Study of nano dust impacts on STEREO using the S/WAVES instrument

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Basics of dust detection with a wave instrument

Electric signal measured is basically a function of the charge $Q$ of the plasma cloud

+ other parameters as:

- the temperature of the plasma cloud
- the local density of the solar wind plasma
- the position of the impact with respect to the antenna
- ...

$$Q \propto m \nu^{3.5}$$

⇒ Nano dust: $r \sim 10 \text{ nm}$, $m \sim 10^{-20} \text{ kg}$, speed $\nu \sim 300 \text{ km/s}$

yields same $Q$ as: $r \sim 0.2 \mu\text{m}$, $m \sim 10^{-16} \text{ kg}$, speed $\nu \sim 20 \text{ km/s}$
Interplanetary dust flux model

Flux (10 nm) / Flux (0.2 microns) > 2000

We expect to detect essentially nano-sized dust through wave instrument detection
Signal detected by the wave-form sampler TDS

- Observations of impacts with a short rise time, and large amplitude (some mV)
- Coherent with what is expected for a nano-dust signal impact
- During some periods, we can observe up to 20 signals in a 60 ms sampling time period
- On the 2007-2009 period, around 200 000 signals were detected on STEREO A and around 70 000 on STEREO B.

STATISTICAL STUDY
Correlations between antenna signals

STEREO A:

- Two categories of signals are clearly visible:
  - Single-hit on the X antenna (Blue)
  - Triple-hit with a signal of the same order of magnitude on the three antennas (Red)

- Nred ~ 5000
- Nblue ~ 150 000
Correlations between antenna signals

STEREO B:

- Same picture as for STEREO A with:
  - Single-hits detected on the Z antenna: Effect of Trigger??
  - Triple-hit with a signal of the same order of magnitude on the three antennas (Red)
    - \( N_{\text{red}} \sim 4000 \)
    - \( N_{\text{blue}} \sim 60\,000 \)
Typical signals detected for the Single/Triple impacts

Single antenna impact characterised by:
- \( V_y \sim V_z \) (STA)
- \( V_{y,z} \sim V_x \times 5\% \) (STA)
- Rise time: \( T_r \sim 30 \) microseconds
- Decay time: \( T_d \sim 1 \) ms

Triple antenna impact characterised by:
- \( V_x \sim V_y \sim V_z \)
- Rise time: \( T_r \sim 70 \) microseconds
- Decay time: \( T_d \sim 110 \) microseconds
Time variation of the dust flux (STEREO A)

- Possibility to determine the impact rate with a good accuracy: the nano-dust are appearing by « bursts » of duration of the order of the month

- Results consistent with the spectral density time variation on the LFR of S/WAVES (figure from N. Meyer-Vernet et al, 2009)
Conclusions

• We analyzed the dust impacts detected by the S/WAVES TDS waveform sampler during 3 years (2007-2009)

• The results obtained in terms of fluxes of detected impacts are improving the previous results obtained with the LFR

• We showed that the impacts are separable in two categories, that seem to have different physical properties (difference in rise and decay time, difference in the total flux)

• May the « blue » be nano-dusts and the « reds » be micron-dusts ? Then why the observed ratio does not lie on the interplanetary dust mass distribution ?

• A more detailed work on the physics of an impact, to enable a better understanding of the signal detected by the antennas is in progress