The Unique Opportunities of Solar Orbiter

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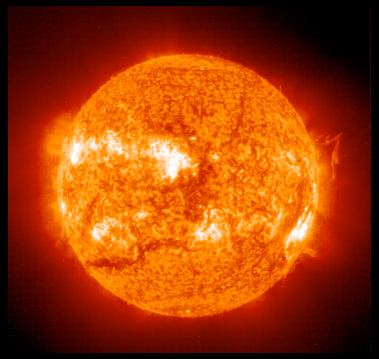

The next phase: Encountering the Sun & Out of the Ecliptic...

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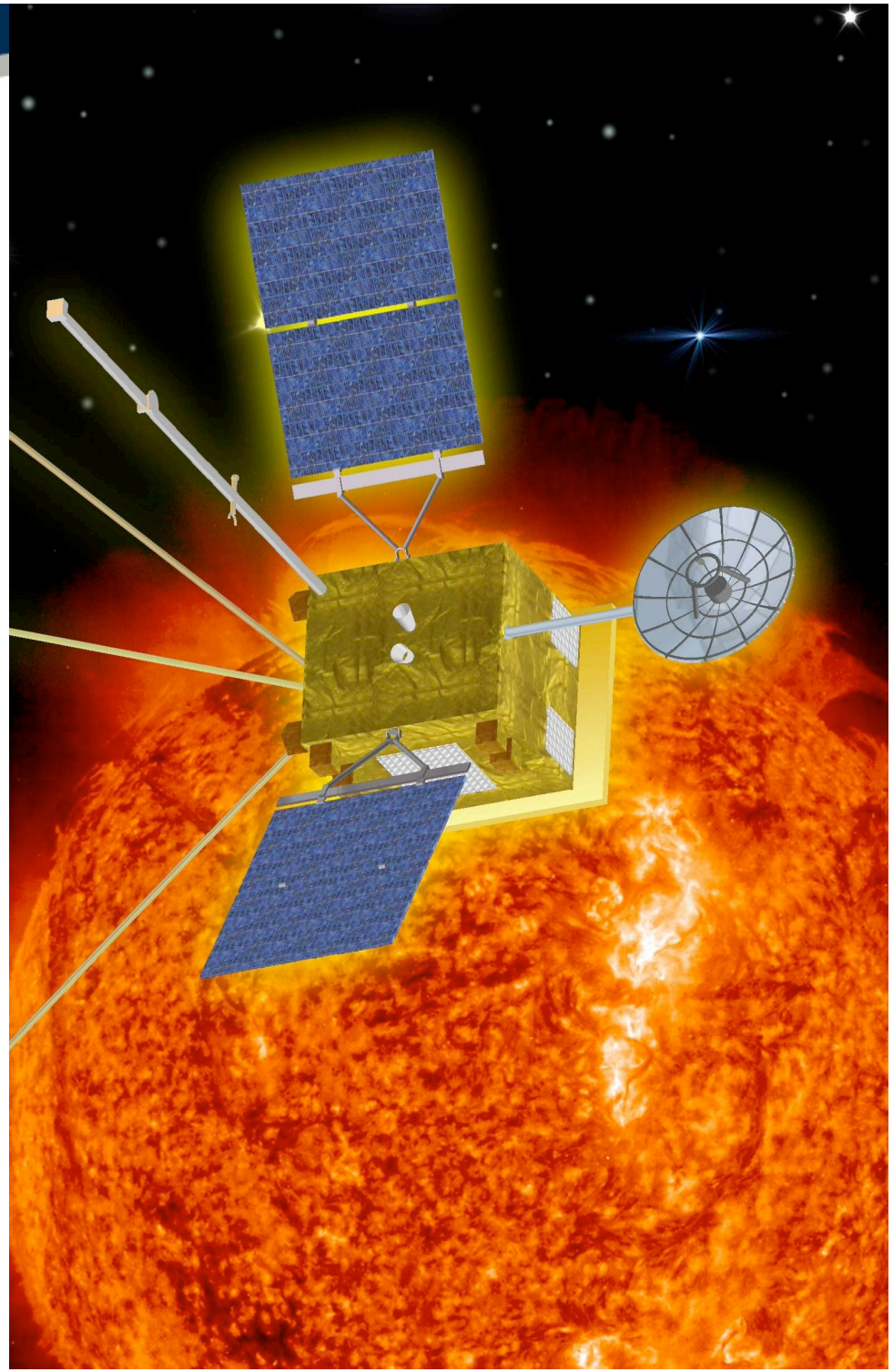
Solar Orbiter:

- 1998: Tenerife Meeting
- 2000: Proposal to ESA
- 2010: Cosmic Vision – down-selection
- Mid-2011 – Decision time!



- Explore the uncharted innermost regions of our solar system
- Study the Sun from close-up (60 solar radii)
- Fly by the Sun tuned to its rotation and examine the solar surface and the space above from a co-rotating vantage point
- Study the Sun's polar regions from heliographic latitudes in excess of 30 deg

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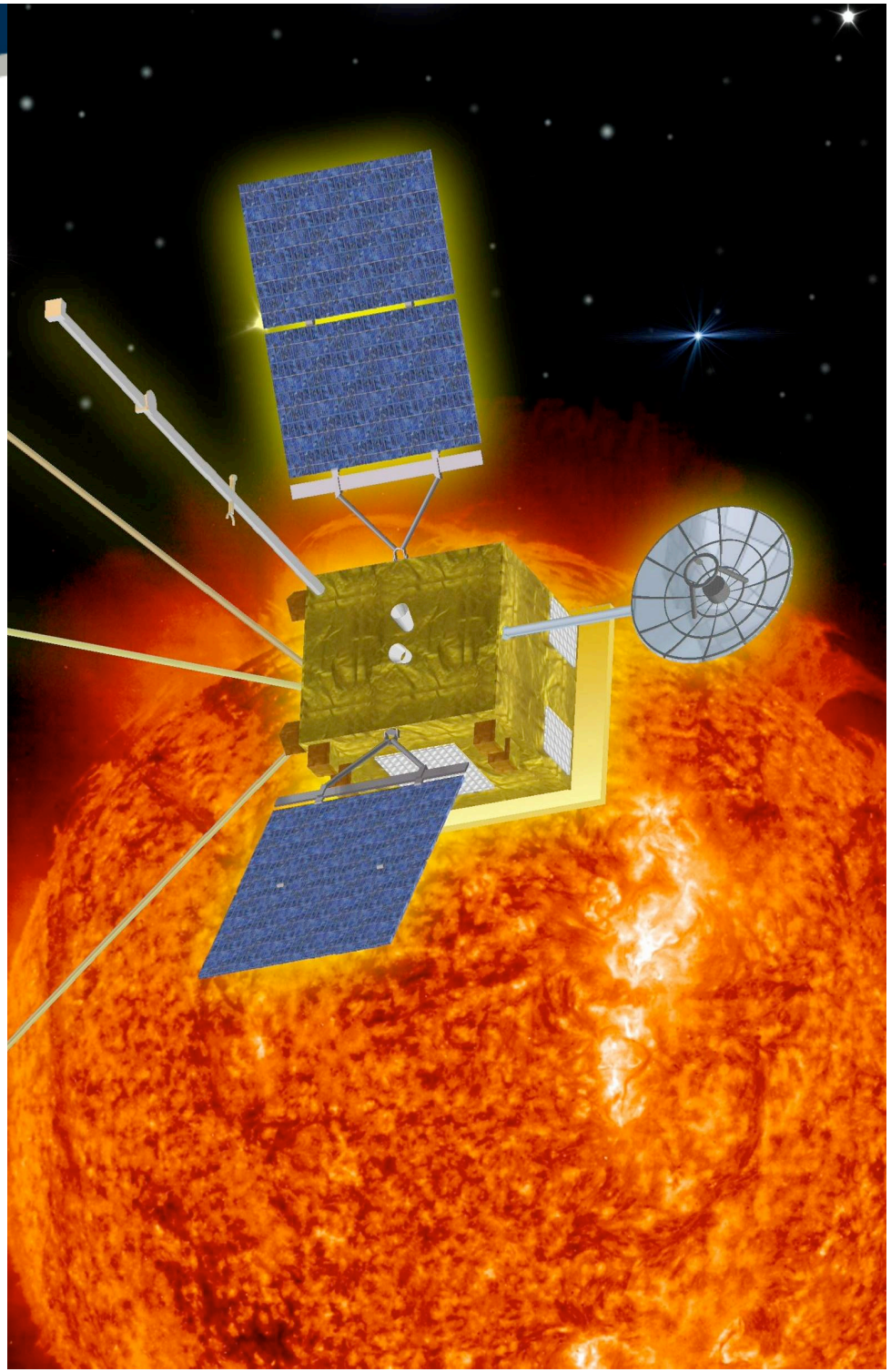
Solar Orbiter:

- Delta V Launch
- Multiple Venus gravity assists
- Perihelion 0.28 AU
- Multiple solutions are possible, final choice not yet made
- 2017/2018?



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Solar Orbiter instruments

Remote sensing

- Visible imager and magnetograph
- Heliospheric imager
- Coronagraph
- EUV imager
- ***EUV spectrometer***
- X-ray imager

In situ

- Solar wind analyser
- Magnetometer
- Radio and plasma wave analyser
- Energetic particle suite

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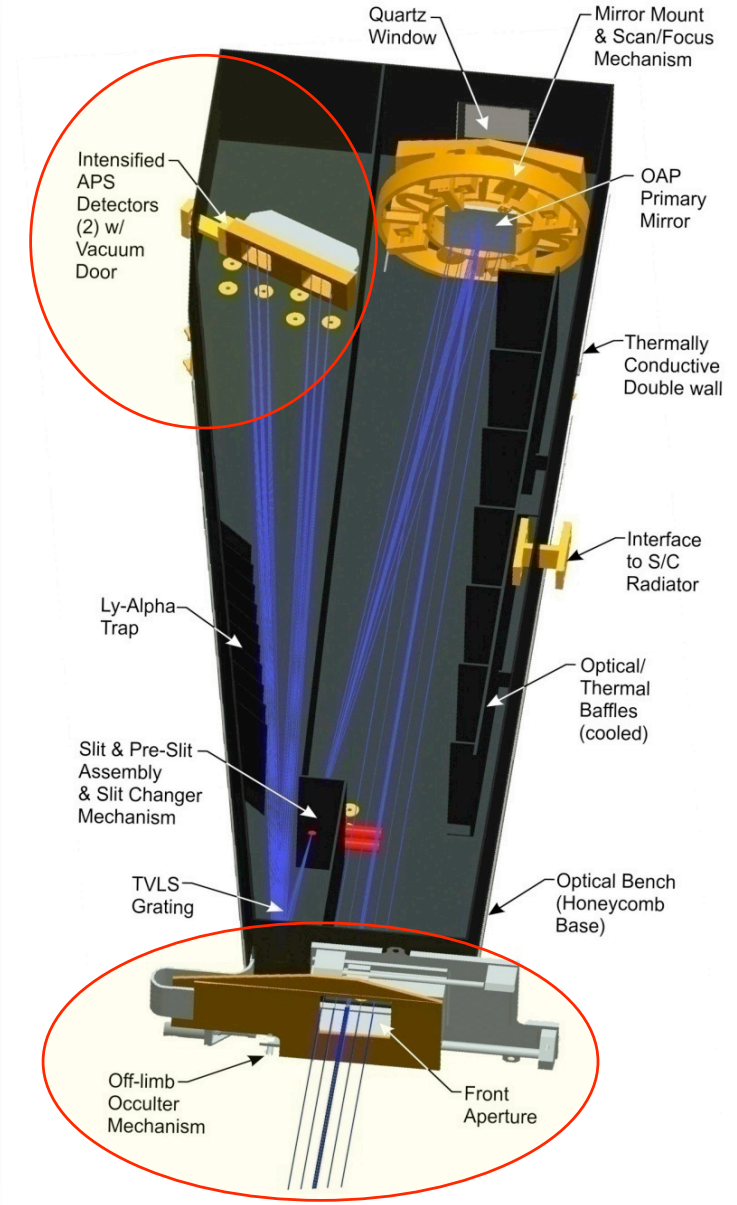
SPICE – Spectral Imaging of the Coronal Environment

Principal Investigator:

Don Hassler (SWRI, Boulder)

Consortium:

- **SWRI, Boulder, USA**
- **GSFC, Greenbelt, USA**
- **RAL, Chilton, UK**
- **MPS, Lindau, Germany**
- **IAS, Orsay, France**
- **ITA, Oslo, Norway**



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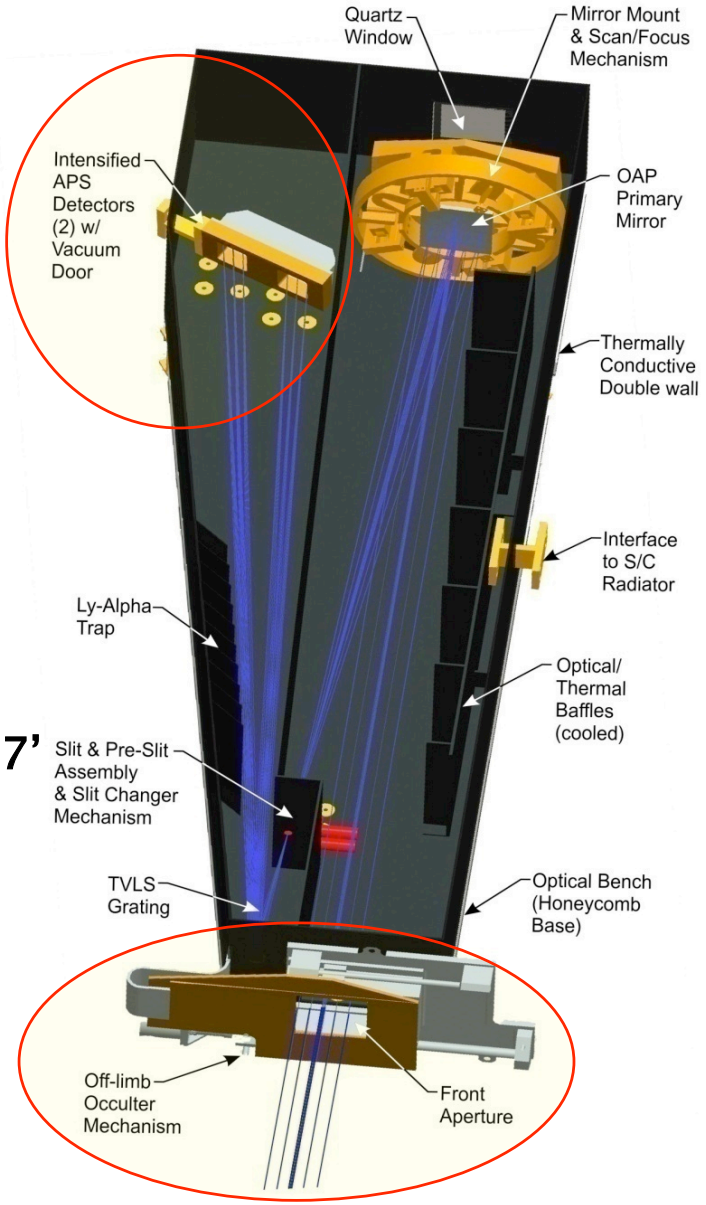
SPICE – Spectral Imaging of the Coronal Environment

Low-mass, off-axis NI spectrometer with VLS grating and APS detectors, with heat rejection through a novel primary mirror;

High resolution imaging/spectra with movable filter door to observe both on the solar disk and off-limb (to 3.0 solar radii at 0.5 AU).

- Telescope geometric area 25 cm^2
- Wavelengths 702-792 Å, 972-1050 Å, 485-525 Å (2^{nd} order)
- Entrance slits 1", 2" and 6" x 17'
- Detectors Two IAPS, 1k x 1k
- Spatial scale (pixel) 1 arcsec (17 micron)
- Spectral scale (pixel) 76 mÅ/pixel
- Velocity Scale (pixel) 23 km/s (1000 Å)
- Velocity resolution +/-3 km/s (centroiding)



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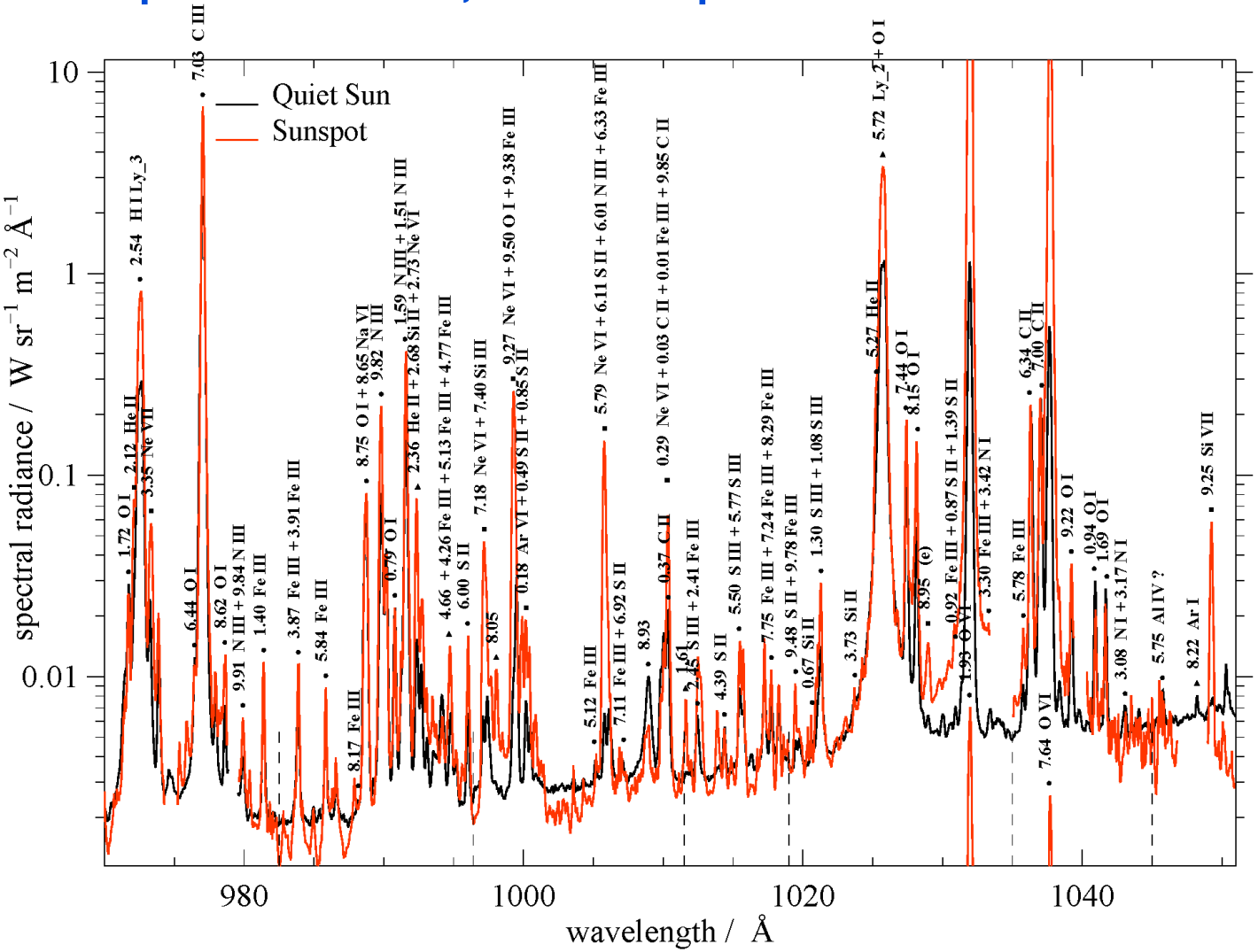
SPICE – Spectral Imaging of the Coronal Environment

Two spectral bands, over70 spectral lines

- 702–792 Å
- 972–1050 Å
- **Intensities**
- **Line profiles**

- **Temperature**
- **Density**
- **Flow velocity**
- **Turbulence**
- **Composition**



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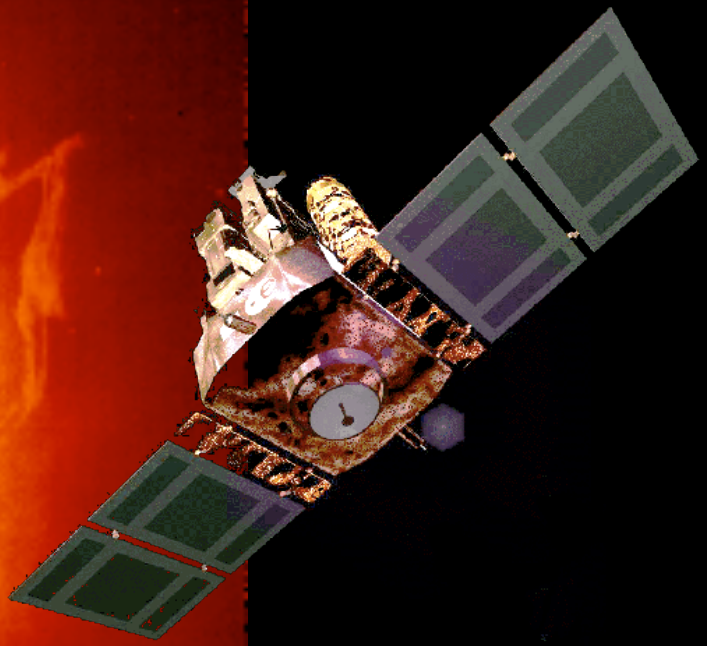
SPICE Primary Emission Lines

Primary Spectral Lines:

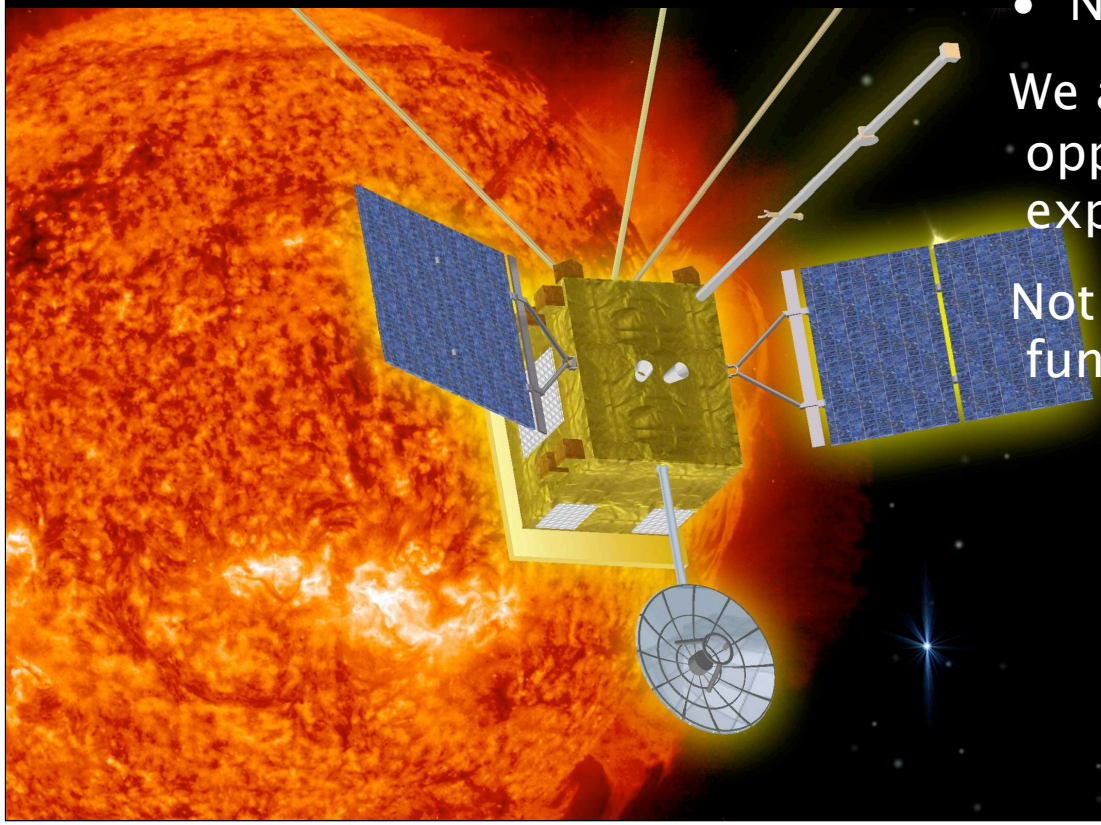
Ion	Wavelength	logT	Detector
H Ly-b	1025 Å	4.0	B
C II	1037 Å	4.3	B
O III	704 Å	4.5	A
N IV	765 Å	5.2	A
O IV	790	5.2	A
O V	759 Å	5.4	A
O VI	1032 Å	5.5	B
Ne VIII	770 Å	5.8	A
Mg IX	706 Å	6.0	A
Si XII	499 Å	6.3	B
Fe XX	721 Å	6.9	A
Fe XXIII	1079 Å	7.1	B

The mythology…

- We are NOT taking a SOHO to 0.2 AU – nobody ever said we were!
- Of course that limits telemetry, mass & communications compared to what we are used to but…



The strategy…



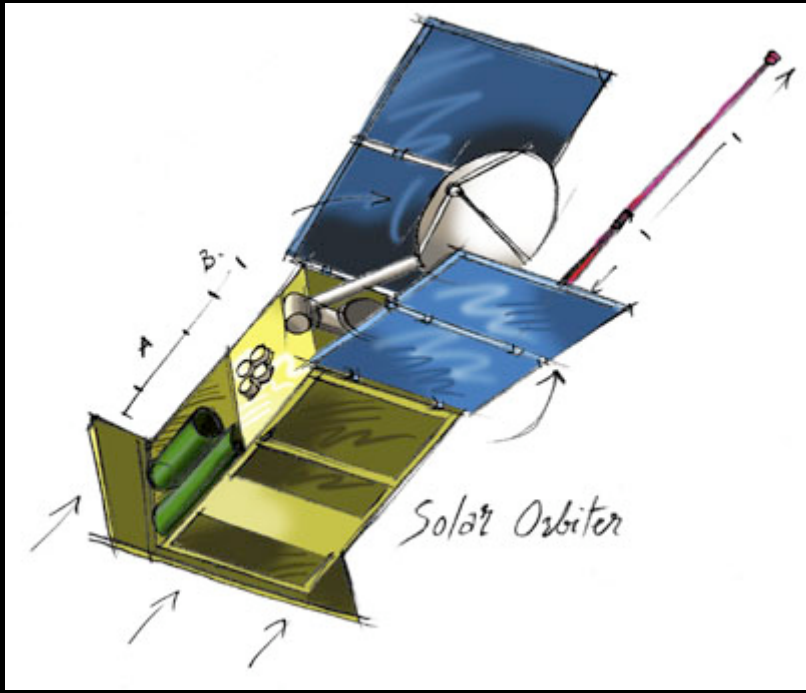
We are talking of a new mission concept to the solar community:

- Prime observations during encounters;
- Burst mode observations & novel compression/selection of data;
- No daily planning or ‘hands on’!

We are talking about science opportunities that we have never experienced before!

Not more of the same – this is fundamentally different…

Let's get up close...



... what for?

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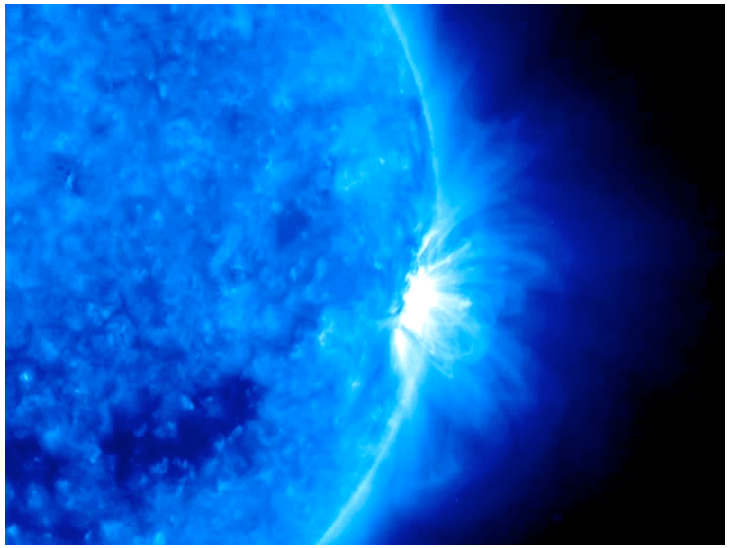
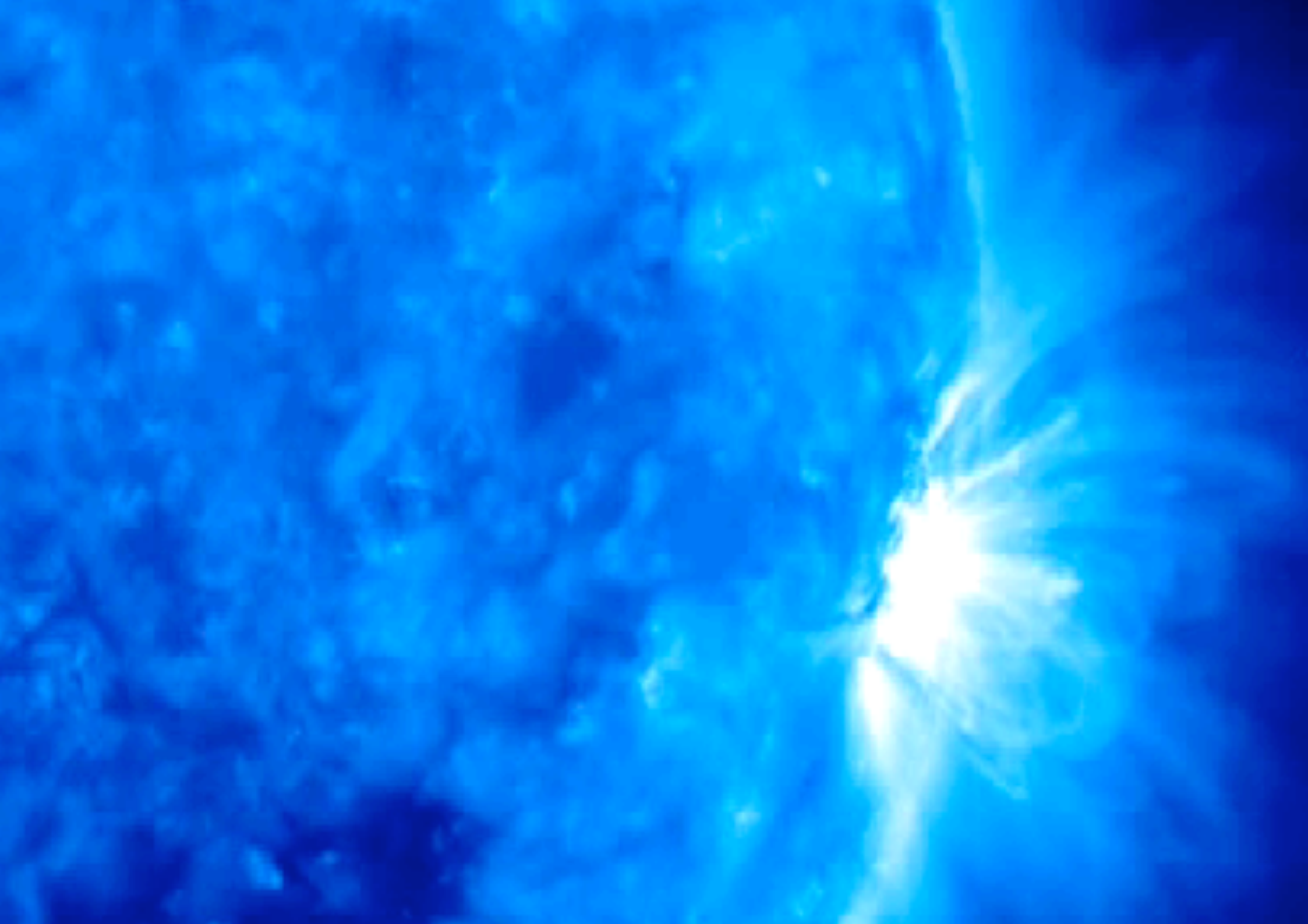
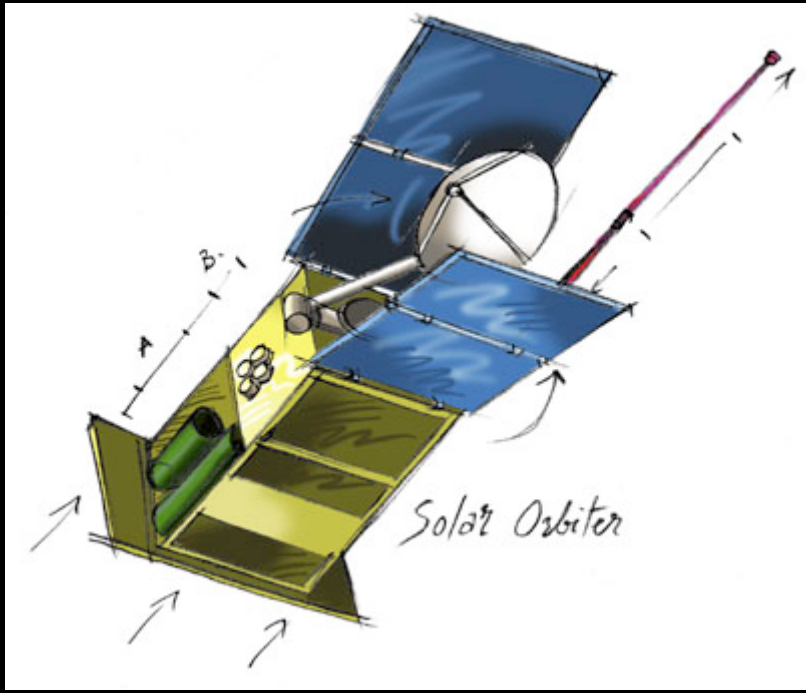


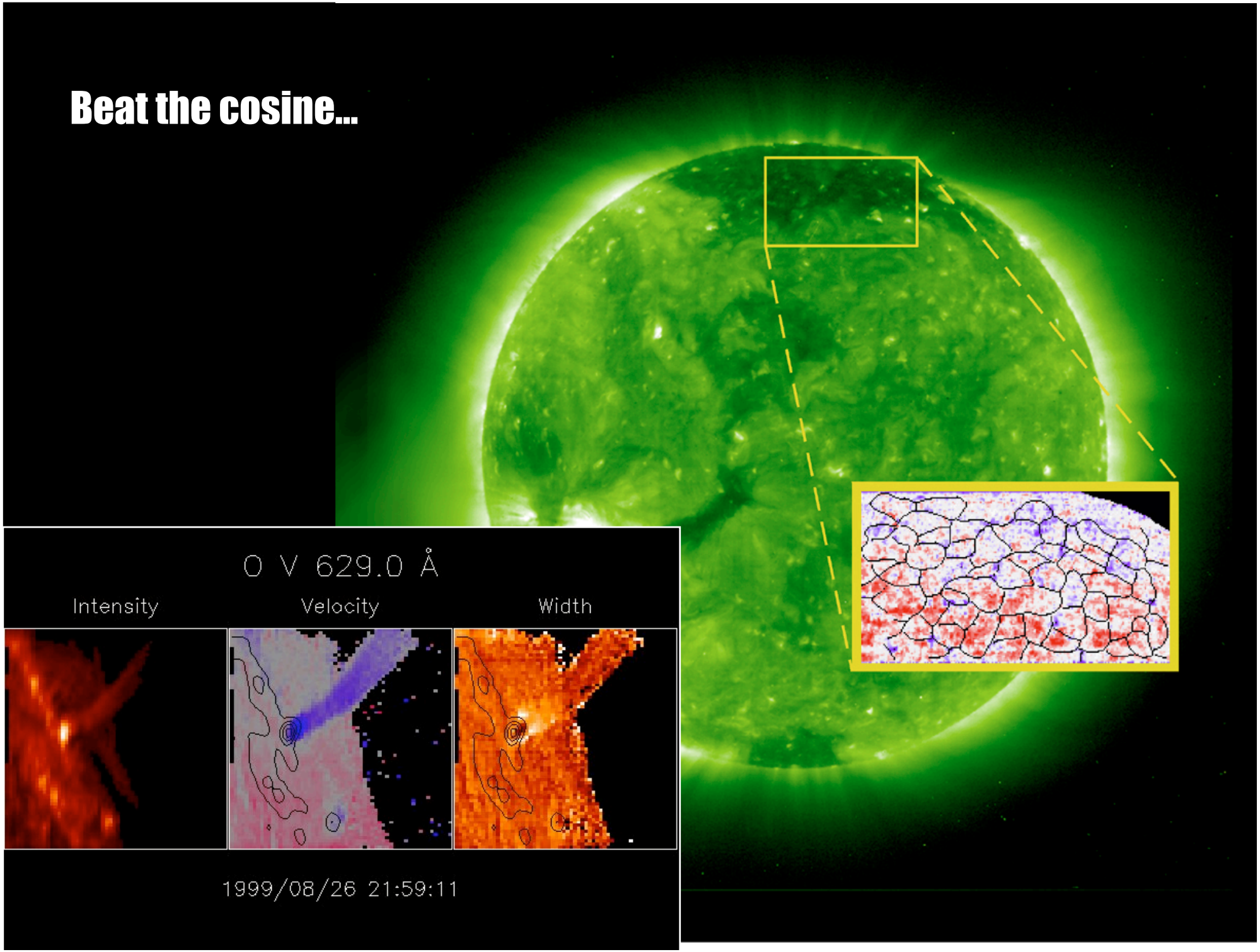


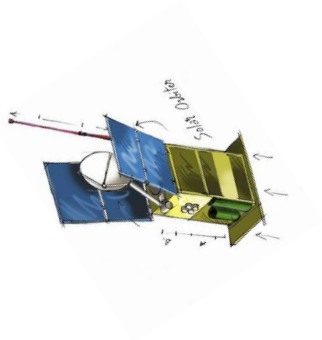
Let's go over the top...

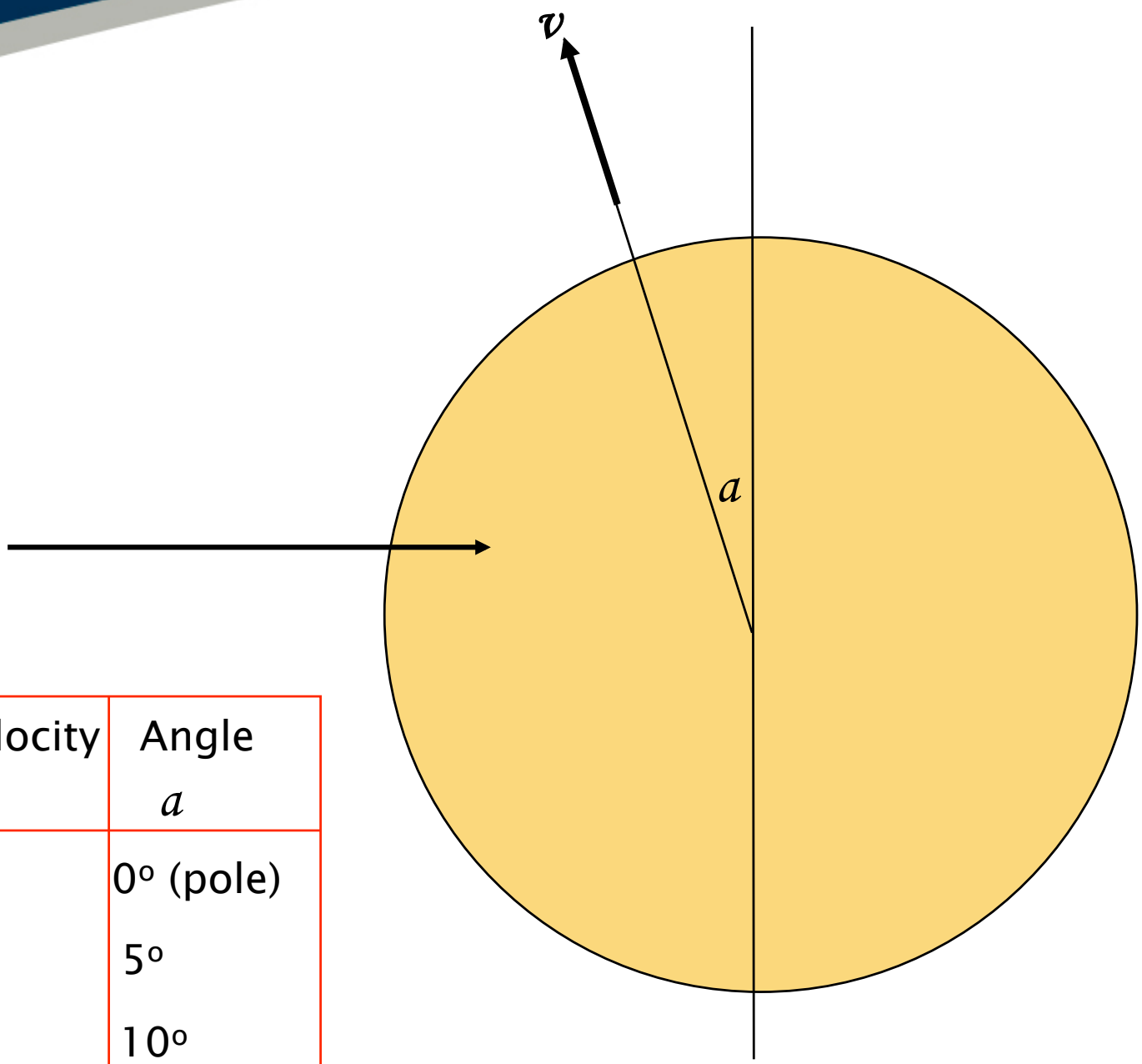


... well, not quite?

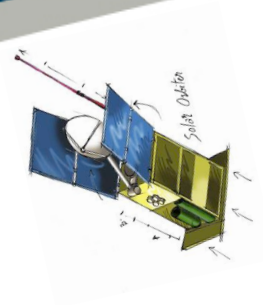
Beat the cosine...

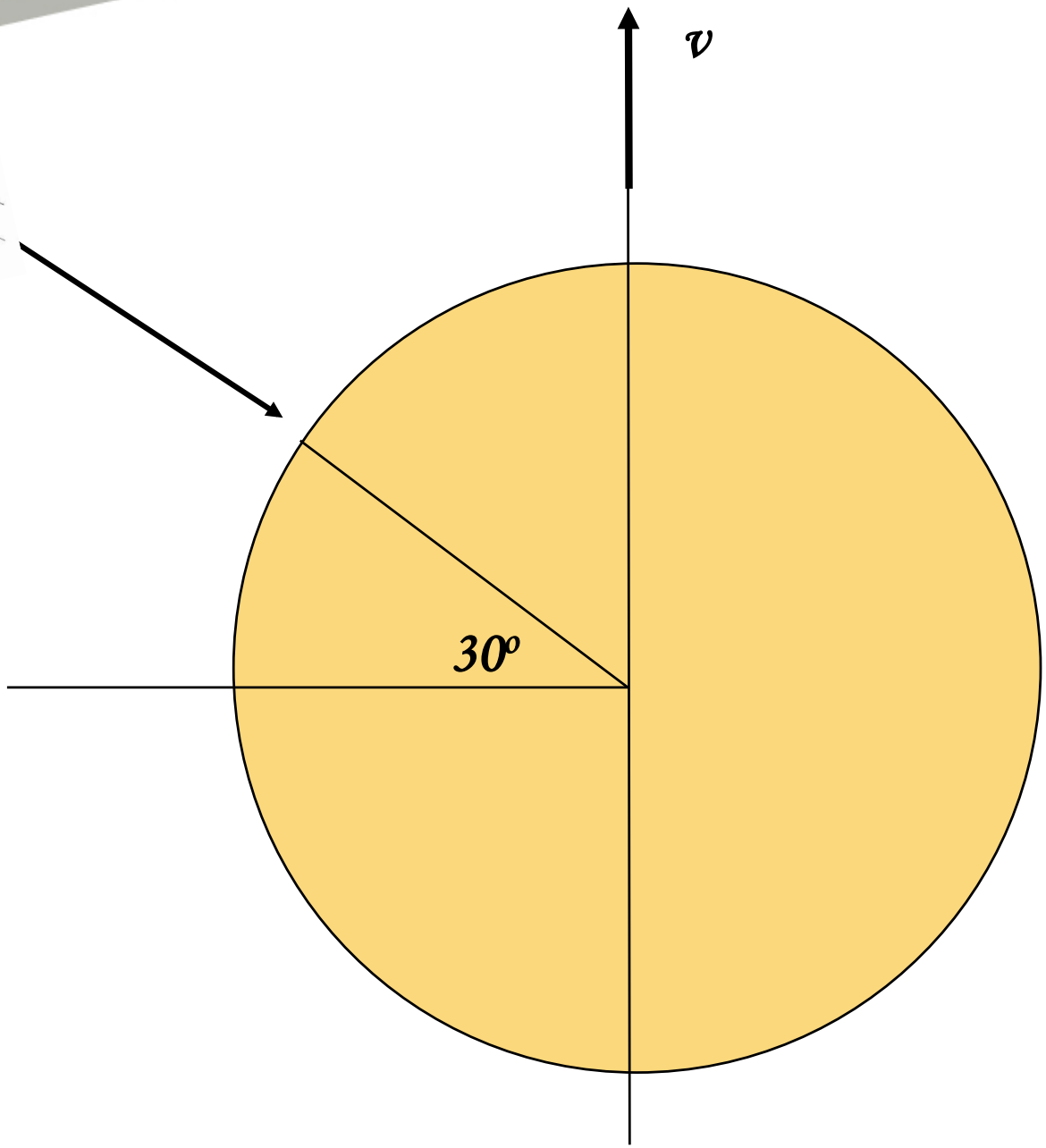






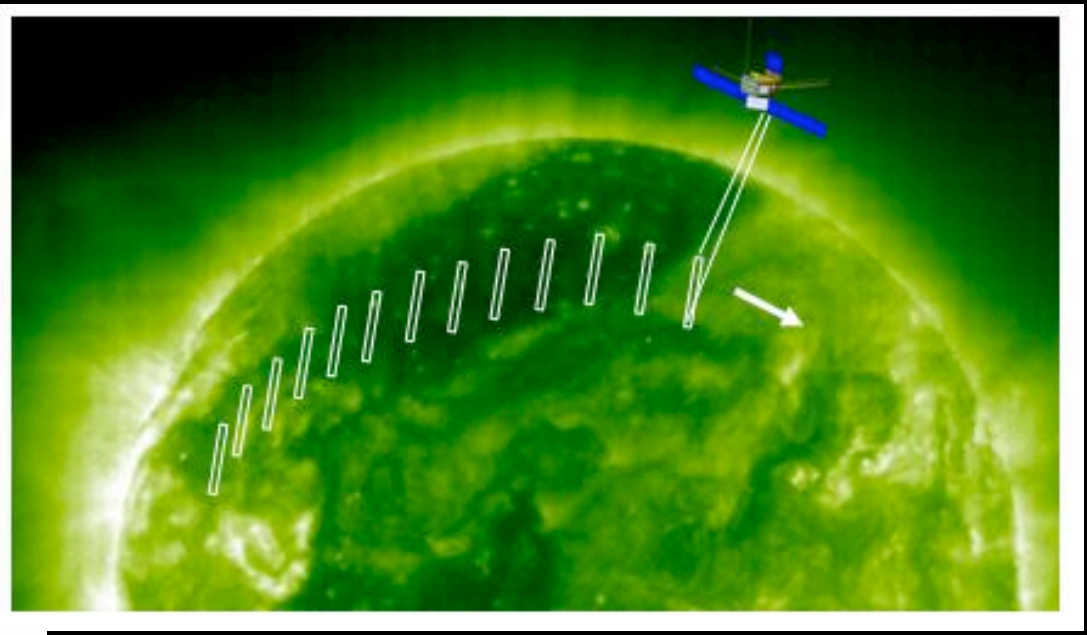
Observed velocity $v\ sin(a)$	Angle a
0	0° (pole)
$0.09v$	5°
$0.17v$	10°

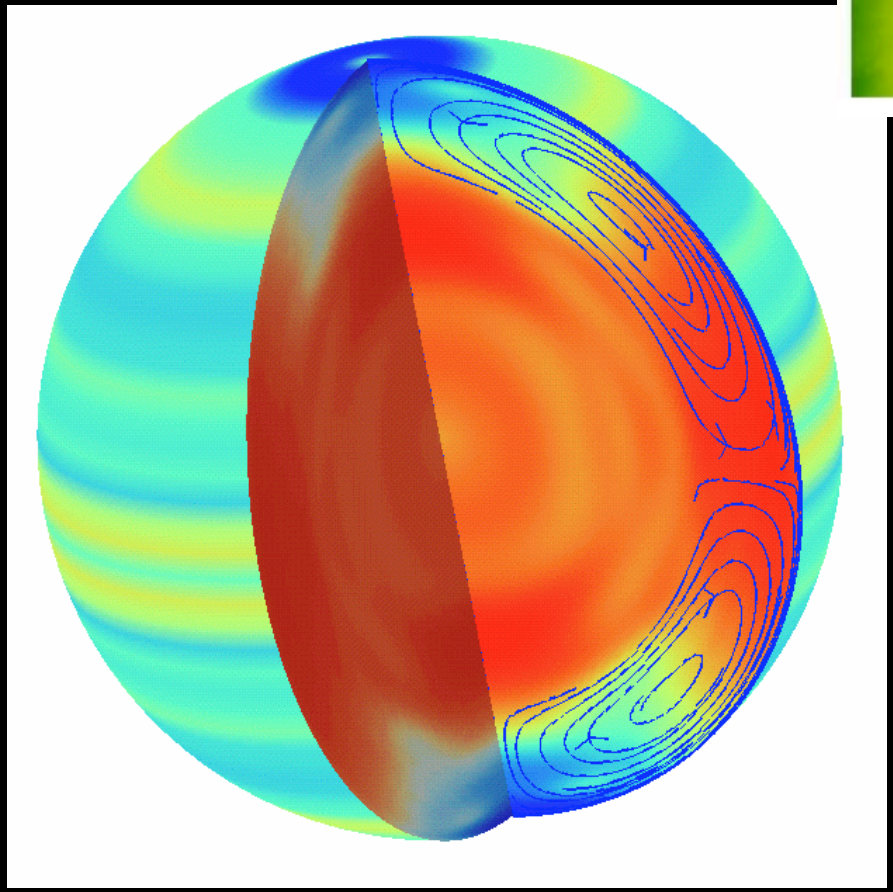


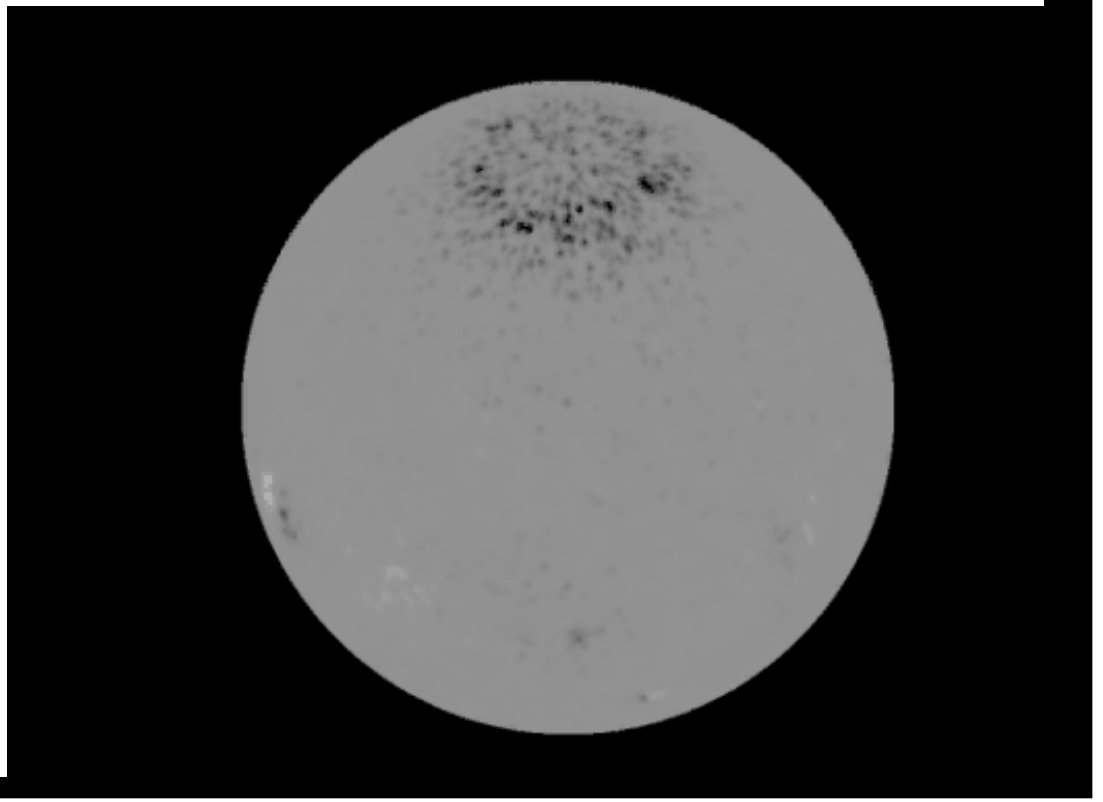


Cos(60º) = 0.5

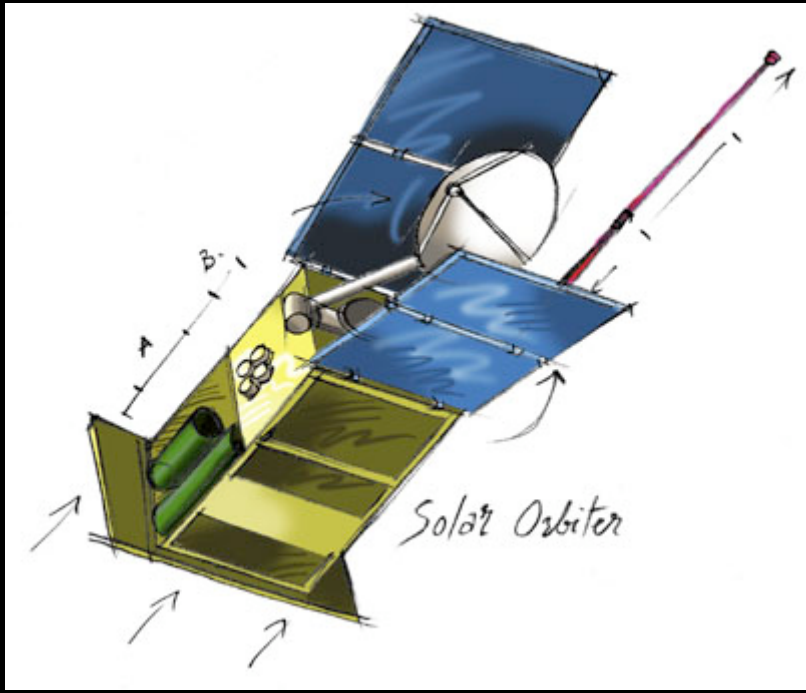
Unprecedented observations of flows and structure of polar regions; studying the Sun as a whole…

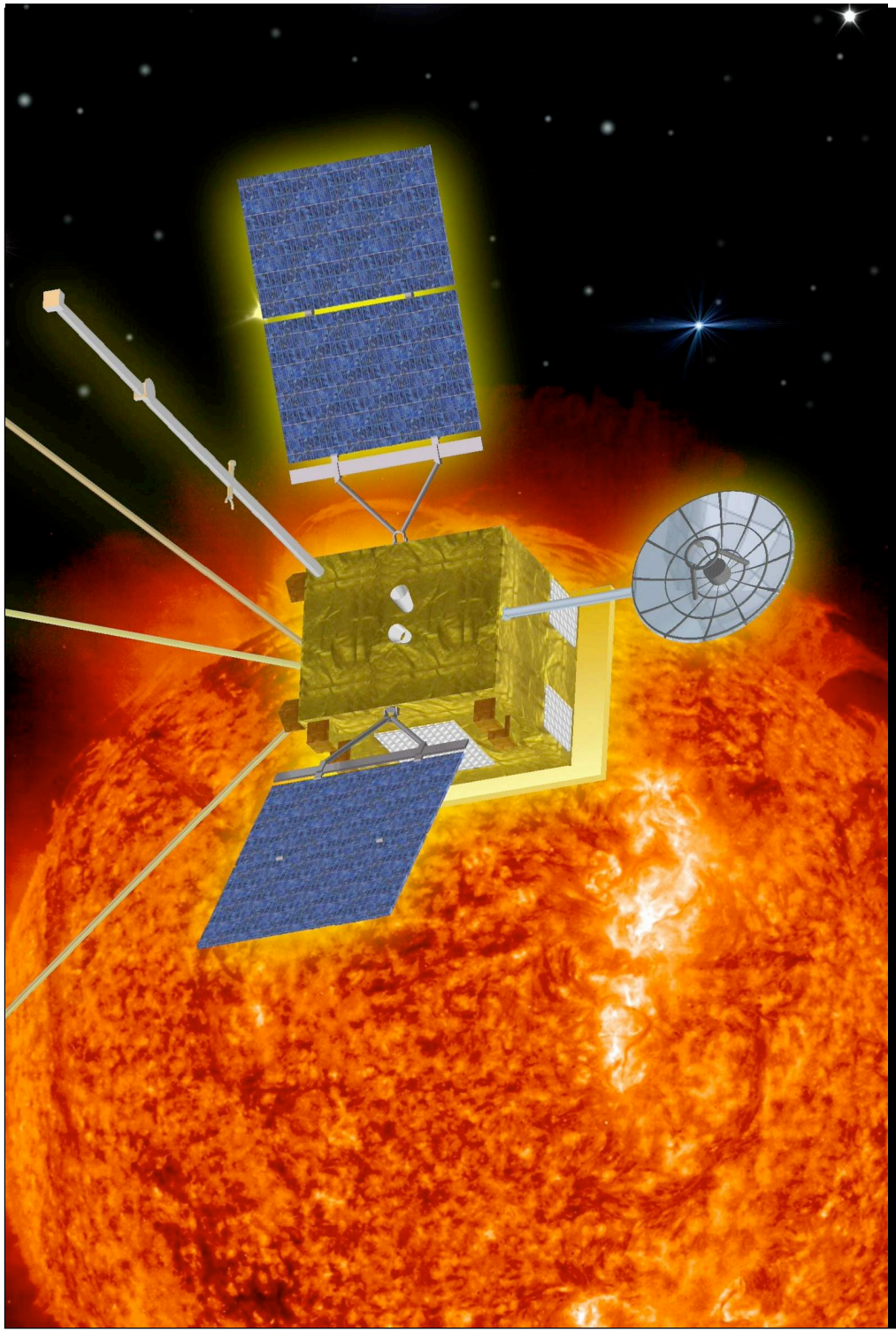






Shall we co-rotate?...

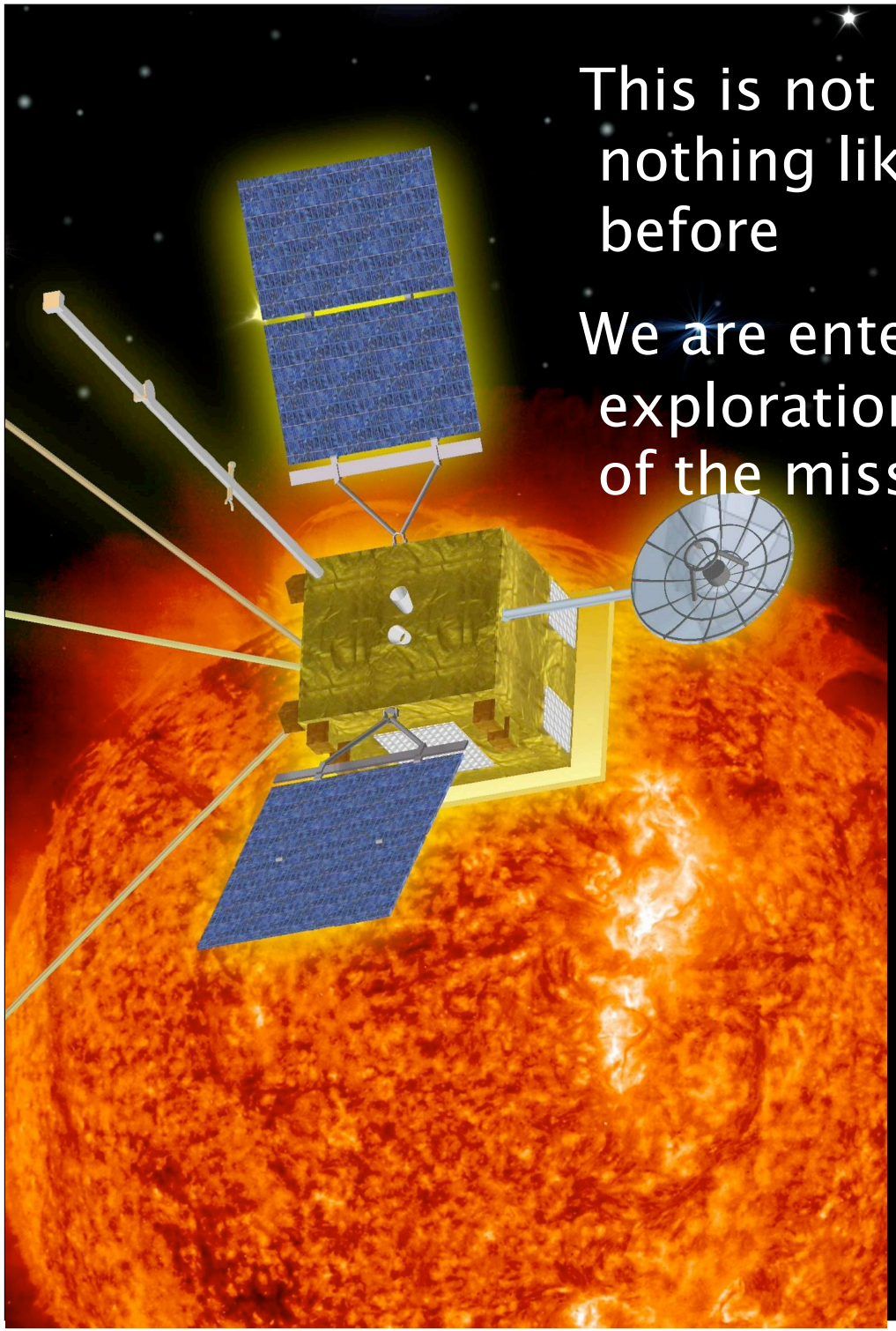




Nobody questions the value of co-rotation with the Earth for some applications – what is the added value here?

Is it a marginal selling point or an essential element in linking the inner heliosphere with the Sun?

- Extended observations of specific targets during encounters
- Studies of linkage between in-situ measurements with



This is not more of the same – nothing like this has been done before

We are entering a new phase in solar exploration and we should be proud of the mission we have proposed

- The first true remote sensing of a star at all latitudes;
- The first solar & heliospheric mission to visit the inner heliosphere – to study how a star links to its 'stellarsphere';
- Spectroscopy is a crucial part of this