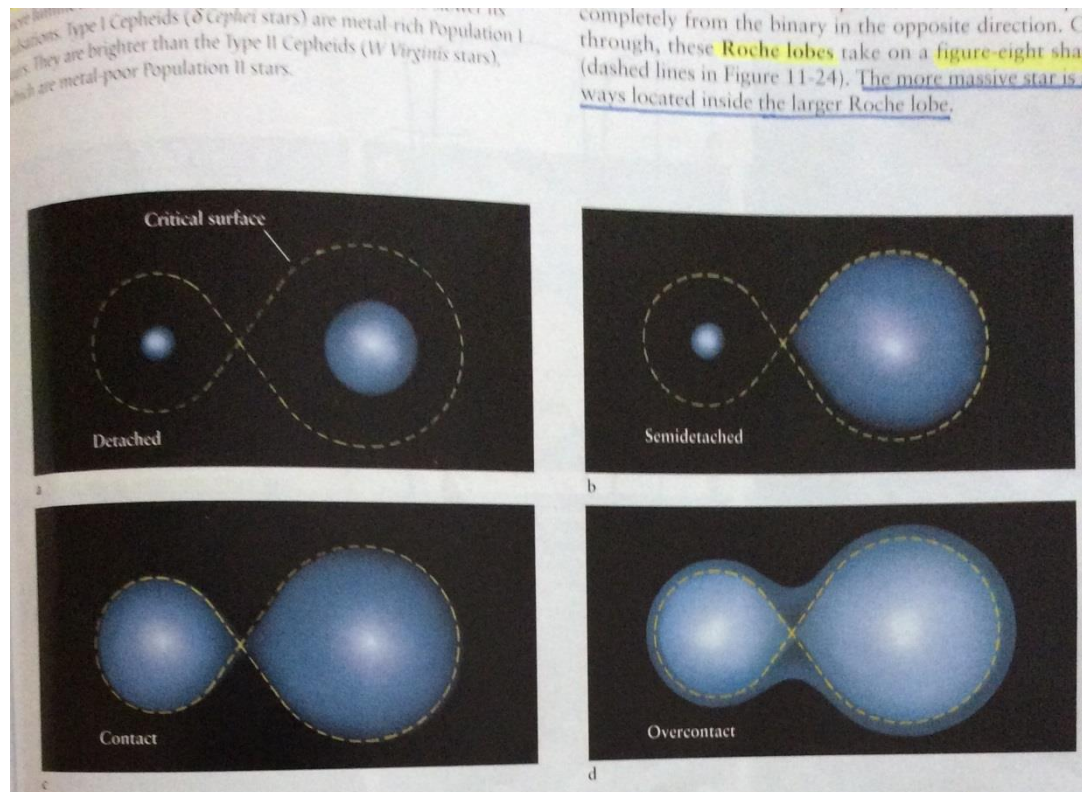
Essentially both stars **form at the same time**

Stars most likely **evolve independently**, with age progression based on initial mass.

Classification of Binary Systems (based on observation methods)

- **Visual binaries** (both stars seen separately)
- **Spectroscopic binaries** (only one star seen); binary nature is observed via doppler shift of star spectrum --- separation is very small and orbital velocity is high
- **Eclipsing binaries** --- via light curves...
- **Astrometric binaries** --- they seem to orbit empty space --- fairly near earth

Binary Class According to Orbit (Roche Lobes)



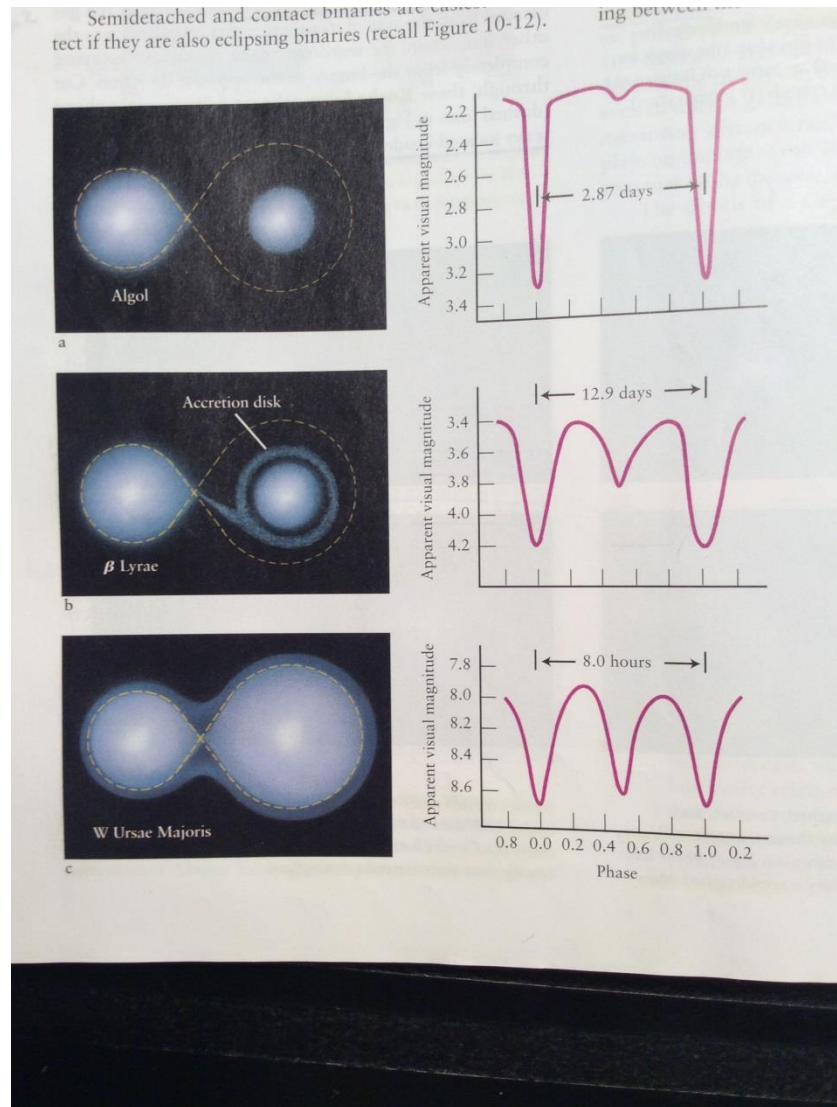
... Type I Cepheids (δ Cephei stars) are metal-rich Population I stars. They are brighter than the Type II Cepheids (*V Virginis* stars), which are metal-poor Population II stars.

completely from the binary in the opposite direction. C through, these **Roche lobes** take on a figure-eight shape (dashed lines in Figure 11-24). The more massive star is always located inside the larger Roche lobe.

Figure 11-24 Detached, Semidetached, Contact, and Overcontact Binaries These figures show the various types of binary star systems. (a) In a detached binary, neither star fills its Roche lobe. (b) If one star fills its Roche lobe, the binary is semidetached. Mass

transfer is often observed in semidetached binaries. (c) In a contact binary, both stars fill their Roche lobes. (d) The two stars in an overcontact binary both overfill their Roche lobes. The two stars actually share the same outer atmosphere.

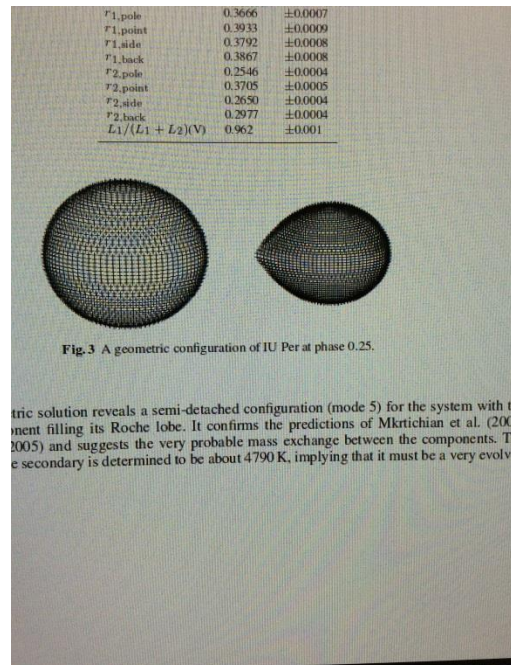
Roche Lobes cont...



Semidetached Ex --- IU Per

Detached binary system (Seen in slide 1)

Semidetached binary --- IU Per/Period 0.857 d



IU Per continued (Light Curve)

$10^{-7} \text{ d yr}^{-1}$. This supports the result of Qian (2001).
ed linear ephemeris (1), we computed the phases of all the measurements. The phase
e was formed as shown in Figure 2. The general feature of the light curve is typical
EA type as assigned in the GCVS (Samus 2004). The depths of the primary and
in the V band were measured to be 0.62 mag and 0.10 mag, respectively. With the
e given for comparison, $V = 11.36 \text{ mag}$, the magnitude of IU Per at the maximum
to be about $V = 10.36 \text{ mag}$.

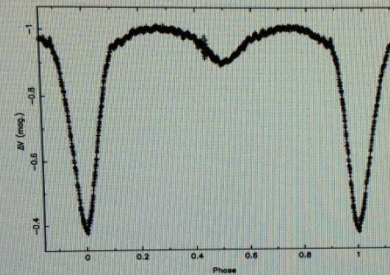


Fig. 2 IU Per: phased V-band light curve and the theoretical synthesis.

The eclipsing light curve was then analyzed by using the 2003 version of the Wilson
, hereafter) code with the Kurucz atmospheres (Wilson & Devinney 1971; Wilson 1979,
et al. 1998). All the measurements were included in the computation of the photomet-
nonlinear limb-darkening law with the logarithmic form was applied in the light curve
idering the probable close distance between the components, the effect of reflection has
account.

ing the photometric solution, the temperature of the primary star was set at 6450 K ac-
ceptual type of A4 through the calibration of Cox (2000). The initial bolometric (X_1, X_2 ,
mochromatic (x_1, y_1, x_2, y_2) limb-darkening coefficients of the components were taken
me (1993). The gravity darkening exponents were set to be $g_1 = 1.0$ for the primary and
the secondary component according to Lucy (1967). The bolometric albedos were taken
at $a_1 = 0.5$ following Buzinski (1969).

Overcontact (overflow) binary

W_UMa



...interesting video...

https://search.yahoo.com/search;_ylt=AnwcJ0S3yLXOg2oE89j1wYWbvZx4?p=Basics+of+astronomy%3B+binary+stars%3B+Kurdistan+planetarium&toggle=1&cop=mss&ei=UTF-8&fr=yfp-t-325&fp=1

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