

Exploring the Universe: Synergies in the ESA Science Programme

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

14th Appleton Space Conference, RAL, 6.12.2018

Towards



BepiColombo Launch



VA245 - October 19, 2018

BepiColombo



European Space Agency



SPACENEWS

★ GOVERNMENT AGENCY OF THE YEAR ★

EUROPEAN SPACE AGENCY
BepiColombo, Aeolus

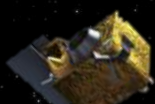
ESA Solar System Missions

Ice Giants?
(e.g. M*)



soho
Facing the Sun

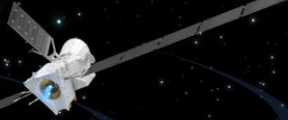
proba-3
Solar Coronagraph



proba-2
Observing coronal dynamics
and solar eruptions



bepicolombo
Exploring Mercury



exomars
Europe's new era
of Mars exploration



juice
Studying Jupiter's icy moons



venus express
Studying Venus' atmosphere



smile
Solar Wind
Magnetosphere
Ionosphere



mars express
Investigating the Red Planet



cassini-huygens
Studying the Saturnian
system and landing on Titan



rosetta
Chasing and landing
on a comet



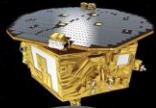
cluster
Measuring Earth's
magnetic shield



Small Bodies?
(e.g. MMX, F)



ESA Astrophysics Missions



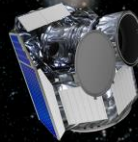
lisa pathfinder

Testing the technology for gravitational wave detection



jwst

Observing the first light



cheops

Characterising exoplanets

plato

Exoplanets & stars

gaia

Surveying a billion stars

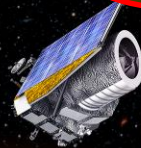


herschel

Unveiling the cool and dusty Universe

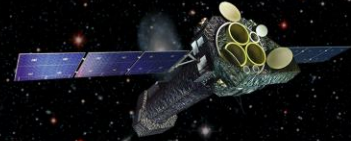
euclid

Exploring the dark Universe



hst

Expanding the frontiers of the visible Universe



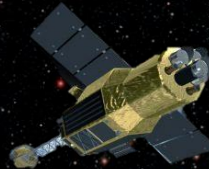
xmm-newton

Seeing deeply into the hot and violent Universe



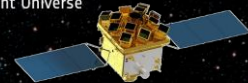
planck

Looking back at the dawn of time



xrism

Formation of the elements



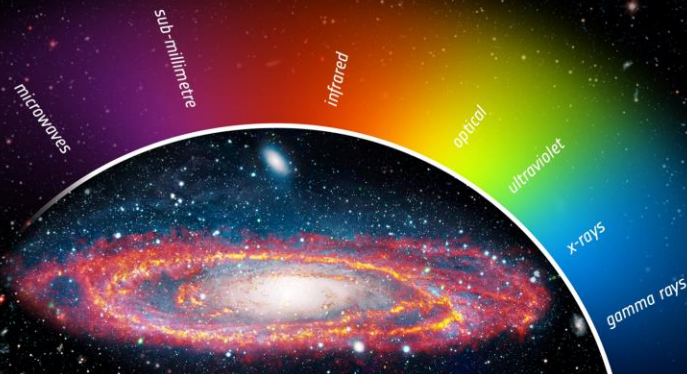
Einstein probe

Exploring the transient sky



integral

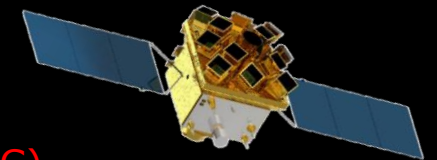
Seeking out the extremes of the Universe



ESA Missions of Opportunity

Corot	Exoplanets	France
Microscope	Fundamental physics	France
Hinode	Solar physics	Japan
Proba-2	Plasma physics	TEC/Belgium
Hitomi	X-ray astronomy	Japan
ExoMars	Planetary science	HRE/Russia
IRIS	Solar physics	NASA
Proba-3	Solar physics	TEC/Belgium
XRISM	X-ray astronomy	Japan
Einstein Probe	X-ray astronomy	China (June '18 SPC)
MMX	Planetary science	Japan (November '18 SPC)
eXTP	X-ray Astronomy	China
LiteBIRD	Cosmic Microwave	Japan
WFIRST	NIR Astronomy	NASA
Taiji	Gravitational Waves	China
HERA	Asteroid deflection	TEC/OPS/Safety
L5	Space Weather	OPS/TEC/Safety
Lunar Gateway	Planetary science	HRE

Einstein Probe



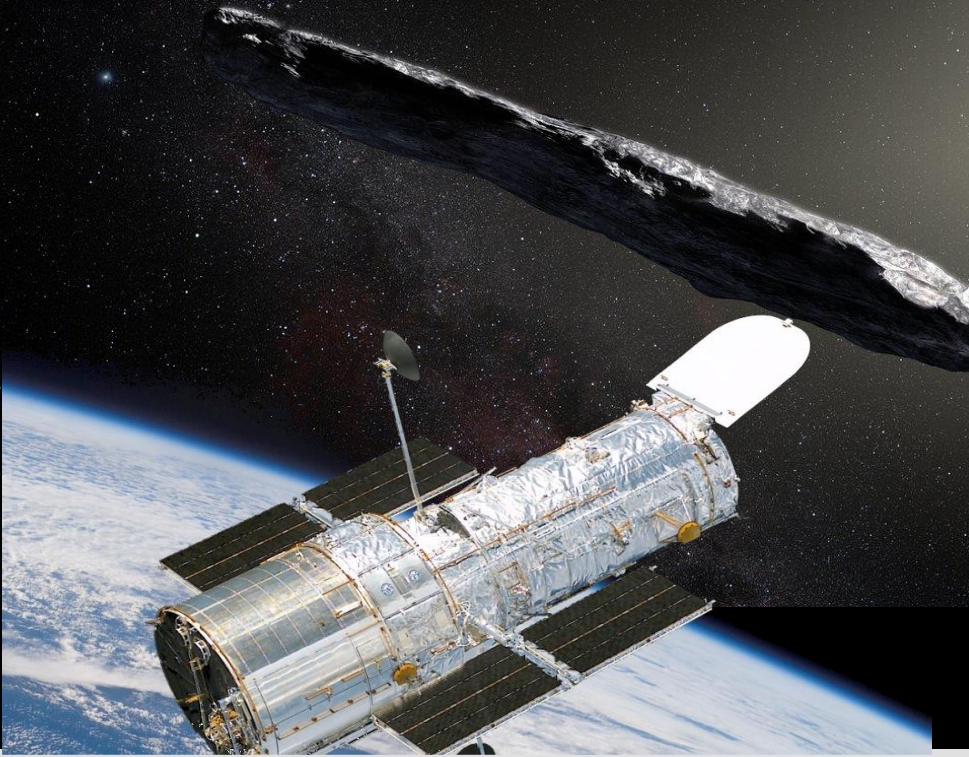
MMX



Interstellar Visitor 1I 'Oumuamua is accelerating!



Hubble observations show it is accelerating (by comet outgassing?)



Gaia

Using the new trajectory, Gaia has just found four possible home stars for 'Oumuamua

So far only a very small fraction of Gaia stars have all the necessary information. Looking forward to DR3 & DR4.

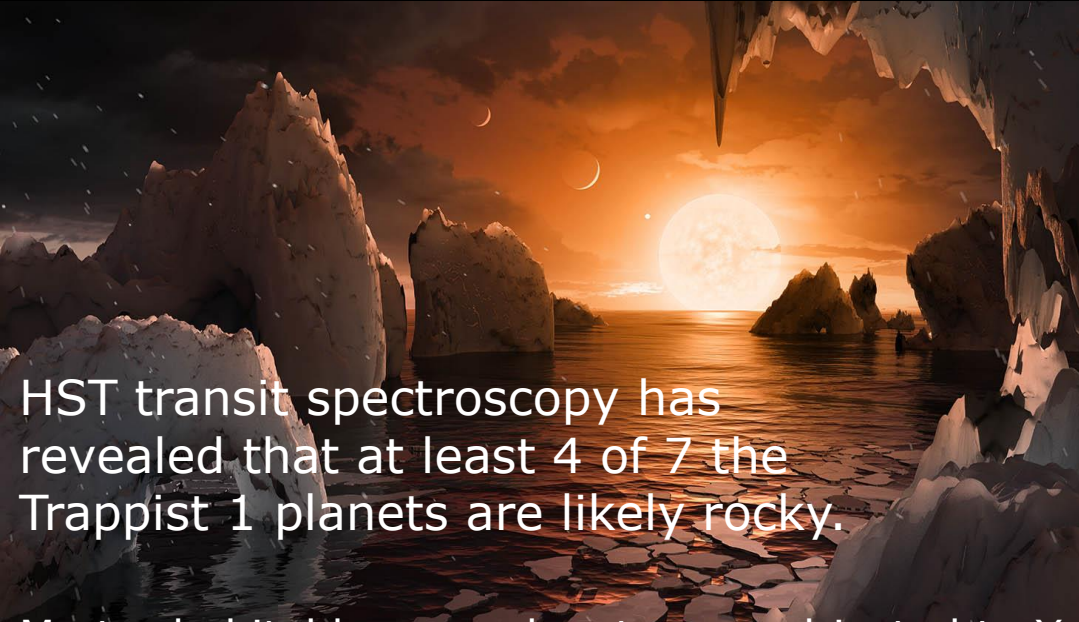


But, every million years 'Oumuamua passes by several stars, thus hard to find its true home.

Gaia Exoplanet Studies

- Although exoplanets were not a primary topic foreseen for the Gaia mission, there are a substantial number of scientific Gaia publications referring to this field.
- Main results are about the properties of the host stars of exoplanets.
- More detailed distance determinations, in particular to the planets discovered by Kepler, came to the conclusion that the actual number of earth-like planets in the habitable zone around other stars is probably significantly smaller than originally estimated.

Trappist-1 and Proxima b system habitability



HST transit spectroscopy has revealed that at least 4 of 7 the Trappist 1 planets are likely rocky.

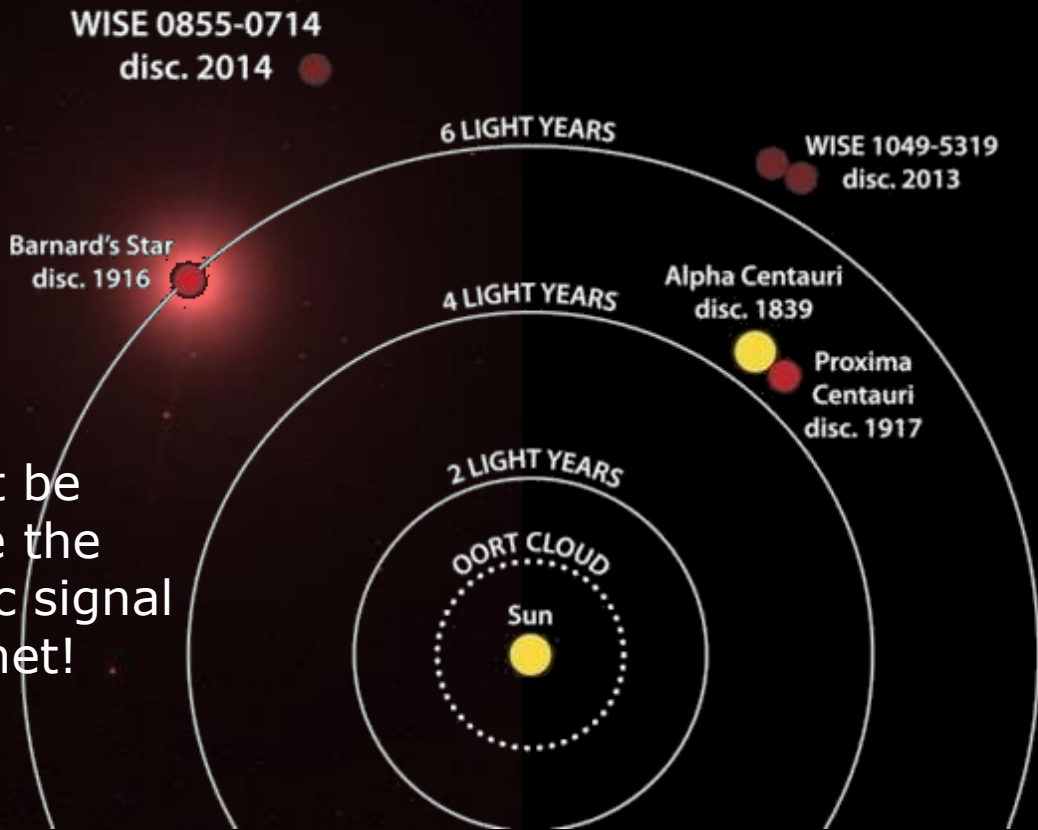
M-star habitable zone planets are subjected to X-ray and EUV radiation, limiting habitability. **XMM-Newton** has detected strong X-ray flares from Trappist-1, and shown that Proxima b receives 250x more X-ray radiation than Earth.

Finally, the strong stellar magnetic field can induce currents which heat up the planets from inside. The surface may consist of liquid lava!

A frozen Super-Earth around Barnard's Star



Gaia might be able to see the astrometric signal of this planet!

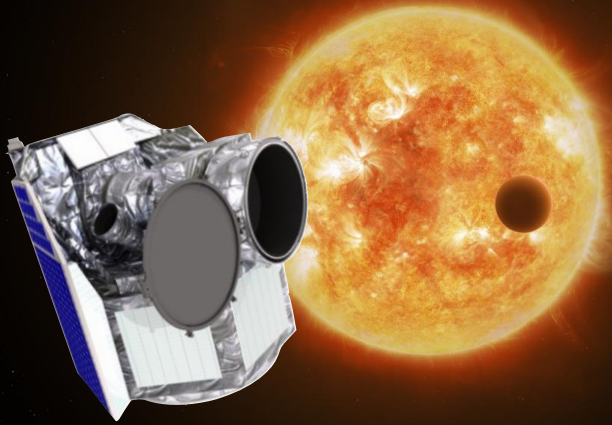


I. Ribas et al., 2018, Nature

ESA UNCLASSIFIED - For Official Use

Hasinger, Appleton Conference, RAL | 6.12.2018 | Slide 11





2019

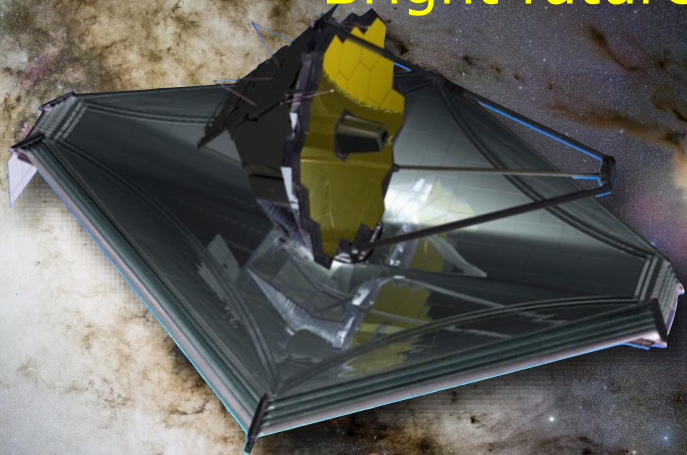
CHEOPS / ESA, CH, et al.



2026

PLATO / ESA

Bright future for ESA Exoplanet studies!



2021

JWST / NASA, ESA, CSA



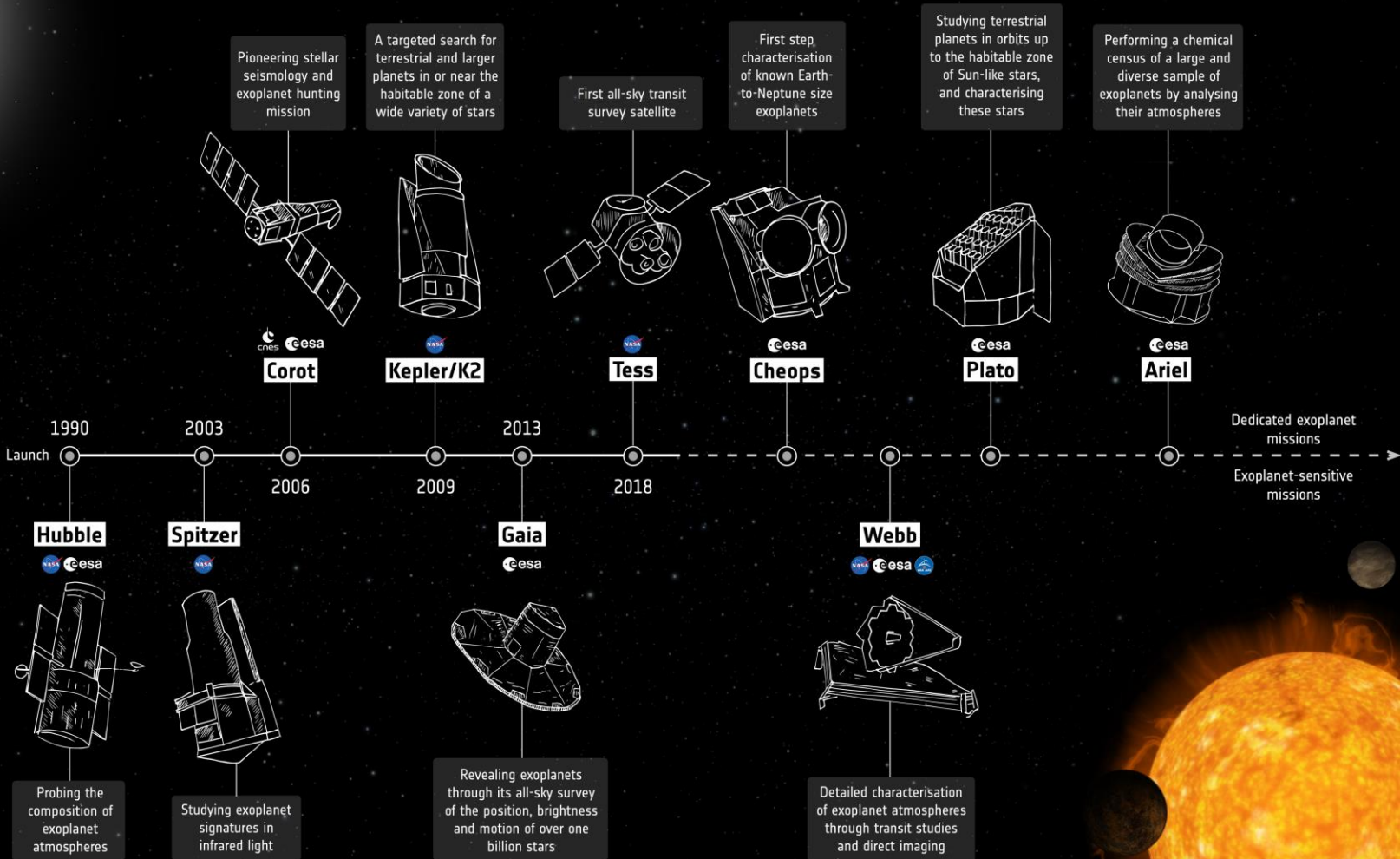
2028

ARIEL / ESA

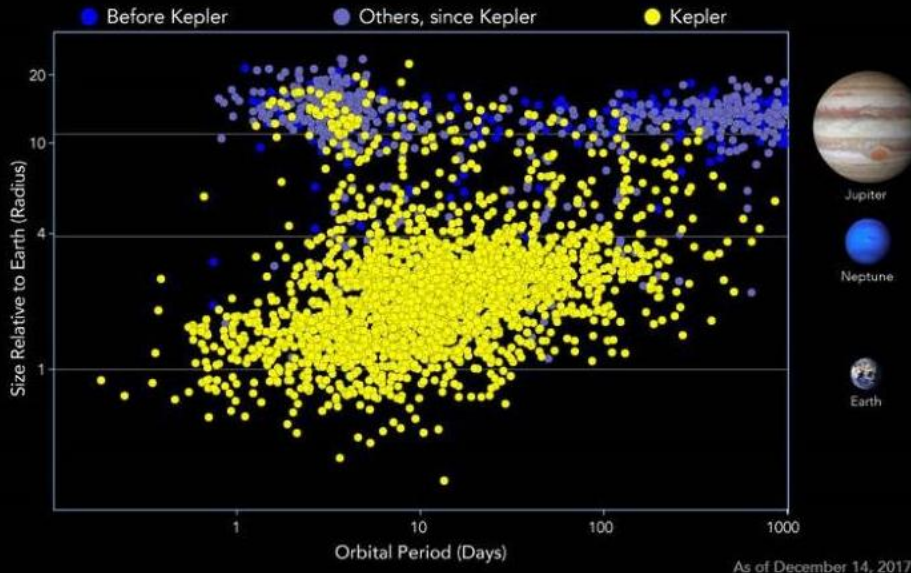


Ground-based observatories

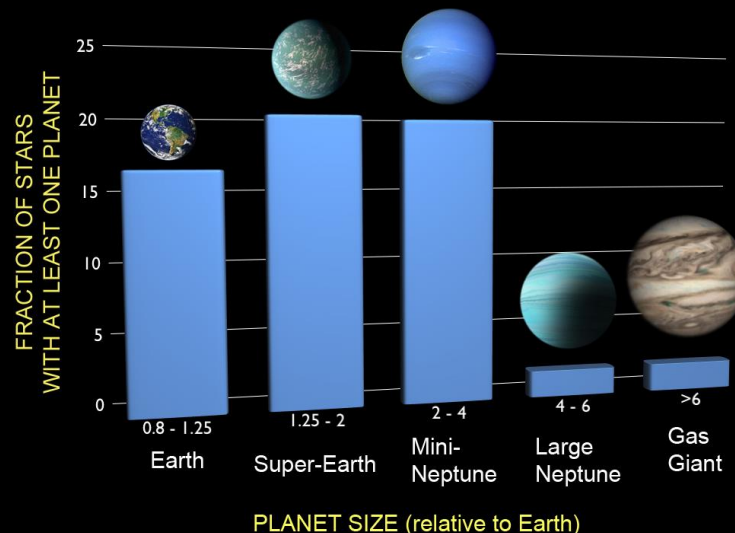
First discoveries of exoplanets in the 1990s opened up the field of exoplanet research. New innovations and discoveries continue to this day



Exoplanets and the Solar System Formation



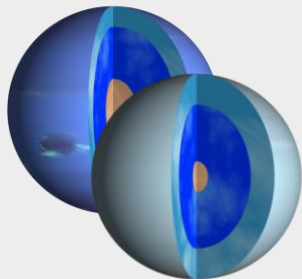
Uranus/Neptune-size planets and Super-Earths are the most abundant classes of exoplanets.



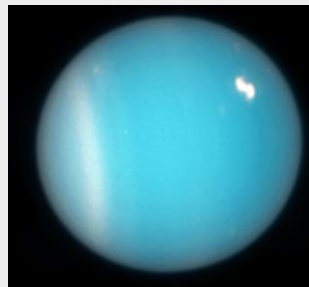
The only ground-truth we have on these types of objects thus far is from Voyager 2 flybys of Uranus (1986) and Neptune (1989). An exploration mission to our ice giants will play a critical role understanding our own planetary system and those beyond

Scientific Themes for a Mission to the Ice Giants

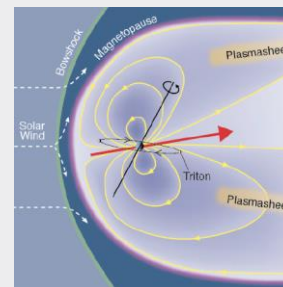
INTERIORS



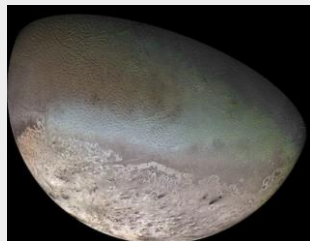
ATMOSPHERES



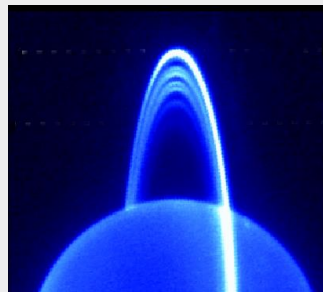
MAGNETOSPHERES



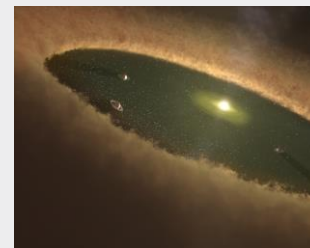
MOONS



RINGS



ORIGINS

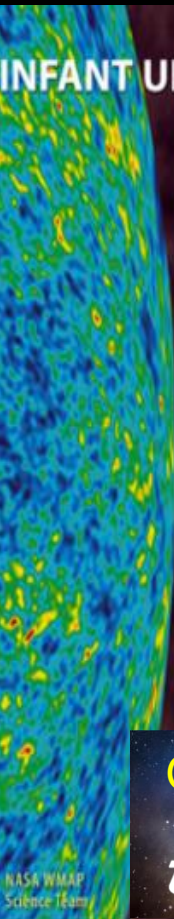


From L2 and L3
Science Themes
Meeting, Paris
September
2013

C. Arridge 2013

Multi-Messenger Quest for the first Black Holes

INFANT UNIVERSE 13.8 billion years ago
with seeds of future galaxies

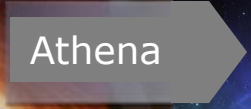


NASA WMAP Science Team

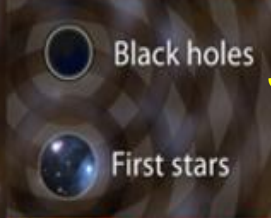
COSMIC DARK AGES
380,000 to 400 million years
after the Big Bang



NASA/JPL-Caltech



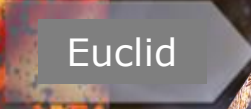
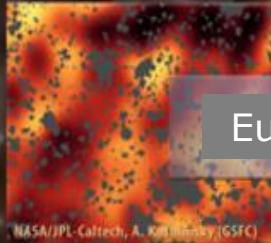
Athena



Black holes

First stars

JWST

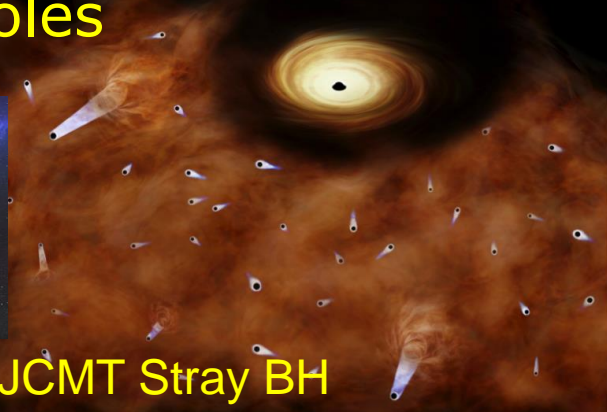


Euclid

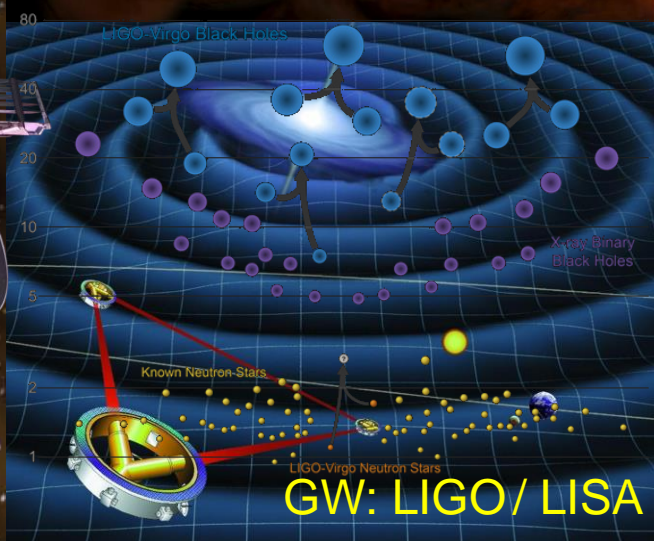
FIRST STARS & QUASARS
400 million years after the Big Bang

NASA/JPL-Caltech, A. Kollmeier (GSFC)

NASA/ESA
S. Beckwith (STScI)
The HUDF Team



JCMT Stray BH



GW: LIGO/ LISA



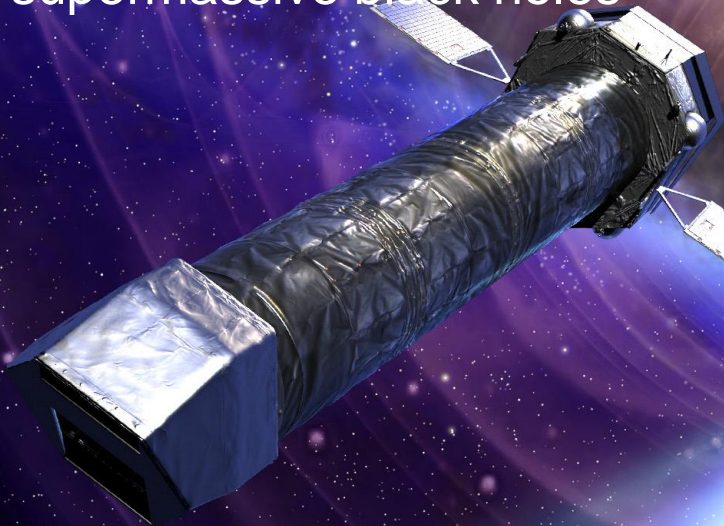
European Space Agency

“Bringing sound to the cosmic movies”



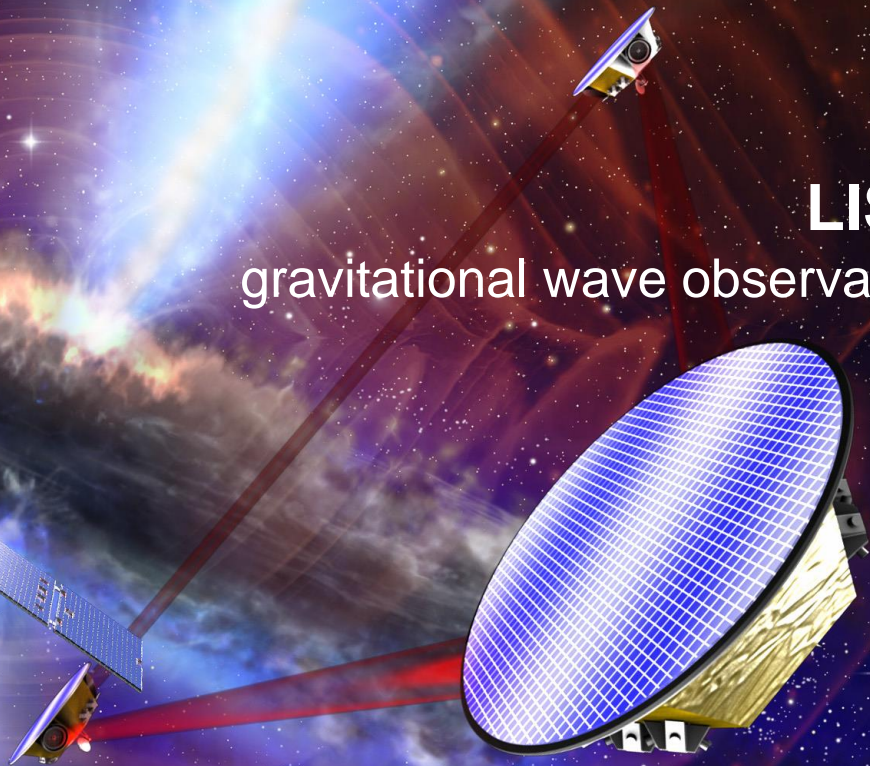
Athena

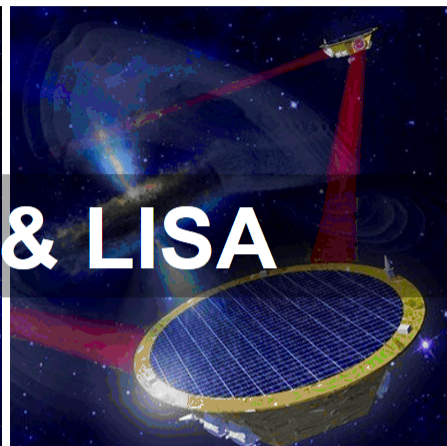
hot gas structures
supermassive black holes



LISA

gravitational wave observation

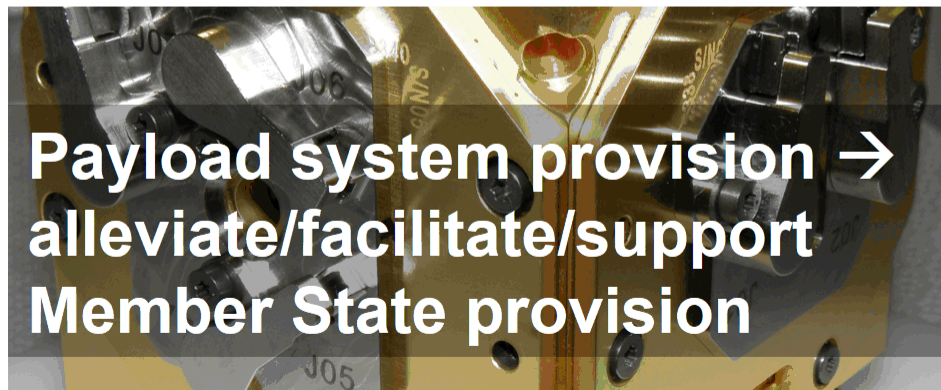
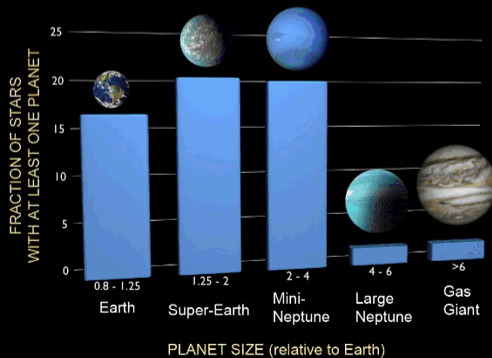




Athena & LISA

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



Payload system provision → alleviate/facilitate/support Member State provision

Preparation of Cosmic Vision in the 2050 time frame



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

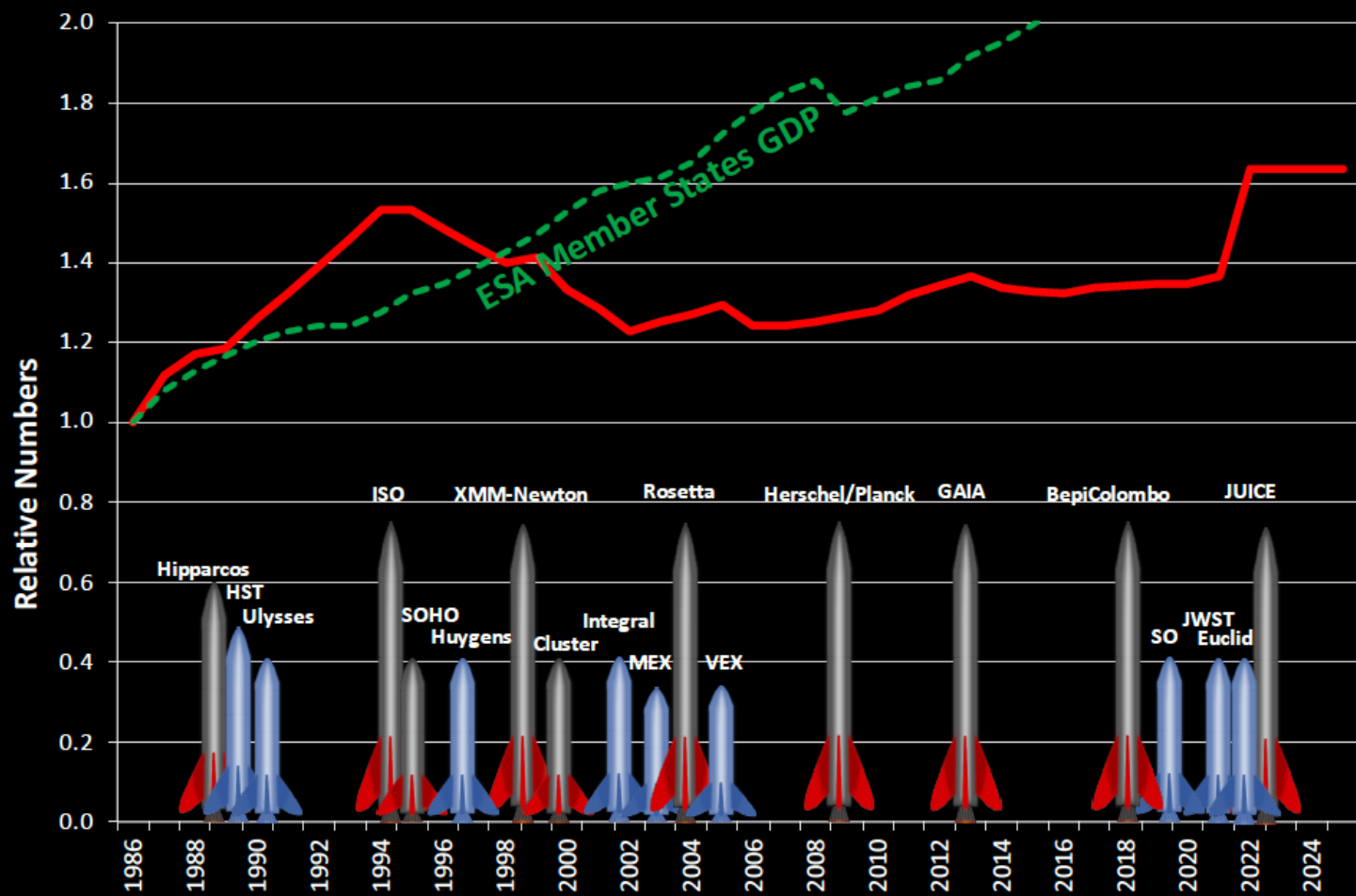
Approved unanimously at IMM18

Strategic guidelines adopted at IMM18



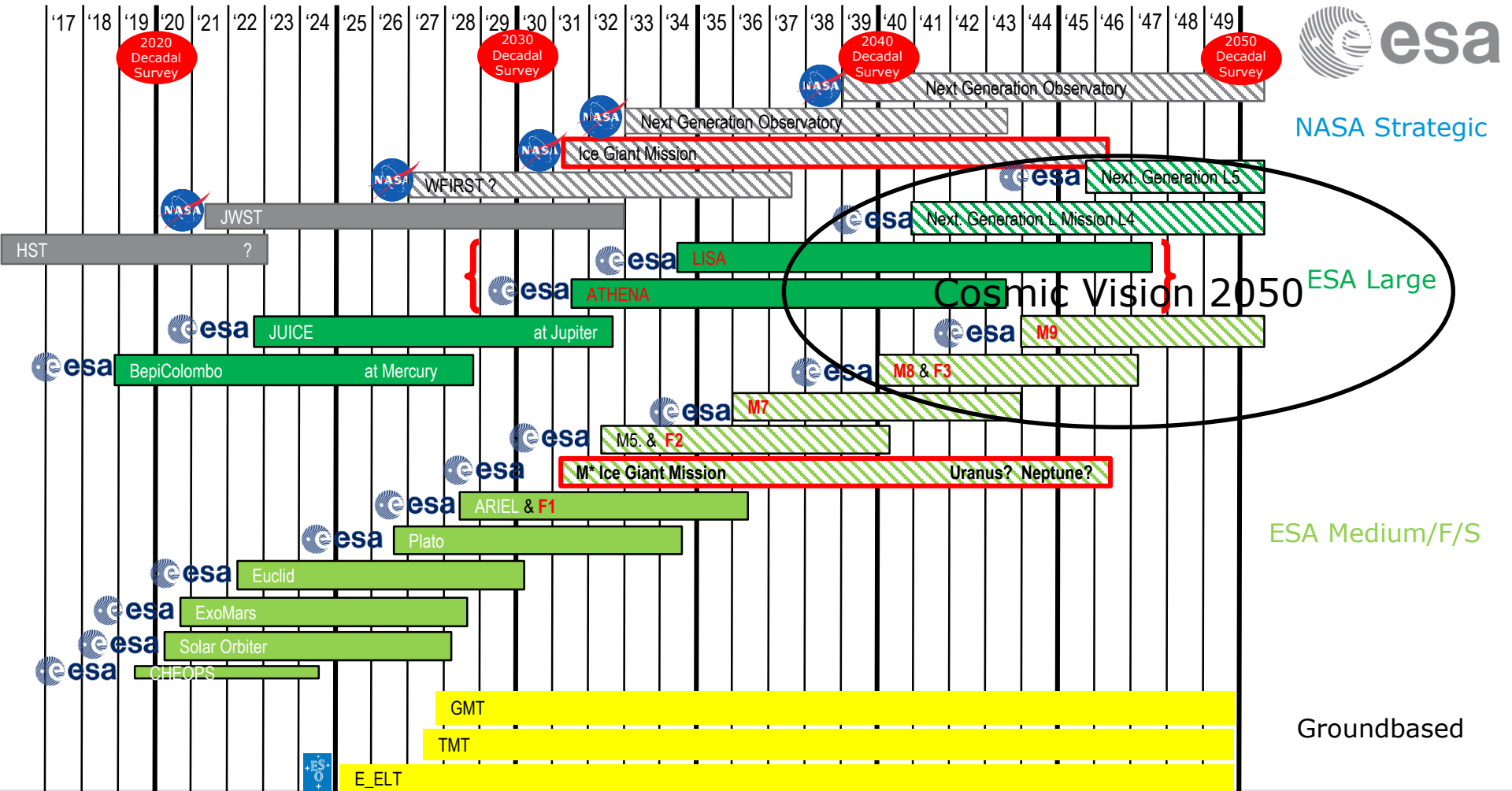
“Council ... recognizes the importance of the Agency’s mandatory activities ... and underlines the objective to secure an adequate level of resources so that the scientific programme ... will continue to build on its remarkable success in past years while giving consideration to increasing the financial resources made available to it so as to allow it to conduct more science activities ...”.





Level of Resources versus Member State GDP Evolution





Cosmic Vision 2050

ESA Large

ESA Medium/F/S

Groundbased

Towards Cosmic Vision 2050



Linda Tacconi



Chris Arridge

Plus
Community
Engagement
Survey
starting this
year.

Members of the ESA Advisory Structure will be involved in various roles.

A composite image of Earth from space, showing the curvature of the planet and the atmosphere. The image is overlaid with a grid of thin blue lines. A bright, glowing light source is visible on the right side, creating a lens flare effect. The text "Thank you very much!" is written in a bold, yellow font in the upper right corner.

**Thank you
very much!**