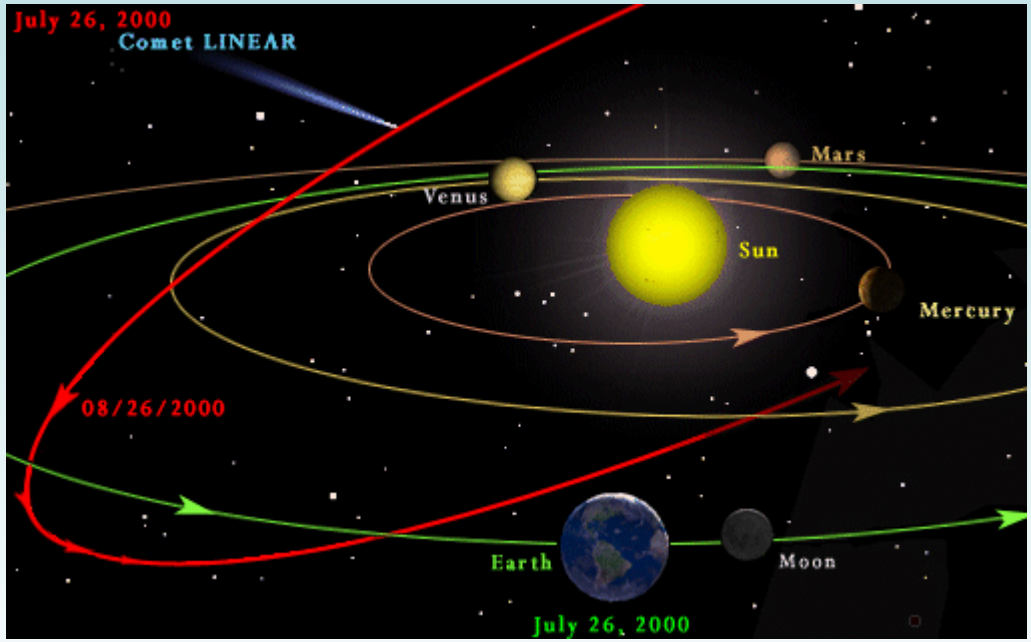
Meteoroid stream simulations at The University of Western Ontario



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Why do we care about meteoroid streams modeling?

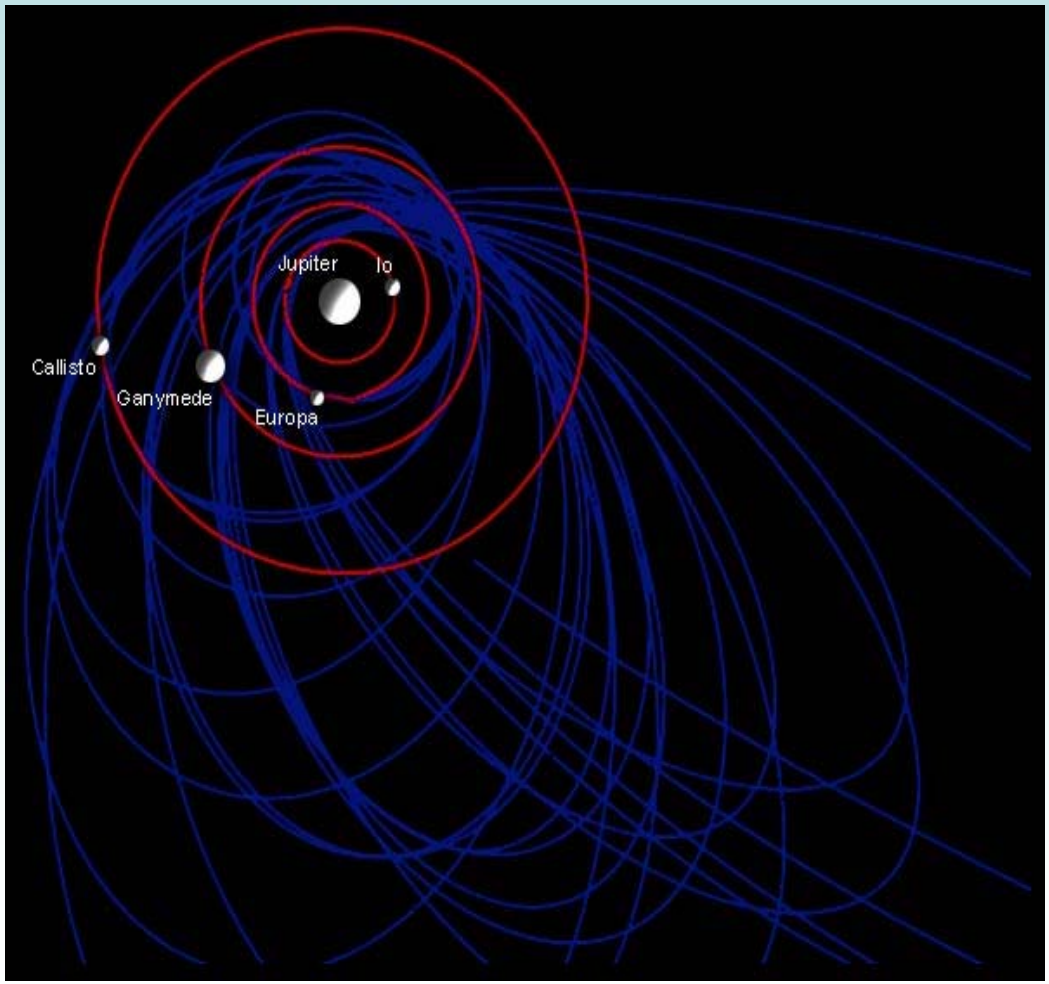
- Comets and asteroids – by-product of The Solar system formation
- Meteoroids are associated with comets and asteroids
- Understand the dynamical evolution of the smallest members of the Solar system
- Infer some physical properties of their parents

What we do…

- Numerical modeling of the dynamics of meteoroid streams
  - Meteoroid stream – Parent association
  - Age of a meteoroid stream
  - Formation mechanism
    - Cometary ejection
    - Collision, tidal, spin-up disruption
  - Predict enhanced meteor activity

How we do it?

- Use video, photographic and/or radar meteor data
  - Initial conditions
- Backwards integration of the Eq. of motion
  - Gravitational
    - Sun
    - Planets
  - Non-gravitational forces
- Look for potential ejection epoch
- Forward integration
- Comparison with observations



Video Equipment

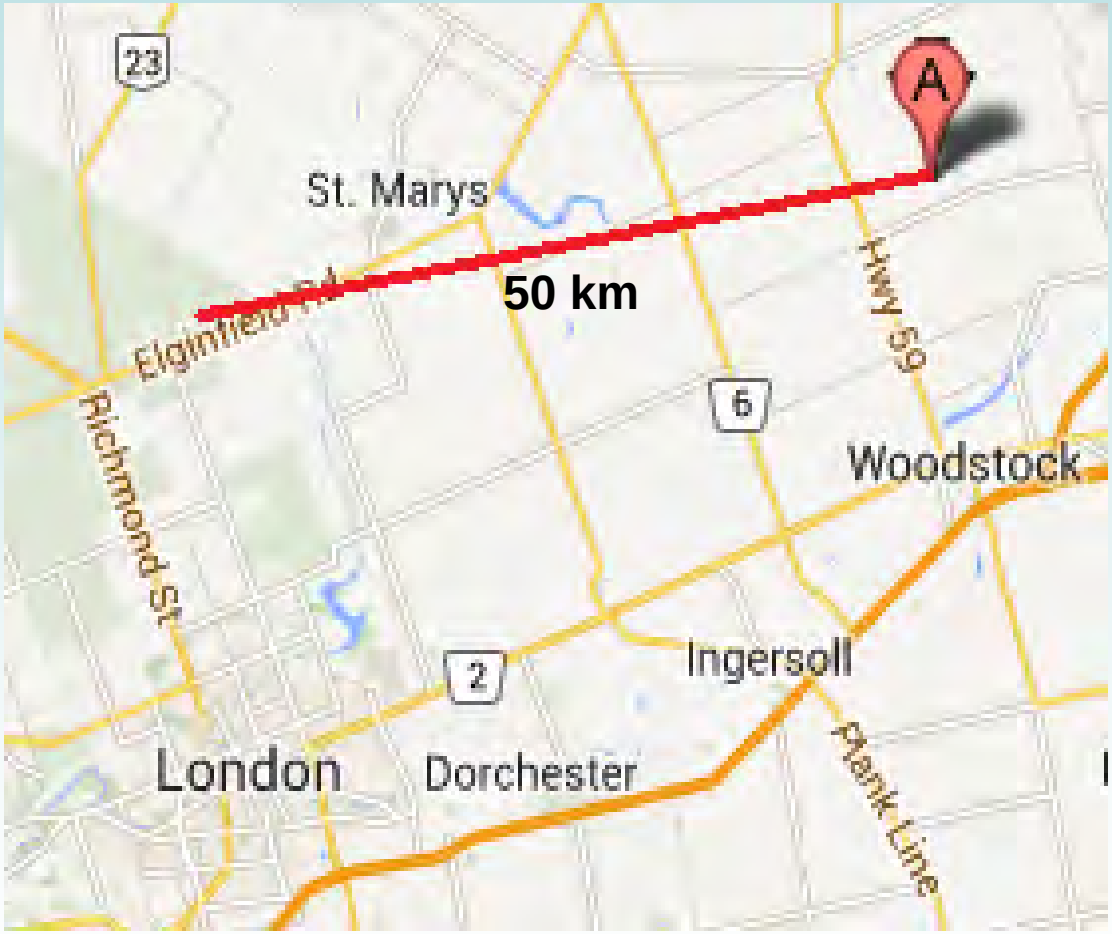
Canadian Automated Meteor Observatory (CAMO)

Two main sites

- **Elginfield**
- **Tavistock**

– **Sample the mm-sized and larger**

– **Determine the physical properties of meteoroids**

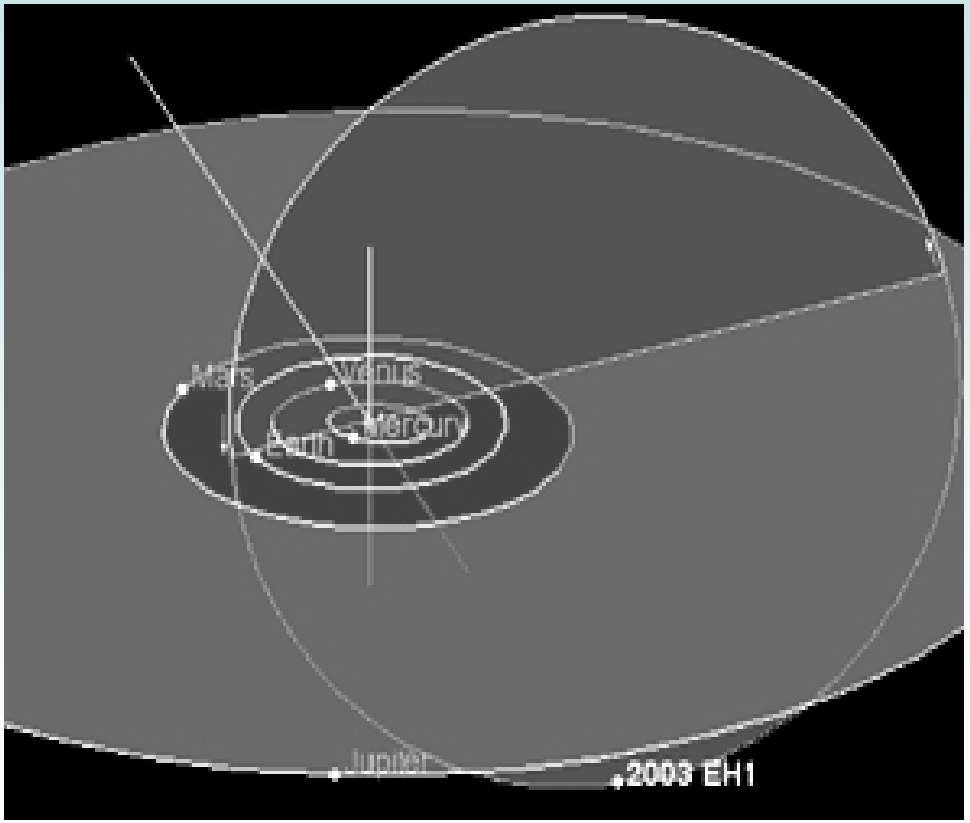


Canadian Meteor Orbit Radar (CMOR)

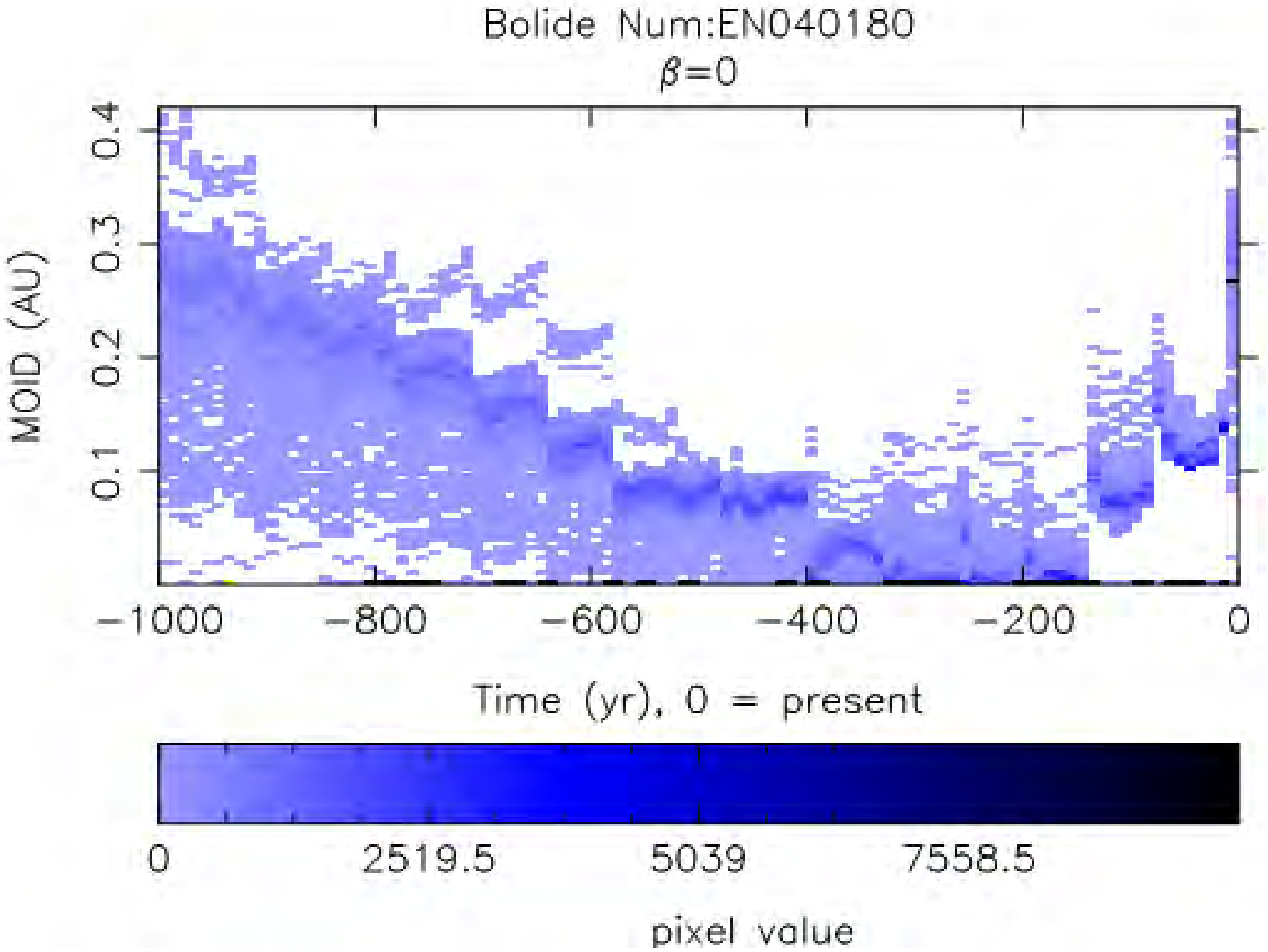
- **Submilimetre – sized particles**
- **Operates during the day and bad weather**
- **Measures ~ 5000 orb/day**
- **Fully-automated**

Sample Work

- **Quadrantids**
  - 2003EH1 (*Jenniskens* 2004) – dormant or extinct comet?
  - The age and probable formation mechanism
  - Backwards numerical integrations
  - Probable formation epoch – circa 1800 A.D
  - Still no information about the formation mechanism



Credit: http://leonid.arc.nasa.gov/leonidnews47.htm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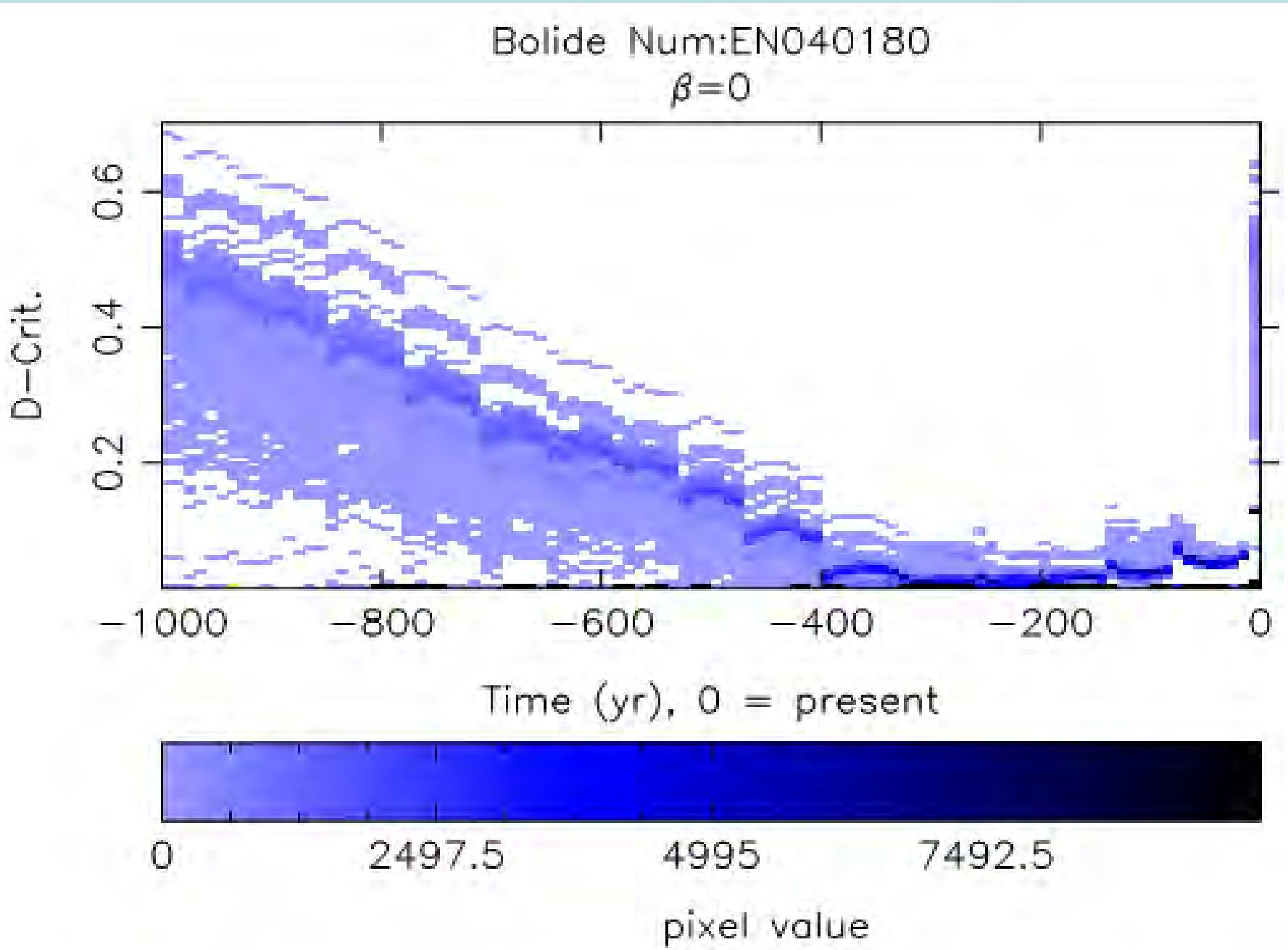
pixel value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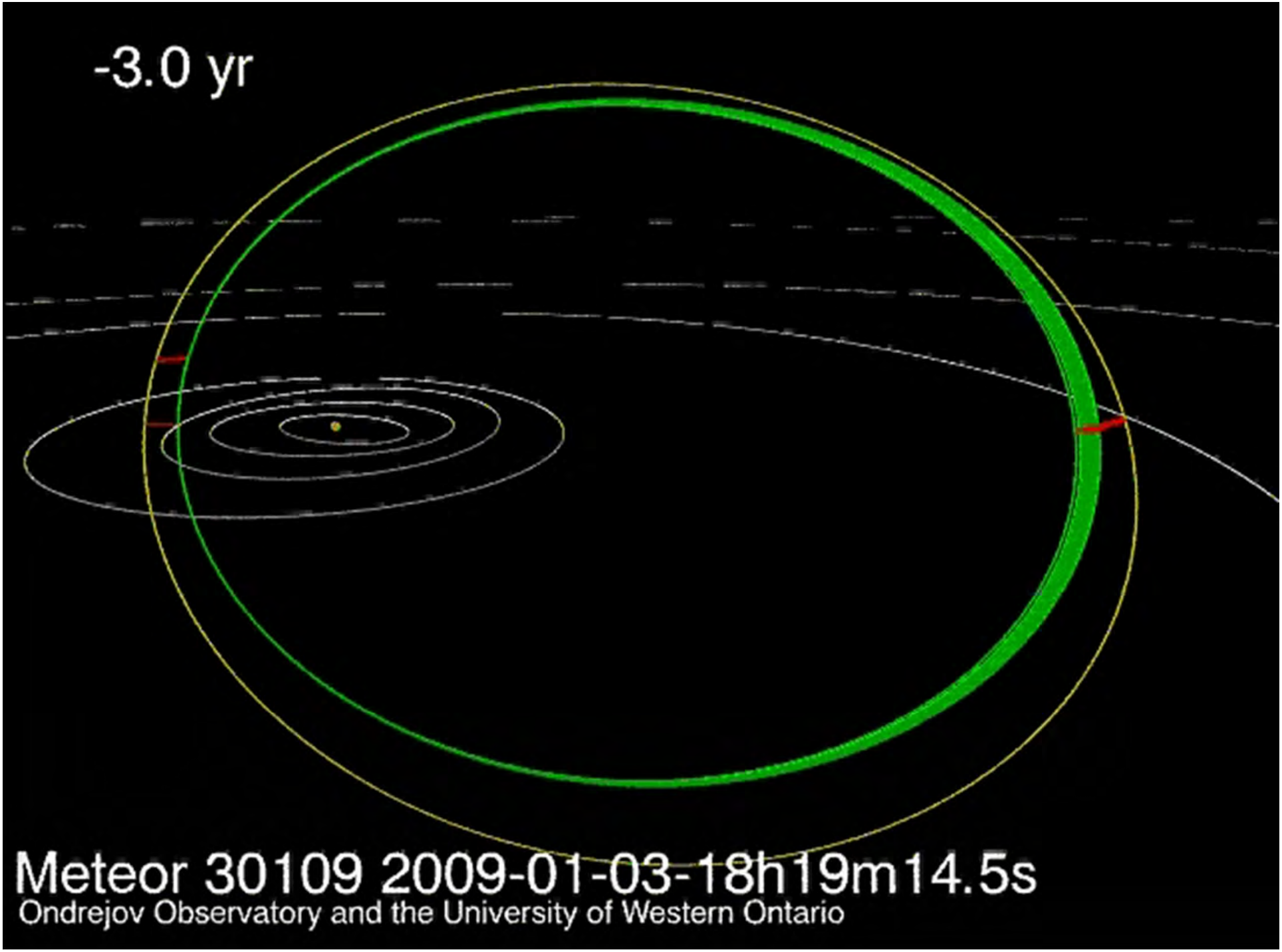
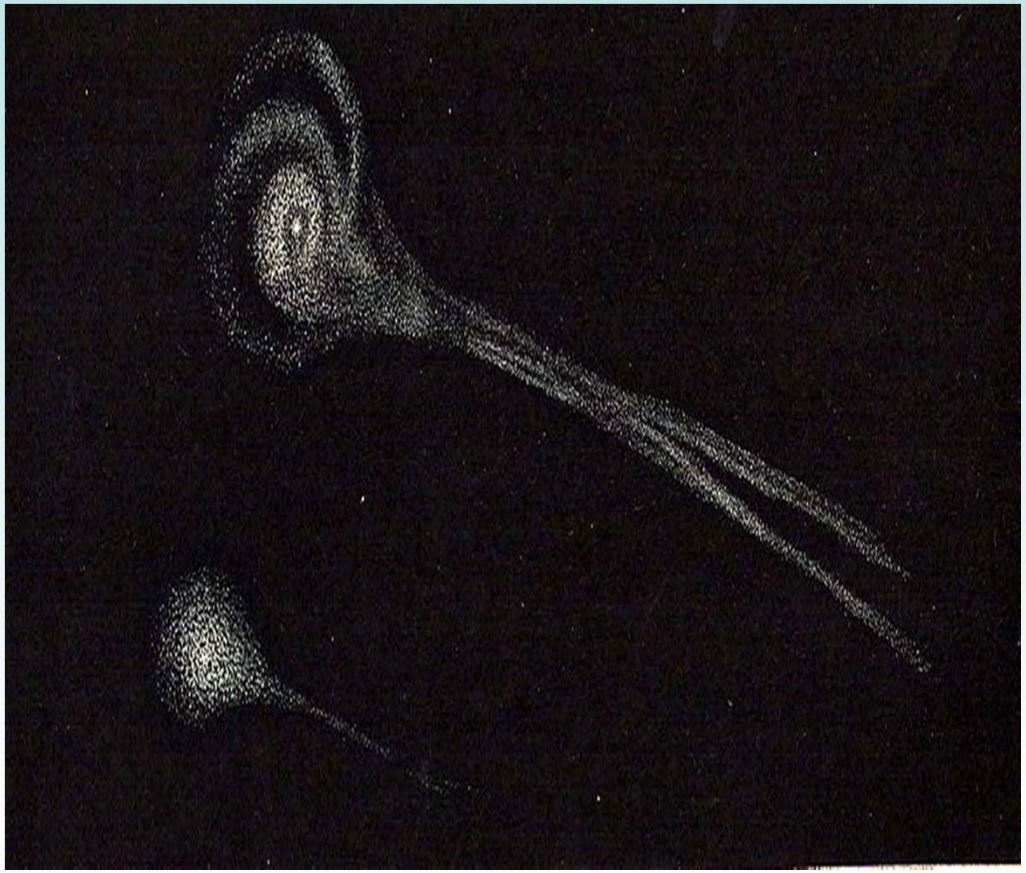

-3.0 yr
Meteor 30109 2009-01-03-18h19m14.5s
Ondrejov Observatory and the University of Western Ontario

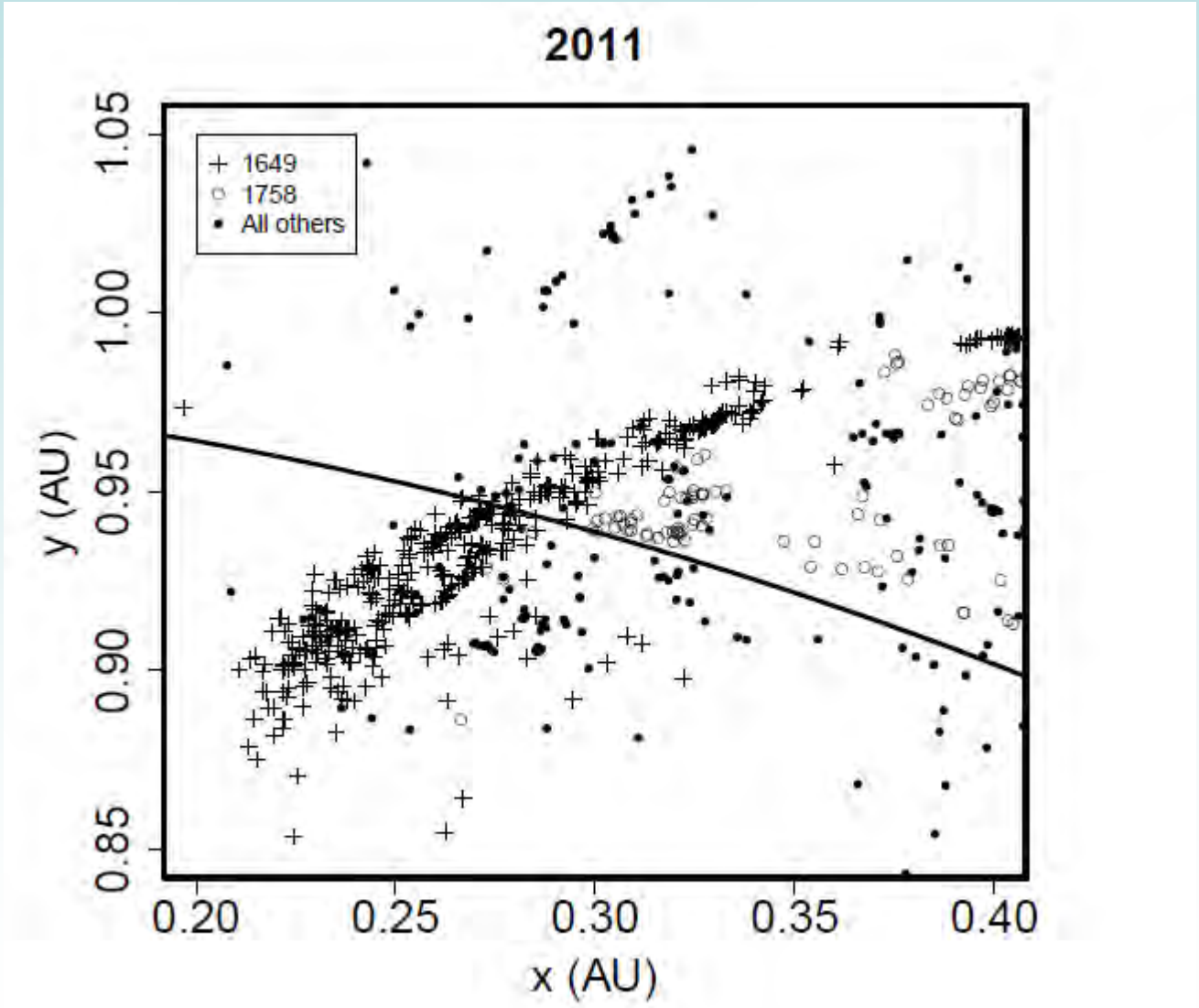
The return of Andromedids

- Andromedids
  - Associated with comet 3D/Biela
  - Peaks Dec 4-5
  - Discovered 1772 (*Kronk* 1999)
  - 1845/1846 disintegration
  - Strong outburst – 1872 and 1885
  - Increased activity 2011
    - 122 Andromedids by CMOR
    - ZHR ~ 50



Drawing of Comet Biela in February 1846.
Eric Weiss, *Bilderatlas der Sternenwelt" 1888.*

Simulations: Nodal footprint of the stream



Simulated peak produced by dust from 1649 perihelion passage (pre-discovery of the comet)

Conclusions

- We perform numerical simulations of meteoroid stream dynamics
  - Determination of ages and formation mechanisms
- Quadrantids:
  - Probable formation epoch circa 1800 A.D.
  - Formation mechanism still under investigation
  - More details at Meteoroids 2013
- Andromedids:
  - 2011 enhanced activity – due to ejection in 1649
- Still much to do …