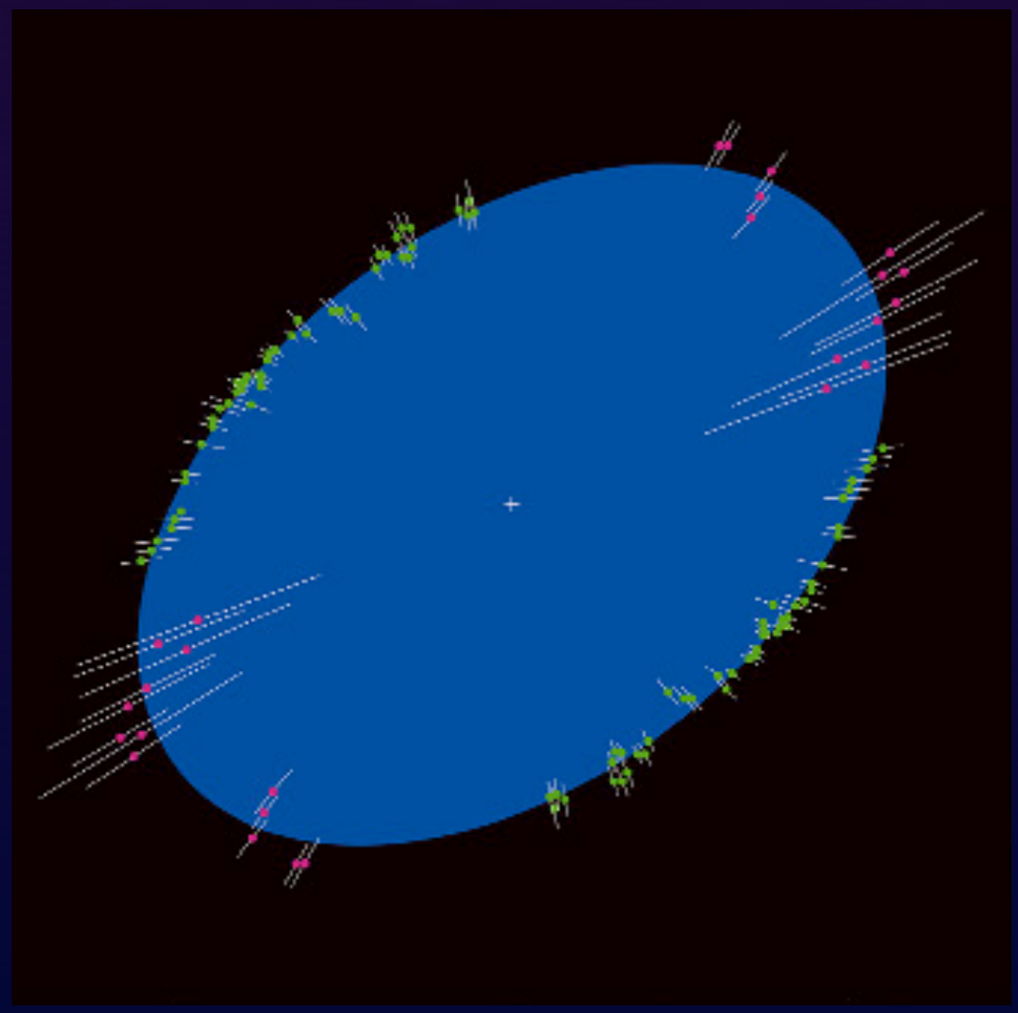
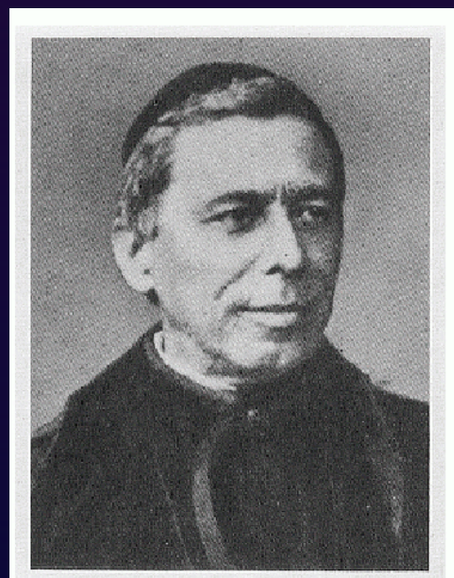
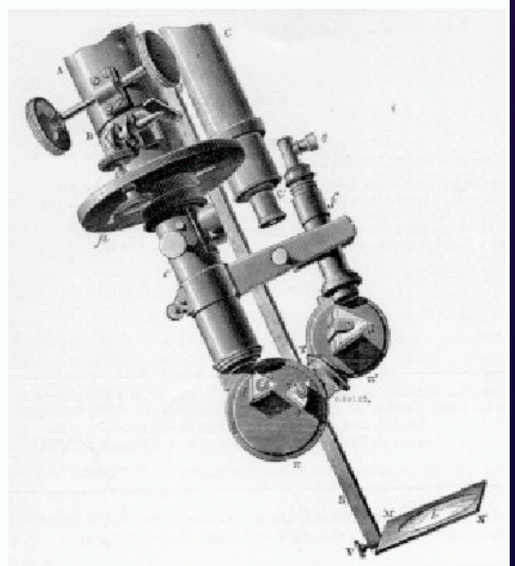
Be stars



Marlene Obbrugger

history

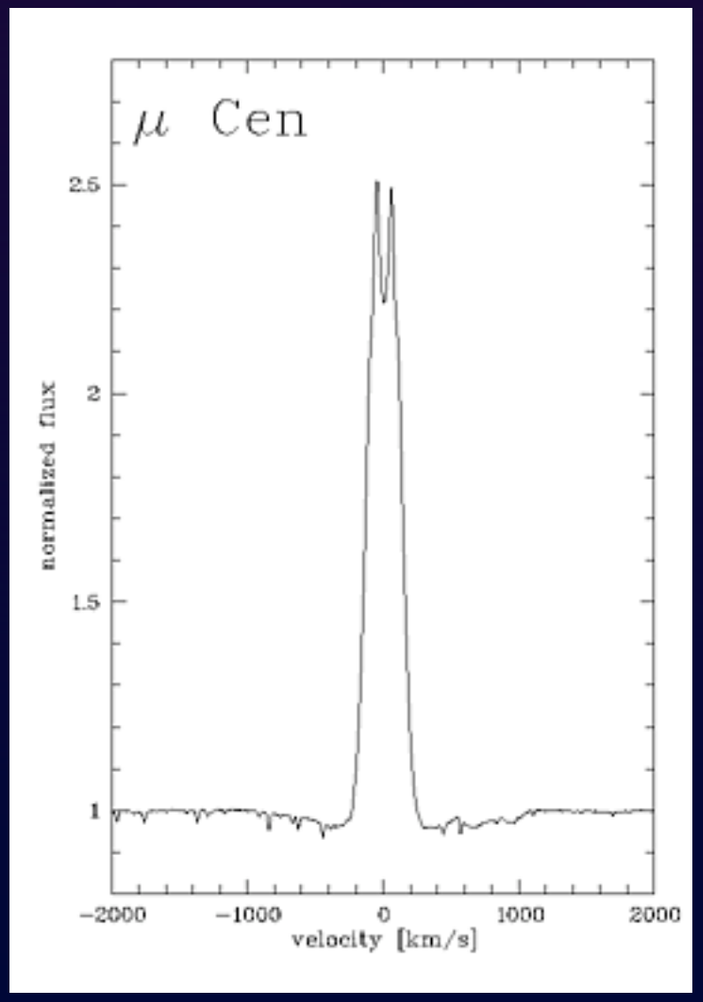




Angelo Secchi 1866

first report of a Be star (γ Cas)
visual inspection through a spectroscope

definition
of a classical Be star



- at least once Balmer line emission displayed
- non-supergiant B stars

corresponds to about 20 % of all B stars

definition
of the B[e] phenomenon

Balmer line emission
forbidden emission lines [FeII] [OI]

applies to:
B[e] supergiants
Herbig Ae/Be stars
planetary nebulae
symbiotic stars

properties

- extremely high rotational velocity (~ 80% v_{bu})

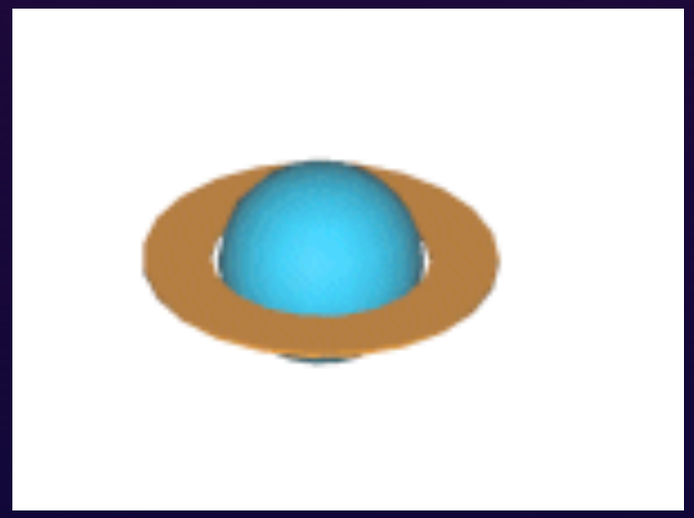
- emission features due to **circumstellar disk**

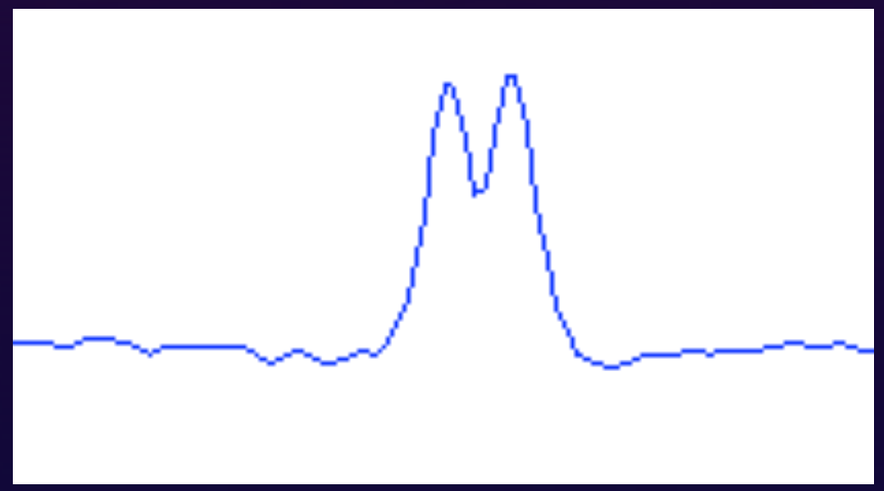
- go through different phases:

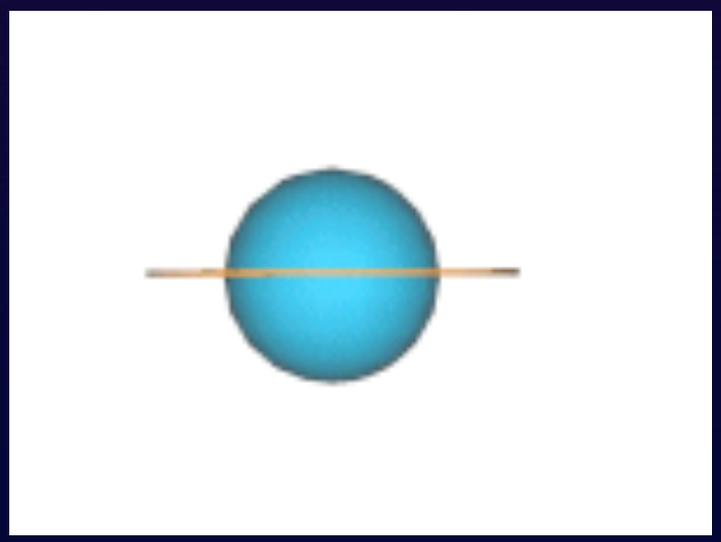
B-normal → Be → Be-shell → B-shell

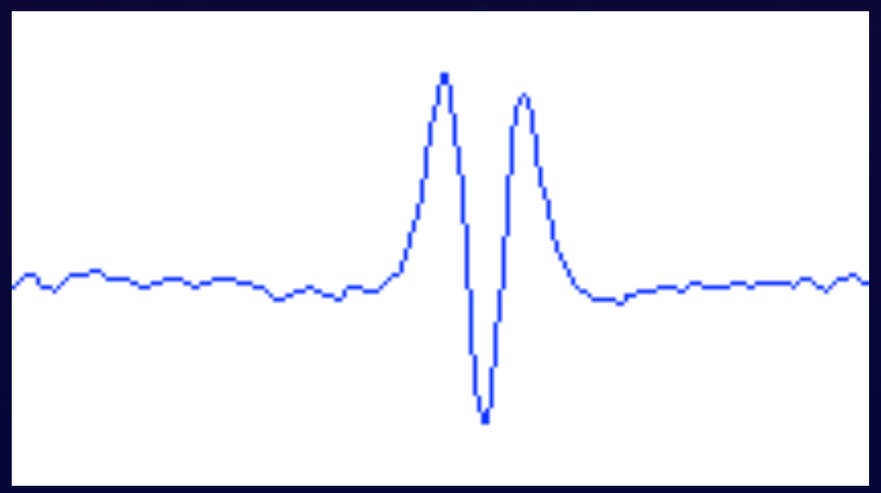
- variable spectroscopic, spectrophotometric, polarimetric and interferometric characteristics

shell feature









feature depends on the position of the observer

disk formation theories

radiatively driven winds (not sufficient)

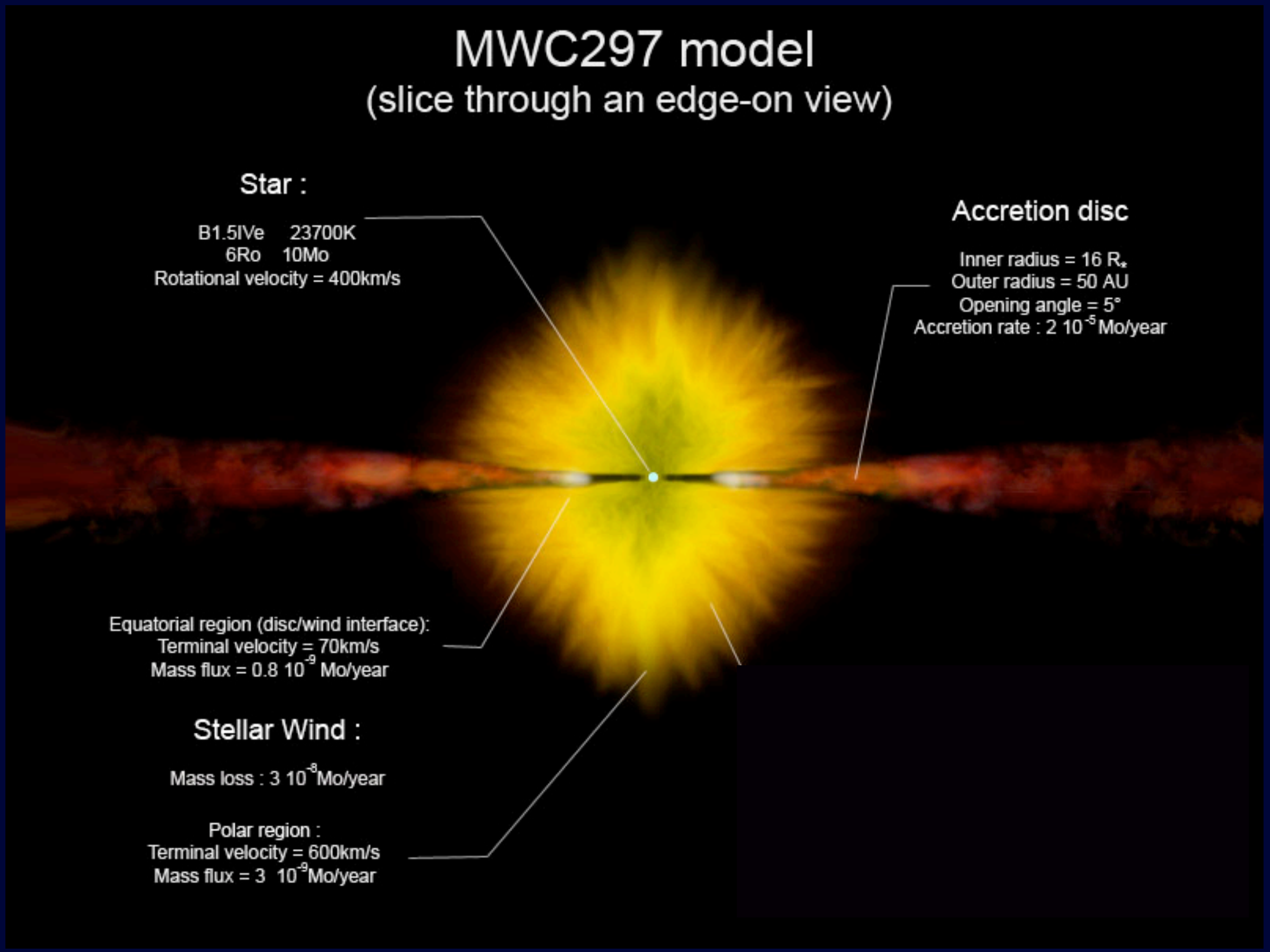
photospheric pulsation reduces gravity locally
(+ driven by radiation)

matter transported along magnetic field lines ?

mass loss due to binary

pulsation → turbulence → angular momentum transfer

MWC297 model
(slice through an edge-on view)



evolutionary state

seem to be quite homogeneously distributed along the main sequence (but debate goes on)

late-type Be stars need higher v/v_{crit} and larger t/t_{ms} ratio

massive Be stars tend to be present at lower t/t_{ms} age ratios

variations

1.formation and dispersal of the disk (weeks - decades)

2. binary motion of some stars (days - weeks)

3. non-radial pulsation (0.3 - 2 days)

4. rotation (0.3 - 2 days)

rotation and binarity

- Be stars have higher v_{rot} than B stars

- 75% might have been spun-up by binary mass transfer

- Be star binaries do not exceed 1/3 (typical for non Be)

- rest supposedly rapid rotating at birth

open questions

Does Be frequency rise toward the TAMS ?

Rotational velocity higher than 70%-80% of v_{bu} ?

What fraction has been spun up by binaries ?

Presence and origin of magnetic fields ?

Firm theoretical basis for mass loss due to magnetic field ?

Credit: A. Meilland

The Be Star Alpha Arae
(Artist's Impression)

ESO Press Photo 35/06 (19 September 2006)