

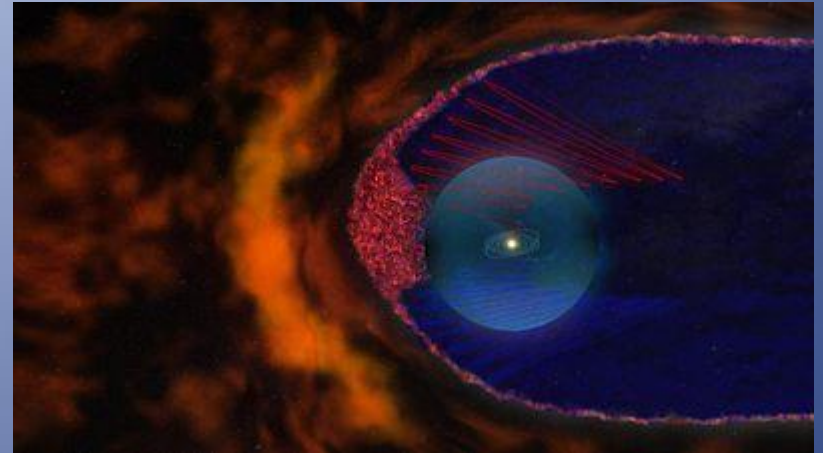


Exploring the Heliosphere

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Exploring the Heliosphere

- Our local laboratory for space plasma physics
- Able to examine ‘in situ’ conditions in a wide variety of locations
- Connecting it all together, from the Solar Dynamo to the aurora of Saturn and beyond.
- Like any scientific investigation the better the data the more subtle the phenomena you can examine.



Current and future approved missions

Solar

- ESA

- SoHO

- Solar
Orbiter
(2017)

- NASA

- RHESSI

- SDO

- SORCE

- Stereo

- TRACE

- IRIS
(2013)

- JAXA

- Hinode

Current and future approved missions

Space Plasma Physics

- ESA

- Cluster

- SWARM
(2012)

- NASA

- ACE

- IBEX

- WIND

- MMS
(2014)

- JAXA

- Akebono

- Geotail*

*joint with NASA

Current and approved missions

Solar System Planetary

- ESA

- Mars Express
- Rosetta
- Venus Express

- Bepi-Columbo
(2014)
- ExoMars (20??)

- NASA

- Dawn
- Epoxi
- LRO
- Mars Explorer
Rovers
- MESSENGER
- Mini-RF
- New Horizons
- Stardust NExT
- Voyager (1&2)
- Juno
- MSL
- GRAIL

- JAXA

- Akatsuki

Planned Planetary Encounters

Aug 2012	MSL: Mars
Feb 2014	Stardust-NeXT: Comet Tempel 1
2014	Rosetta: Comet Churyumov-Gerasimenko
Feb 2015	Dawn: Ceres
2015	New Horizons: Pluto
2016	Juno: Jupiter
20??	ExoMars: Mars



Observations (1)

- While there are a large number of missions exploring the Heliosphere, there are relatively few in development at this time.
- However, there are plenty of missions that have been proposed or that remain in play (e.g. Juice; Solar C), interest is still strong.
- China and India have developing programmes especially associated with Lunar Exploration

Observations (2)

- Funding for future missions around the world is presently very constrained.
- ESA can presently offer one M/L heliospheric mission start about every ~5 years?
- Existing assets, while very productive, but some are now very mature and will not last forever (e.g. Cassini, Cluster). Nevertheless their legacy in terms of high quality data will be with us for years to come.

Observations (3)

- Some very exciting encounters are coming up (Mercury, Churyumov-Gerasimenko, Mars, Ceres, Jupiter, Pluto) and so we will have access to excellent data from around the solar system for at least another decade.

Constraints and Ground Rules

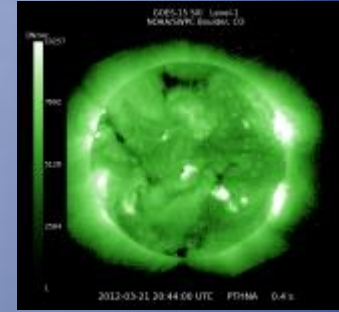
- Mission Cost
 - Technology development prior to selection
 - Flight build programme
 - Operations
 - Exploitation
- Competition
 - Fierce
 - Focus, consistency, consensus, joined-up



In situ

- *In situ* measurement
 - Requires transport to the ‘site’
 - Can be quite modest in mass and power (compared with large observatories)
 - Provides ‘ground truth’
 - Permits simultaneous ‘sampling’ providing a 3-D perception separated in time
 - Are often inspirational
- Proximity
 - Viewing perspectives/sensitivity not otherwise available.

Space Weather



- It is generally accepted that there are genuine threats to commercial assets and human well being from solar events
- Managing this threat requires
 - Monitoring systems
 - A profound understanding of the phenomena from the complexity of the sub-photosphere magnetic fields to the robustness of vulnerable systems
- Do not see Space Weather as a banner that will bring additional resource to Heliospheric Science. Rather, genuinely engage with it as an issue.

Technology (1)

- Sensor systems
 - Low mass and power to ensure inclusion of a wide range of instrumentation on future missions
 - Stable performance
 - Underpinning roadmap of technology *incremental* development
 - Imagers, optics, analysers, landed elements

Technology (2)

- Access to Space
 - Low cost platforms – CubeSats/Nano Sats
 - Low cost launch options – VLM, Skylon, ...
 - Power systems – RTSG, ...
 - Orbit control – Ion drives, Solar sales
 - Soft and hard landers', impactors – Penetrators
- Operations
 - Robotics and automation
 - Ground station networks - GENSO

Alternative opportunities

- Bi-lateral collaborations with, e.g. China, Russia or India. Currently not funded by UKSA but ...
 - Huge opportunity for strategic engagement but currently missions are not as scientifically competitive as NASA/ESA/Japan
 - Requires strategic investment
 - Requires long term engagement, but ...
 - Currently over sold which threatens our credibility
- EU programmes
 - E.g. QB50
- A UK programme
 - CubeSats or pipedreams?

Threats and Opportunities

- When talking to emerging space nations understand where the funds will come from before building the expectations.
- The future exploitation of the Heliosphere depends upon the pro-active support and engagement of its research community
- There will be plenty of opportunities but most may come from outside the ESA programme