

ESA Heliophysics missions

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ESA Heliophysics Missions



- In operations
 - SOHO
 - Hinode
 - Cluster



- Proba 2

- In Implementation
 - Solar Orbiter



- In Technology
 - Proba 3



- Earth observation
 - Swarm



BepiColombo and
 Rosetta
 European Space Agency

ESA Heliophysics Missions: current mission results



- In operations
 - SOHO
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- Proba 2



- Earth observation
 - Swarm



SOHO Overview





Comet Ison: faded glory SOHO image

- 1. Joint ESA/NASA mission, studying the Sun and its effects on Earth
- 2. Launched on 2 Dec 1995 (18 years)
- 3. Spacecraft and Science operation centre at GSFC
- 4. 4754 papers in refereed literature
- Extension up to end 2016 and preliminary extension to end 2018 (to be decided in fall)
- ESA/NASA Memorandum Of Understanding (MOU) extended up to 31 Dec 2016.

Evidence for a deeply penetrating meridional flow

- Novel global helioseismic analysis method to MDI data to infer the meridional flow in the deep solar interior
- Method based on perturbation of eigenfunctions of solar p modes due to meridional flow
- 3. Evidence of a very deep meridional flow down to the base of the convection zone
- 4. Meridional flow plays key role in determining strength of Sun's polar magnetic field, which determines the strength of sunspot cycle
- Knowledge of meridional flow therefore important for understanding of global solar dynamo



esa

Schad et al.: ApJ 778, L38

Comet ISON: Faded Glory





Hinode Overview





- Hinode is a Japanese mission, with NASA (USA), STFC (UK), ESA and NSC (Norway) as international partners
- ESA support (ground station and data centre) was one of contribution to ILWS
- Mission objective: to understand generation, transport and dissipation of solar magnetic fields
- Launched 22 September 2006
- 838 publications in refereed literature since launch
- ESA Extension up to end 2016 and preliminary extension to end 2018 (to be decided in fall)

Thermal structure of a hot non-flaring corona



- 1. Active region where narrowband imagers identified two very different dominant temperatures:
 - Cool (C) а.
 - b. Hot (H)
- 2. Average spectra in 14 selected lines recorded with Hinode/EIS
- 3. Differential Emission Measure (DEM) analysis
- 4. Cool region: flat DEM that drops at log T \geq 6.3
- 5. Hot region: well defined peak at log T=6.6
- 6. Supports earlier evidence for the existence of a minor very hot plasma component in active region cores with temperatures T > 4 MK



Petralia et al.: A&A 564, A

AIA94 XRT_Ti/Poly 6.5 Log Temperature (K) (b) Hot Region

6.5

7.0

7.0

Cluster Overview





- Mission of international cooperation between ESA and NASA to study plasma structures and processes in 3D with four identical spacecraft
- Launched July and Aug 2000 (14 years)
- 2020 papers in refereed literature
- Extension up to end 2016 and preliminary extension to end 2018 (to be decided in fall)
- Cluster Active Archive was one of ESA contribution to ILWS

Cluster key input to new Earth magnetic field model





- Cluster data are a key input for the model since:
 - Almost 14 years of data collected
 - only spacecraft to cover polar region since many years [Tsyganenko 2014]

Cluster Science Archive (ESA contribution to ILWS)



O O Cluster Science Archive v1.1.3		
File View Windows Actions Tools Help	Username	Pwd
		CLUSTER
Search View		
Time Criteria Date Range <i>yyyy-MM-dd HH:mm:ss</i> Begin Begin End	Duration HH:mm:ss Days	œ
		Ŷ
Cluster Mission Experiment All ASPOC active spacecraft potential control CIS ion spectrometer DWP wave-particle correlator EDI electron drift instrument EFW electric field double probe antenna FGM fluxgate magnetometer PEACE electron spectrometer RAPID energetic electron and ion spectrometer STAFF search coil magnetometer and spectrum analyzer WBD radio receiver – electric field waveforms WHISPER relaxation sounder	Measurement Type () All Context Electric_Field Emitted_Current Energetic_Particles Instrument_Status Ion_Composition Magnetic_Field Particle_Correlator Radio_and_Plasma_Wa Radio_Soundings Spacecraft Status	ves
Auxiliary, MAARBLE and ECLAT support data	Status Thermal_Plasma	
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Cluster Experiments Panel		0
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- New User interface (Java) and moved from NL to Spain
- High res. data open to public
- Special effort in calibration
- Data 2001-2013
- CDF or ASCII
- Good quality plots (spectro., 3D) in GIF or PS format
- Command line and streaming interface

European Space Agency

http://cosmos.esa.int/csa

Double star overview





- First ESA-China collaboration
 involving hardware
- China: 2 spacecraft (TC1/TC2), 8 instruments, 2 launchers, science and spacecraft operations
- ESA : 8 European instruments, data acquisition 4h/day,
- Launches: Dec 2003, Jul 2004
- Mission completed
- IAA award for team achievements in Sept 2010
- Archive phase on-going and first data in the archive after summer

PROBA 2: technology mission and sun watch





•Mini-sat (120 kg)

•17 technologies: Lithium-ion battery, advance data and management system, new reaction wheels, dualfrequency GPS receiver, new star tracker, solar flux concentrators, high precision magnetometer, new xenon gaz propulsion ..

•Four science instruments:

- •Large Yield Radiometer (LYRA)
- •EUV telecope (SWAP)
- •Dual segmented langmuir probes
- •Thermal plasma measurements

Launched 2 November 2009Extension financed by ESA SpaceWeather programme



Observations of a Hybrid Double-Streamer/ Pseudostreamer in the Solar Corona





- First observation and analysis of a hybrid structure showing a double-streamer and pseudo-streamer alongside each other.
- The analysis is based on ground-based linear polarization measurements from CoMP (a first for pseudo-streamers) and from the EUV imager SWAP on-board Proba2.
- Current understanding is that the doublestreamer is the source for slow solar wind. If the pseudo-streamer produced solar wind is slow or fast is debated.
- The current observation links the doublestreamer and the pseudo-streamer into one single hybrid structure, that might be responsible for a strong interaction of slow and fast solar wind originating from this hybrid structure.

. Seaton, A. Yeates

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L. Rachmeler, S. Platten, C. Bethge, D. Seaton, A. Yeates in The Astrophysical Journal Letters

SWARM: nominal mission started





- ESA Earth observation mission: 3 spacecraft to study core dynamics and geodynamo processes, crustal magnetisation, and ocean circulation from low Earth orbit.
- Ionosphere-magnetosphere current systems need to be derived and taken care of.
- Very high-precision magnetometers
- Electric Field Instrument (Ion Drift Meter) provided by Canada Space Agency
- Orbit: 400 km altitude
- Launched in November 2013
- Data access: http://eopi.esa.int

SWARM: first results





ESA Heliophysics Missions: future mission status



- In Implementation
 - Solar Orbiter



- In Technology
 - Proba 3



• BepiColombo and Rosetta

Solar Orbiter





- ESA-NASA joint mission:
 - ESA: spacecraft, AIV, operations
 - ESA members states and ESA: 10 instruments
 - NASA: launcher, 2 instruments
- Mission duration: 3.5 years (+2.5 years extension)
- Orbit: 0.28-0.91 AU
- Out of ecliptic: > 24 deg. (>35 deg. extension)
- Launch planned in July 2017

Solar Orbiter: status



• All 10 instrument and spacecraft Preliminary Design Reviews successfully completed

• Instrument Critical Design Reviews are on-going (6/10 successfully completed).

 Spacecraft Critical Design Review: Kick-Off scheduled for Dec 2014

• Ground segment development progressing on schedule.

PROBA 3: continuous solar eclipse



- The PROBA 3 mission consists of two spacecraft, the Coronagraph and the Occulter spacecraft, flying in a close proximity (about 150m with accuracy of a few mm).
- The giant coronagraph is implemented by one satellite occulting the sun and the other satellite flying a telescope.
- Mission Duration
 - > Launch:
 - Lifetime:

2017 2 years

Mission Orbit and Satellite Attitude

- Orbit type: 600 x 60 530 m
- Inclination: 59°
- Formation Flying manoeuvres and coronagraphy at apogee



BepiColombo

General Status



- BepiColombo: two spacecraft mission to mercury. One ESA + one JAXA
- BepiColombo is now foreseen for a launch in July 2016. Science activities around Mercury will start in early 2024.
- The most important milestone in 2014 is the thermal balance acceptance test of the MPO pro-flight model in August/September.
- All science instruments have been delivered and integrated onto the MPO flight model spacecraft. Some to be exchanged later.
- During the last month most teams were busy with instrument calibration and building the flight spare units.

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Rosetta status





Will provide the most detailed study of a comet during its closest approach to the Sun

Rosetta measures comet's surface temperature





@ESA_Rosetta http://blogs.esa.int/rosetta

6 August 2014 November 2014 August 2015 December 31, 2015 Arrival at comet Lander deployment Perihelion Nominal end-of-mission



ESA/Rosetta/MPS for OSIRIS Team MPS/UPD/LAM/IAA/SSO/INTA/UPM/ DASP/IDA

OSIRIS detects clear coma -~1500 km across
12.4 hour rotation rate

27 March 3 April 14 April 17 April 20 April 27 April 4 May 4.6 - 2.0 million km Rosetta- C67P distance

6 June "less" activity400,000 km

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