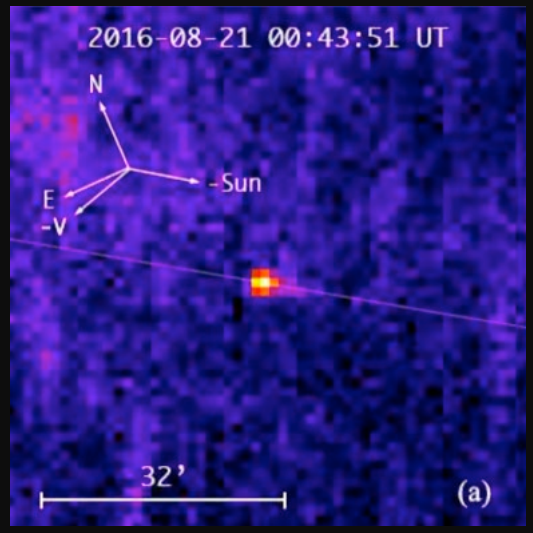
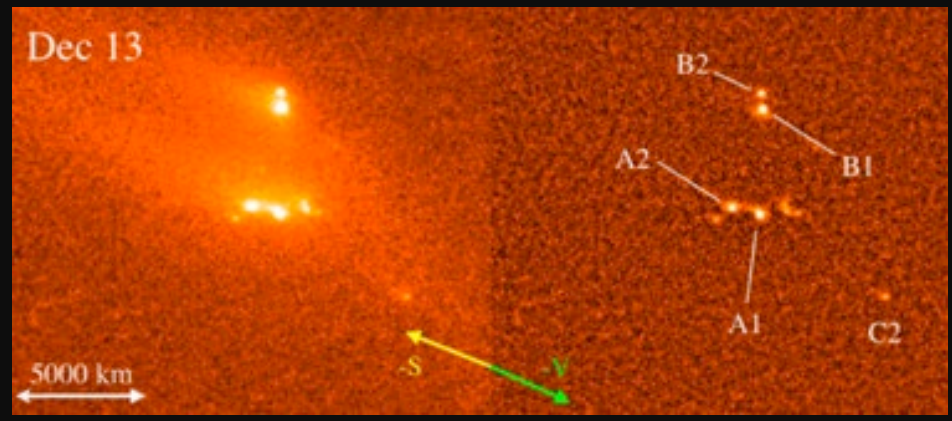
Discussion: What is an Active Asteroid?

300163/288P ESA/NASA HST, Agarwal et al. 2017



3200 Phaethon, Hui & Li, 2016



P/2013 R3, Jewitt et al. 2014

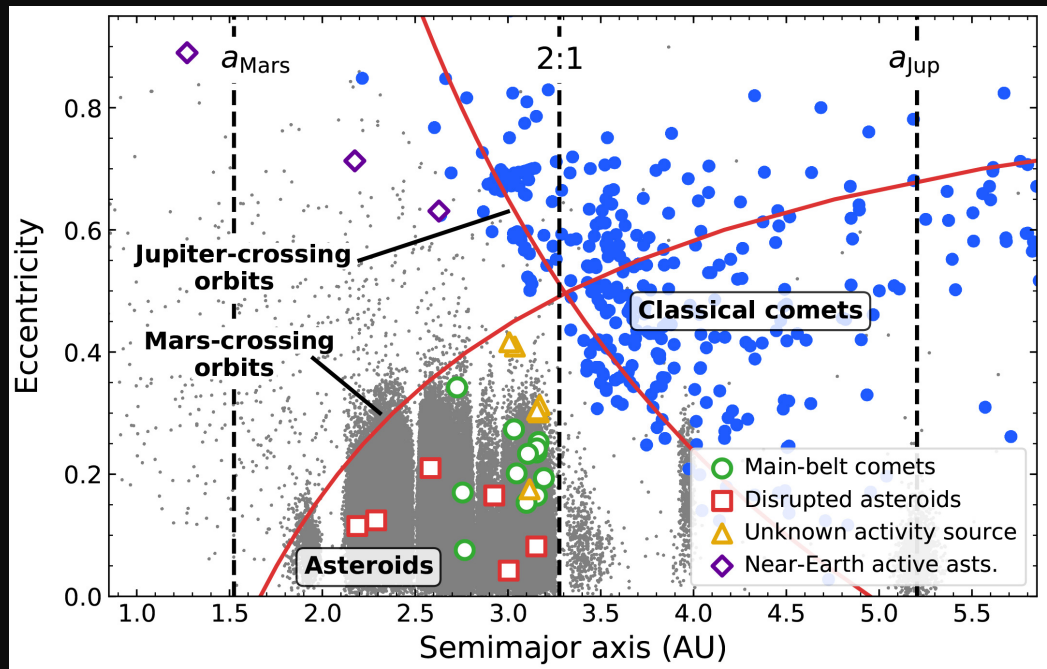
Gerbs (James) Bauer (UMD)

Jessica Sunshine (UMD), Henry Hsieh (PSI), Tim Swindle (LPI, UofA)

Some Active Asteroid Milestones

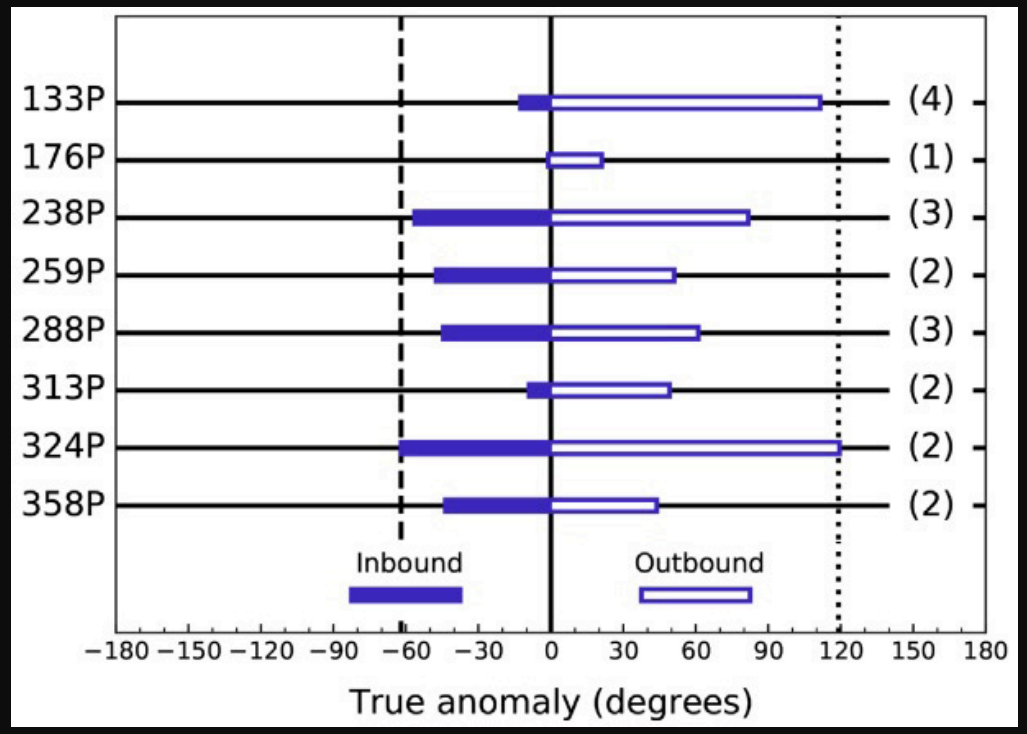
- July 1996: 133P/ Elst-Pizzaro discovered, active?
- 1999/2000 133P activity recurrent
- 176P/ LINEAR – Now a class of objects
- P/2010 A2 – A Disrupting/Impacted asteroid?
- Schiela – an impacted active asteroid
- P/2012 F5 & P/2013 R3 – Disrupting
- Bennu?

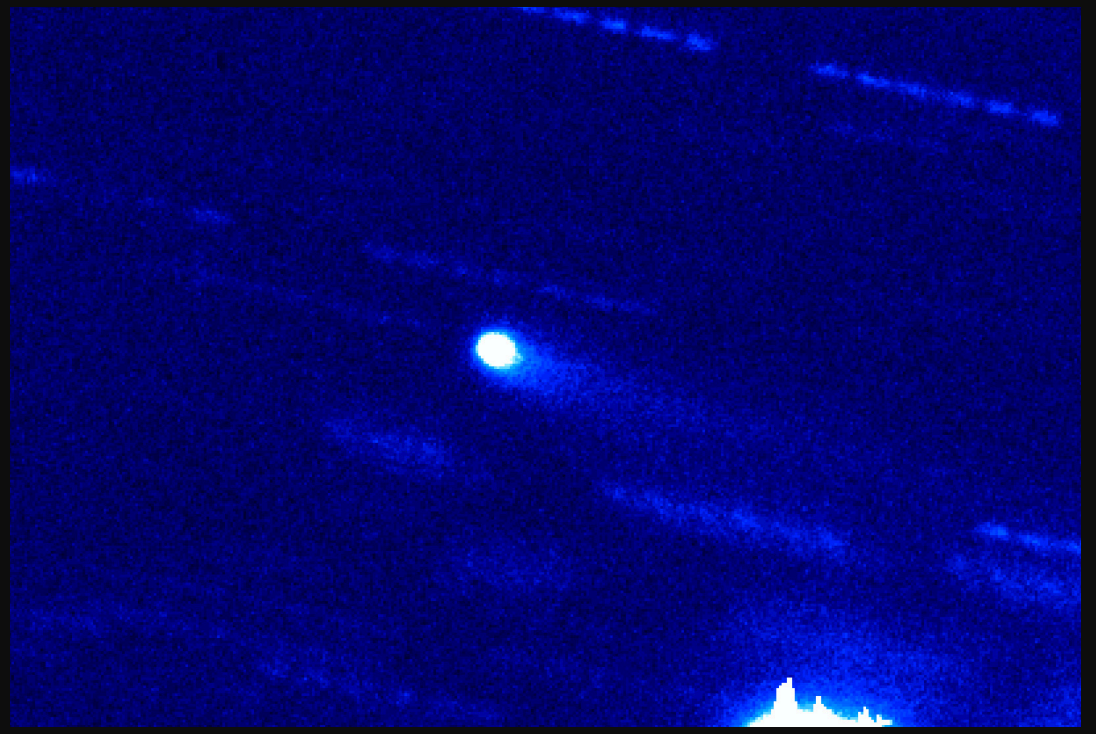
Multiple possible drivers for activity



Active Asteroids – Sublimation (Main-Belt Comets)

- **Repeated periodic dust production near perihelion**
  → **Suggests sublimation, but not detected yet (probably very weak)**
  → **Maybe water, *but probably not other volatiles***

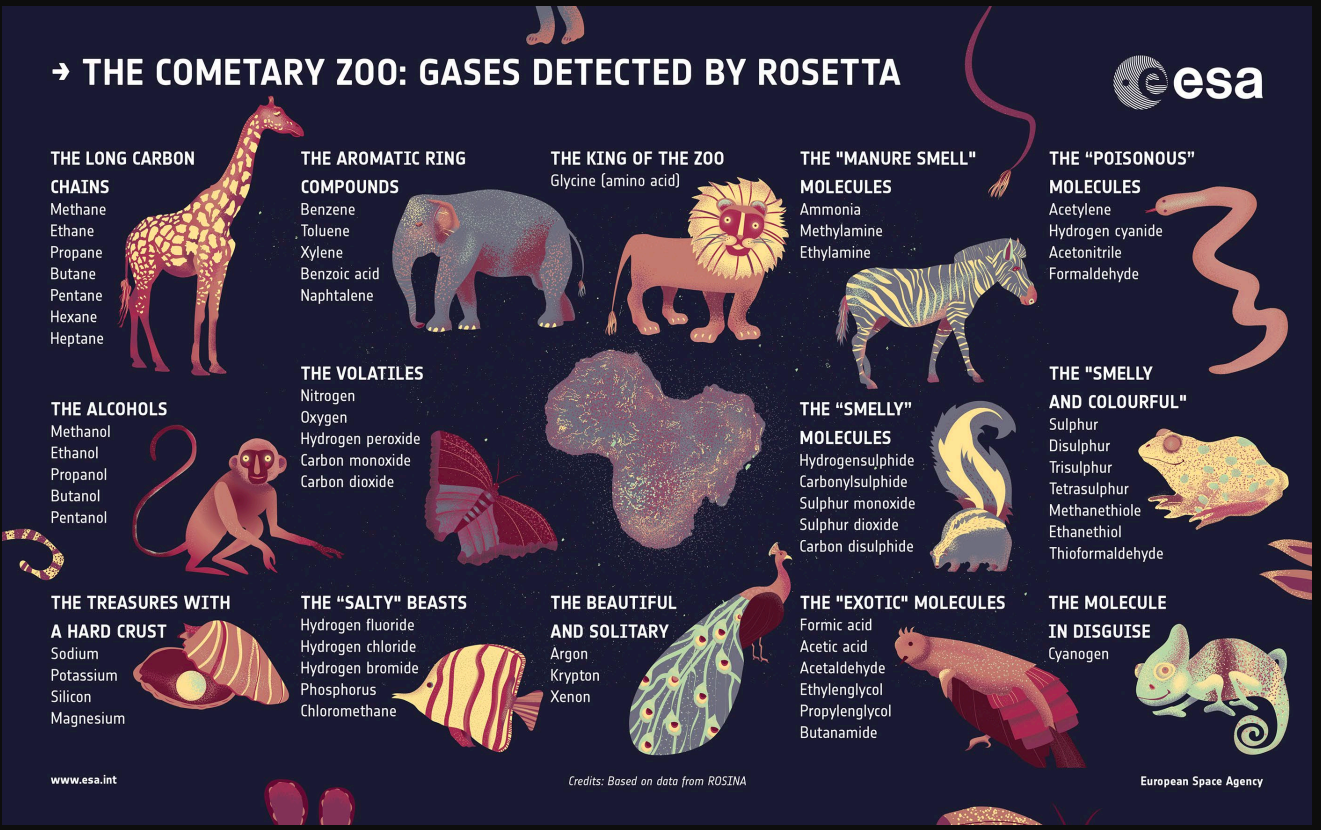




Hsieh & Jewitt (2006); Hsieh et al. (2008, 2018)

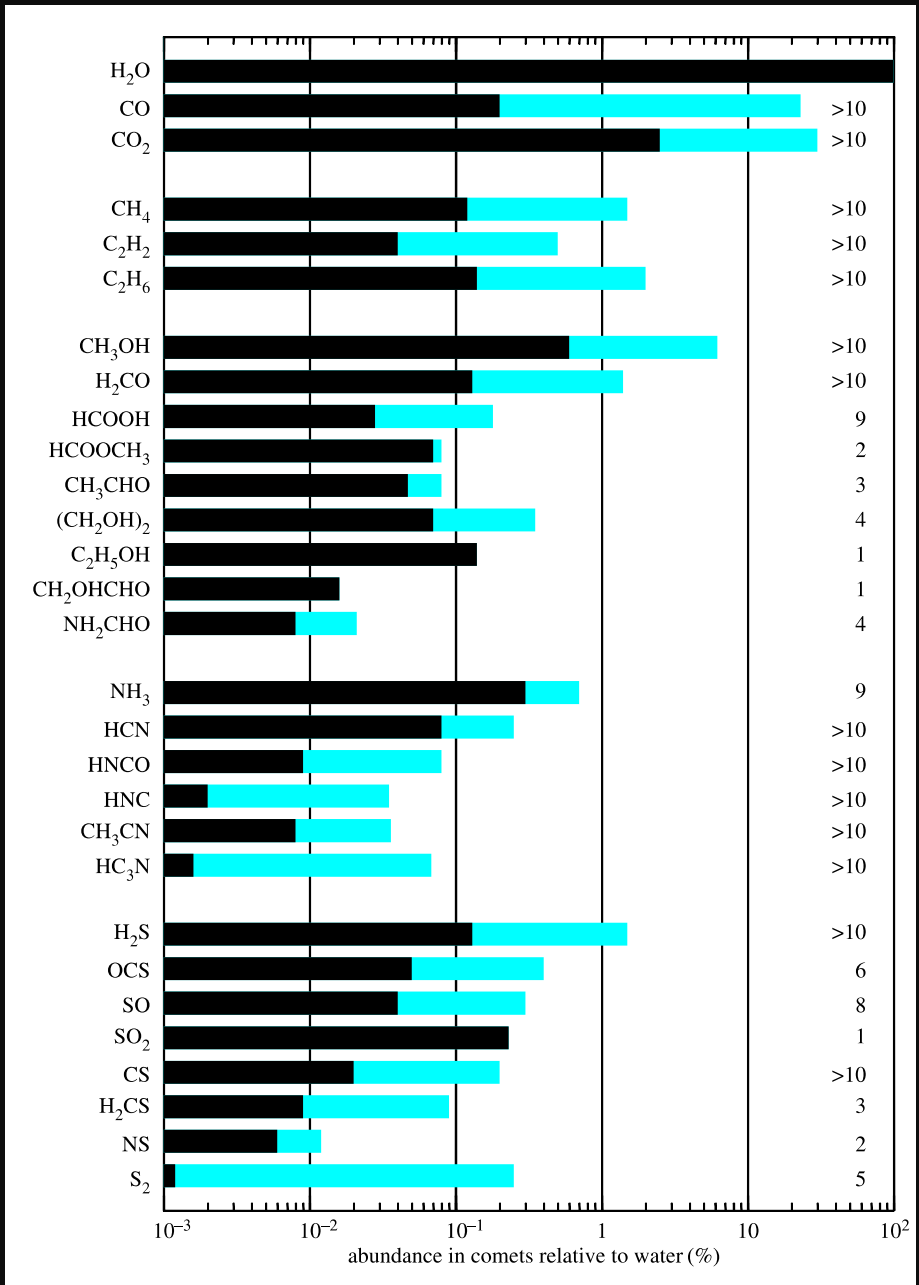
Reminder - Cometary Volatiles: Far More than Water

- **Highly volatile compounds (mass spec)**
  - **Formation temperatures <30K**
  - **CO_2, CO, CH_4, complex hydrocarbons, glycine, N_2, O_2, Ar, K, Xe** Altwegg+16

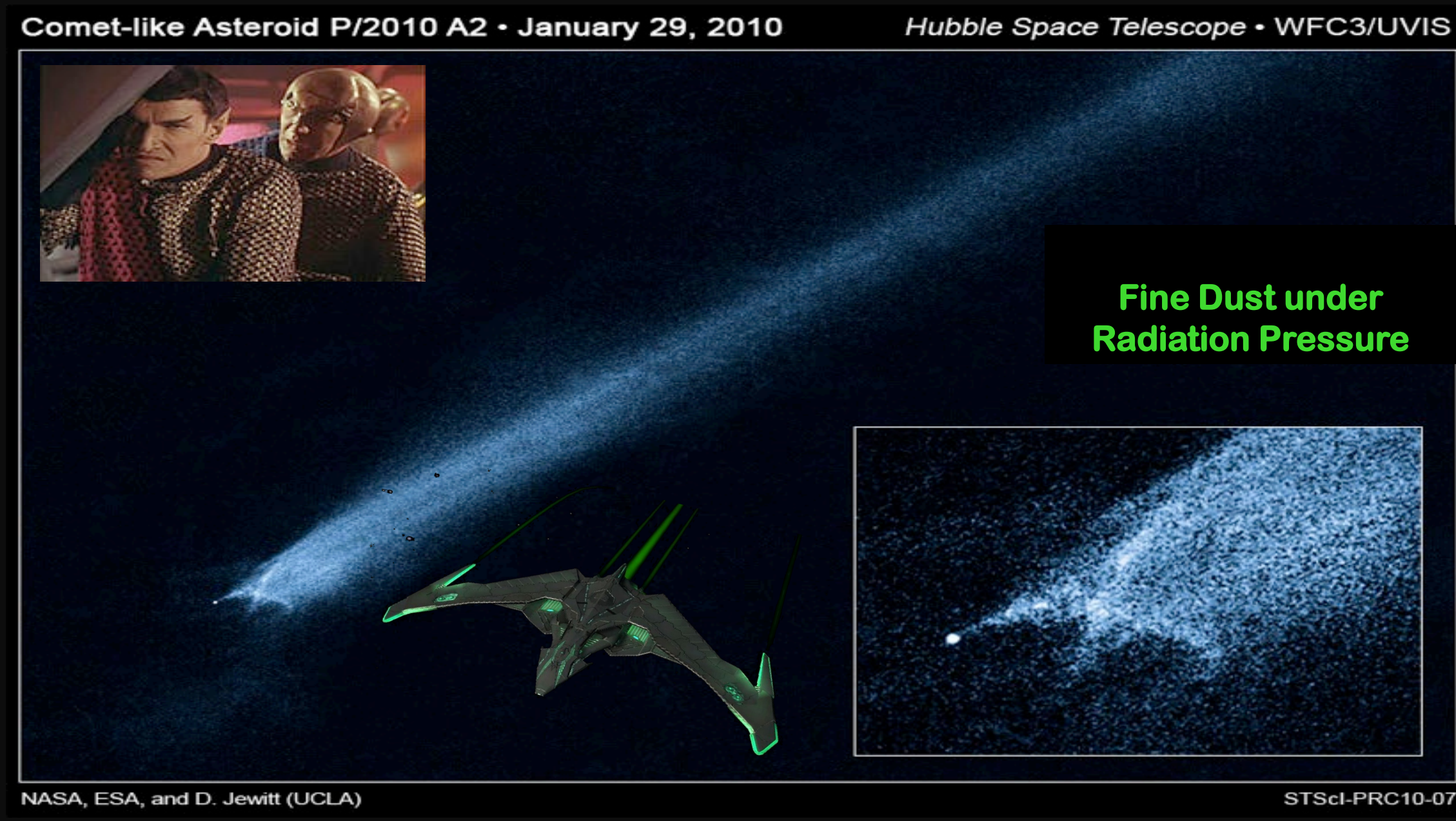


- **IR Remote Sensing**

Bockelée-Morvan & Biver+17

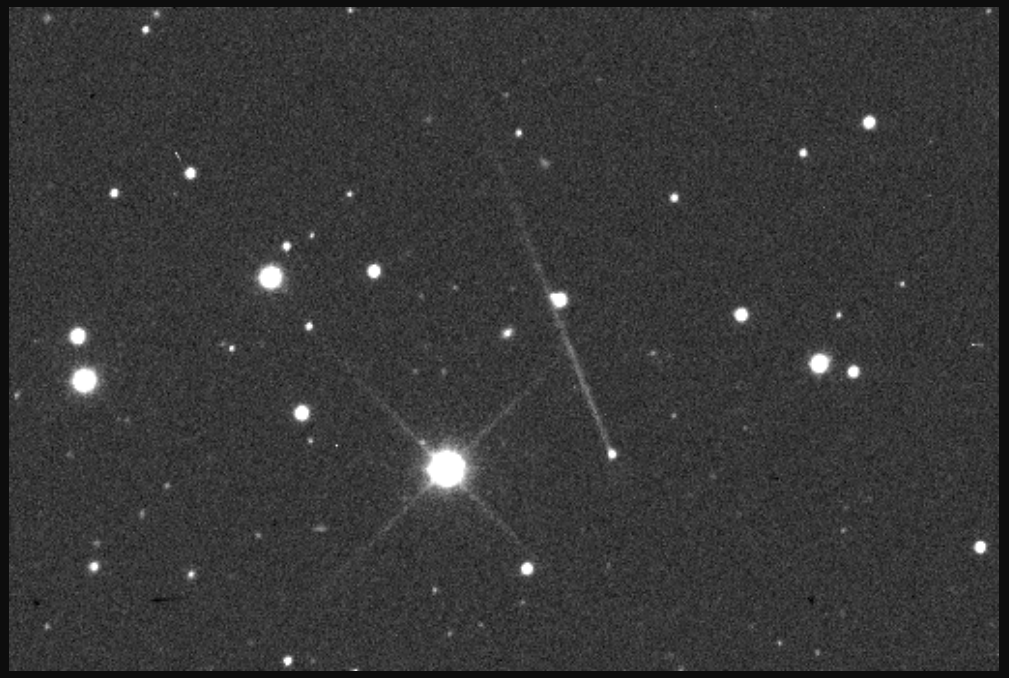


Active Asteroids – Impacts



Active Asteroids – Rotational Disruption

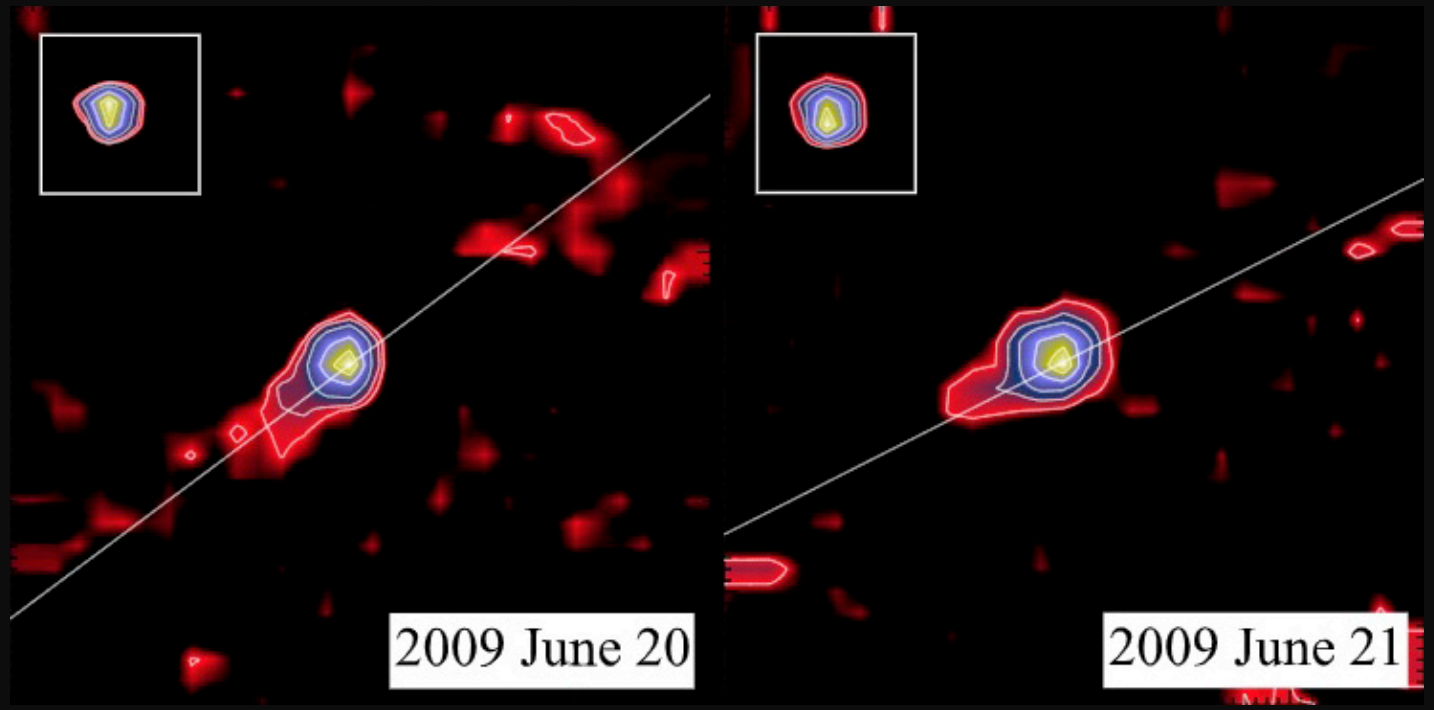
- e.g., (62412) 2000 SY178
  - Activity discovered by Sheppard & Trujillo (2015)
  - P_{rot} = 3.33 hr
- Also P/2012 F5 and (6478) Gault



Gault

Active Asteroids – Thermal Fracturing

- Thermal fracturing/dessication for NEOs at high temperatures
  - e.g., Phaethon (q = 0.14 au; T ~ 1000K)

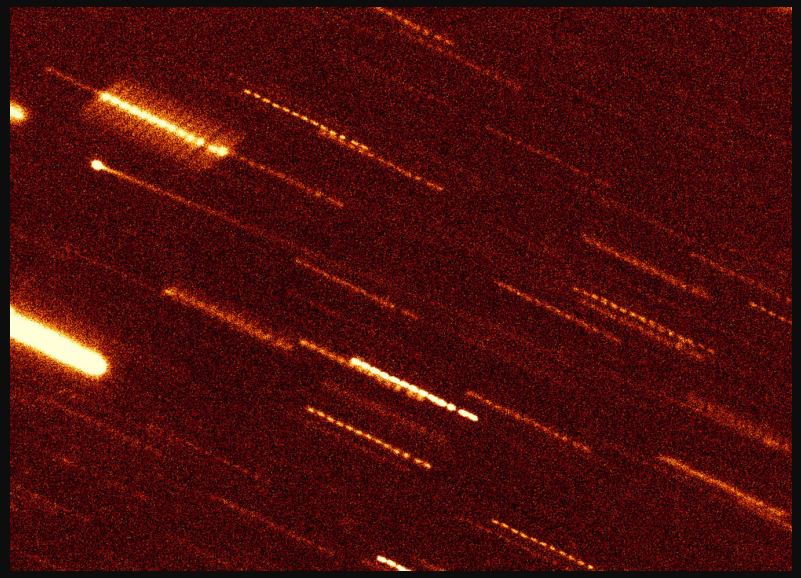


Jewitt et al. (2013)

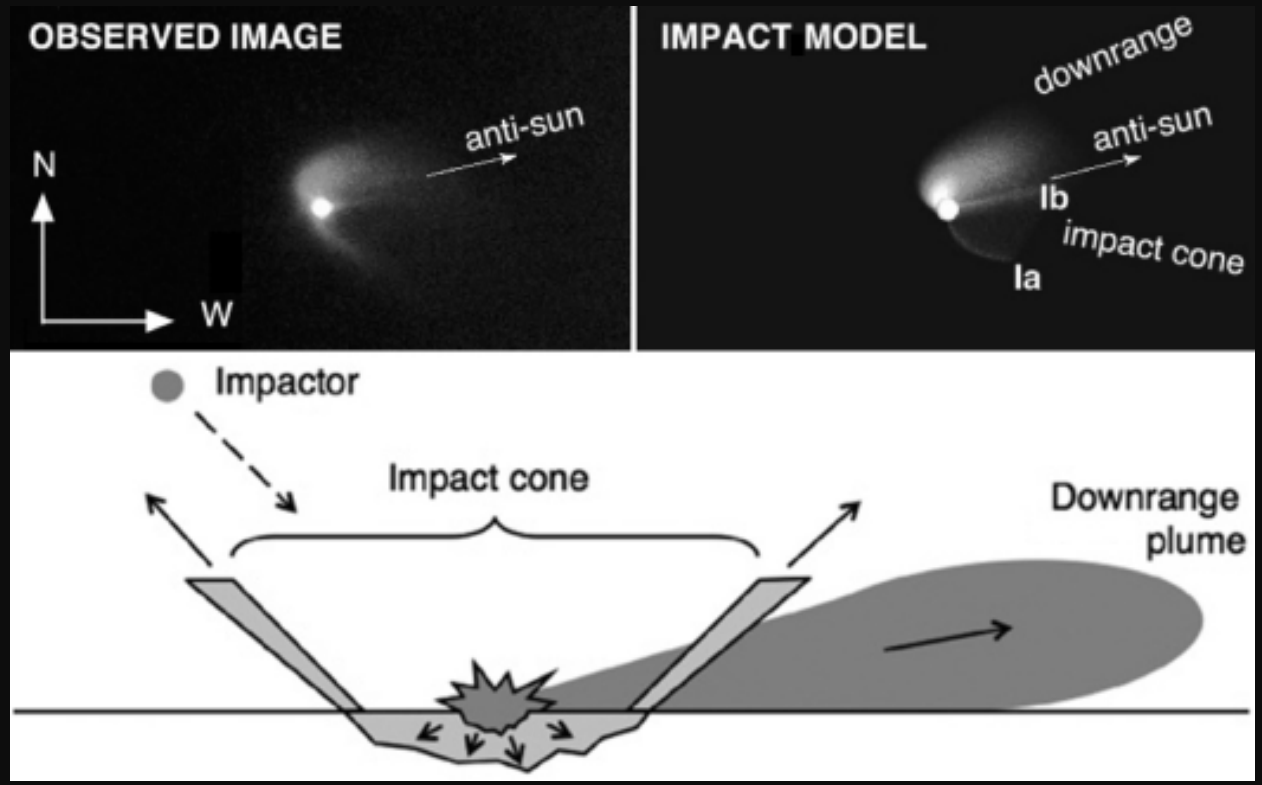
Active Asteroids – Combinations of Mechanisms

- **Multiple mechanisms could operate simultaneously**

- e.g., Elst-Pizarro could be impact + rotation + sublimation
  - Impact as initial trigger
  - Recurrent activity = sublimation
  - P_{rot} = 3.47 hr



- **Asteroids (mainbelt) with extended sources**
- **Some dust from impact collisions**
  - **596 Scheila plume Dec 2010 (Larson+10)**



Active Asteroid Bennu?

- Smaller-scale mass-shedding
- Not detectable from ground-based observatories
- Alternatively, Comet P/1999 RQ36 (LINEAR)?

Some Active Asteroid Question Topics

Science Taxonomy:

- What do we consider “active” or “activity”?
- What are the dynamical boundaries?
- Sub-classes (MBCs, RAMBOs, ABCs, DAs, IAs, ANEAs/APHAs, SGAAs, etc.)?
- Where do they separate from “comets” (non-phenomenologically)?

Practical:

- What is the Hazard component?
- Should the ANEAs be included in NHATs?
- Are these a resource?
- If we include AAs in NHATs, do we include Comets (like P/2009 WX51 Catalina)?
- AA Bennu? P/1999 RQ36 (LINEAR)?