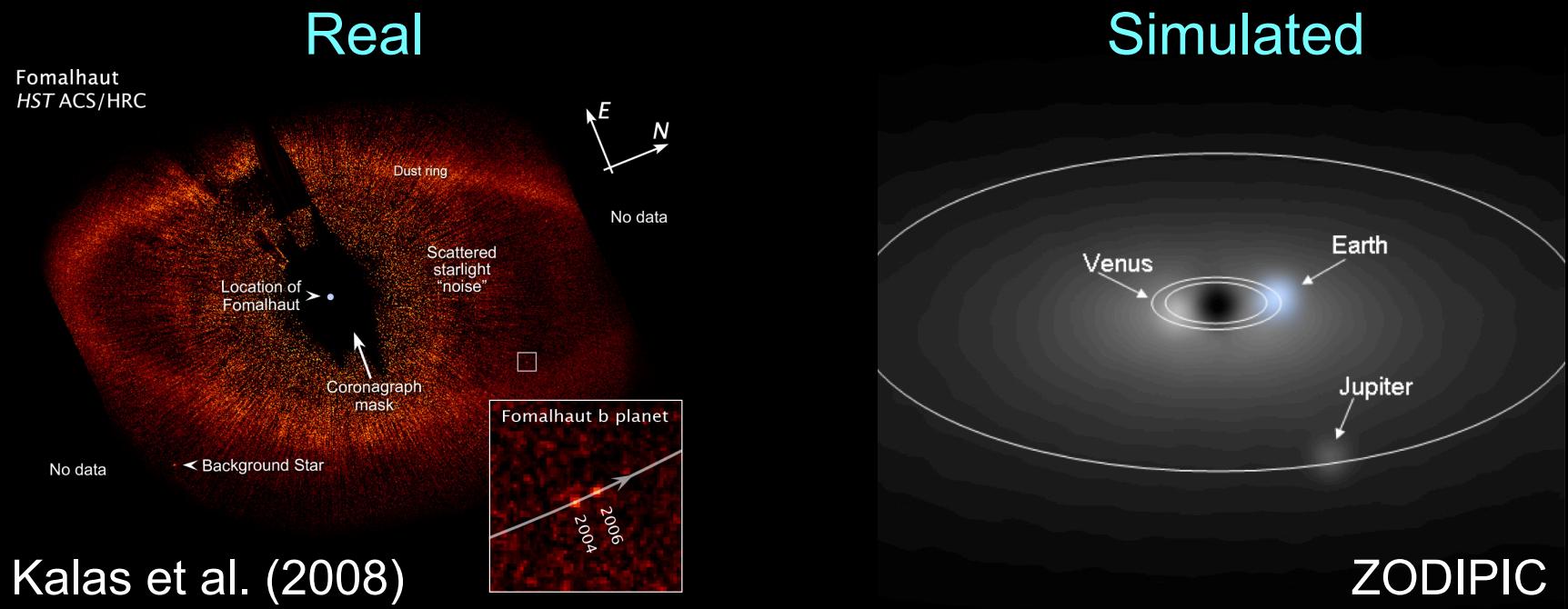


Exozodiacal Dust (aka. Debris Disks)

Aki Roberge (NASA GSFC)



Debris Disks

AU Mic – 12 Myr

Krist et al. (2004)



- Wide age range
- Gas-poor, low-mass dusty disks
 - Optically thin, short dust lifetimes
- Secondary material from asteroids & comets

Zodi and Exozodi

- Debris disk parameters
 1. Fractional IR luminosity
 $(L_{\text{IR}}/L_{\text{star}})$ → dust abundance
 2. Dust temp. → distance
- Solar System defines “1 zodi”
 - In practice, 1 zodi is
 $L_{\text{IR}}/L_{\text{star}} = 10^{-7}$
 - Beta Pic : $\sim 10,000$ zodis
- Solar System over last 100 Myr :
0.5 – 2 zodis (Kuchner & Farley 2010)

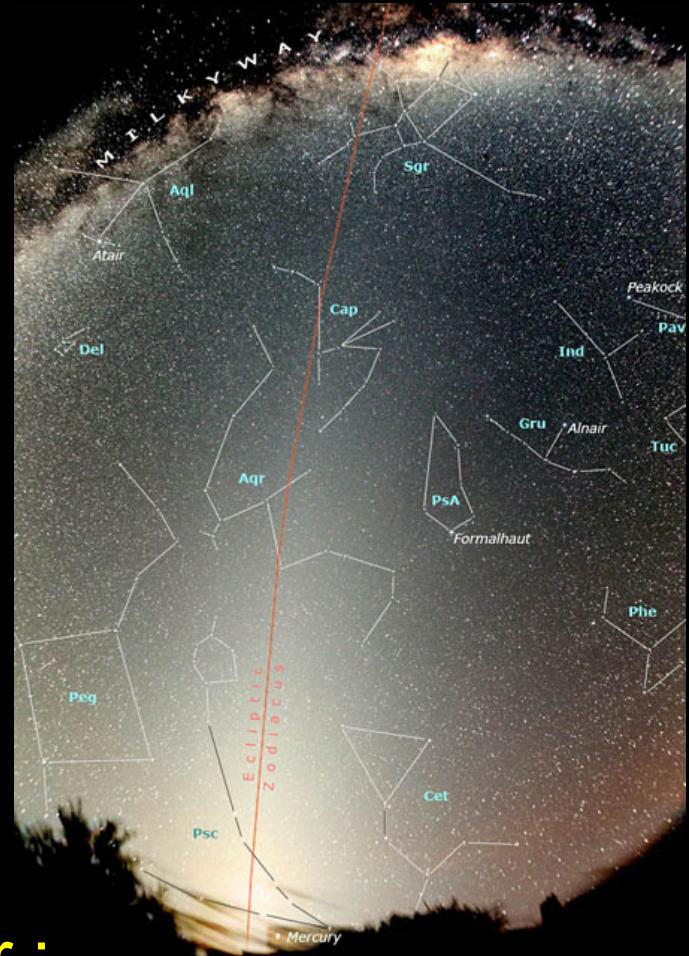
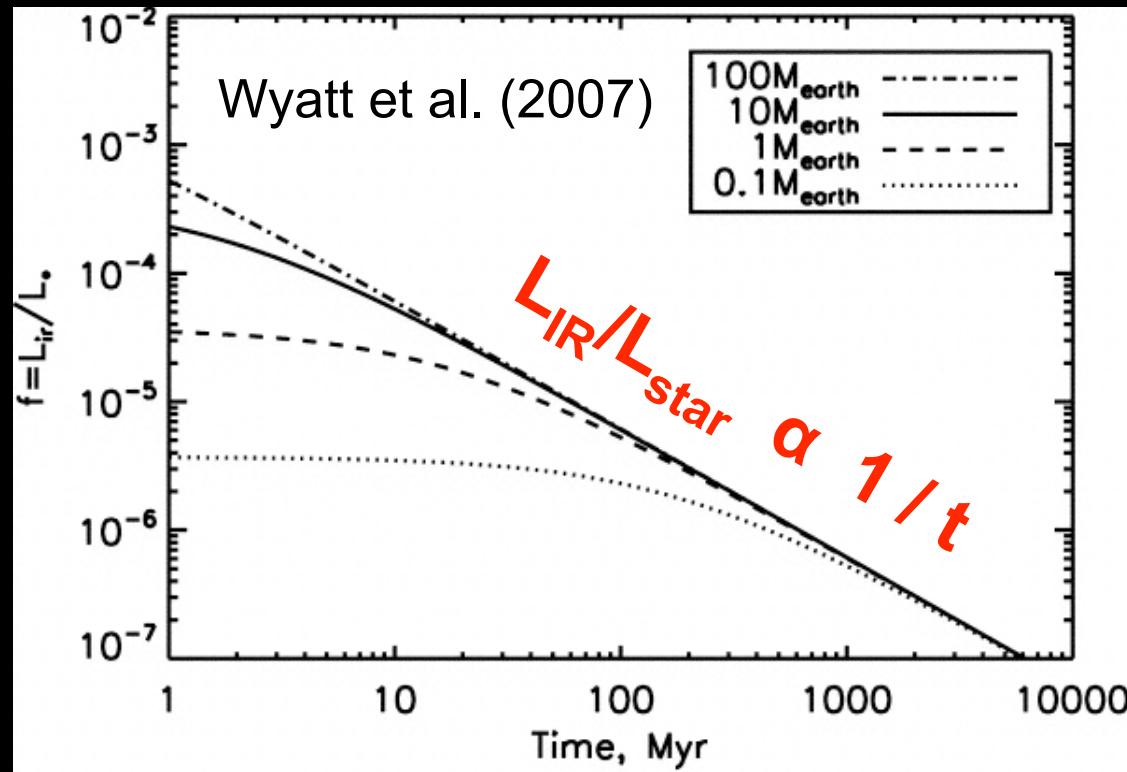


Image credit: Stefan Seip

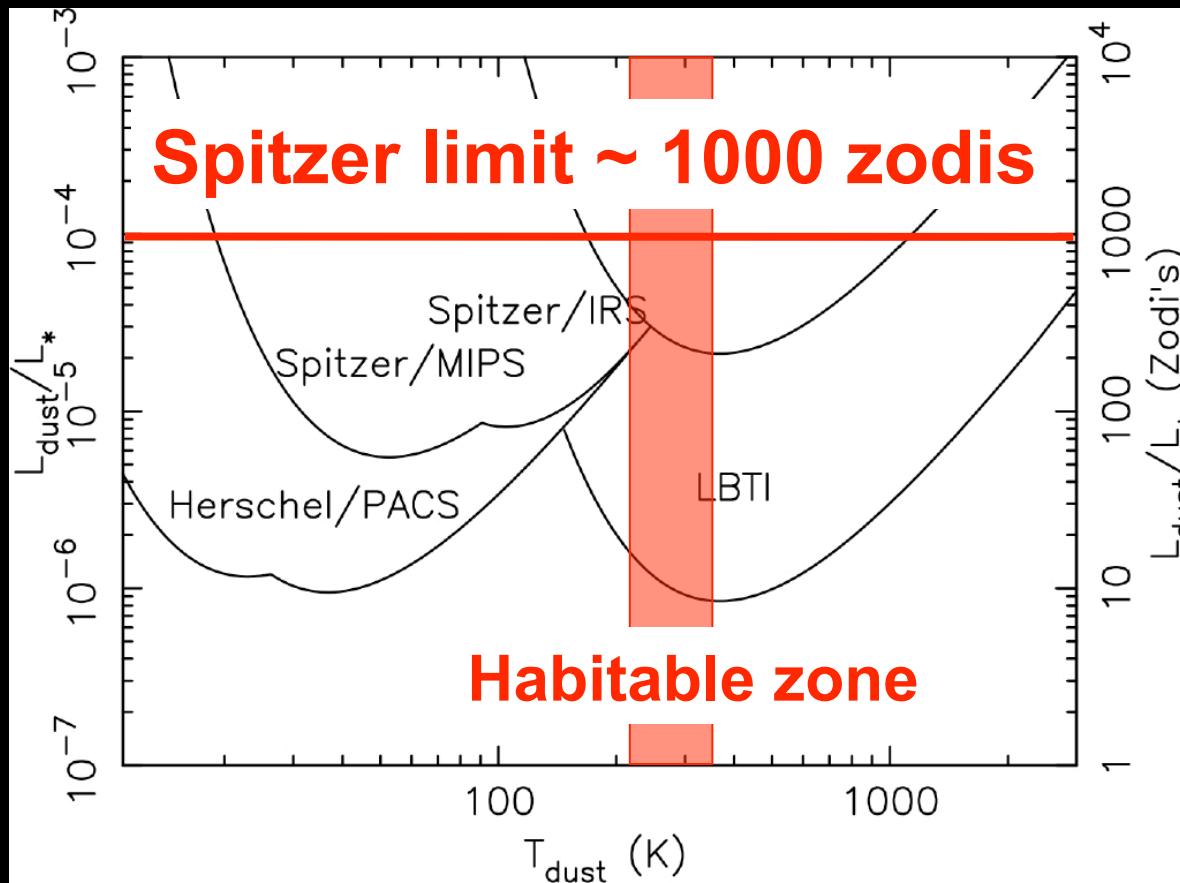
Debris Disk Evolution Theory



- General behavior broadly consistent with debris disks surveys (e.g. Najita & Williams 2005, Su et al. 2006)
- Exact values uncertain by > 2 orders of magnitude

Limits for Solar-Type Stars

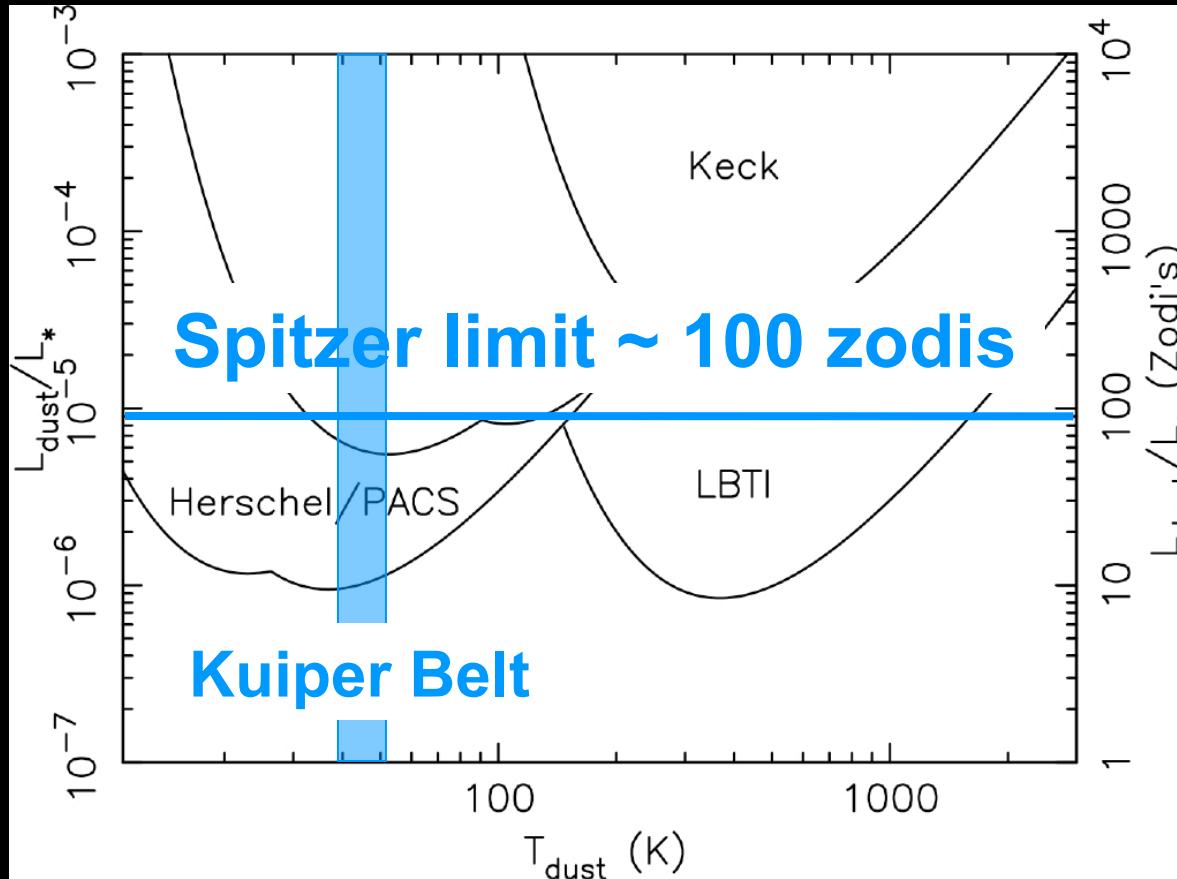
Image credit: G. Bryden



- Few stars w/ Spitzer detection of hab. zone dust
(Beichman et al. 2006)

Limits for Cold Dust

Image credit: G. Bryden



- F, G, K stars: disk frequency $\sim 13\%$ (Bryden et al. 2006)
- A stars: disk frequency $> 33\%$ (Su et al. 2006)

Upcoming Survey Limits

Facility	Region	$3\sigma \text{ L}_{\text{IR}}/\text{L}_{\star}$ limit	Sci. Ops.	Ref.
Keck Interferometer Nuller	Hab. zone	~ 600 zodis	Now	1
Herschel	Kuiper Belt	~ 10 zodis	2010	2
Large Binocular Telescope Interferometer	Hab. zone	~ 10 – 30 zodis	~ 2011	3
ALMA	Kuiper Belt	< 1 zodi	2012 ?	4
JWST	Hab. zone	~ 1000 zodi	2014	5

References: 1) G. Serabyn & M. Kuchner, 2) C. Eiroa, 3) P. Hinz,
4) Holland et al. 2009, 5) C. Beichman

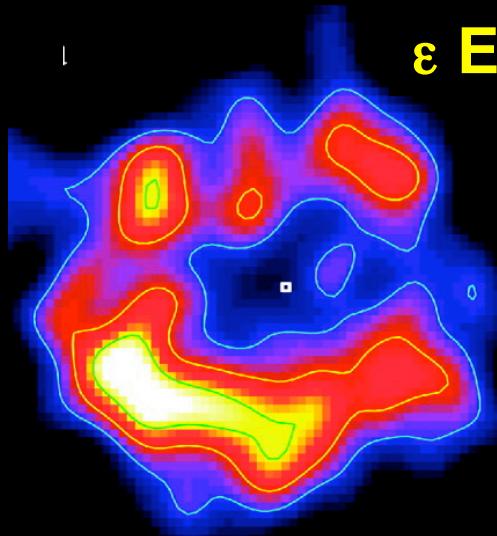
Ground-Based Near-IR Interferometry

- Detections of resolved NIR emission
 - Vega, β Leo, ζ Lep, τ Cet, Fomalhaut, ...
(e.g. Absil et al. 2006, Akeson et al. 2009, di Folco et al. 2007, Absil et al. 2009)
- Hot dust in known debris disks with colder dust ?
 - 100s to 1000s of zodis in inner few AU !?!
 - Not consistent with steady-state collisional cascade models. Transient event(s) ?

Dust Structures

Clumps

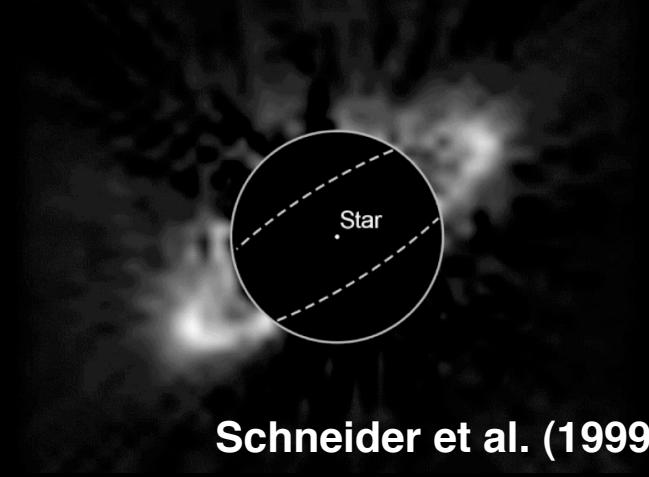
ϵ Eridani @ 850 μ m



Greaves et al. (2005)

Rings

HR 4796 w/ NICMOS



Schneider et al. (1999)

Caused
by
planets



Golimowski et al. (2006)

Warps

β Pictoris w/ ACS

