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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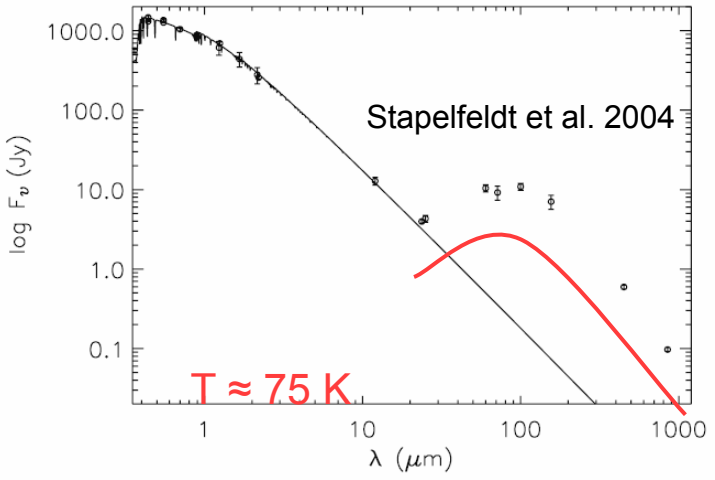
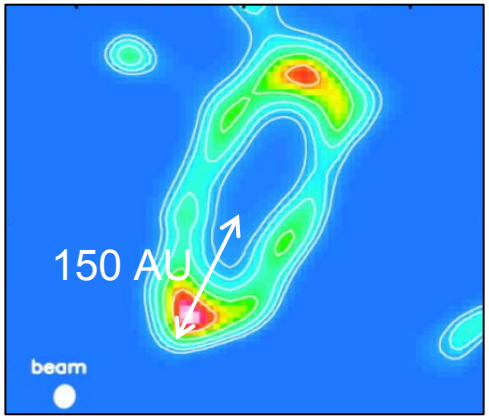
The quest for warm dust

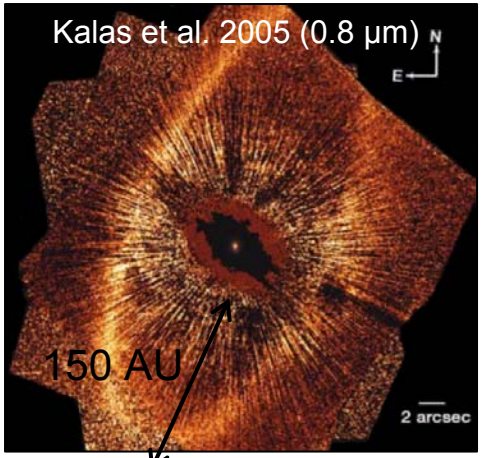
- Detected debris discs
  - Far-IR, sub-mm, visible
  - Cold and distant (~100 AU)
  - Massive (few 100 solar Kuiper belt)
  - Evidences for inner holes
- Zodiacal disc analogues?
  - Inner planetary region
  - Spitzer: first evidence for warm dust (~300 K)
  - Sensitivity ~ 1000 zodi!
- Goal: direct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



Marsh et al. 2005 (350 μm)



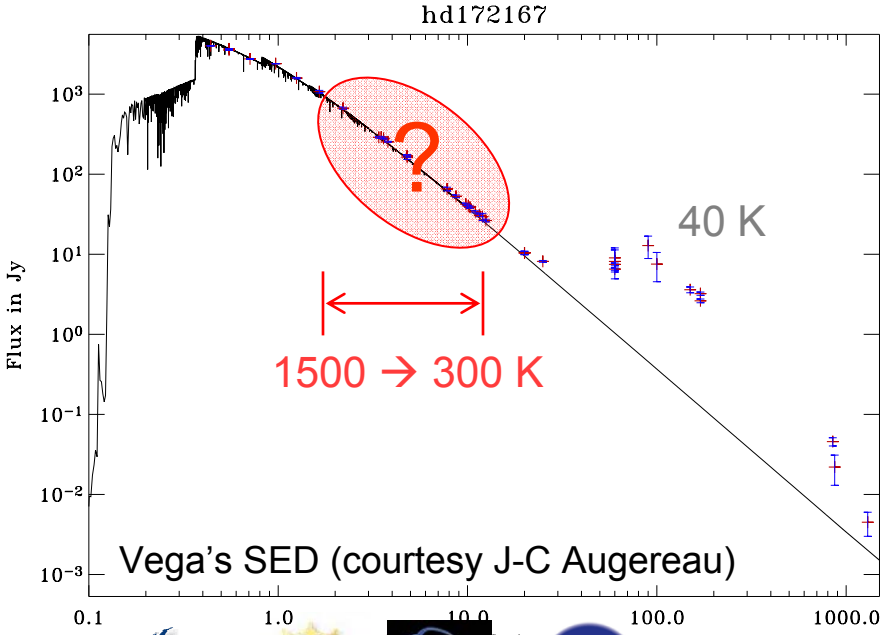
Kalas et al. 2005 (0.8 μm)

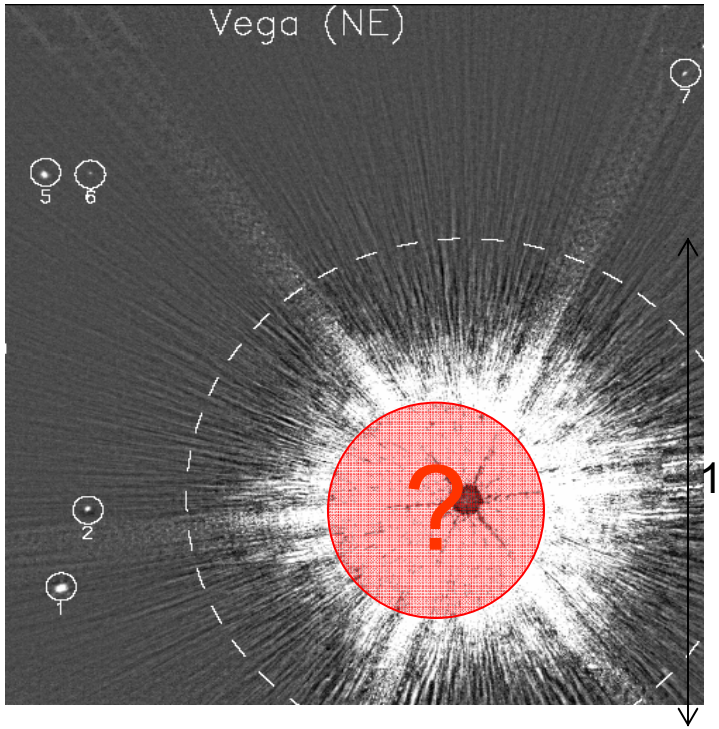


(150 AU ≈ 20'' at 7.7 pc)

Challenges of direct imaging

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

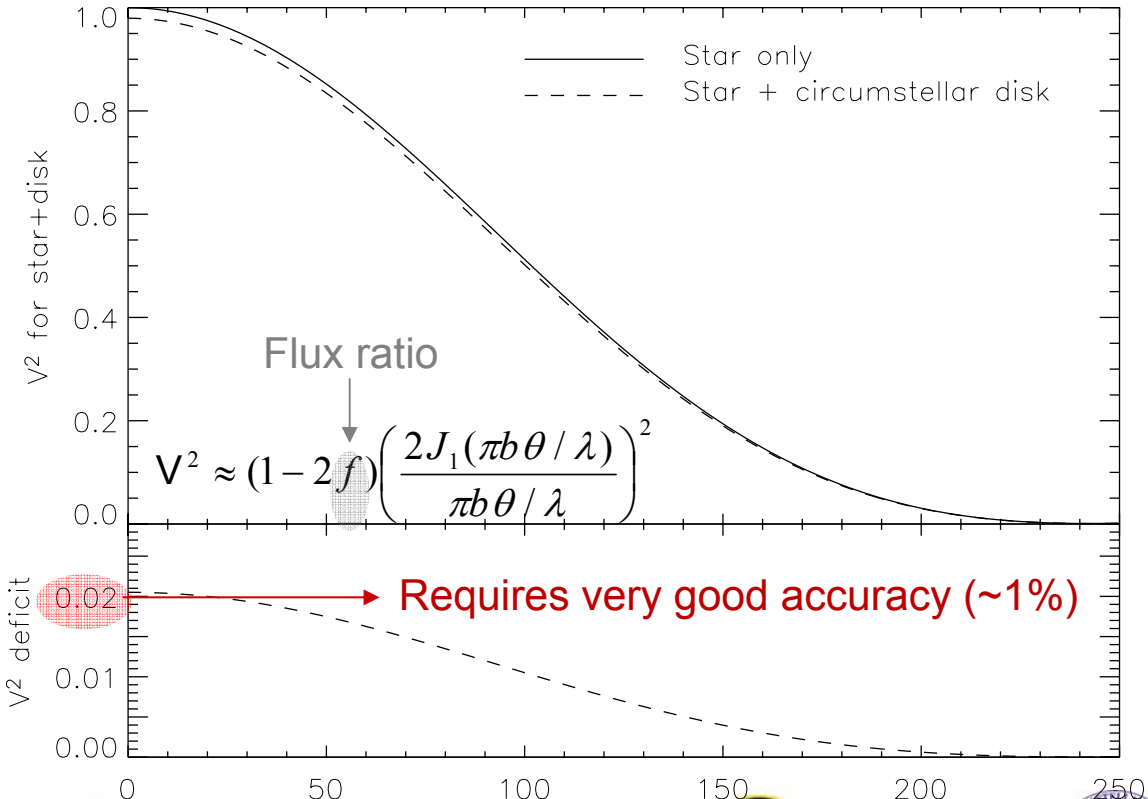




Macintosh et al. 2003 (Keck AO)

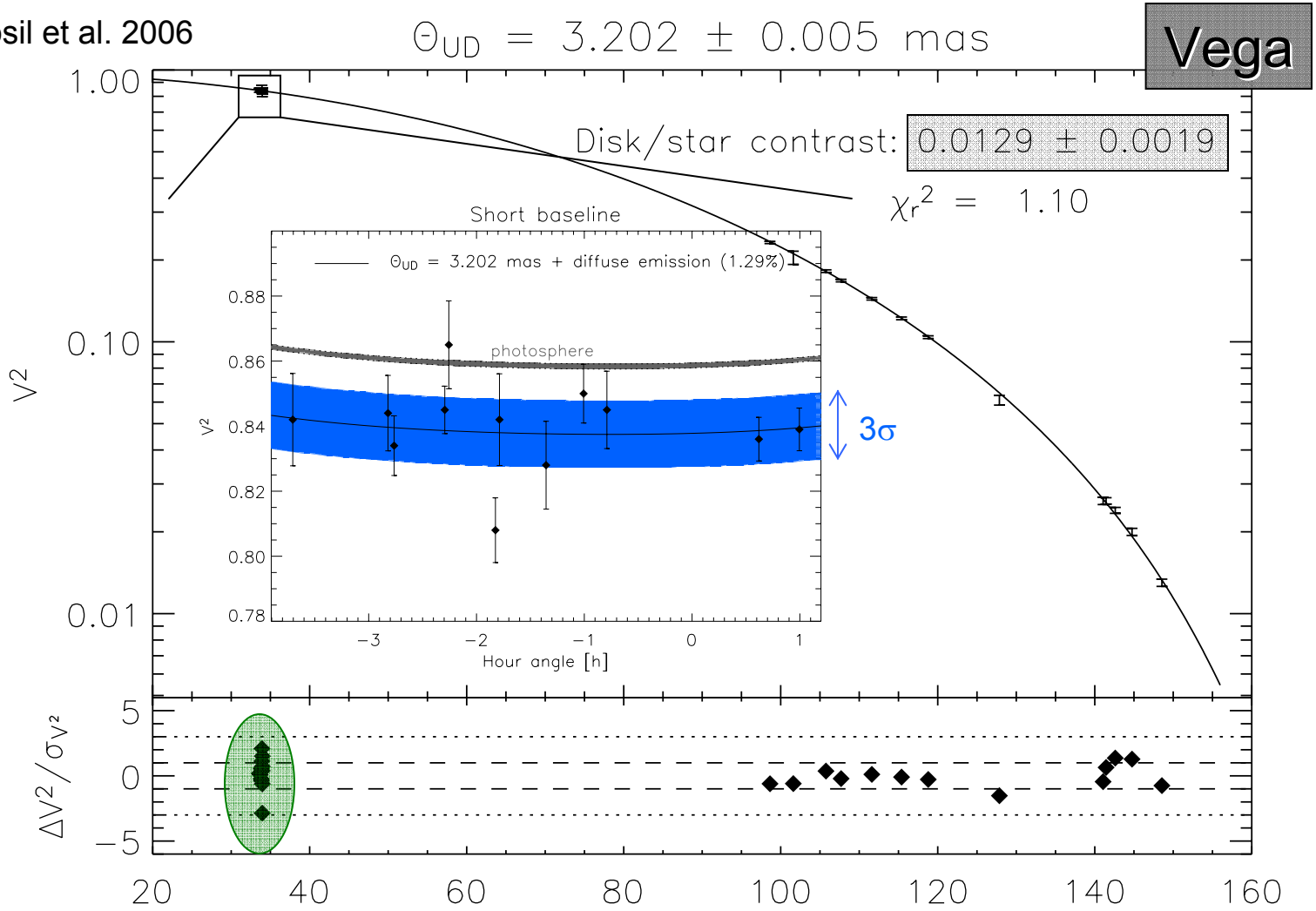
Debris discs by interferometry

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



Fitting photosphere + debris disc

Absil et al. 2006

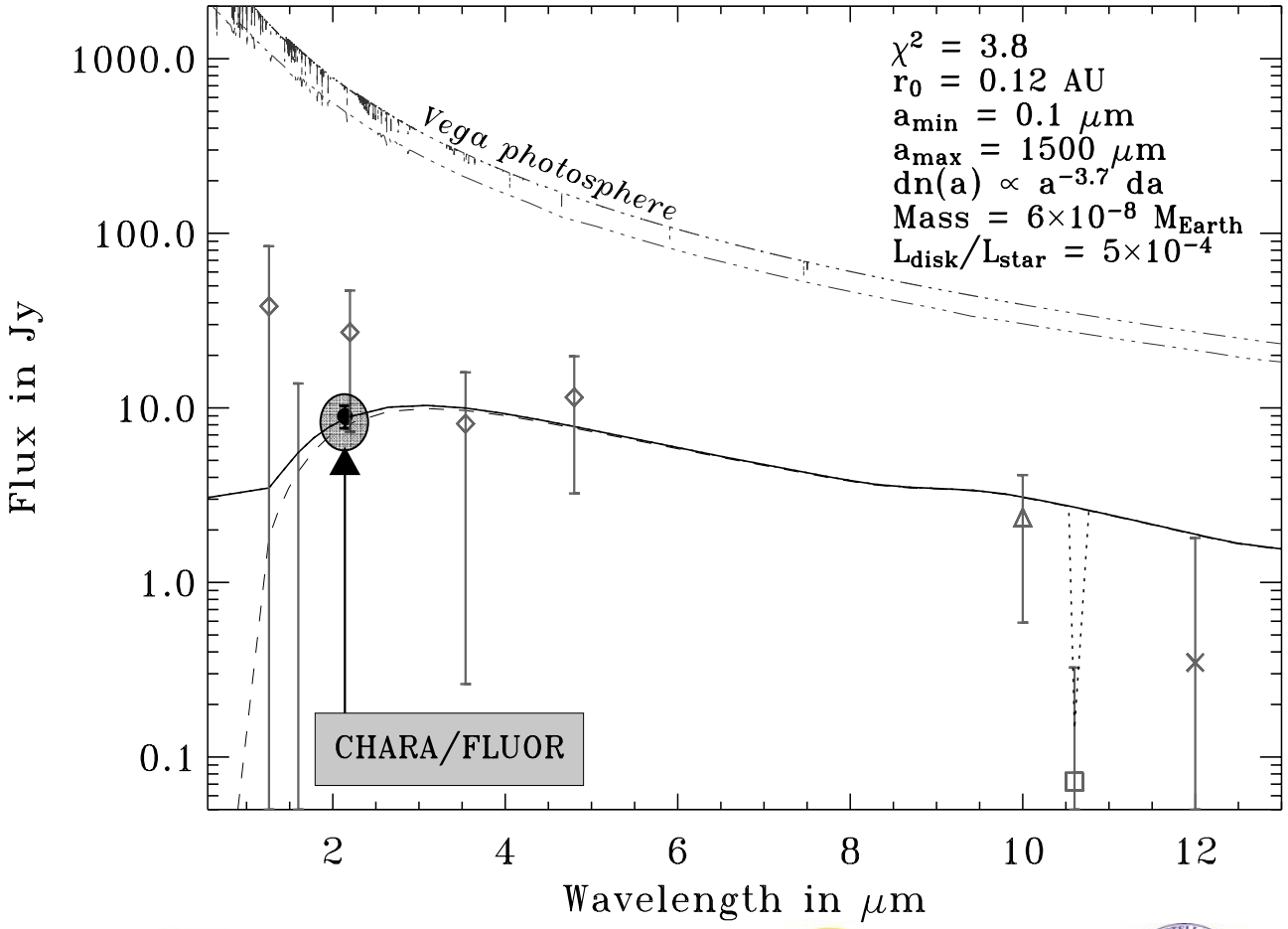


Possible origins of near-IR excess

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

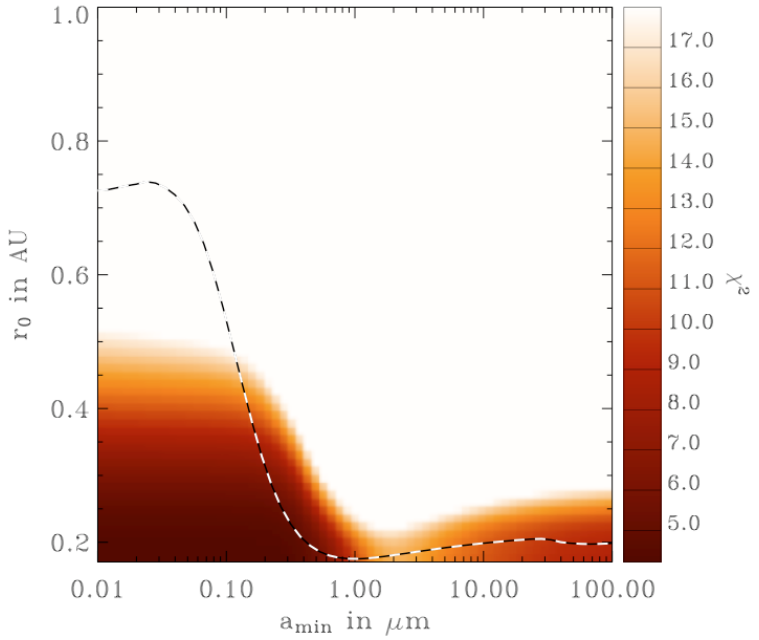
Fitting the global Vega SED

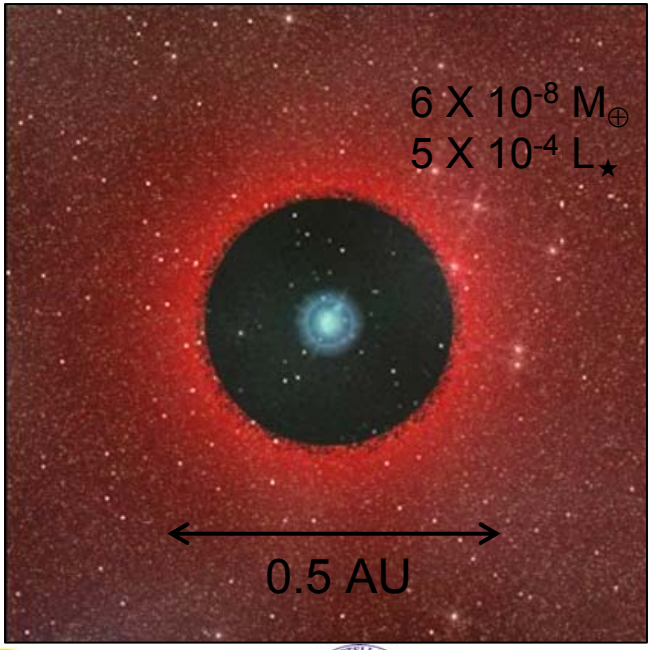
- Using the debris disc models of Augereau et al. (1999)



Best-fit disc properties

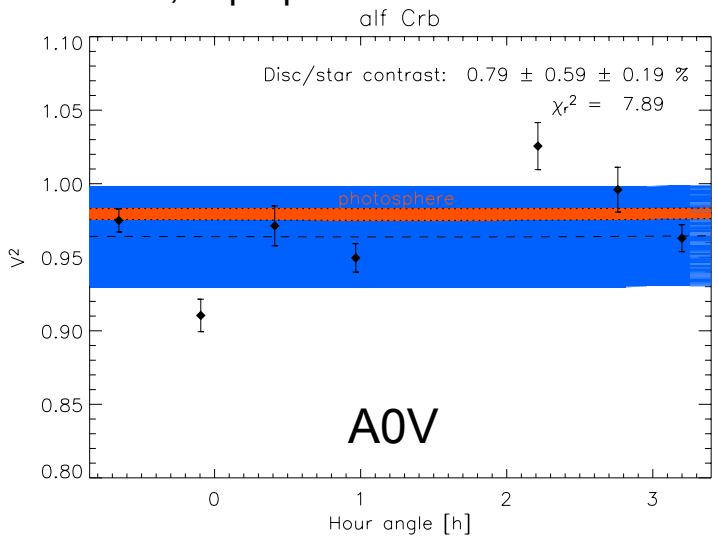
- Fitting procedure:
  - Various density power laws, size distributions & compositions
  - 2 fit parameters: minimum grain size (a_{min}) and inner radius (r_0)
- Small grains (mostly < 1 μm) at distances ~ 0.1 – 0.5 AU
- Highly refractive grains, no silicate feature → carbons ≥ 50%
- Steep density power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

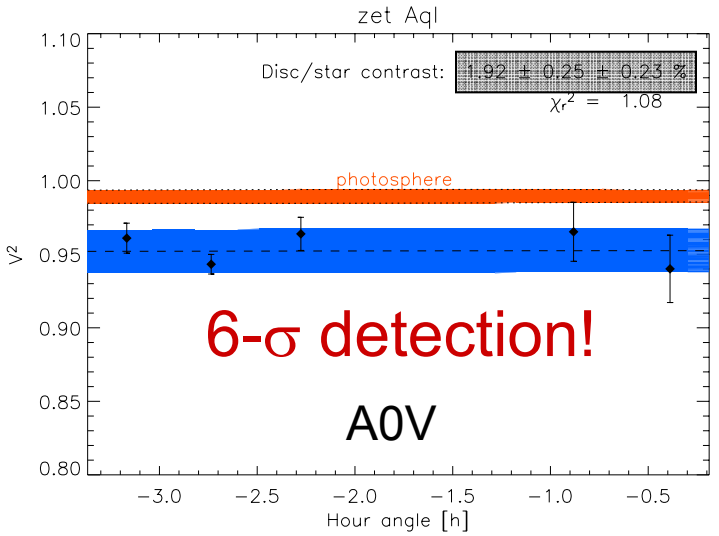


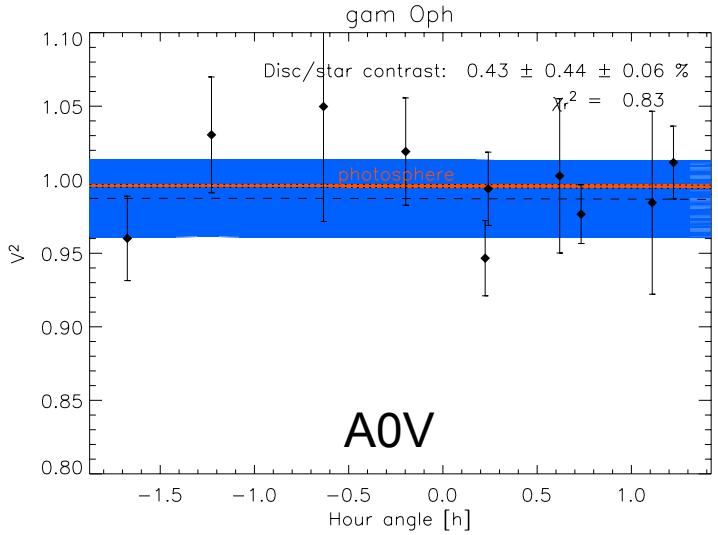


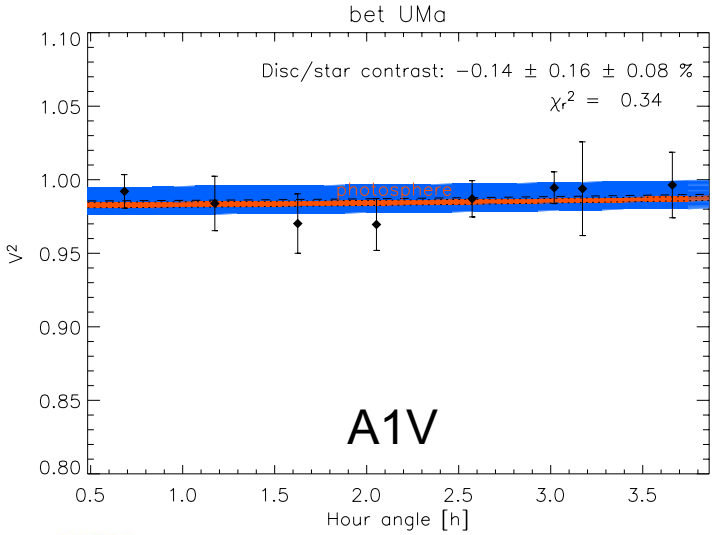
Survey: early-type stars

Absil et al., in prep









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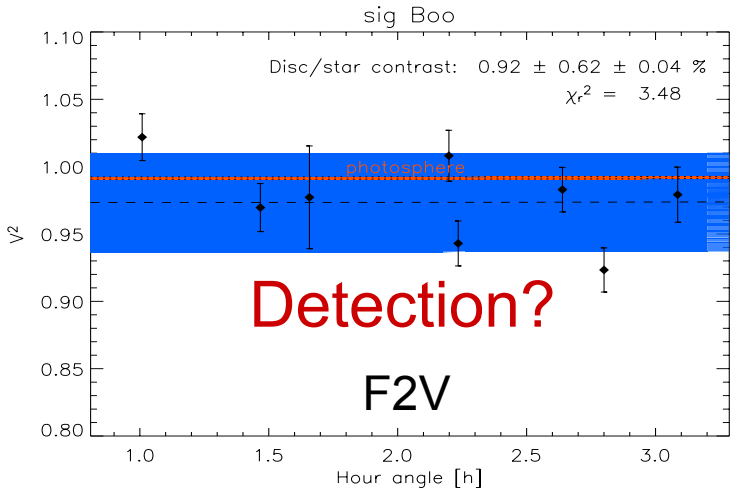
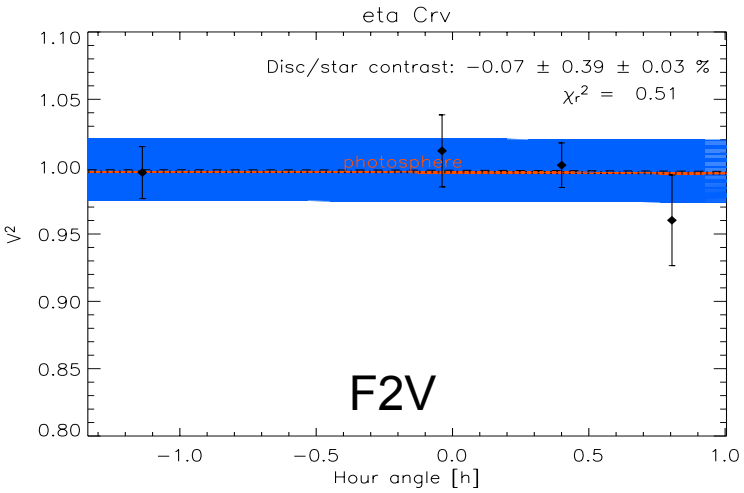
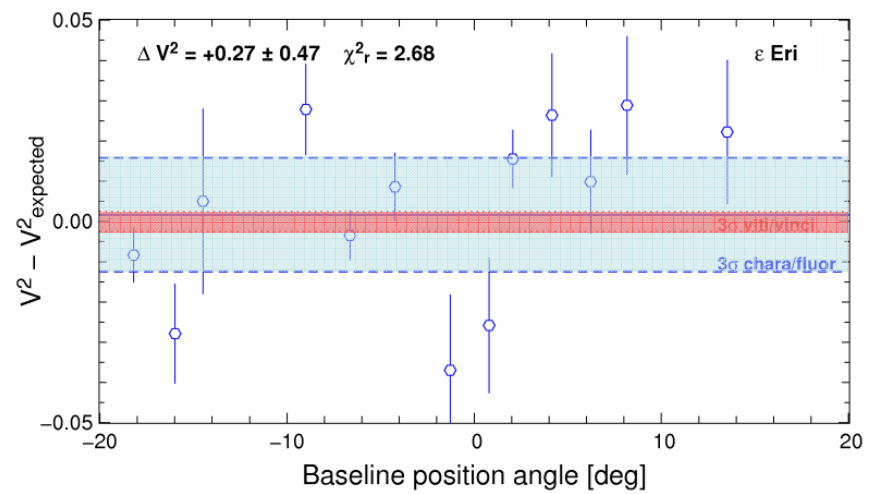


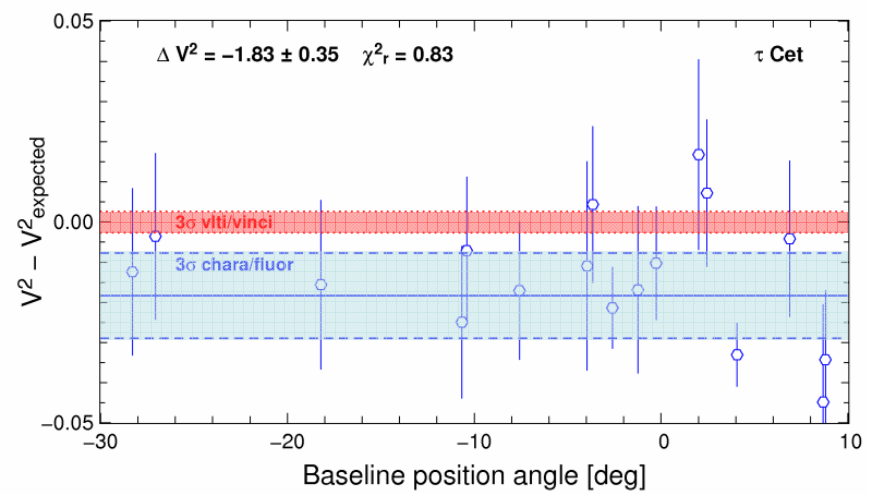


- Vega is not an isolated case!
- Non-detections have a “healthy” behaviour
  - Detection is not an instrumental effect!
- Akeson *et al*: two more candidates (A2V, A3V)

Survey: solar-type stars

Di Folco et al., in prep





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

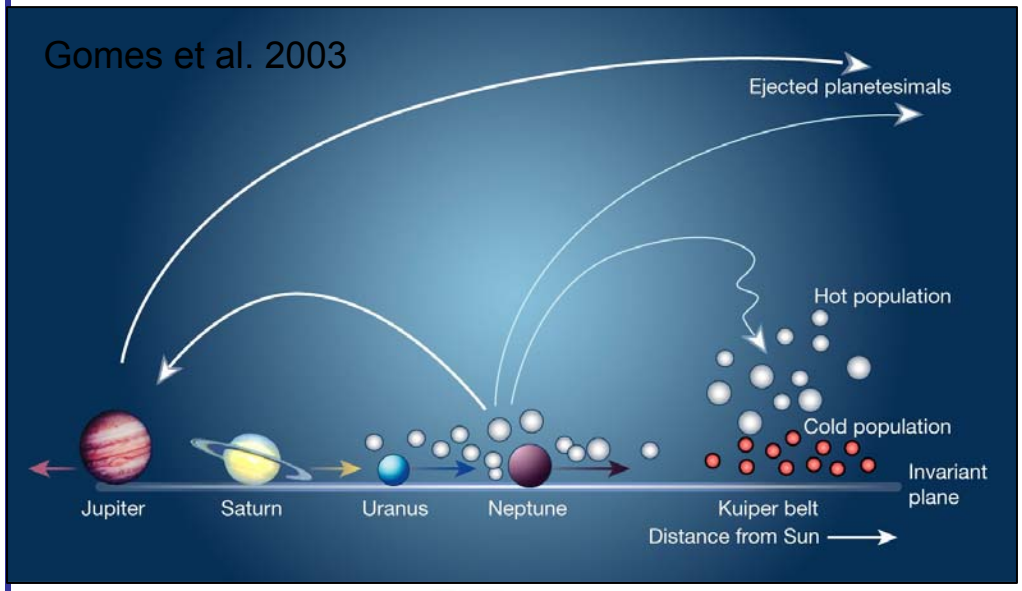
Origin of the dust

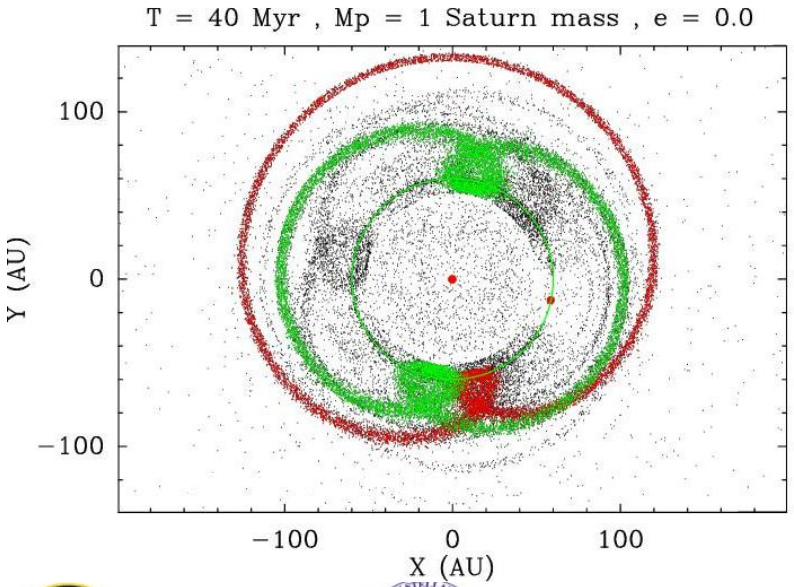
- 1st scenario: Falling Evaporating Bodies
  - Proposed for β Pic (Beust & Morbidelli 2000)
  - Local disc perturbation by a planet
  - Production of star-grazing comets
  - Needs replenishment (migration?)

  - In the case of Vega: production rate is equivalent to the daily fall of 13 Hale-Bopp comets !

Origin of the dust

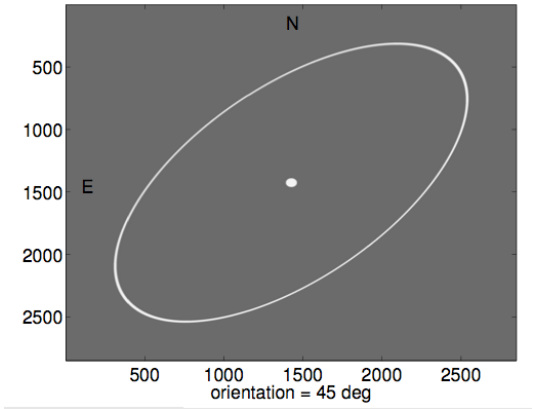
- 2nd scenario: Late Heavy Bombardment
  - Dynamical re-arrangement of planets
  - Global disc perturbation
  - Bodies from asteroid belt and Kuiper belt

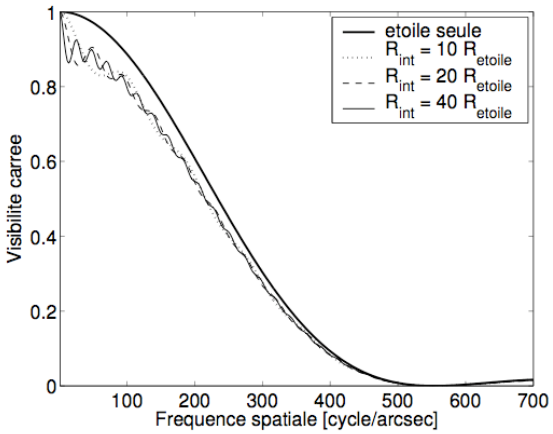


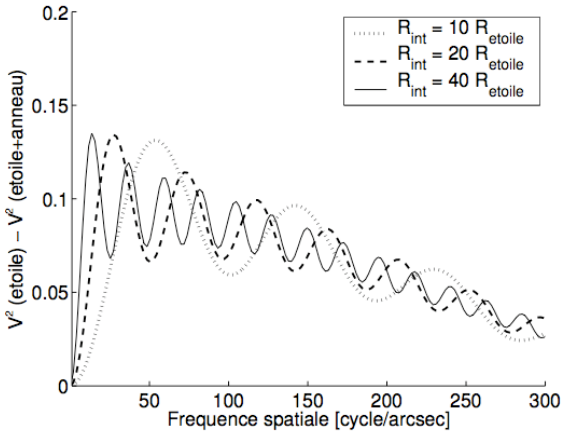


Perspectives with CHARA

- 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)

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 d 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. Y 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.)