Is it possible to observe meteoroids ejected from asteroid (3200) Phaethon in 2009?

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Asteroid (3200) Phaethon

- Discovered as 1983TB
- NEA, $a = 1.4$ AU, $e = 0.9$ $\Rightarrow q = 0.14$
- Geminid’s parent body
- No activity was observed
- … till 2009

Dead comet?  
Asteroid?

Phaethon brightened by 2 mag or more at UT 2009 June 20.2 ± 0.2

Outburst lasted 2 days

- Interaction with the solar wind
- Sublimation of the deep ice
- Thermal decomposition and fracture
Model

- Ejection of 30,000 particles
- Ejection velocity < 100 m/s
- Integration forward till 2021 (Everhardt, all planets)

Phaethon will approach the Earth in 2017
\[ \Delta = 0.0689 \text{ AU} \]
We looked for the following answers:

- could the dust produced be observed on the Earth as meteors?
- could these meteors somehow be separated from the ‘regular’ Geminid meteors?
What was found

- Swarm approach the Earth in 2014 (278 particles), 2017 (1036), 2018 (8), 2020 (326)
- $\Delta r \geq 0.018$ AU
- In all cases the swarm behaves in much the same way
2017: Δr : 0.018 – 0.030 AU, nodes — 0.1 AU
Activity profile
Activity profile

- The outburst may take place at 262°.5
- To exceed the usual level of activity, mass of the 2009 swarm should exceed approximately $2 \times 10^8$ kg.
- The upper limit of dust production by Phaethon due to thermal fracture is estimated about $10^{10}$ kg.
Radiant
Radiant

- **Small spot:**
  \[ \alpha \approx 114^\circ.65 \pm 2^\circ.5, \ \delta \approx 32^\circ.7 \pm 0^\circ.1 \]

- **Feature:** concentration of radiants of meteors of various magnitudes in this spot

- **Problem:** the fine structure of the Geminid’s radiants
Summary:

- Minimal distance $\geq 0.018$ AU, Earth Influence sphere $\approx 0.03$ AU $\Rightarrow$ possible, but the probability is not high.
- Probability increases with time.
- **Problem:** the observational bias calls for investigation.