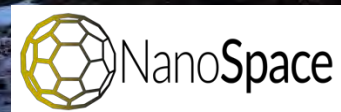


# Dust and heliosphere coupling on large and small scales

Dr. Veerle Sterken et al.  
(Astrodust team, DOLPHIN team, etc.)

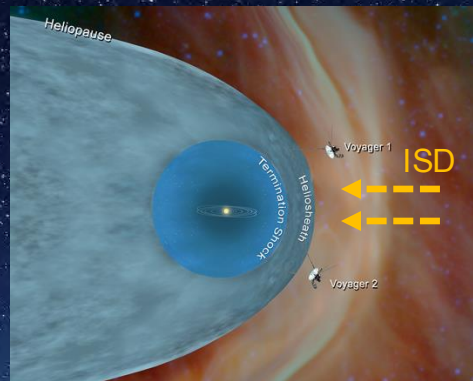
20 November 2024 - Heliophysics in Europe and 1st European Heliophysics Community meeting – Location: Online

**ASTRODUST**



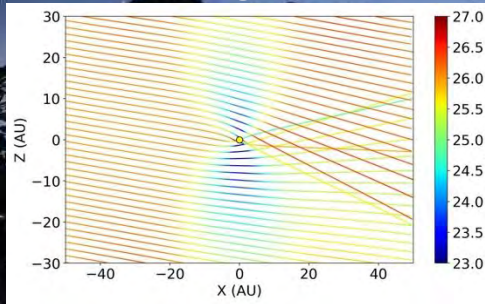
# Synergies between heliospheric and dust science: coupling on large and small scales

## Large-scale dust-heliosphere coupling

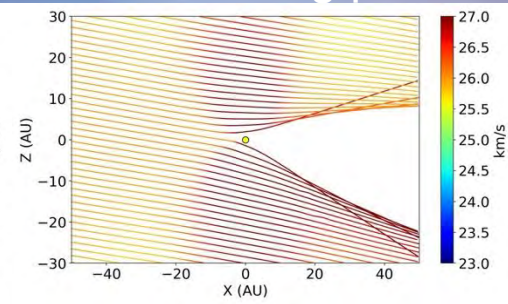


- Charged dust + solar wind plasma  $\Rightarrow$  Lorentz force
- Flux depends on 22-year solar magnetic cycle
- Interstellar Dust, Nanodust,  $\beta$ -meteoroids

### Focussing phase



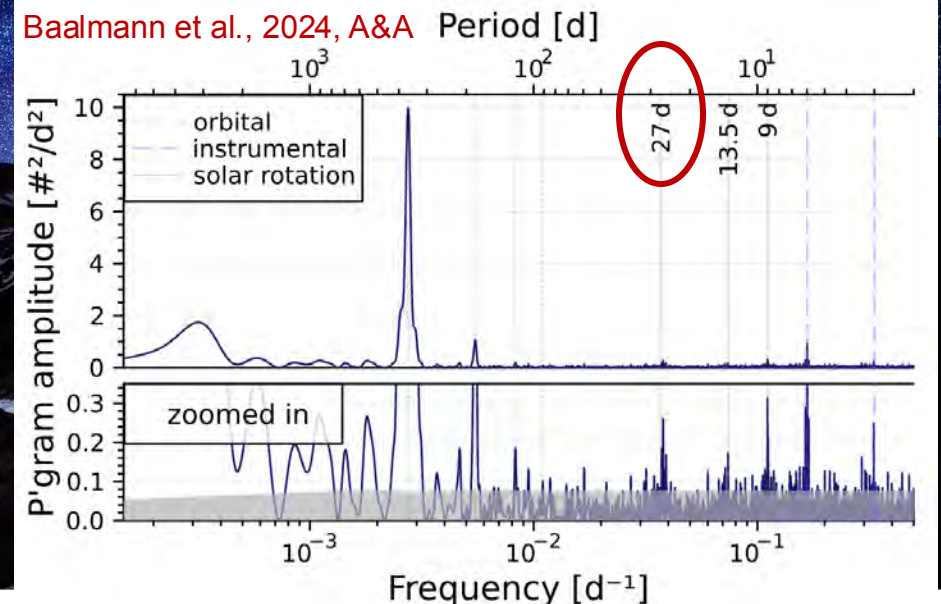
### Defocussing phase



Sterken et al., 2022, SSR

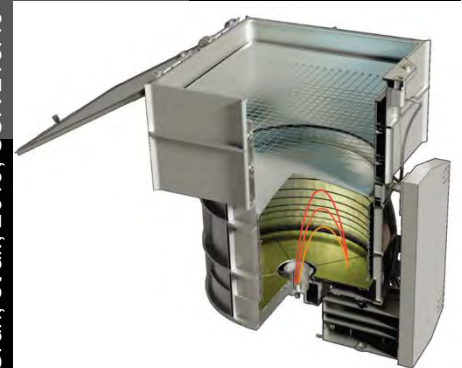
## Small-scale dust-heliosphere coupling

- Jovian and Saturnian dust streams
- Solar rotation frequencies in dust impact data (Wind, STEREO)
- Dust reacts to solar CIRs?



# Synergistic use of instruments for science

- **Plasma wave antennas measuring dust impacts:** large surface area, but no dust mass + velocity measurements
- **Dust telescope:** small surface area, but dust mass + velocity measurement
- ⇒ Combine PWA + dust instrument in one mission ⇒ **cross-calibration**
- Faraday cup
  
- **Constrain dust bulk density  $\rho$  using plasma and dust data:**
  - (1) Plasma data, (2) dust trajectory grid, (3) impact ionization detector
  - Disclaimer: (!) *large uncertainties so far [J. Vermeirssen, ETHZ]*
  
- **Use dust measurements to constrain heliospheric models**
- **Dust as a parameter in plasma physics**



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# Call for joint missions: dust & plasma science belong together

- DOLPHIN mission proposal to ESA (Febr. 2022) – resubmit in the future

**Compelling interdisciplinary science questions !**

*The **D**ust **O**bservatory to study the **L**IC, inter**P**lanetary dust, and **H**eliospheric **I**nteractions in our **N**eighborhood*

- L4 mission - KASA (2035) – solar observatory with dust instrument
- JUICE mission: use plasma wave antennas for dust as well
- Interstellar Probe - towards interstellar space



## Science questions – a few examples

*What produces inner and outer source of pick up ions? How porous is cosmic dust? How are solar wind and dust correlated? What is the role of dust in plasma physics (e.g. during CMEs)? Etc.*



**Synergies between interstellar dust and heliospheric science with an Interstellar Probe**  
Decadal Survey for Solar and Space Physics (Heliophysics) 2024–2033 – 7 Sept. 2022  
**Sterken+, 2023, RASTI. Vol. 2, Iss. 1, P. 532-547**  
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# Dust to dust !



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1. Synergies between heliospheric science ↔ cosmic dust science due to:
  1. Dust coupling with solar wind magnetic fields, processes
  2. Common use of instruments & data
2. Focusing and defocusing phases in the solar cycle, for dust – 2030s: next opportunity
3. Solar transient events in dust data
4. Future space projects shall include joint dust-heliophysics science  
Lunar Gateway / L4 mission / Interstellar Probe concept / DOLPHIN concept / JUICE