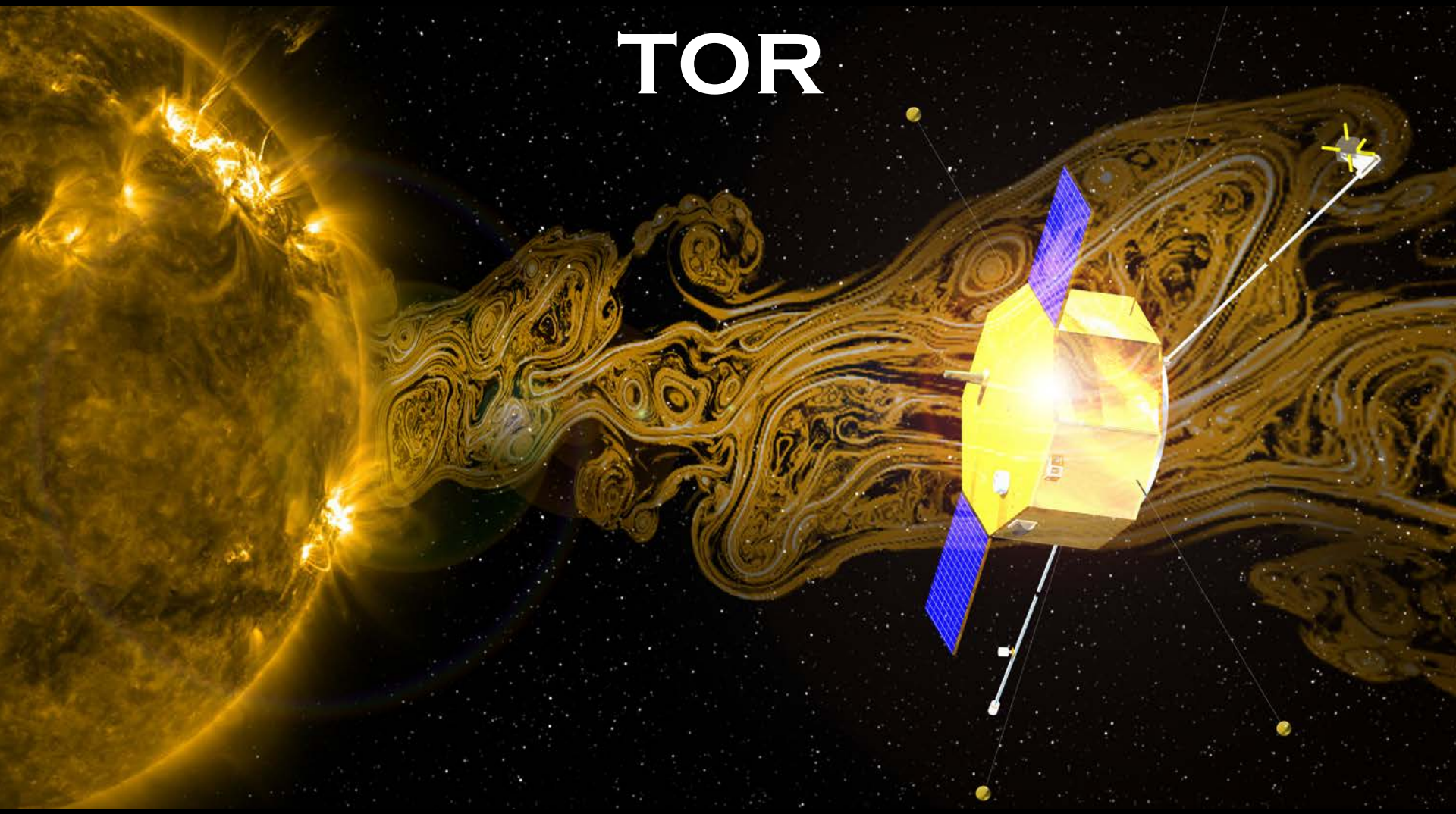
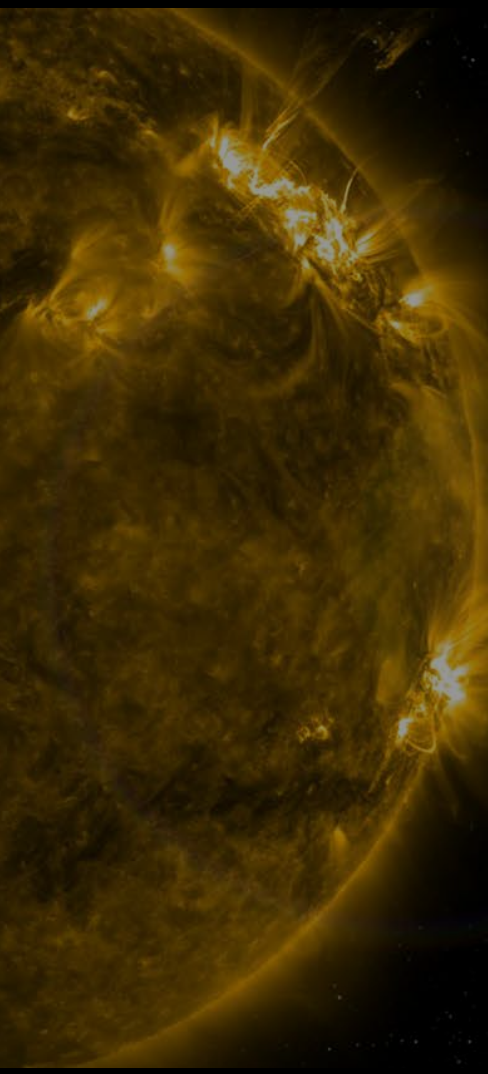
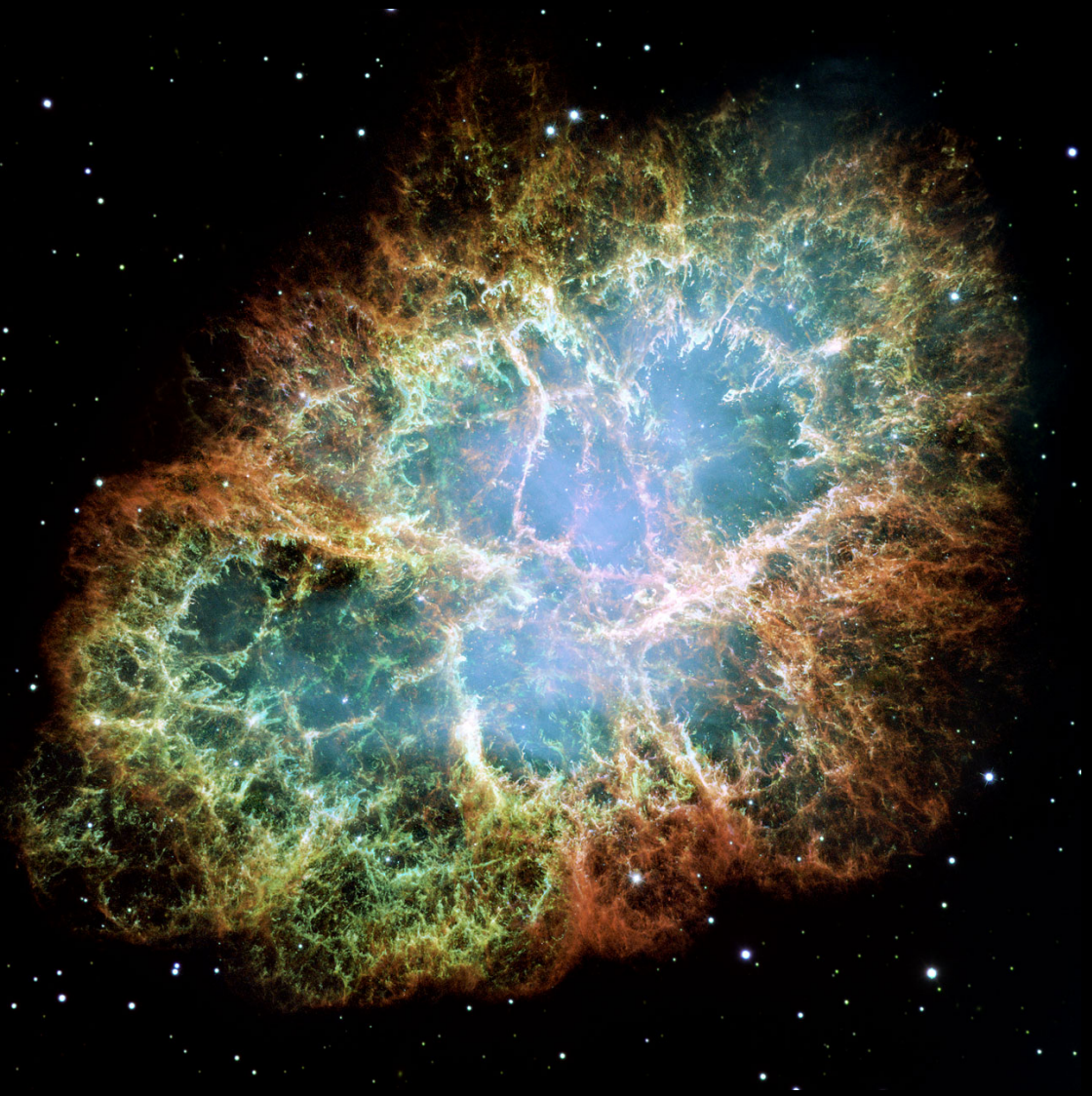


Exploring dissipation in solar wind turbulence



Austria R.Nakamura(IWF), Y.Narita(IWF), Z.Vörös(IWF)
Belgium J.DeKeyser(BISA), G.Lapenta(K.U.Leuven)
Canada C.Cully(U.Calgary), I.Mann(U.Alberta)
China X.Deng(Nanchang U.), A.Du(IGG,CAS), H.Fu(Beihang U.), Y.Ge(IGG,CAS), X.-S.Feng(NSSC,CAS), J.He(Peking U.), Z.X. Liu(NSSC,CAS), Q.Lu(USTC), C.Shen(NSSC,CAS), Q.Shi(Shandong U.), H.Zhang(IGG,CAS), Q.Zong(Peking U.), P.B.Zuo(NSSC,CAS), L.-P.Yang(NSSC,CAS), Y.Wang(NSSC,CAS), X.Wang(Peking U.)
Czech Republic J.Soucek(UFA/CAS)
France O.Alexandrova(LESIA), G.Belmont(LPP), D.Fountaine(LPP), S.Galtier(U.ParisSud), V.Génot(U.Toulouse), R.Grappin(LPP), B.Lavraud(U.Toulouse), O.LeContel(LPP), M.Maksimovic(LESIA), J.L.Pinçon(CNRS,Orleans), A.Retinò(LPP), F.Sahraoui(LPP), T.Passot(CNRS,OCA), P.L.Sulem(CNRS,OCA)
Italy R.Bruno(IFSI/INAF), F.Califano(UNIPI), S.Servidio(U.Calabria), L.SorrisoValvo(CNRIPCF)
Japan M.Fujimoto(ISAS/JAXA), H.Hasegawa(ISAS/JAXA), T.Nakamura(ISAS/JAXA), I.Shinohara(ISAS/JAXA)
Norway S.Haaland(U.Bergen)
Poland W.Macek(SRC), M.Strumik(SRC)
Russia A.Petrukovich(IKI)
Sweden M.André(IRF), L.Blomberg(KTH), A.Brandenburg(Nordita), A. Eriksson(IRF), T.Fülöp(Chalmers), M.Hamrin(Umeå U.), N.Ivchenko(KTH), T.Karlsson(KTH), Yu.Khotyaintsev(IRF), T.Leyser(IRF), P.A.Lindqvist(KTH), G. Marklund (KTH), H.Opgenoorth(IRF), S.Ratynskaia(KTH), A.Vaivads(IRF), E.Yordanova(IRF)
UK C.Chen(ICL), C.Owen(MSSL), S.Schwartz(ICL), A.Schekochihin(U.Oxford), K.Yearby(U.Sheffield)
USA V.Angelopoulos(UCLA), S.Bale(SSL), J.Bonnell(SSL), H.Ji(PPPL), H.Karimabadi(U.California), J.Kasper(HSCA), L.Kistler(UNH), H.Kucharek(UNH), A.Lazarian(U.Wisconsin), D.Sundkvist(SSL), B.Zieger(Boston U.)

Turbulence - One of the fundamental and universal plasma processes

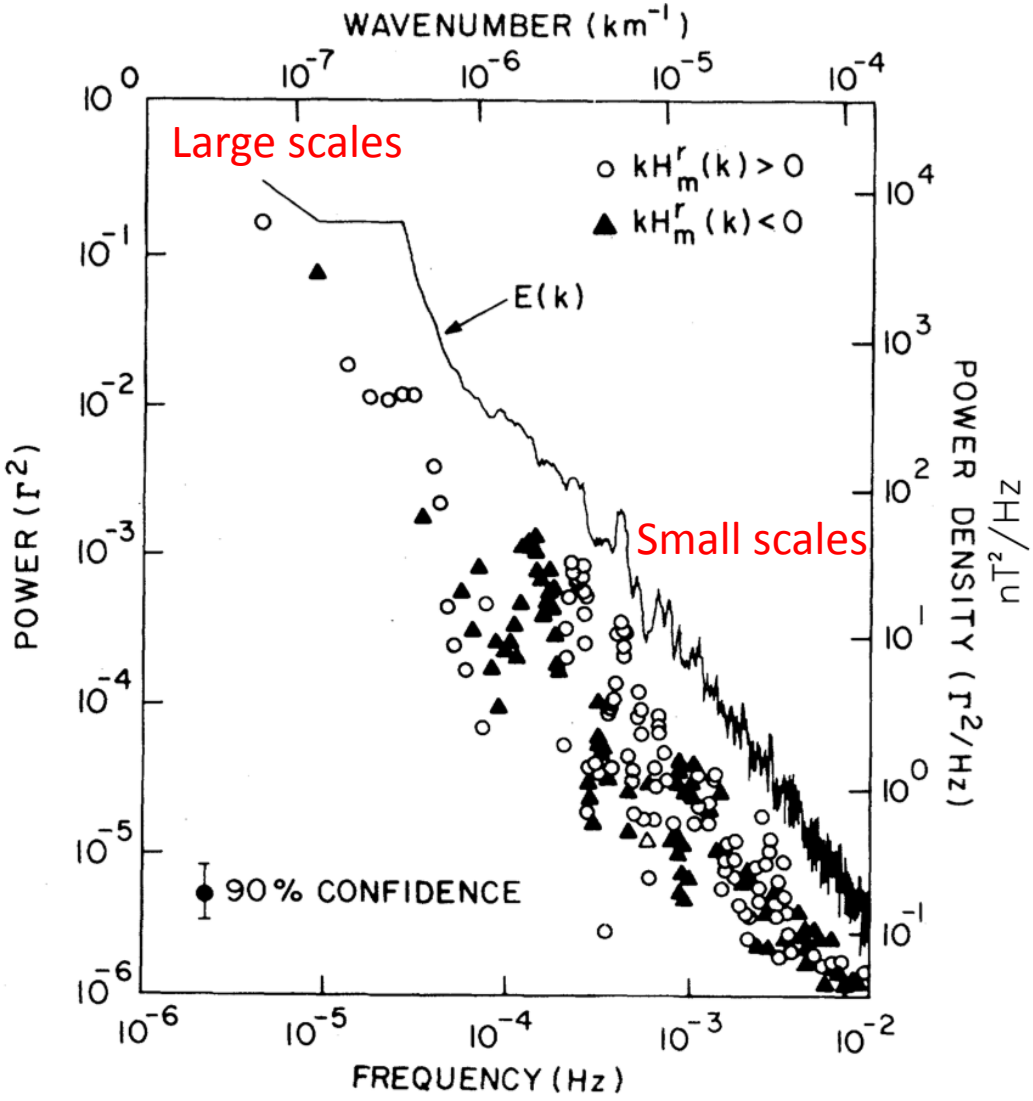


Most of the visible universe exists in a highly ionised plasma state.

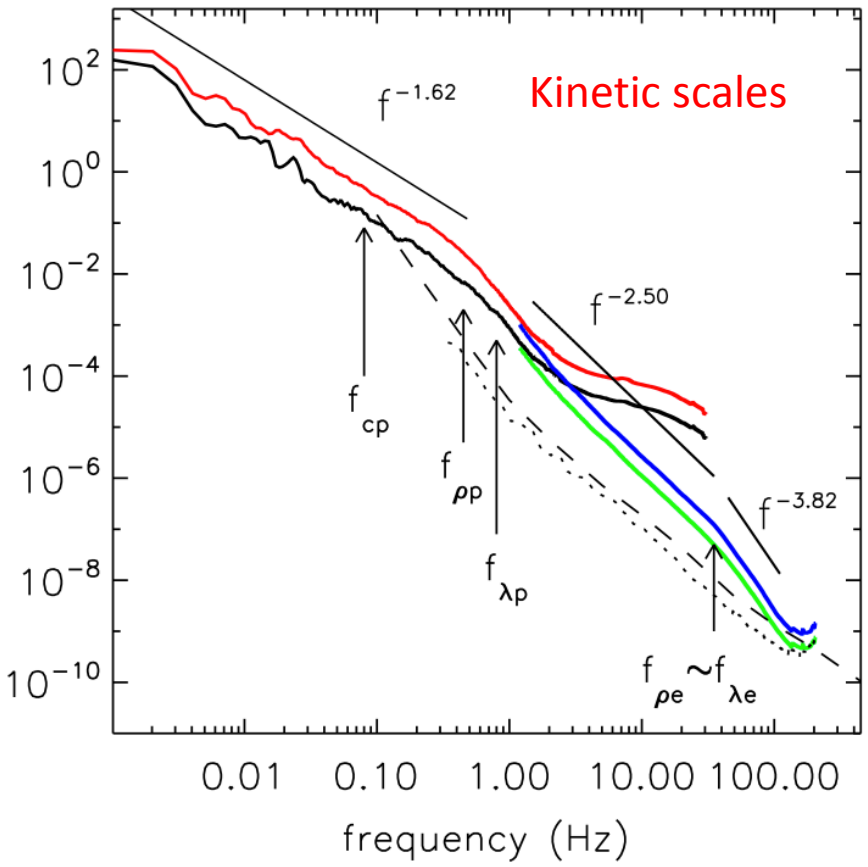
Plasma processes are at work everywhere, from radio galaxy jets and supernova explosions to solar flares and planetary magnetospheres.

Most of the irreversible dissipation of electromagnetic energy in turbulent plasmas occurs at kinetic scales - ion and electron gyroradii and inertial length scales.

Turbulent cascade

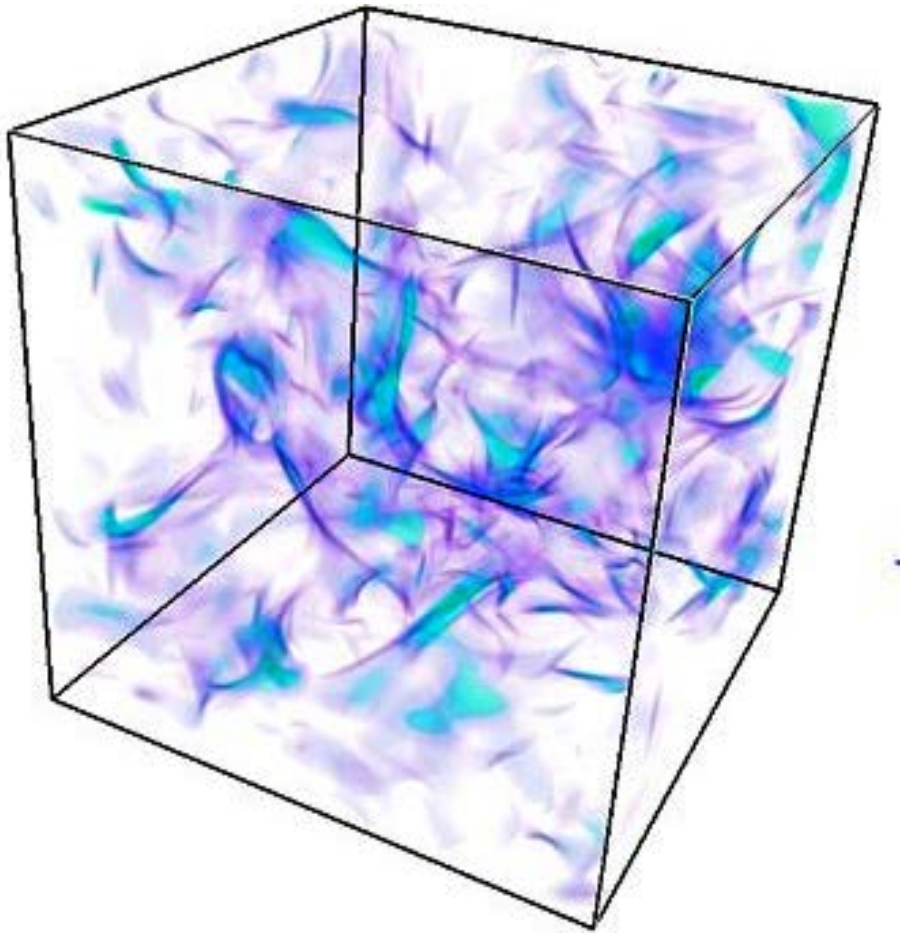


Matthaeus, W. H., & Goldstein, M. L., 1982



Sahraoui, F., et. al., 2009

Key science question:

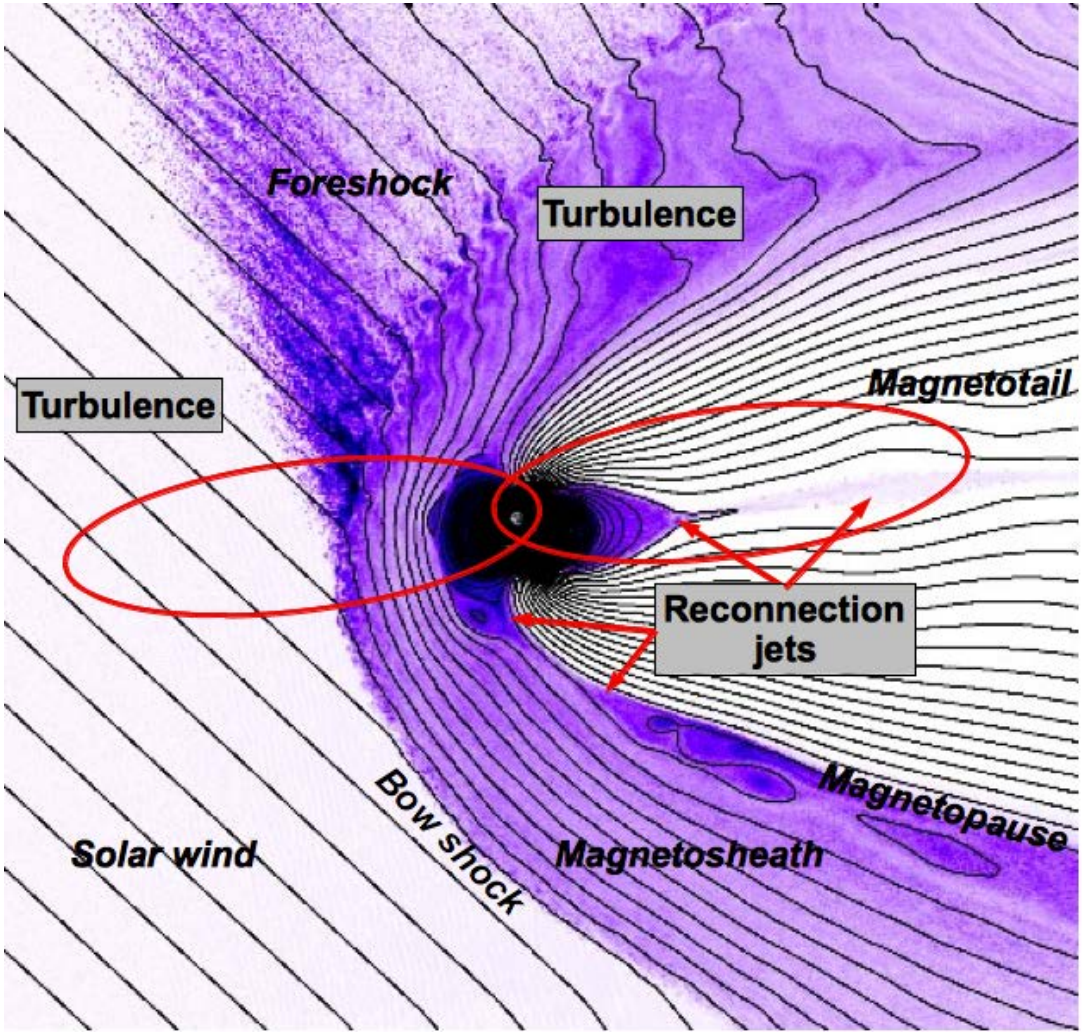


A. Greco et. al, 2008

How is electromagnetic energy dissipated in solar wind turbulence at kinetic scales?

Distinguish the relative importance of two processes:

- Kinetic damping through wave-particle interactions over large plasma volumes and operating over long time scales.
- Dissipation by coherent structures localized in space and time.

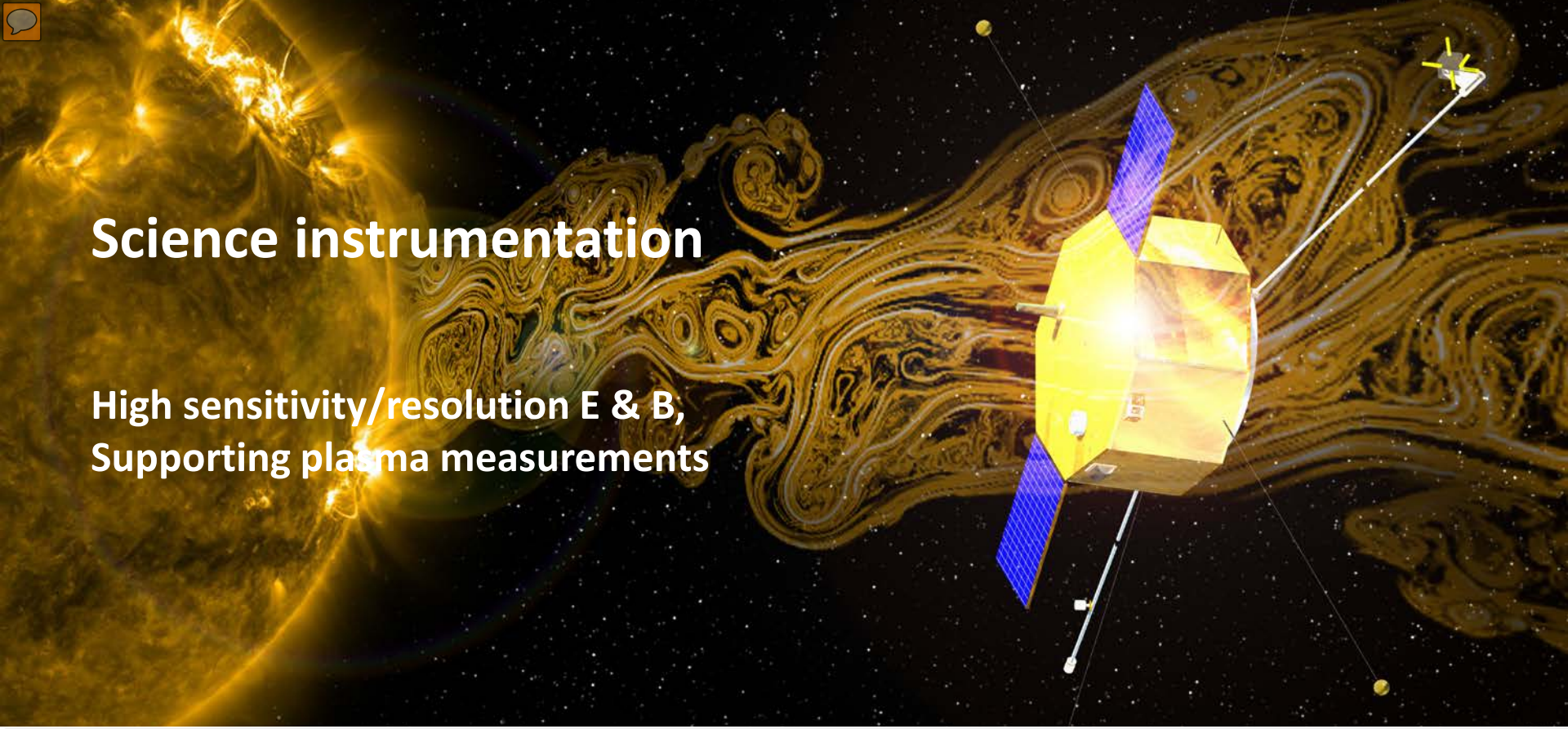


Mission summary

Spacecraft:
Sunpointing (heritage Freja, FAST, CRESS, RBSP), slow spinner 2 rpm.
Payload mass 26 kg, total dry mass 178 kg, total wet mass 229 kg.

Orbit:
~2,000 km × ~25 RE, low inclination, orbital period ~3 days. Piggy-back payload into GTO orbit.

Operational lifetime: 2 years



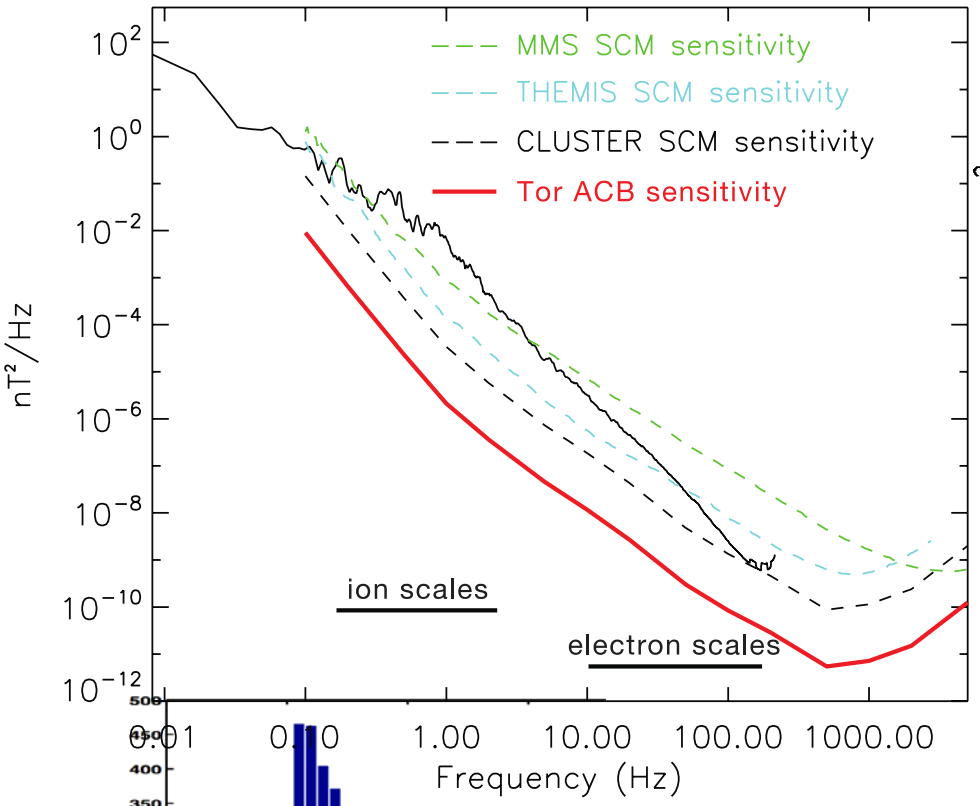
Science instrumentation

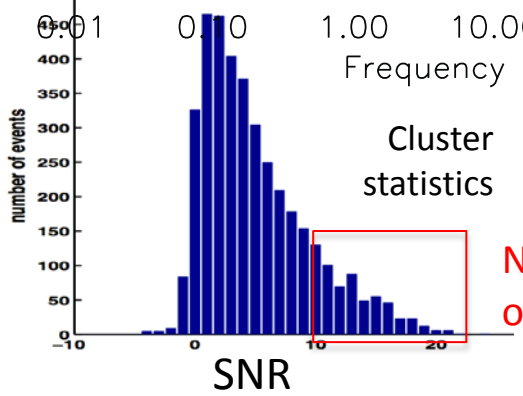
High sensitivity/resolution E & B,
Supporting plasma measurements

Instrument	Range	Mass [kg]	Power [W]	TRL	Heritage/Note
MAG	DC-25 Hz, 64 sps	0.6	0.5	8	BepiColombo, Themis, VEX.
ACB	10Hz-25 kHz, 64 ksps	1.5	0.3	7	Cluster, Themis, MMS
E2D	DC-100 kHz, 256 ksps	8.1	0.5	8*	Cluster, RBSP. 4 units
FC	50 eV–8 keV, 128 sps	1.8	1.5	6	Wind, Solar Probe Plus
EESA	1 eV–2 keV, 16 sps	2.0	2.0	7	Stereo, Solar Orbiter. 2 units
IESA	5 eV–32 keV, 16 sps	2.5	3.4	7	Cluster CIS-HIA
HEPA	e^- : 2 keV–500 keV, spin. i^+: 20 keV–500 keV, spin.	2.7	2.0	6	Elfin-Lomonosov
Common electronics box		3.2	11.5	(see individual instruments)	
Total (incl. DMM)		**26.0**	**26.0**		

High-sensitivity measurements of electromagnetic field

Magnetic field sensitivity

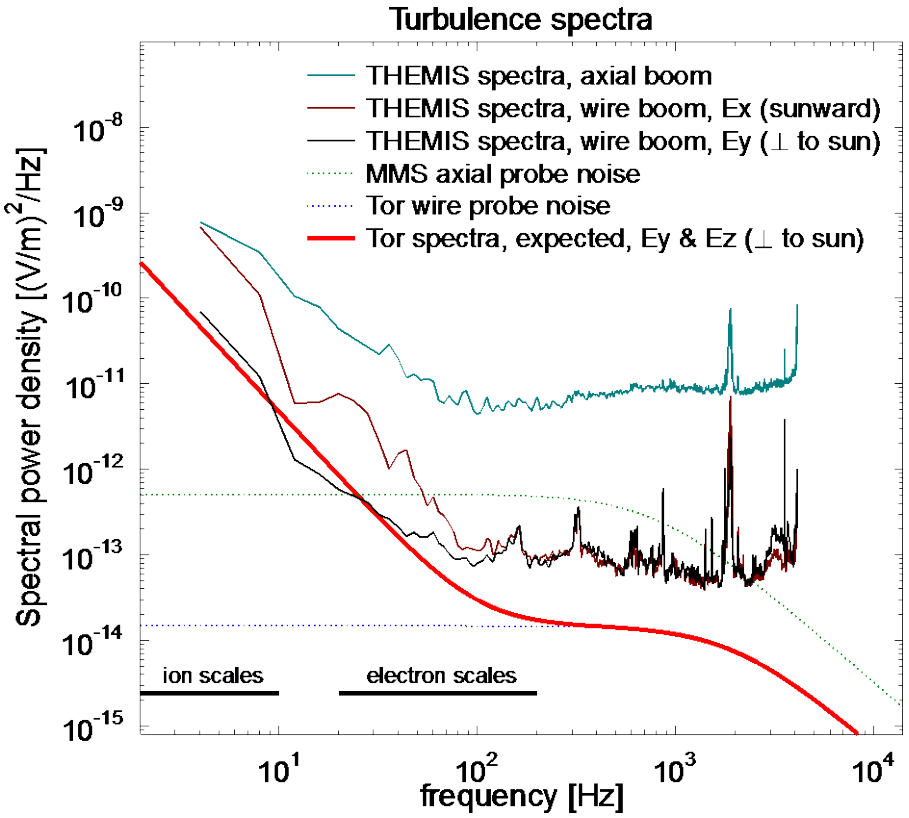




Cluster statistics

Not sufficient number of events with SNR>10

Electric field sensitivity



Strong requirements on EM cleanness!

Operations : high resolution fields data with selective data downlink

No real-time operations.
Autonomous spacecraft sun-pointing.
Orbit determination using GPS during perigee passes.

Low-latitude stations, one ground station contact per orbit. Contact duration >3.1 h. S-band uplink/downlink, 11-13 m S-band antenna.

Payload operational above 64,000 km distance.

Science data telemetry: 1 Gbit/orbit, 125 Gbit/year.

Survey data downloaded from the whole period.

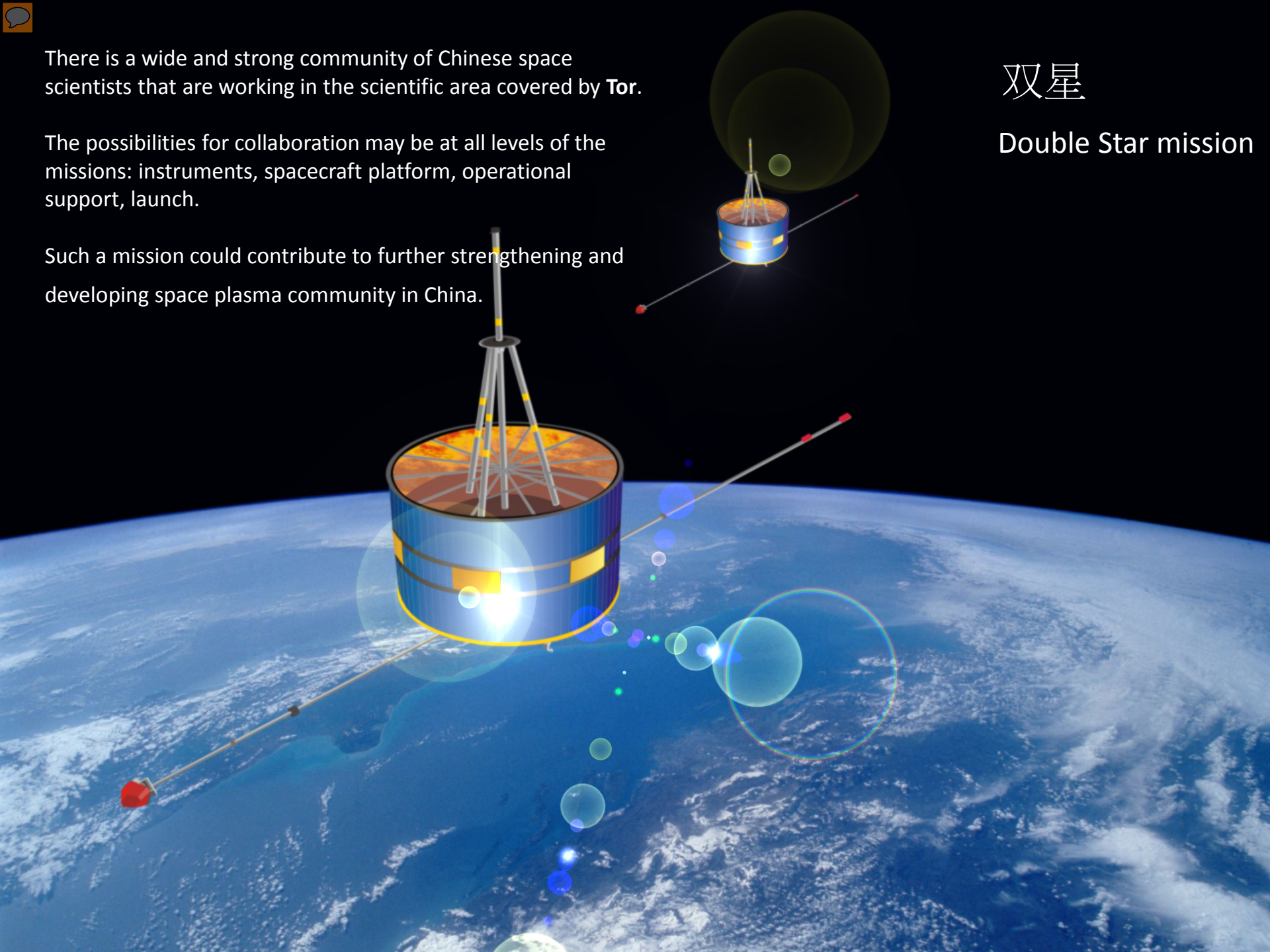
Normal and Burst data downloaded from short intervals, together ~2h per orbit, **selected after-the-fact by the Scientist in the Loop**.

	Survey	Normal	Burst	Total
Recorded [minutes]	3480	3480	50	
Downloaded [minutes]	3480	120	1	
MAG+ACB+E2D Rate [kbps]	0.24	61.5	1792	
FC+EESA+IESA +HEPA Rate [kbps]	0.05	54.8	0	
Total Rate [kbps]	0.296	116.3	1792	
Total Data [%]	6.1	83.2	10.7	
Data [Mbit/orbit]	60.4	818.0	105.0	**983.4**
Storage [Gbit/orbit]	0.06	23.17	5.13	**28.4**

There is a wide and strong community of Chinese space scientists that are working in the scientific area covered by **Tor**.

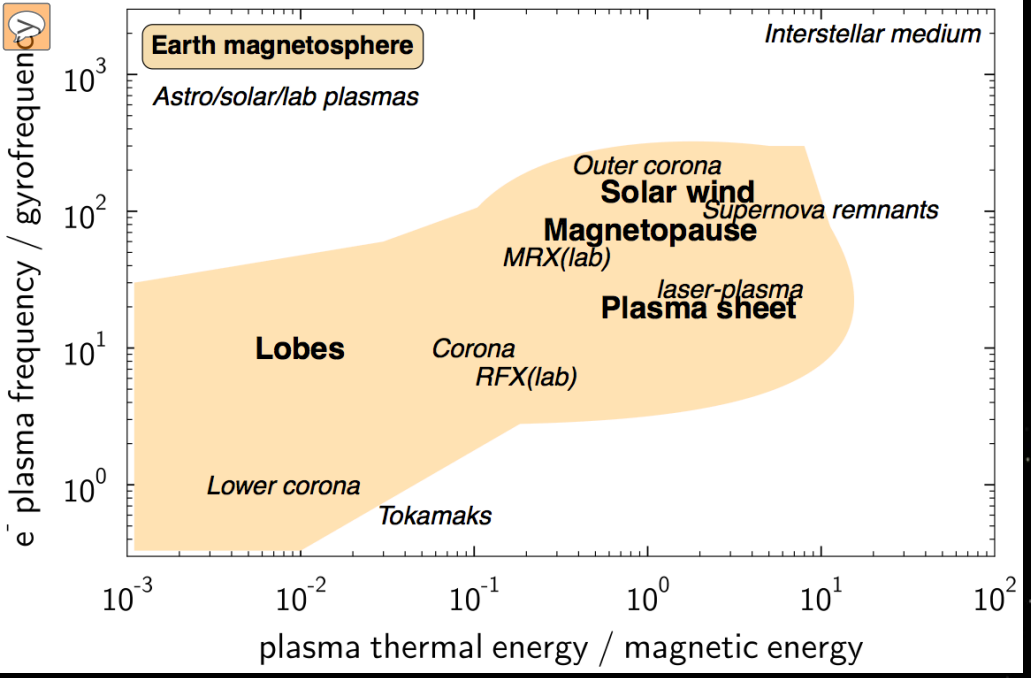
The possibilities for collaboration may be at all levels of the missions: instruments, spacecraft platform, operational support, launch.

Such a mission could contribute to further strengthening and developing space plasma community in China.

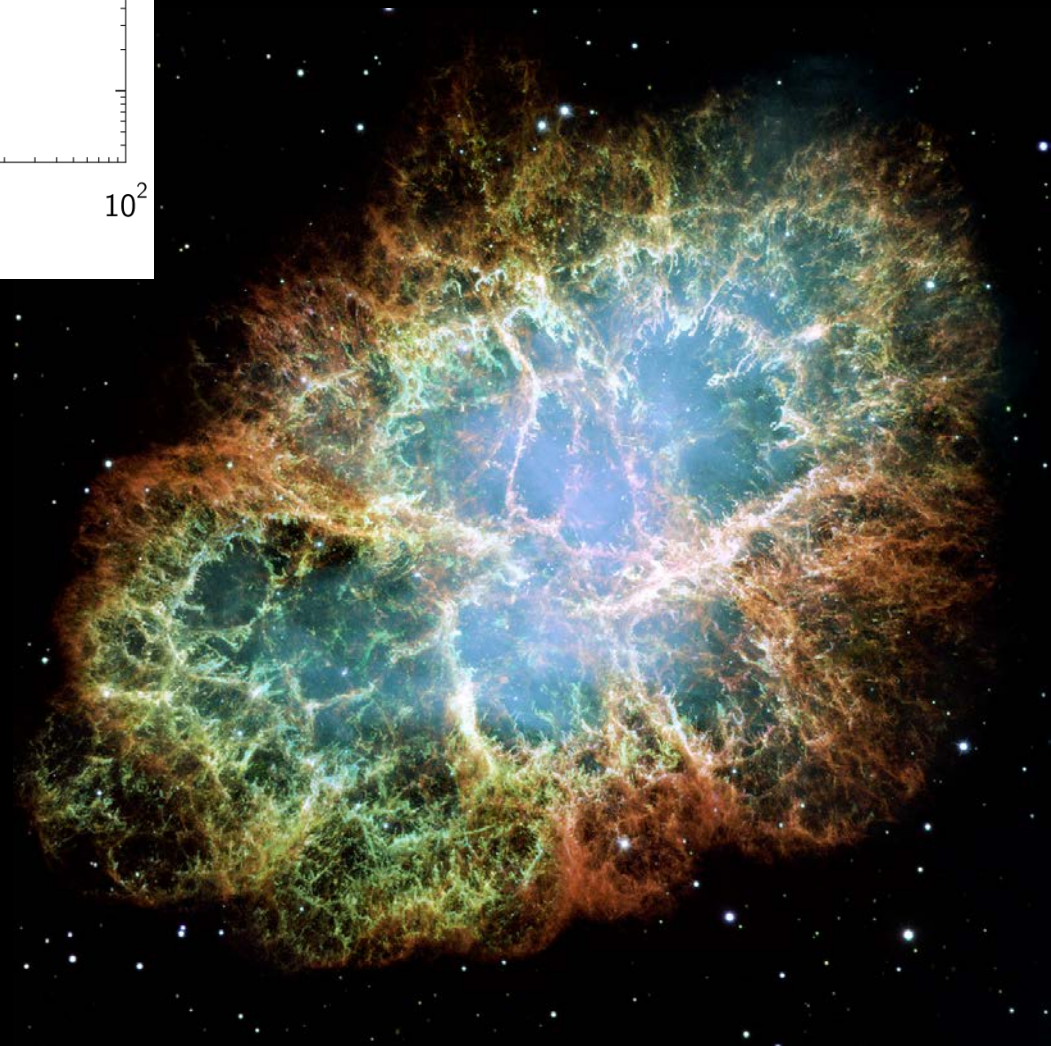


双星

Double Star mission



The solar wind is the best environment in the near-Earth space where turbulence at kinetic scales can be studied



Tor scientific results will lead to groundbreaking detailed quantitative studies of kinetic scale dissipation processes that will shed light on this fundamental yet poorly understood problem of *Plasma Turbulence*.