Herschel and Planck: ESA's New Astronomy Missions – an introduction

Martin Kessler

Schloss Braunshardt

19/03/2009

Missions in Operations

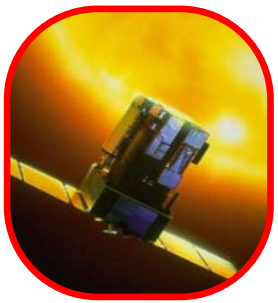
Hubble

Integral

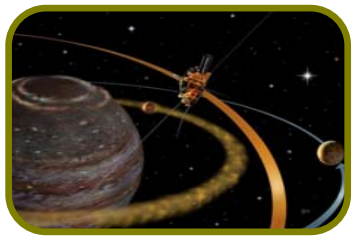
Newton

Rosetta

Mars Express

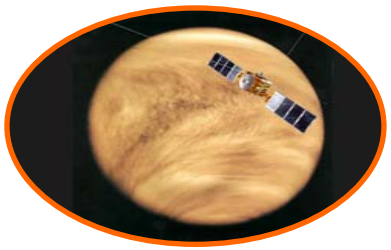


SOHO



Ulysses

Cluster



Venus Express

Herschel and Planck – Two missions, One programme

Two Missions

- **Herschel**: **space observatory**: unlock secrets of star & galaxy formation in unexplored wavelengths
- **Planck**: **survey mission**: measure Cosmic Microwave Background radiation, relic of the Big Bang

Two Spacecraft

- **Herschel**, three axis stabilised, **pointing** satellite
- **Planck**, a low-spin-rate sky **scanning** satellite

Two Cryogenic Telescopes

- **Herschel**: 3.5 meter aperture telescope - largest ever flown in space – cryogenic temperature
- **Planck**: off-axis, 1.5 meter aperture cryogenic telescope

Two Cryogenic Payloads

- **Herschel**, superfluid-Helium cryostat down to 1.7 K, instrument coolers down to 0.3 K
- **Planck**, passive cooling to 60 K and instrument active coolers down to 0.1 K

One Orbit Type

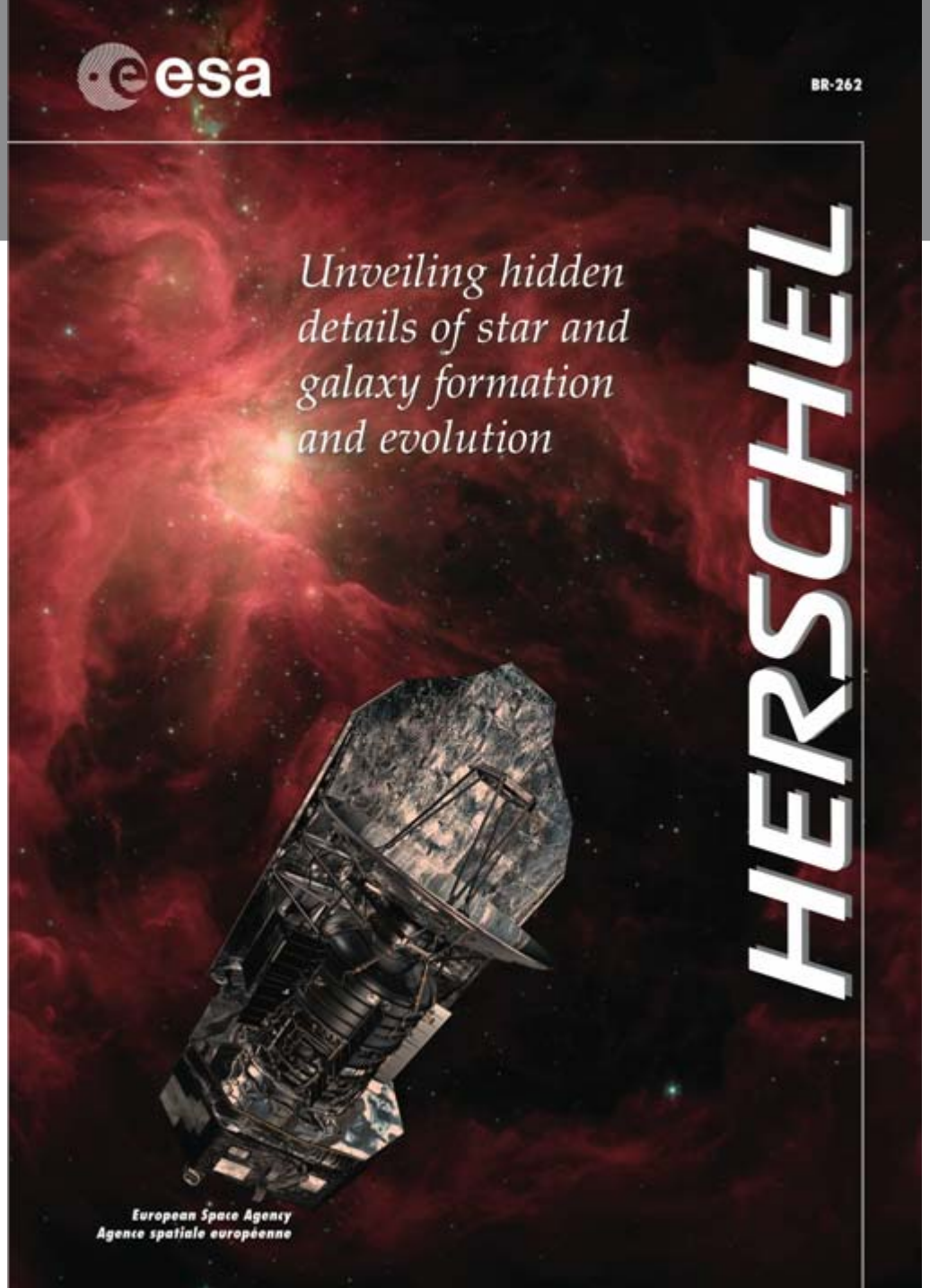
- First ESA missions to orbit around the 2nd Lagrangian point in space – 1.5 million km from Earth

One Launcher

- **Ariane 5 ECA** with single launch for both Spacecraft

One Programme

- One ESA project team, One industrial Architect, One development concept



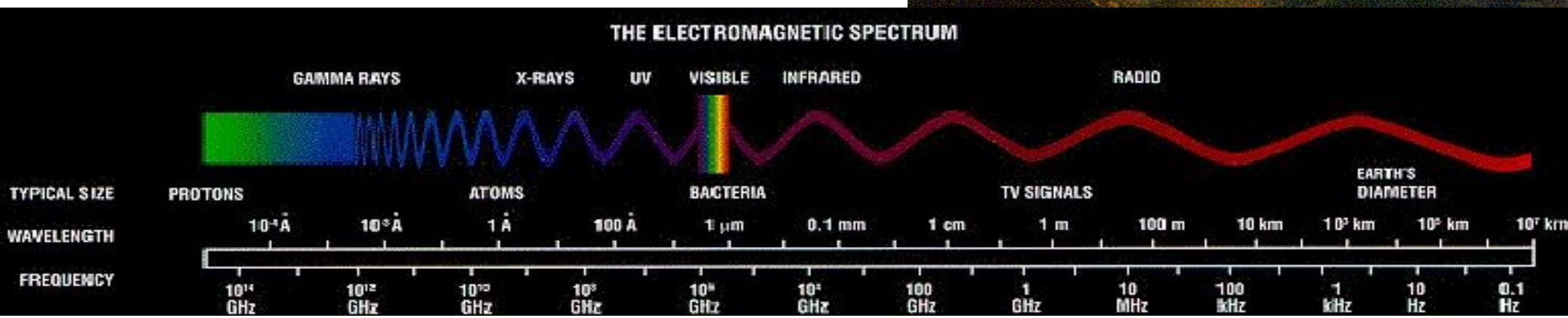
esa

European Space Agency

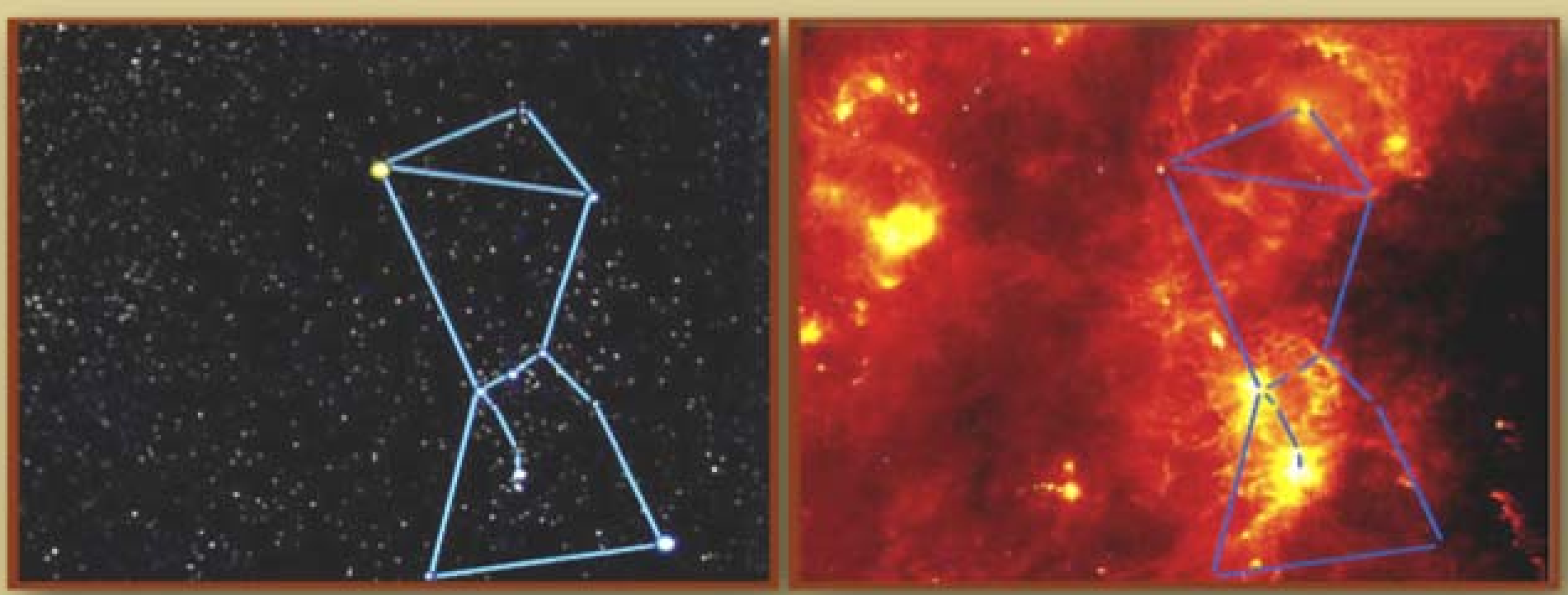
Herschel Space Observatory

Mission named in honour of Sir William Herschel (1738 – 1822), who demonstrated the existence of infrared radiation in 1800.

Both he and his sister, Caroline, were pioneering and successful astronomers.



The sky is different at different wavelengths!

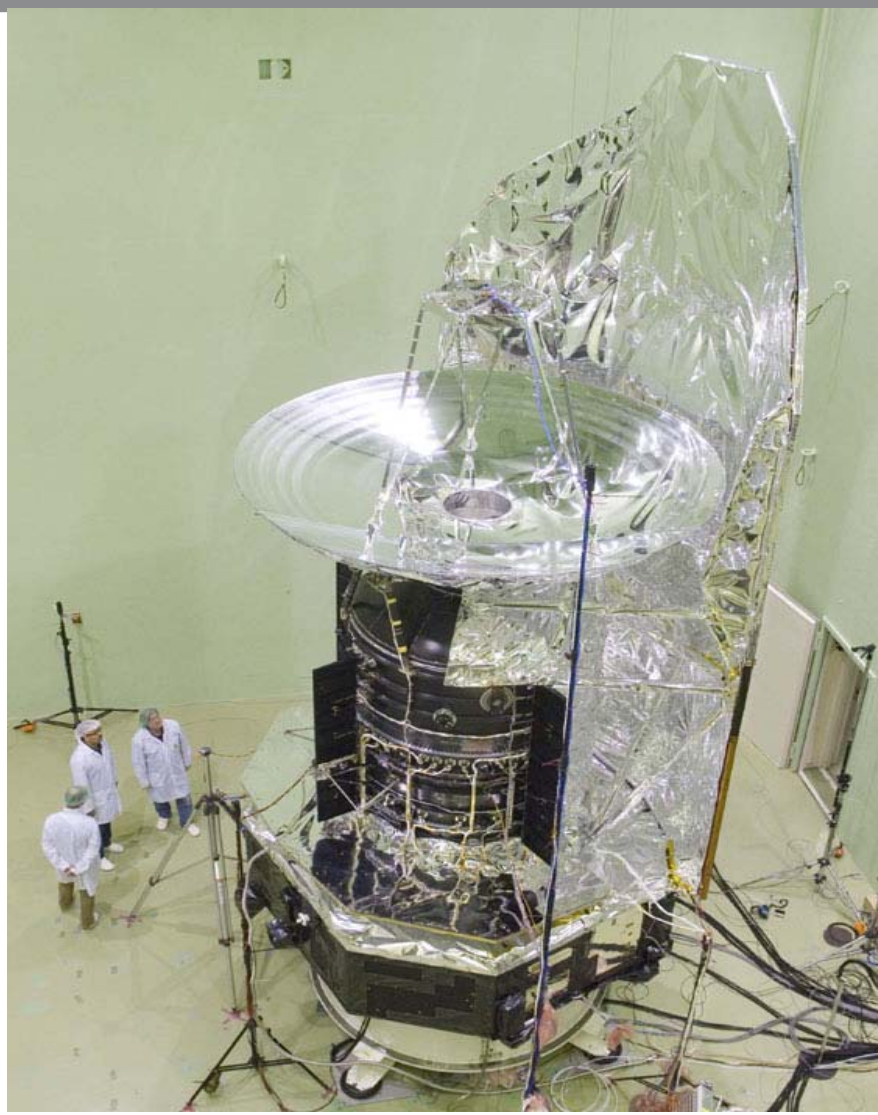


Herschel Science

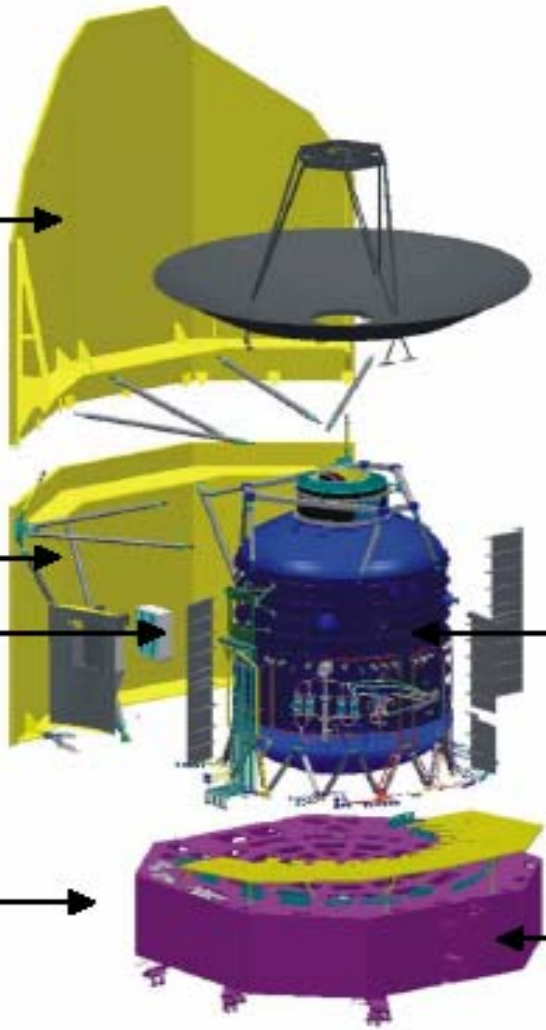
- **Formation and evolution of galaxies** and large-scale structure
  - nature of galaxies as function of time
  - energy and ‘metal’ production history of the universe
- **Formation and evolution of stars** and stellar systems
  - physics and chemistry of the interstellar medium
  - from clouds to stars, planets, and potentially life
- **Our Galaxy and solar system** as examples
  - our Galaxy as template for other galaxies
  - comets and other pristine bodies, planetary atmospheres,…
- **Herschel special strengths:**
  - large telescope: more **collecting area** and **sharper view**
  - spectral coverage: opening up new window – **cool universe**
  - designed for **wide area mapping** and **spectral line scans**
  - designed to capture the **most interesting physics**

Herschel Tools

- **Large telescope**
  - 3.5 m diameter
- **New spectral window**
  - 55-672 μm – bridging the far infrared & submillimetre
- **Three novel instruments**
  - photometry in 6 ‘colours’
  - imaging spectroscopy
  - very high resolution heterodyne spectroscopy
- **3 years of operations**



Herschel Spacecraft



Sun Shade

Telescope

Solar Array

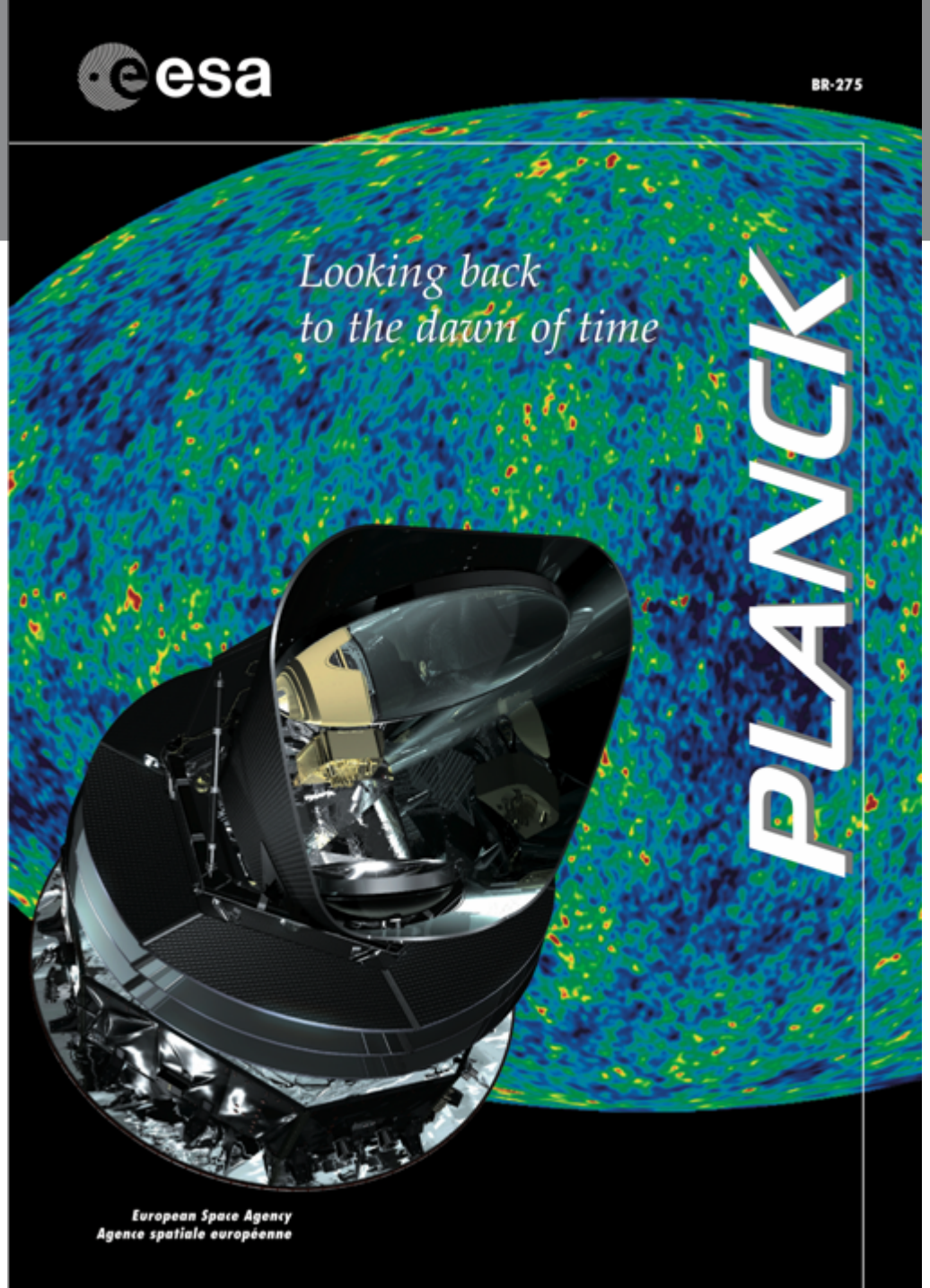
Local Oscillator Unit

Cryo Vacuum Vessel

Service Module

Thermal Shields

Instrument Warm Units

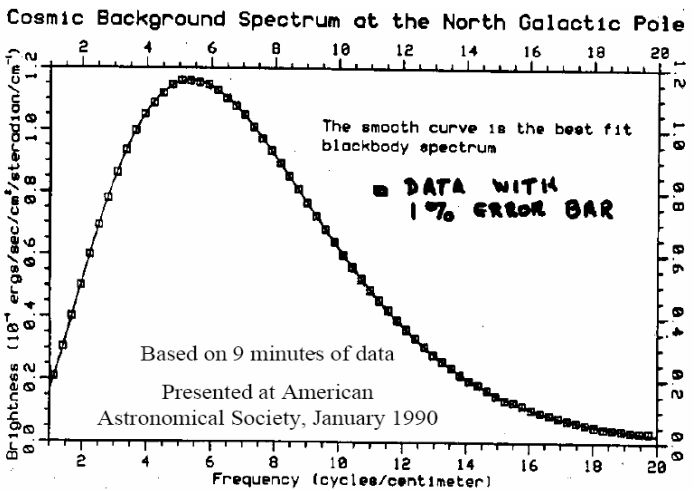

esa
BR-275
Looking back
to the dawn of time
PLANCK
European Space Agency
Agence spatiale européenne

Planck

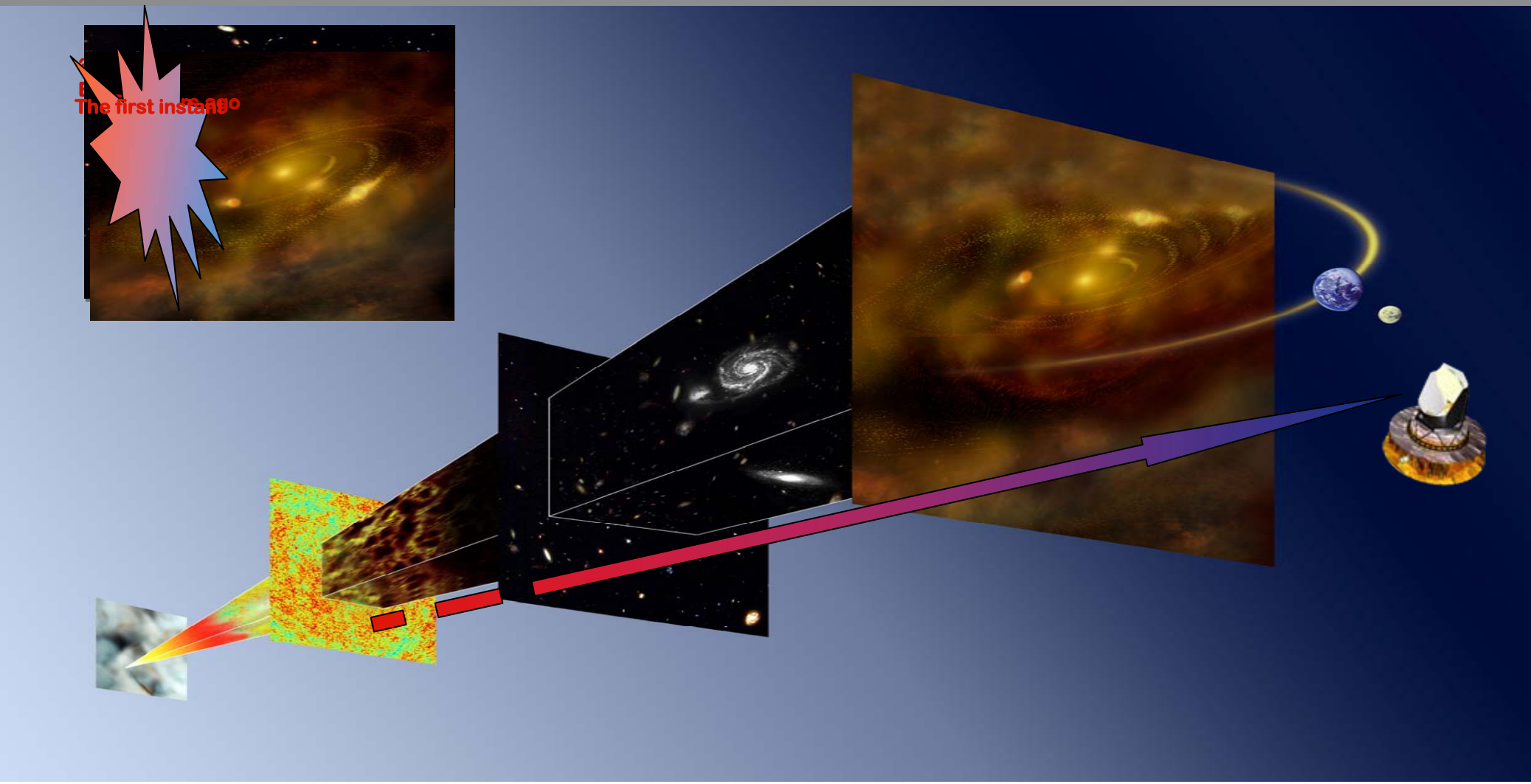
Mission named in honour of the German scientist Max Planck (1858 – 1947), Nobel Prize for Physics in 1918.

–Max Planck started the quantum revolution, explaining the spectrum of a blackbody based on the quantisation of radiation.

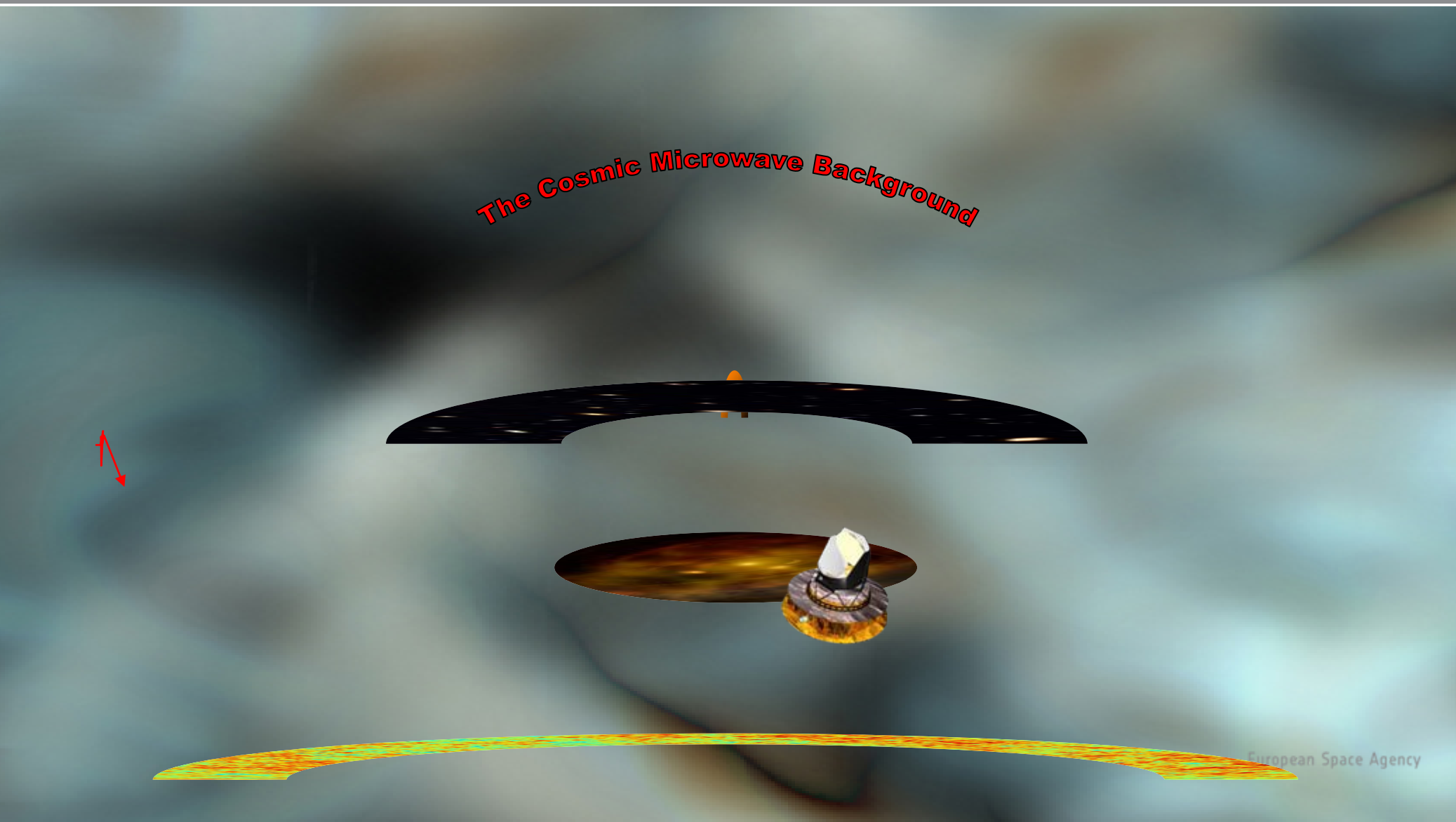
–Cosmic Microwave Background is the most perfect blackbody known in nature



Planck: The History of the Universe



Planck: Looking back in time !

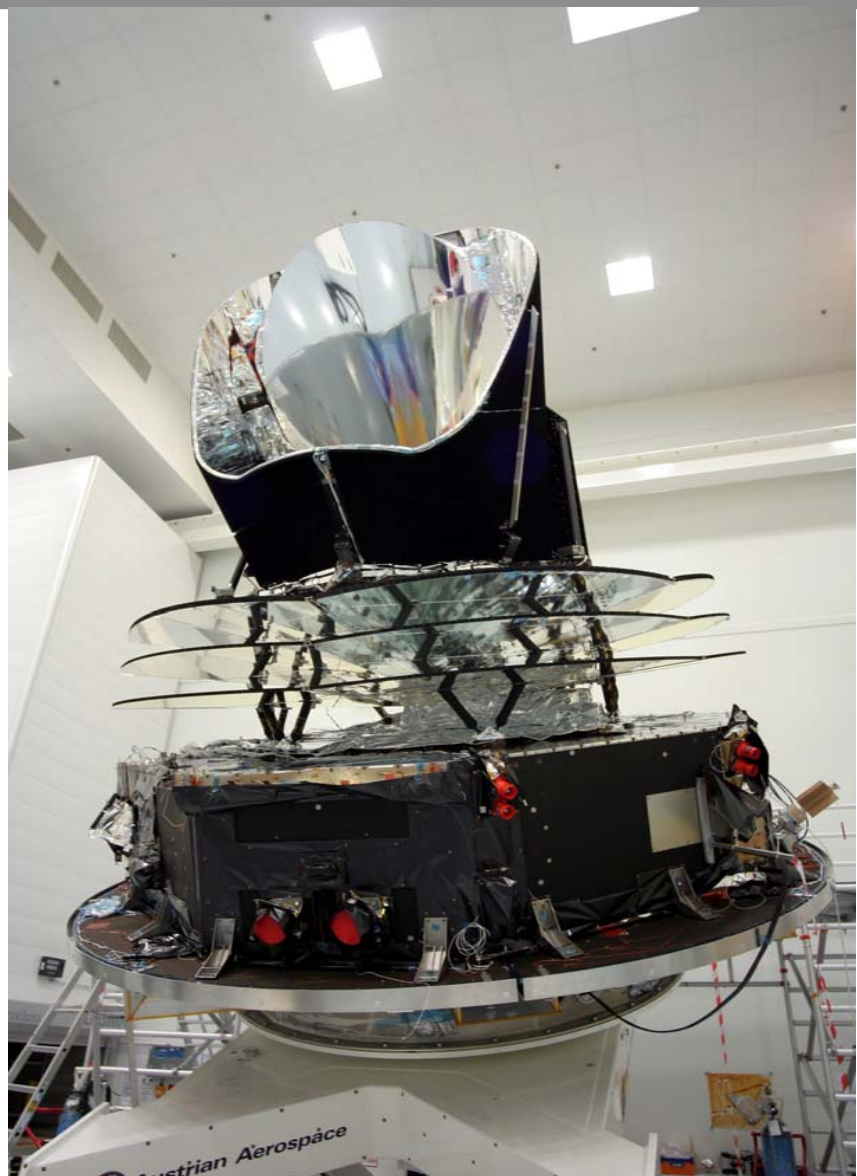


Planck Science

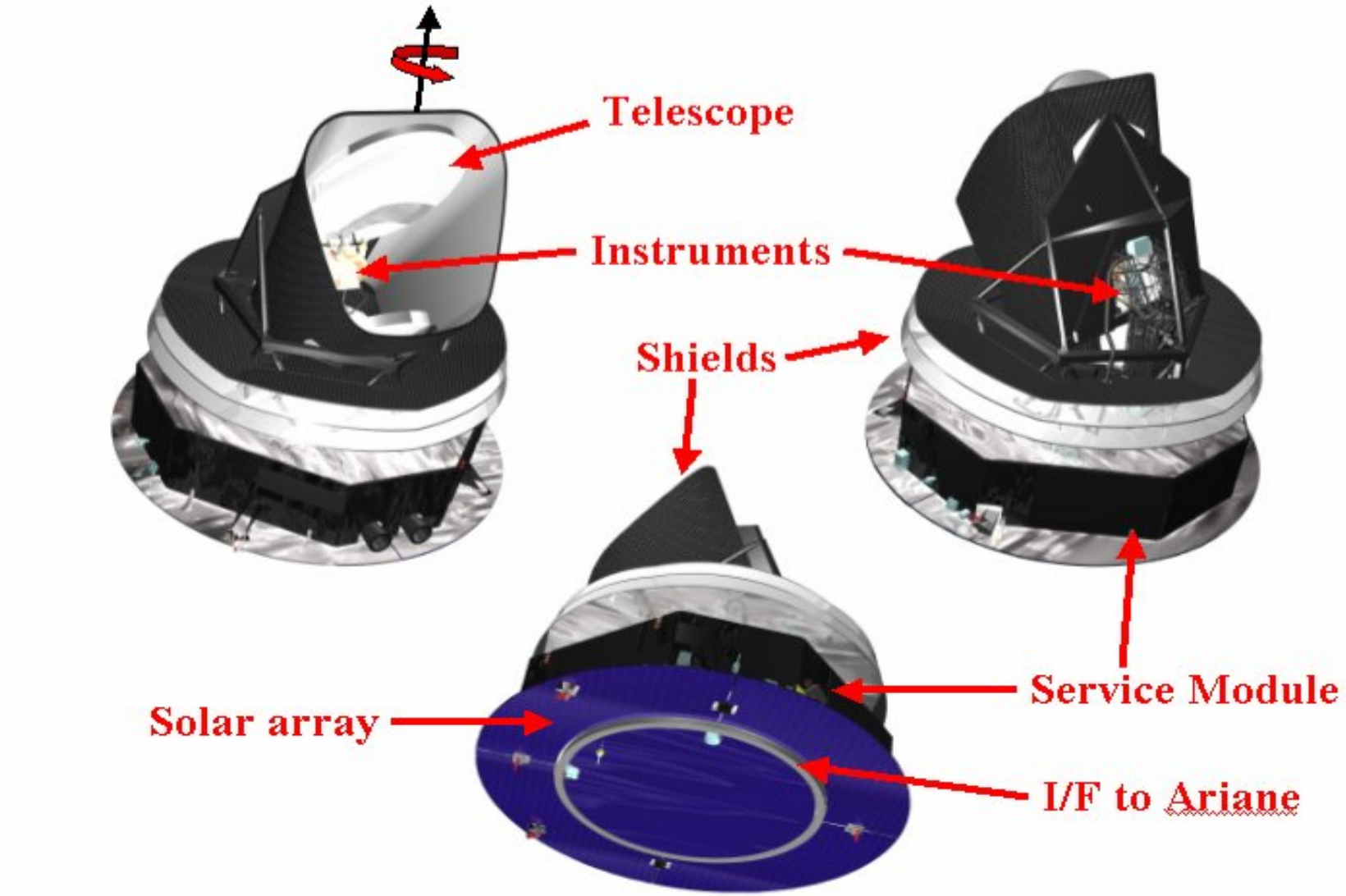
- **Will provide all-sky maps at unprecedented angular resolution and sensitivity of the remnants of the radiation that filled the Universe shortly after the Big Bang.**
- **Next major milestone in space Cosmic Microwave Background (CMB) research,**
  - plus huge impact in many other areas of astrophysics
- **Addresses fundamental questions,** as examples
  - values of fundamental cosmological constants,
  - search for support that the early Universe passed through an inflationary phase,
  - search for primordial gravitational waves.

Planck Tools

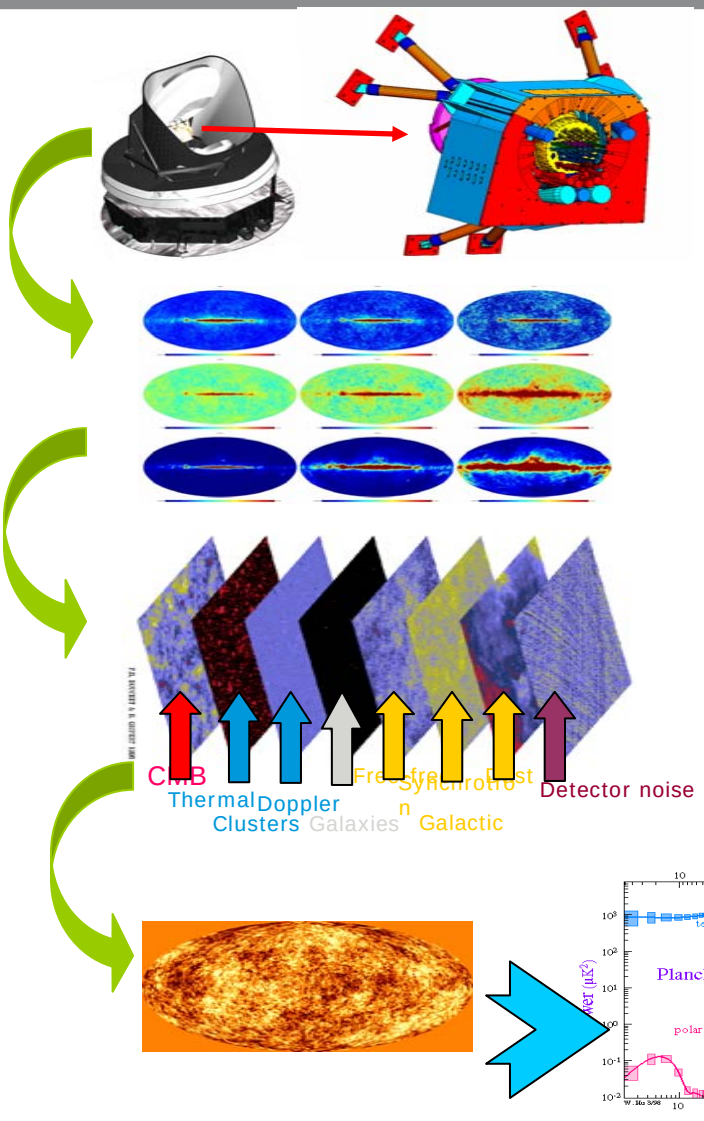
- Telescope aperture of 1.5m.
- Two instruments (LFI and HFI)
  - Image the sky in 9 frequency bands from 27 – 77 GHz and 83 Ghz – 1 THz.
- 2 (possibly 4) complete scans of the sky in 15 (27) months.



Planck Spacecraft



Planck Data Processing



Acquiring and processing
time-ordered information

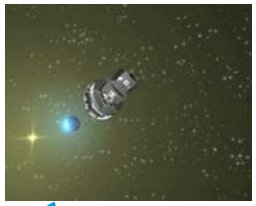
Converting time-ordered data
to maps of the sky emission
at many frequencies

Converting frequency
maps to component maps,
e.g. the Cosmic Microwave Background

Estimating the CMB
angular power spectrum
and cosmological parameters

Herschel and Planck missions – Mission and Science Operations

Spacecraft (L2)



Ground Station
(New Norcia)

Mission Control Center
(ESOC, Germany)

Scientific community

NASA Herschel Science Centre

ESA Herschel Science Centre

ESA Planck Science Office

Planck LFI Data Processing Center

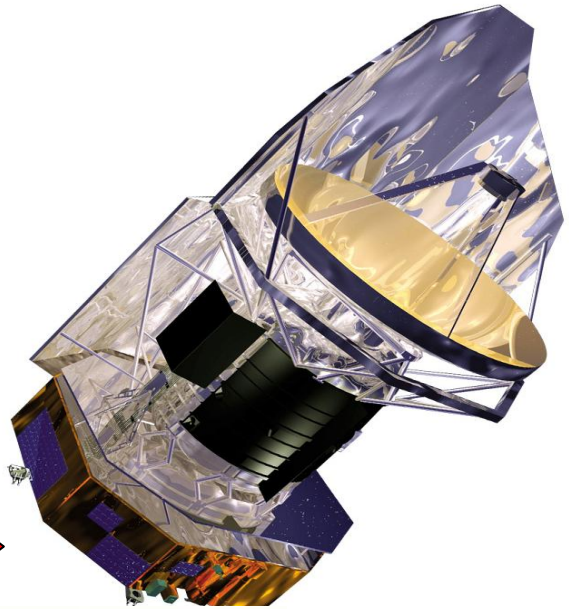
Planck HFI Data Processing Center

Herschel HIFI Instrument Control Center

Herschel PACS Instrument Control Center

Herschel SPIRE Instrument Control Center

Almost Ready for Launch …



After Herschel / Planck, now in development...

Deconstructing our galaxy

Precursor for Gravitational Wave Observatory

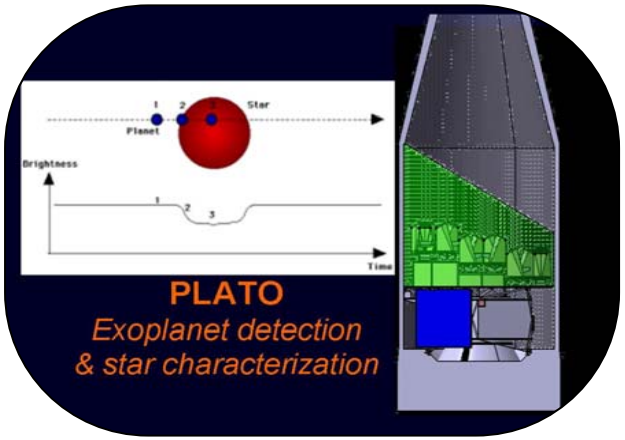
Mercury

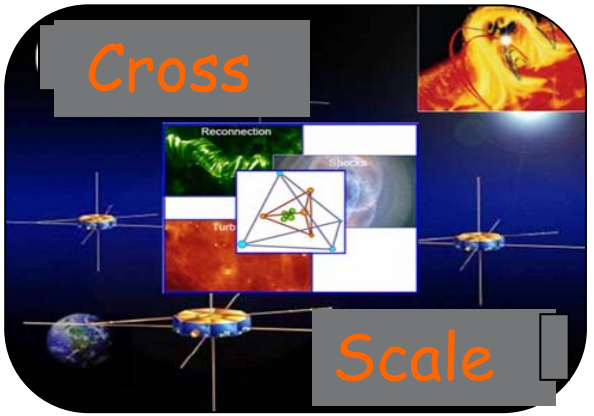
The most distant universe the first light

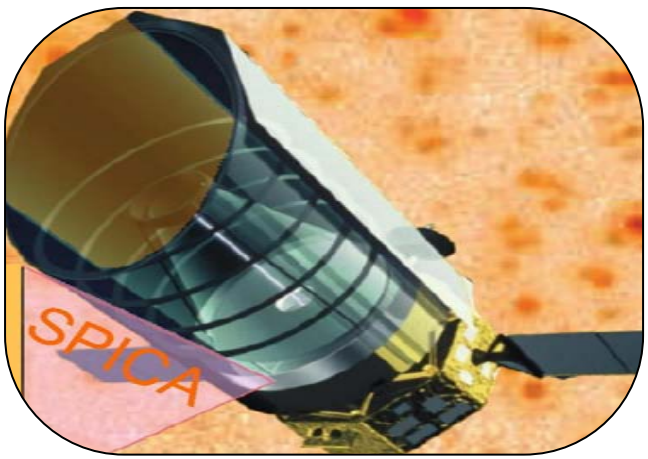
Mars

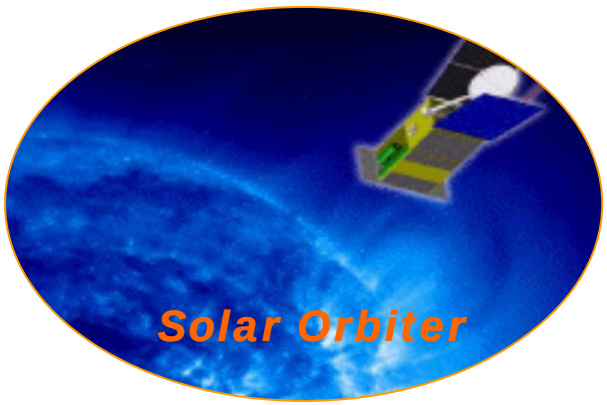
Medium Missions, under study, for launch opportunities in 2017 and 2018

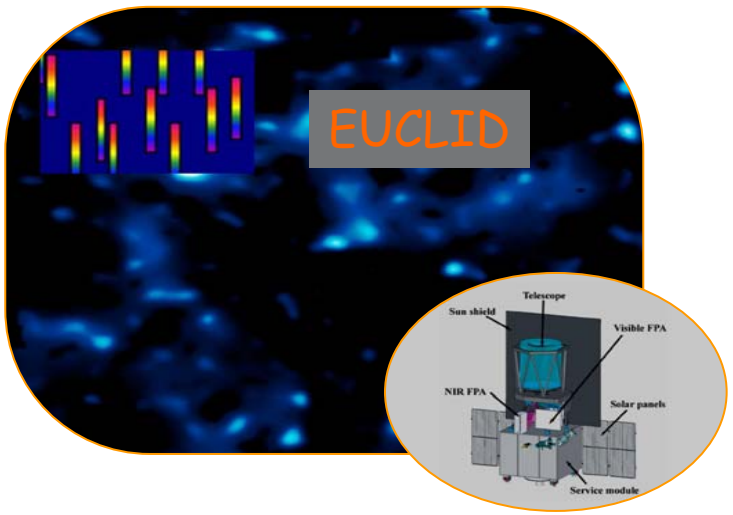
Cosmic Vision, 2015 – 2025







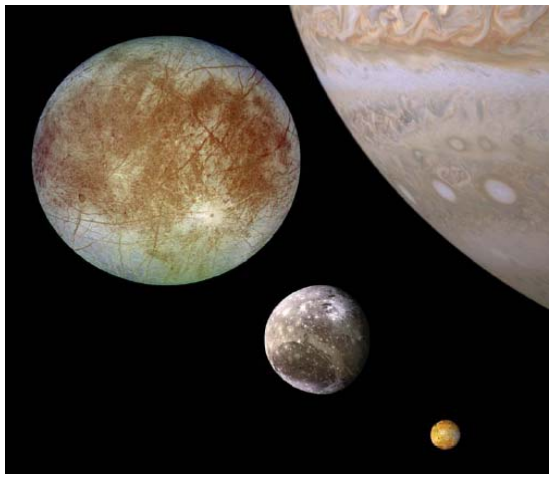


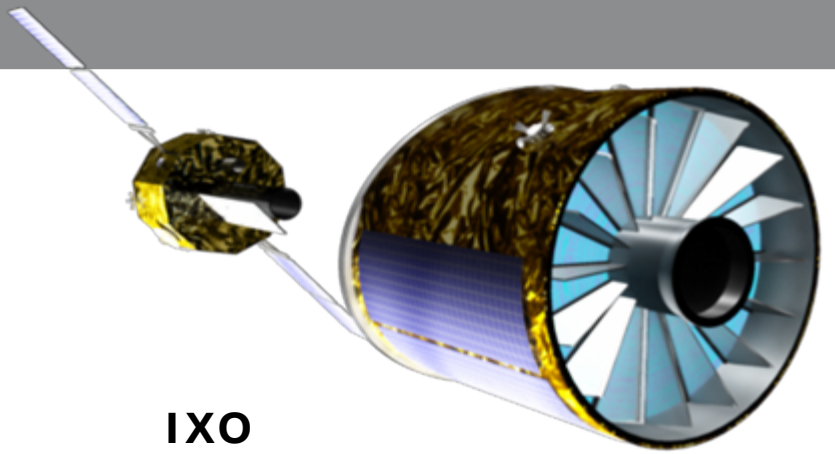


Large Missions, under study, for launch opportunities around 2020

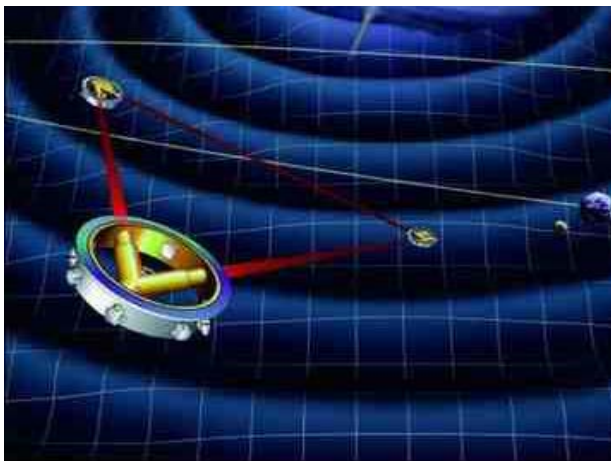
Cosmic Vision, 2015 – 2025

Europa Jupiter System Mission,
(was Laplace)

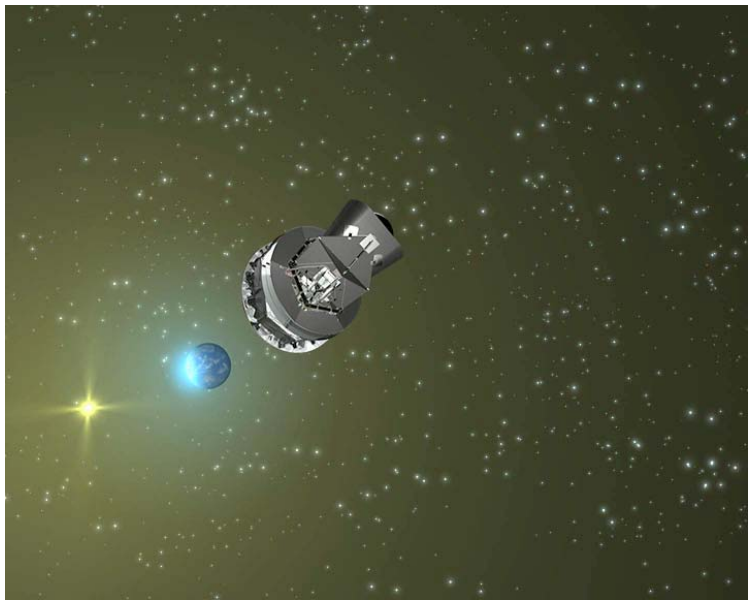


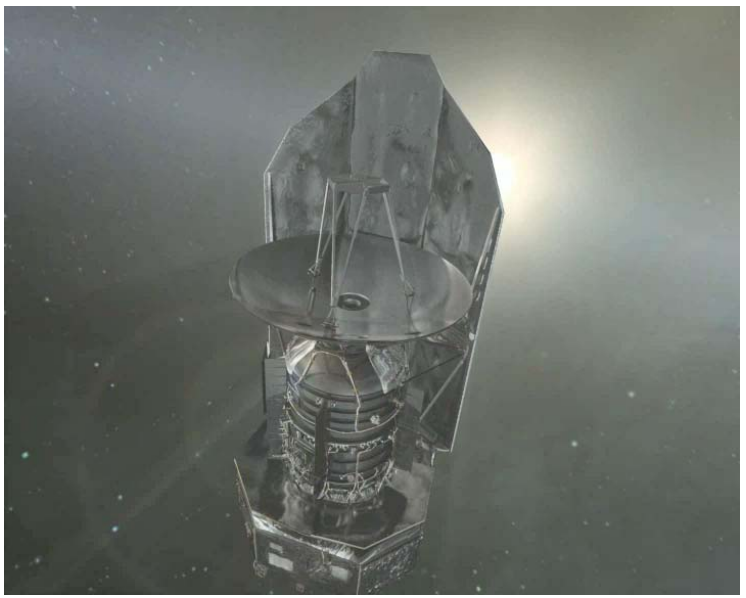


IXO
International X ray observatory (was Xeus)



LISA
Gravitational waves measurement





THANK YOU

Martin Kessler
Head, Science Operations Department
Martin.Kessler@esa.int

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