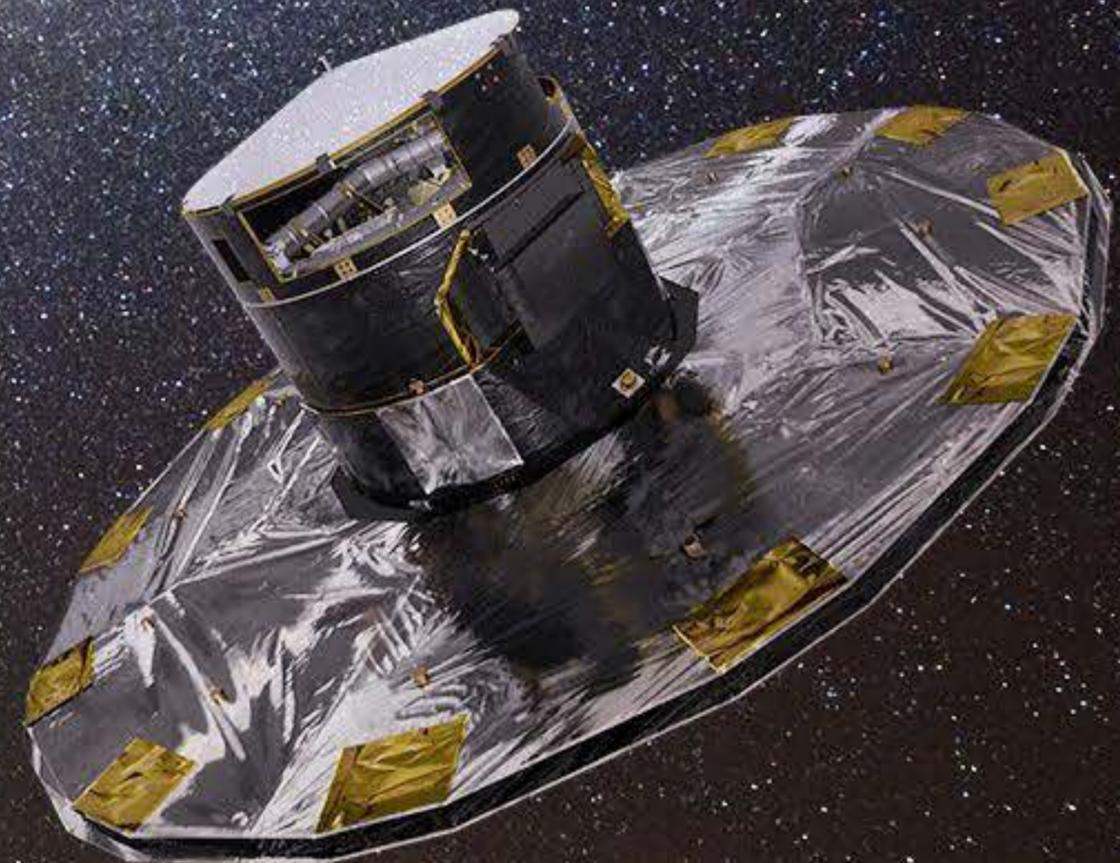
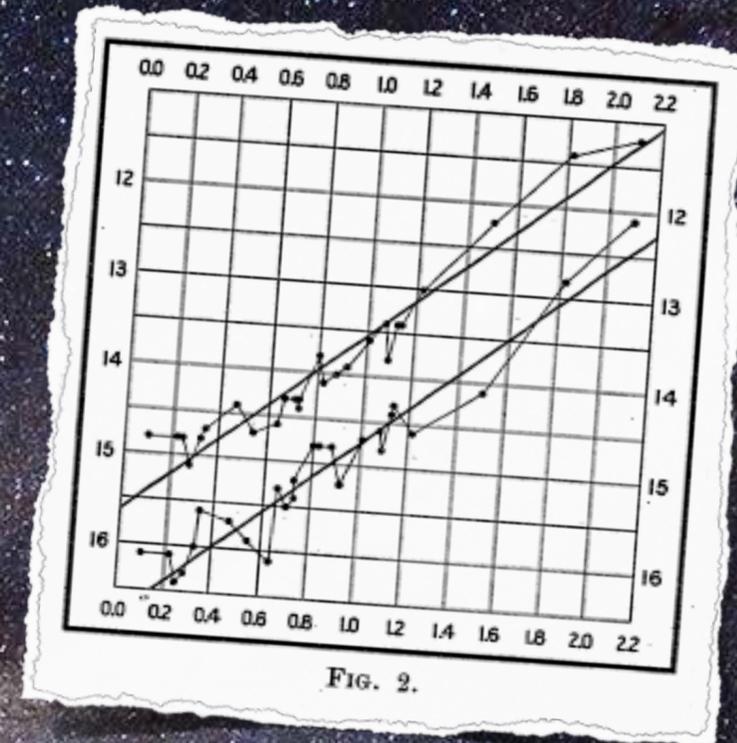


Unlocking the potential of Cepheids as distance calibrators

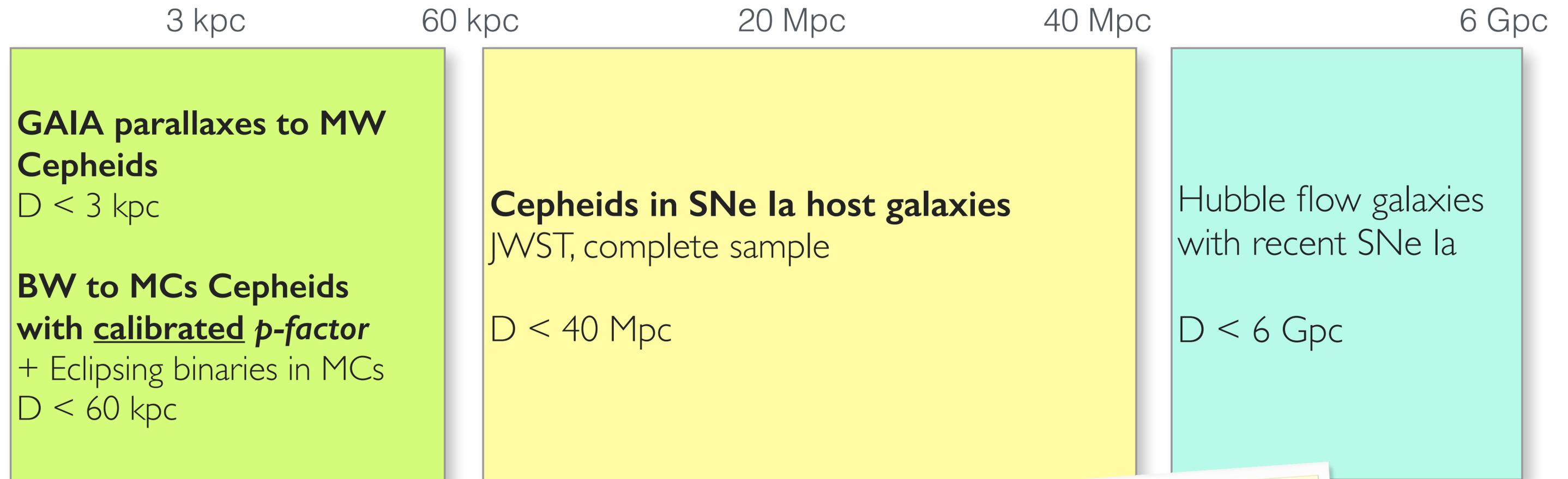
Pierre Kervella

CNRS UMI FCA 3386 & Observatoire de Paris

Antoine Mérand, Alexandre Gallenne, Nicolas Nardetto, Richard I. Anderson, Joanne Breitsfelder, Wolfgang Gieren, Grzegorz Pietrzynski



THE EXTRAGALACTIC DISTANCE SCALE

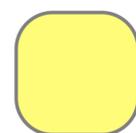


Goal: $\sigma(H_0)/H_0 \sim 1\%$

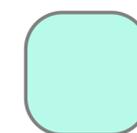
Calibration of the Cepheid distance scale ?



"Direct" distances

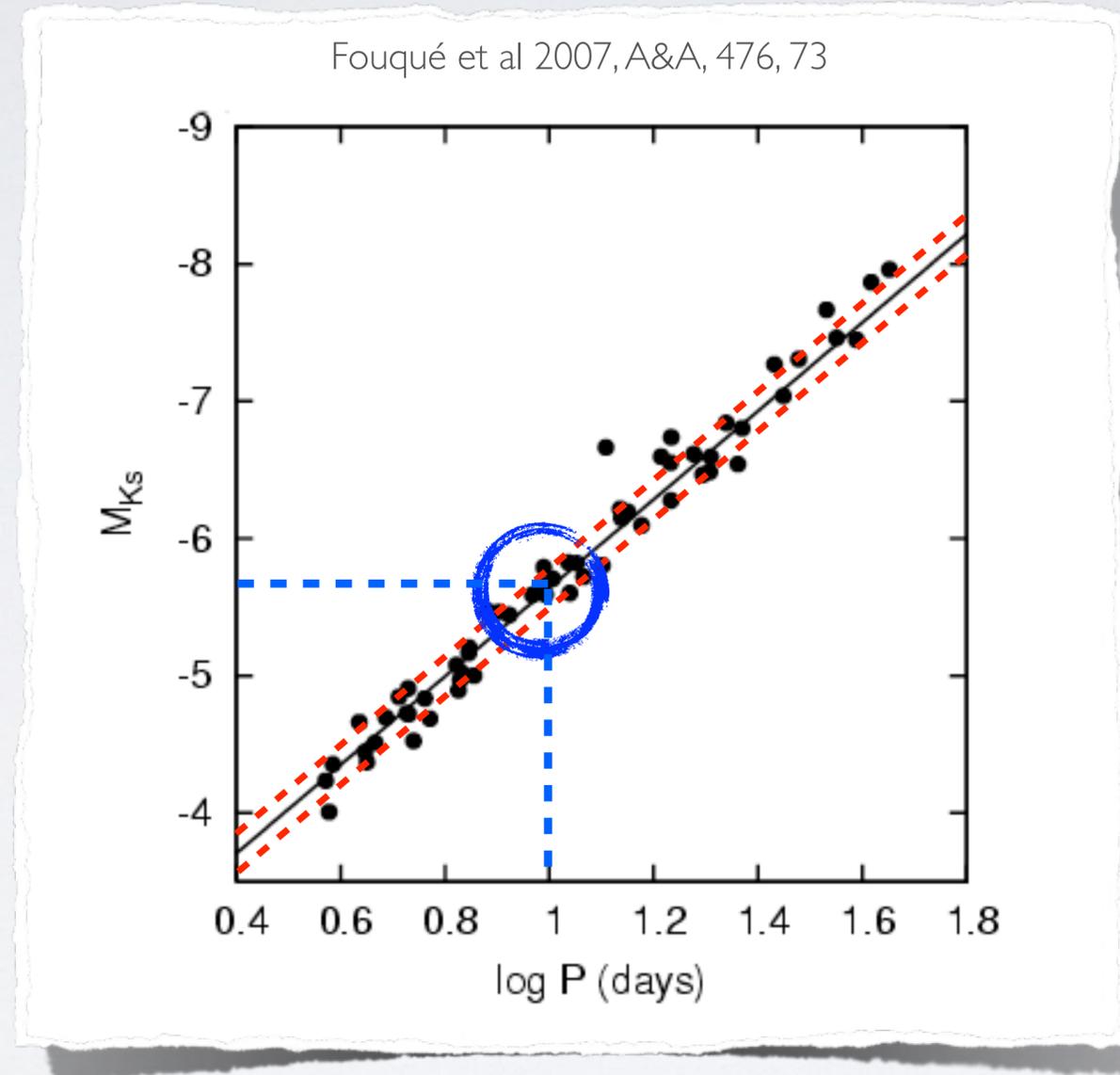


Period-luminosity

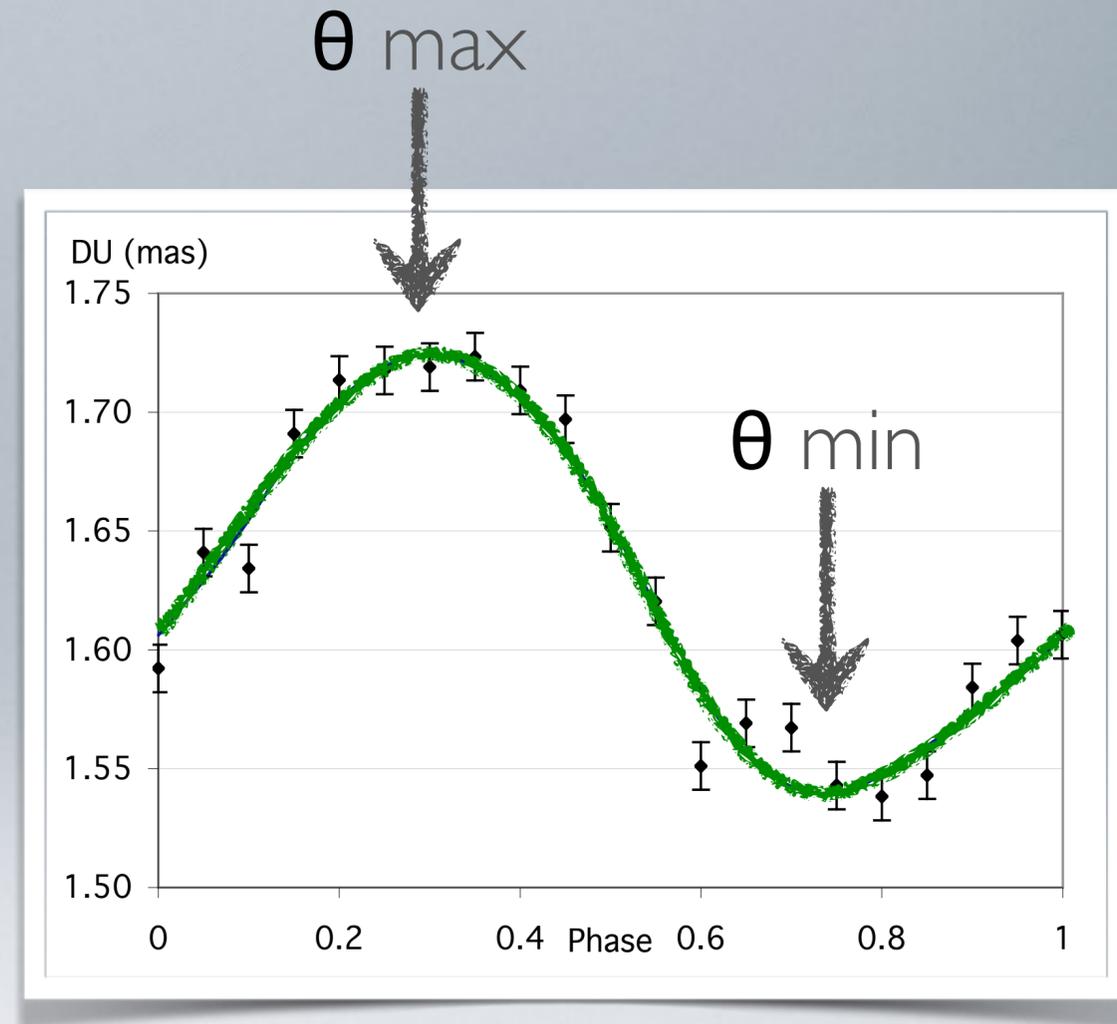
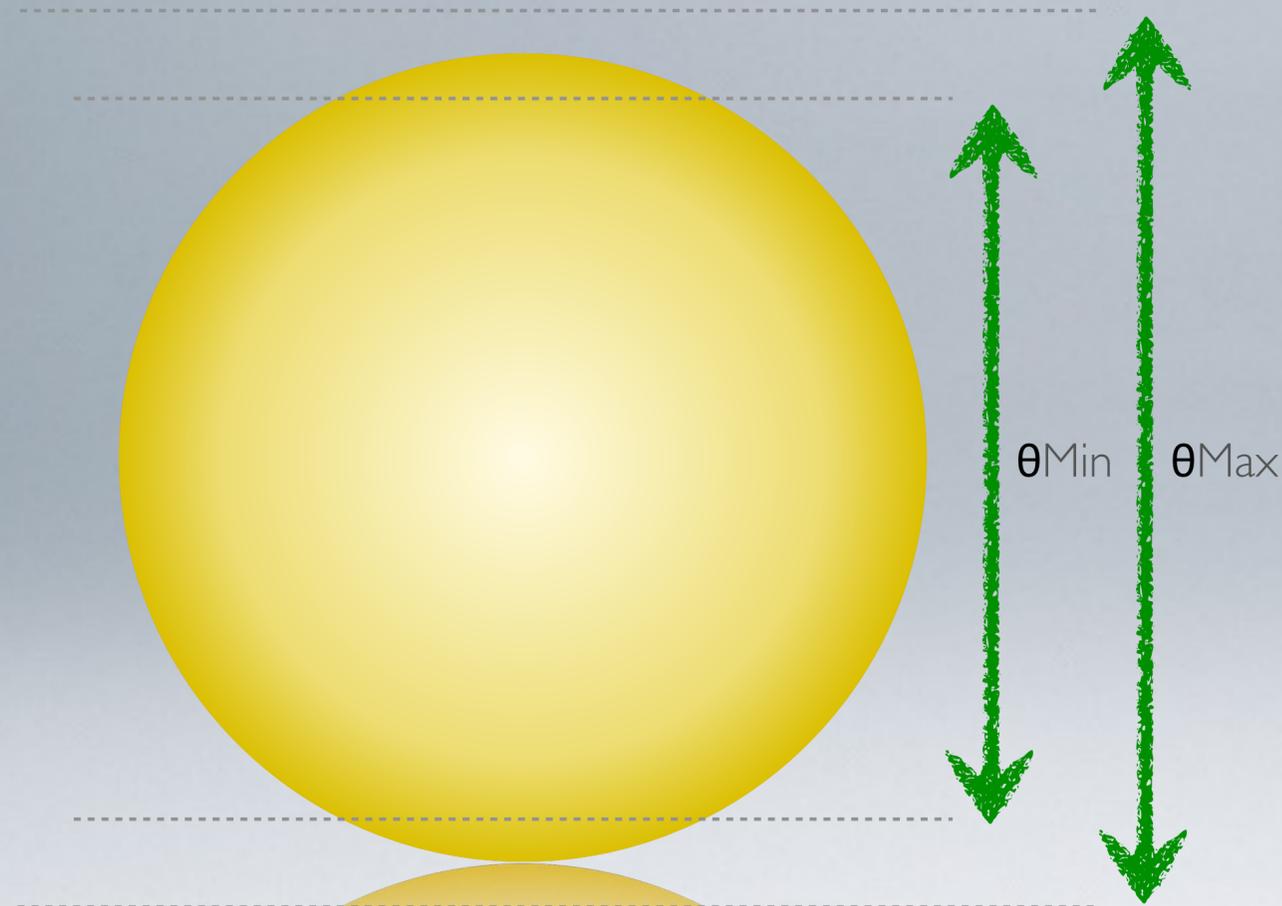


SN Ia

PERIOD-LUMINOSITY

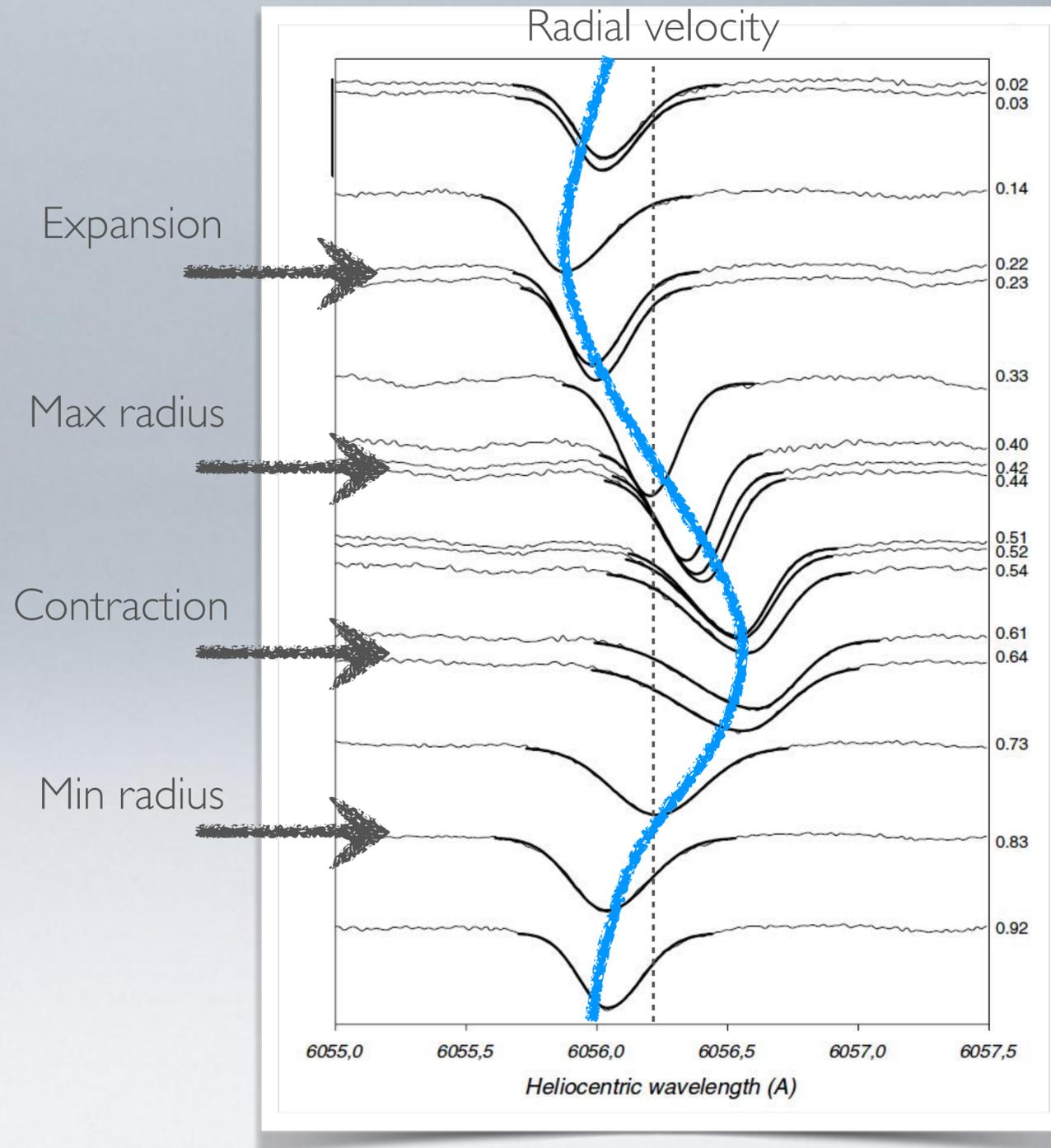
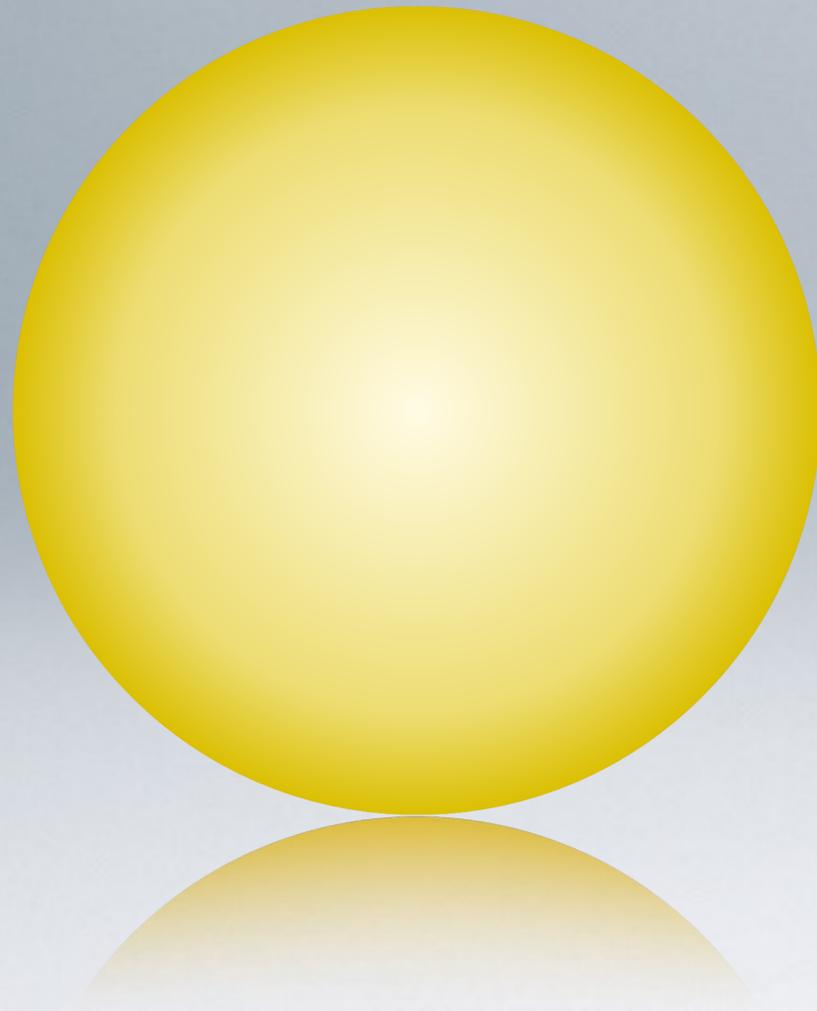


I. INTERFEROMETRY



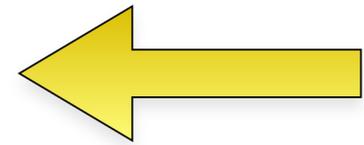
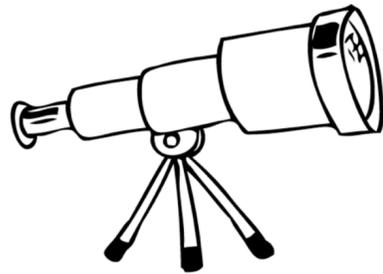
Gives the *angular size variation* of the star

2. SPECTROSCOPY

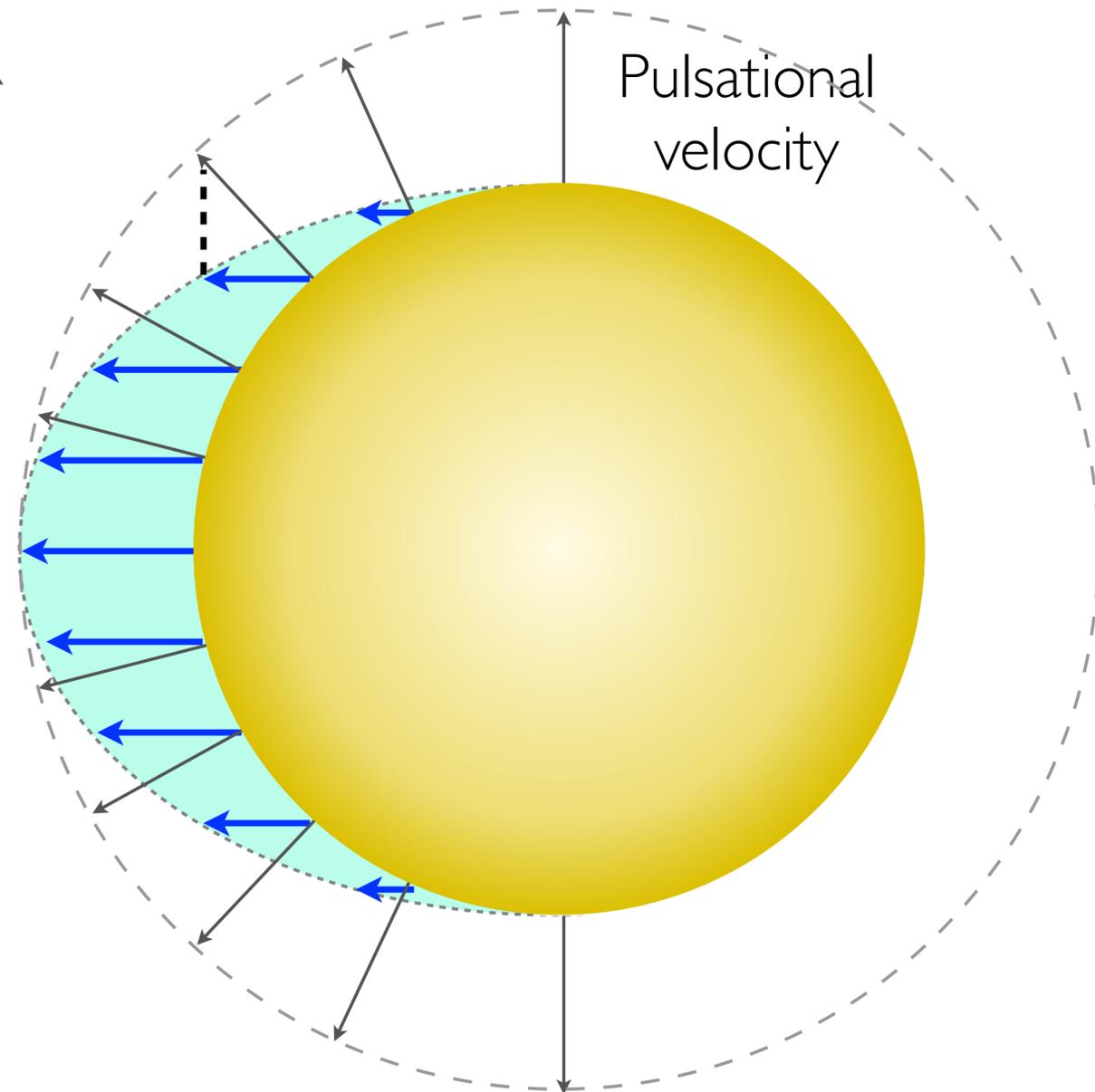


THE P-FACTOR

Disk-integrated
radial velocity



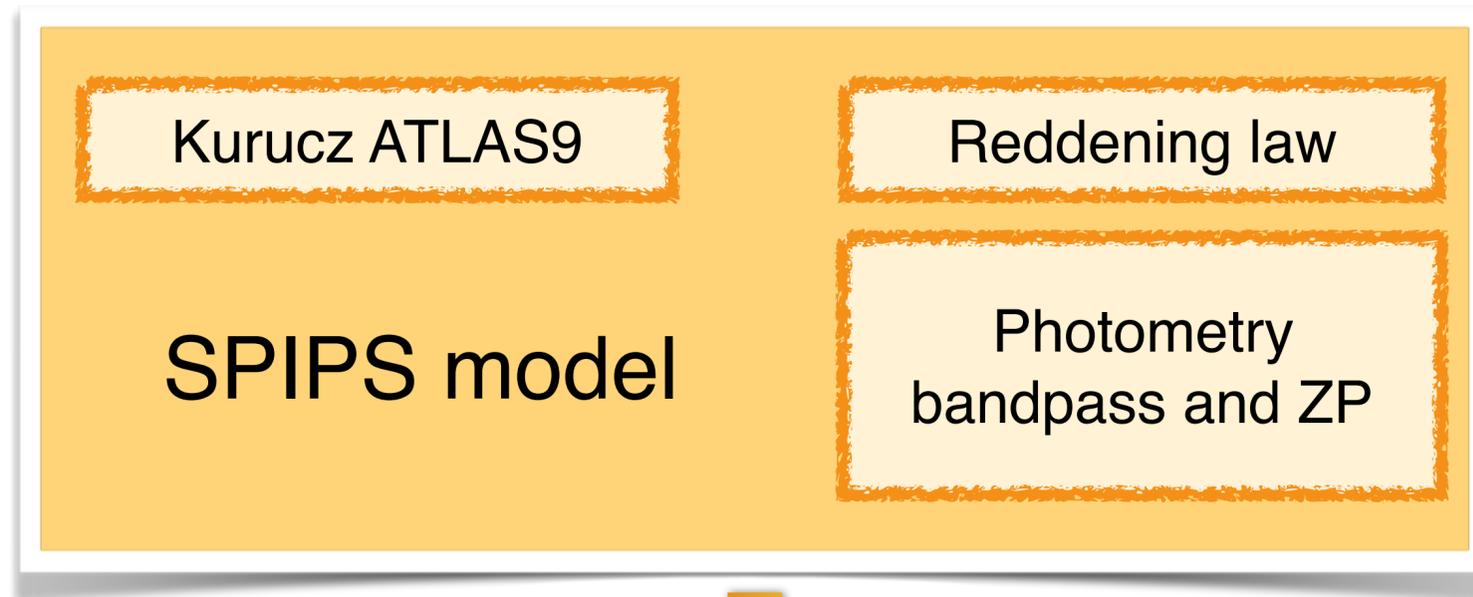
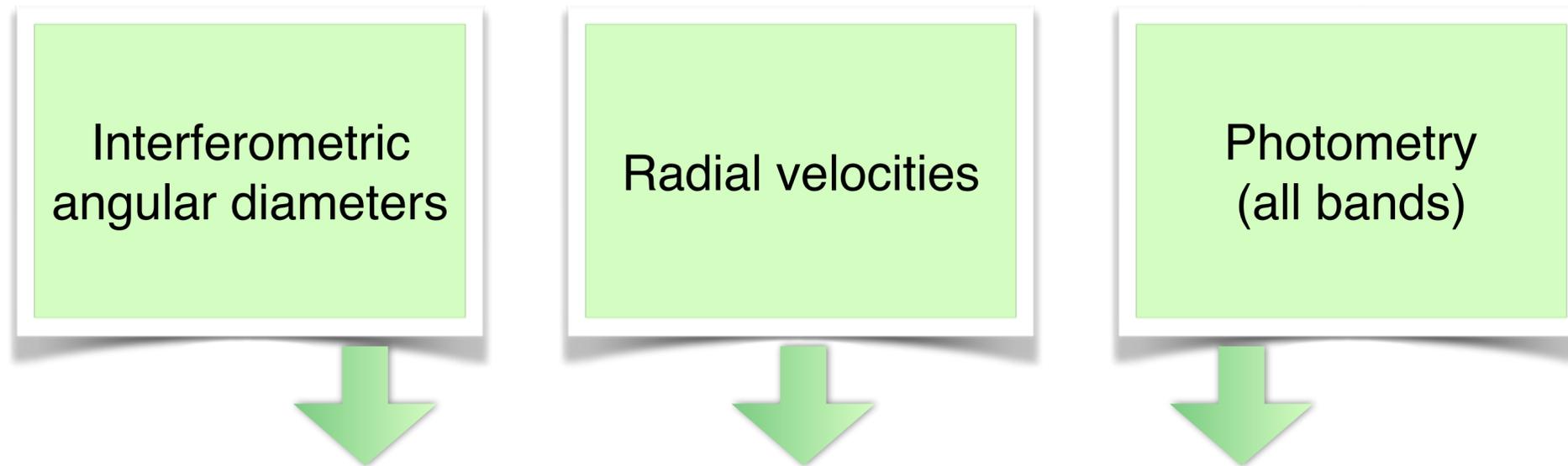
Radial
velocity



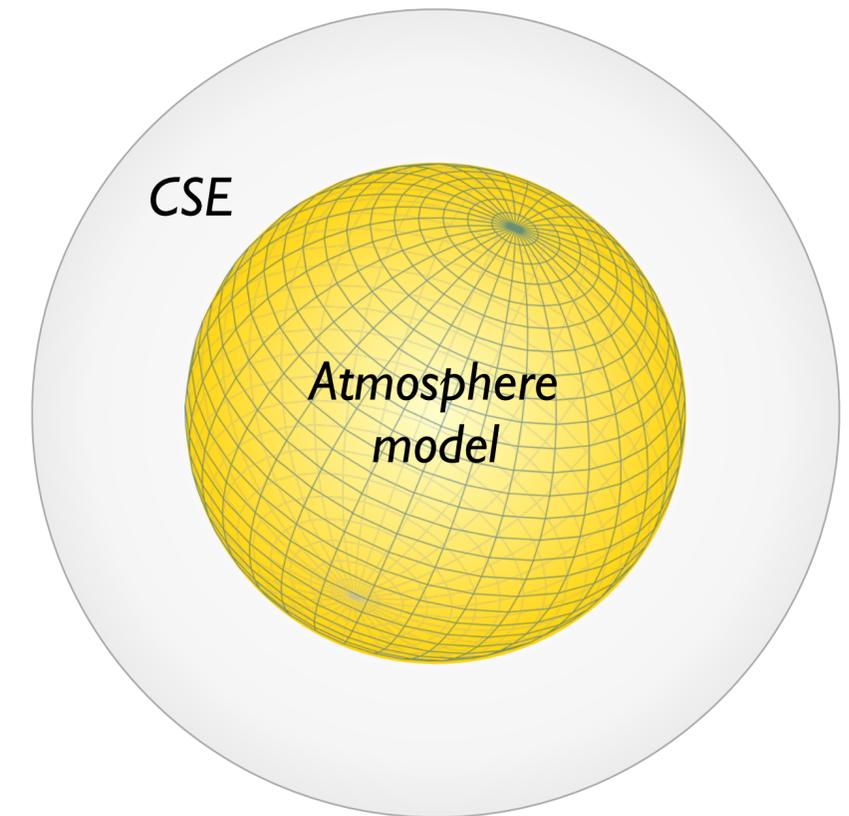
- $p = \text{pulsational} / \text{radial velocity}$
- Geometrical component = 1.5
- Limb darkening component < 1
- Atmosphere dynamics = ?

$p \sim 1.39 - 0.03 \log P$ from stellar atmosphere models
(Hindsley & Bell 1986, PASP, 98, 881)

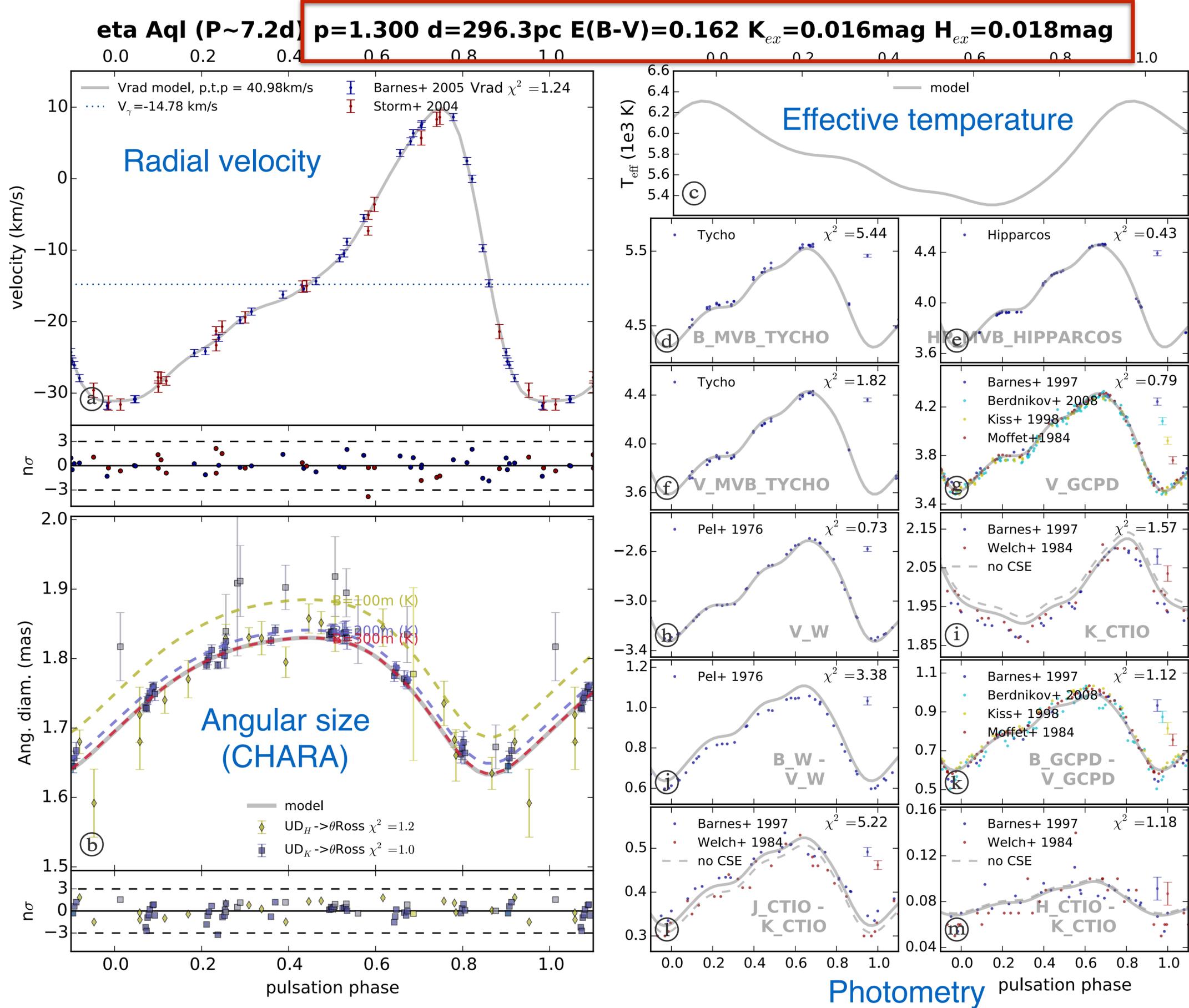
Main limitation for BW
Cepheid distances



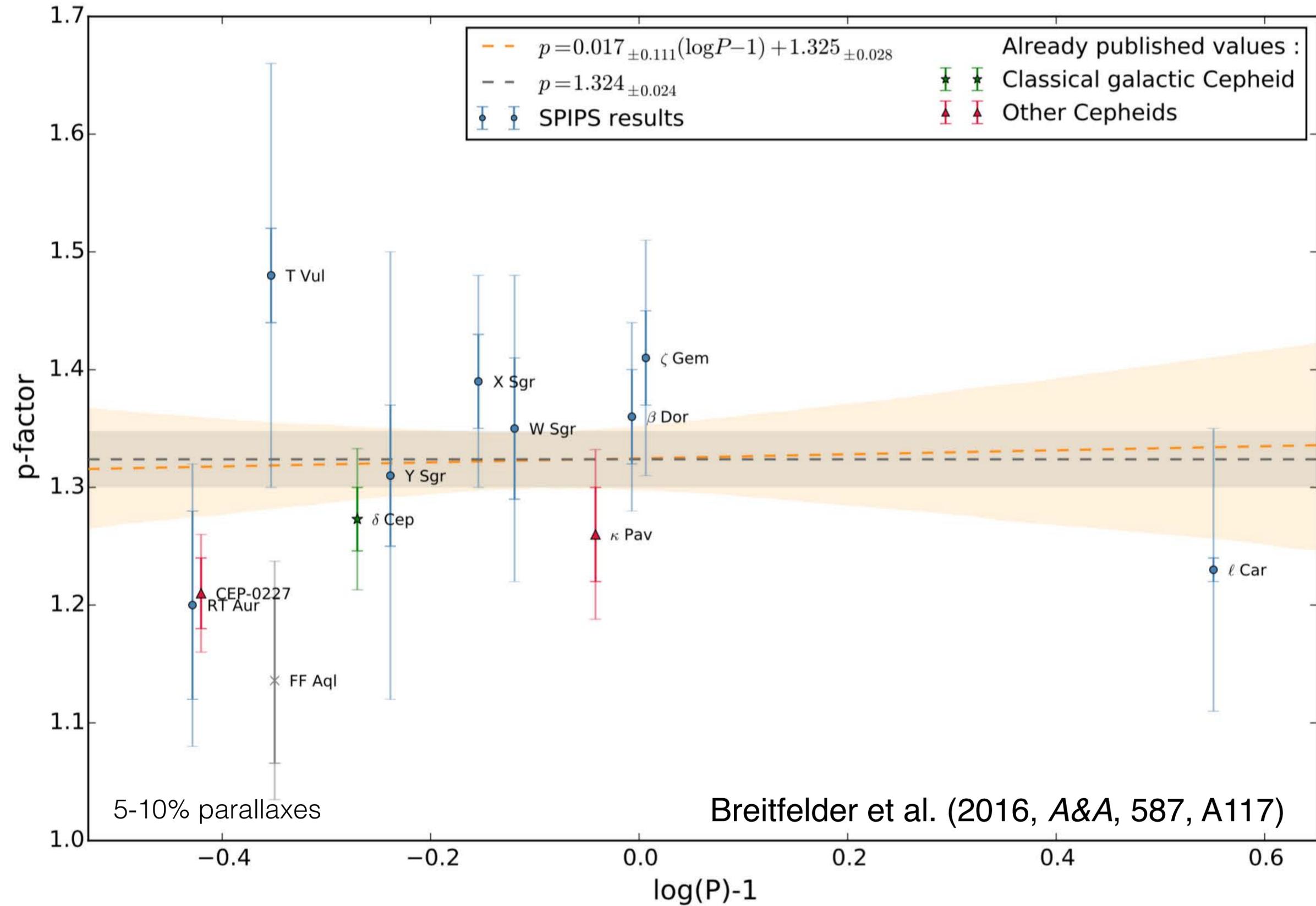
- Distance or projection factor
- Color excess $E(B-V)$
- Effective temperature
- Envelope contribution (H+K)



- Future evolutions:
- direct V^2 input
 - thermal infrared
 - high resolution spectra
 - rotational velocity



P-FACTORS FROM SPIPS + 9 HST-FGS PARALLAXES



DATABASE OF OBSERVATIONS: RADIAL VELOCITIES

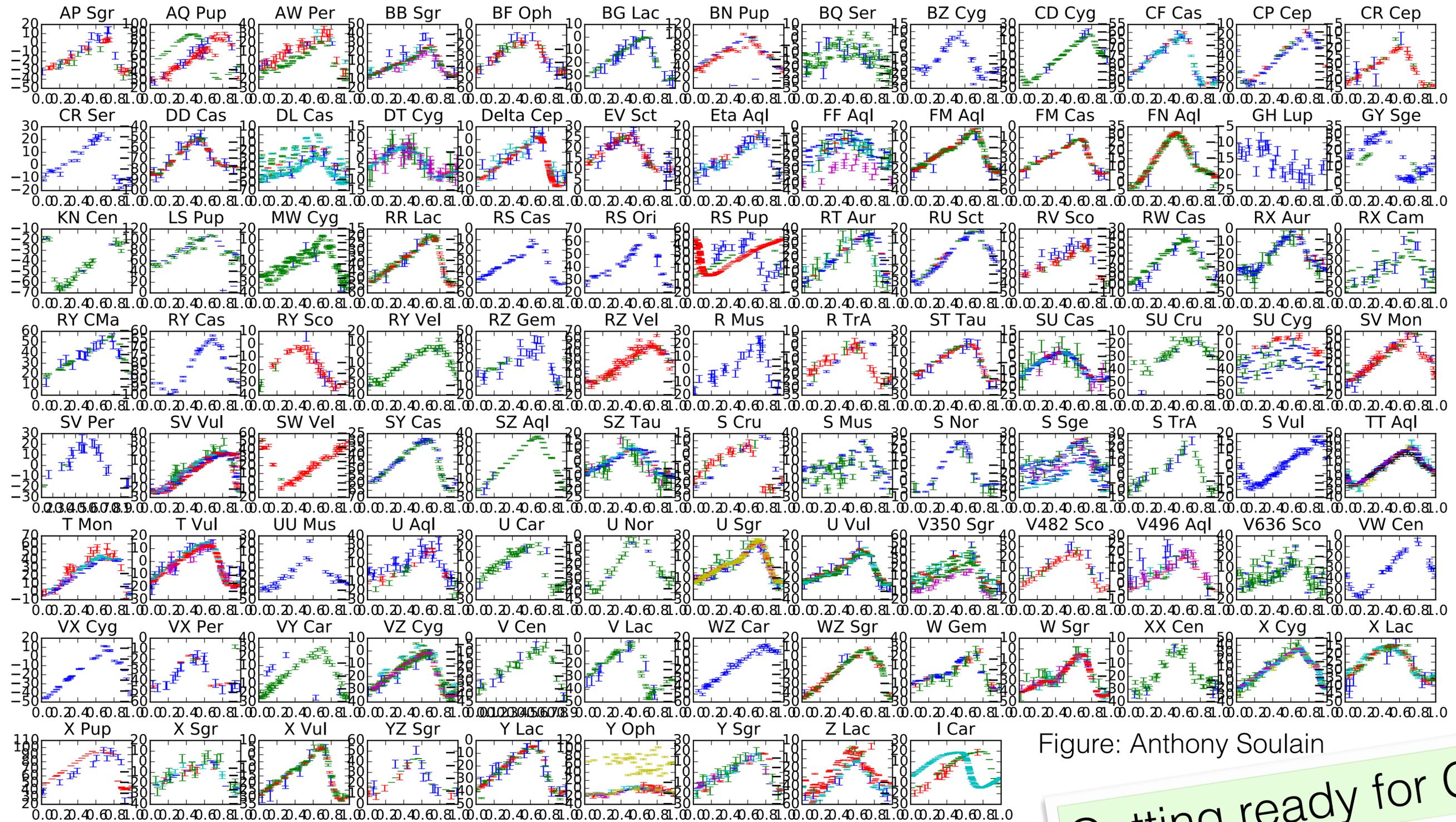


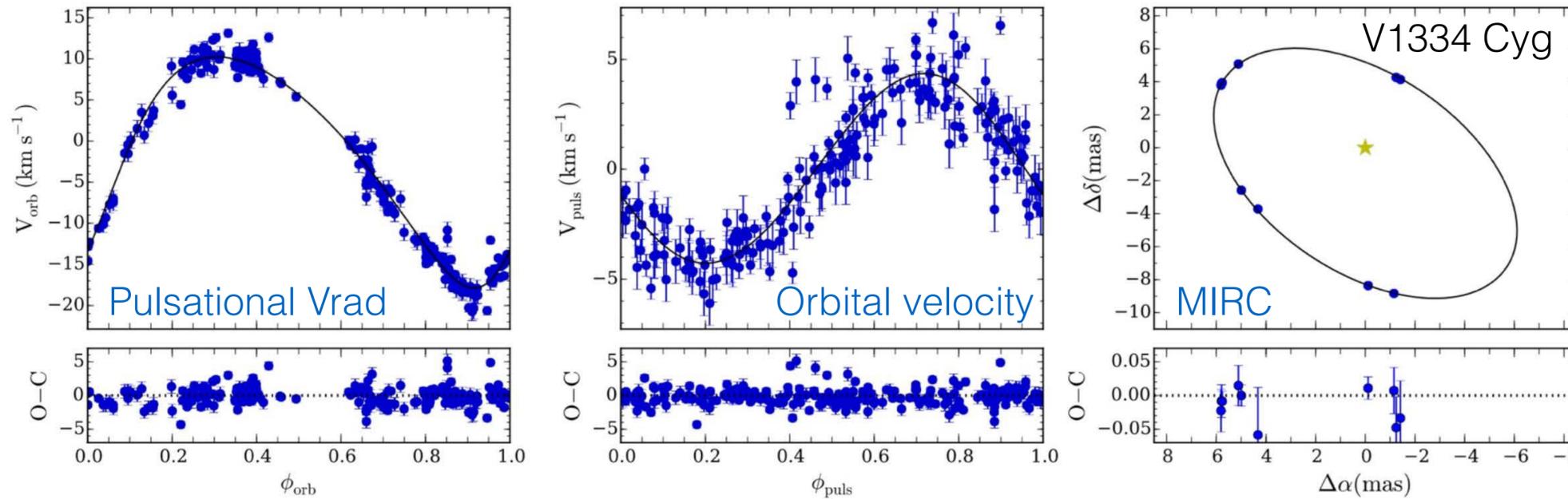
Figure: Anthony Soulain

Getting ready for Gaia !

+ Photometry (colors,...)

Binary Cepheids

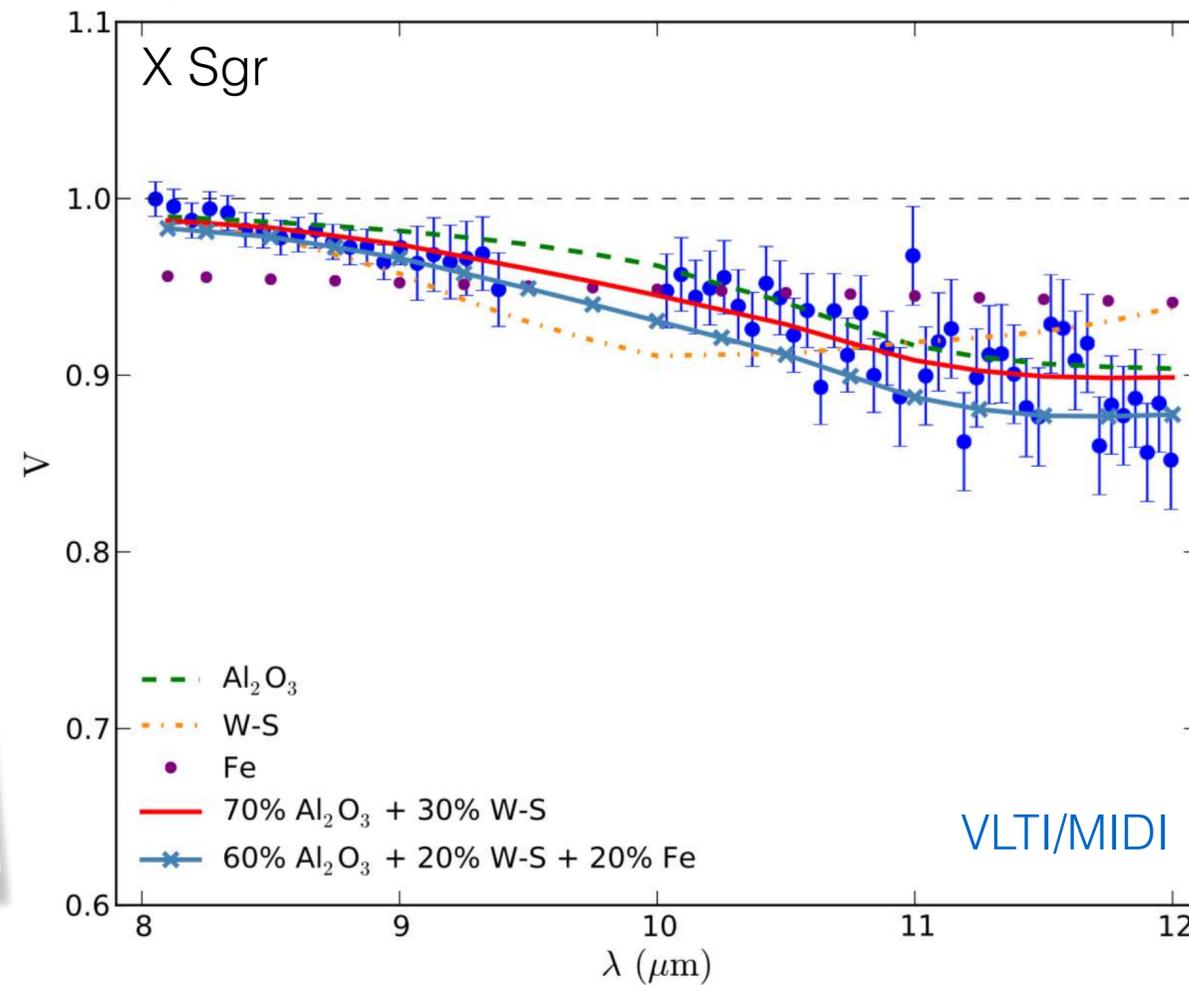
Gallenne et al. (2013, *A&A*, 552, A21)
 Ongoing HST-FGS+STIS program
 (with Nancy Evans, Ed Nelan, Charles Proffitt,...)



Circumstellar envelopes

Gallenne et al. (2013, *A&A*, 558, A140)

Four year program funded by ANR:
 - 2 PhD theses
 - 1 post-doc (3 years)



RS Puppis

Kervella et al. 2014, A&A

