Spitzer/IRAC Observations of C/2013 A1 (Siding Spring)

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Motivation

- Comet nucleus will not hit Mars, but the dust particles could.
- Dust particles ejected at >3 AU have the potential to be placed on Mars impacting orbits.
- Distant activity is unlikely to be driven by water.
- Need to measure the production rates of the more volatile species: CO_2, CO.
- *NEOWISE* observation in January 2014, indicated the presence of CO_2+CO gas (see next talk by Bauer et al.).

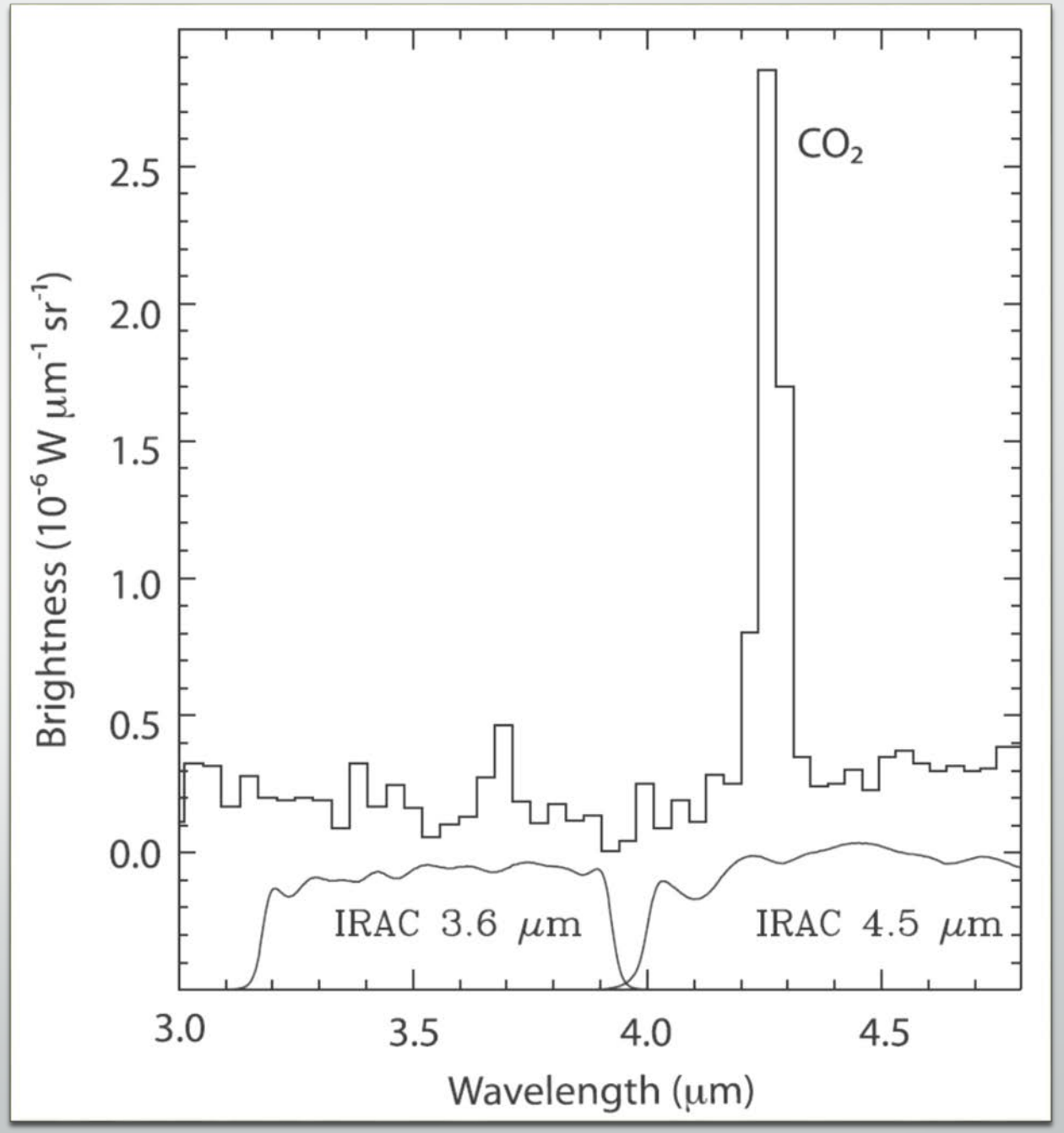
Goals

1. To measure the CO_2+CO gas coma and dust coma+tail.
2. To confirm and refine the *NEOWISE* photometry with a constraint on the reflectance and thermal emission of the dust.
3. To determine the gas responsible for driving the comet's activity: CO_2 or CO.
4. To determine the heliocentric dependence on activity from 3. to 3.1 AU.

ISO/ISOPHOT spectrum of comet Hartley 2, and *Spitzer*/IRAC bandpasses (Reach et al. 2013).

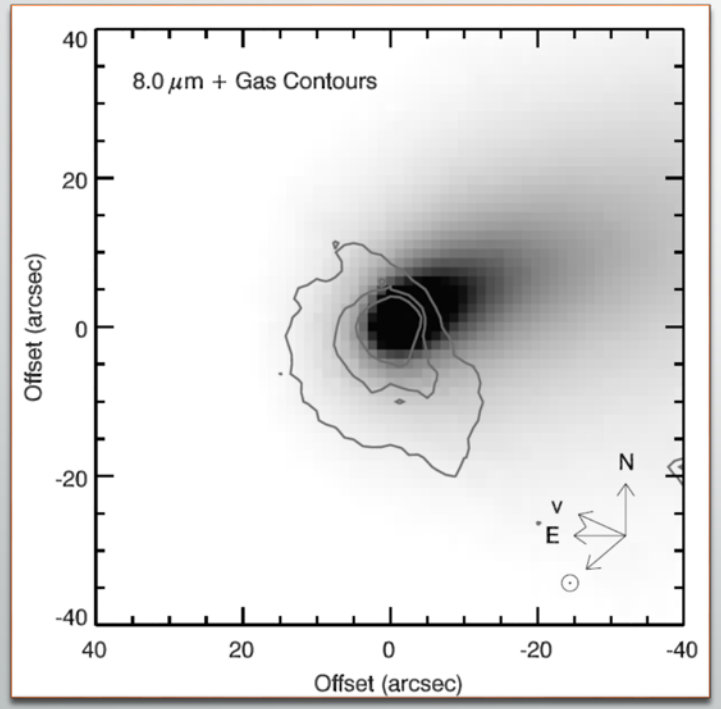
The 3.6-μm bandpass is nominally dust dominated.

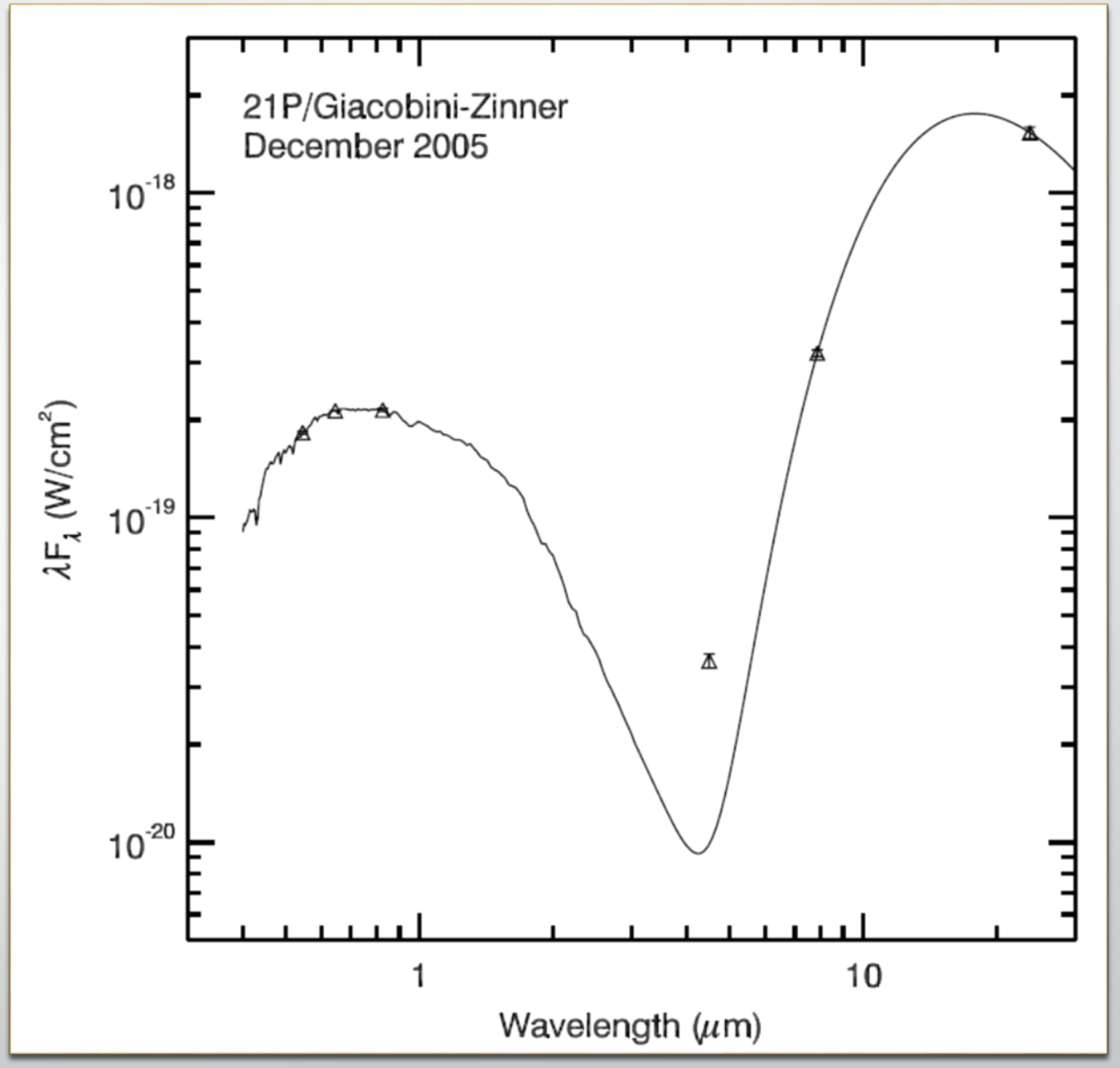
The 4.5-μm bandpass may have strong emission from CO_2 (4.26 μm) or CO (4.67 μm) gas.



Comet 21P/Giacobini-Zinner photometry from Pittichova et al. (2008).

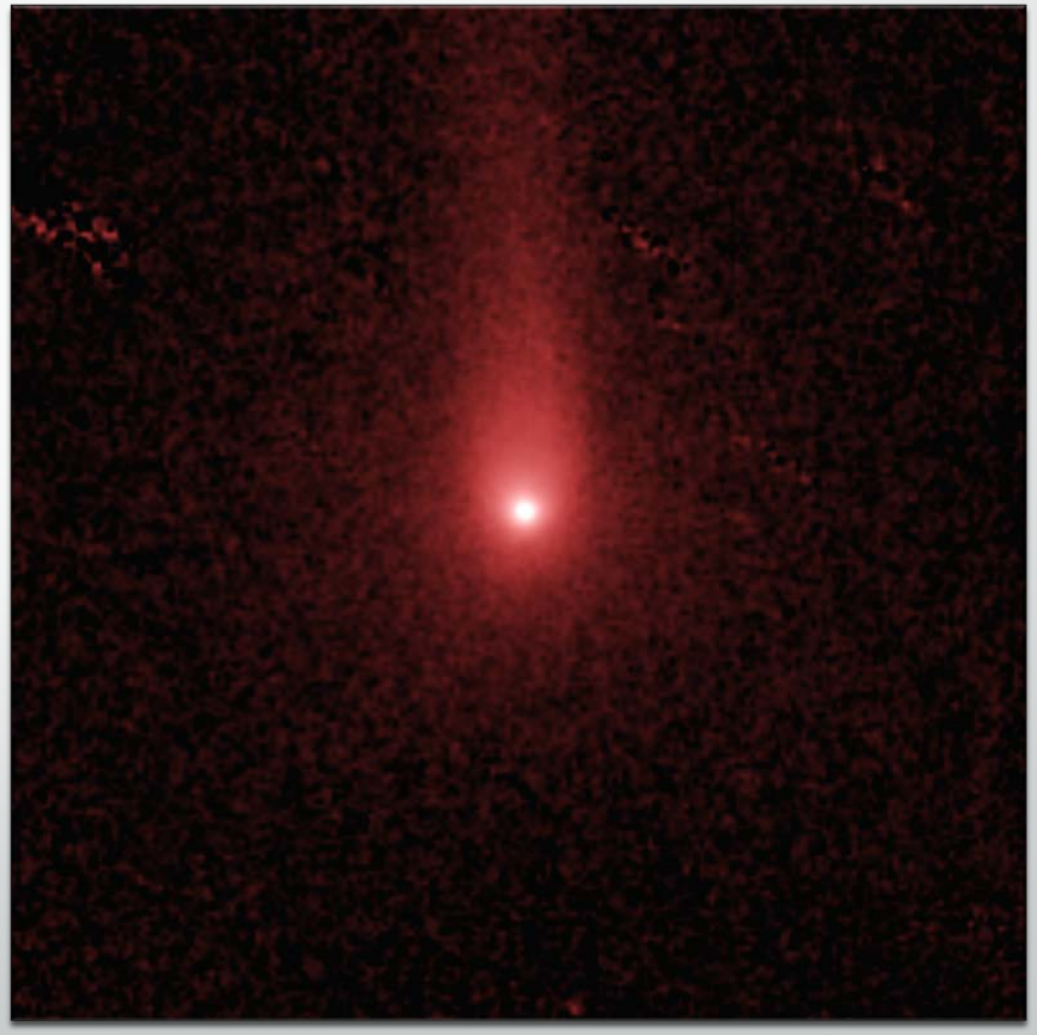
- UH 2.2-m: *V*-, *R*-, and *I*-band.
- *Spitzer*: 4.5, 8.0, and 24 μm.
- 2.3 AU from the Sun.
- Clear excess from gas at 4.5 μm.
- For more *Spitzer* detections of CO2+CO gas, see Reach et al. 2013.





Observations

26 March 2014, r_h = 3.1 AU, Δ = 3.1 AU



Observations

- Color combination:
  - Blue = 3.6
  - Green = 3.6 + 4.5
  - Red = 4.5
- The dust is blue/white, the gas is red/orange.

Interpretation

- Q(dust) ~ 20 kg/s based on tail modeling of *Hubble* images.
  - ✓ $Q(CO_2) = 3.5 \times 10^{26}$ molec/s = 26 kg/s Preferred!
  - $Q(CO) = 4.1 \times 10^{27}$ molec/s = 200 kg/s Implied dust-to-gas ratio too low.

- CO_2 activity should be very low at larger distances from the Sun
  - T_{sublim} ~ 80 K, occurring around 13 AU for a comet.
  - Depending on the nucleus size, millimeter-sized dust may not even be liftable beyond 8 AU (Kelley et al. in press).

- $Q(CO_2) \sim r_h^{-0}$ for 3.8 to 3.1 AU (*NEOWISE* to *Spitzer*).

- Results to be published in Farnham et al. (in preparation).