Leonid meteoroids from different filaments

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Outline

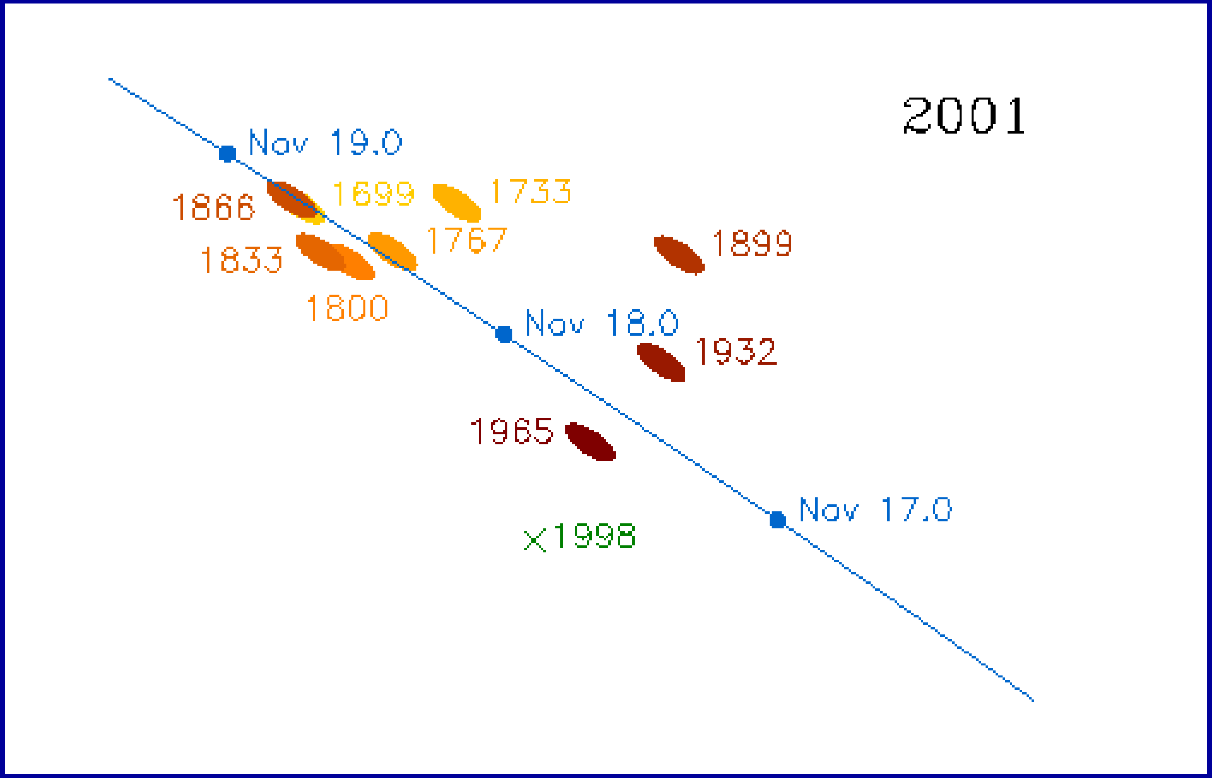
- Leonids in 1999-2009
- Observations, equipment, methods
- Beginning heights and properties of meteoroids
- Results and comparison of different filaments

Leonids between 1998 and 2009

comet 55P/Tempel-Tuttle - perihelion 1998 February 28
strong activity or storms in 1998 – 2002
another enhanced activity 2006 and 2009

different filaments of the stream, i.e. different time of ejection from parent comet

(situation in 2001 by D. Asher)



Individual filaments

Year	1998	1999	2000	2001	2002	2006	2009
Date	17.11.	18.11	18.11 .	18.11.	19.11.	19.11.	17.11.
Time [UT]	1:29	2:13 1:49	3:48 7:57	10:06 18:25 17:59	4:02 10:48	4:45	21:44 22:02
Year of ejection	1333	1899 1932	1733 1866	1767 1866 1699	1767 1866	1932	1466 1533
Note	fireballs	OK OK	OK -	OK - -	clouds -	OK	OK OK

Sources – Vaubaillon et al. (2005); McNaught and Asher (1999)

Our observations of Leonids

Year	**Filaments (age)**	**Location**	**Number of D-S Leonids**
1999	1899, 1932 (3, 2)	Spain	97
2000	1733 (8)	Spain	54
2001	1767 (7)	Arizona USA	362
2006	1932 (2)	Czech Republic, UK	27
2009	1466, 1533 (16, 14)	Tajikistan	56

D-S means double-station (D_{SH}, D’ criterions)

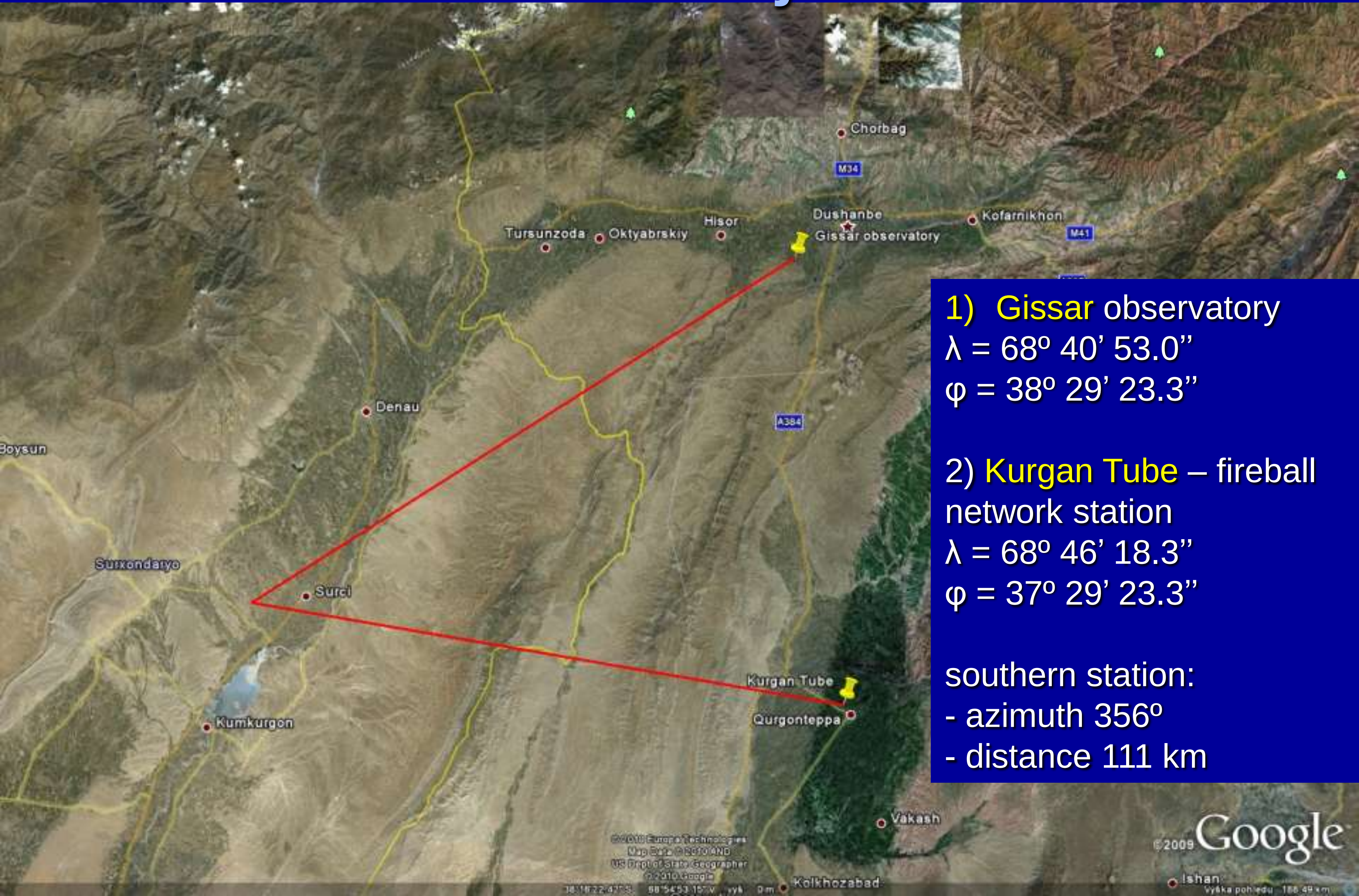
Instrumentation

S-VHS video camera
+ image intensifier
Dedal-41 (till 2002)
Mullard XX1332

Arsat 50mm/F1.4:
Ø FOV = 25º/44º
MLM +5.0m

spectral camera
600 grooves/mm

Observation in Tajikistan 2009



1) Gissar observatory
λ = 68º 40’ 53.0”
φ = 38º 29’ 23.3”

2) Kurgan Tube – fireball network station
λ = 68º 46’ 18.3”
φ = 37º 29’ 23.3”

southern station:
- azimuth 356º
- distance 111 km

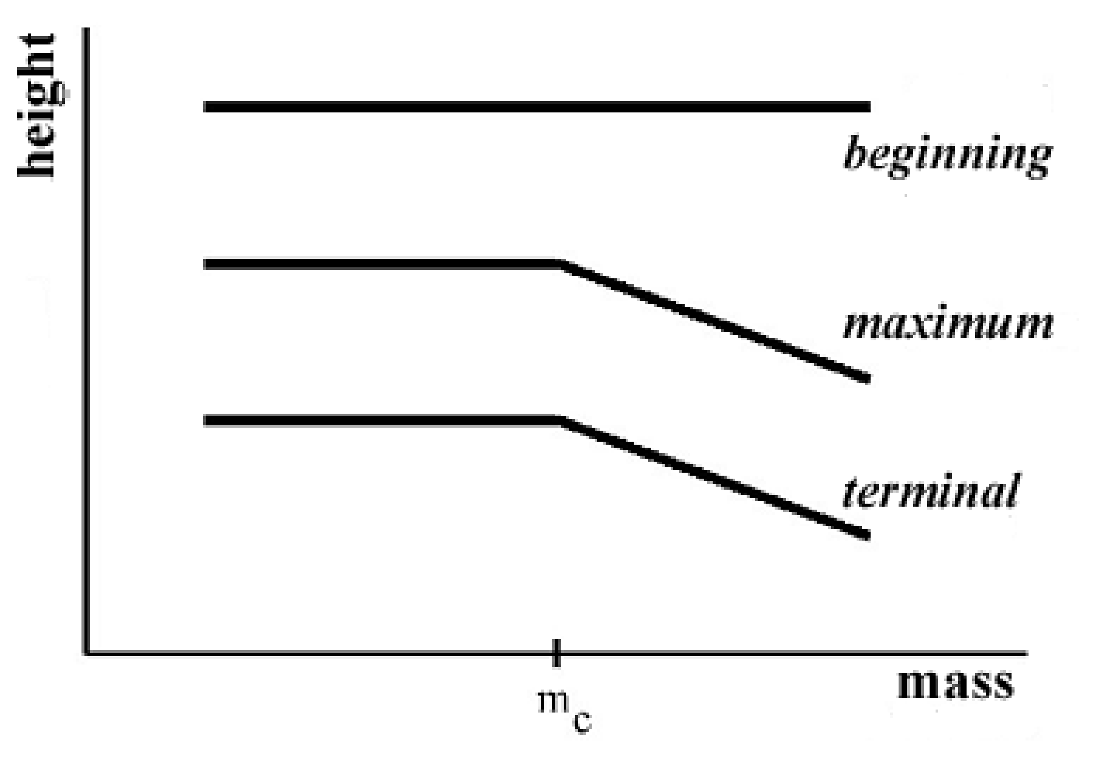
Dust-ball model

Hawkes & Jones (MNRAS, 1975):
silicate or iron grains (3000 – 3500 K) + organic “glue” (~ 1300 K)
radiation – only grains, not glue

implications:

Beginning height constant
(for the same velocity meteors)

Height of maximum light,
terminal height – constant for
smaller particles, decreasing
for bigger masses
of meteoroids



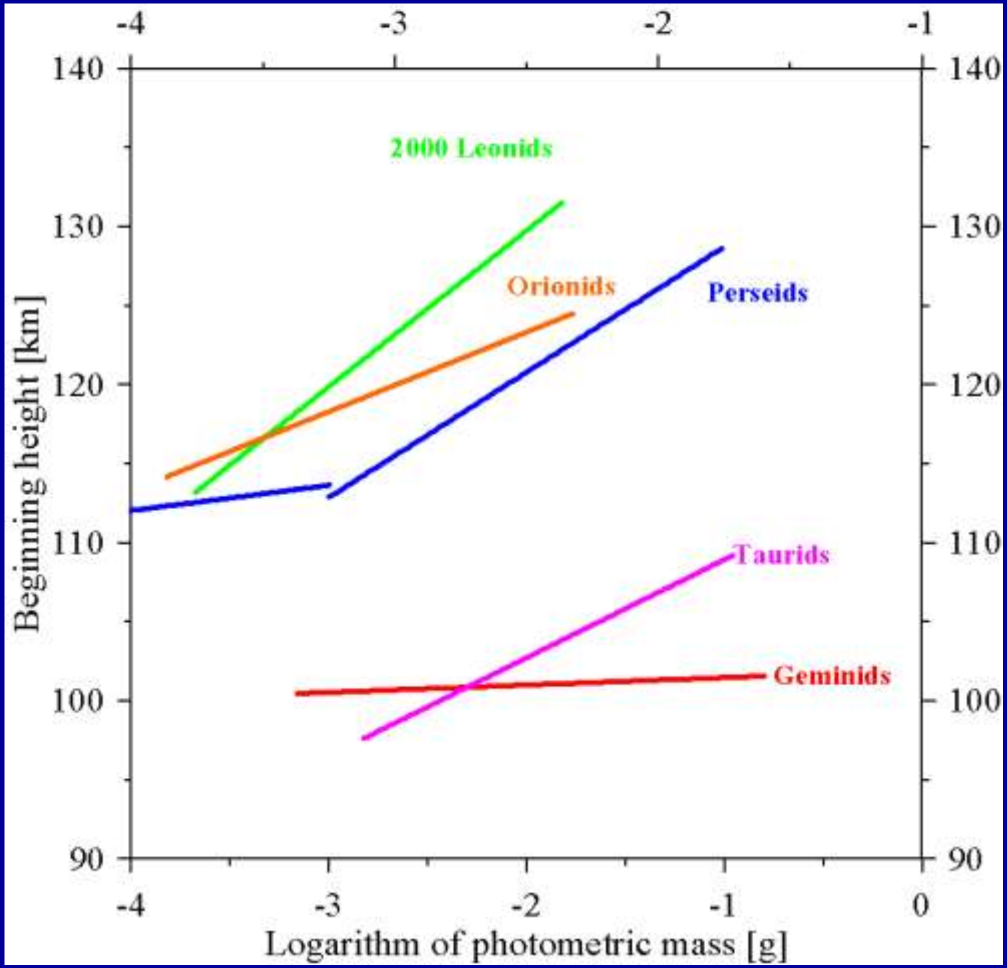
Beginning heights of different showers

Geminids – almost constant
other showers – increasing HB

GEM – just beginning of ablation and radiation
others – actual beginning higher, observation at sensitivity limit

More fragile meteoroids =
= more steep curve

(Koten et al., A&A, 2004)

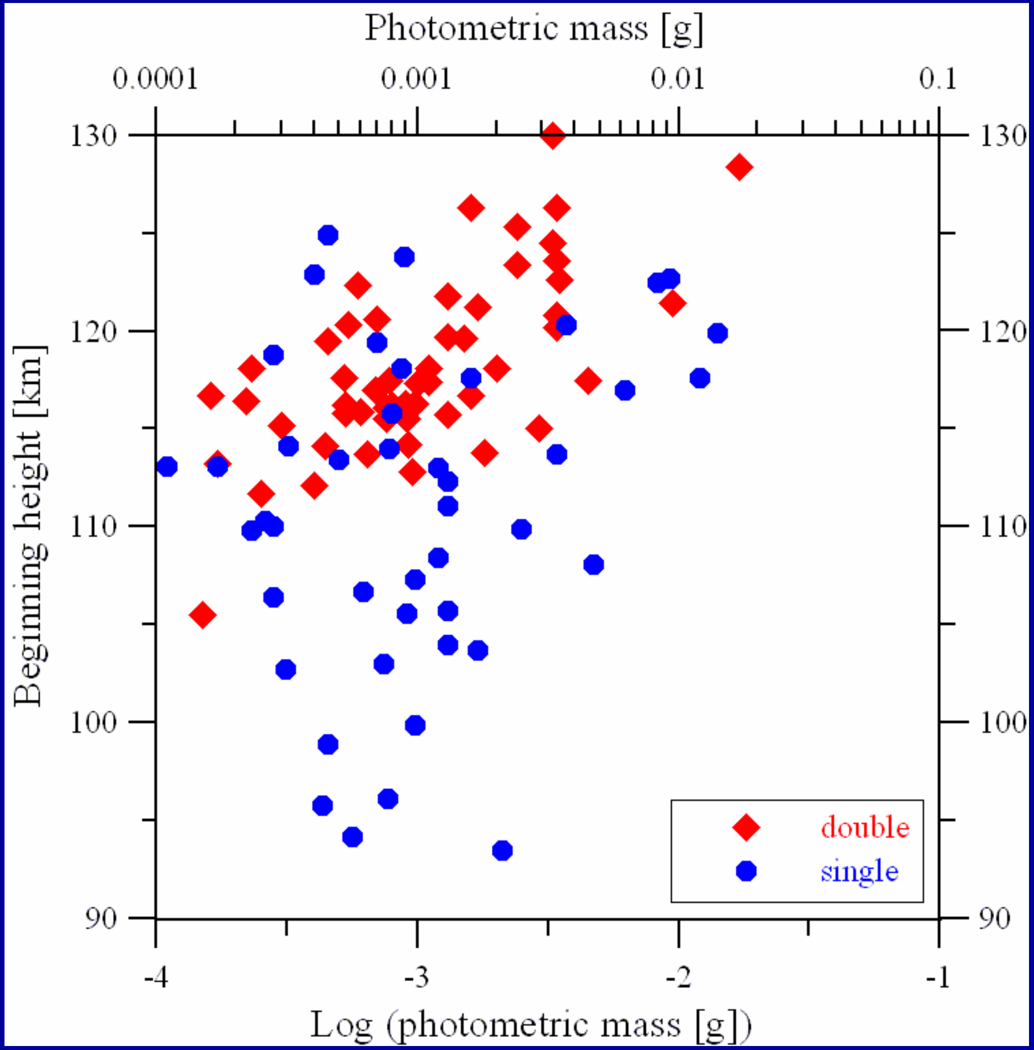


Beginning heights in 2009

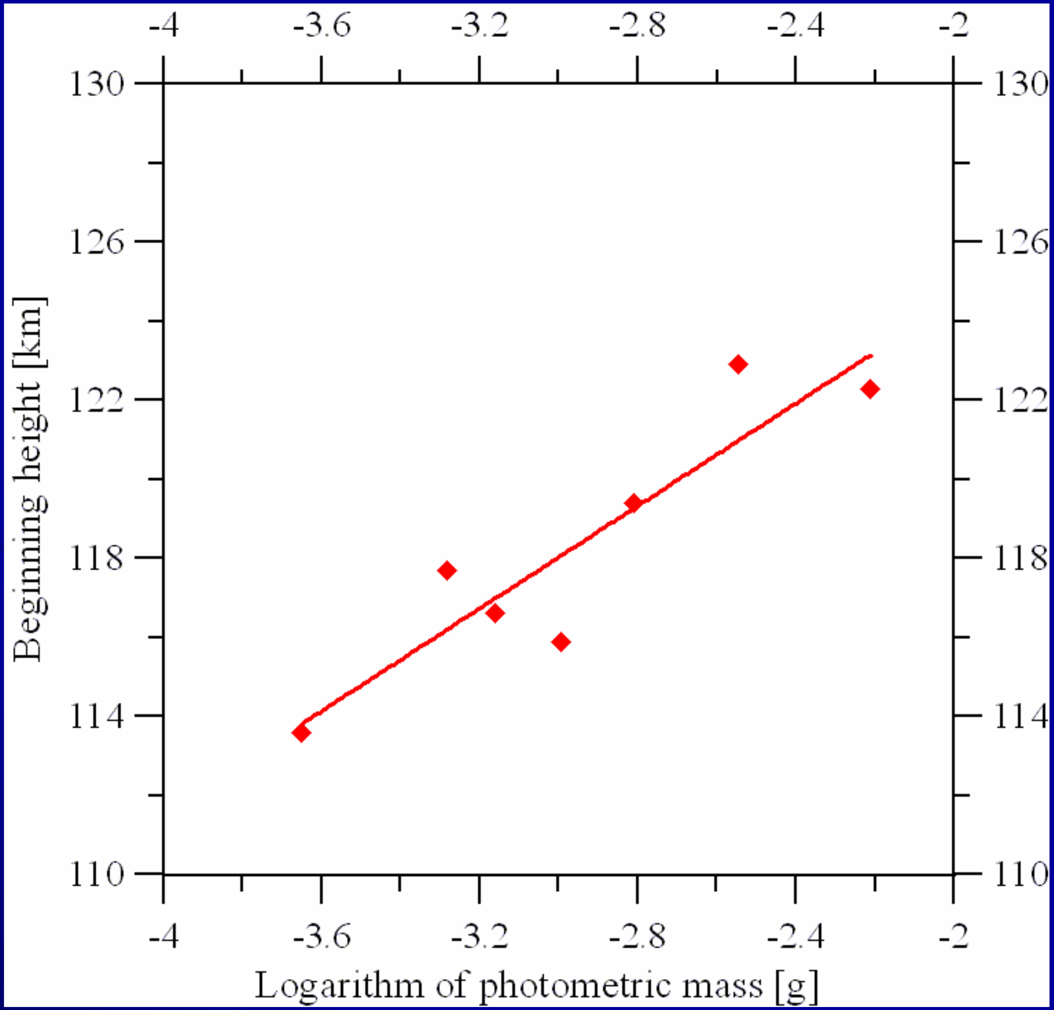
Leonids 2009:

beginning heights:
single and double station data

single station – estimated trajectories, wide spread of height data
=> useful for activity profile, mass index etc.



Distribution of beginning heights



distribution of H_B shows increase with mass

2009:
slope k = 6.5

Parameter K_B

One dimensional parameter – eliminates potential effect of different zenith distance of radiant (observations in different countries)

$$K_B = \log(\rho_B) + 2.5\log(v_\infty) - 0.5\log\cos(z_R)$$

Do we observe same effect for K_B as for H_B?

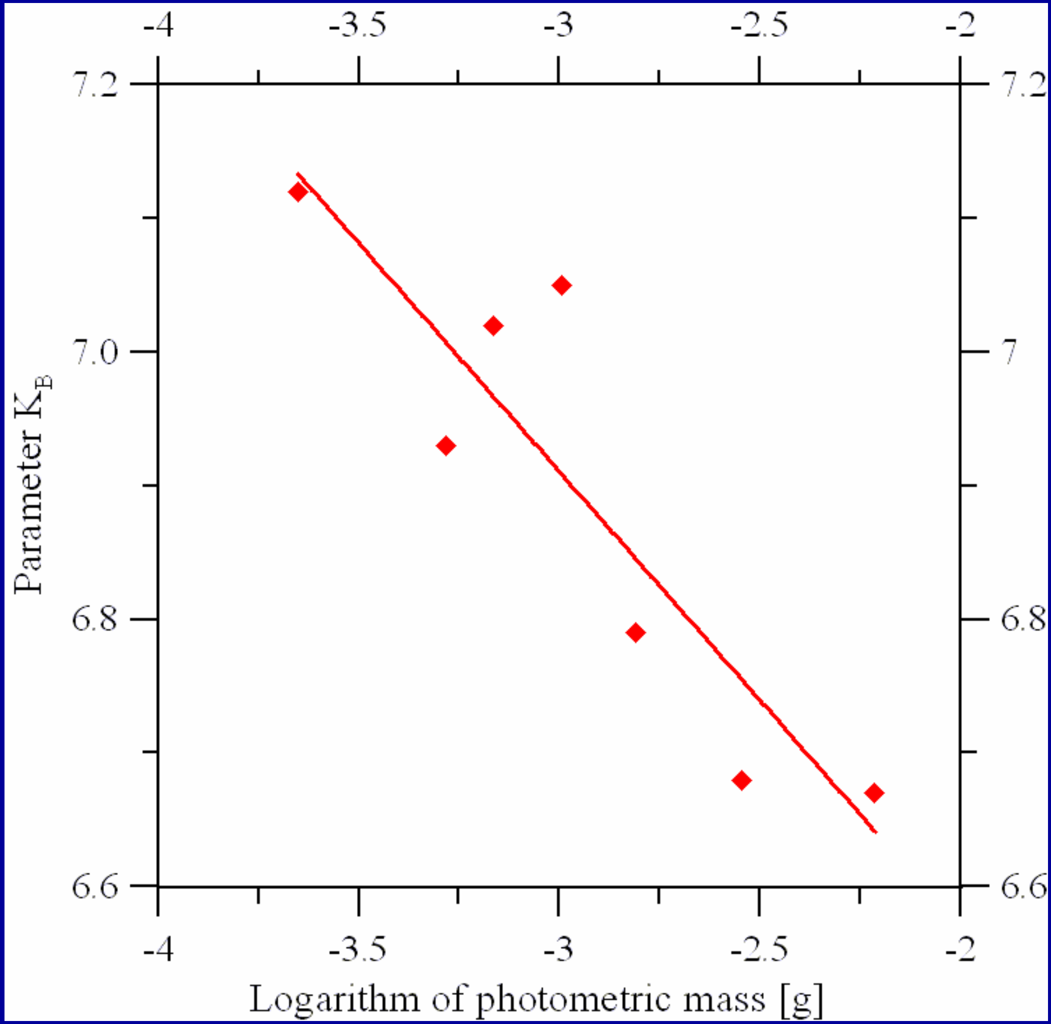
K_B vs. m_{phot}

<u>Leonids 2009:</u>

K_B decreases with increasing mass

observed among all studied filaments

not zenith distance of radiant effect

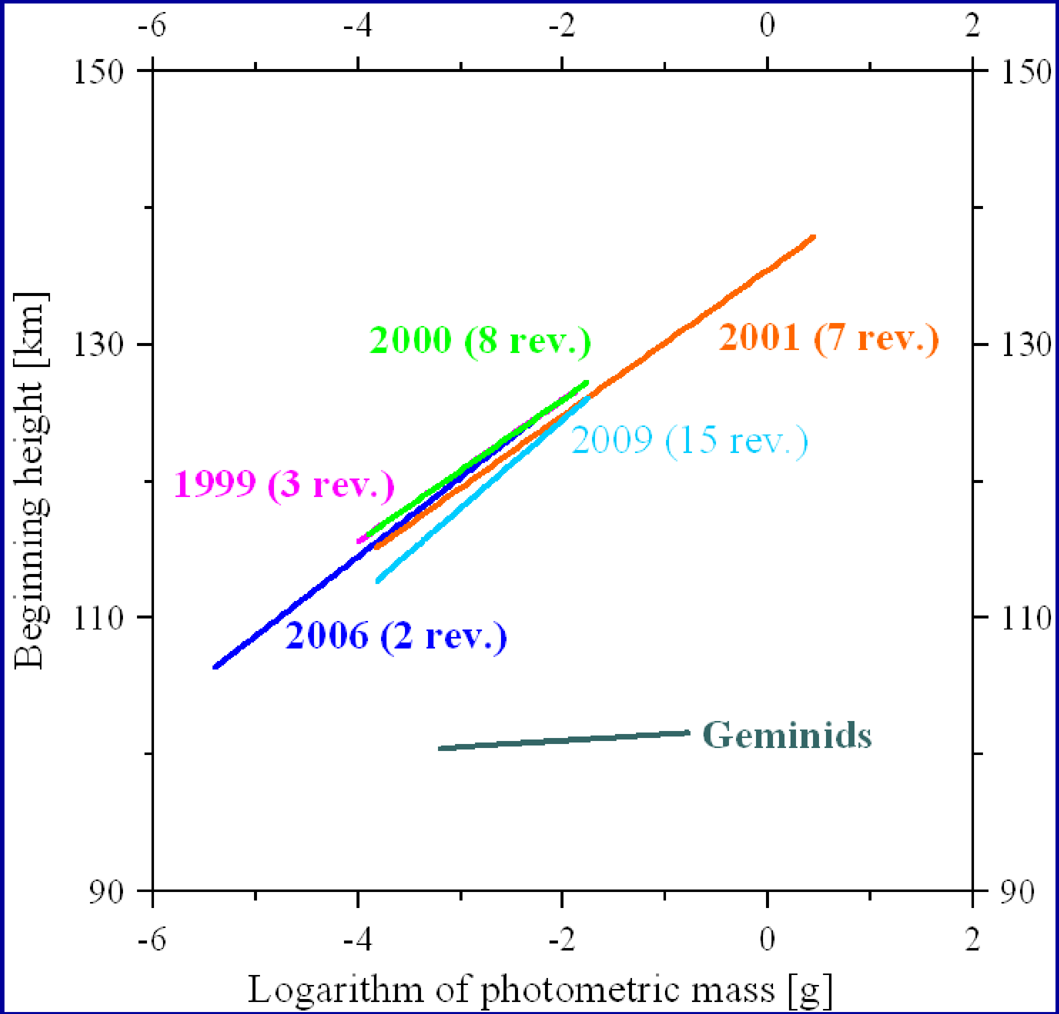


Comparison of different filaments

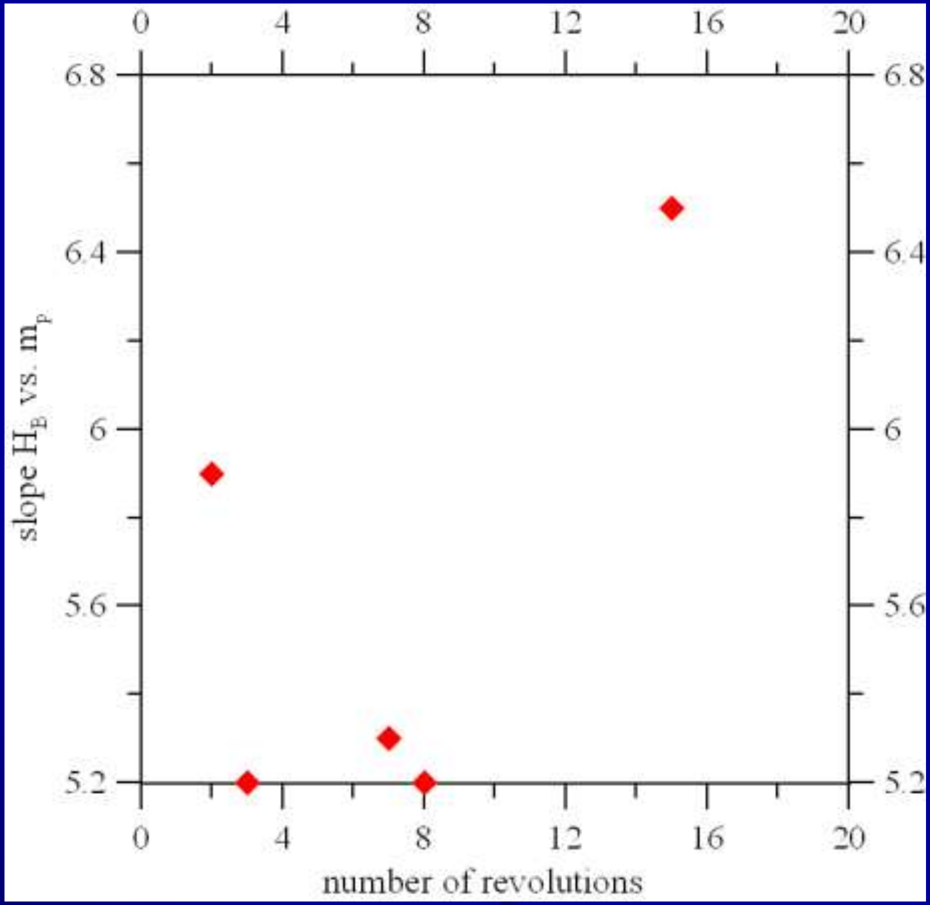
each line represents whole range of observed masses and beginning heights

different Leonid filaments = different values of *k* (slope H_B vs. M_{phot})

(Geminids for comparison - almost mass independent)



Fragility vs. time from ejection



higher *k* => more fragile particles (theoretical limit is 10)

does it depend on age?

idea:

dust is more influenced by spaceweathering

1466, 1533 – support idea

Conclusions

- 10 years of Leonid outbursts and storms
– samples of different age of meteoroids
- All filaments – more fragile material (according to H_B in the atmosphere)
- Small differences among filaments
- Suspicion – fragility dependence on age – cannot be clearly confirmed
- Next work => search for possible reasons

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