Voltage Pulses on STEREO/WAVES: Nanoparticles Picked-up by the Solar Wind

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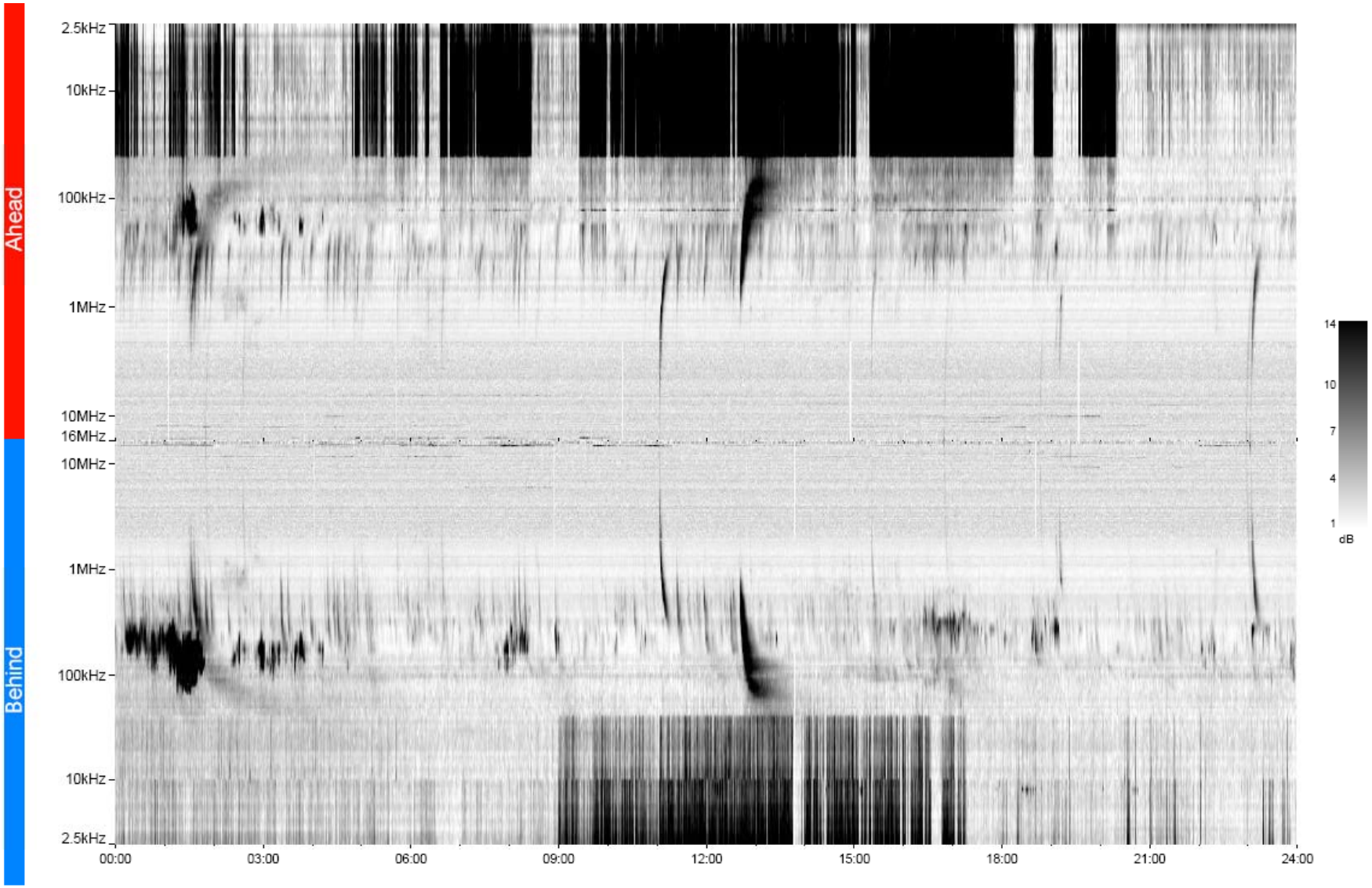

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Time (UTC)

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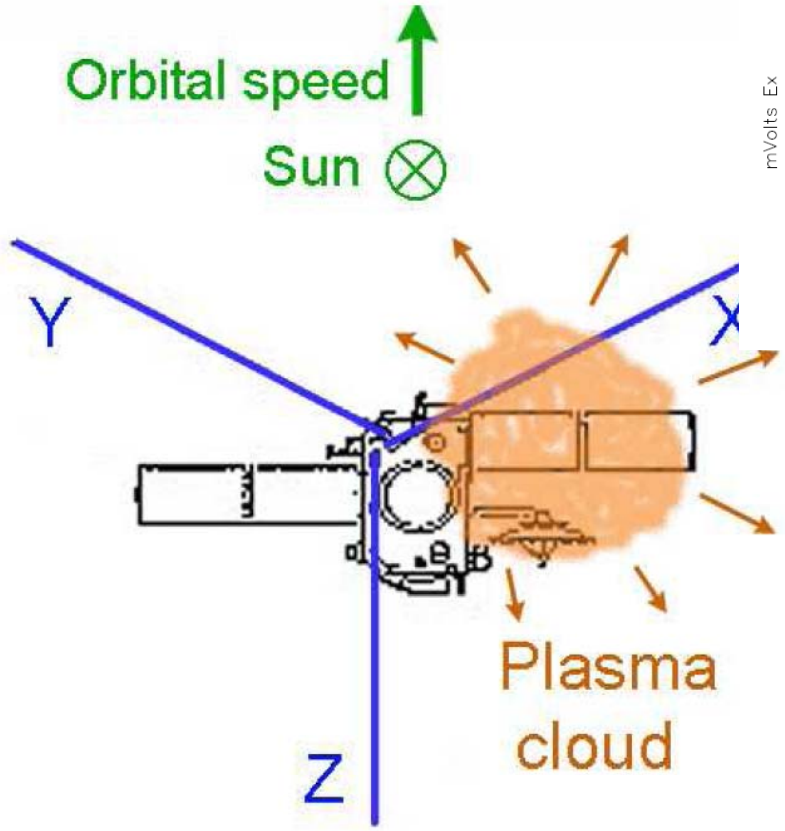
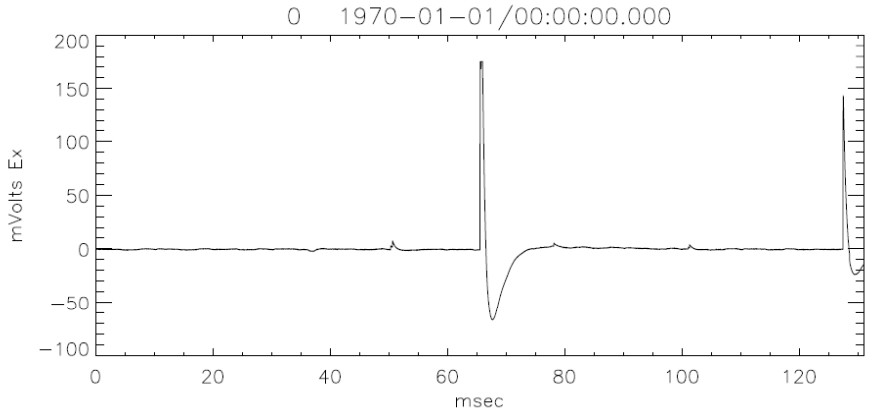
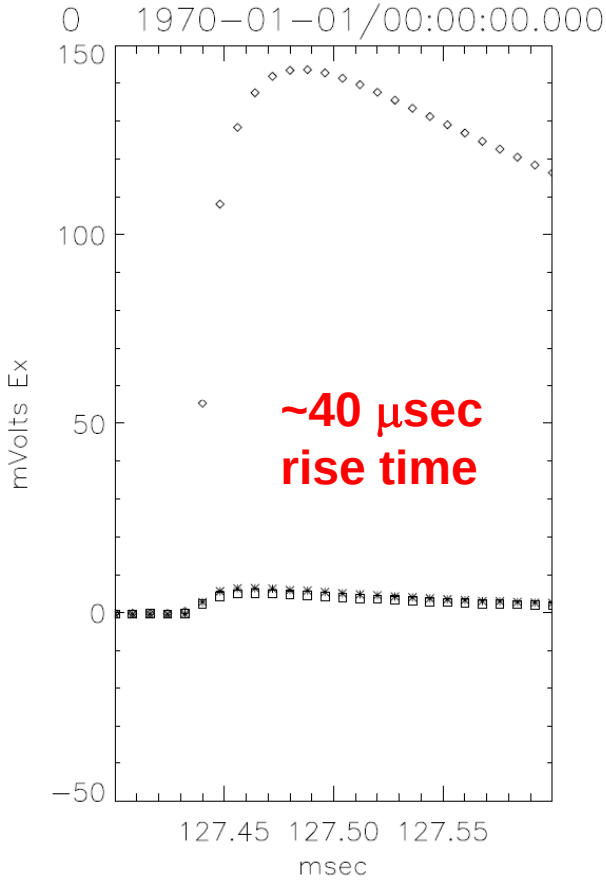
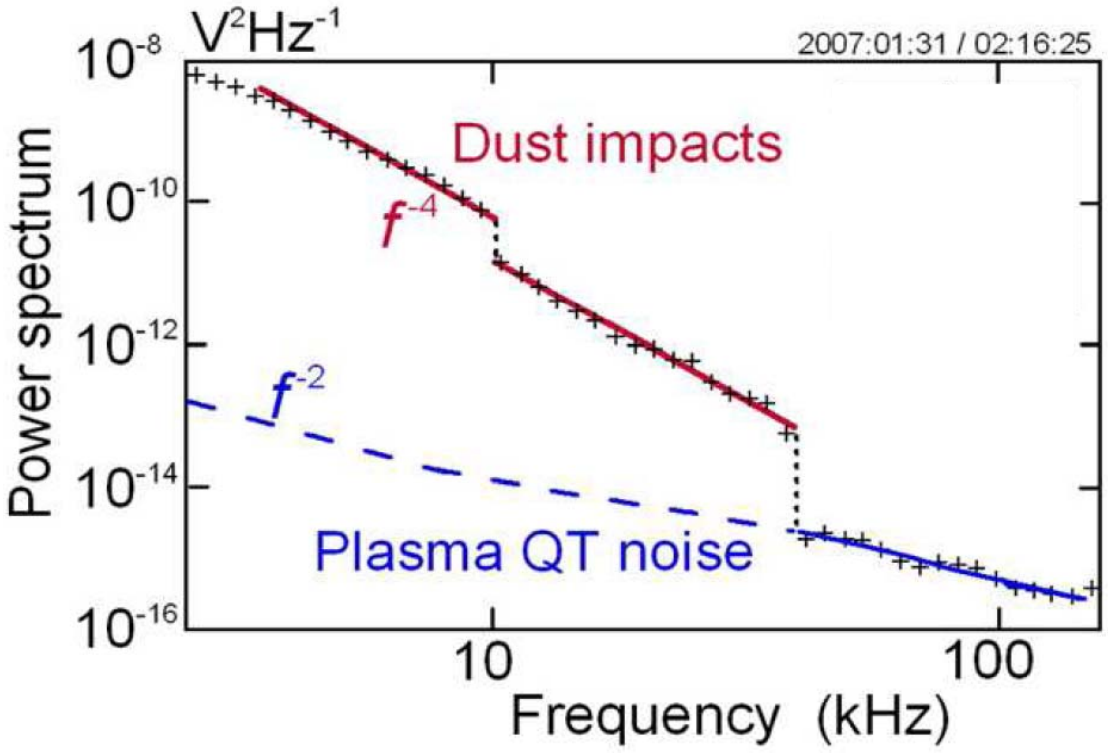






Released charge : $Q \simeq 0.7 m^{1.02} v^{3.48}$

Induced voltage pulse on S/C of capacitance *C* : $\delta V \sim -Q/C$



In the spectral domain :

For pulses of rate N, max. amplitude δV, and rise time τ (~40 μs), the theoretical power spectrum is

$$V_f^2 \simeq 2 < N\delta V^2 \omega^{-2}(1+\omega^2\tau^2)^{-1} >$$

$V_f^2 \propto N\,\delta V^2\,\omega^{-4}$ **, for** $\omega >> 1/\tau$

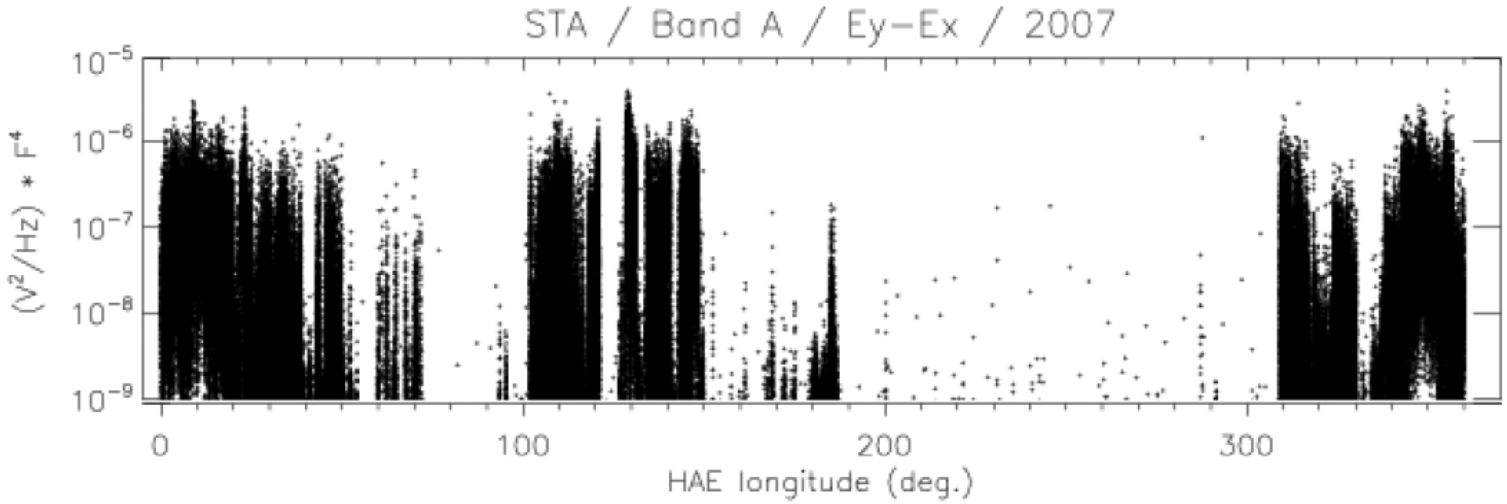
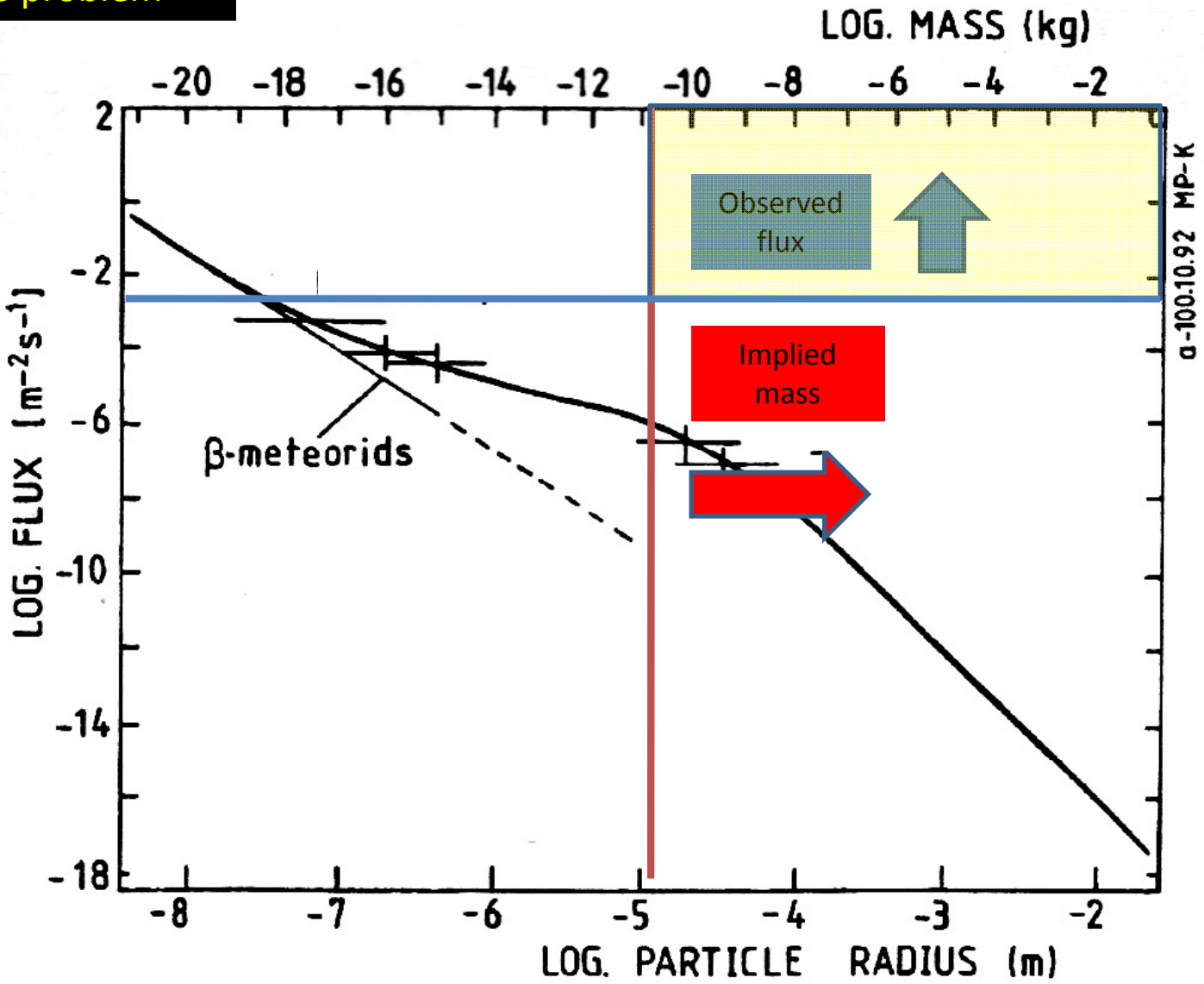


Figure 3. Average power observed by the STEREO/WAVES low frequency receiver (normalised to f^4_{kHz} and integrated in the lower band) on STEREO A as a function of ecliptic longitude in 2007.

Grün's Interplanetary Dust Distribution at 1 AU
Grün, E, et al., *Icarus, 62*, 244-272 (1985)

The BIG problem

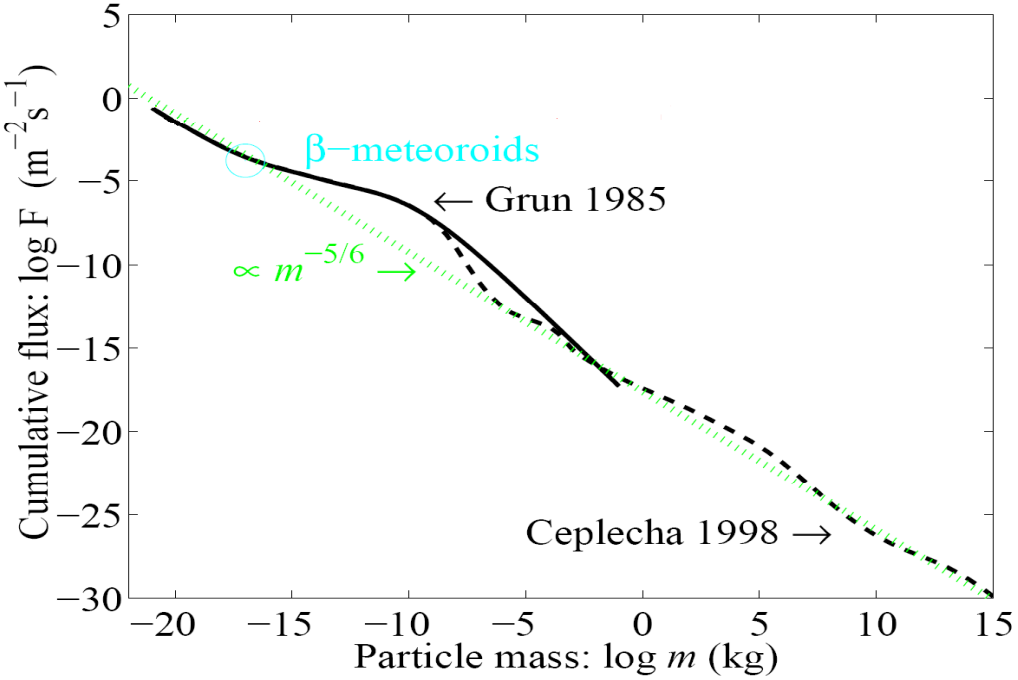


The solution to the problem

Released charge : $Q \simeq 0.7 m^{1.02} v^{3.48}$

→ *A nanoparticle @ 300 km/s* ~ *a grain of mass 10^4 greater @ 20 km/s*

Picked-up by the VXB field

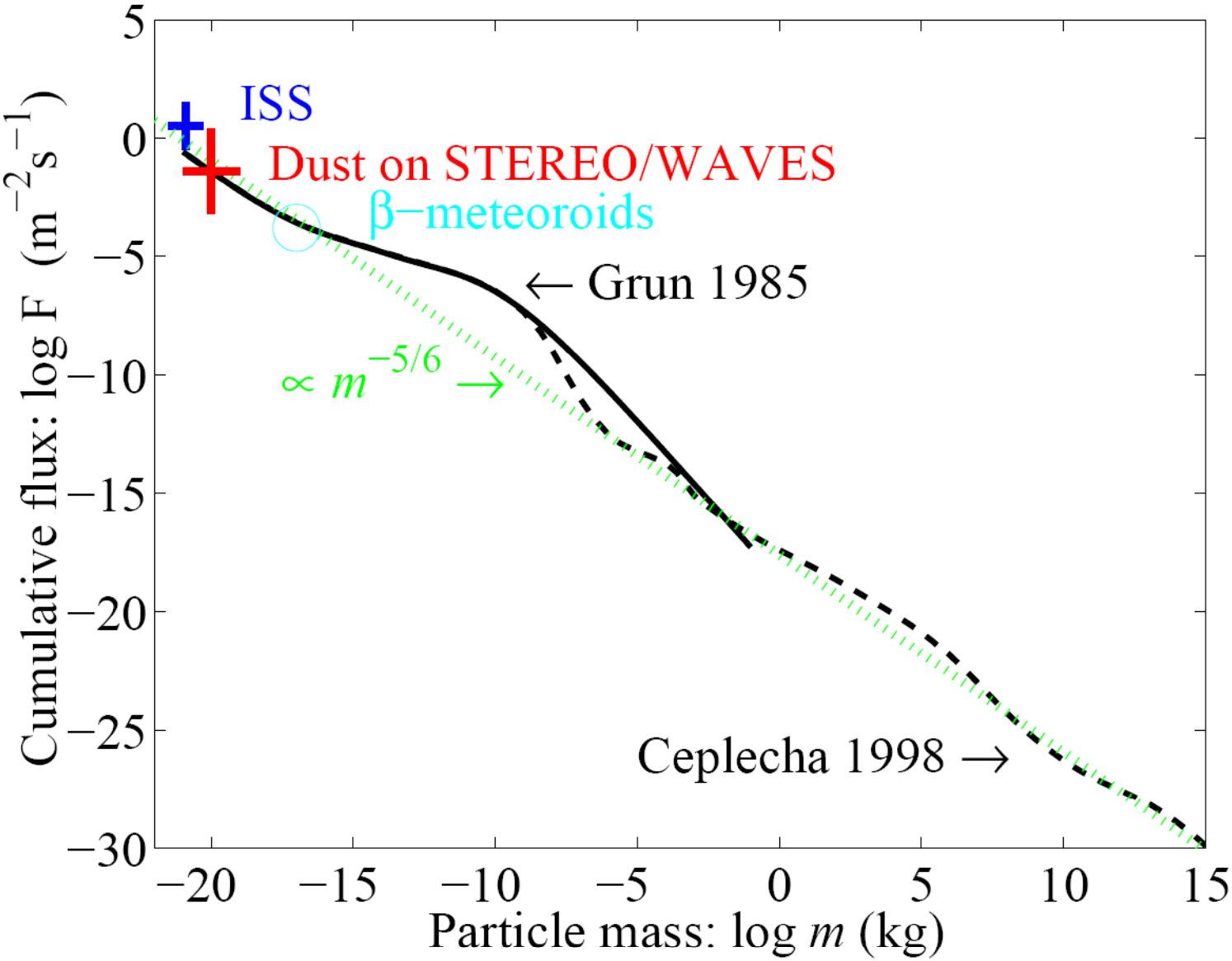


Assuming a flux $F \propto F0\ m^{-5/6}$ and integrating over mass this impact rate, we deduce :

$$< N\delta V^2/\tau^2 >^{1/2} \sim 0.6 \times 10^{11} T_{\mathrm{eV}}\, v_{E(\mathrm{km/s})}\, F_0^{1/2}\, m_{\mathrm{min}(10^{-20}\mathrm{kg})}^{-1/12}$$

↑ ~ 2 X 10^4 Volts $s^{-3/2}$

↓ ~ 3 X 10^{-2} Volts $m^{-2}s^{-1}$


ISS
Dust on STEREO/WAVES
β−meteoroids
← Grun 1985
∝ m^−5/6 →
Ceplecha 1998 →
Cumulative flux: log F (m^−2 s^−1)
Particle mass: log m (kg)
5
0
−5
−10
−15
−20
−25
−30
−20
−15
−10
−5
0
5
10
15

Why do we see the nano-dusts on Stereo ?

Induced voltage pulse on S/C of capacitance *C* :

$$\delta V_1 \sim -Q/C$$

Voltage induced by the electric field inside the ionized dust cloud :

$$\delta V_2 \sim (k_B T/e) R_2/L$$

$$R_2 \sim (3Q/4\pi e n_a)^{1/3}$$

R_2 : size of the cloud when it reaches n_a

In the case of Stereo the antennas are short compared to R_2 and thus:

$$\delta V_2 >> \delta V_1$$

Conclusions :

- We see plenty of nano-dusts with SWAVES

- We should explore their spatial distribution and understand better their origin (role of the IMF)

- Jovian nano-dusts streams are also observed by Cassini

- The dusts seen by SECCHI are larger particles