UV/EUV Spectroscopy for Plan A

Based on brief discussions in high Throughput UV/ EUV Spectroscopy sub-WG

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high throughput UV/EUV spectroscopy sub-WG

Plan A mission: *High throughput UV/EUV spectrometer*

- A brief discussion was made in the 2nd s-WG meeting at Lindau in June 2009.
- A small-sized UV/EUV spectrometer for investigating dynamics of coronal/TR plasma, especially origin of fast solar wind.
- A future direction of UV/EUV spectroscopic instruments: high throughput
  - Much better than EIS and SUMER
  - Higher throughput even with 1" resolution provides higher sensitivity or temporal cadence.
- Length in order of 1m for Plan A mission

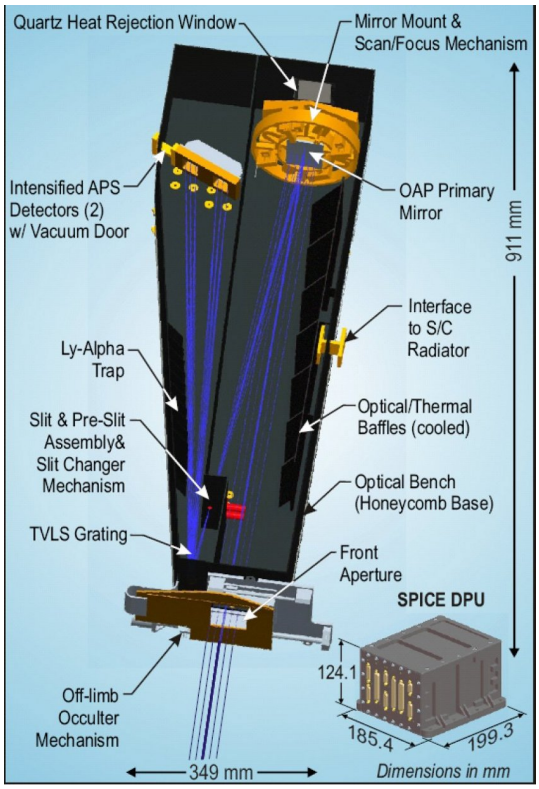
Plan A mission:
High throughput UV/EUV spectrometer

- 1m scale, high-throughput spectrometer
- Smaller version of the Plan B spectrometer
- A very similar spectrograph has already been selected as one of payloads on ESA/NASA Solar Orbiter (SO)
  - SPICE (Spectral Imaging of the Coronal Environment, PI: D.Hassler)

http://solarorbiter3.oato.inaf.it/Presentazioni/so3_2805_hassler_talk.pdf

SPICE on Solar Orbiter

- The simplest configuration with minimum number of optics (similar to Plan B)
  - Primary mirror (aperture 5cmx5cm) with scan/focus mechanism
  - Slit
  - TVLS Grating
  - Intensified APS detectors
- FOV 16-17 arcmin (1Kx1K), spatial 1" @0.3AU
- Two wavelength bands:
  702-792 A
  972-1050A (2nd order 486-525A)
  - Intense lines: C III 977 (logT=4.8),
    O VI 1032 (logT=5.5)
    Ne VIII 770 (logT=5.8)
    Si XII 521 (logT=6.3)
- Off-limb occulter for >3.08R



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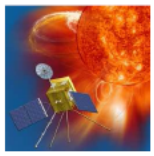
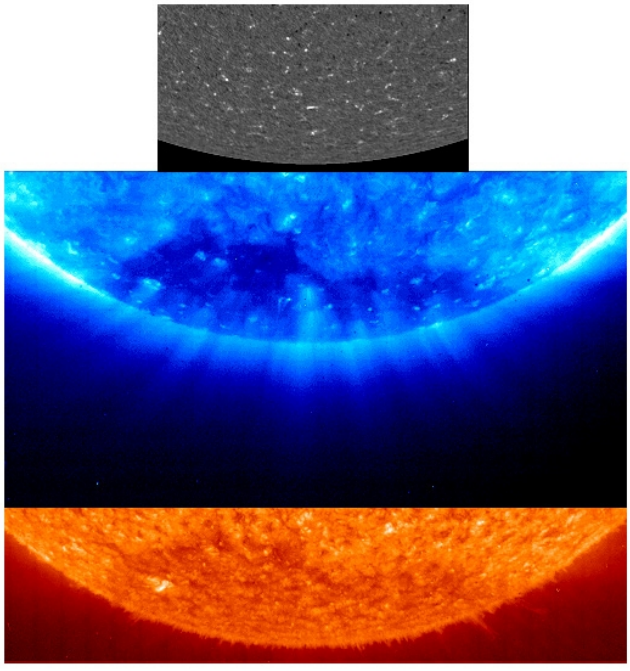
SPICE Science Objectives



- **1) Where do fast and slow solar wind streams originate?**
  - Map both fast & slow solar wind streams to their solar origins by matching compositional signatures.
- **2) How do fast and slow solar wind streams originate?**
  - Discriminate physical processes that inject material into solar wind streams by observing dynamic and thermal signatures (jets, shocks, waves) at the source regions.
- **3) How is the extended solar wind accelerated?**
  - Discriminate between solar wind acceleration models by measuring line broadening versus height of minor ions with different charge/mass ratios from the solar limb to beyond the sonic point (~2 Rs).
- **4) What are the source regions (seed populations) of energetic particles?**
  - Remotely image supra-thermal ions (broad spectral wings) thought to be the seed populations of energetic particle events as they are accelerated and depleted.
- **5) How is the structure of ICMEs related to their origin?**
  - Quantitatively characterizing flux ropes and current sheets in their pre-eruptive and erupting state.
  - Search for partial reconnections in post-CME current sheets
- **6) How and when do shocks form near the Sun?**
  - Image the turbulent broadening associated with shock formation.

Plan A mission's merits for EUV spectroscopy?

- A polar viewing mission gives scientific benefits to us in UV spectroscopic observation area.
- Good opportunity for studying coronal hole regions at the poles, to understand dynamics in the source of fast solar winds. See Dr. Teriaca's talk.
- However, we need to consider Solar Orbiter.



SOHO views of polar plumes
1996 March 7
Top to bottom:
MDI hi-res magnetogram

Polar view from Solar Orbiter

From ESA Solar Orbiter AO documents

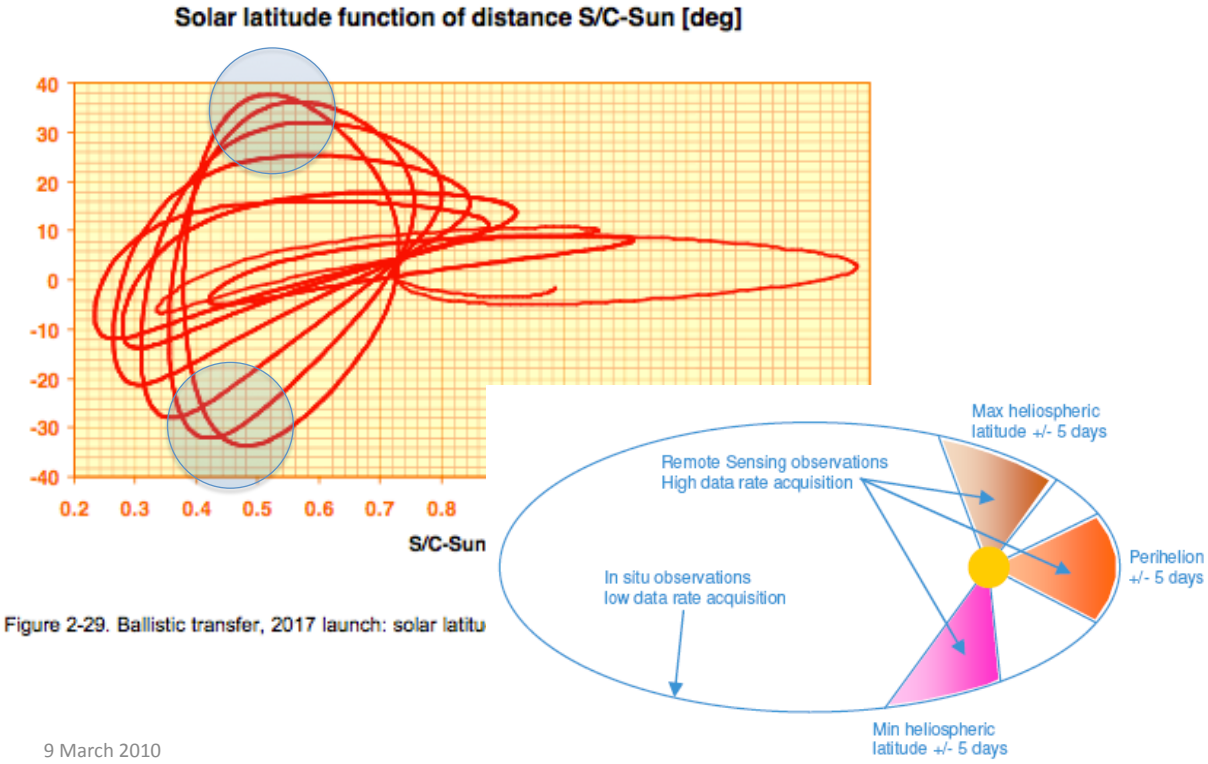


Figure 2-29. Ballistic transfer, 2017 launch: solar latitu

Comparisons with Solar Orbiter (SO)

- When compared with SO, Plan A may not provide substantial benefits to polar region researches, because of the following reasons:
  - Lower spatial resolution (~1", 720km):
    - SPICE: instrument resolution 1", but ~360km at polar view periods (~0.5AU distance)
  - Lack of coordination with in-situ measurements
    - Linked with dynamics (velocity etc) of the inner corona/ TR revealed with UV spectroscopy
    - SO: instruments for in-situ measurements available, at ~0.5AU distance from the Sun

Comparisons with Solar Orbiter (SO)

- When compared with SO, Plan A may provide substantial benefits to polar region researches, because of the following reasons:
  - Almost same telemetry rate (~20Kbps on average)
    - SPICE: 17kbps
  - Continuous coverage with ~20 kbps for more than 1 month at early and continuously at latter period.
    - Remote sensing observations only for +/-5 days at maximum heliospheric latitude
    - Longer duration of observations produces higher scientific returns (Yohkoh, SOHO, TRACE, Hinode ….).
  - Polar view every 6 months.

High Throughput UV/EUV Spectrometer

- The common desire that all the s-WG members have is to realize a large-scale EUV/ UV spectrometer with high throughput performance as soon as possible, which requires Plan B.
- Usefulness of the smaller-scale spectrometer for Plan A highly depends on the status of Solar Orbiter.
  - Continuous 1-month observations realized by the Plan A mission