The Cepheid distance scale and Gaia

Pierre Kervella
CNRS UMI FCA 3386 & Observatoire de Paris
+
Antoine Mérand, Joanne Breitfelder,
Alexandre Gallenne, Anthony Soulain,…

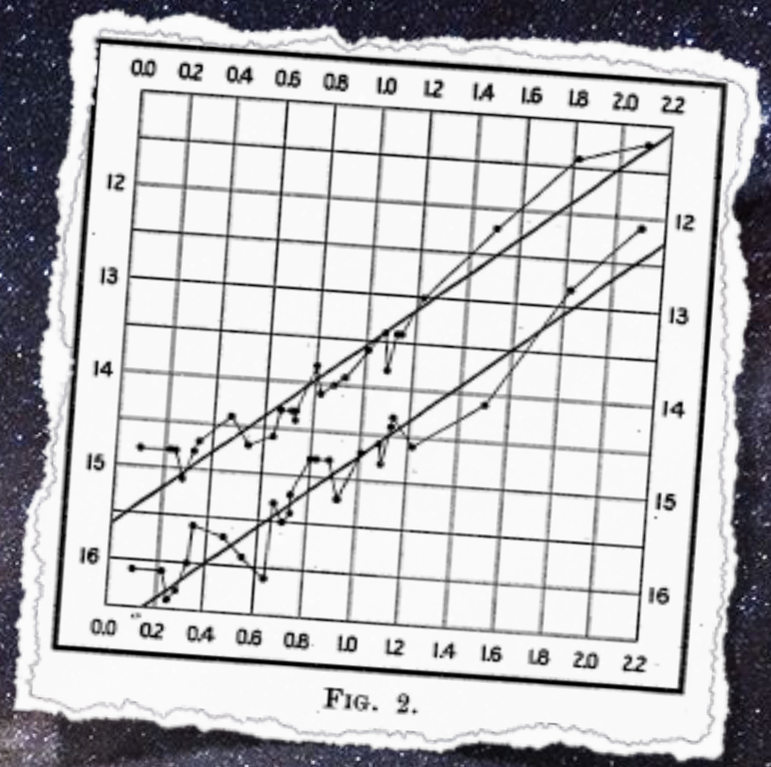
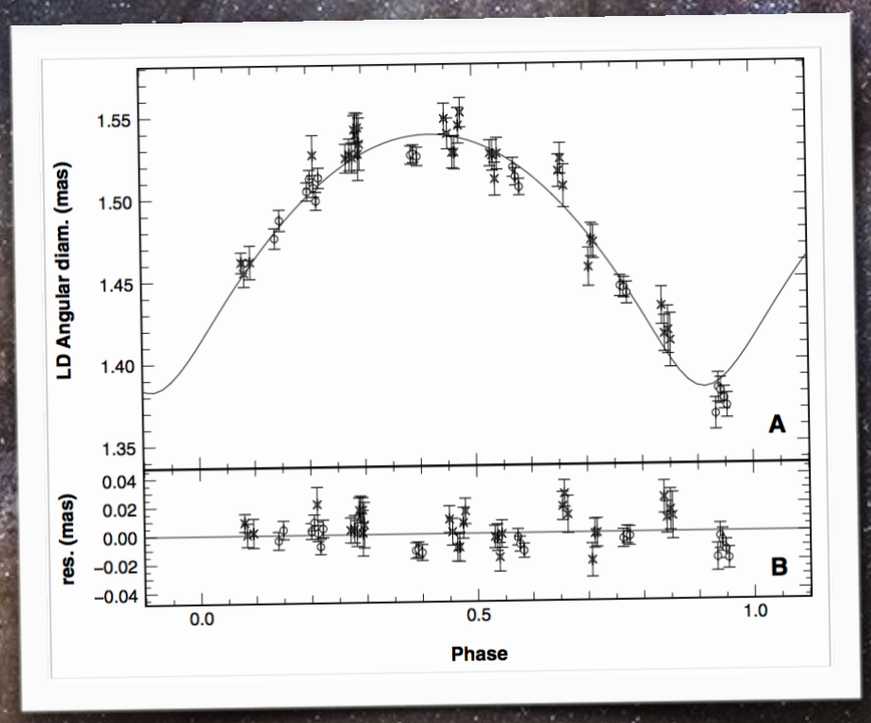
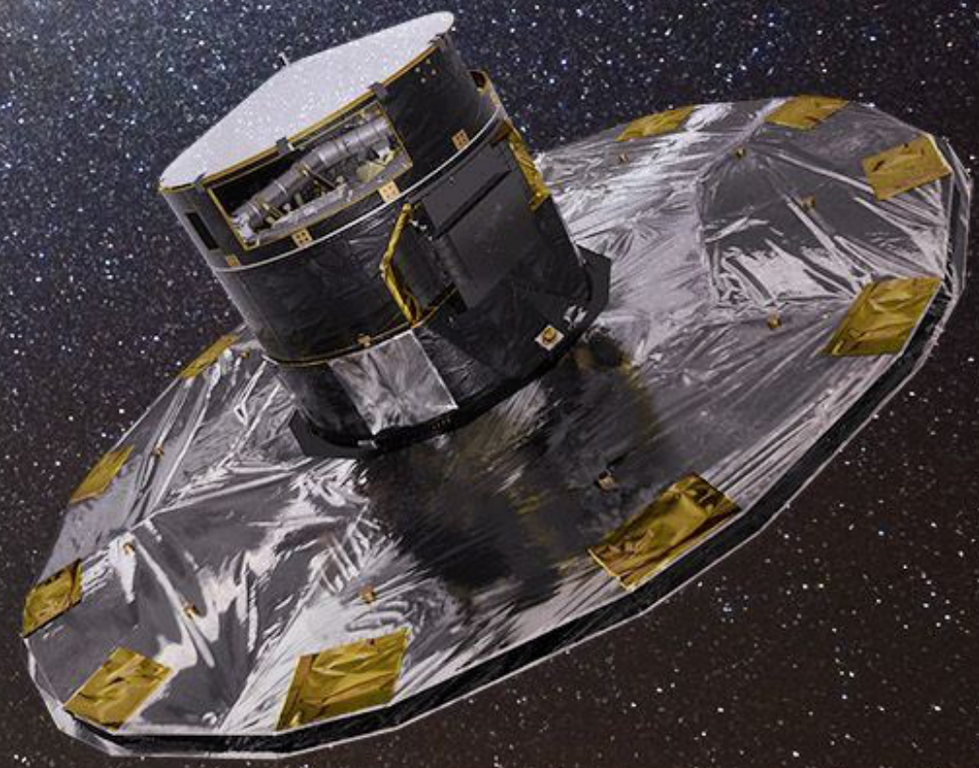
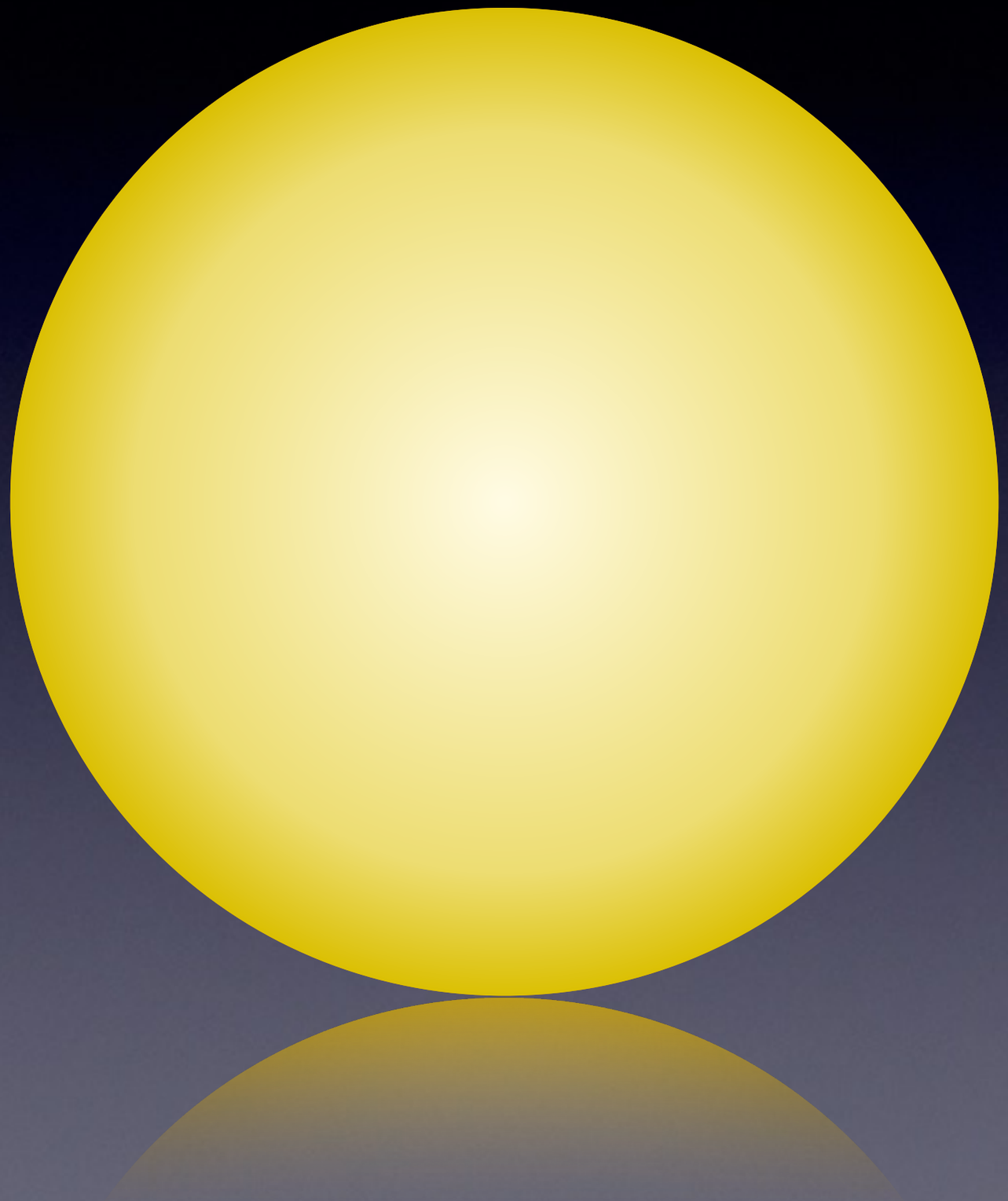


FIG. 2.

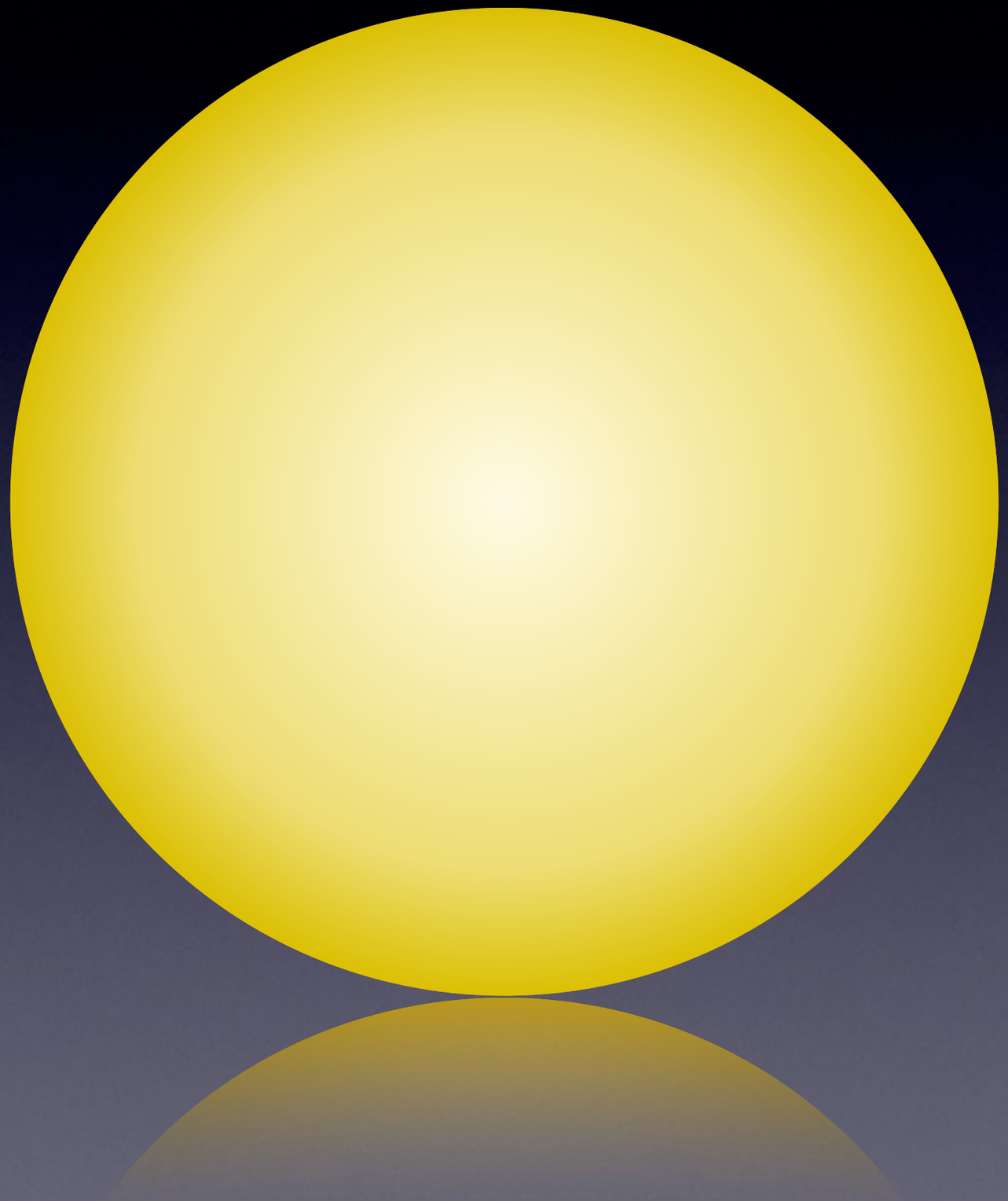




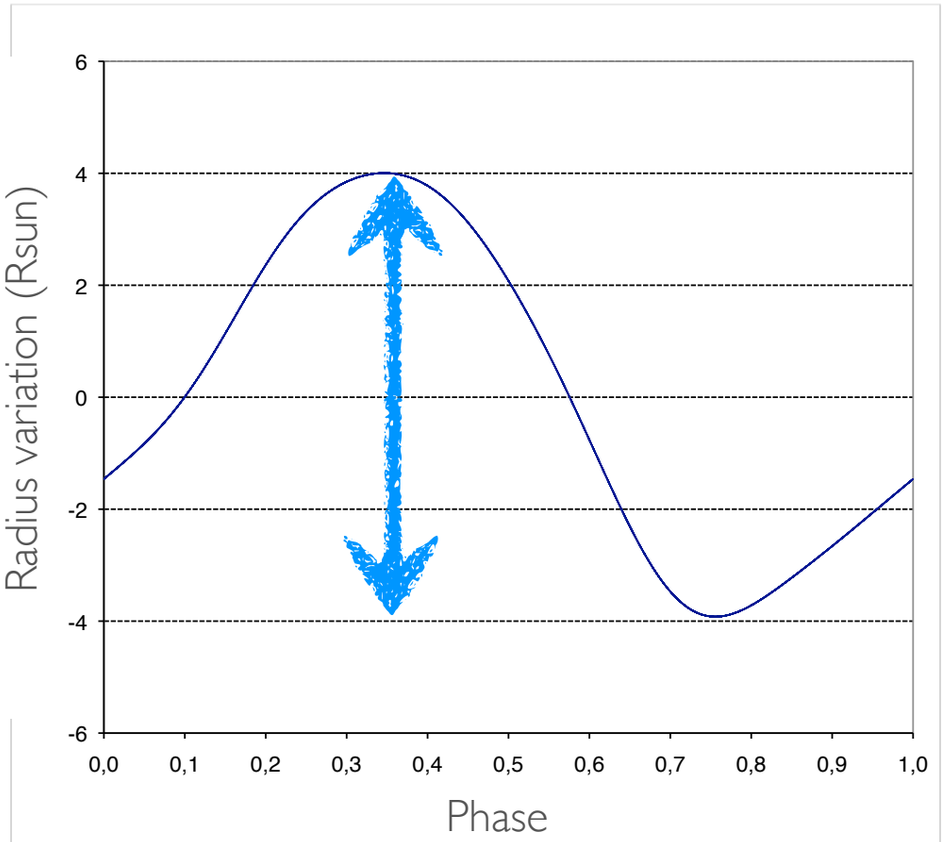
Pulsation of a Cepheid



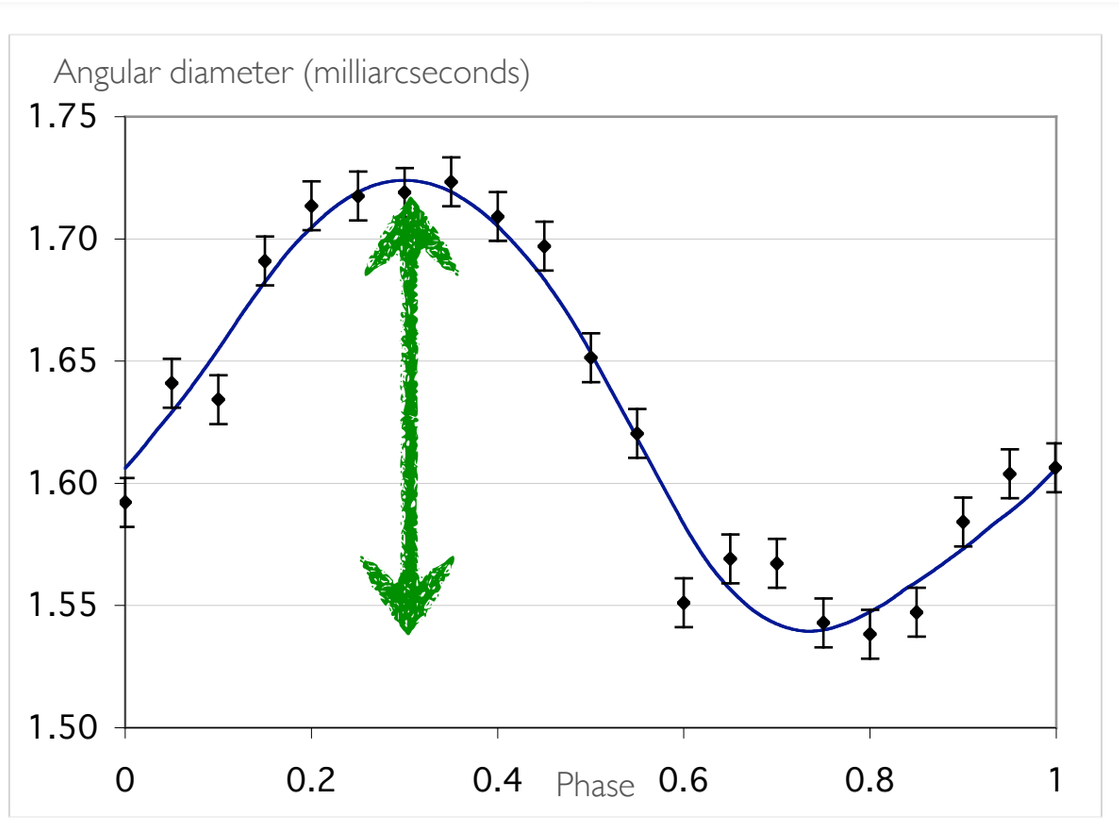
Pulsation of a Cepheid



Spectroscopy



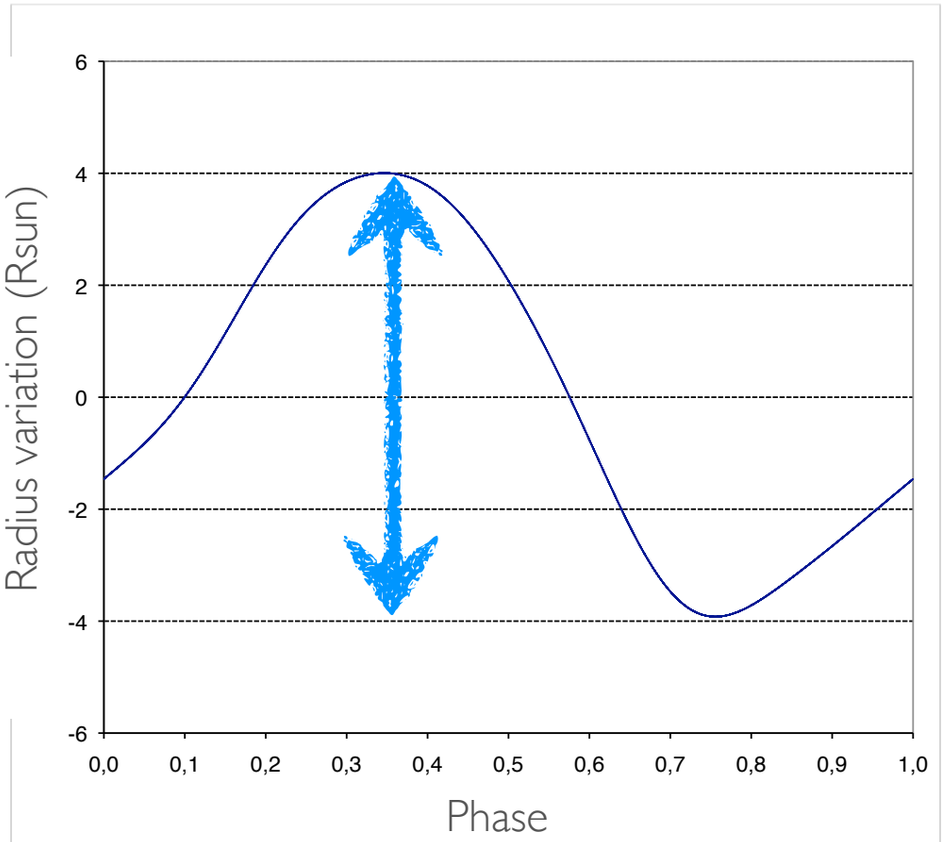
Interferometry / Surface brightness



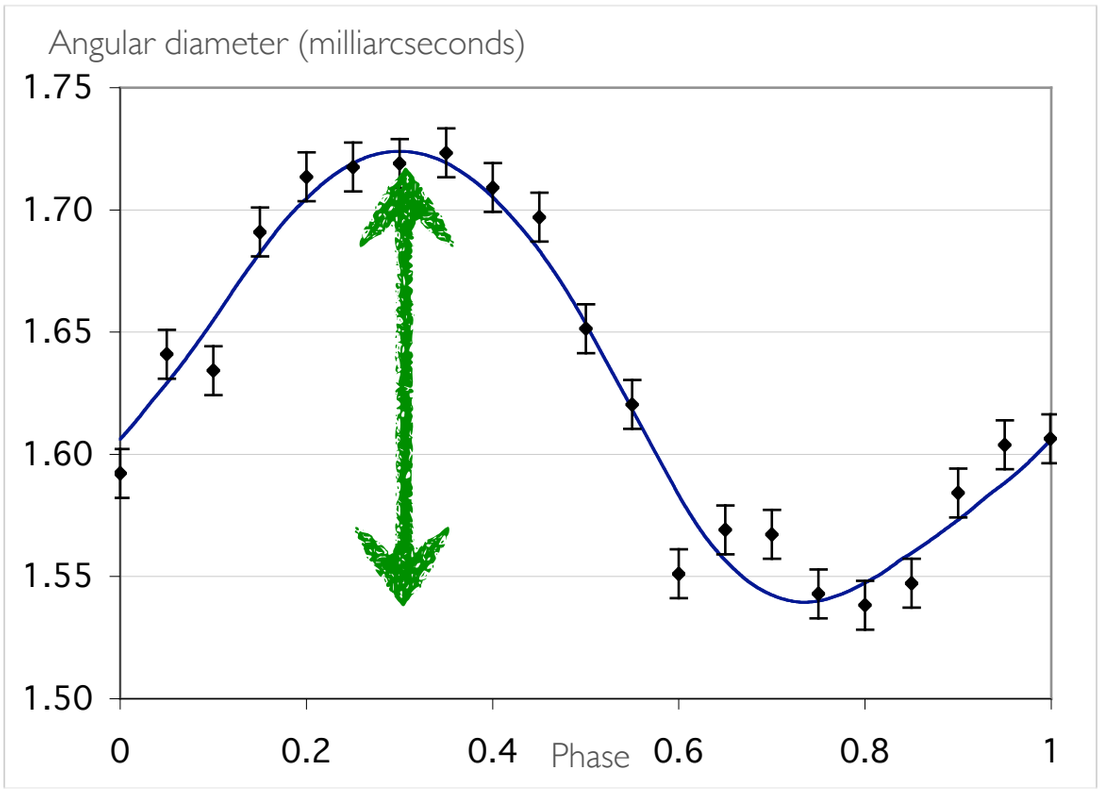
The distance d is given by the relation:

$$d = \frac{2\delta R(T)}{\delta\theta(T)} = \frac{-2\,k\,p\,\int_0^T v_{\mathrm{rad}}(t)\,dt}{\theta_{\mathrm{UD}}(T) - \theta_{\mathrm{UD}}(0)}$$

Spectroscopy



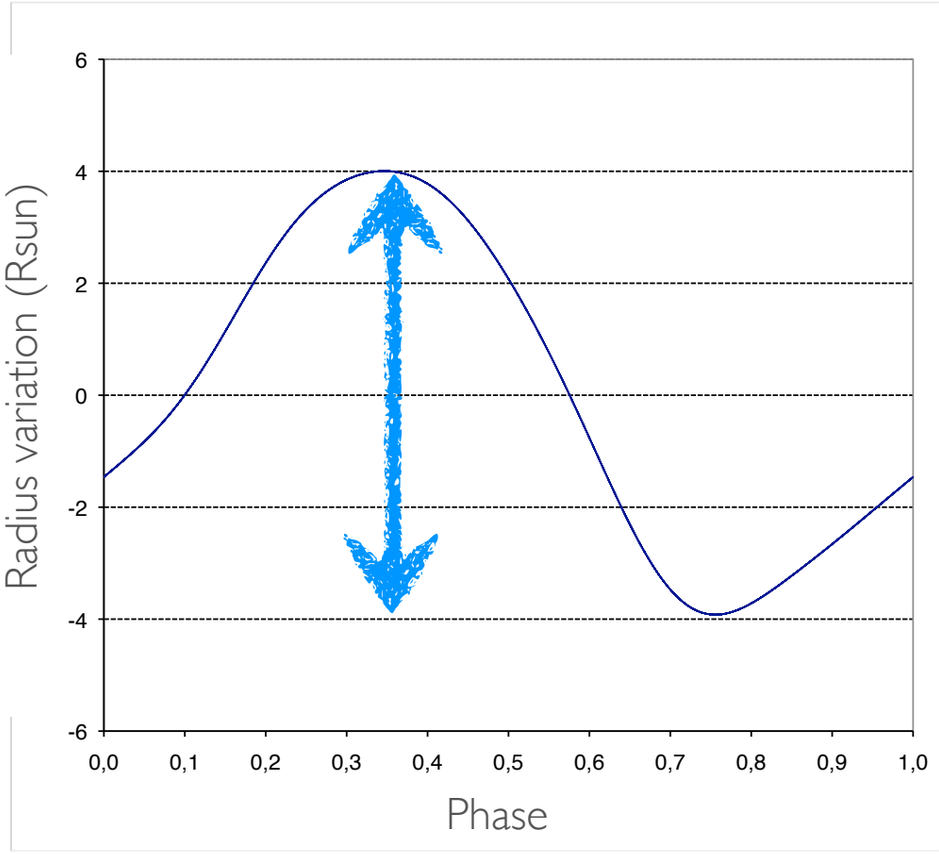
Interferometry / Surface brightness



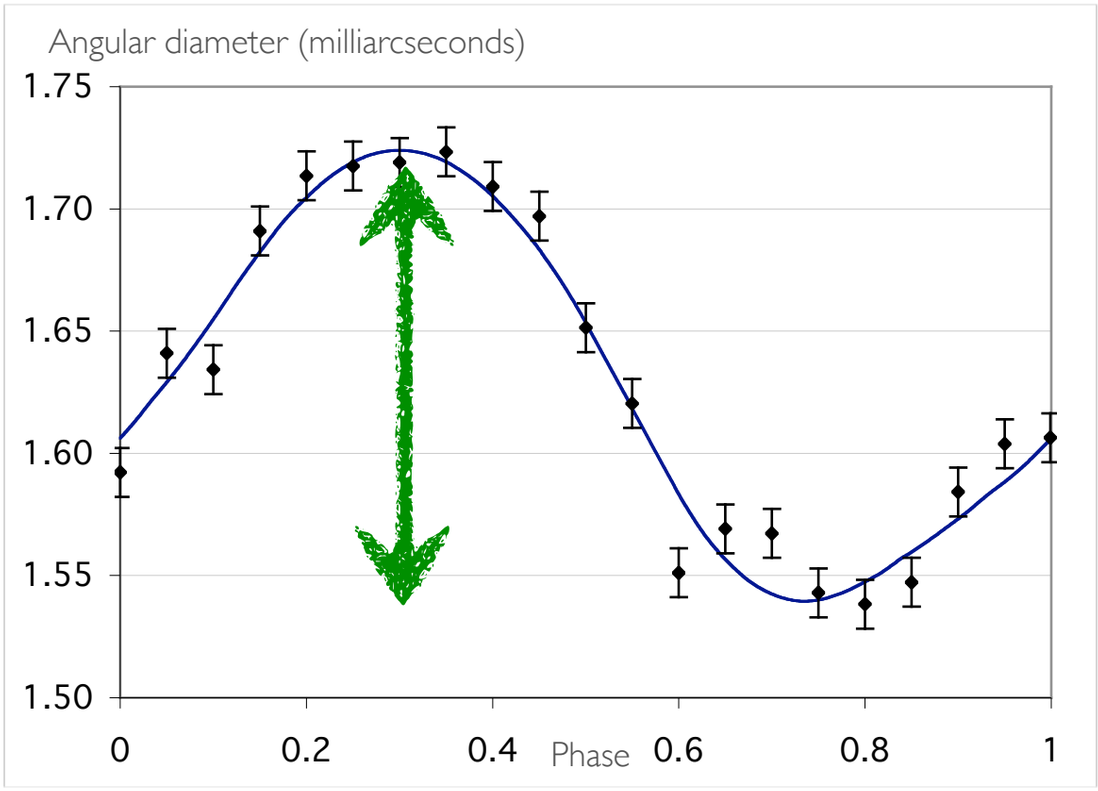
The distance d is given by the relation:

$$d = \frac{2\delta R(T)}{\delta\theta(T)} = \frac{-2\,k\,p\,\int_0^T v_{\mathrm{rad}}(t)\,dt}{\theta_{\mathrm{UD}}(T) - \theta_{\mathrm{UD}}(0)}$$

Spectroscopy



Interferometry / Surface brightness



The distance d is given by the relation:

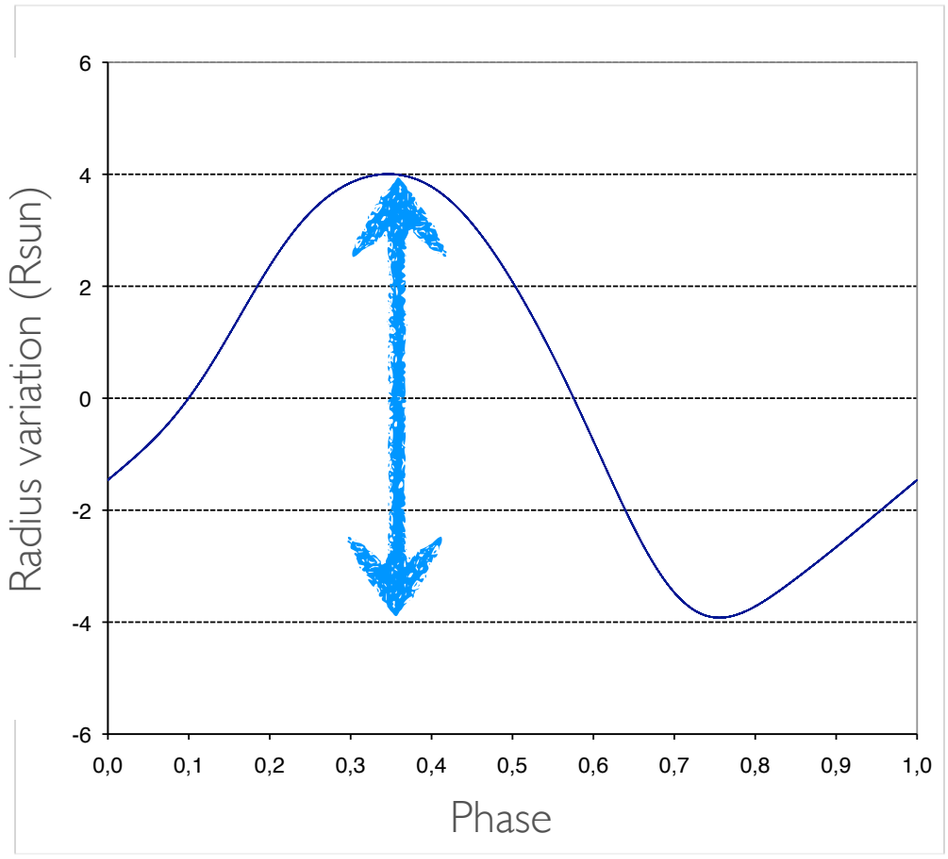
$$d = \frac{2\delta R(T)}{\delta\theta(T)} = \frac{-2\,k\,p\,\int_0^T v_{\rm rad}(t)\,dt}{\theta_{\rm UD}(T) - \theta_{\rm UD}(0)}$$

k = limb darkening correction (from models)

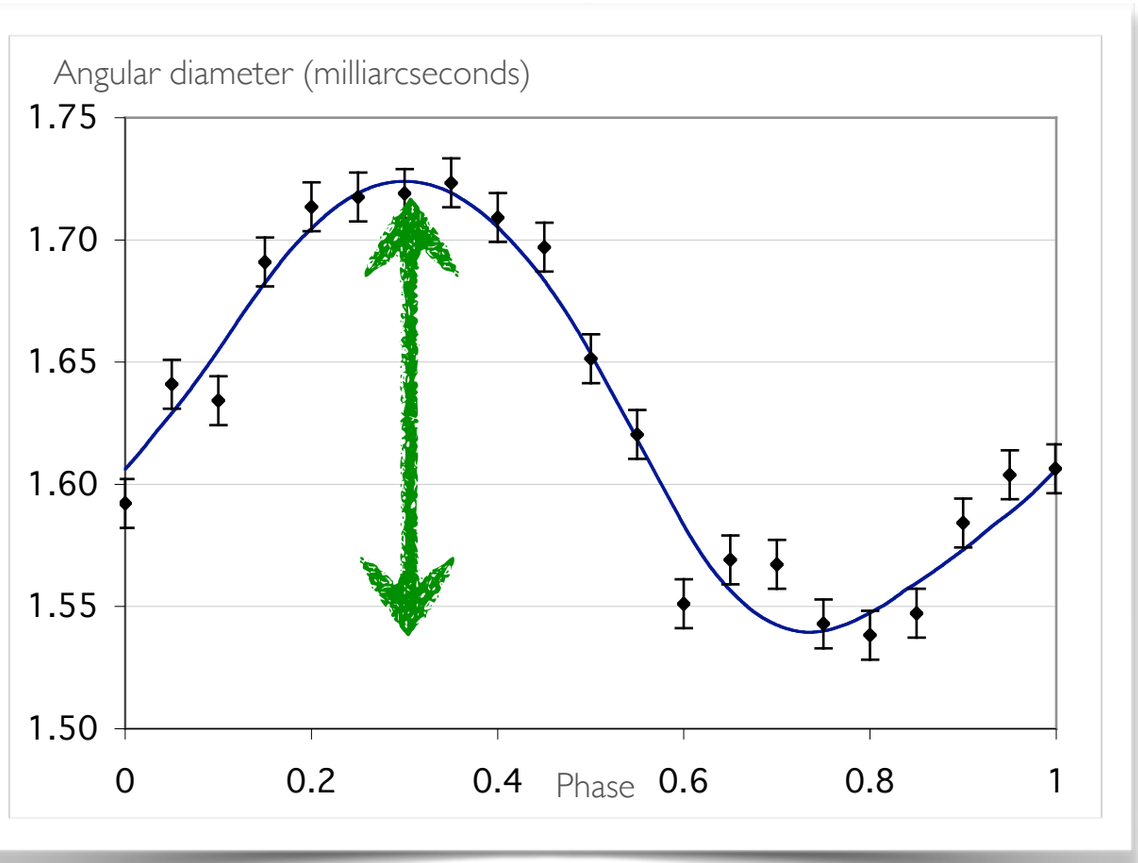
$= \theta_{UD} / \theta_{LD}$

$\sim$ 0.94 in visible, 0.98 in IR

Spectroscopy



Interferometry / Surface brightness



The distance d is given by the relation:

$$d = \frac{2\delta R(T)}{\delta\theta(T)} = \frac{-2\,k\,p\int_0^T v_{\rm rad}(t)\,dt}{\theta_{\rm UD}(T) - \theta_{\rm UD}(0)}$$

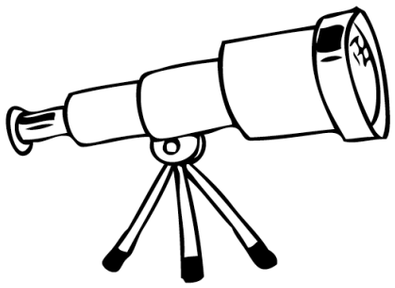
k = limb darkening correction (from models)

$= \theta_{UD} / \theta_{LD}$

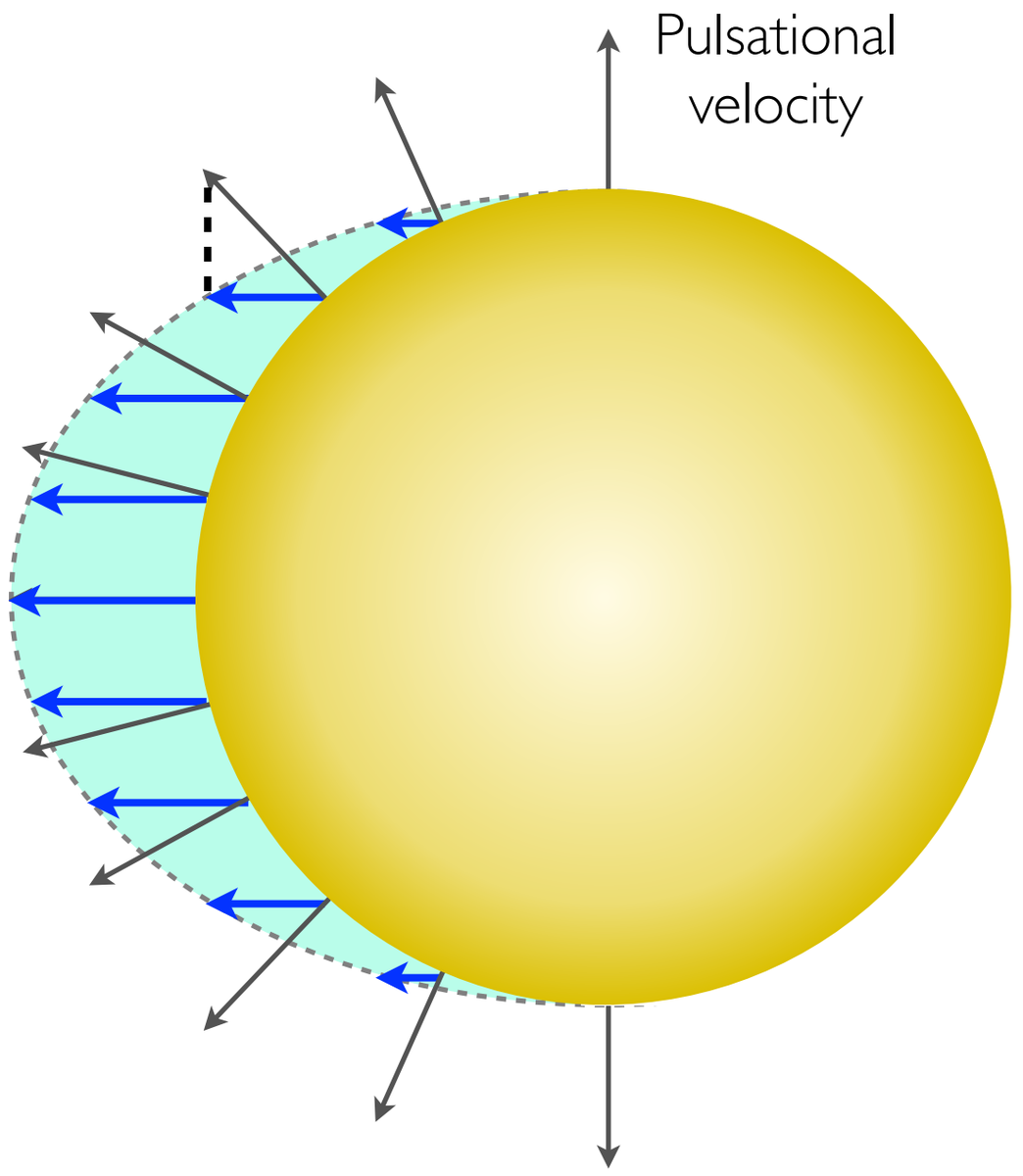
~ 0.94 in visible, 0.98 in IR

THE P-FACTOR

Disk-integrated radial velocity

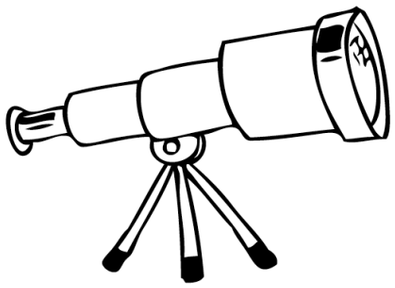


Radial velocity

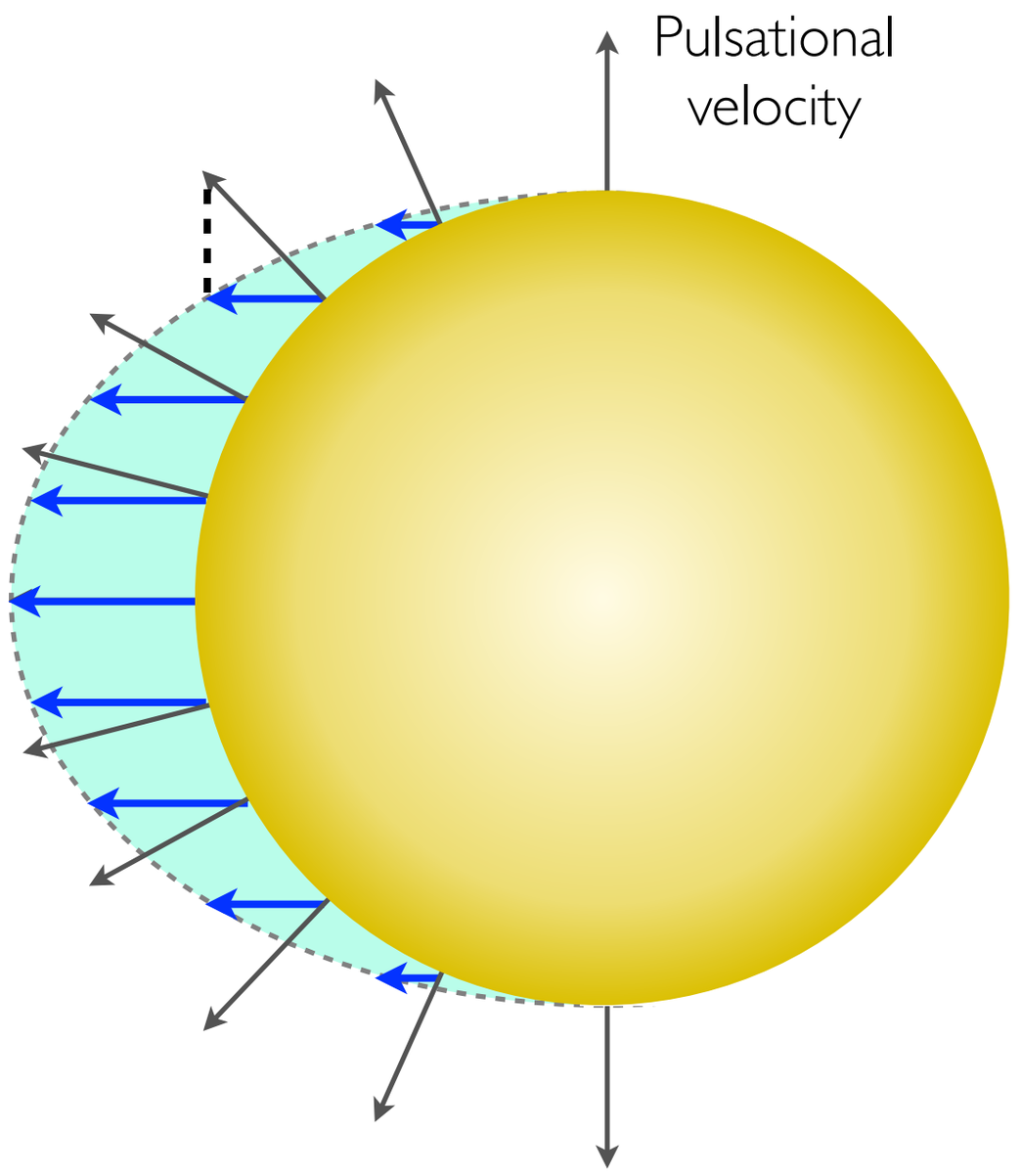


THE P-FACTOR

Disk-integrated radial velocity



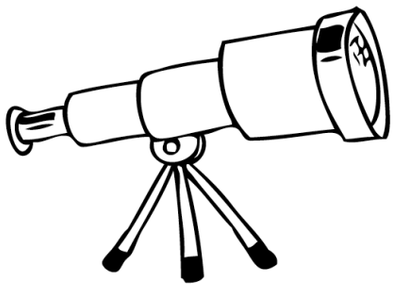
Radial velocity



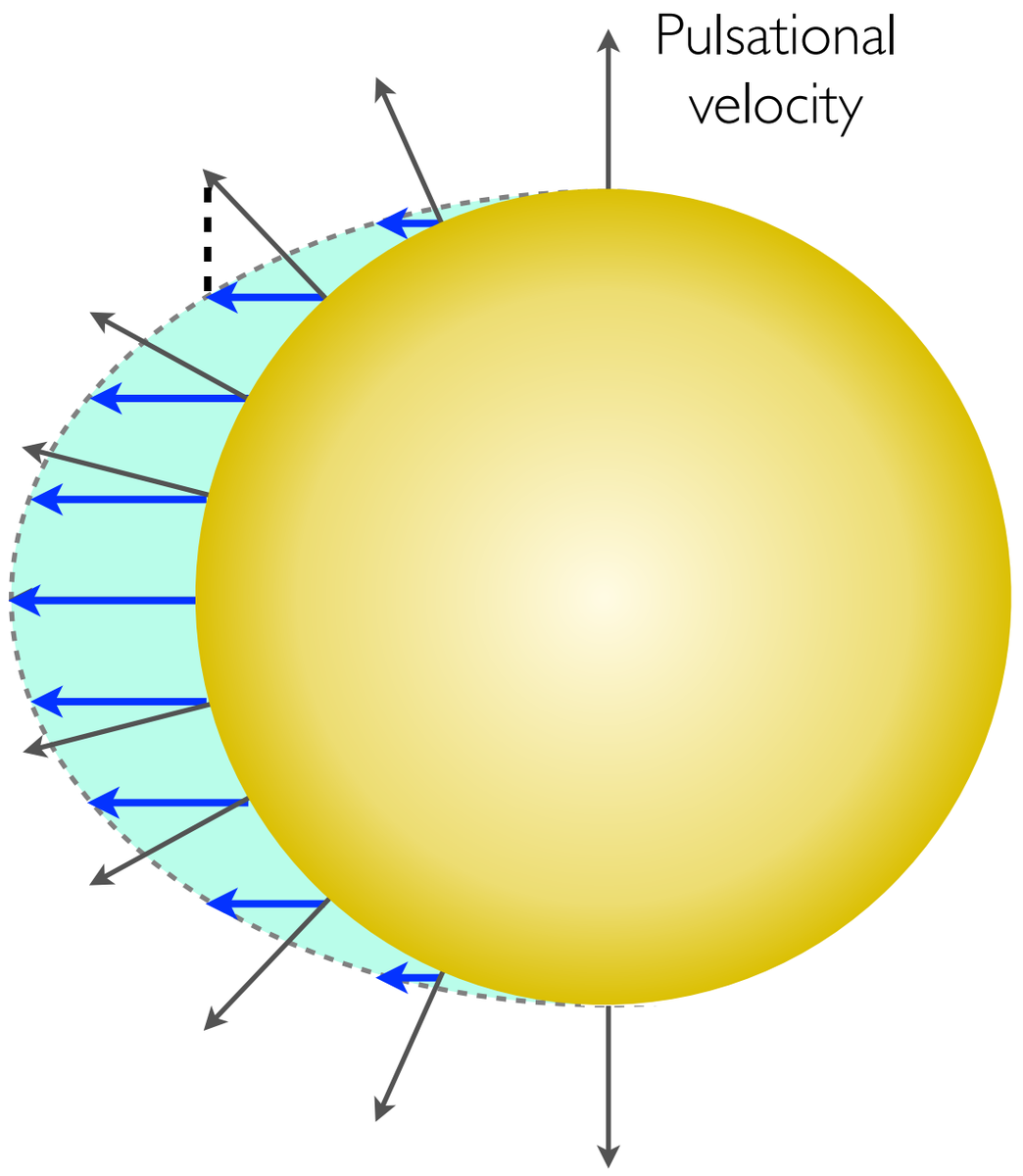
- Geometrical component = 1.5
- Limb darkening component < 1
- Atmosphere dynamics = ?

THE P-FACTOR

Disk-integrated radial velocity



Radial velocity



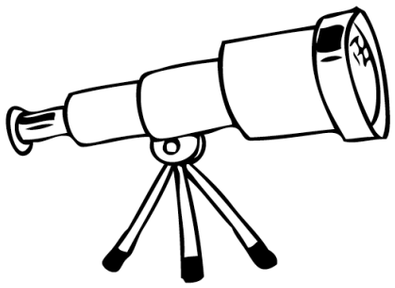
- Geometrical component = 1.5
- Limb darkening component < 1
- Atmosphere dynamics = ?

$p \sim 1.39 - 0.03 \log P$ from stellar atmosphere models

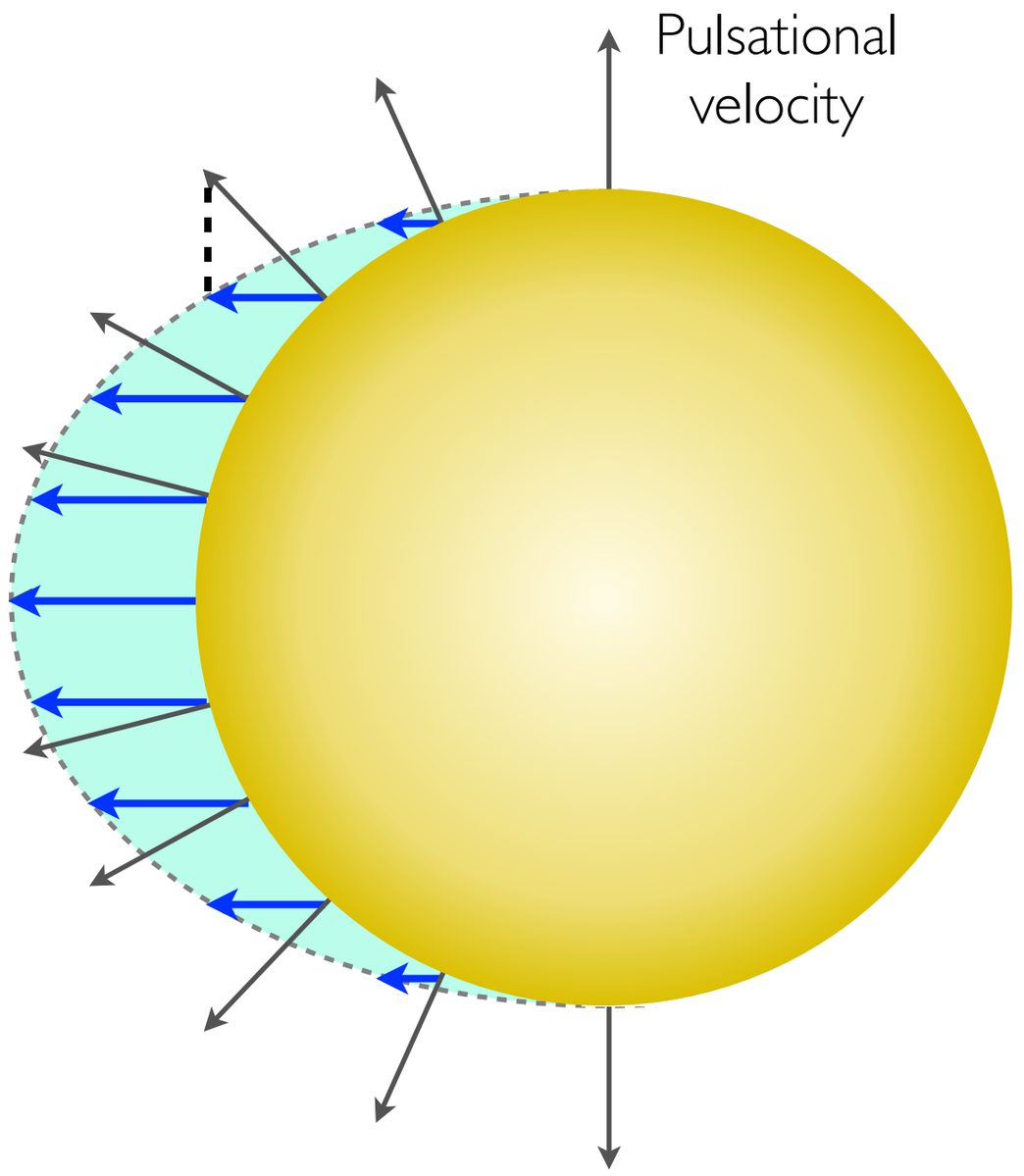
(Hindsley & Bell 1986, PASP, 98, 881)

THE P-FACTOR

Disk-integrated radial velocity



Radial velocity



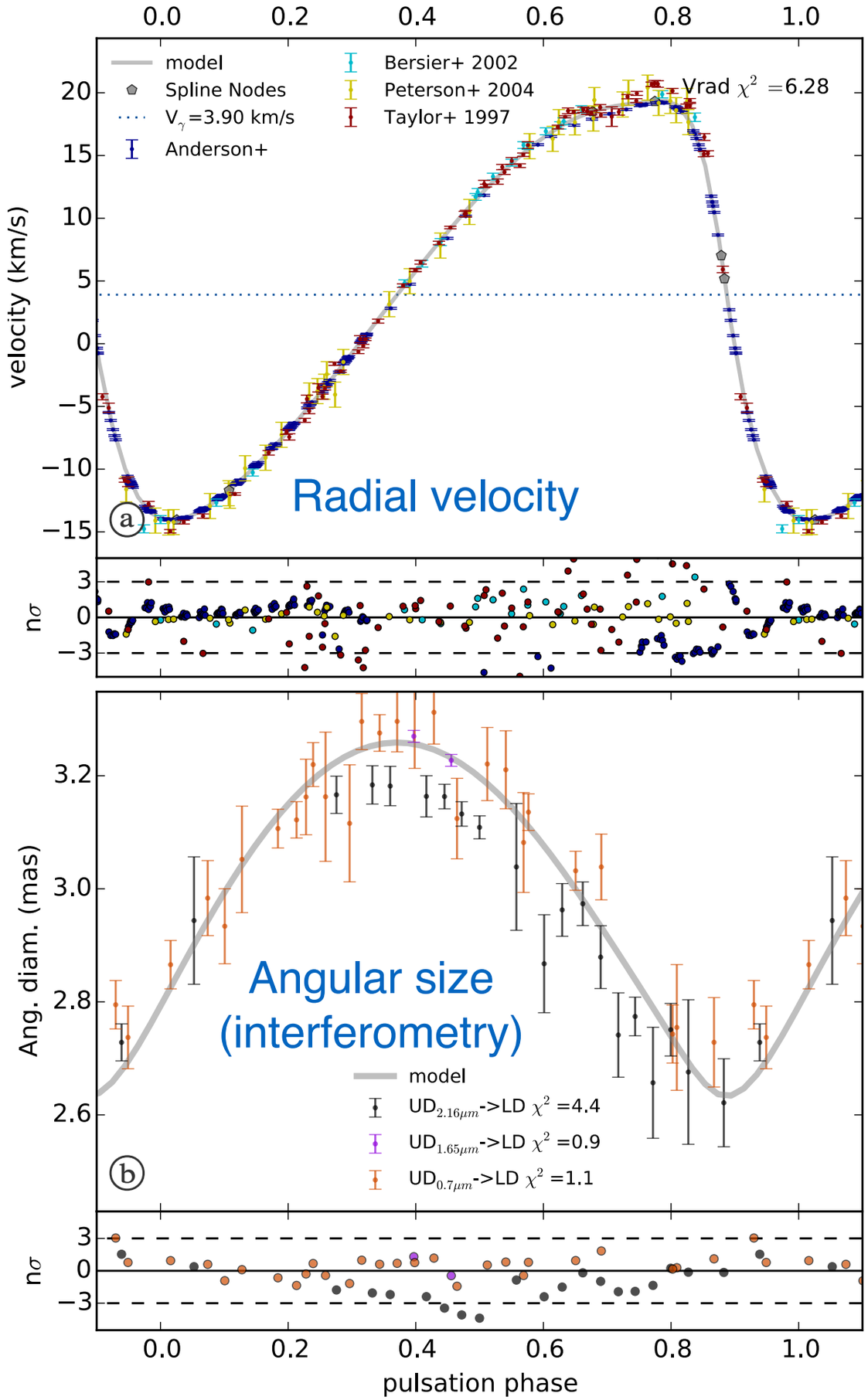
- Geometrical component = 1.5
- Limb darkening component < 1
- Atmosphere dynamics = ?

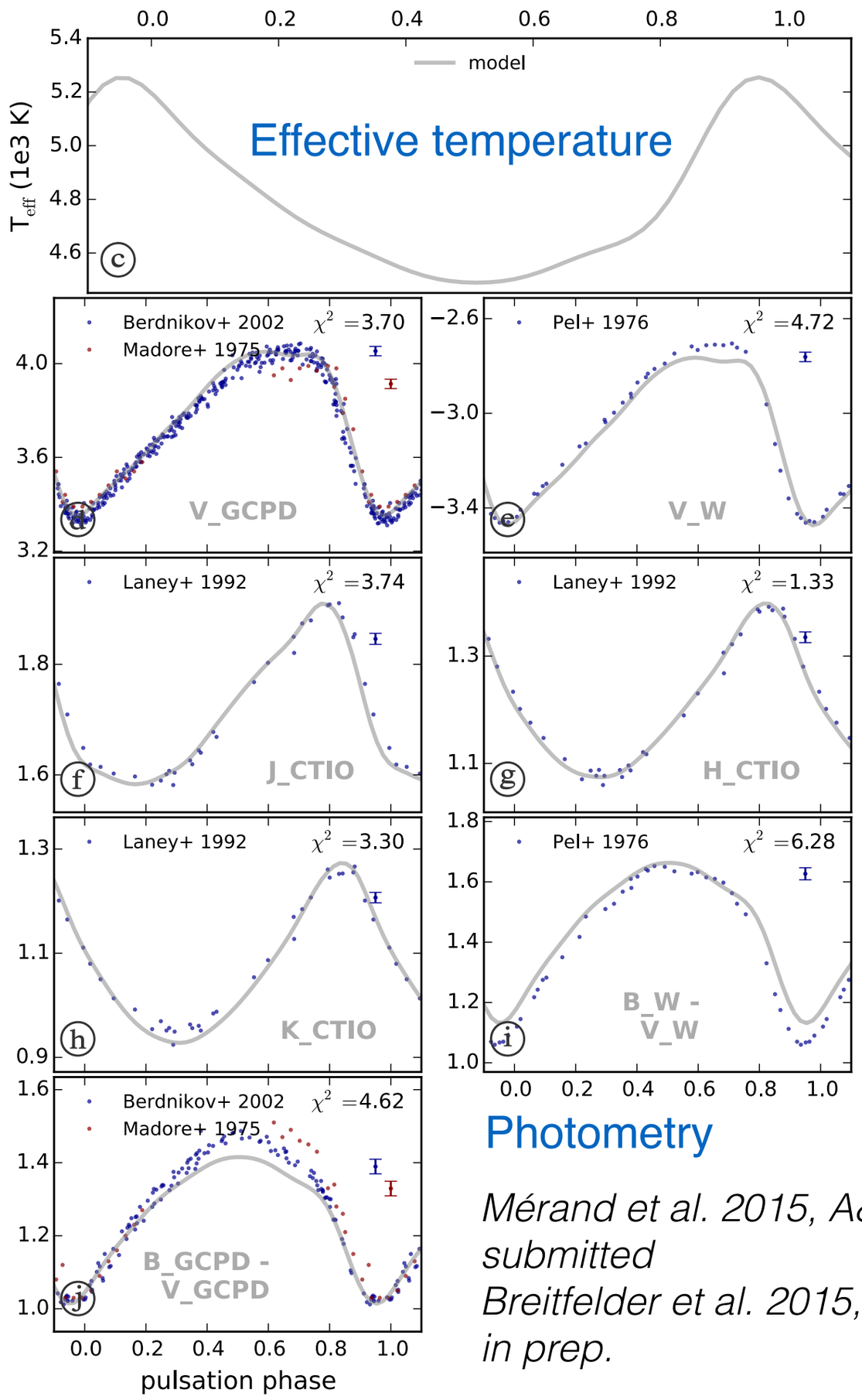
$p \sim 1.39 - 0.03 \log P$ from stellar atr

(Hindsley & Bell 1986, PASP, 98, 881)

Main limitation for BW Cepheid distances

ℓ Car p=1.403 d=497.5pc E(B-V)=0.134





Photometry

Mérand et al. 2015, A&A, submitted
Breitfelder et al. 2015, A&A, in prep.

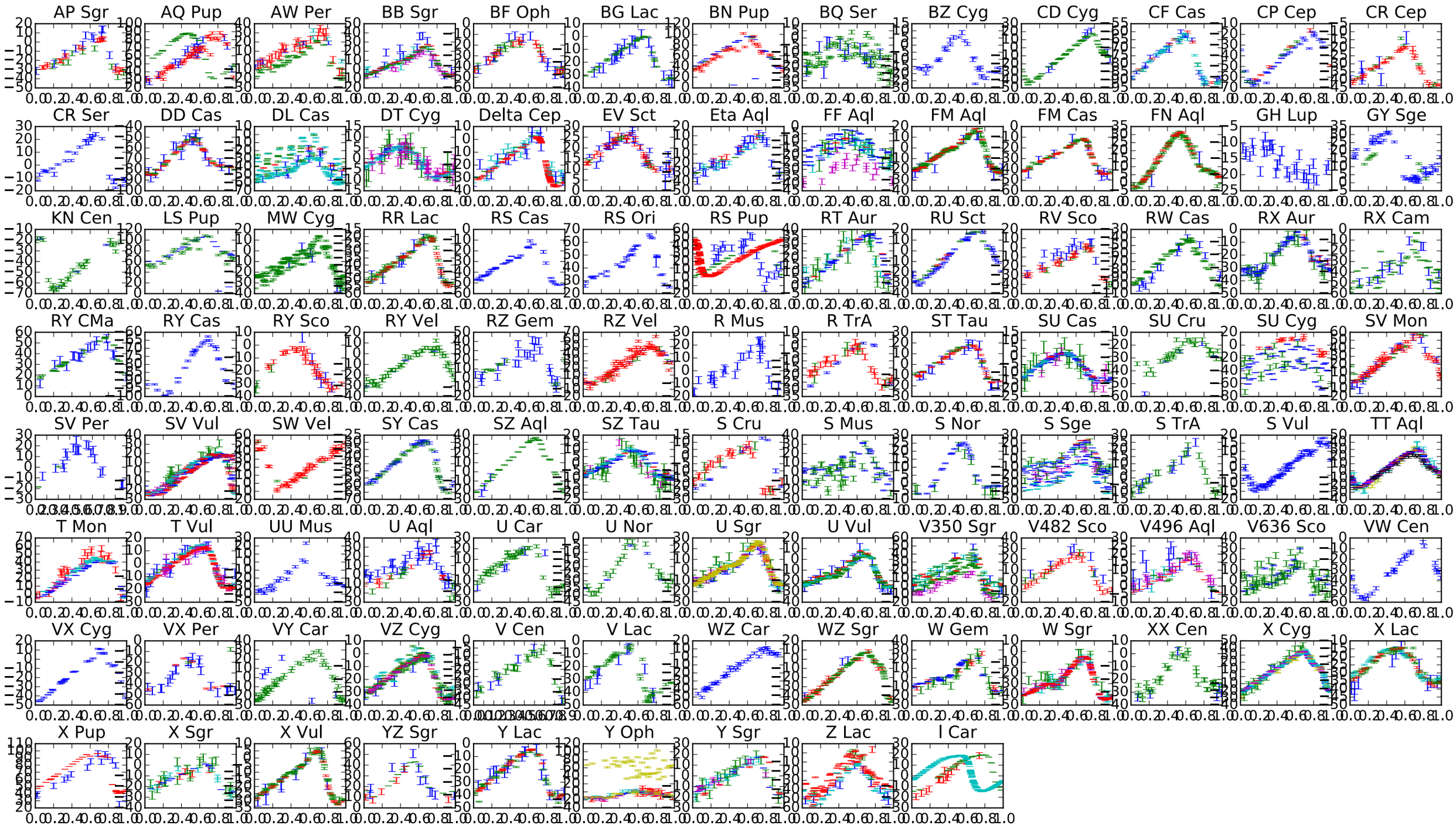
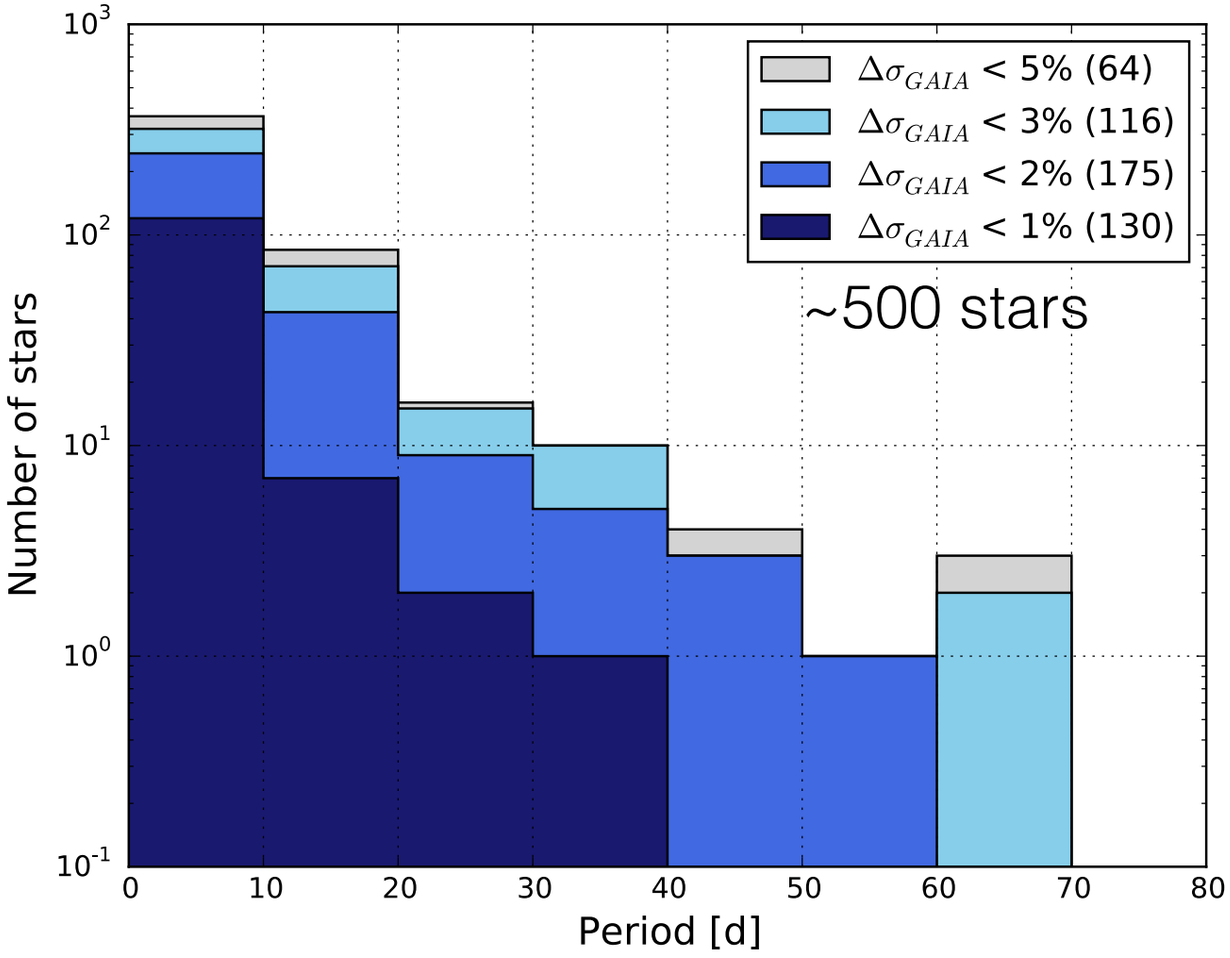
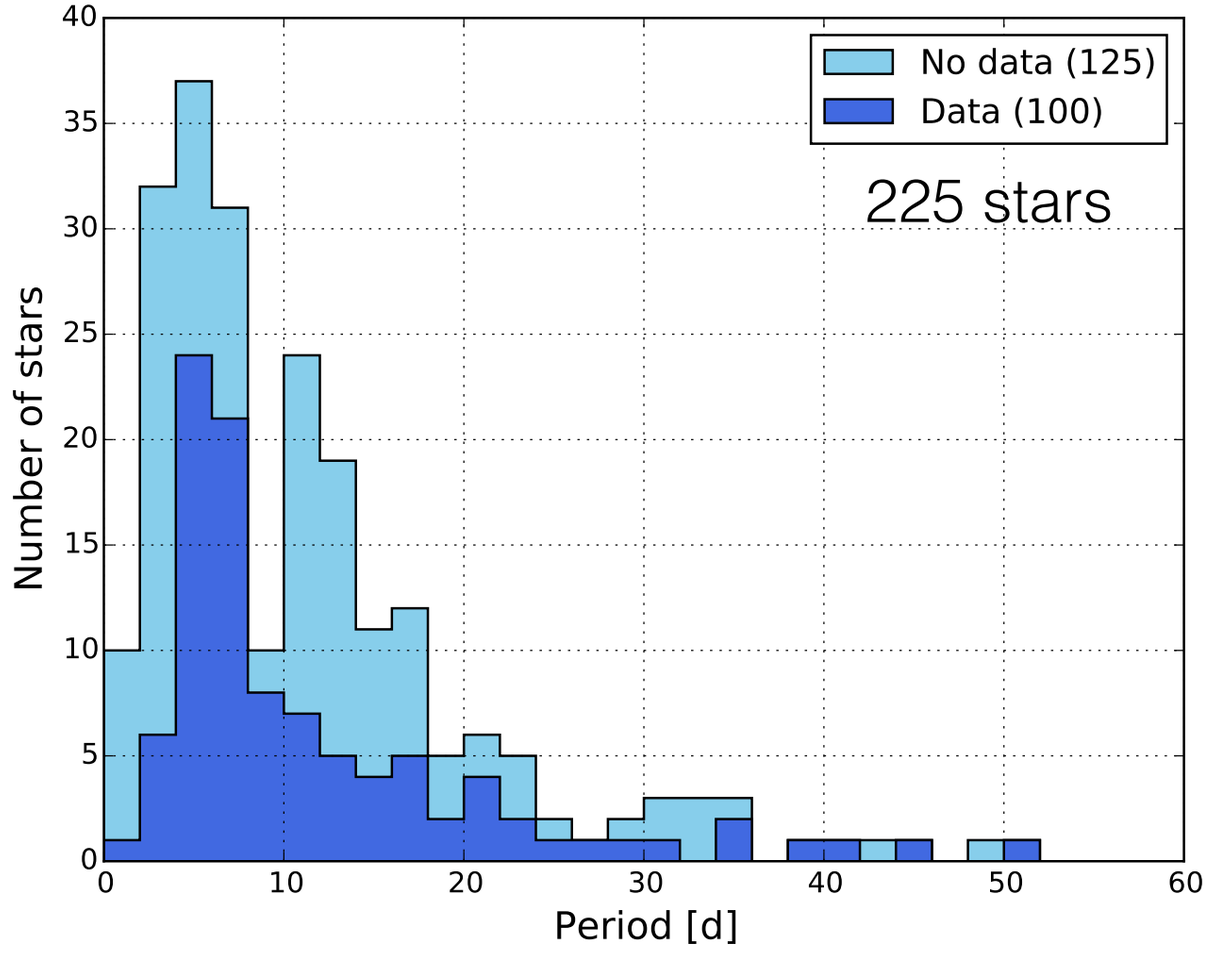


Figure: Anthony Soulain

Gaia parallaxes of Galactic Cepheids

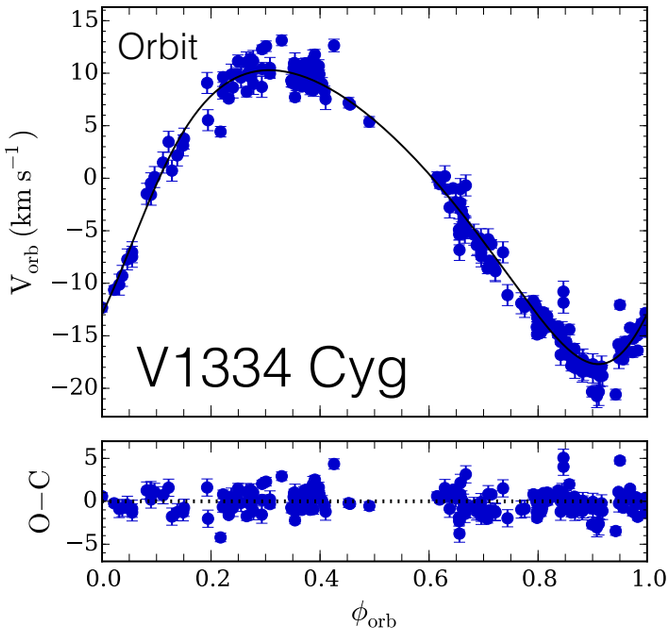


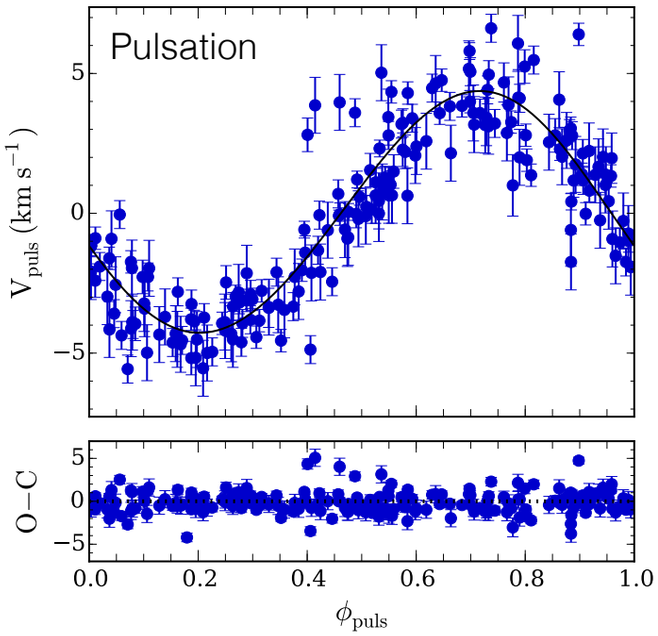


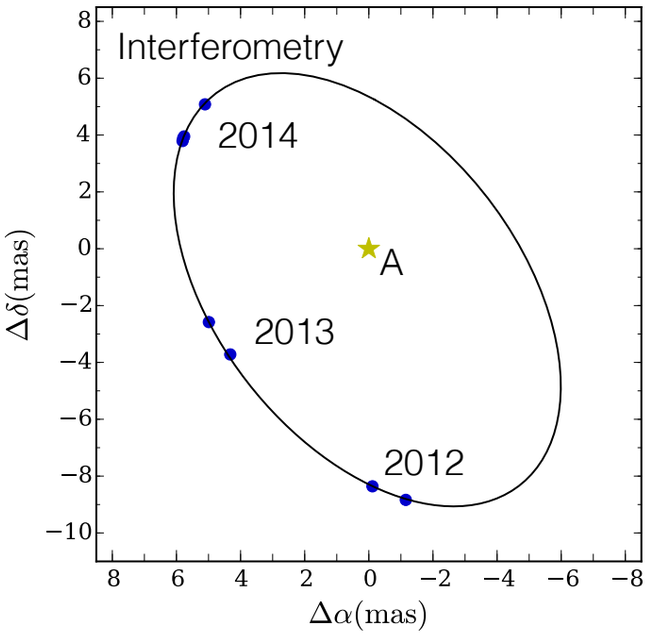
Figures: Anthony Soulain

Binary Cepheids

Gallenne et al. 2013, A&A
+ A&A in prep.

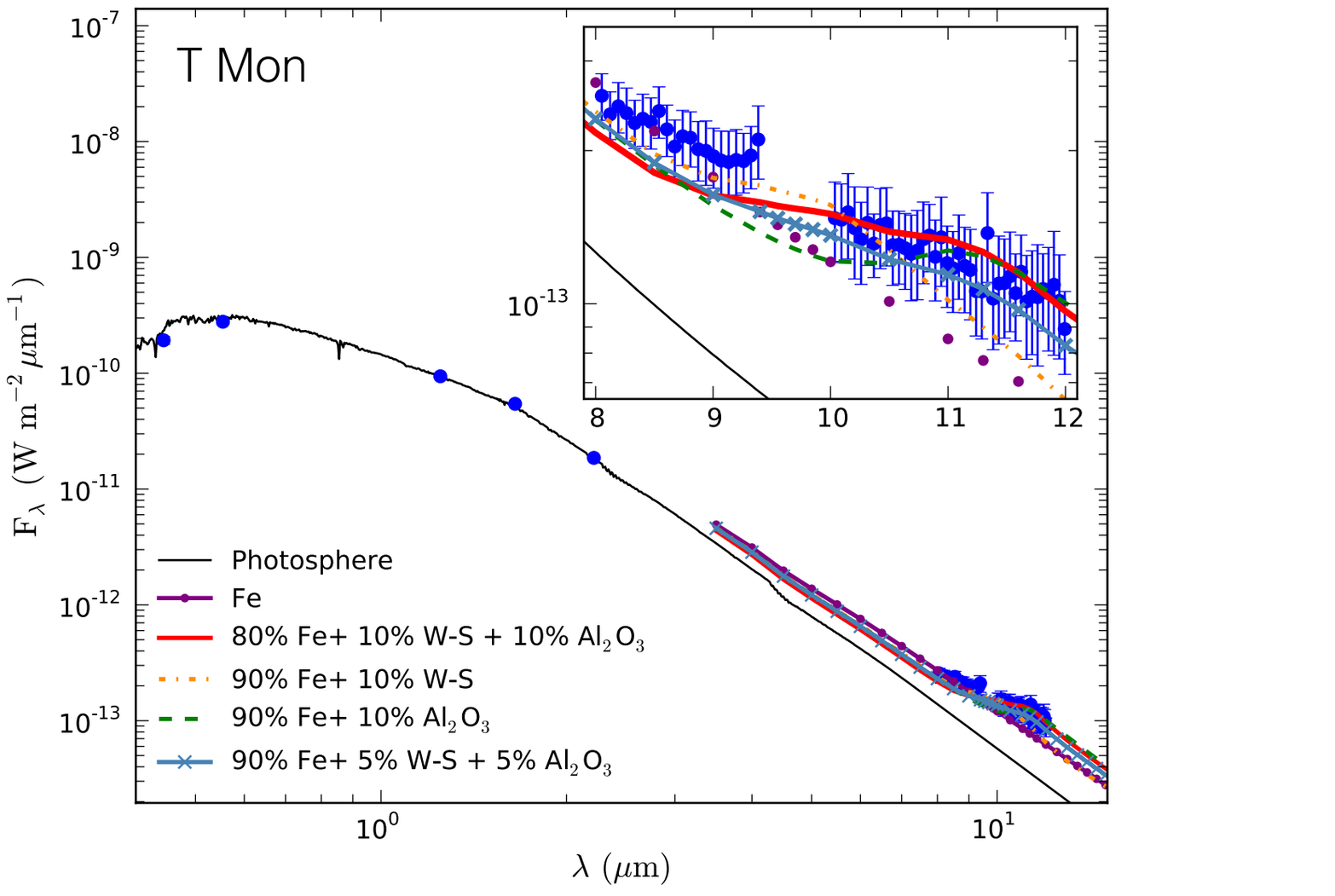






Circumstellar envelopes

Gallenne et al. 2013, A&A.



RS Puppis

Kervella et al. 2014, A&A