

Debris discs: hot dust revealed by IR interferometry



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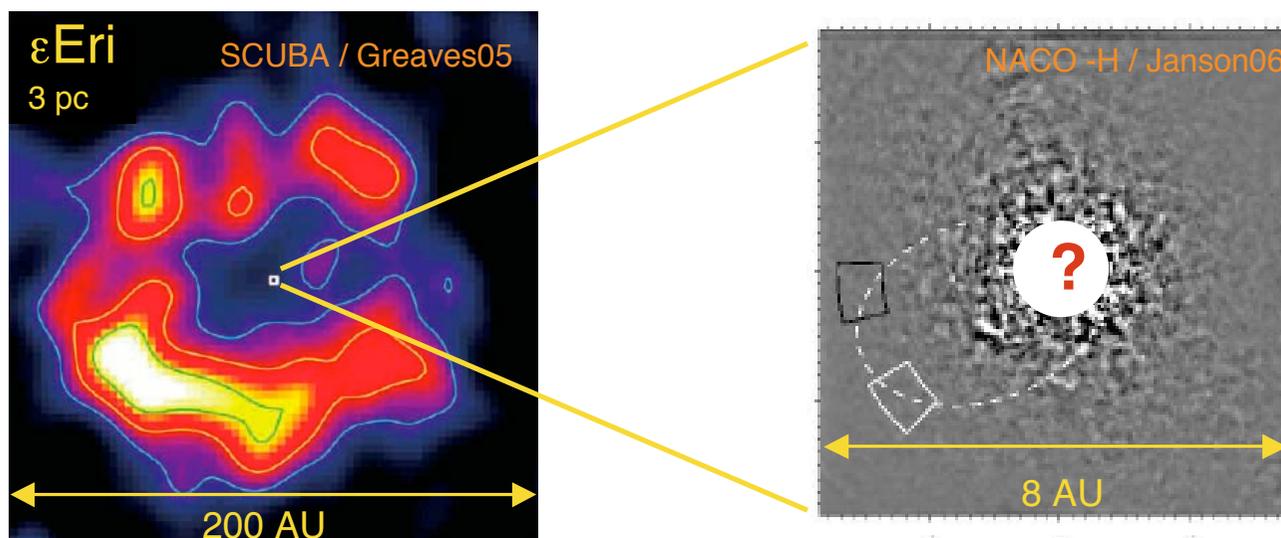
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The quest for exo-zodiacal warm dust

Spitzer photometry (Bryden 06, Beichman 06, Chen 06)

- Positive detections < 2.5% of 1-10Gyr sun-like stars at 10 μm
- Sensitivity threshold ~ 1000 Zodi $8 < \lambda < 24 \mu\text{m}$
- Absolute accuracy $\sim 2\text{-}5\%$ photospheric flux

Direct Imaging



Needs: small FOV, high spatial resolution, high dynamics

Why look for warm exo-zodii ?

Dust grains distribution -> dynamics of the parent bodies

How common is our own solar system ?
How do planetary systems evolve ?

Requires information on :
morphology of dust exo zodi
composition of dust (multi- λ)

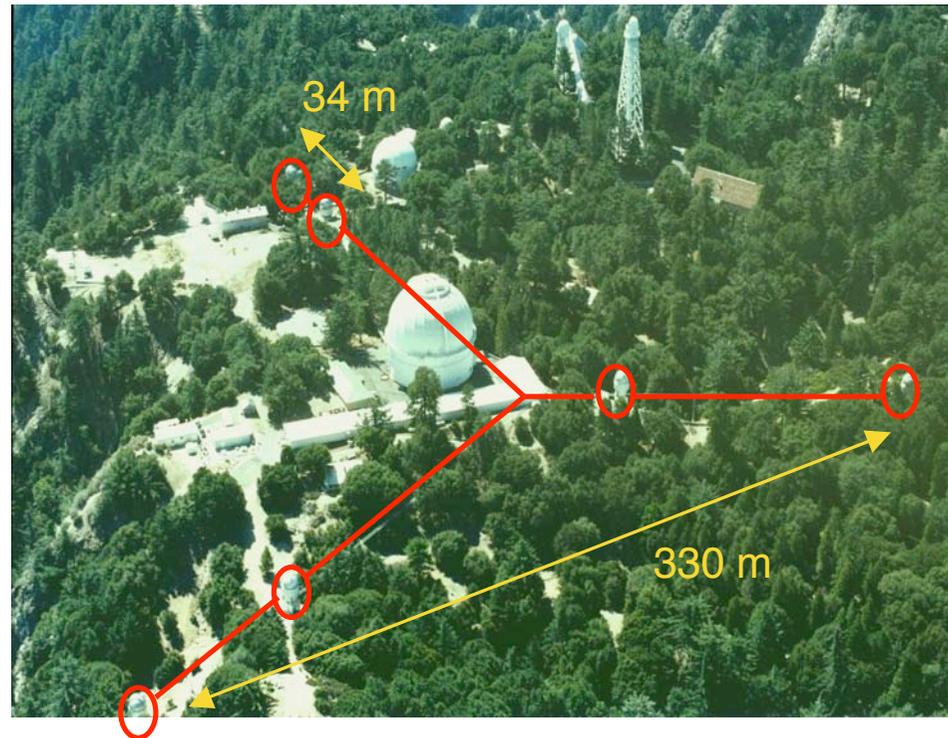
Prepare future exo-Earth imaging missions
(DARWIN / TPF1) -> Target selection ?



A survey of debris discs with CHARA/FLUOR

CHARA Array (Mt Wilson, CA)
6 1m-telescopes

FLUOR instrument
2-T combiner, 2.2 μm fiber-filtered
high precision visibility



Survey of MS stars ($K < 4$) with known, cold debris discs

ϵ Eri
K2V

τ Cet
G8V

σ Boo η Crv
F2V

⋮

β UMa
A1V

Vega ζ Aql
 α CrB γ Oph
A0V

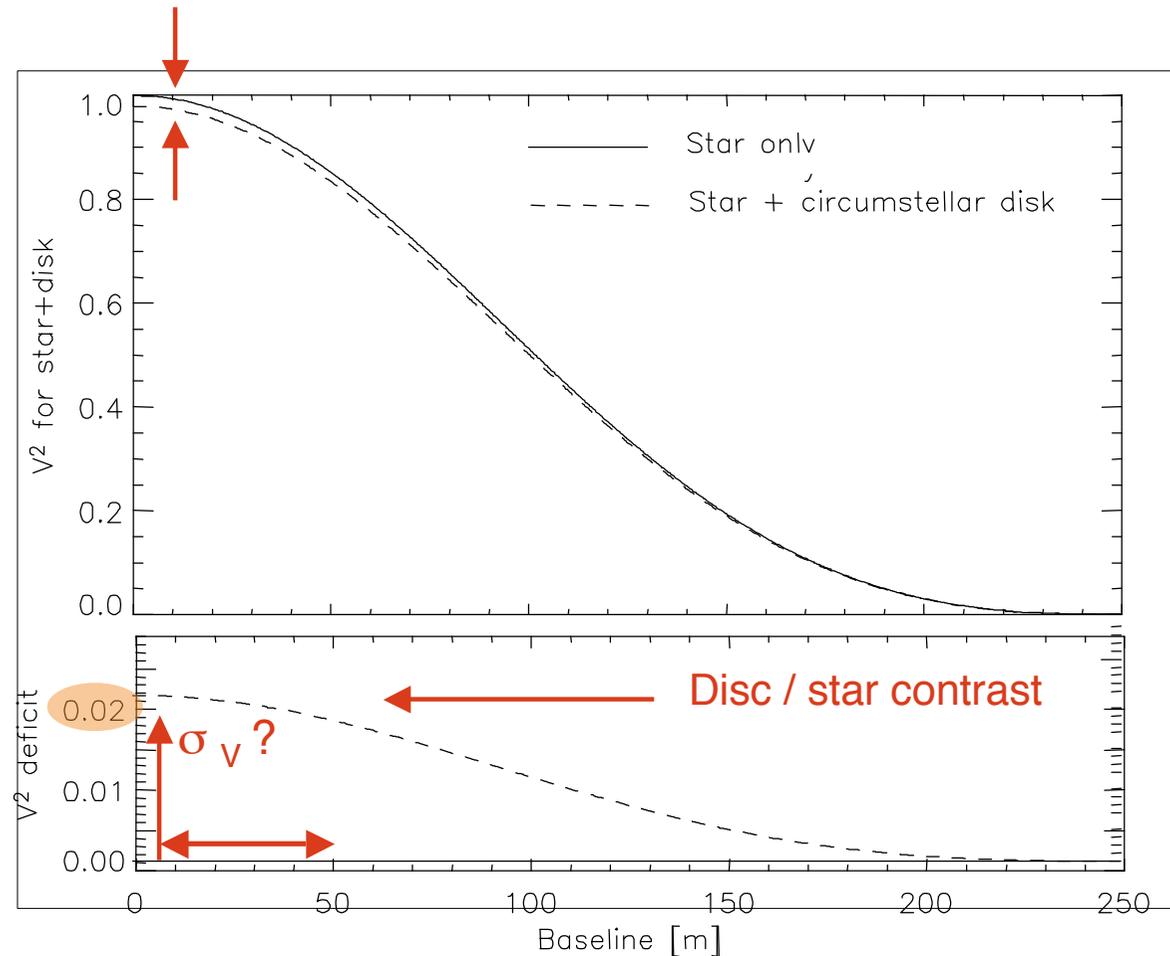


IR interferometry: towards high contrast imaging

FOV = Airy disk $\sim \lambda / D$ (5AU @ 10 pc)

Disc extended emission induces a

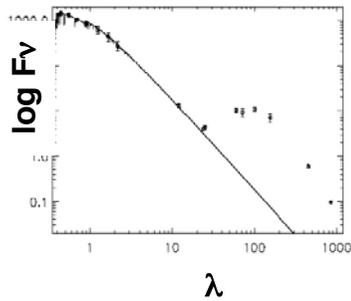
Visibility drop, best detected at short baselines



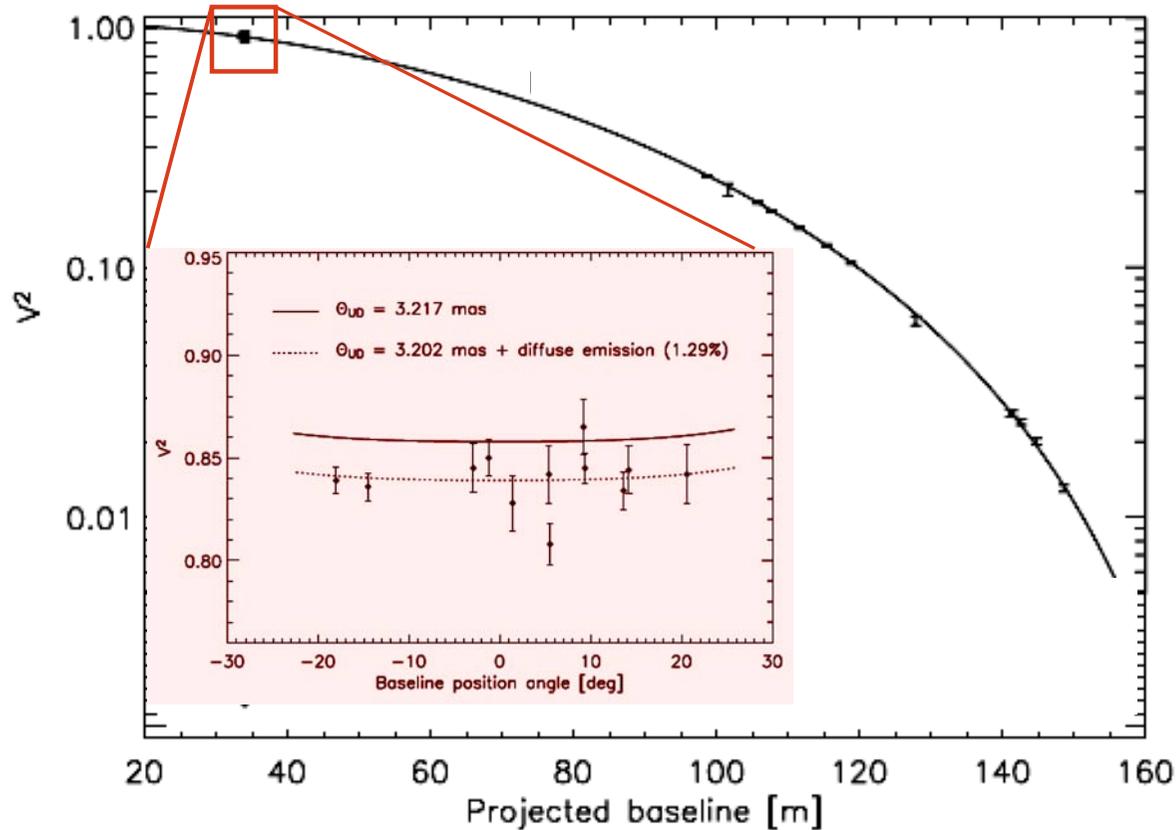
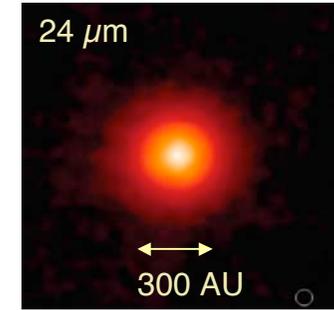
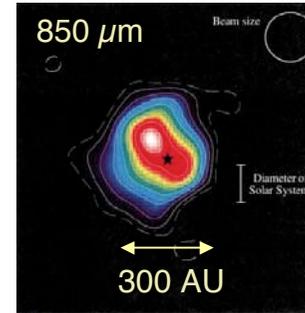
Direct measurement of the contrast ('w/o absolute calibration')

Vega: the first detection

Absil et al. 2006



Vega:
fast rotating A0V
7.7 pc ~300 Myr



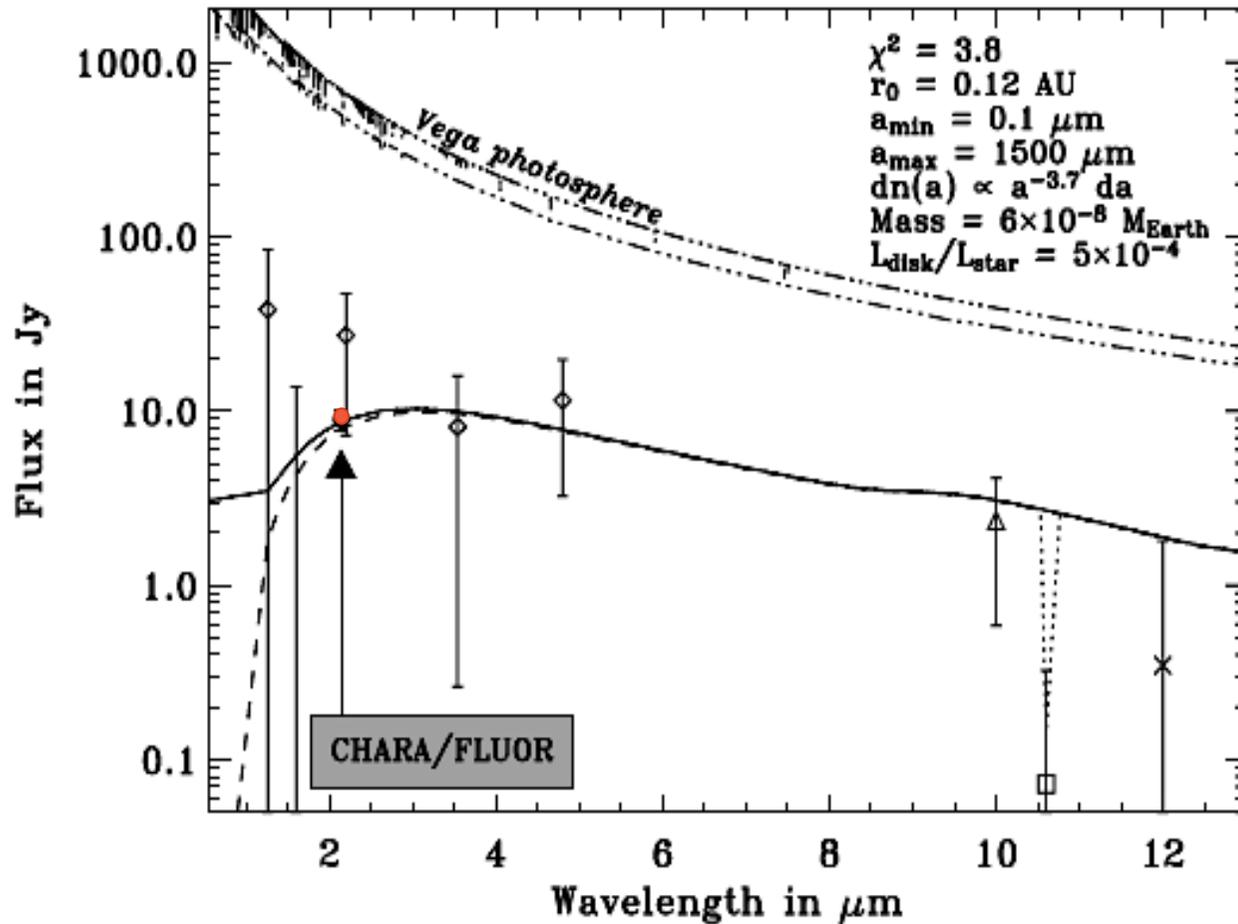
Detected excess:

$$f_K = 1.29 \pm 0.2 \cdot 10^{-2}$$

Origin:

- background object ?
- bound companion ?
- stellar wind ?
- hot dust grains ?

Vega: modeling the hot dust grains



Model Augereau (1999)

- ✓ Sub-micron grains
- ✓ Steep distribution close to sublimation distance
- ✓ Carbon/Si > 50%
- ✓ $M_{\text{dust}} \sim 10^{-8} M_{\oplus}$

Large amount of small grains: 10 Hale-Bopp comets/day !?
Origin? LHB-like phenomenon ? (see also Wyatt 07)

τ Ceti & ε Eridani: two sun-like stars

τ Ceti

G8V

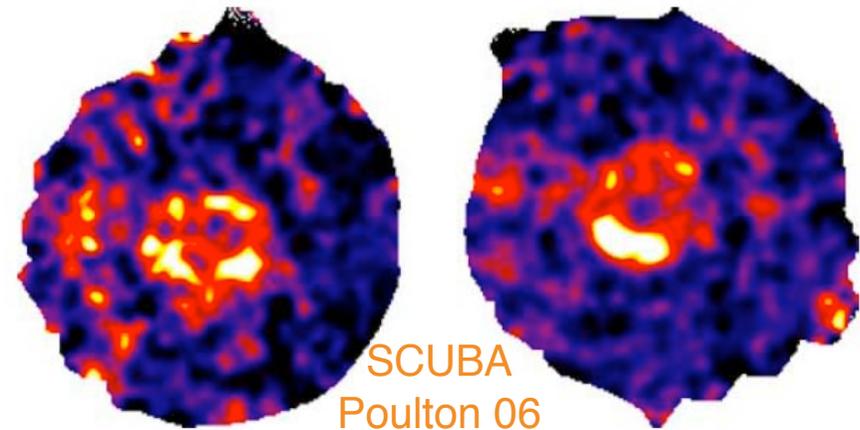
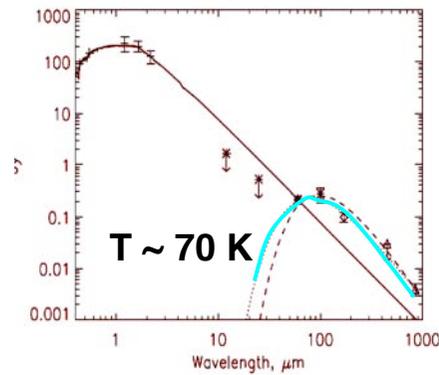
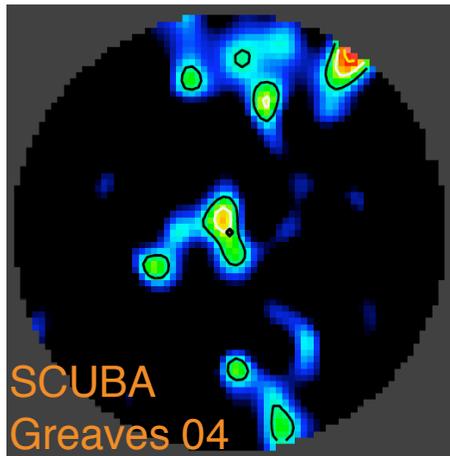
3.6 pc, ~ 10 Gyr

ε Eridani

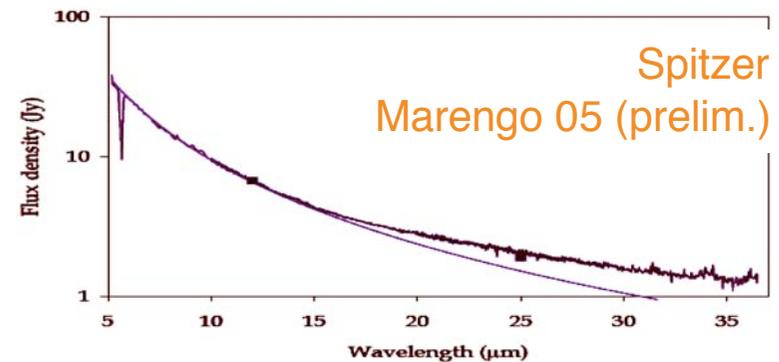
K2V (active)

3.2 pc, ~ 0.5 Gyr

+1 Jupiter (Hatzes00, Benedikt06)

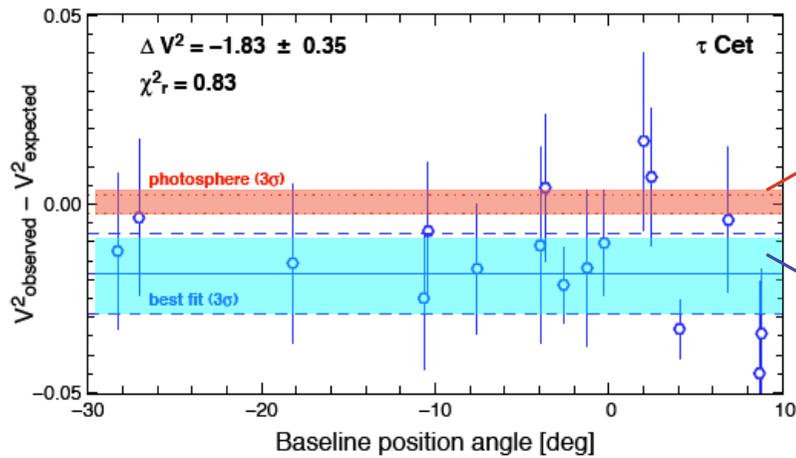
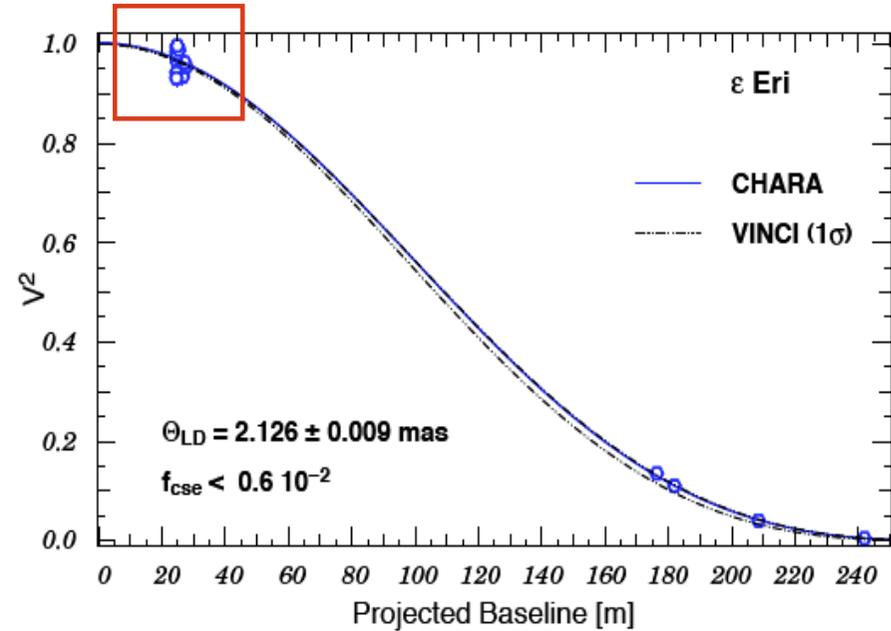
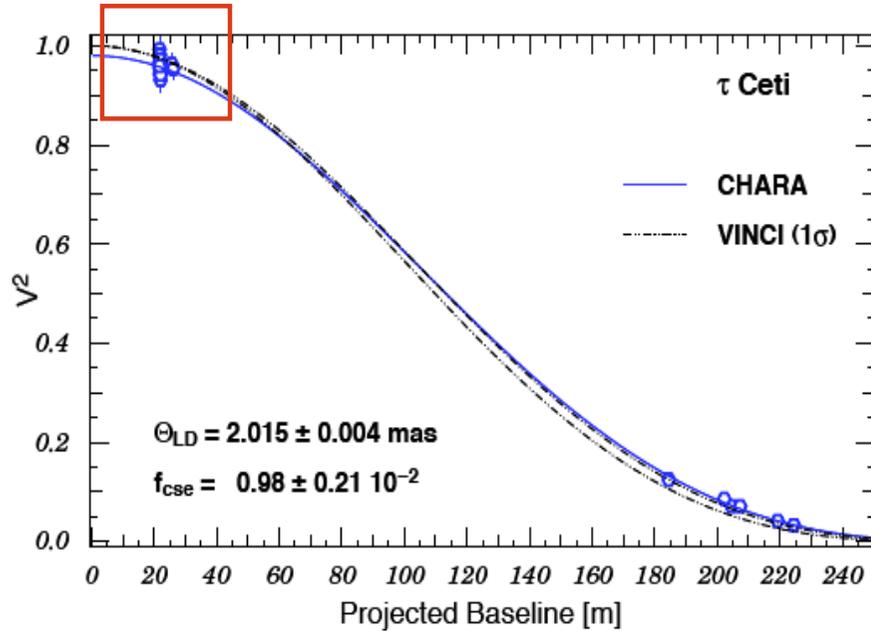


Spitzer 8-24 μm
Consistent with photospheric
Chen 06



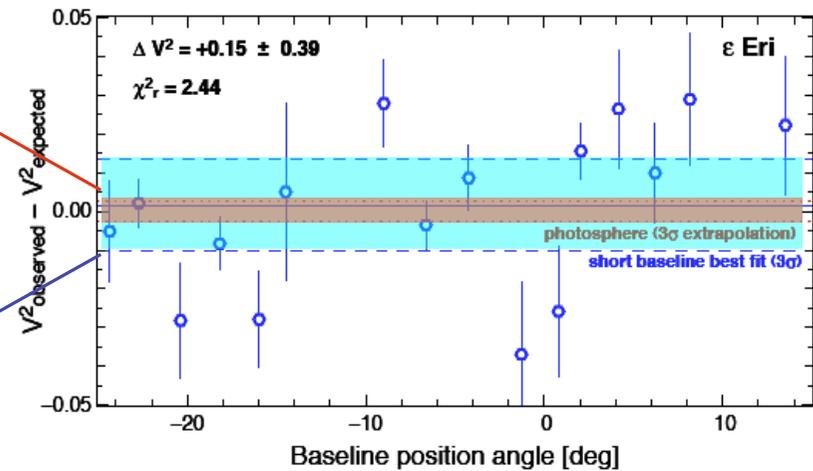
Hot zodiacal dust around τ Ceti

Di Folco et al. in press



3 σ

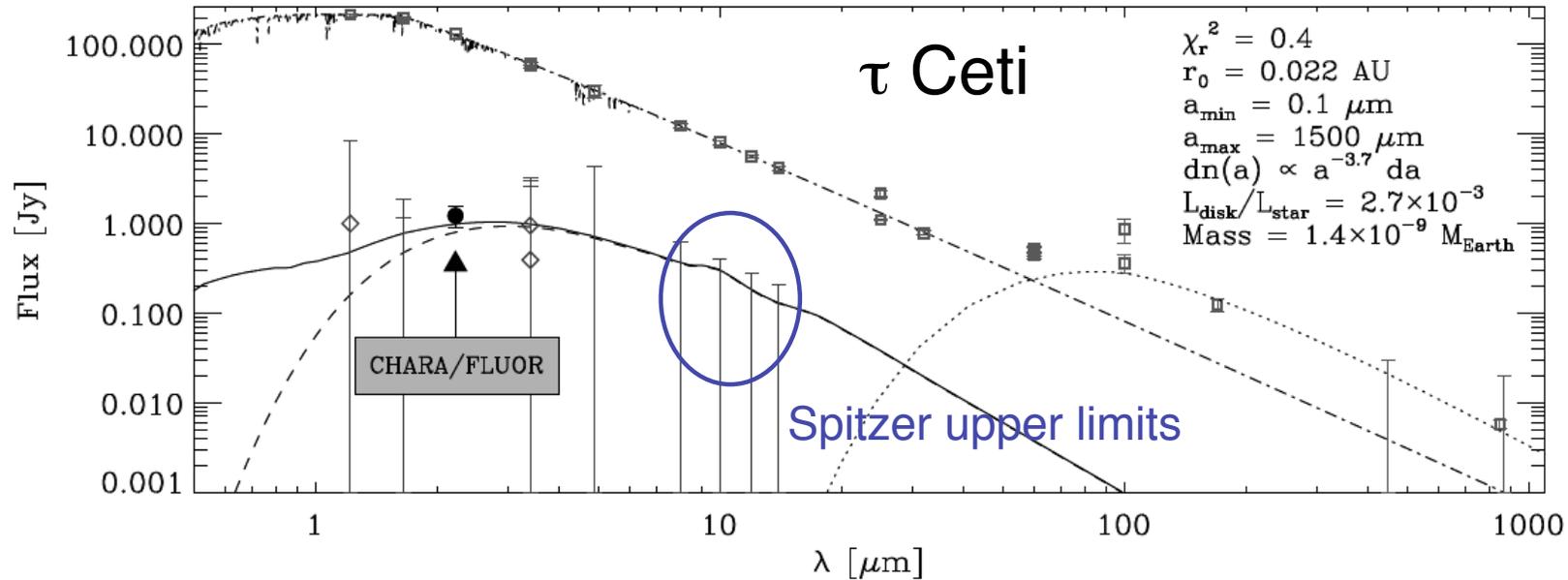
3 σ fit



$f_{d/*} = 0.98 \pm 0.21 \%$

$f_{d/*} < 0.6 \%$

Dust properties: from observation to modeling



Excess $\sim 10^3$ Zodi at $2\mu\text{m}$

$10/2 \mu\text{m}$ excess \rightarrow grain size, composition, distribution

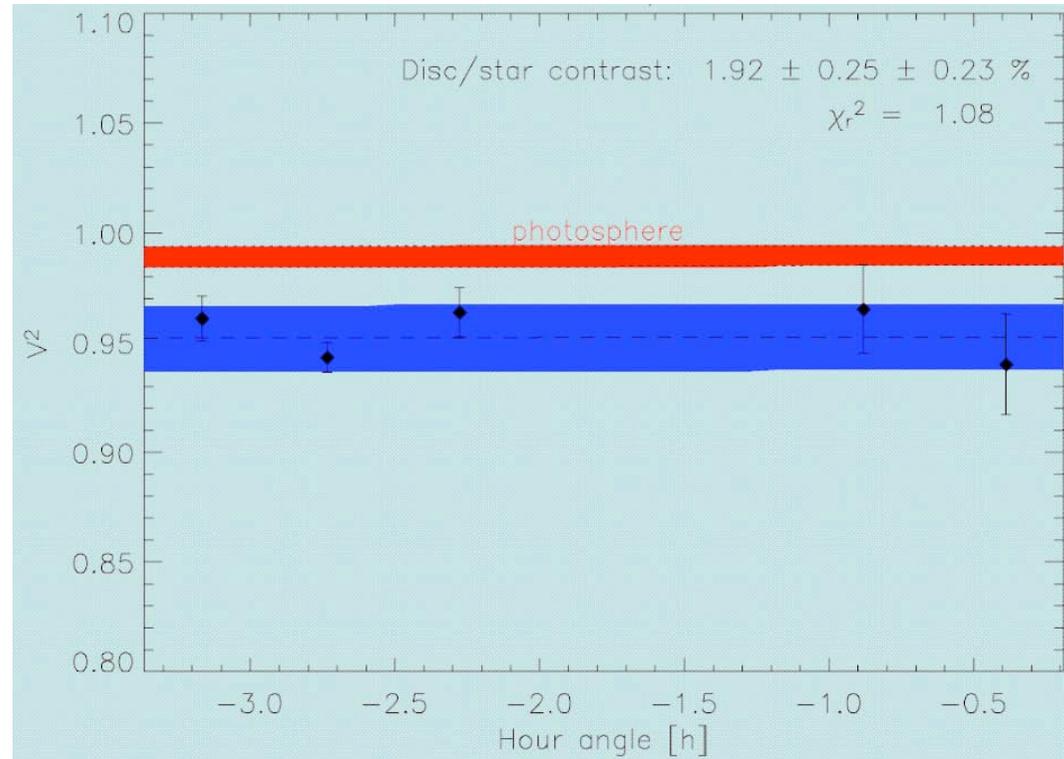
Small grains are favored (but degeneracy)

Density as steep as r^{-4} (solar system: $r^{-0.4}$ with $10\text{-}100\mu\text{m}$ grains)

The zodiacal cloud around τ Ceti departs from solar system scheme

ζ Aql: another A-type star with 6σ detection

Absil et al. in prep.



$f_{d/\star} = 1.92 \pm 0.35 \%$
Interpretation in progress !

Is Vega still an anomaly ?!

Conclusion & Perspective

Detections: $f_{d/\star} \sim 1\text{-}2\%$; $\sigma_f \sim 0.2\%$ ~ 200 zodi
10 x better than $2\mu\text{m}$ -photometry

Statistics: 3 / 9 positive detections
A-stars: Vega, ζ Aql + 3 non detections
FGK-stars: τ Cet + 3 non detections

Multi- λ approach (leverage of wavelength differential)
-> more precise $10\mu\text{m}$ measurements = KIN / MIDI?

Perspective: impact on exo-Earth detectability?
Spatial characterisation of dust grains
Correlation with far-IR excess or stellar properties
Criteria for favorable targets (DARWIN/TPF)?