

Astro 8501 – 6944

Binary Stars

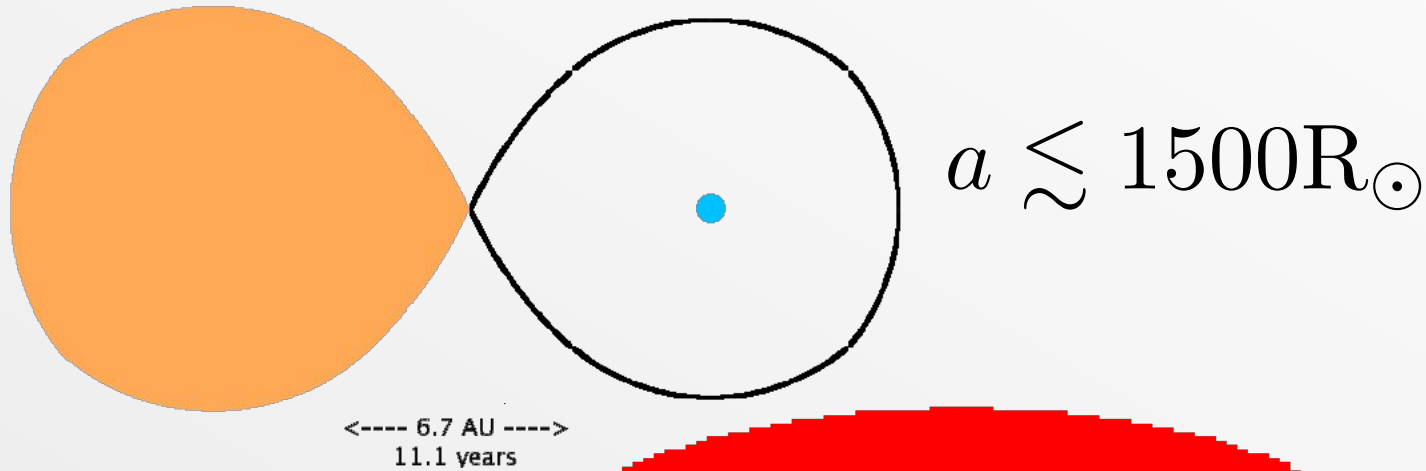
Thursdays 9am
AIfA 0.008



Robert Izzard izzard@astro.uni-bonn.de

http://www.astro.uni-bonn.de/~izzard/binary_stars.html

Close Binary Systems

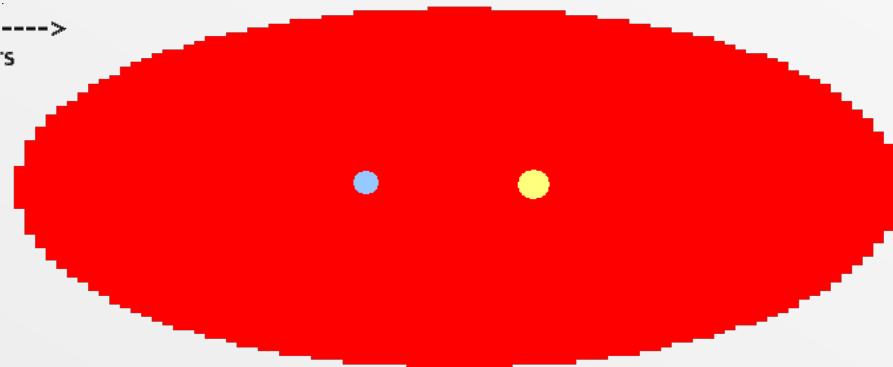


$$M_1 = 3M_{\odot}$$

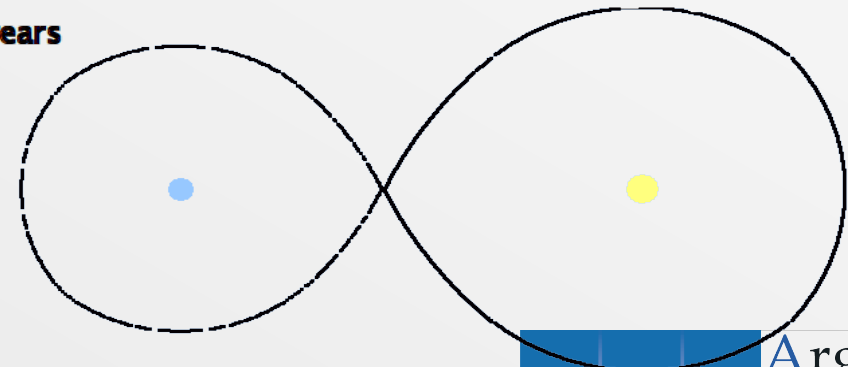
TPAGB

$$M_2 = 1M_{\odot}$$

Main Sequence



6.7 AU
 11.1 years



1.4 AU
 1.3 years

Cataclysms

- Classical novae

Thermonuclear explosion caused by pile-up of accreted matter

- Dwarf novae

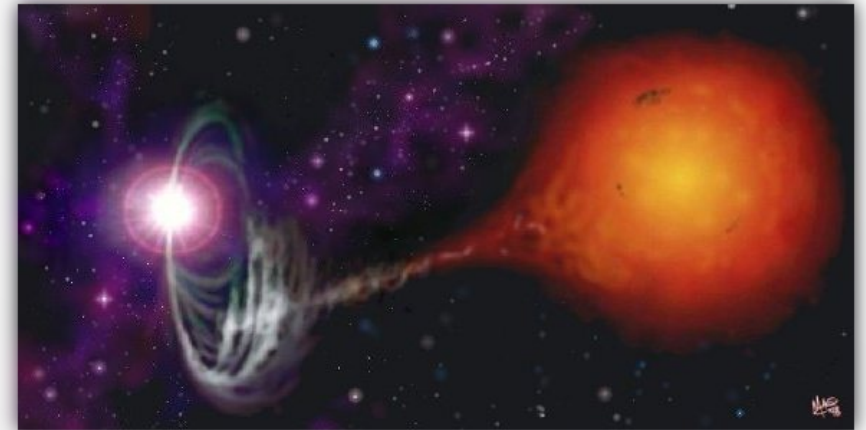
Accretion disc instability

- Polars / Intermediate Polars

High B-field matter streams onto pole

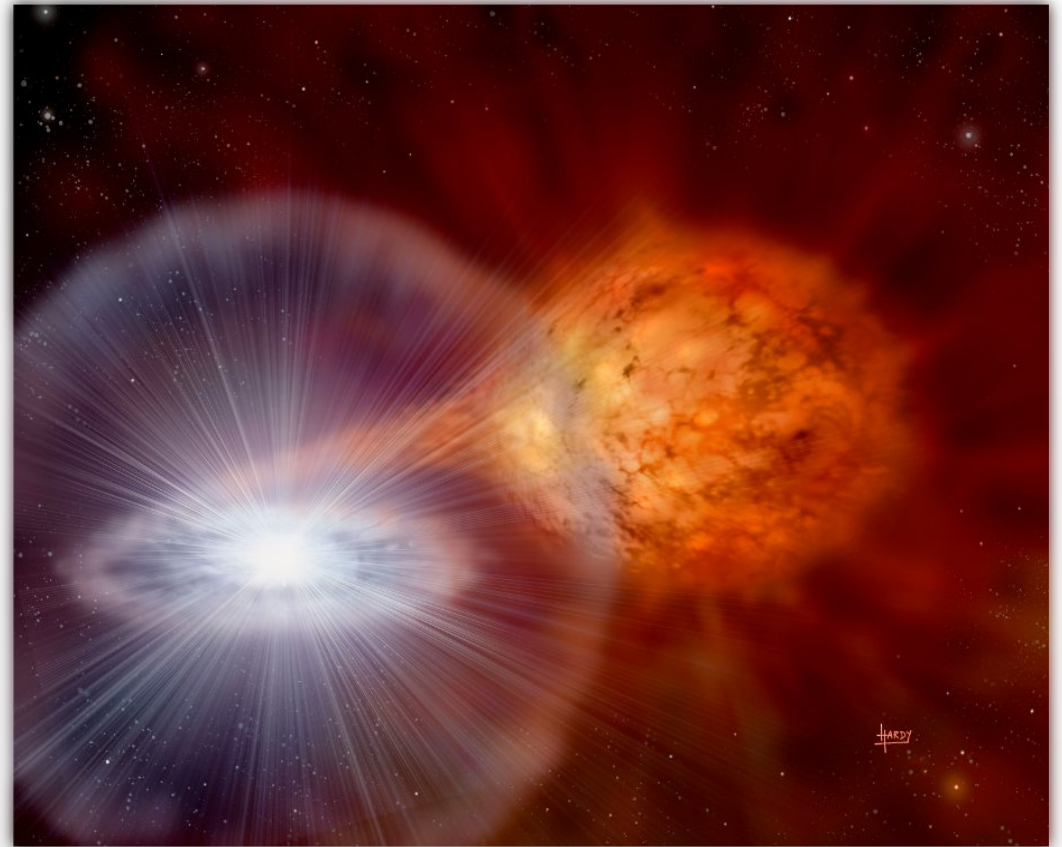
- AM CVn white dwarf-white dwarf binary

- Supersoft X-ray sources



Cataclysmic Variables

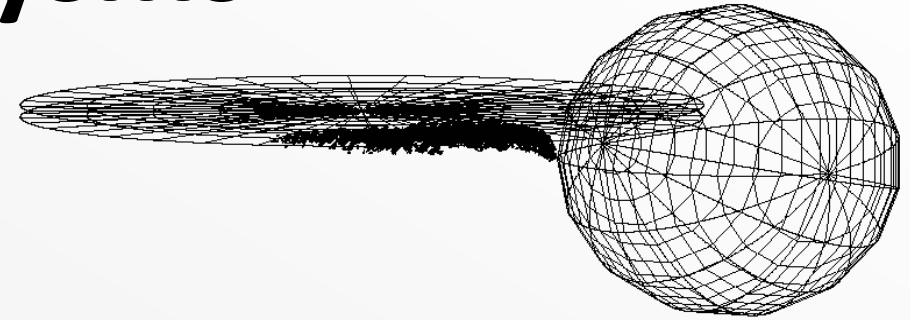
- White Dwarf +
- Low mass star
- WD accreting:
- Disc, outbursts etc.
- WD $M \uparrow$



Cataclysms

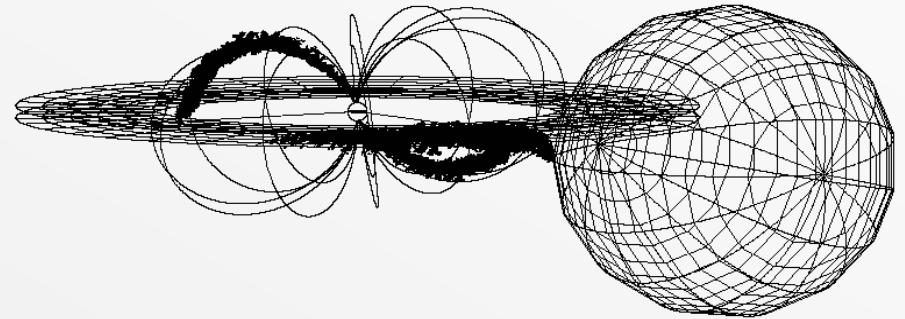
- Classical novae

Thermonuclear explosion caused by pile-up of accreted matter



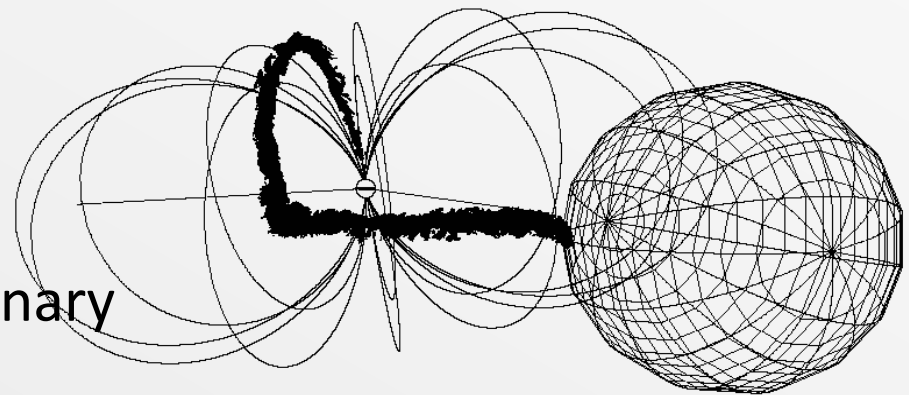
- Dwarf novae

Accretion disc instability



- Polars / Intermediate Polars

High B-field matter streams onto pole



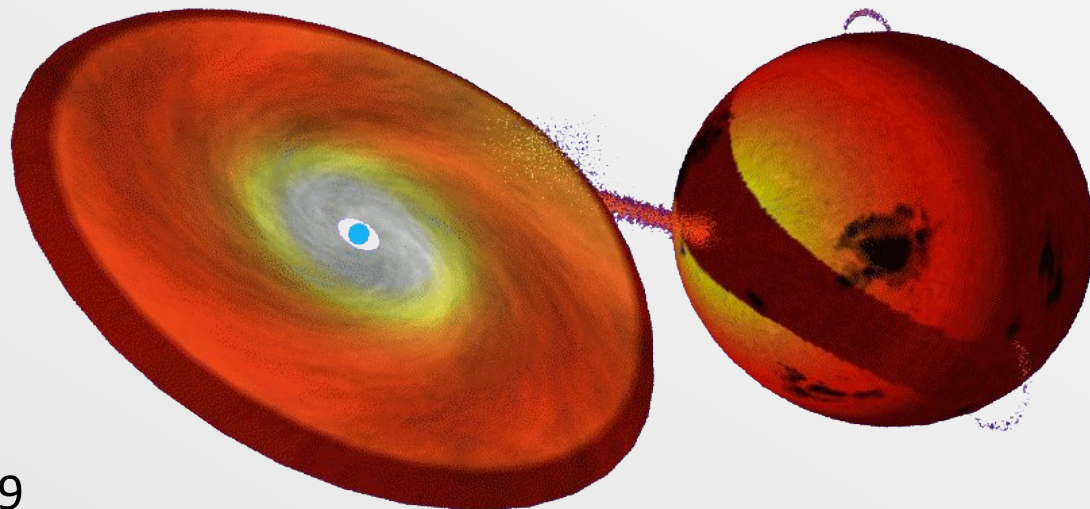
- AM CVn white dwarf-white dwarf binary

- Supersoft X-ray sources

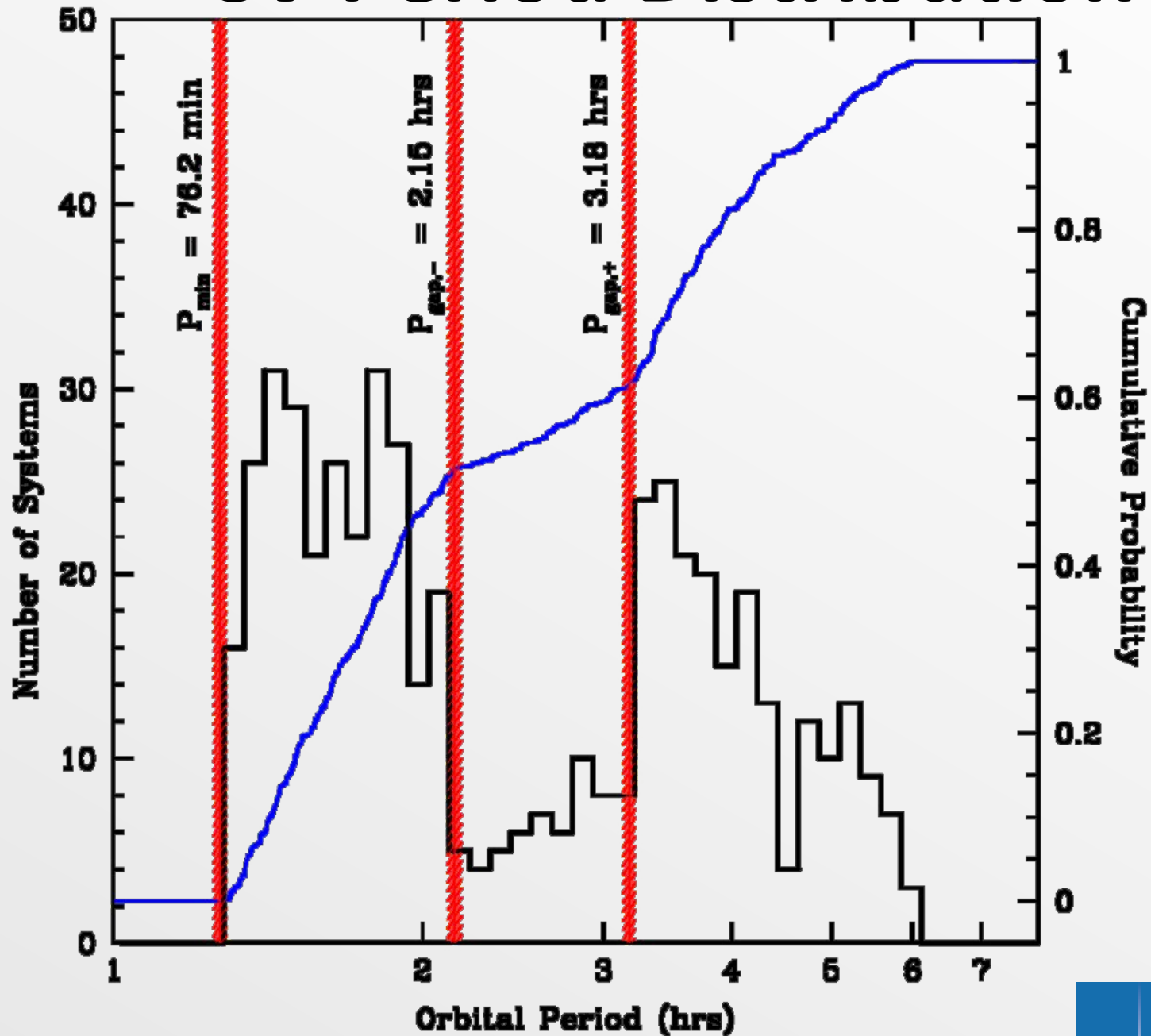
Cataclysmic Binary Systems

| name | spectra | type | Period(d) | M_1/M_\odot | M_2/M_\odot | R_2/R_\odot |
|--------|------------|---------------------------------------|-----------|---------------|---------------|---------------|
| AM CVn | He em | ultra-compact | 0.012 | | 0.04 | |
| OY Car | sdBe+M7-8 | dwarf nova | 0.063 | 0.685 | 0.07 | 0.127 |
| Z Cha | sdBe+M5.5V | dwarf nova | 0.075 | 0.84 | 0.125 | 0.17 |
| AM Her | sdBe+M4V | magnetic polar | 0.129 | 0.44 | 0.29 | 0.33 |
| U Gem | sdBe+M4V | dwarf nova | 0.177 | 1.26 | 0.57 | 0.51 |
| DW Her | sdBe+M3V | classical nova, intermediate polar | 0.194 | 0.60 | 0.40 | 0.49 |
| BT Mon | sdBe+G8V | classical nova | 0.334 | 1.04 | 0.87 | 0.89 |
| GK Per | sdBe+K1IV | classical nova | 2.00 | 0.9 | 0.5 | 2.5 |
| V Sge | WN+B8 | supersoft X-ray | 0.514 | 0.9 | 3.3 | 2.1 |
| U Sco | sdBe+F8V | supersoft X-ray | 1.23 | 1.55 | 0.88 | 2.1 |

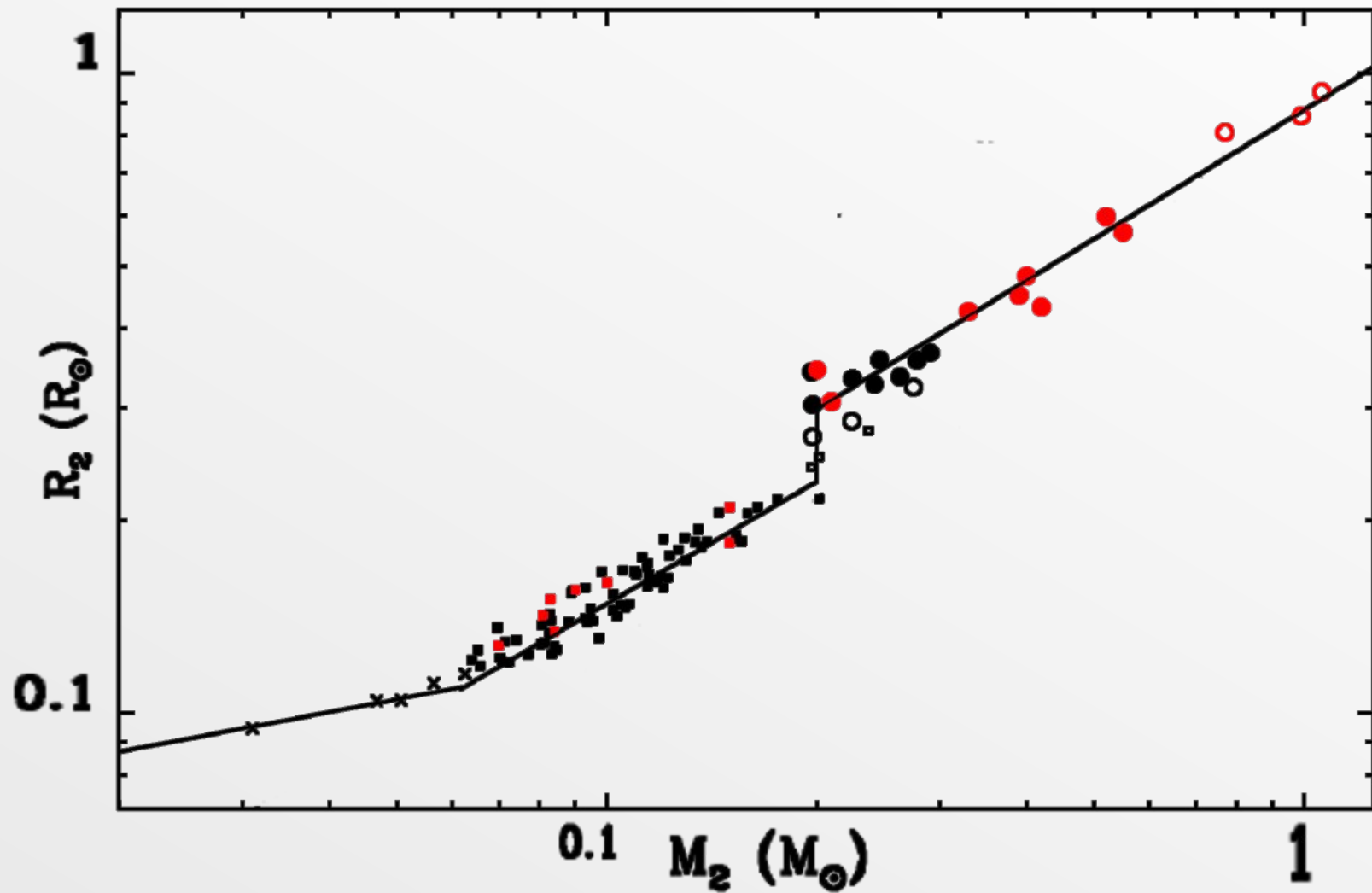
Adapted from Onno Pols' table



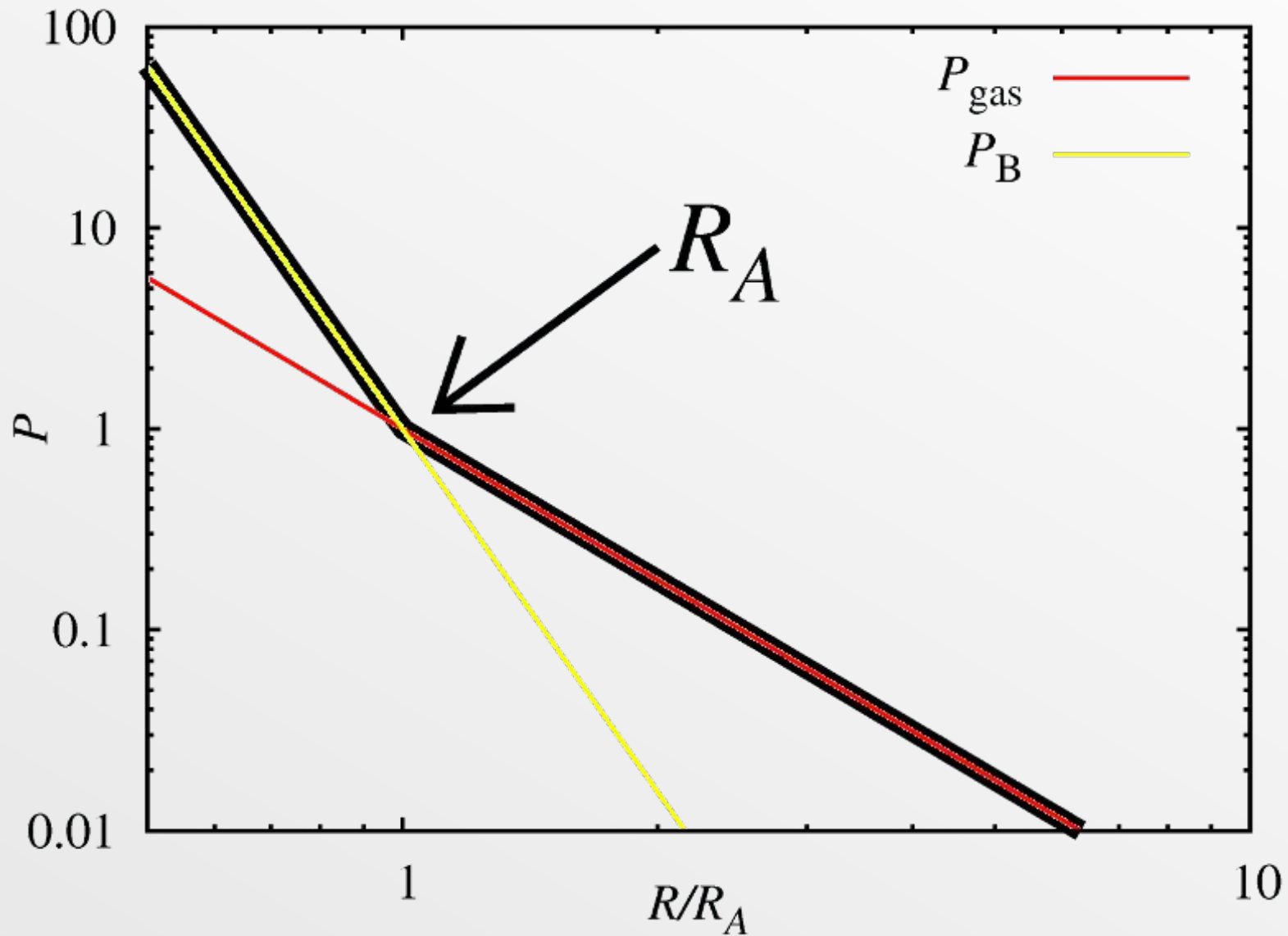
CV Period Distribution



CV $R_2 - M_2$ distribution

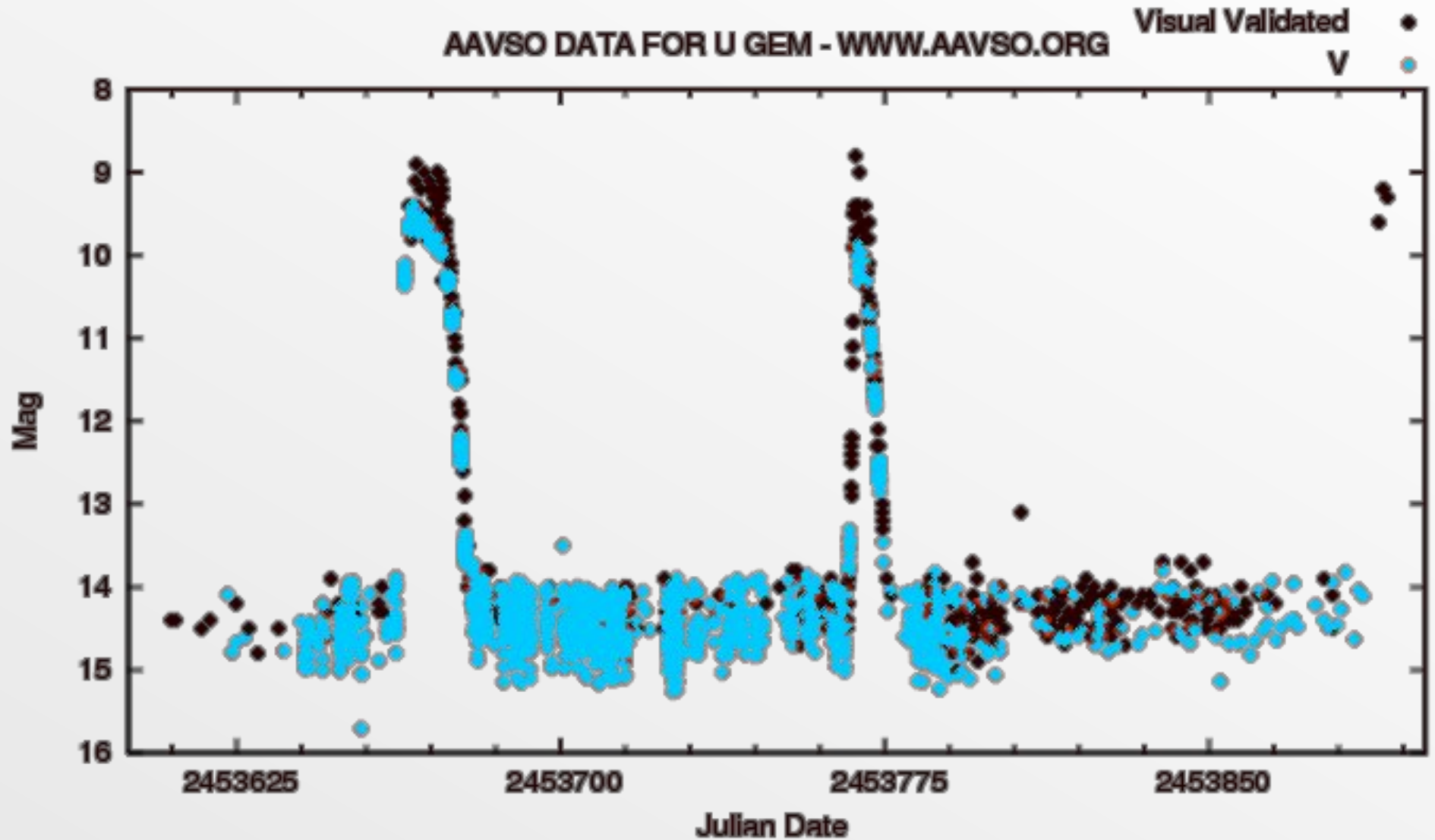


Alfven Radius



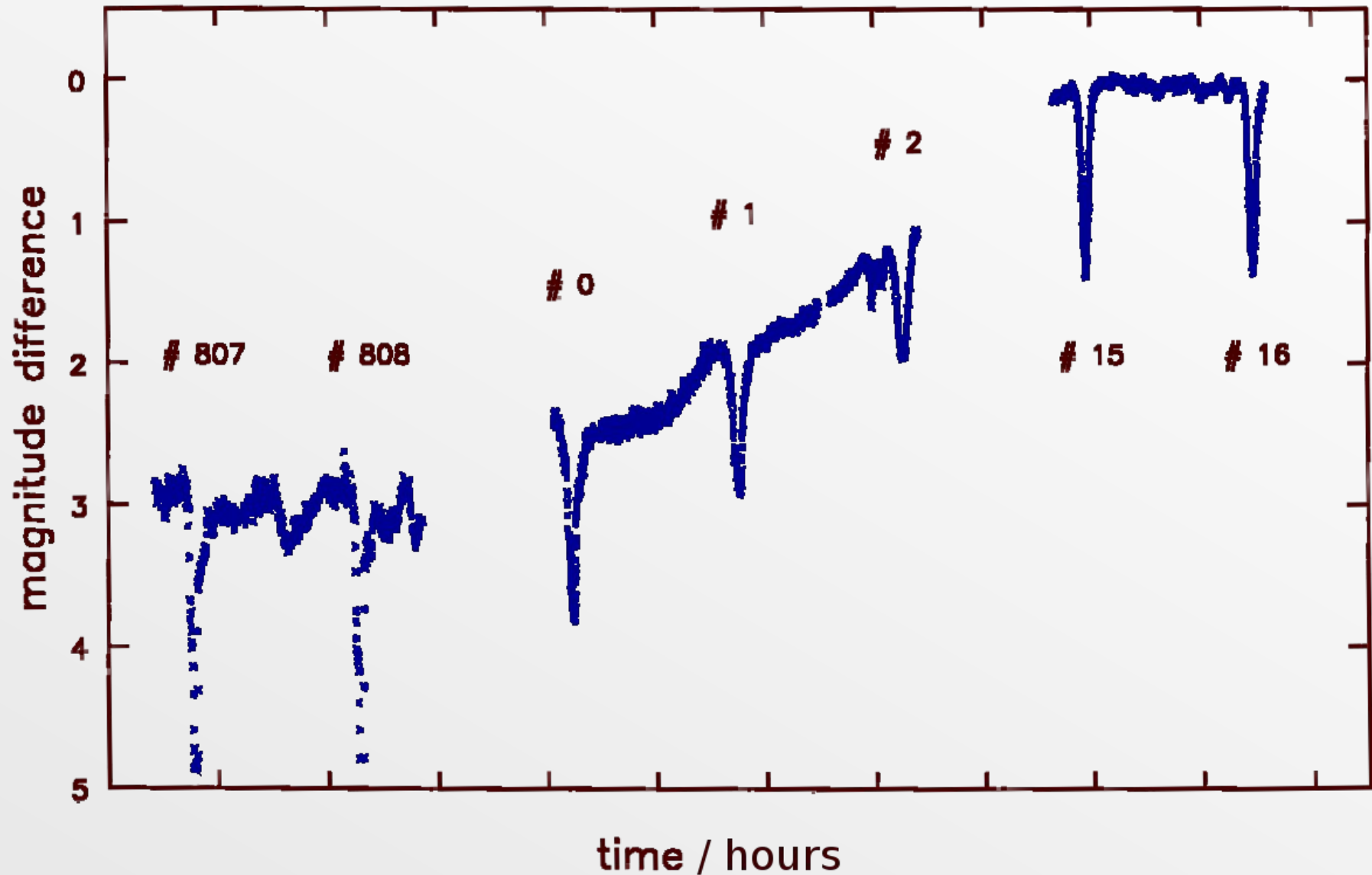
$$P_B \sim r^{-6}$$
$$P_{\text{gas}} \sim r^{-2.5}$$

U Geminorum – dwarf nova



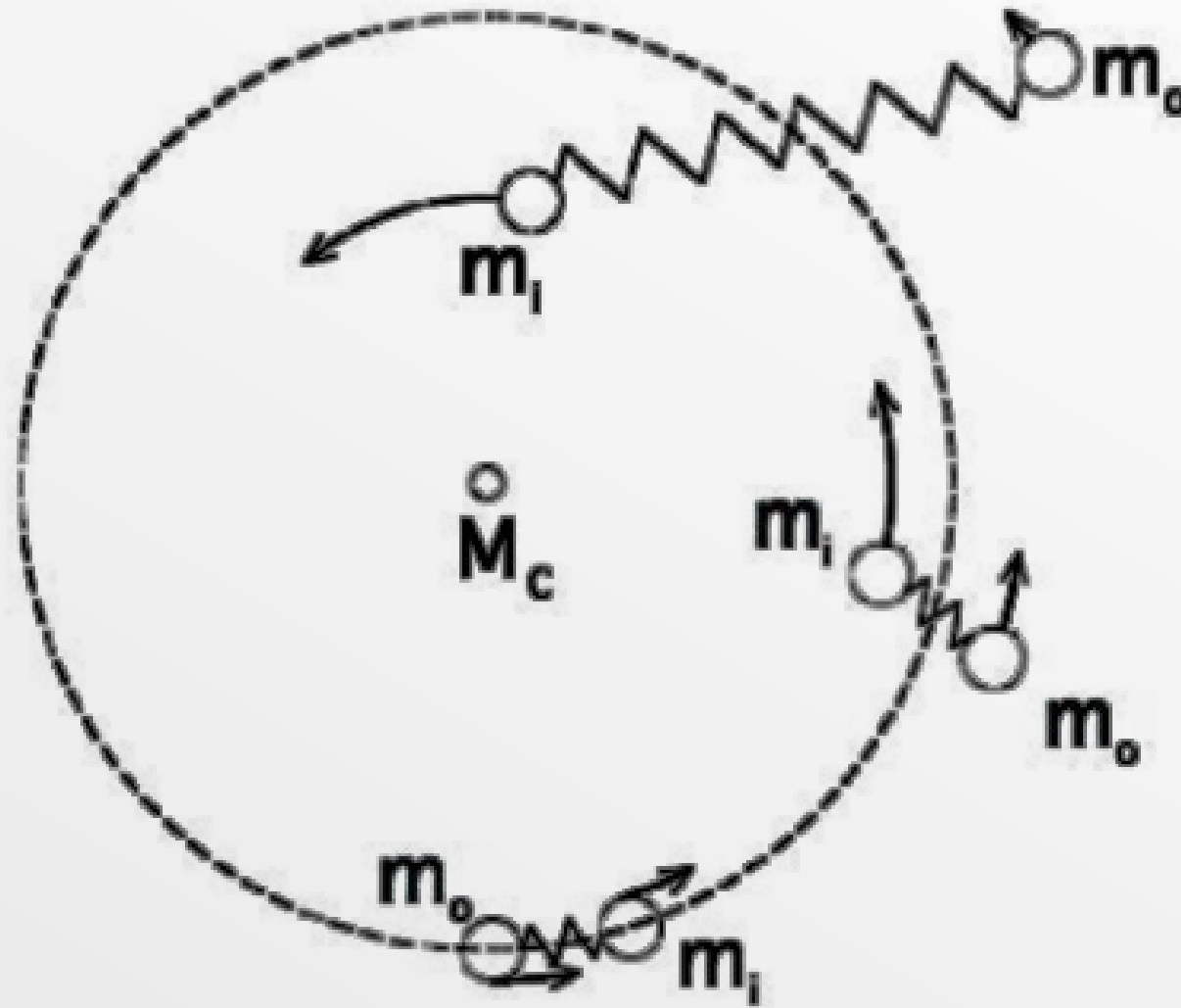
Source: AAVSO

OY Carinae in outburst



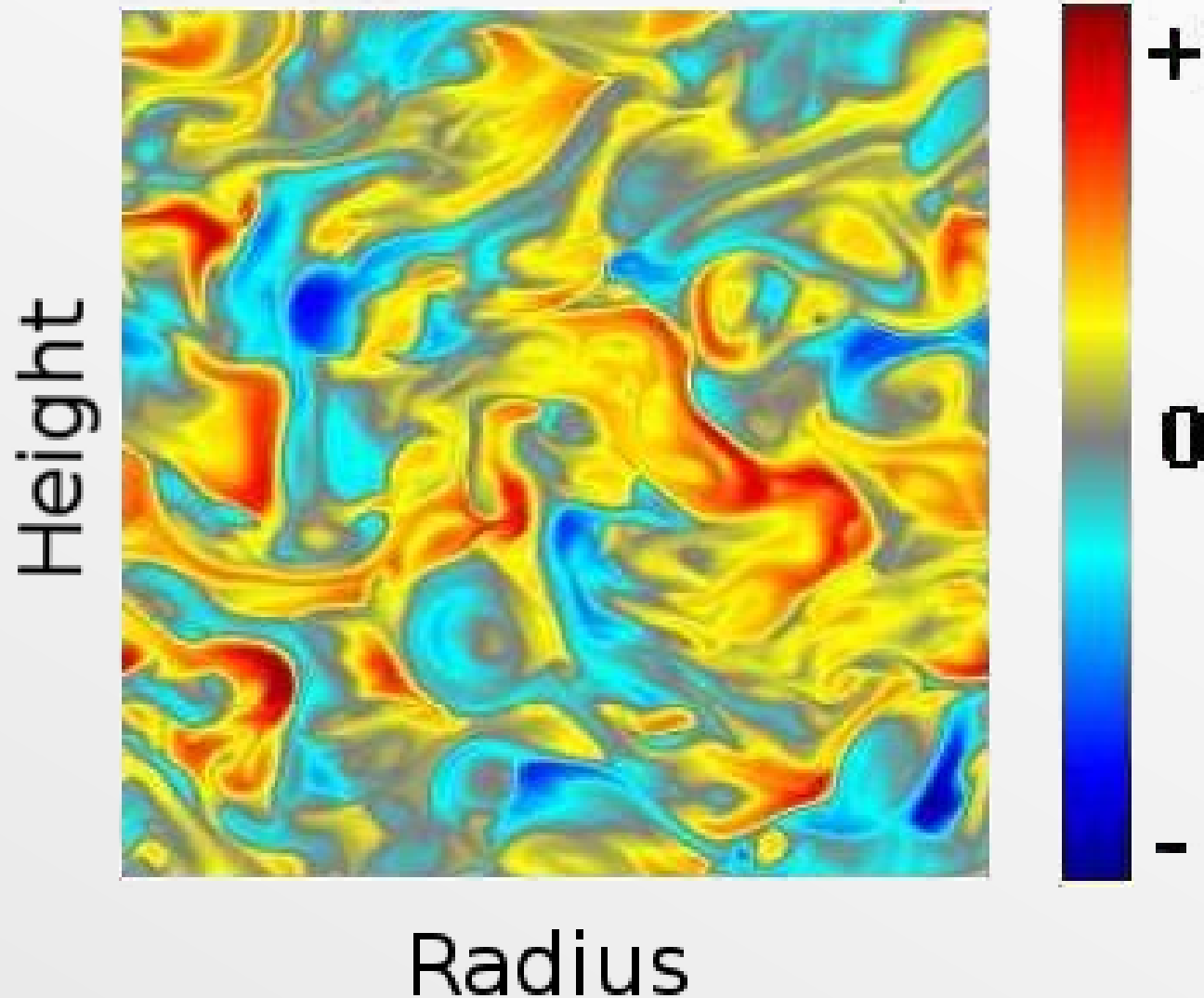
Rutten et al A&A 265, 159

Magnetorotational Instability



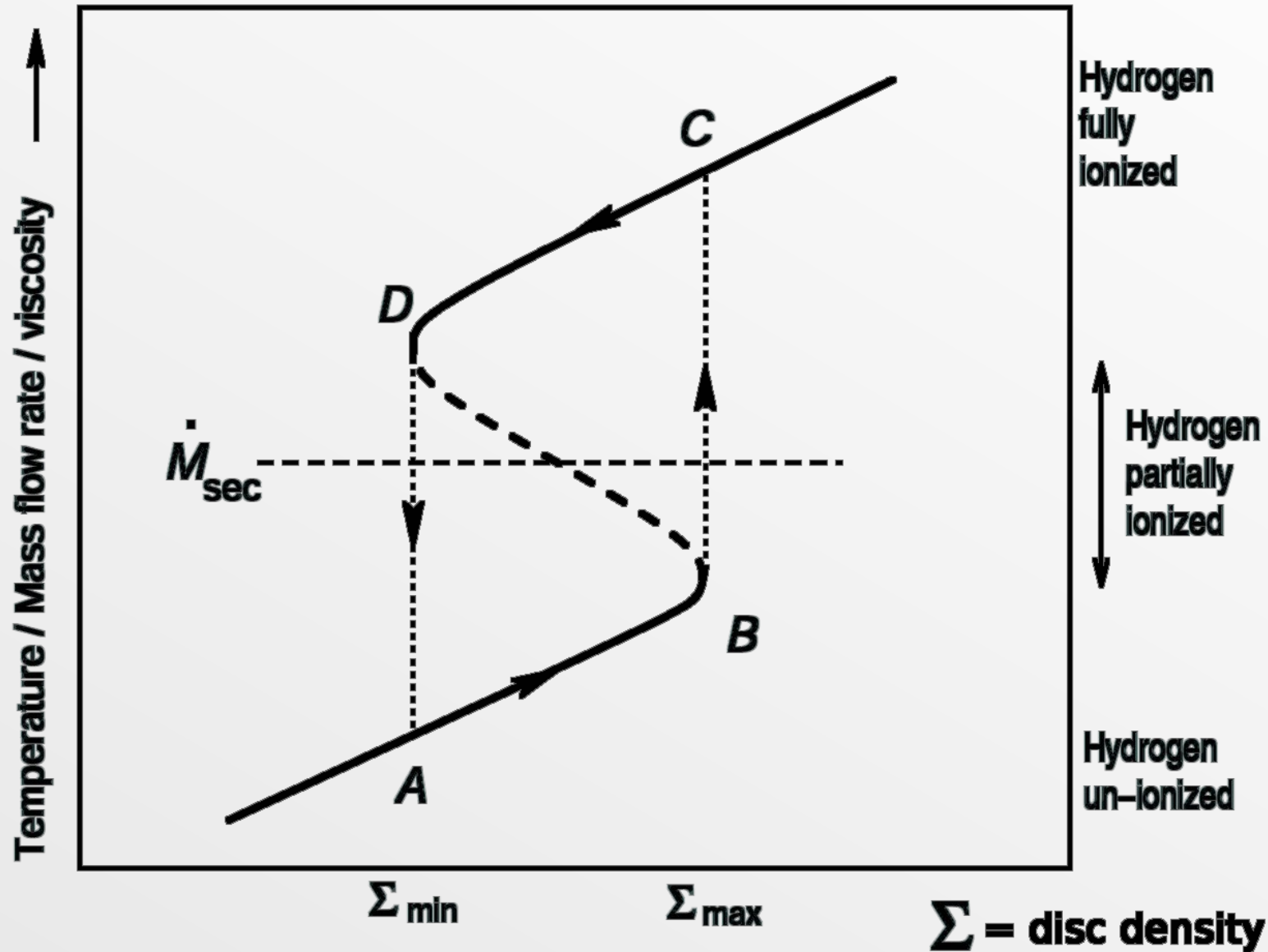
http://www.scholarpedia.org/article/Magnetorotational_instability

Magnetorotational Instability



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Thermal Instability



From Hellier's book "Cataclysmic variable stars"

Algol and its paradox

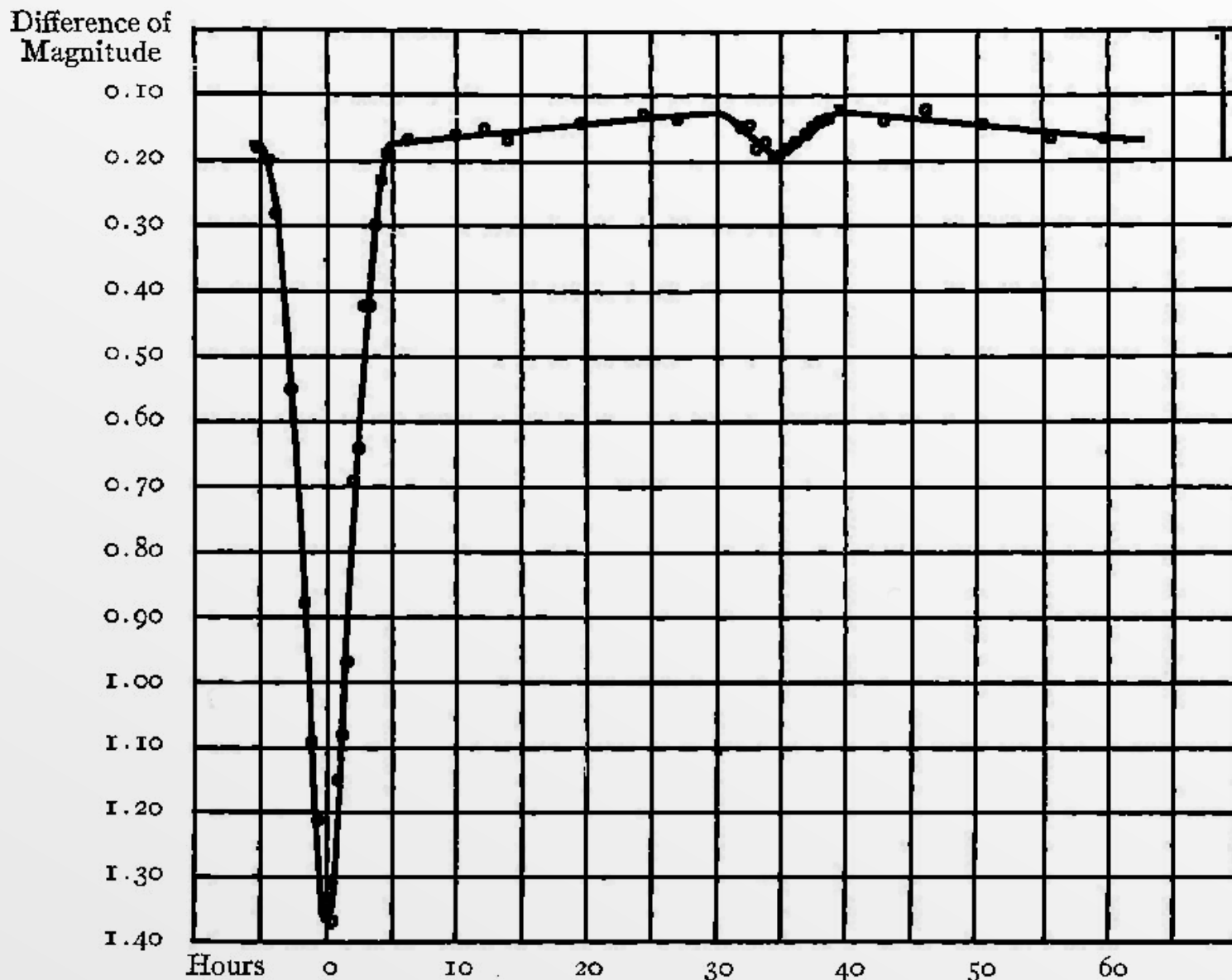
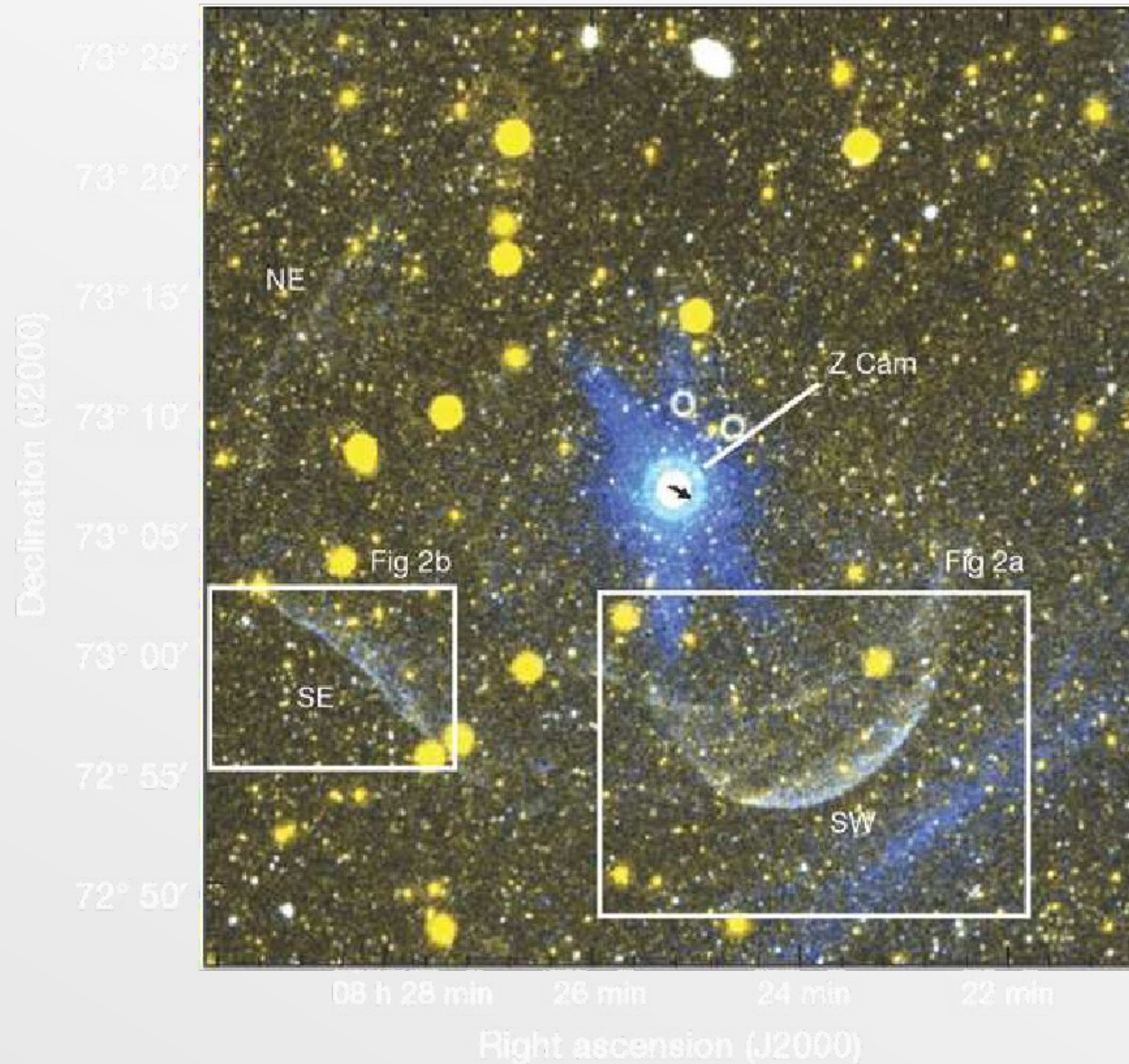


FIG. 3.—The Light-Curve of *Algol*

Stebbins 1911

Classical – Dwarf Connection



Shara et al 2007
Nature 446,159