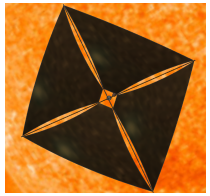
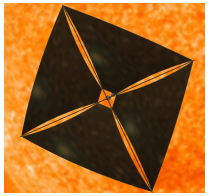


PoLAr Investigation of the Sun
POLARIS

T. Appourchaux

Institut d'Astrophysique Spatiale, Orsay



A set of polar missions

Existing missions

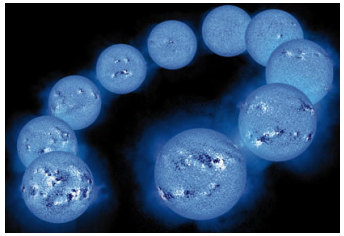
- Ulysses: ESA mission operated from 1990 to 2009
- Solar Orbiter: ESA mission to be launched in 2018

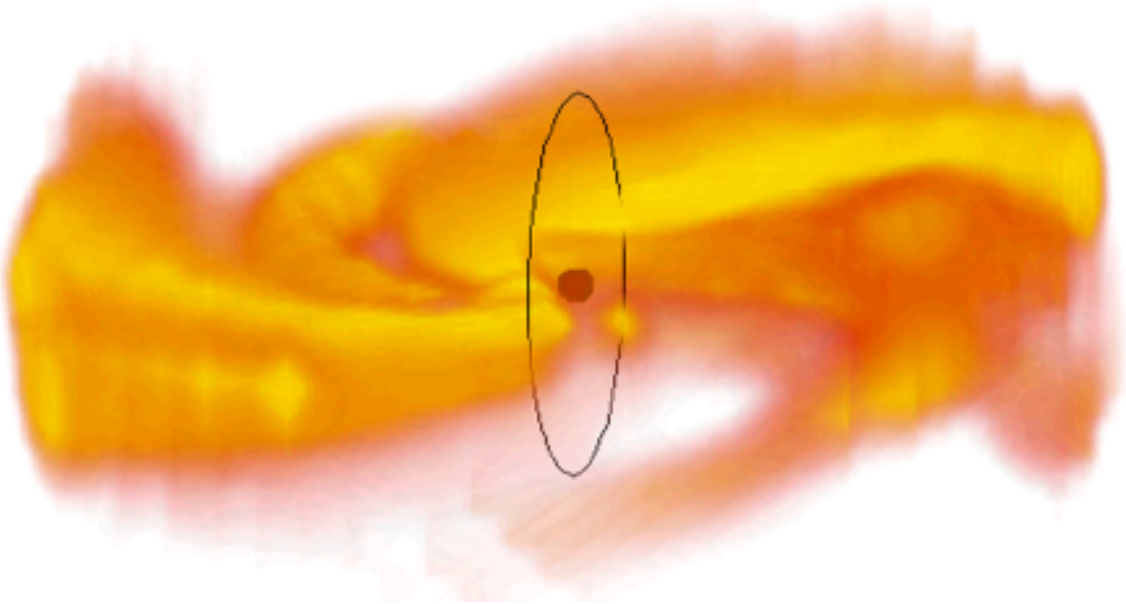
Projects

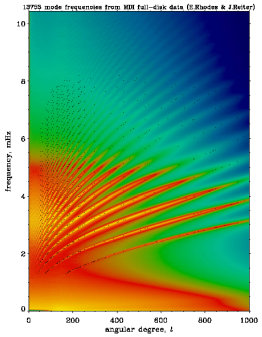
- Polaris proposed to Cosmic Vision in 2007
- Solar-C Plan A studied at JAXA in 2008-2010

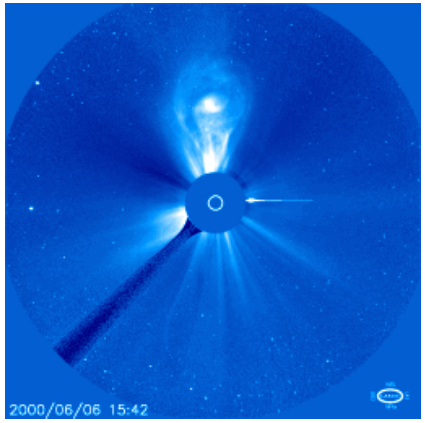
No true polar mission yet!

POLARIS



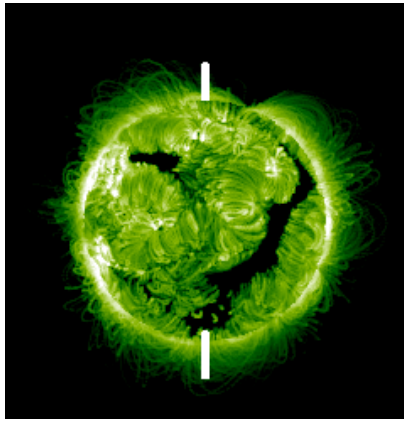


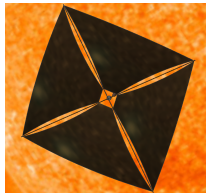




A Solar Polar Imager reaching a 75º inclination can answer a class of heliophysics science questions not possible using any other existing or planned mission.

Major breakthroughs in both solar & heliospheric physics will results from observations made possible by its unique polar orbit.



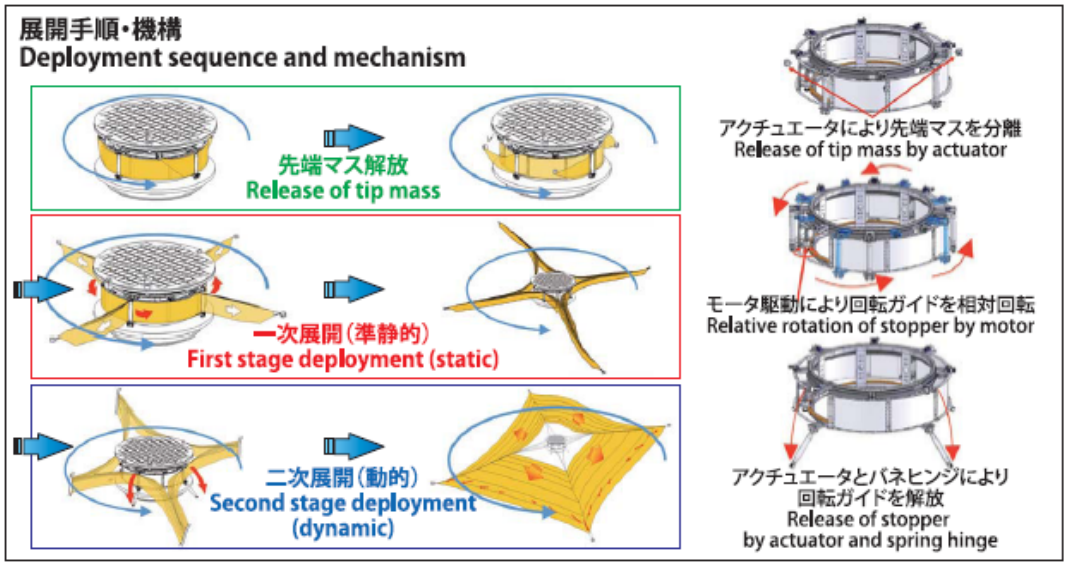


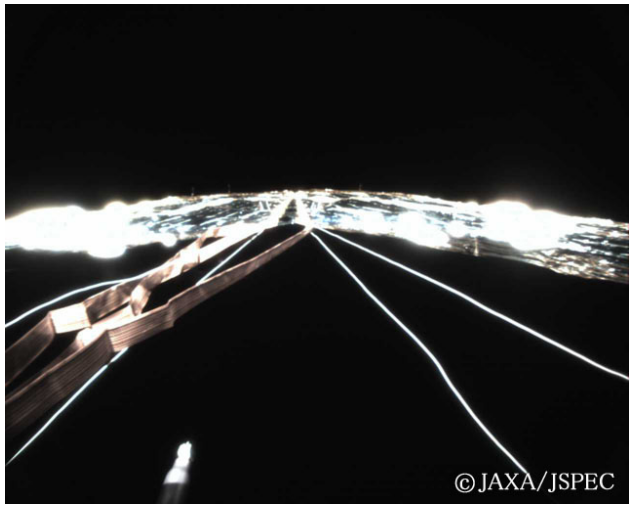
Why and how?

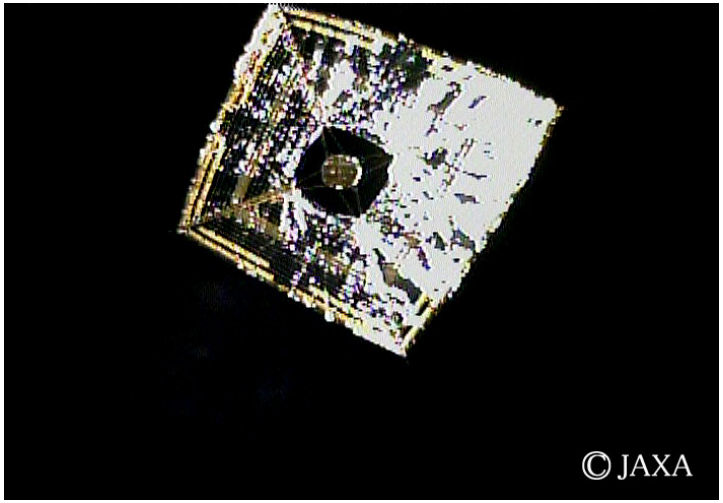
- Solar sail propulsion use of photon pressure (not solar wind...)
- Solar sail propulsion is propellant free and continuous (chemical propulsion is short and use propellant)
- Acceleration is small, solar sail needs to be light and large (180 m x 180 m)
- Payload needs also to be light

Deployment

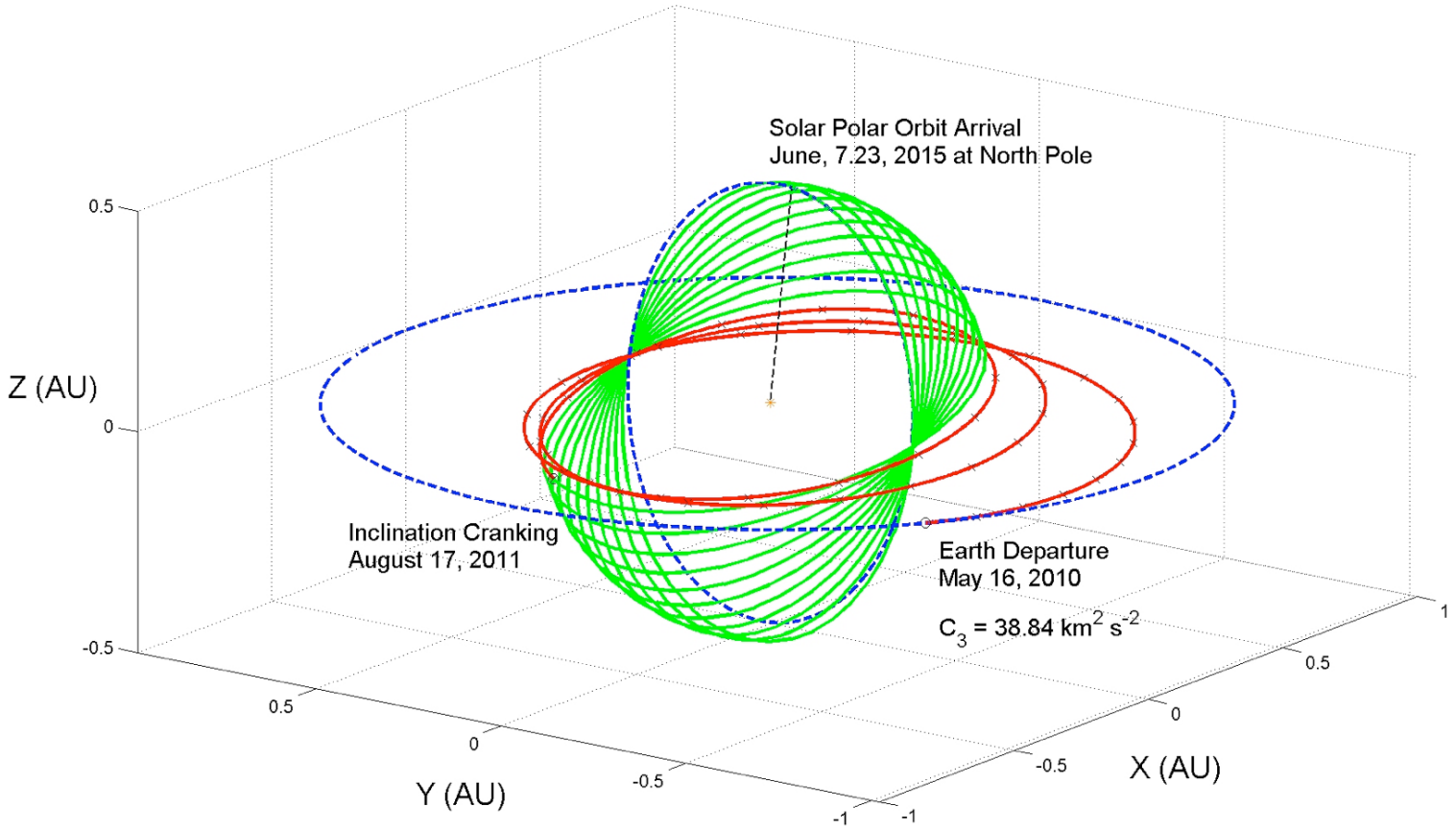
IKAROS


展開手順・機構
Deployment sequence and mechanism
先端マス解放
Release of tip mass
一次展開（準静的）
First stage deployment (static)
二次展開（動的）
Second stage deployment
(dynamic)
アクチュエータにより先端マスを分離
Release of tip mass by actuator
モータ駆動により回転ガイドを相対回転
Relative rotation of stopper by motor
アクチュエータとバネヒンジにより
回転ガイドを解放
Release of stopper
by actuator and spring hinge


©JAXA/JSPEC


© JAXA

An example of orbit



Science for a Polar Mission

	Remote sensing				
Scientific Objectives	DSI	TSI	HI	EUI	EUS
How is the global cyclic, solar magnetic field generated?	x				
What is the nature of flows in the polar regions of the Sun, and how do they vary with magnetic fields?	x				
How does the radiative energy output of the Sun depends on latitude?		x			
How does magnetic activity shape the structure and evolution of the polar solar corona and how does it affect the Earth?			x	x	x

DSI = Doppler and Stokes Imager
TSI = Total Solar Irradiance
HI = Heliospheric Imager

EUI = Extreme Ultraviolet Imager
EUS = Extreme Umtraviolet Spectrometer

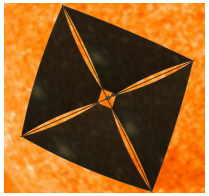
What are the priorities?

Each priority corresponds to a well identified payload or mission

1. Latitude variations of irradiance
2. Solar internal structure and dynamo
3. Corona, Coronal Mass Ejection and dynamo

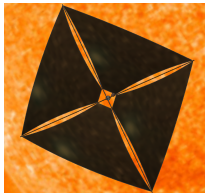
1. Latitude variations of irradiance

- Requires long observation at high latitude in a thermally stable environment
- No long observation of the poles are available for irradiance
- Circular orbit preferred
- High latitude >75° (goal 60°)
- Minimal payload is:
  - TSI (Total Solar Irradiance)
  - Mass < 5 kg



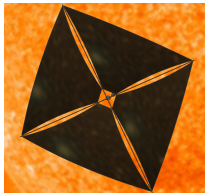
2. Solar internal structure and dynamo

- Requires long observation at high latitude in a thermally stable environment
- No long observation of the poles are available for helioseismology and magnetic field studies
- Circular orbit preferred
- High latitude >75° (goal 60°)
- Minimal payload is:
  - DSI (Doppler velocity and magnetic field)
  - TSI (Total Solar Irradiance)
  - Mass < 15 kg



3. Corona and dynamo

- Close to the Sun (about 0.5 to 1 AU)
- High inclination >60^{o}
- Maximum payload (<40 kg):
  - Doppler and Stokes Imager
  - Heliospheric imager (coronagraph)
  - Extreme Ultraviolet Imager and Spectrometer



Conclusion

- Priority 1: Focus on irradiance with a minimal payload and a truly new mission (payload<5 kg)
- Priority 2: Focus on helioseismology with a minimal payload and a truly new mission (payload<15 kg)
- Priority 3: add coronal objectives mean additional RS instruments (payload <40 kg)
- Need to work on genuine science objectives for Priority 3 (different from Solar Orbiter / Ulysses)

European legacy for polar missions: use it !

The "Polaris" speech

"We choose to go to the Moon. We choose to go to the Moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win, and the others, too."

J.F. Kennedy (1962)

J.F.Kennedy "Moon Speech"

A displaced orbit