



FLUOR science

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Themes

- Cepheids (see Antoine's talk)
- Photospheres (see Jason's talk)
- Debris disks (Absil, di Folco)
- Asteroseismology of red giants (Barban)





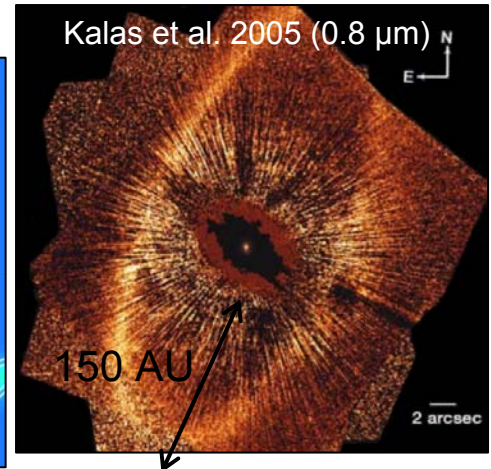
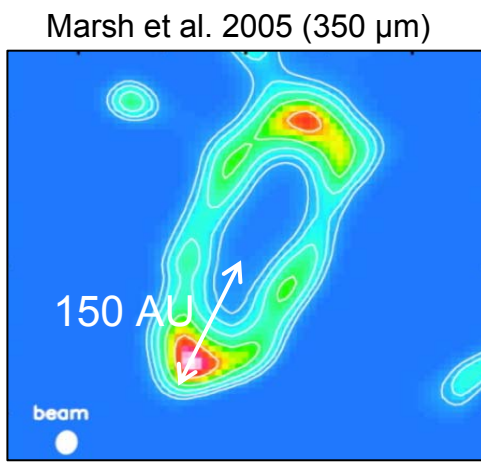
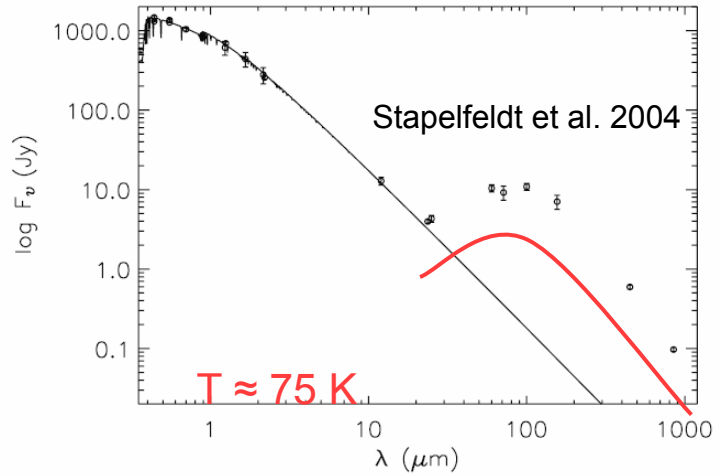
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The quest for warm dust

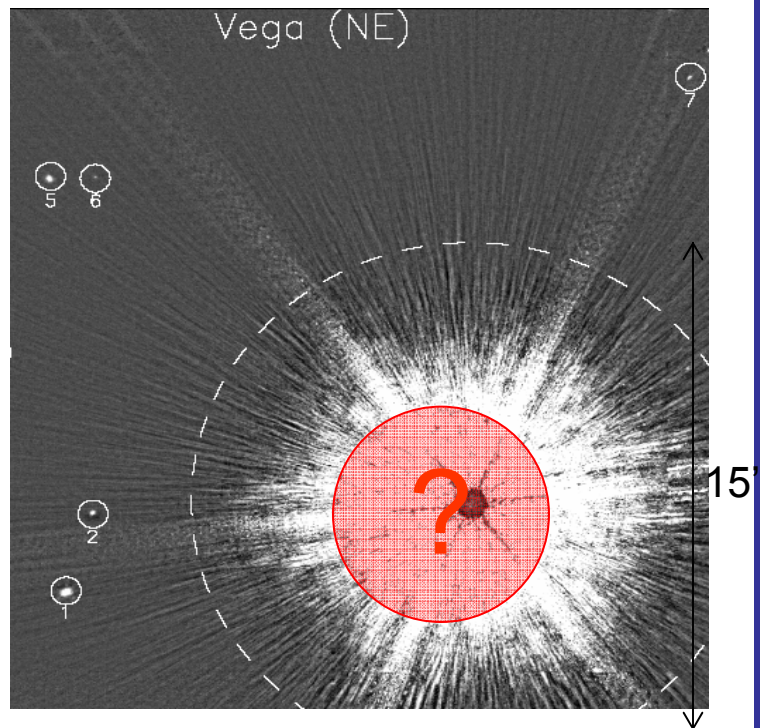
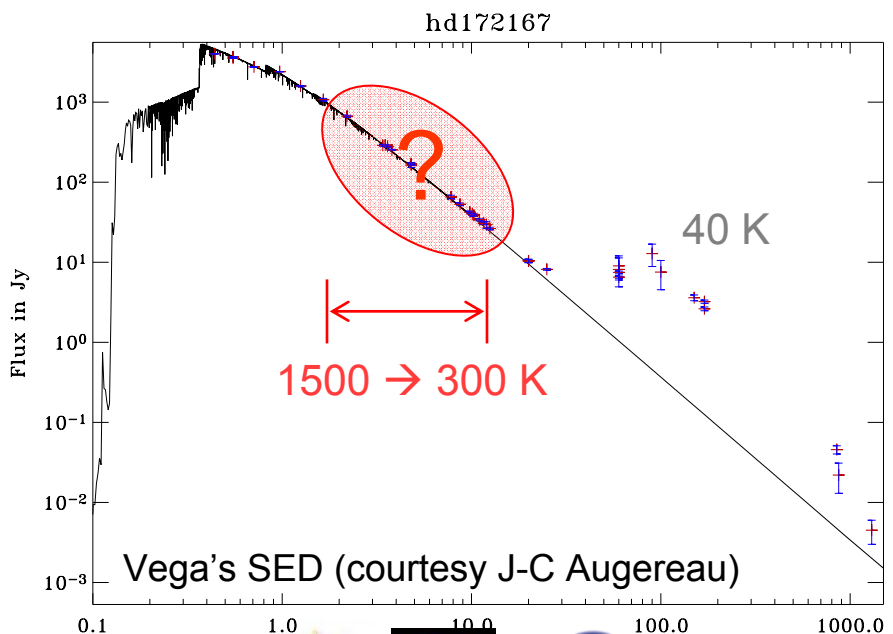
- Detected debris discs
 - Far-IR, sub-mm, visible
 - Cold and distant (~ 100 AU)
 - Massive (few 100 solar Kuiper belt)
 - Evidences for inner holes
- Zodiacal disc analogues?
 - Inner planetary region
 - Spitzer: first evidence for warm dust (~ 300 K)
 - Sensitivity ~ 1000 zodi!
- Goal: direct imaging of exozodiacal discs
 - Towards Darwin / TPF...



(150 AU \approx 20" at 7.7 pc)

Challenges of direct imaging

- High contrast ($\geq 1:100$)
- Small angular separation
 - Inner disc: a few 10 mas
 - Requires IR interferometry

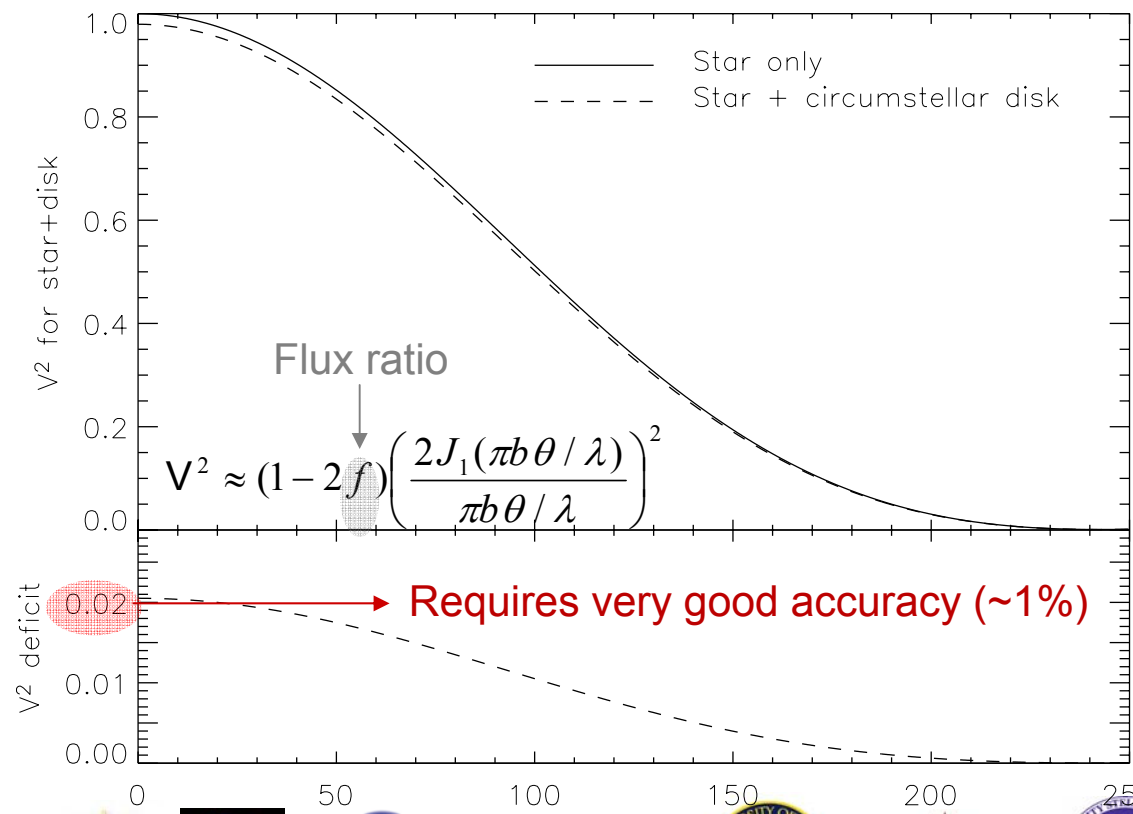


Macintosh et al. 2003 (Keck AO)



Debris discs by interferometry

- Disc larger than angular resolution (λ/b) \rightarrow incoherent flux
- Induces a visibility deficit at all baselines
- Best detected at short baselines



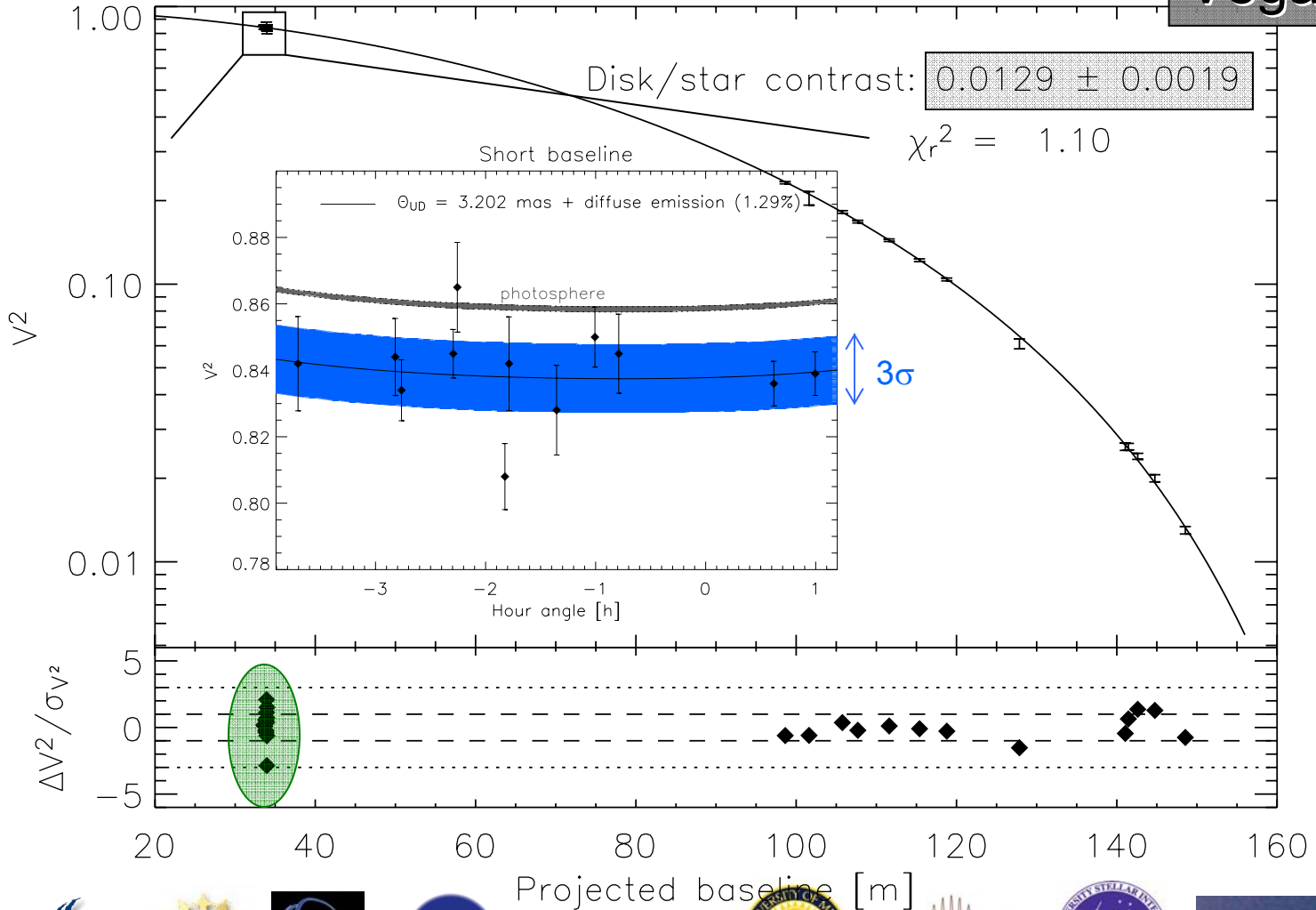


Fitting photosphere + debris disc

Absil et al. 2006

$$\Theta_{UD} = 3.202 \pm 0.005 \text{ mas}$$

Vega





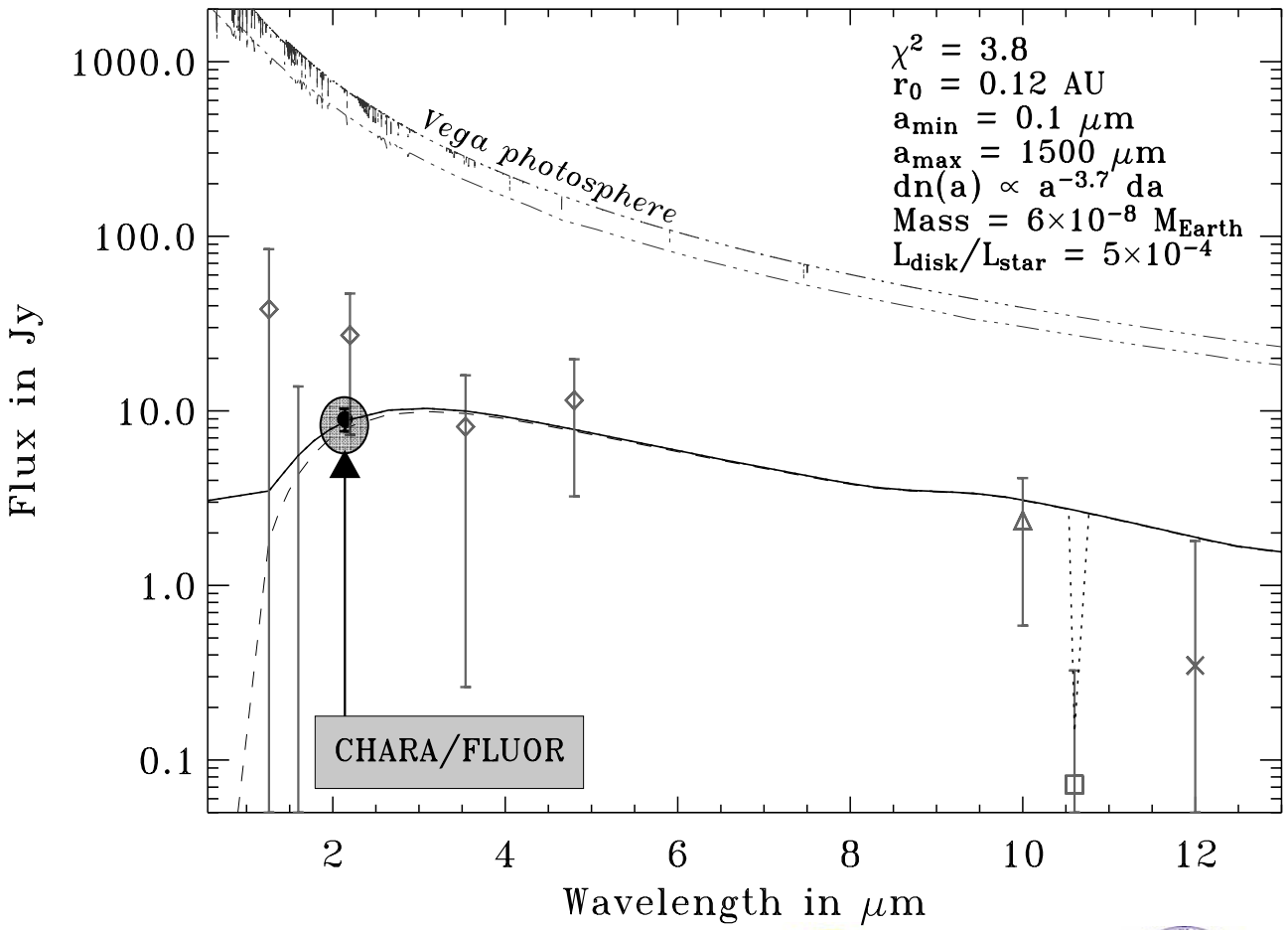
Possible origins of near-IR excess

- Point-like source
 - RV and astrometry stable \rightarrow no companion
 - Very low probability for background star
- Stellar wind / mass loss
 - A-type stars: very weak winds ($\sim 10^{-14} M_{\text{sol}}/\text{yr}$)
- Circumstellar dust
 - Thermal emission & reflected flux
 - Need to check compatibility with literature



Fitting the global Vega SED

- Using the debris disc models of Augereau et al. (1999)



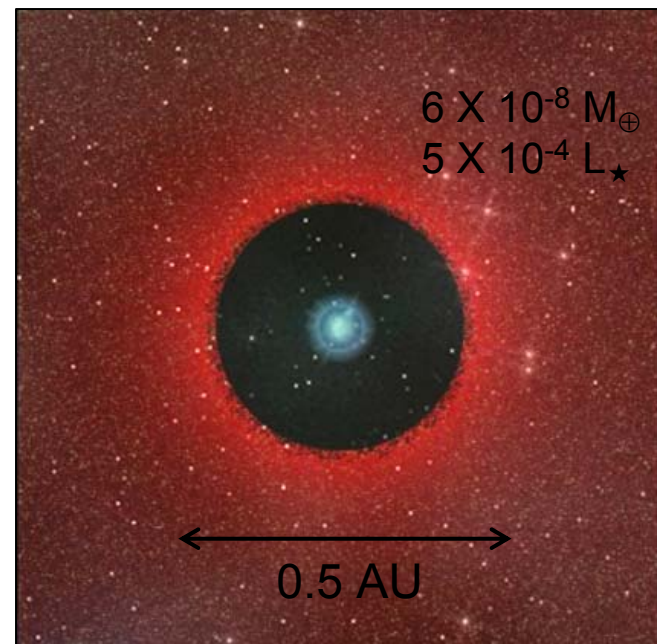
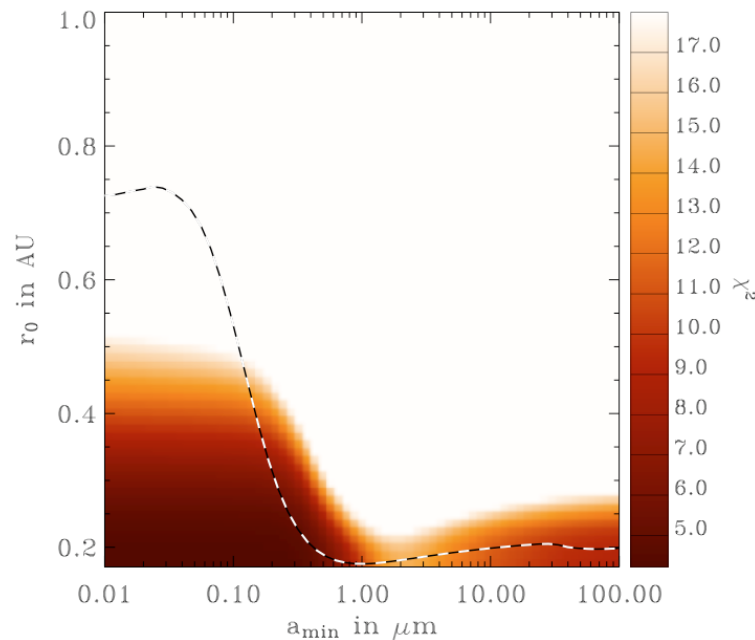
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Best-fit disc properties

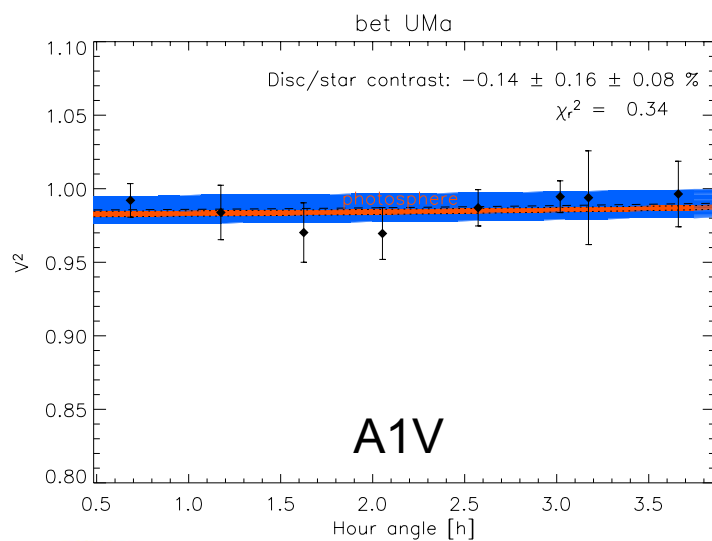
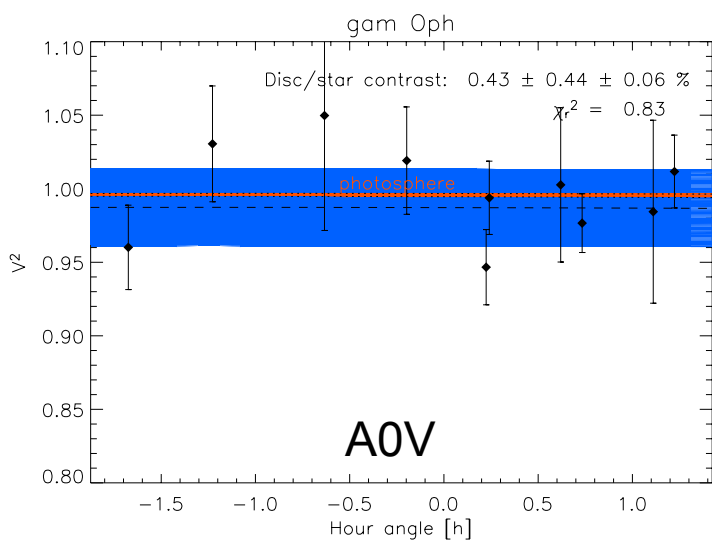
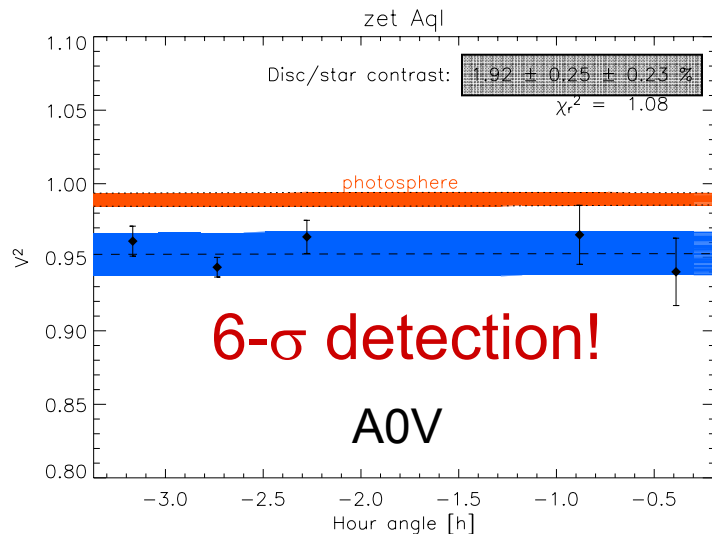
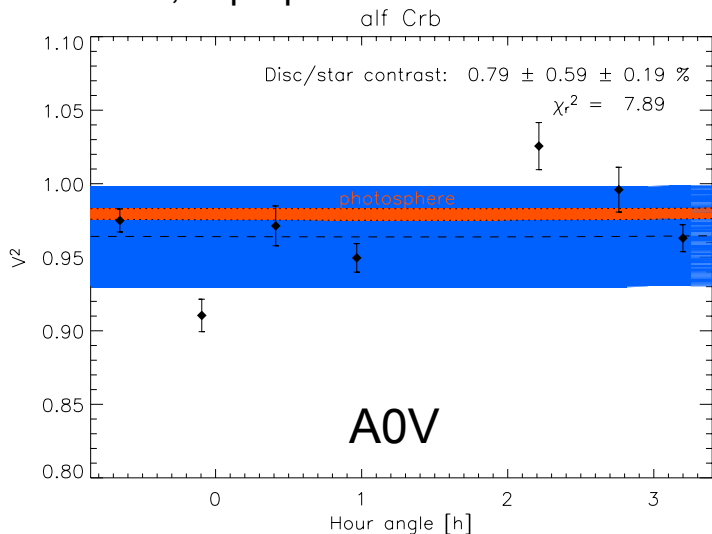
- Fitting procedure:
 - Various density power laws, size distributions & compositions
 - 2 fit parameters: minimum grain size (a_{\min}) and inner radius (r_0)
- Small grains (mostly $< 1 \mu\text{m}$) at distances $\sim 0.1 - 0.5 \text{ AU}$
- Highly refractive grains, no silicate feature \rightarrow carbons $\geq 50\%$
- Steep density power law: $\Sigma(r) \sim r^{-4}$ (or steeper)





Survey: early-type stars

Absil et al., in prep



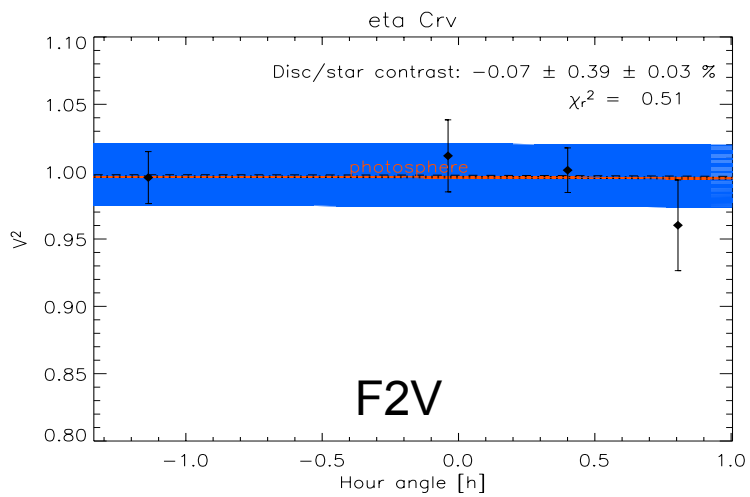
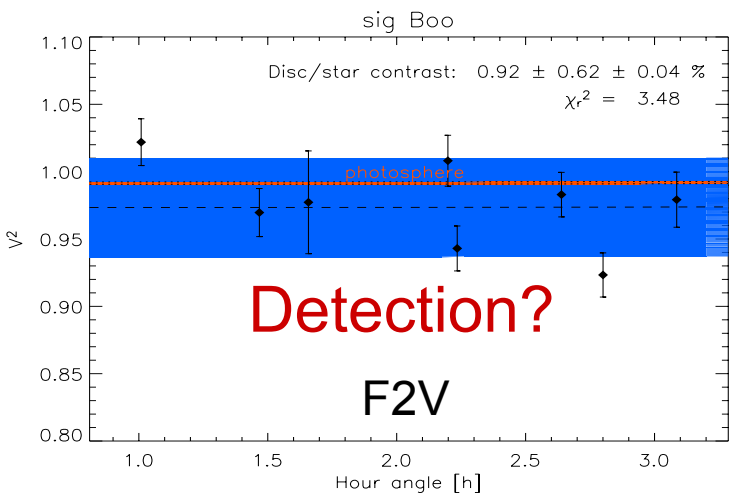
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Survey: early-type stars

Absil et al., in prep



- Vega is not an isolated case!
- Non-detections have a “healthy” behaviour
 - Detection is not an instrumental effect!
- Akeson *et al*: two more candidates (A2V, A3V)



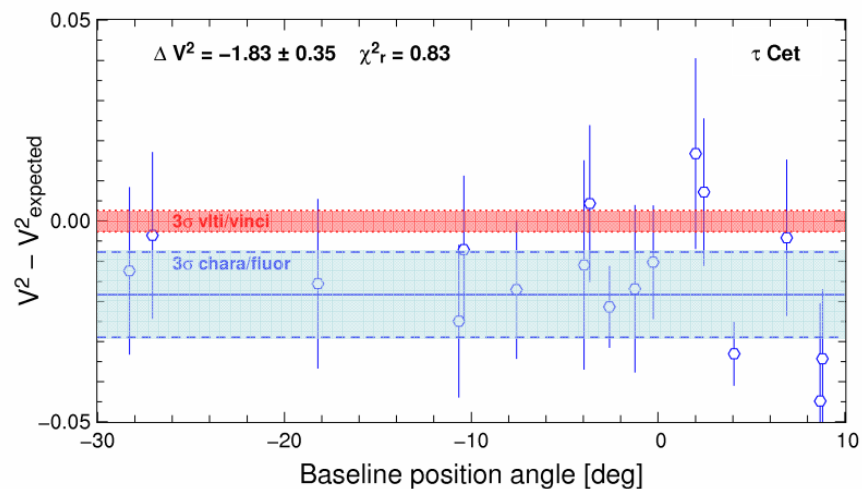
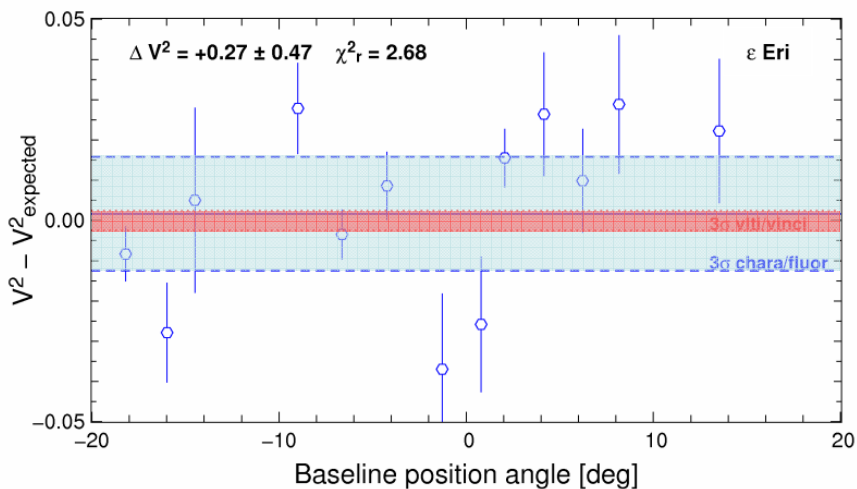
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Survey: solar-type stars

Di Folco et al., in prep



- Suggests hot dust around τ Cet (~ 10 Gyr, G8V)
- Where does all this dust come from?
 - Small \rightarrow very short lifetime (radiation pressure)
 - Need high replenishment rate





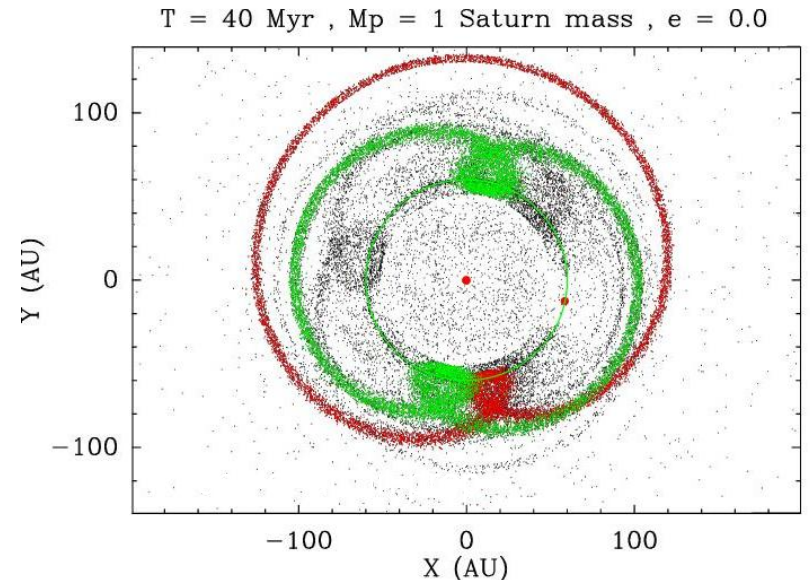
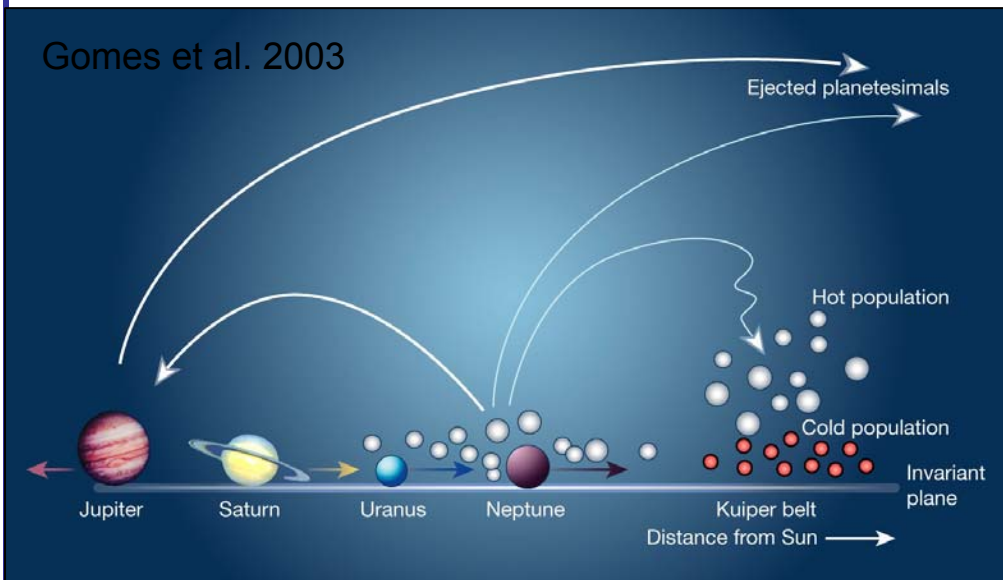
Origin of the dust

- 1st scenario: Falling Evaporating Bodies
 - Proposed for β Pic (Beust & Morbidelli 2000)
 - Local disc perturbation by a planet
 - Production of star-grazing comets
 - Needs replenishment (migration?)
- In the case of Vega: production rate is equivalent to the daily fall of 13 Hale-Bopp comets !



Origin of the dust

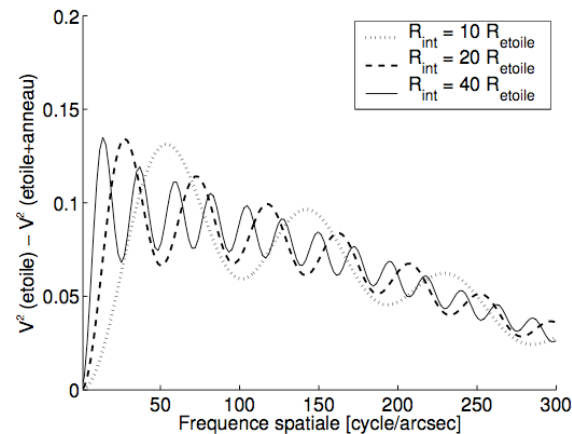
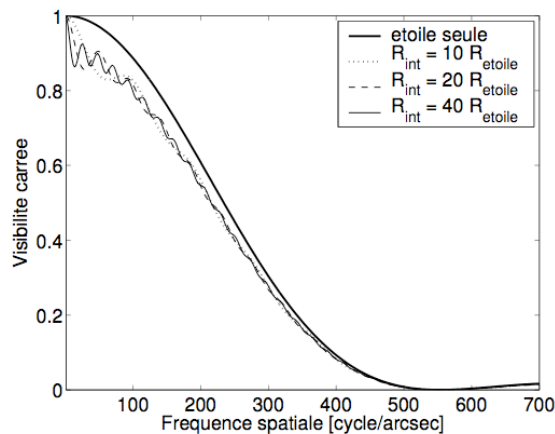
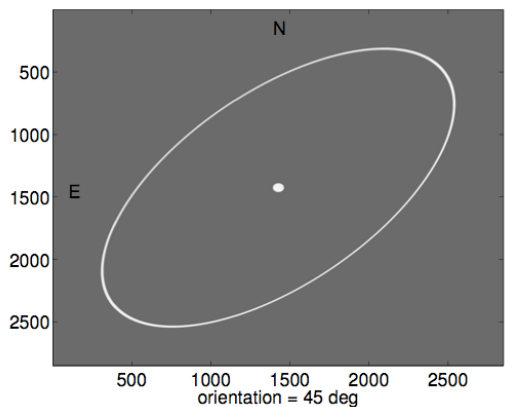
- 2nd scenario: Late Heavy Bombardment
 - Dynamical re-arrangement of planets
 - Global disc perturbation
 - Bodies from asteroid belt and Kuiper belt





Perspectives with CHARA

- Extend the survey (but there are only so many stars)
 - Prevalence of warm dust as a function of stellar characteristics
 - Return in a few years
- Lift modelization degeneracy through:
 - Spatial characterization (need fine (u,v) sampling)
 - Spectral characterization (FLUOR+prism; H band?)



E. di Folco, PhD thesis (2004)



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Asteroseismology of red giants

- Red giant asteroseismology gives a unique opportunity to probe the interior of these evolved stars:
 - Large radii
 - Extremely dense cores
 - Hydrogen-shell or helium-core burning shell
- Objective: combine asteroseismologic data and *linear* diameter for full characterization of stellar structure
- Two sources successfully observed last summer:
 - Eps Oph (diameter only) + *MOST photometric data*
 - 58 Ser (diameter + limb darkening) + *CORALIE, ELODIE data*
- Work in progress...



Papers

- Published since last year's meeting:
 - *Circumstellar material in the Vega inner system revealed by CHARA/FLUOR.* O. Absil et al., *A&A* **452**, 237 (June 2006)
 - *Extended envelopes around Galactic Cepheids. II. Polaris and δ Cephei from near-infrared interferometry with CHARA/FLUOR.* A. Mérand et al., *A&A* **453**, 155 (July 2006)
 - *First Results from the CHARA Array. VII. Long-Baseline Interferometric Measurements of Vega Consistent with a Pole-On, Rapidly Rotating Star.* J. Aufdenberg et al., *ApJ* **645**, 664 (July 2006)
- Submitted or almost submitted:
 - *Near-IR interferometric survey of debris-disk stars: probing the hot dust content around τ Cet and ε Eri with CHARA/FLUOR.* E. di Folco et al., submitted to *A&A*
 - *Extended envelopes around Galactic Cepheids III. γ Oph and α Per from near-infrared interferometry with CHARA/FLUOR.* A. Mérand et al., submitted to *ApJ*
- In the writing phase (summer release date):
 - A-type stars debris disks (Absil et al.)
 - Diameters and asterosismology (Barban et al.)