Where's the flux?

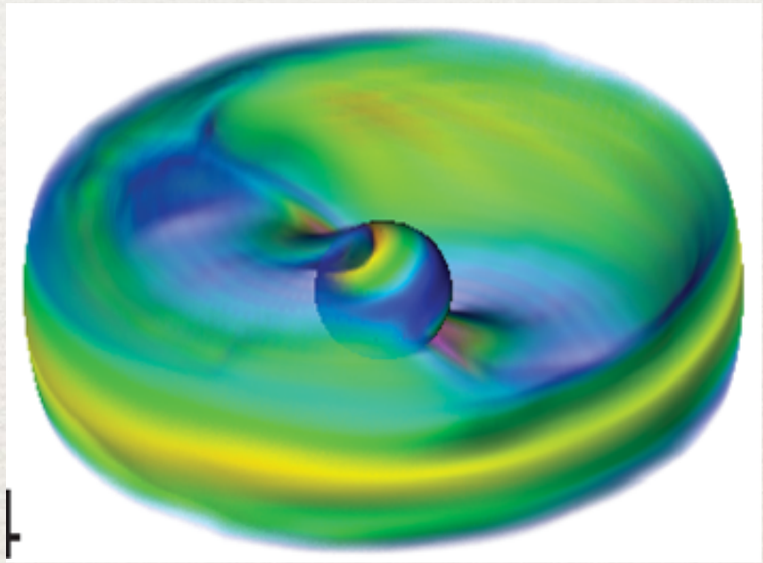
(behind exploding asteroids and comet fragments)

Grant Kennedy, IoA, Cambridge

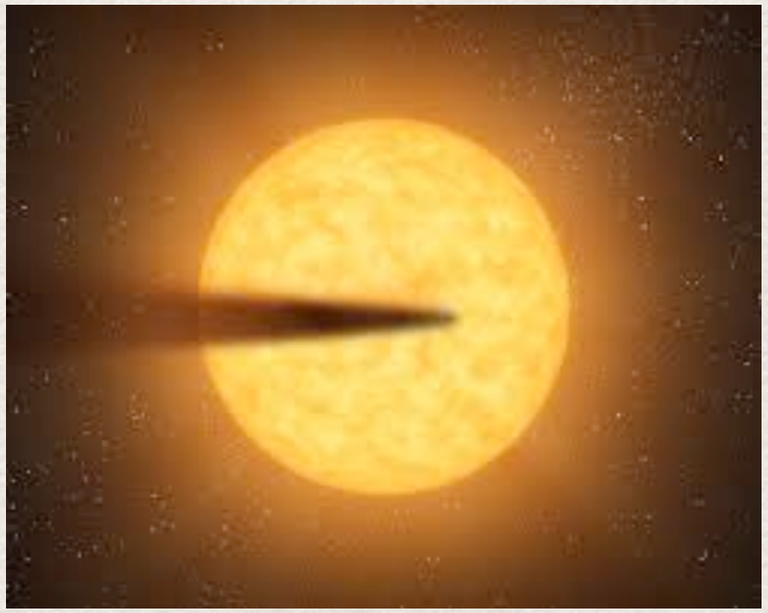
NGM/Dana Berry

Disk-related variability

- Gas disk (warps, accretion)
  - (T Tauri/Herbig AeBe)



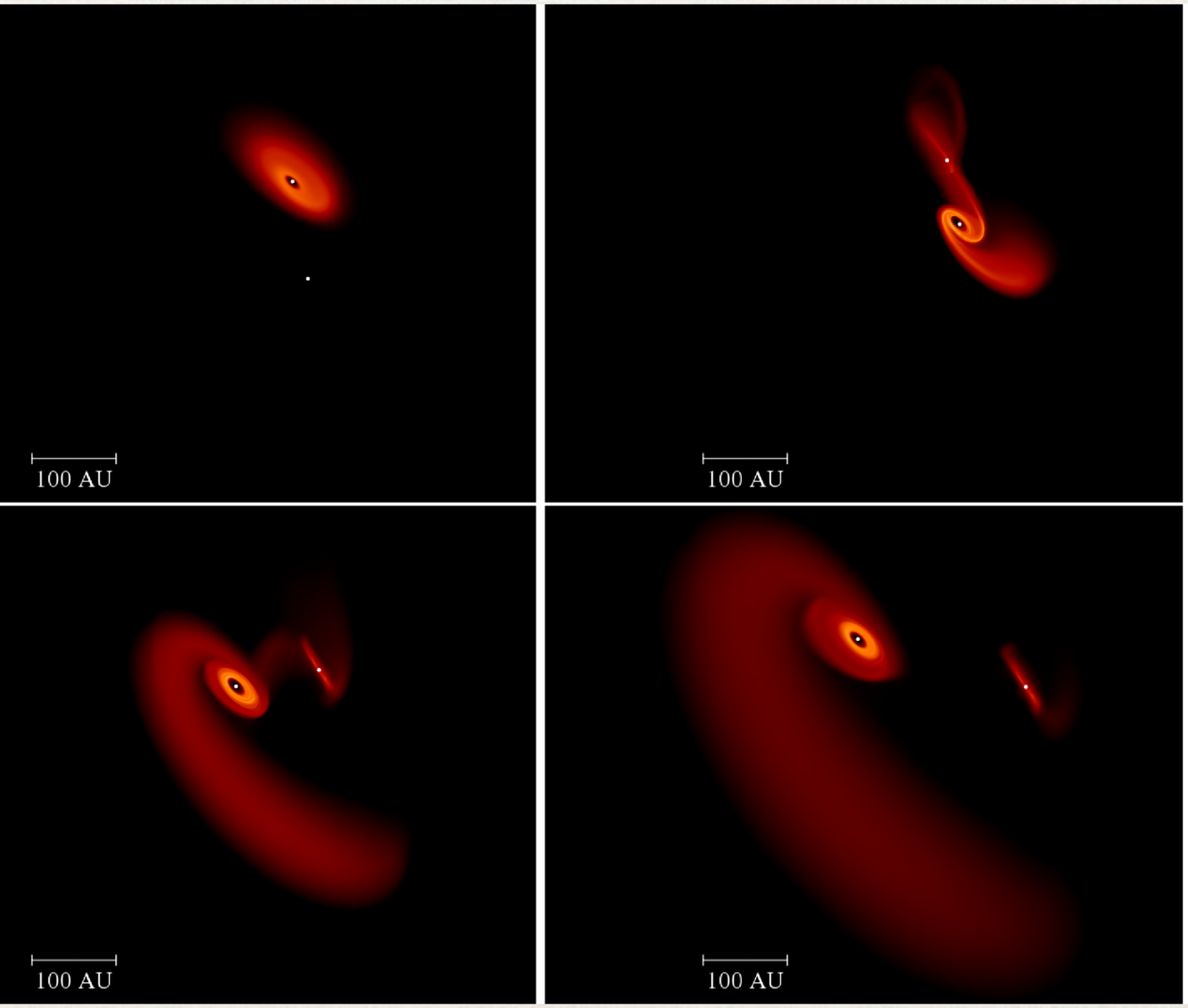
- Dust disk-related (clumps)
  - (main-sequence)

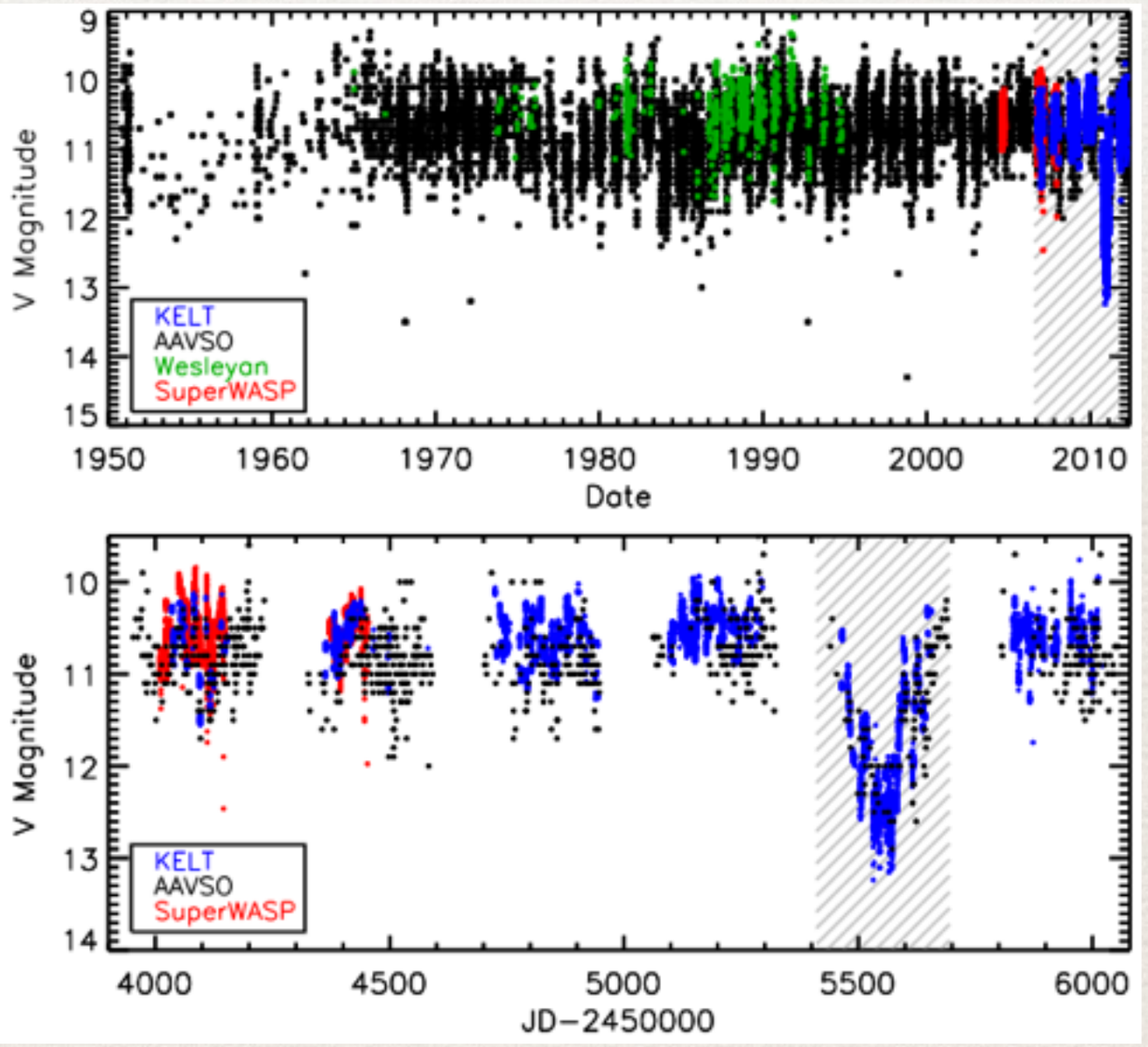


Kurosawa & Romanova 2013, Rappaport et al 2012

Gas disk-related

rare and deep events possible - e.g. RW Aur (also brightening - FU Ori)

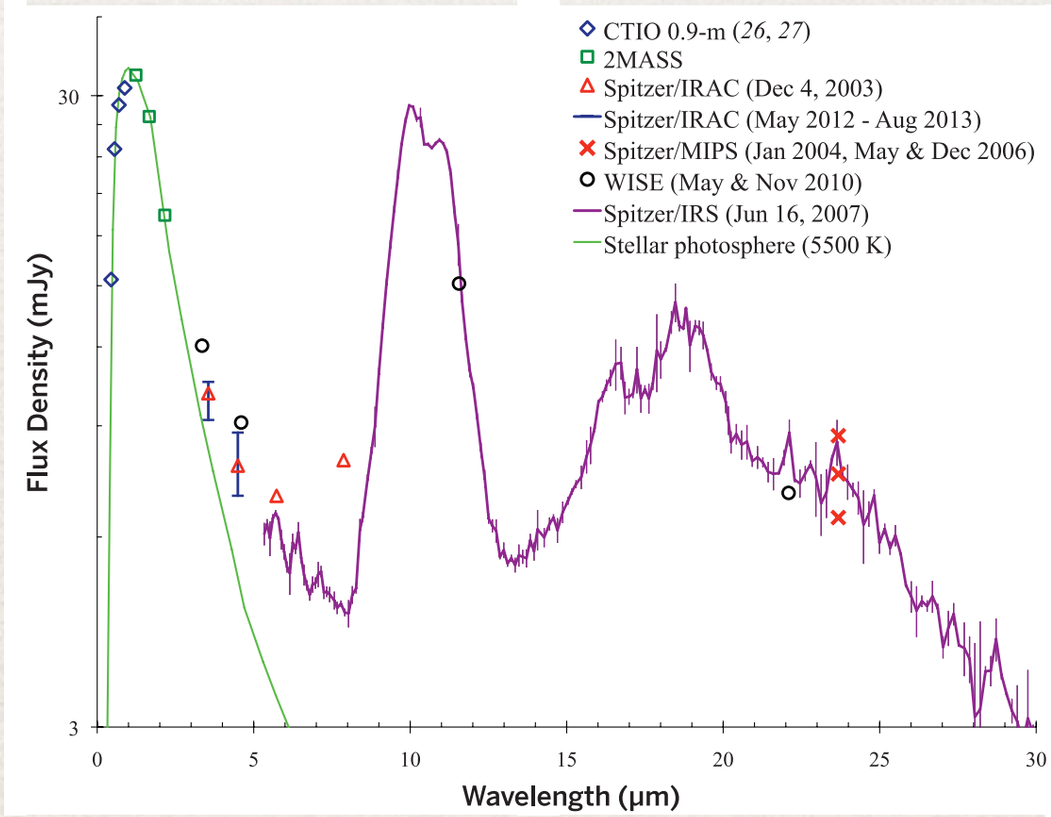


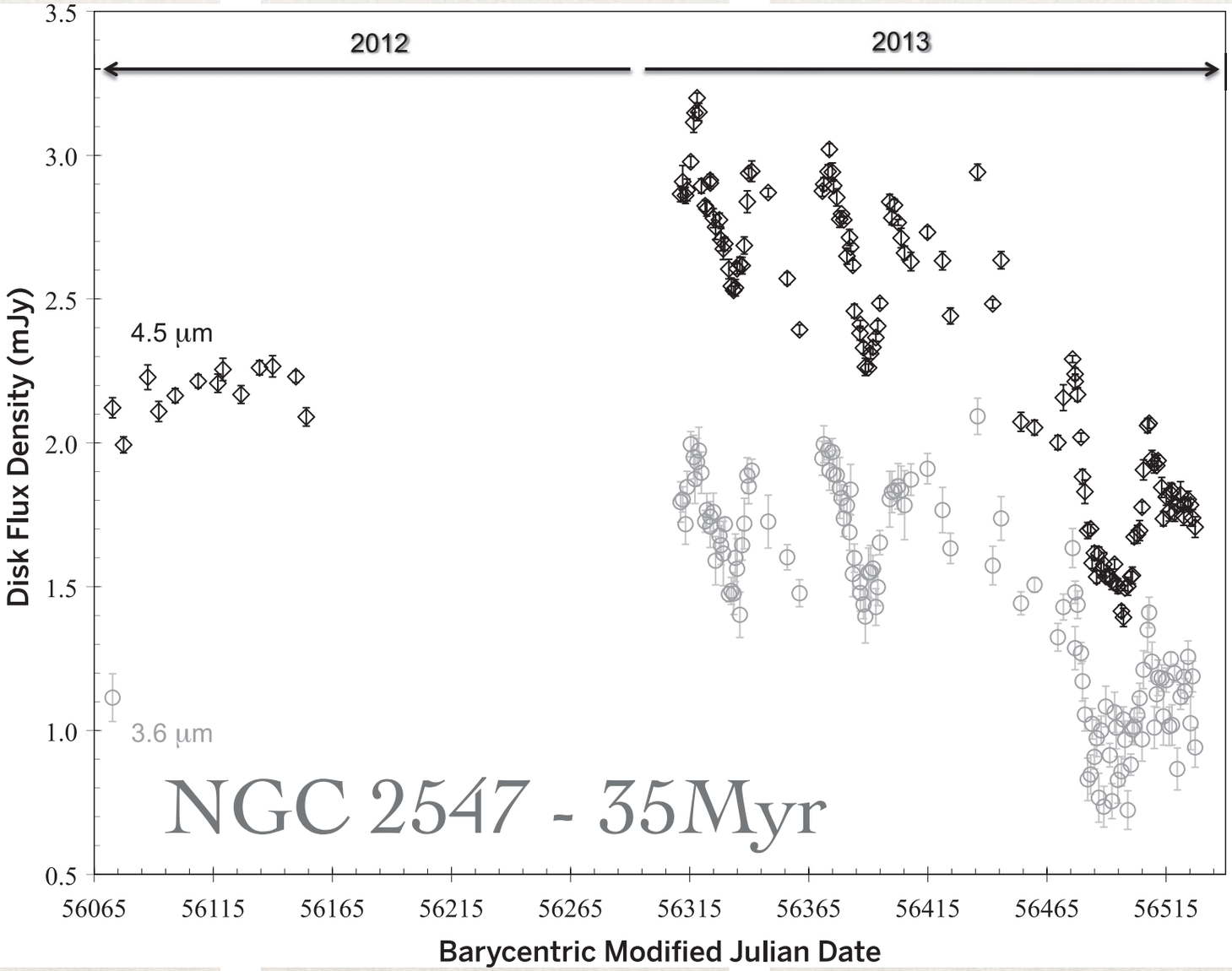


Dai et al 2015, Rodriguez et al 2013

Aftermath of collisions

analogous to Earth-Moon forming impact or collisions within a bright asteroid belt



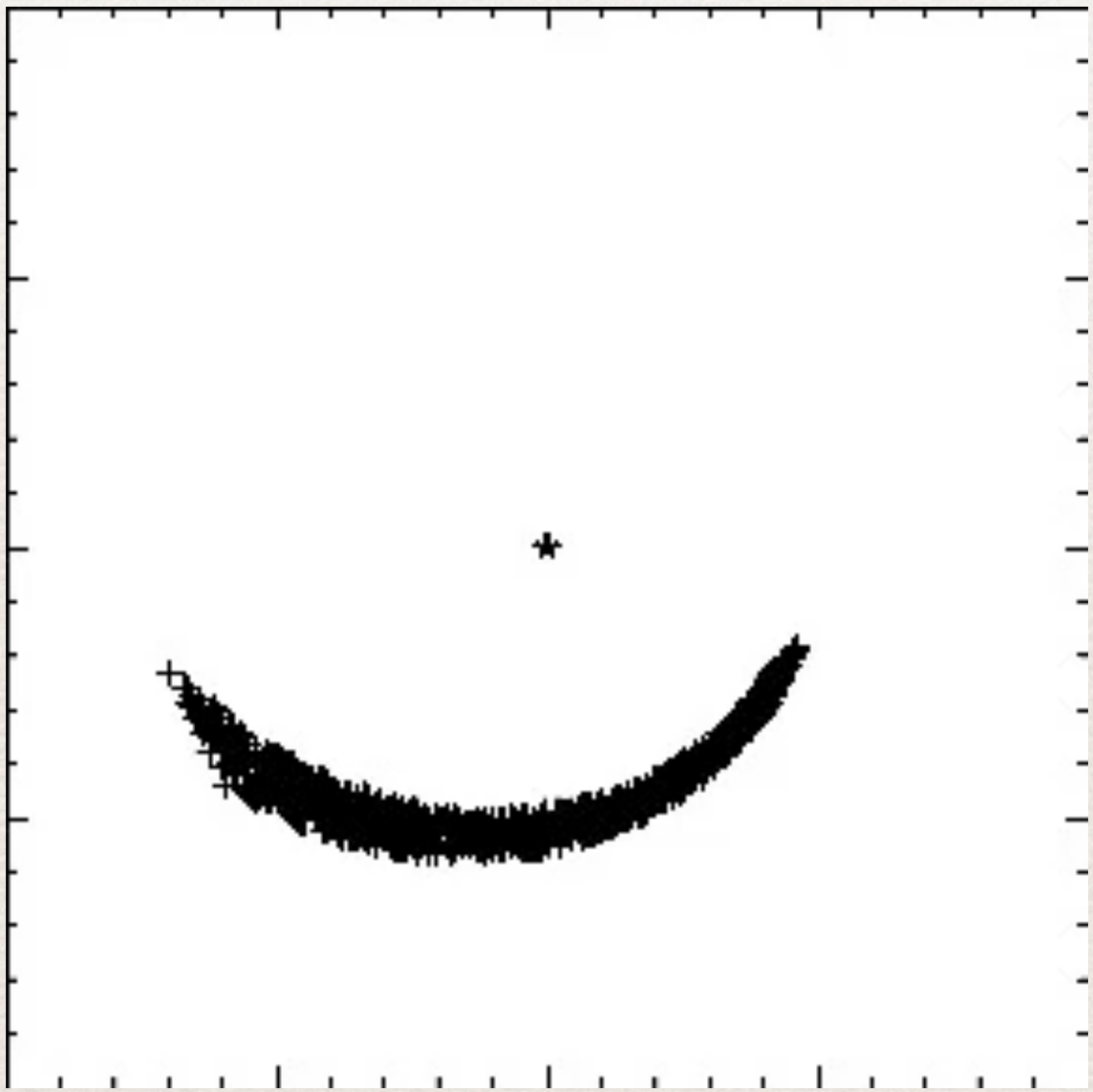


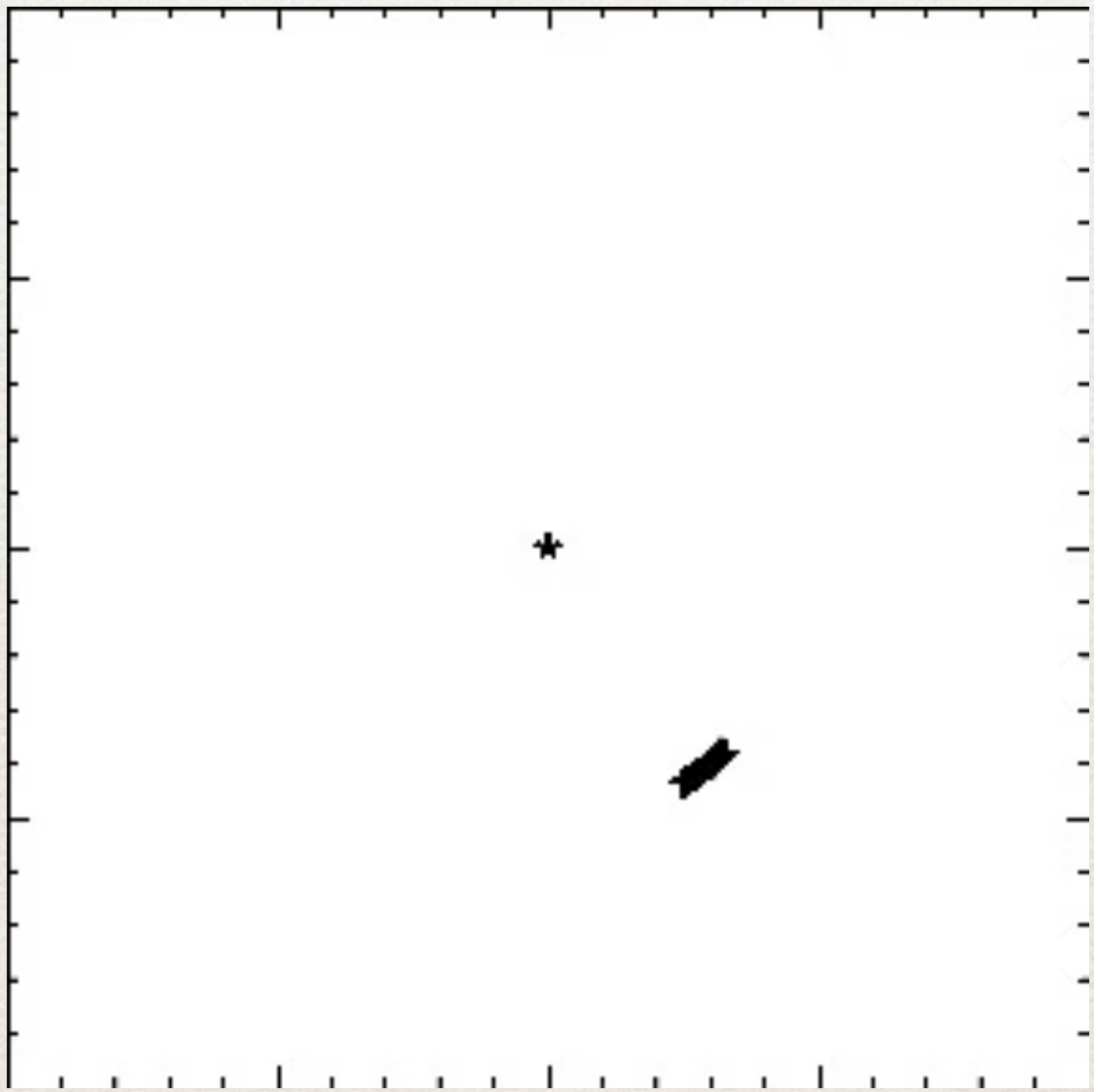
NGC 2547 - 35Myr

Meng et al 2014

Clump evolution

lifetime depends on ejection velocity - linked to masses





2452760.5

2004
2453126.5

2005
2453491.5

2006
2453856.5

2007
2454221.5

2008
2454587.5

2009
2454952.5

Relative Flux

1.2
1.0
0.8
0.6
0.4
0.2
0.0

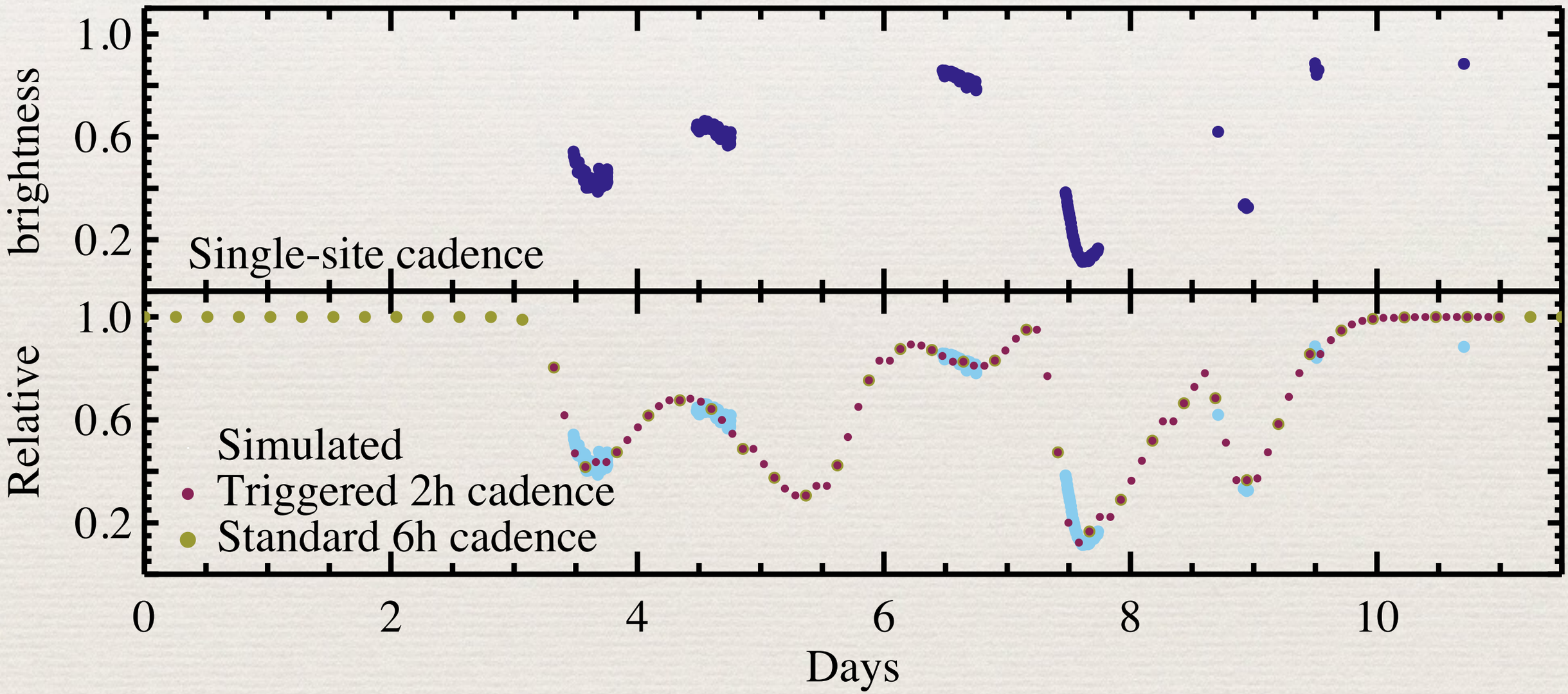
0
100
200
300

Days since 1 May each year

AAVSO
ASAS
Catalina
Herbst99
KELT
Kardopolov80
Karetnikov73
Kiselev91
Plates
Potravnov14
WASP
Zajtseva85

In detail

immediate multi-colour follow up highly valuable

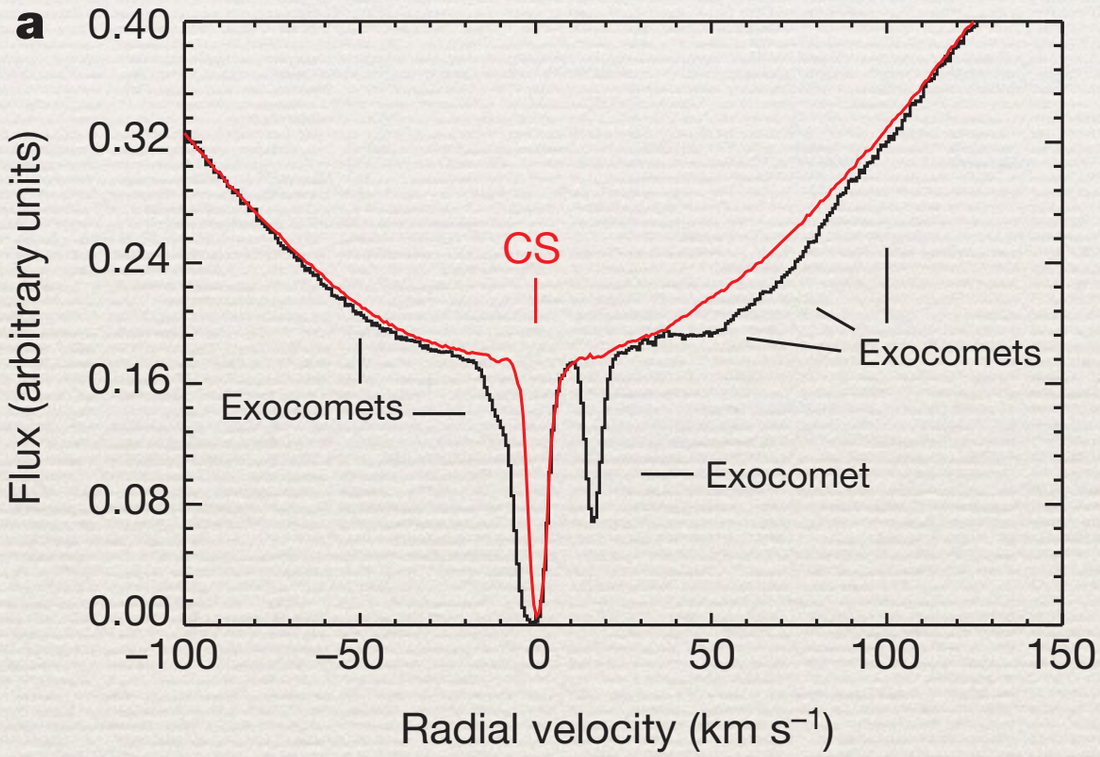


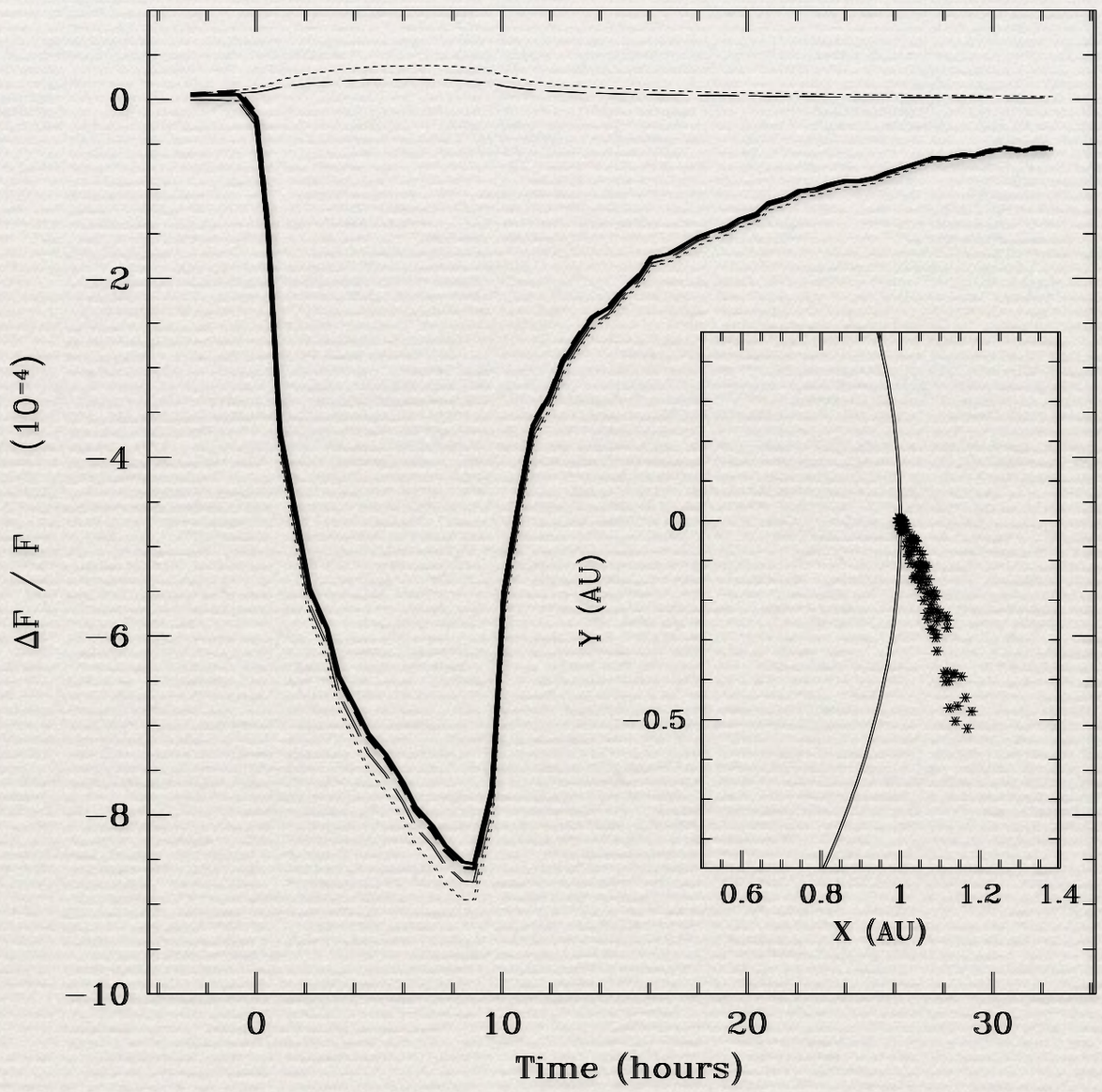
Aftermath of collisions

- Can watch post-collision clump evolution
  - properties of colliding bodies
  - collision outcomes
- Combine with thermal emission
  - independent constraints on dust properties
  - quantify “clumpiness”

Comets

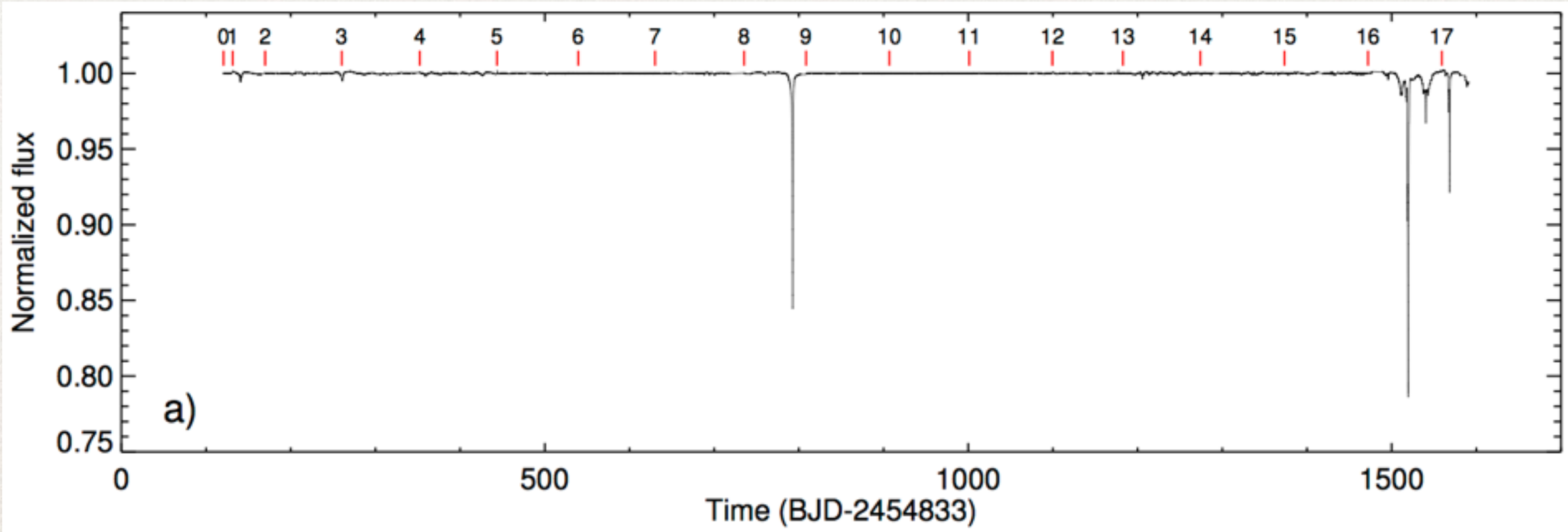
first exocomet evidence seen towards beta Pictoris in the late 1980s - “falling evaporating bodies”

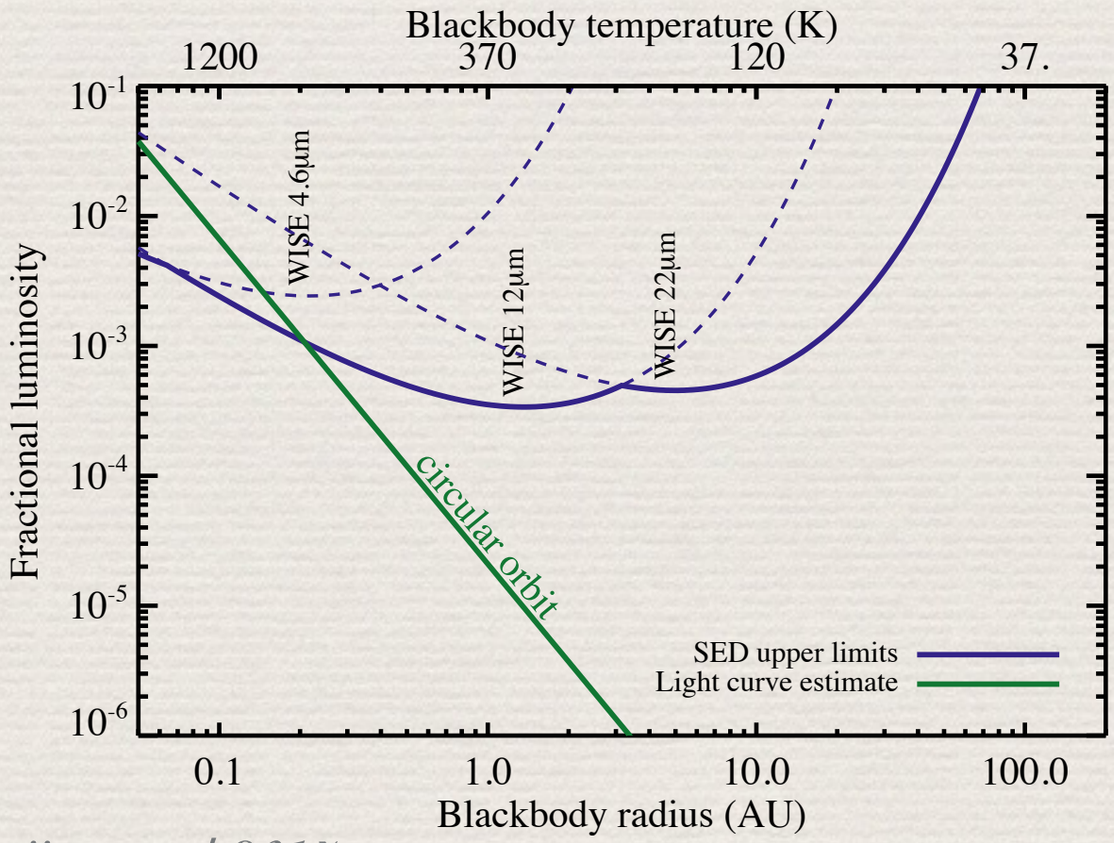


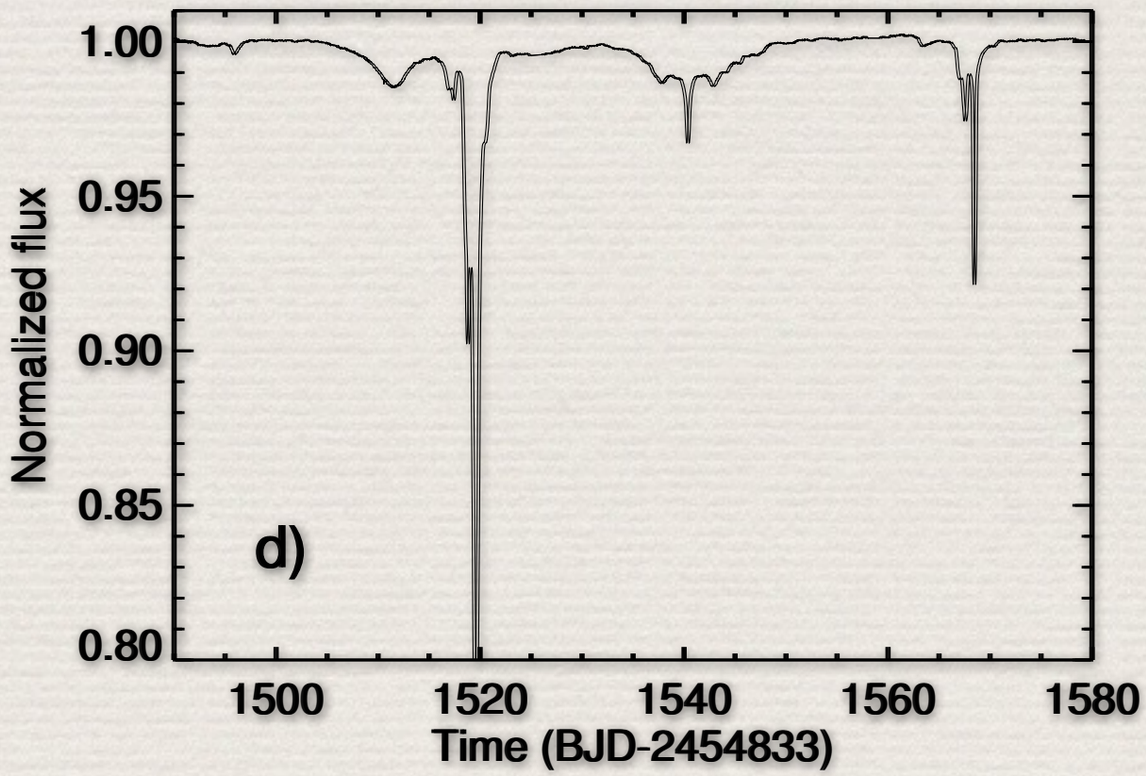


Kiefer et al 2014, Lecavelier des Etangs et al 1999

KIC 8462852 - an otherwise normal F-type dwarf

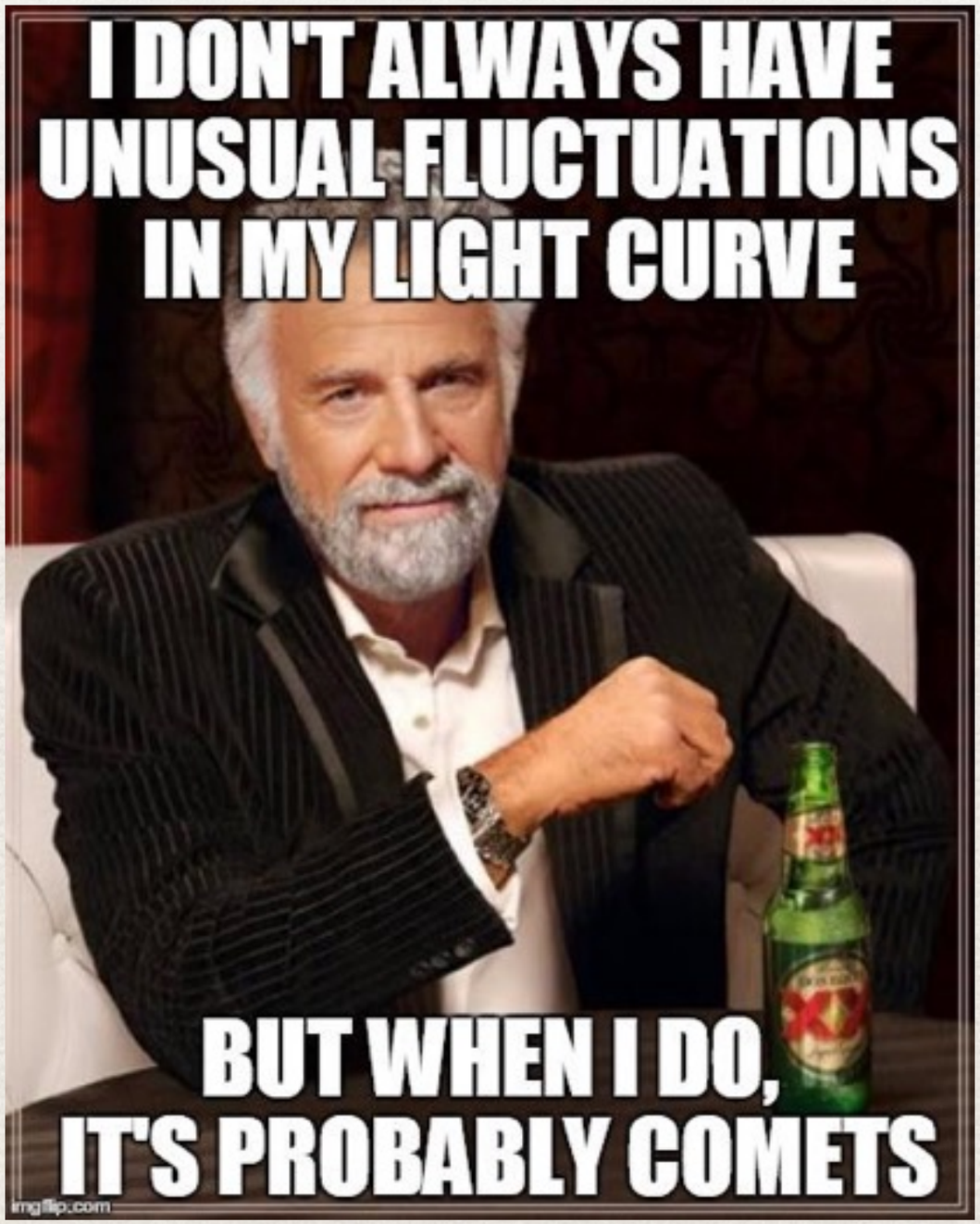


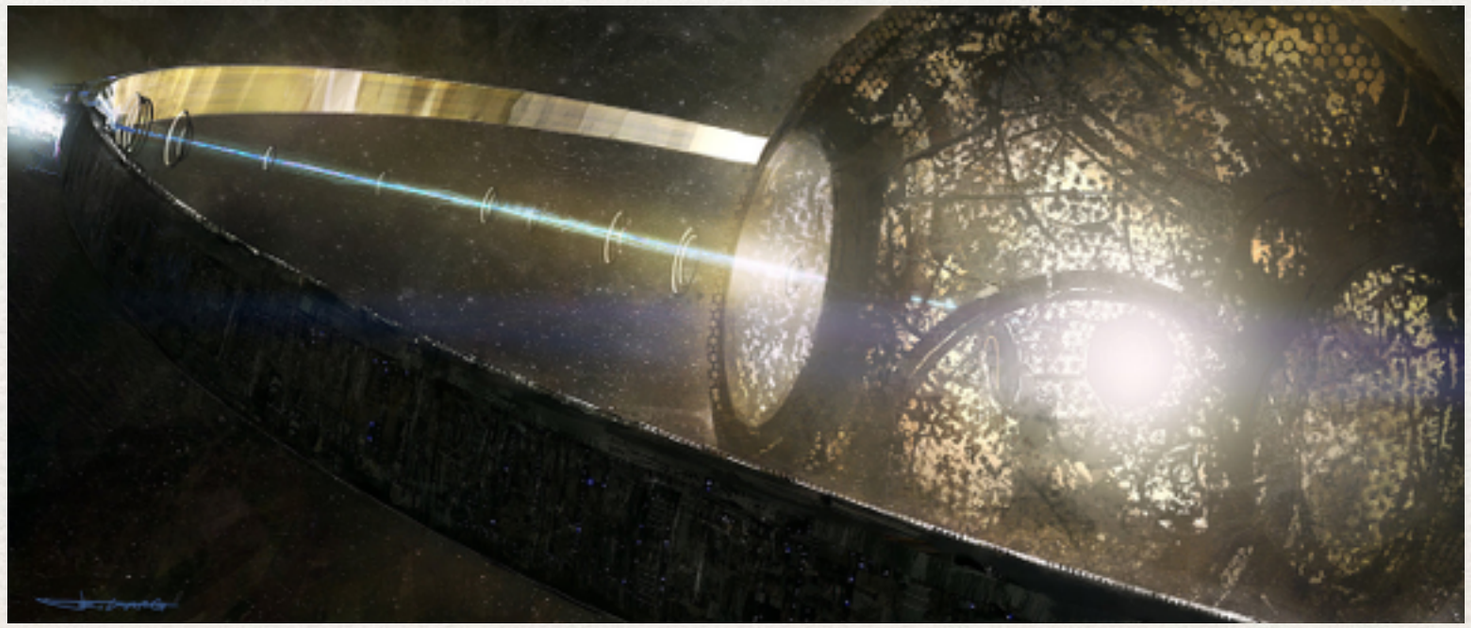




Boyajian et al 2015

Press coverage: try google images-ing “KIC8462852”





“So let me get this straight, they found a planet with a possible alien civilization, and then the telescope broke?”

Why comets?

- Few shallow dimming events
  - large population of occulting bodies unlikely
    - comet fragments share similar orbits
- Velocity inferred to be large from gradient
  - <1au if circular, but events not repeated
  - eccentric with small pericenter - disruption

Why not comets?

- Fragments/clumps must be roughly star sized
  - depth 20% vs 0.1% from beta Pic model
  - Requires ~10^{18} g of only micron sized grains
    - e.g. roughly Hale Bopp mass
    - but larger grains likely present so mass higher
- Too improbable? (a 1:150,000 event from *4* years)

GAIA Alerts

✓ Sample - vast increase in numbers monitored

✓ Cadence - dimming events days to weeks

✓ Real-time - can follow up immediately

✓ Sensitivity - gas-disk and collisions no problem

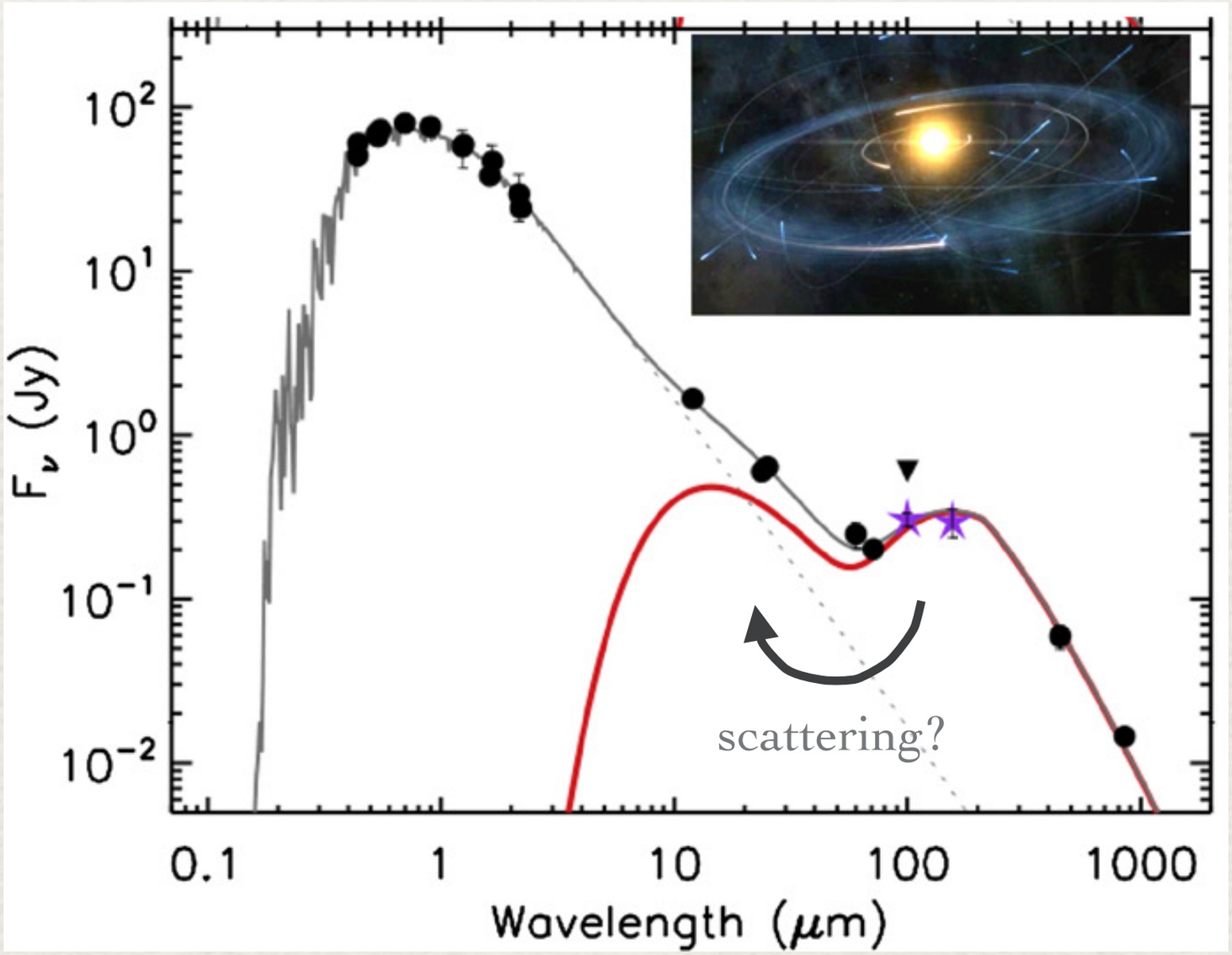
? KIC8462852 only 20% at most (but very stable)

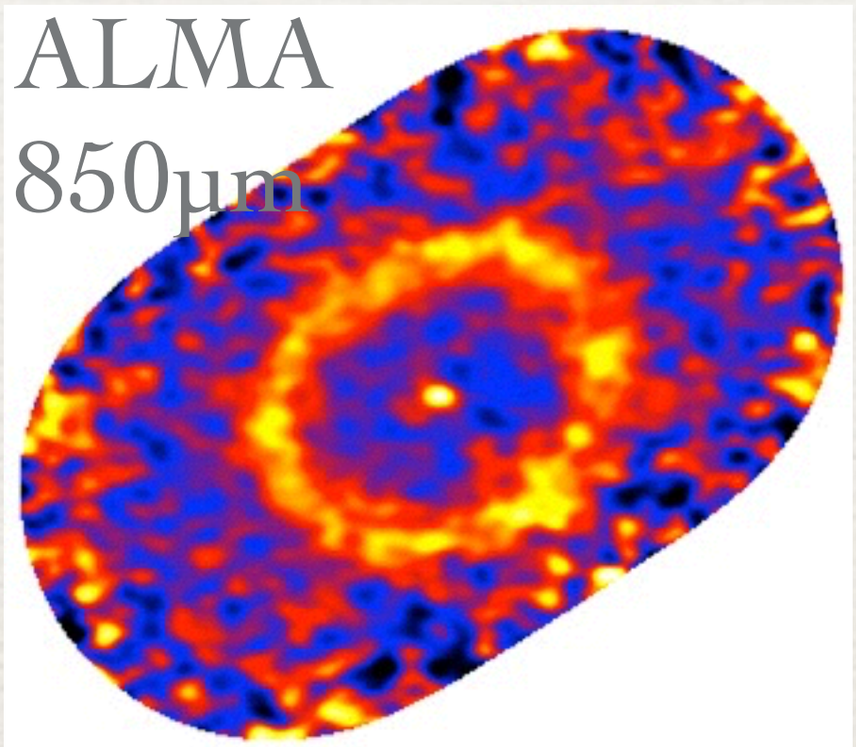
Summary

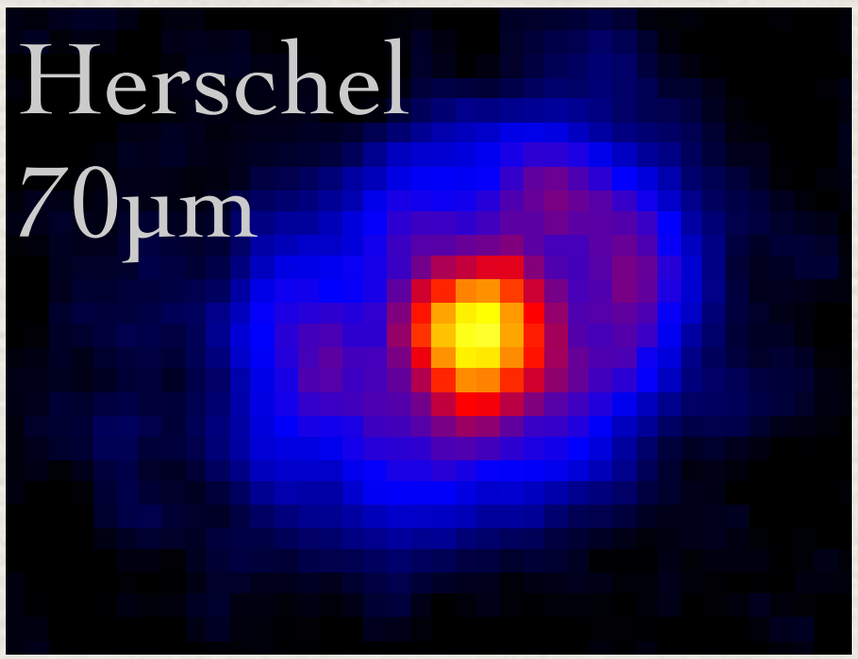
- Transiting debris
  - largely a new field - opportunity for discovery
  - real-time follow up essential for rare events
  - terrestrial planet formation, asteroid belt evolution, comets - access to the habitable zone

η Corvi - comet delivery?

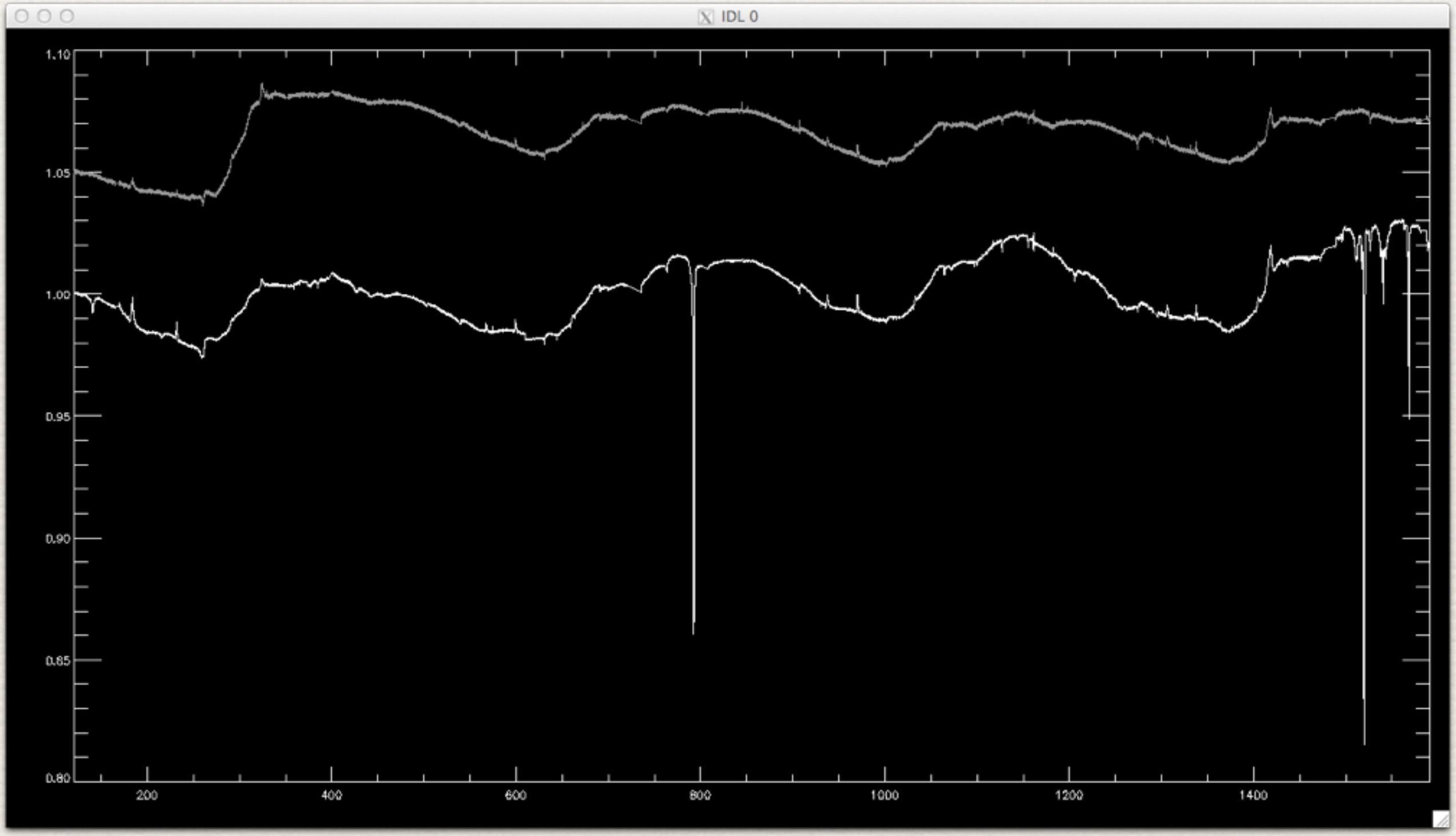
possible origin: comet delivery
from outer belt - needs planets!







Matthews et al 2010, Duchene et al 2014, Smith et al 2008, 2009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