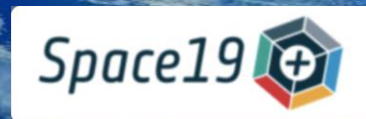


ESA Mandatory Scientific Program Update

Günther Hasinger, ESA Director of Science (D/SCI)

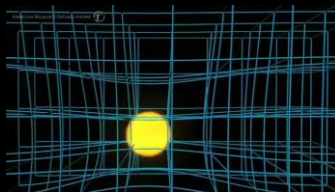
57th European Space Sciences Committee Plenary Meeting
KNAW Amsterdam, 9. May 2019

Towards

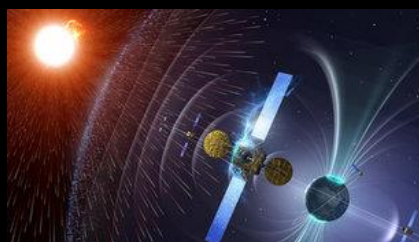


One ESA – Four Main Programmatic Pillars

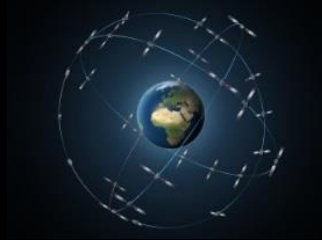
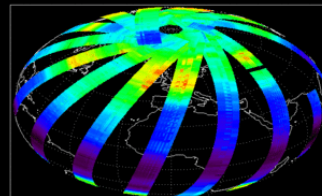
Science and Exploration



Safety and Security



Applications



Enabling and Support (transp., tech, & ops)



Science is Everywhere

**Scientific
Program**
Bottom-up,
mandatory

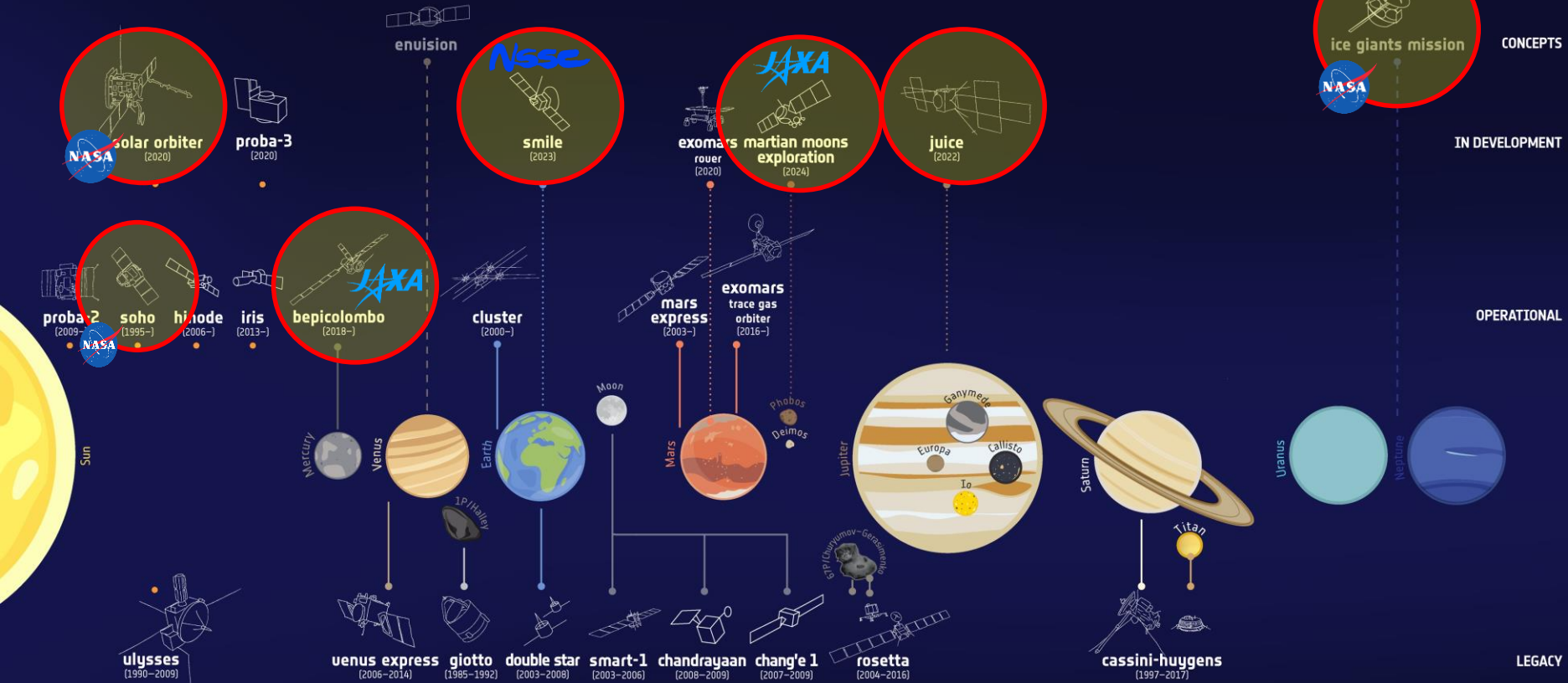


**Exploration
Program**
Top-down,
optional

The ESA Fleet in the Solar System



→ SOLAR SYSTEM EXPLORERS

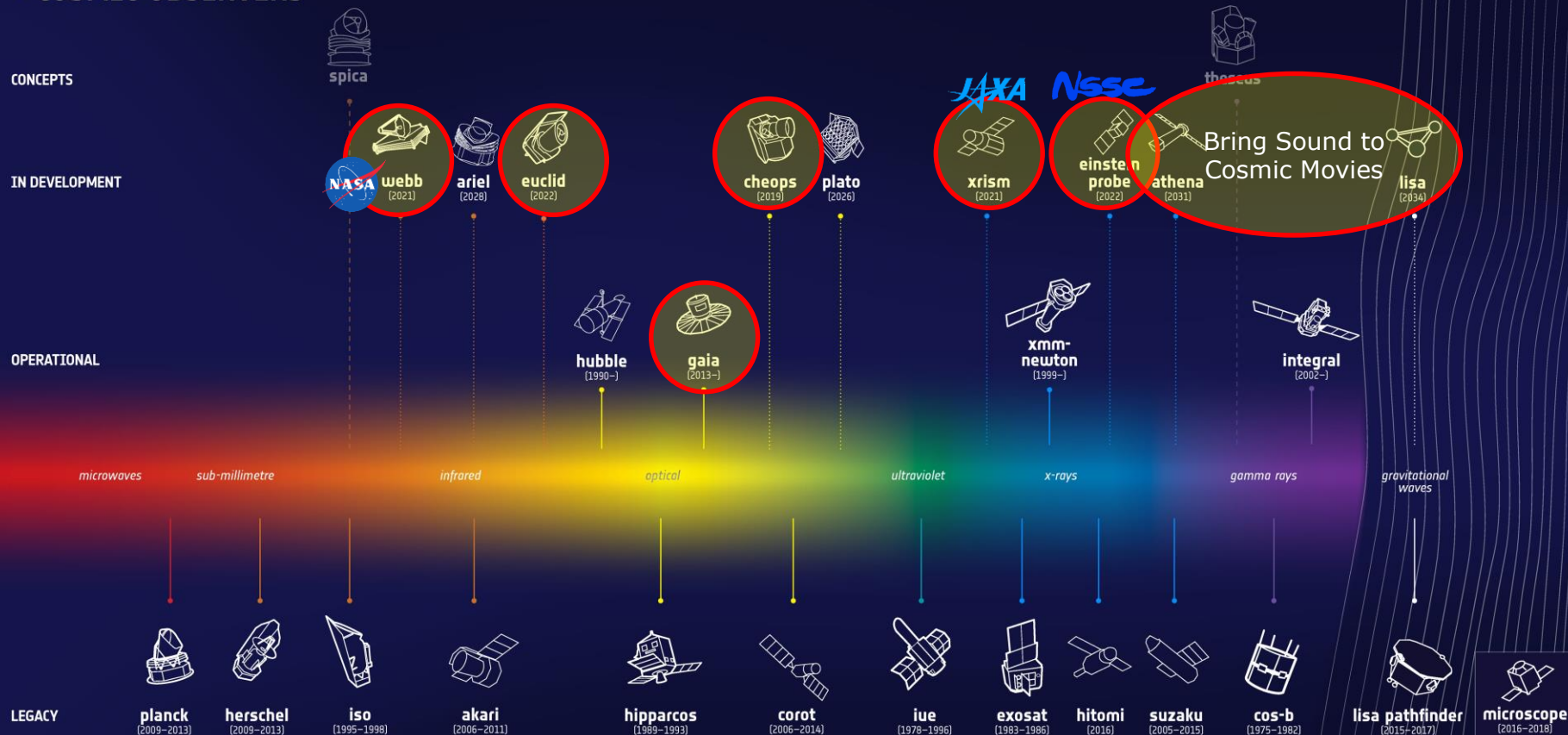


#Space19plus

The ESA Fleet for Astrophysics



→ COSMIC OBSERVERS



#Space19plus

Space19

BepiColombo

Ariane 5
launch from
Kourou on
20. October
2018



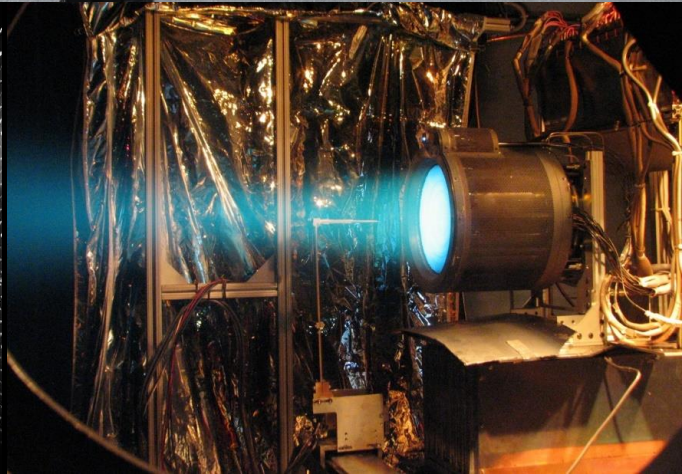
Mission Control Team: ESA, JAXA, Industry



a milestone of international collaboration

Challenging technological innovations, but all systems are nominal!

First arc of electromobility with 220 mN through the the solar system completed.
2 more months of solar electric thrust in 2019, until challenging Earth swing-by in April 2020.



CHEOPS launch planned in October 2019



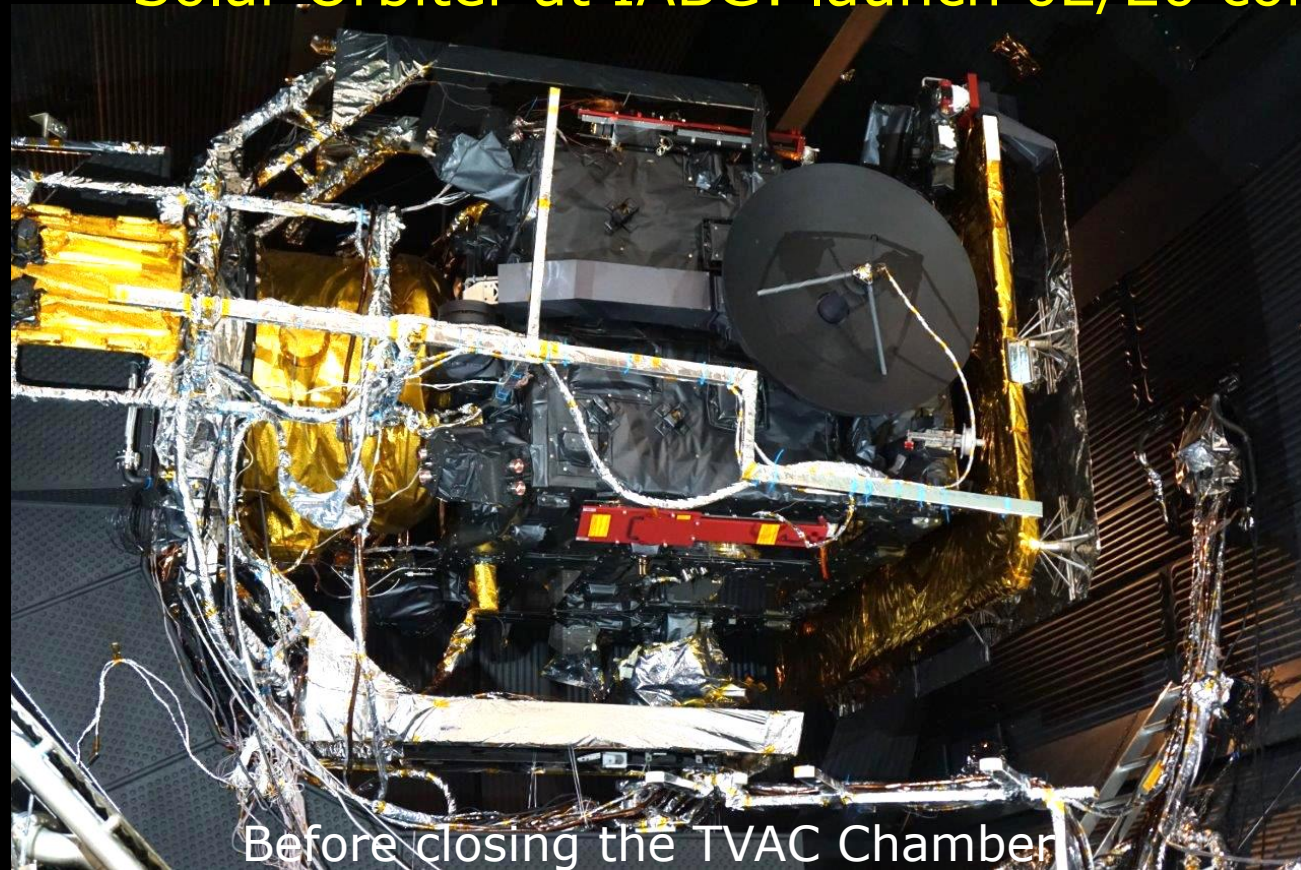
CHEOPS (2019) will measure known size exoplanets, and will be followed by a mission to study the composition of exoplanet atmospheres (European leadership on exoplanet missions)



Dedicated exoplanet missions



Solar Orbiter at IABG: launch 02/20 confirmed!



Solar Orbiter: Scientific Community and Industry Teams



7th Solar Orbiter Workshop, April 2017 Granada



ESA&NASA visit ADS Scheveninge, June 2018



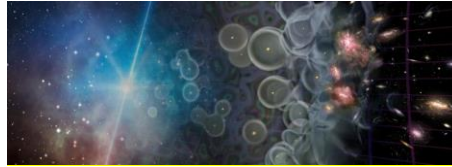
ESA Medium Class Mission (M5) candidate studies



SPICA
Unveiling the
obscured
Universe



Dr. P. R. Roelfsema
On behalf of the international
SPICA consortium



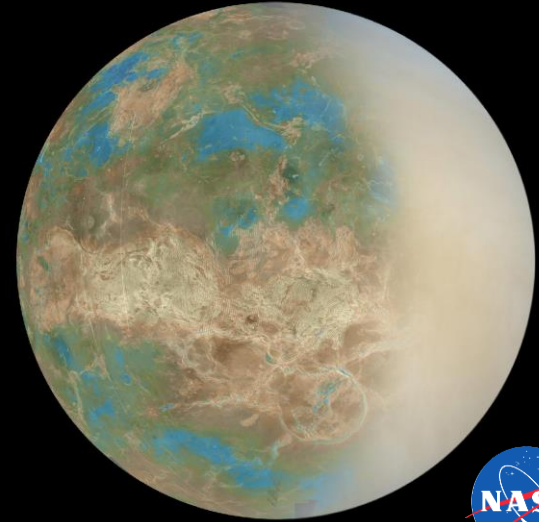
theseus

**Transient high energy sky and
early universe surveyor**


Lead Proposer: Lorenzo Amati (INAF-IASF Bologna, Italy)

EnVision

*Understanding why our most Earth-like
neighbour is so different*



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 **Cosmic Vision 2015-2025** Science Programme
European Space Agency
5th ESSC Meeting, KNAW | 09.05.2019 | Slide 10



European Space Agency

ESA-CAS joint SMILE Mission

First joint mission with China, a
pathfinder for future endeavors

*"three strategic partners, the United
States, Russia and China for primarily
scientific and exploration missions"*
(ESA/C-M/CCXLVII/Res. 3)

Magnetosheath/
Magnetopause

SXI FOV
16x27°

Highly Elliptical Orbit,
5000 km x 19 RE

UVI FOV
10x10°

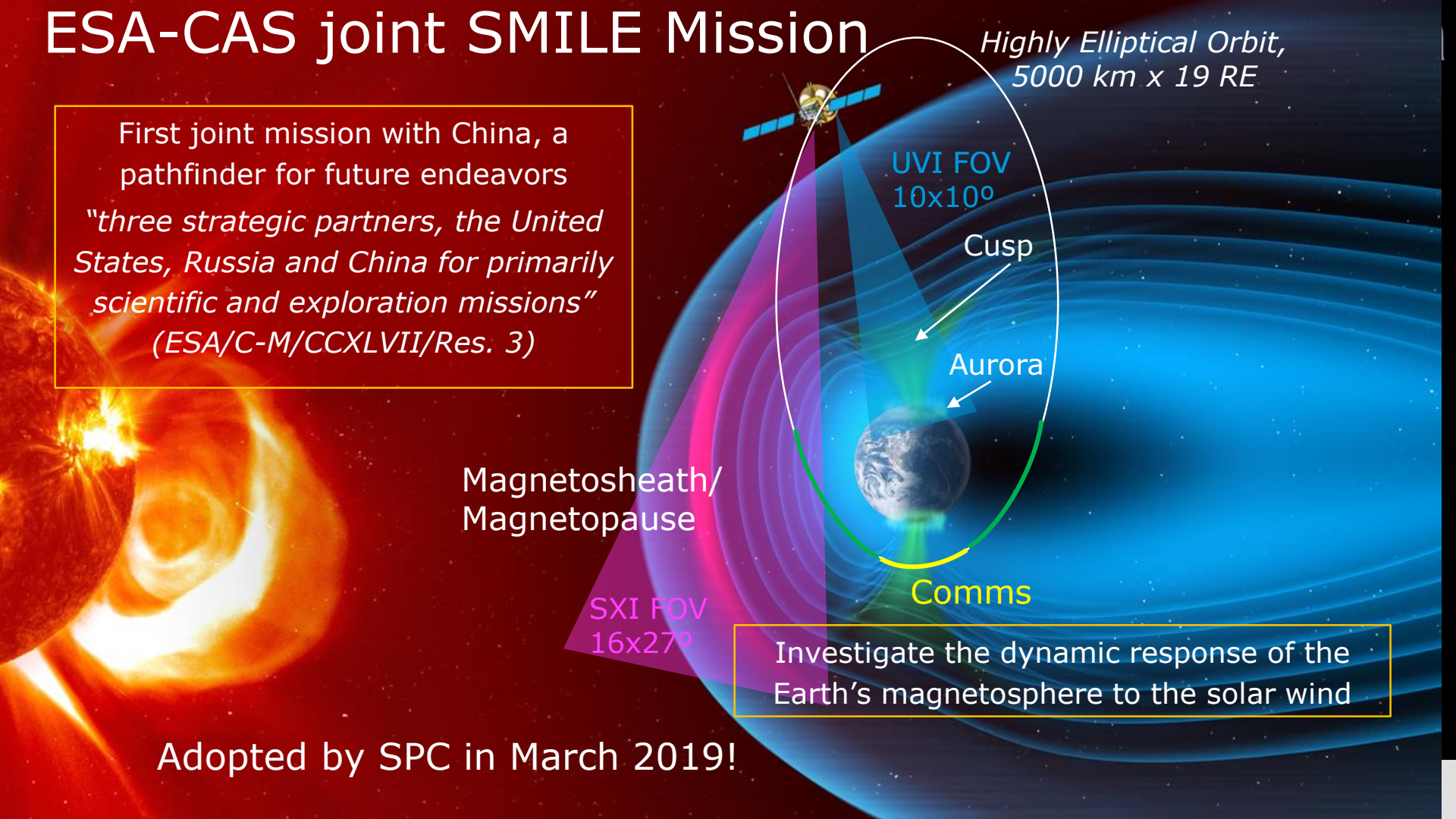
Cusp

Aurora

Comms

Investigate the dynamic response of the
Earth's magnetosphere to the solar wind

Adopted by SPC in March 2019!



ESA Missions of Opportunity

ESA is THE  partner of choice for international cooperation

Corot
 Microscope
 Hinode
 Proba-2
 Hitomi
 ExoMars
 IRIS
 Proba-3
 XRISM

Einstein Probe

MMX

WFIRST
 LiteBIRD
 eXTP
 Taiji
 ULTRASAT
 HERA
 Lagrange L5
 Lunar Gateway

Exoplanets
 Fundamental physics
 Solar physics
 Plasma physics
 X-ray astronomy
 Planetary science
 Solar physics
 Solar physics
 X-ray astronomy

X-ray astronomy

Planetary science

NIR Astronomy
 Cosmic Microwave
 X-ray Astronomy
 Gravitational Waves
 UV All-Sky Survey
 Asteroid deflection
 Space Weather
 Planetary science

France
 France
 Japan
 TEC/Belgium
 Japan
 HRE/Russia
 NASA
 TEC/Belgium
 Japan

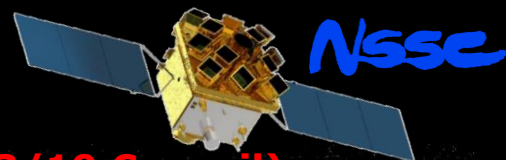
China (6/18 SPC; 3/19 Council)

Japan (11/18 SPC; 3/19 Council)

NASA
 Japan/France
 China
 China
 Israel
 TEC/OPS/Safety
 OPS/TEC/Safety
 HRE

Einstein Probe

Gamma-burst, multi-messenger

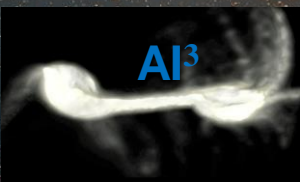


MMX

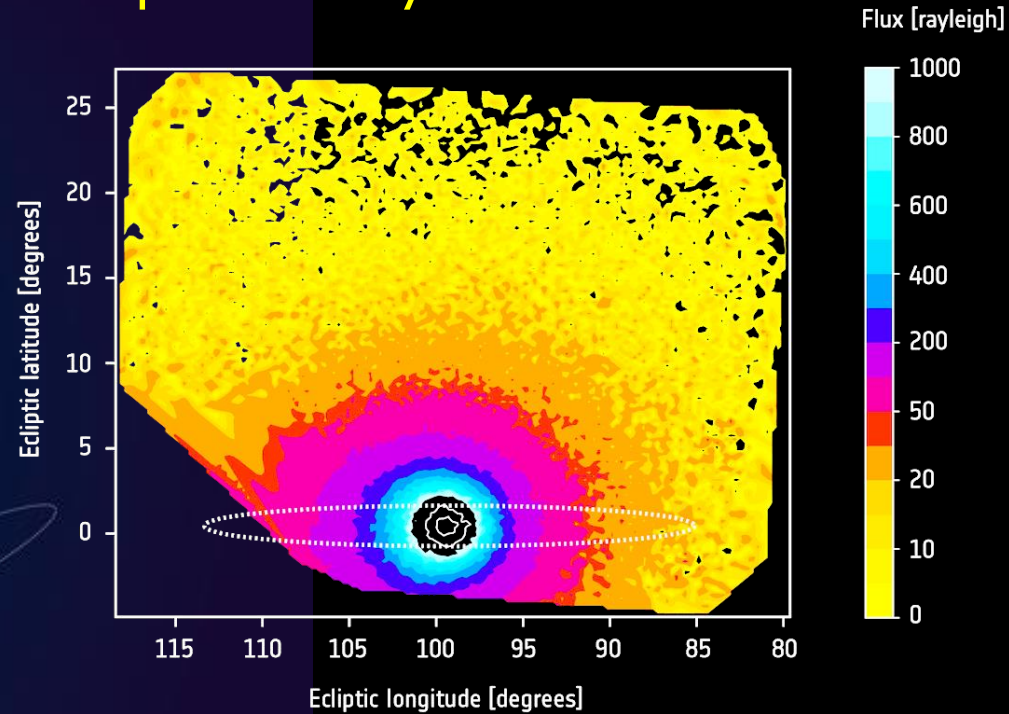
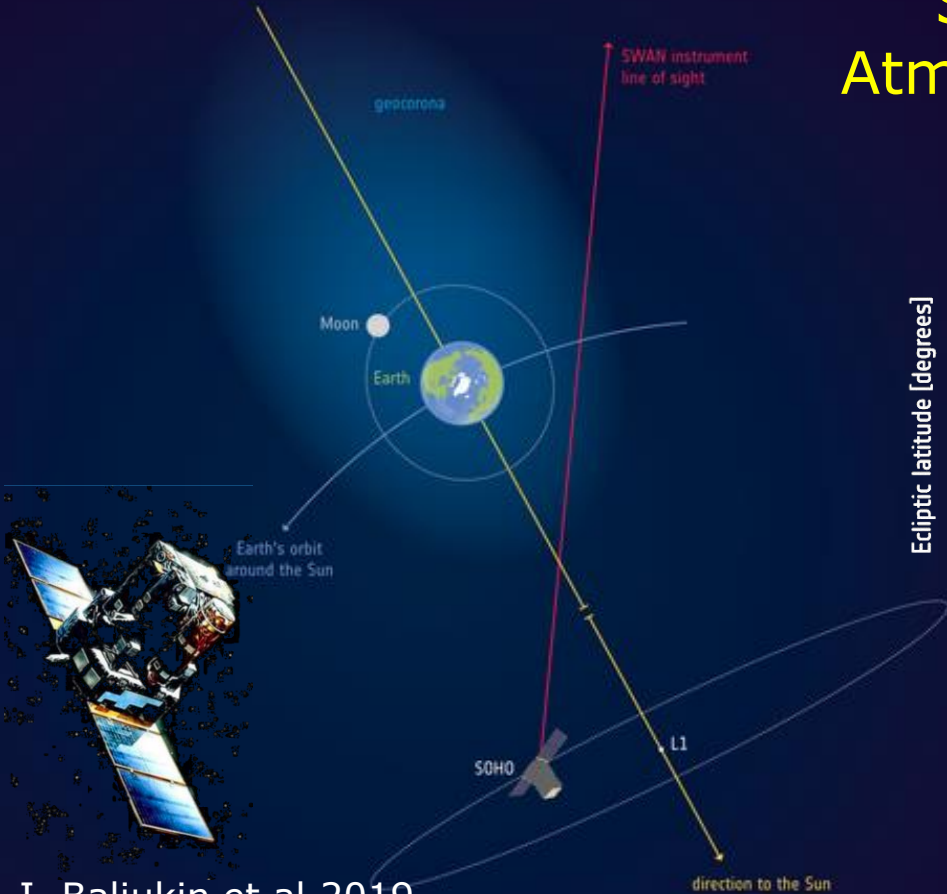
Mars Moon Exploration
 Phobos Sample Return

First Fast/Flexi Mission Call

- New ideas for implementation, new European Space Science teams
- Six teams selected from a pool of 23 proposals in December 2018.
- Broad topics: Asteroids, Comets, Heliophysics, Astronomy.
- Phase-2 proposals received March 19; Mission Peer Review in May
- SPC Selection expected in June 2019



SOHO discovers Earth's Atmosphere beyond the Moon

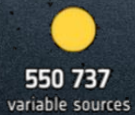
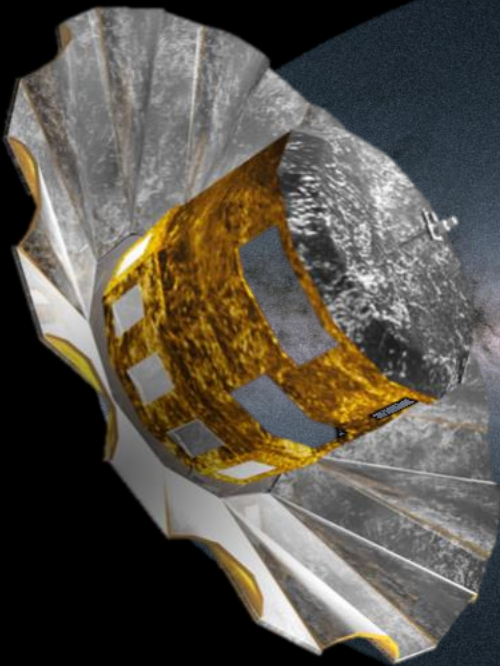


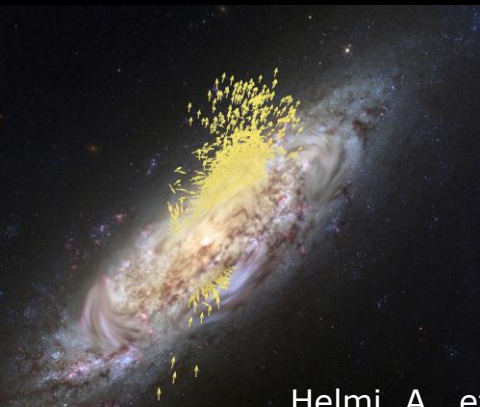
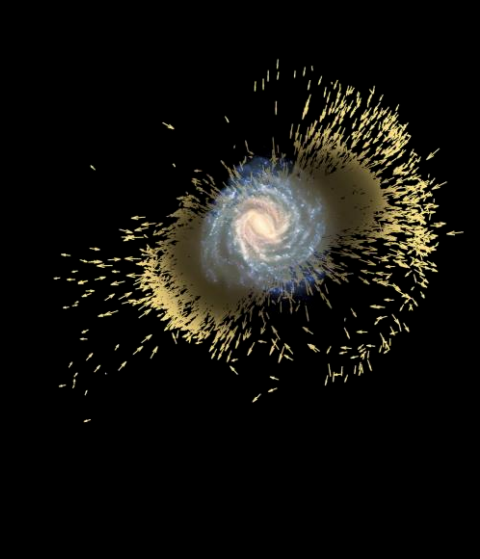
SWAN Ly-alpha image

I. Baliukin et al.2019



Gaia Data Release 2





30,000 out of 7 million stars with measured velocity are found on a "collision course".

The event happened ~ 10 billion years ago and has created the Thick Disk, but likely also the "Bulge" of the Milky Way and the Galactic Center Black Hole.

Helmi, A., et al., 2018, Nature



Fate of the Milky Way and Andromeda

- now
- > in 2.5 billion years
- ✕ in 4.5 billion years



Triangulum (M33)

© Chris Butler

Milky Way



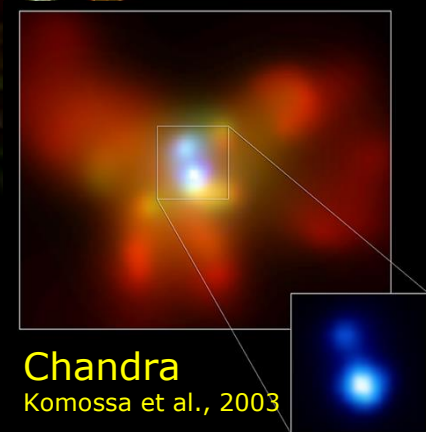
Andromeda (M31)



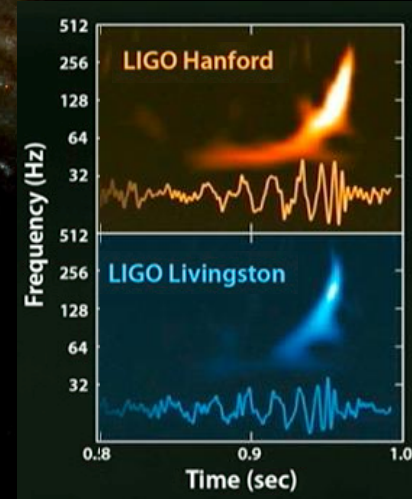
1 million light years



What happens to the Black Holes in a Merger?



Chandra
Komossa et al., 2003



“Bringing sound to the cosmic movies”



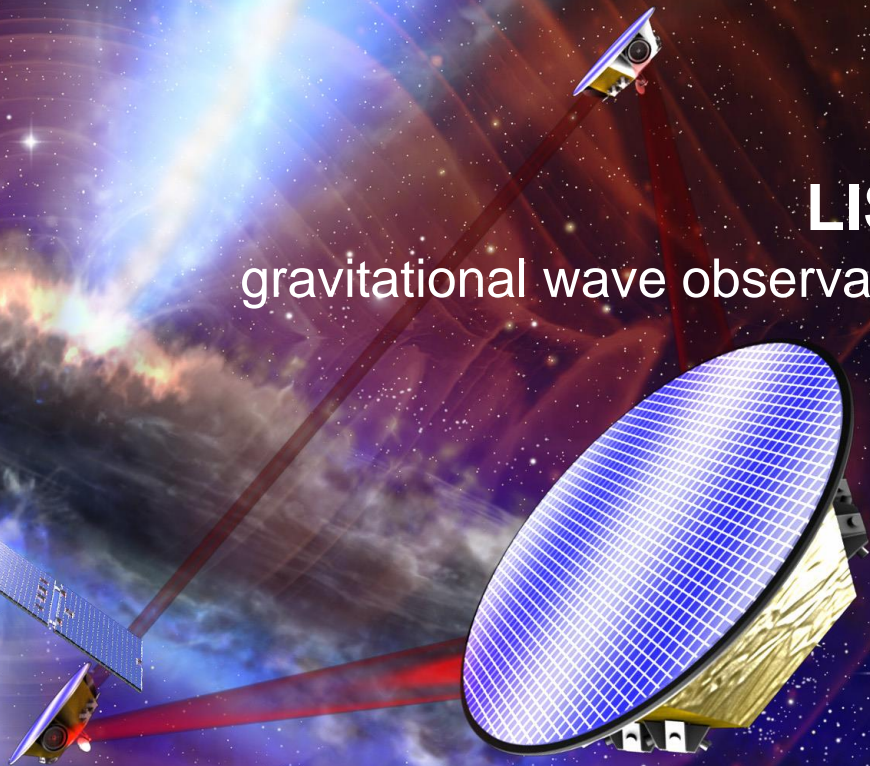
Athena

hot gas structures
supermassive black holes



LISA

gravitational wave observation



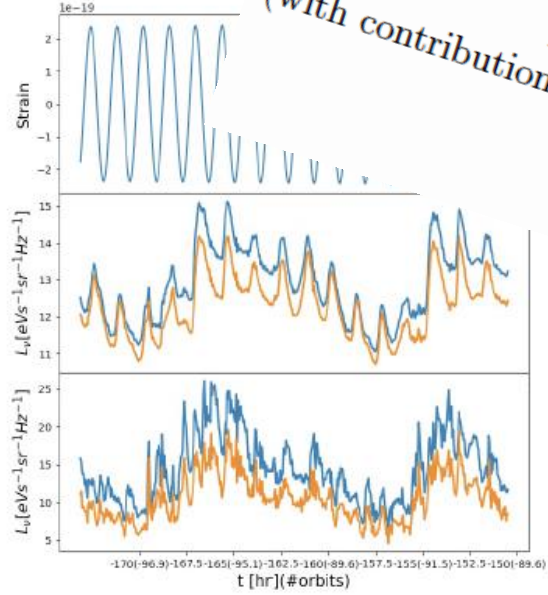
Synergies would be significantly enhanced with a second gravitational wave observatory!



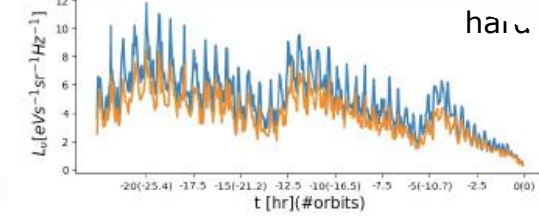
Athena / LISA Synergies

Feasibility of joint Athena/LISA observations of BH mergers

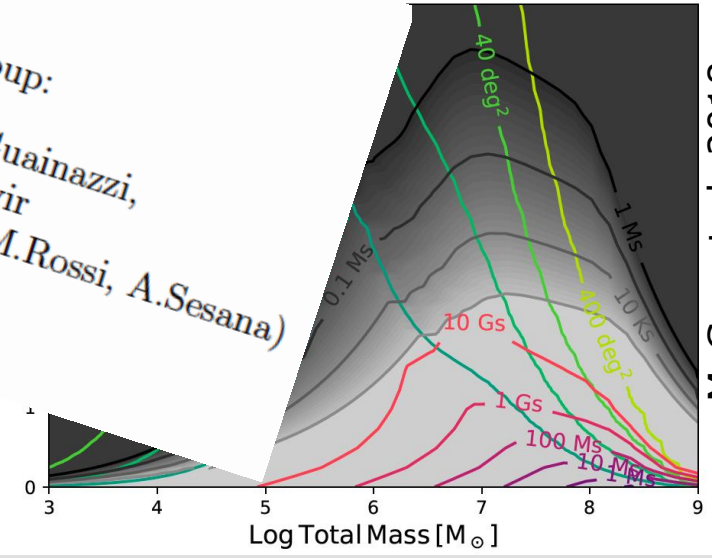
Athena-LISA Synergies
 Athena-LISA Synergy Working Group:
 Monica Colpi, Andrew C. Fabian, Matteo Guainazzi,
 Paul McNamara, Luigi Piro, Nial Tanvir
 (with contributions by J.Aird, A.Klein, A.Mangiagli, E.M.Rossi, A.Sesana)



20 February 2019
 X-rays

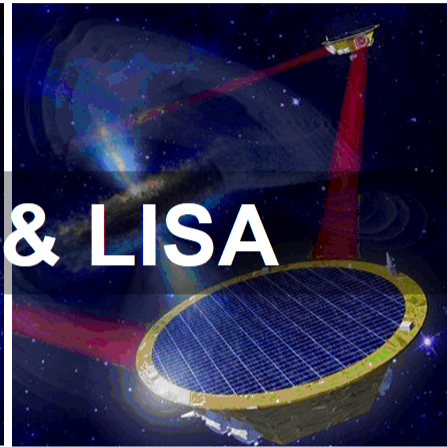


Tar



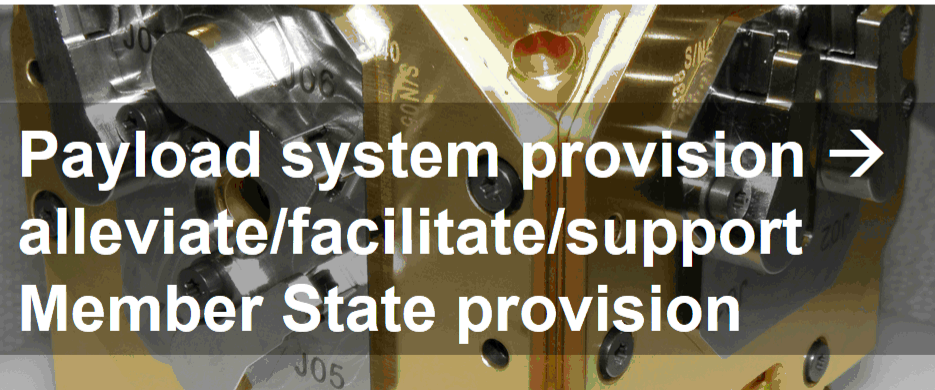
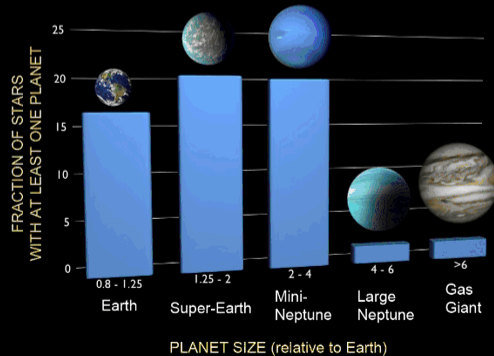
McGeet al. 2018





F-missions in sync with M-missions (joint launch) → new line of opportunities with special emphasis on novel implementations

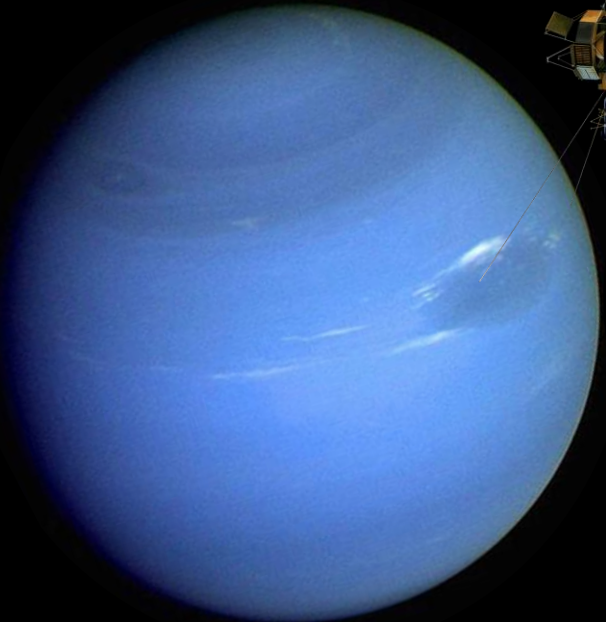
Unique celestial opportunity to explore Ice Giants



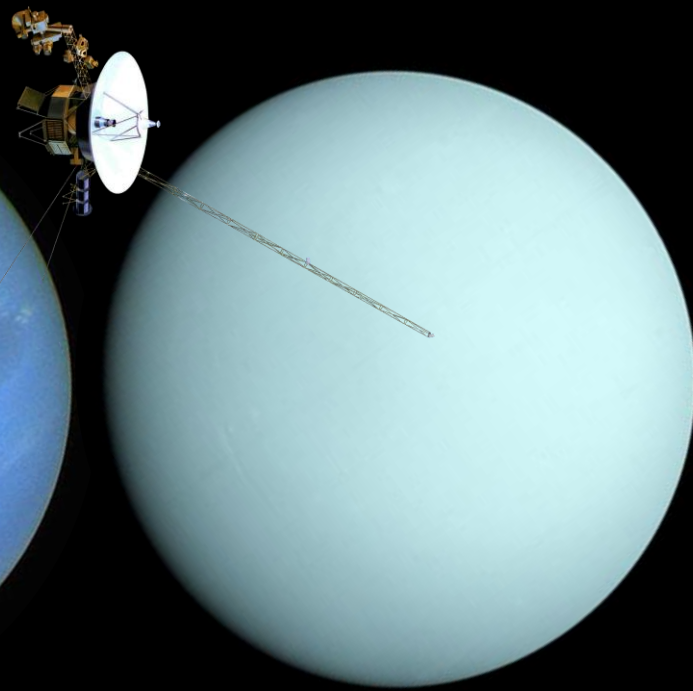
Preparation of next strategic plan: Voyage 2050

Joint mission with NASA to the ice giants, Uranus & Neptune: a Rosetta Stone

Voyager 2: launch 20 August 1977

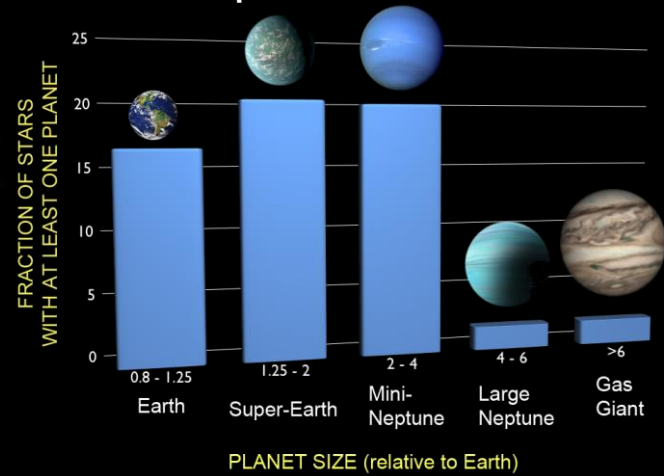


Neptune: 25 August 1989



Uranus: 24 January 1986

Exoplanet Statistics



Planetary conjunctions allow use of Jupiter for gravity assist trajectories:
 Neptune orbiter: launch 2030, arrival 2043. Uranus orbiter: launch 2031, arrival 2043.
 Or two missions launched together



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57th ESSC Meeting, KNAW | 09.05.2019 | Slide 22

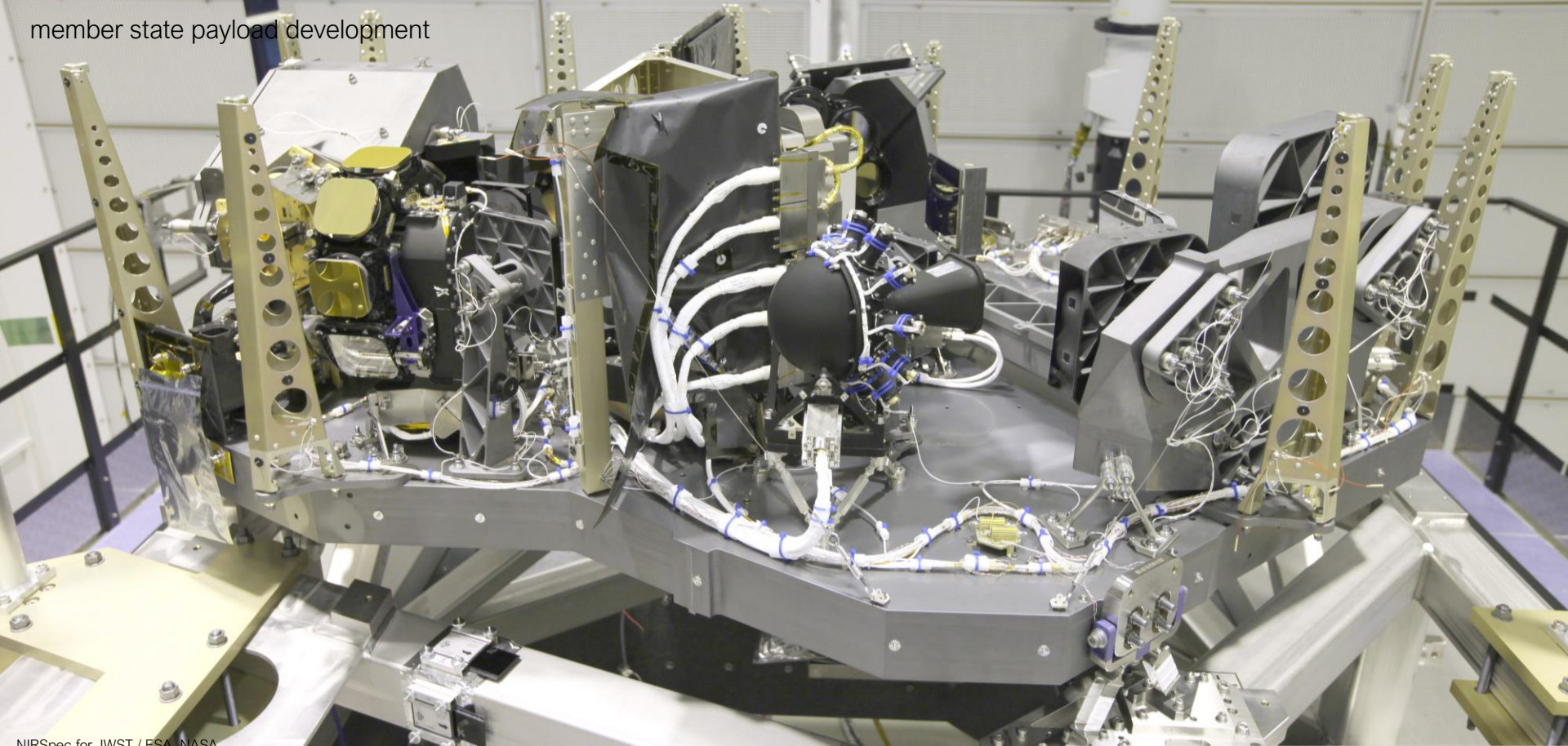


European Space Agency

Payload Provision by Member States & ESA

Provision to facilitate, alleviate, & support

member state payload development



Cosmic Vision

Space Science for Europe 2015-2025



Voyage 2050

European Space Agency
Agence spatiale européenne



Linda Tacconi



Chris Arridge

Advisory Structure is involved in various roles.

Call for topical teams nominations and white papers, as well as Community Engagement Survey released in March 2019

Voyage 2050 – Senior Committee



The Senior Committee has been appointed by the Director of Science, and is comprised of scientists working in institutions in ESA Member States. The Senior Committee is tasked with producing the final recommendation to the Director of Science for the Voyage 2050 plan.

Linda Tacconi (Chair)

Max Planck Institute for Extraterrestrial Physics,
Garching, Germany

Alessandra Buonanno

Max Planck Institute for Gravitational Physics,
Potsdam, Germany

Amina Helmi

University of Groningen,
The Netherlands

Jérémy Leconte,

CNRS/Bordeaux University,
France

Rumi Nakamura

Space Research Institute,
Austrian Academy of Sciences, Austria

Chris Arridge (Co-Chair)

Lancaster University,
United Kingdom

Mike Cruise

Retired,
United Kingdom

Luciano Iess

Sapienza University of Rome,
Italy

Jorrit Leenaarts

Stockholm University,
Sweden

Darach Watson

University of Copenhagen
Denmark

Olivier Grasset

University of Nantes,
France

Eiichiro Komatsu

Max Planck Institute for Astrophysics,
Garching, Germany

Jesús Martín-Pintado

Spanish Astrobiology Center (CAB),
Madrid, Spain



A vibrant cosmic background with a blue-to-purple gradient. It features various celestial objects: a large sun with rays at the top center, a ringed planet (Saturn) to its right, several spiral galaxies, a comet streaking across the middle, and numerous stars of varying sizes. In the bottom left corner, there are white silhouettes of five people of different heights and builds standing in a row.

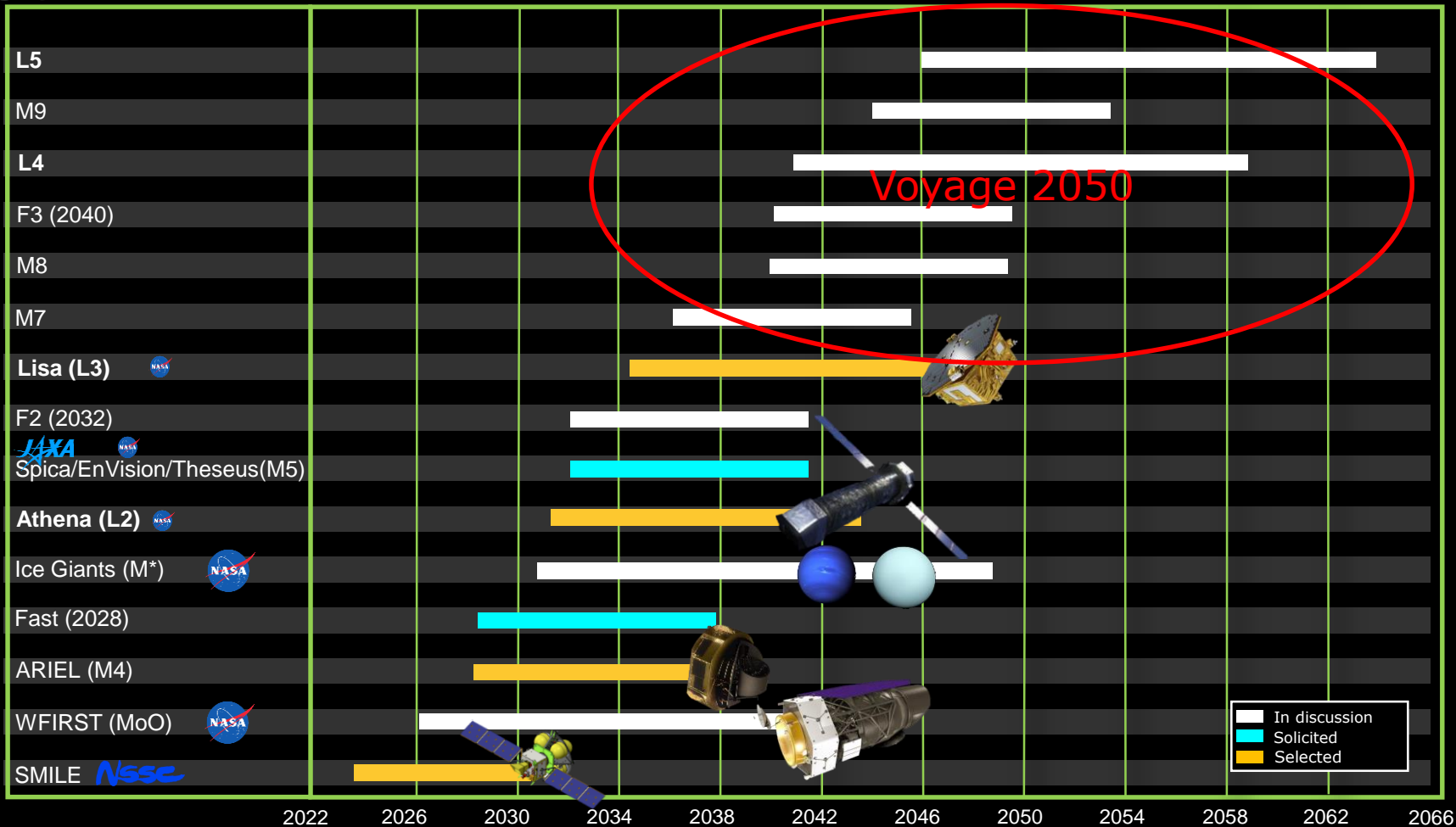
→ DISCOVERING OUR UNIVERSE

Share your views on future directions for space science
March – June 2019

sci.esa.int/discovering-our-universe

Horizon 2000 → **Cosmic Vision** → **Voyage 2050**

Future ESA Space Science Missions



Voyage 2050

In discussion
 Solicited
 Selected



Director General's proposal on "A United Europe in Space"

1. Resolution giving mandate to the Director General to establish appropriate relations between the European Space Agency and the European Union
2. Resolution providing strategic guidelines for the preparation of the Agency programmes and activities

Approved unanimously at IMM18

Strategic guidelines adopted at IMM18

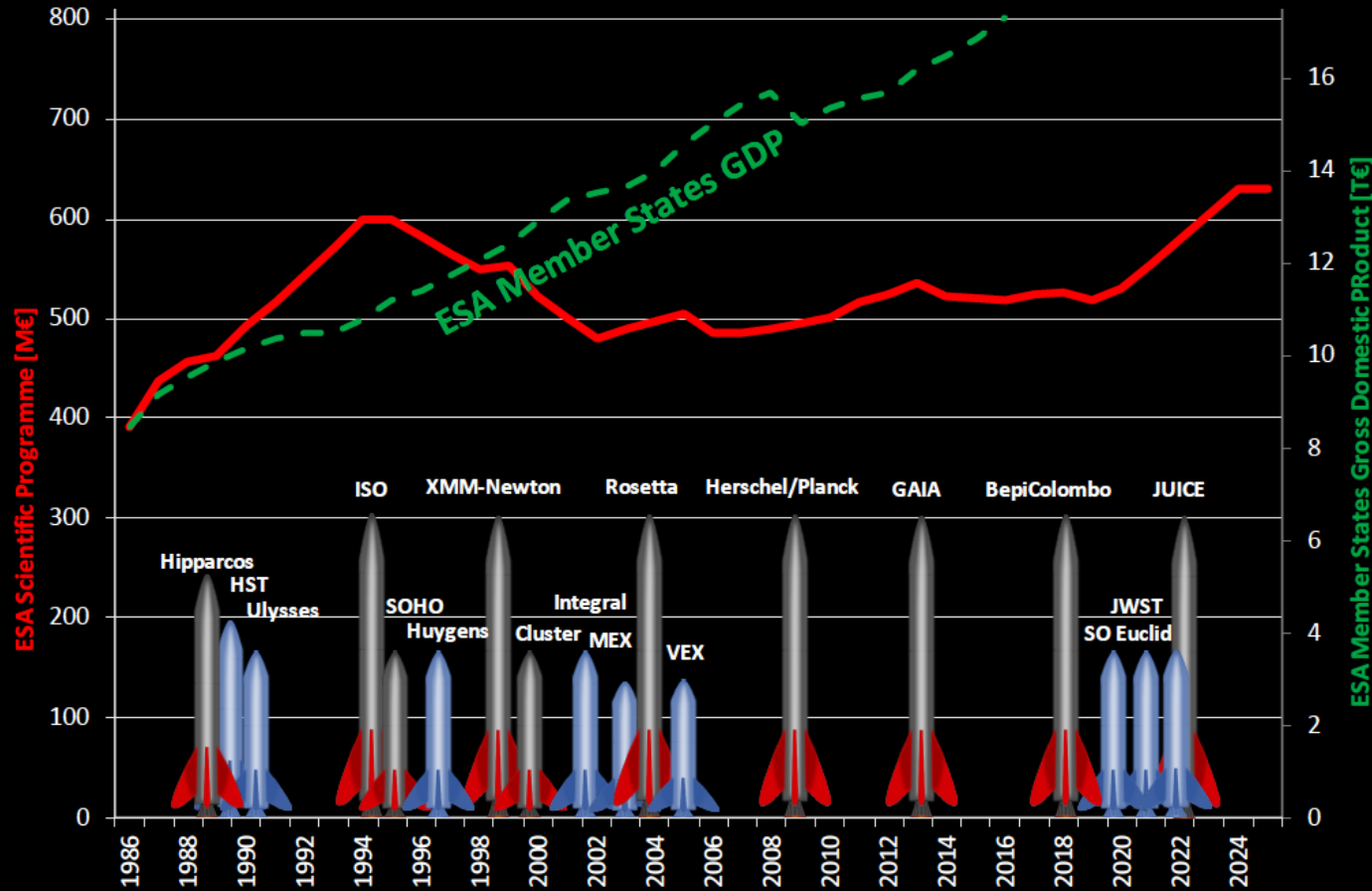


... The most important decisions facing Member States at Space19+ will be:

- to restore ESA's science programme as the world leader in the physics of the Universe by reversing the long-standing decline in buying power of the Level of Resources ...



Level of Resources versus Member State GDP Evolution



We propose a modest increase of the Level of Resources for Space 19+ to secure European leadership in a number of key scientific areas.



A night view of Earth from space, showing the curvature of the planet and the glowing city lights of the continents. A bright sun or star is visible in the background, creating a lens flare effect. The image is overlaid with a faint grid of blue lines.

**Thank you
very much!**