Cosmic Vision 2015 – 2025

ESA's new long term plan for space science

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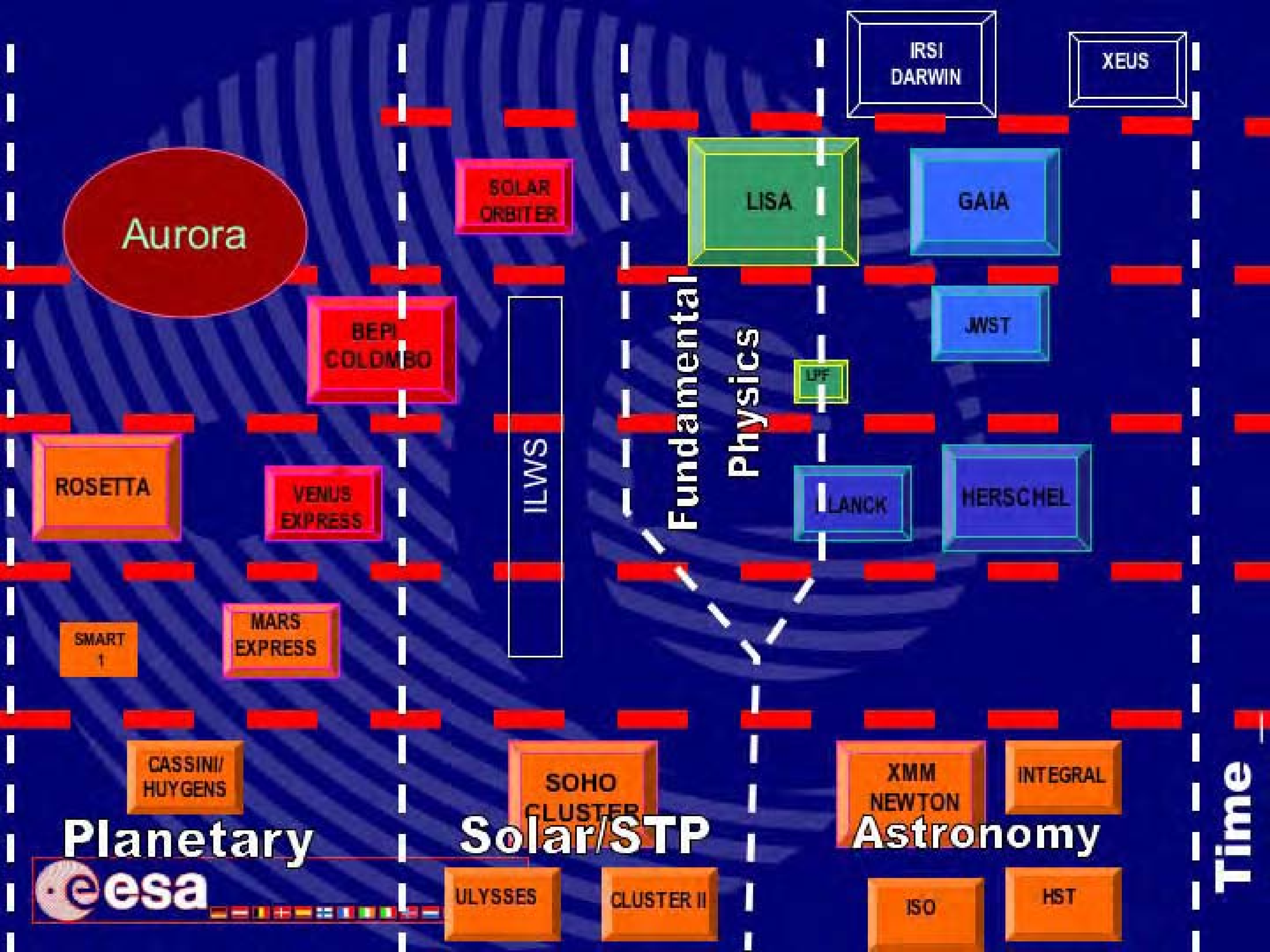

IRSI
DARWIN
XEUS
Aurora
SOLAR ORBITER
LISA
GAIA
BEPI COLOMBO
ILWS
Fundamental Physics
JWST
LPF
ROSETTA
VENUS EXPRESS
PLANCK
HERSCHEL
SMART 1
MARS EXPRESS
CASSINI/ HUYGENS
SOHO CLUSTER
XMM NEWTON
INTEGRAL
Planetary
Solar/STP
Astronomy
Time
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ULYSSES
CLUSTER II
ISO
HST

Missions in preparation

Cosmic Vision process

- Cosmic Vision 2015 –2025 process launched on 2 April 04 with call for Science themes

- 1June 04: deadline for proposal submission

- July 04: Analysis of responses by the ESA Science advisory
bodies (AWG, SSWG, FPAG, SSAC)

- 15-16 September 04: Workshop in Paris (~400 participants)

- Nov 04: progress report to SPC

- Spring 05: presentation of Cosmic Vision 2015-2025 to community (ESLAB Symposium 19-21 April, ESTEC)

- May 05: Endorsement of Cosmic Vision by SPC

Response to Cosmic Vision call

- In excess of 150 responses received !
- Horizon 2000 + consultation received less than 100 responses
- Reveals today's strong expectations of the community from the ESA Science Programme

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Cosmic Vision proposal evaluation

Proposals evaluated for prime scientific objectives by ESA's working groups

- Astronomy/Astrophysics (AWG)
- Fundamental Physics (FPAG)
- Solar System Science (SSWG)

Space Science Advisory Committee (SSAC) merged working group objectives into 4 grand themes

- Building on scientific heritage from Horizons 2000 missions
- Capitalizing on synergies across disciplines

Grand themes

1. What are the conditions for life and planetary formation?
2. How does the Solar System work.
3. What are the fundamental laws of the Universe?
4. How did the Universe originate and what is it made of?

1. What are the conditions for life and planetary formation?

1.1 From gas and dust to stars and planets.

1.2 From exo-planets to bio-markers.

1.3 Life and habitability in the Solar System

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1.1 From gas and dust to stars and planets

Map the birth of stars and planets by peering into the highly obscured cocoons where they form.

Investigate conditions for star and planet formation and evolution

Are there specific characteristics in stars that host planets?

What are the different kinds of planets?

Tool: Far Infrared observatory with high spatial and low to high spectral resolution.

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1.2 From exo-planets to bio-markers

Search for and image planets around stars other than the Sun, looking for biomarkers in their atmospheres

Census of exo-planets from high accuracy astrometry Detection of planets of smaller mass in the habitable zone from high accuracy photometric transits .

Direct detection of Earth-like planets. Physical and chemical characterization of their atmospheres for the identification of unique biomarkers.

Tool: Space nulling interferometer with near to mid-infrared low resolution spectroscopy capability.

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1.3 Life and habitability in the Solar System

Explore 'in situ' the surface and subsurface of the solid bodies in the Solar System more likely to host –or have hosted- life.

Appearance and evolution of life depends on environmental conditions (geological processes, water presence, climatic and atmospheric conditions)

Mars is ideally suited to address key scientific questions of habitability. Europa is the other priority for study of internal structure, composition of ocean and icy crust and radiation environment around Jupiter.

Tools: Mars exploration with in-situ measurements(rovers) and sample return. Dedicated Europa orbiter (lander) on Jupiter Explorer Probe (JEP).

2. How does the Solar System work ?

2.1 From the Sun to the edge of the Solar System

2.2 The building blocks of the Solar System, gaseous giants and their moons

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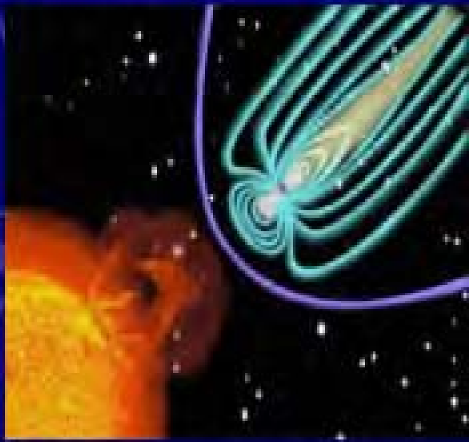
2.1 From the Sun to the edge of the Solar System

Study the plasma and magnetic field environment around the Earth, the Jovian system –as a mini Solar System-, the Solar poles and the heliopause where the Solar influence area meets the interstellar medium.

The structure of the magnetic field at the solar surface requires in particular, observations from above the poles to understand the field's origin.

The Solar System pervaded by the solar plasma and magnetic field provides a range of laboratories to study the interactions of planets (Jupiter) with the solar wind

In-situ observation of the heliopause would provide ground truth measurements of the interstellar medium .



Tools: Solar Polar Orbiter, Earth magnetospheric swarm, Jupiter Probe, Interstellar Helio-Pause Probe

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2.2 The building blocks of the Solar System, gaseous giants and their moons

Study Jupiter In-situ , its atmosphere and internal structure. Obtain direct laboratory information of the building blocks of the Solar System by analysing samples from a Near-Earth Object (NEO).

Giant planets with their rings,diverse satellites and complex environments, constitute systems which play a key role in the evolution of planetary systems.

As primitive building blocks in the solar system, small bodies give clues to the chemical mixture and initial conditions from which the planets formed in the early solar nebula

Tools: Jupiter Explorer Probe/JEP, NEO sample return

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Solar System Science Missions

2015-2025

Look at Small Scales! Understand Space plasmas

EARTH MAGNETOSPHERIC SWARM, SOLAR POLAR ORBITER, HELIOPAUSE PROBE

2020

Go Outward! Explore the outer Solar System

JUPITER & EUROPA PROBE

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Solar System Science Missions

2015-2020

Look for Life! Everywhere in Solar System

Mars rovers and sample return, Europa Probe

2020-2025

Seek Ground Truth! Land on NEOs, Moons, Planets,look below surface, return samples

Jupiter and Europa Probe, NEO Sample Return

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Aurora Programme

The strategy of D/HME contains three elements:

- Developing a robotic Mars mission that will provide Europe with new enabling technologies for the exploration of Mars and to search for evidence of life on Mars, to understand its habitability and to prepare for future human exploration. – it offers explicitly science opportunities for US community and aims for the preparation of a significant European participation in the US-led Mars Sample Return mission

- Cooperation with Russia in the preparation for the design, development, demonstration and operation of the Clipper crew transportation system

- Further development of scenarios and architectures, within Europe and internationally, in order to establish the European role in the longer term global exploration programme.

Tracing the origin of the Solar System

Michel Blanc, Denis Moura, Sushil K Atreya, Mathieu Barthelemy, Antonella Barucci, Bruno Bézard, Dominique Bockelée-Morvan, Scott J. Bolton, Robert H. Brown, Luigi Colangeli, Angioletta Coradini, Alain Doressoundiram, Pierre Drossart , Michel Festou, Marcello Fulchignoni, Daniel Gautier, Tristan Guillot, Reinald Kallenbach, Norbert Krupp, Philippe Lamy, Jean-Pierre Lebreton, Alain Leger, Dennis Matson, Alessandro Morbidelli, Toby Owen, Renée .Prangé, Christophe Sotin, Darrell F. Strobel, Nicolas Thomas, Philippe Zarka, Yann Alibert, Nicolas André, Isabelle Baraffe, Reta Beebe, Willy Benz, Gérard Chanteur, Michele Dougherty, Enrico Flamini, Marina Galand, Tamas Gombosi, Tom Krimigis, William Kurth, Yves Langevin, Philippe Louarn, Jonathan Lunine, François Raulin, Ralf Srama, Hunter Waite, Olivier Witasse, John Zarnecki.

SUMMARY

SMALL BODIES

- ASTEROIDS
- COMETS
- TNOs
- SATELLITES

Pristine material characterization

Surface evolution

Internal structure

Orbiter

Surface element

Sample return

GIANT PLANET SYSTEMS

- SATELLITES
- INTERNAL STRUCTURE

• Surface characterization
• Internal structure & dynamics
• Size of core

Satellite orbiter

Low periapsis polar orbiter

- ATMOSPHERE

Key chemical and isotopic composition

Entry probe

- GIANT PLANET DISKS/ NEBULAE

Structure/composition Dynamics, coupling to central body

High eccentricity equatorial orbiter +Low periapsis polar orbiter

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	NEO's	Comets	TNO's	Jupiter	Saturn	Uranus	Neptune
Orbiter + Surface Element + Sample return	X	Post Rosetta mission	Ground-based studies first				
Low periapsis polar orbiter				X JUNO (NASA)	Cassini		
Entry probe				Galileo (?)	X	X	X
Satellite orbiter		X		X			X
Satellite in situ probe		X		X	x		
Magneto-spheric explorers				X	Cassini		x
Mission Concepts	NEO Sample return	Post-Rosetta Sample return		Europa Orbiter + Magnetosphere Explorer	Post Cassini Titan/ Saturn mission	Uranus Orbiter and probe	Neptune Orbiter and Probe

Mission Concept	For immediate study/design By ESA (and partners)			Following steps		
	NEO Sample return	Europa Orbiter + Magnetosphere Explorer	Neptune Orbiter and Probe	Post C/H Saturn mission	Post Rosetta Comet sample return	TNO Mission
International Cooperation level	ESA	ESA or International	International	International		
Enabling Technologies	Large european Heritage Entry vehicle/ planetary protection	Solar cells or RTG's ——— Radiation resistance	RTG's ——— Entry probe	RTG's		
	Resource minimization (mass,power,data)					
Cost level	*	**	***	***		
Additional science		Comparative Planetology Plasmas, Astrobiology	Comparative Planetology Plasmas			

From themes to proto-missions

How does the Solar System work ?

- **From the sun to the edge of the solar system**
  - Solar-Polar Orbiter (Solar Sailor)
  - Helio-pause Probe (Solar Sailor)
  - Earth Magnetospheric Swarm
  - Jupiter Magnetospheric Explorer (JEP)
- **The Giant Planets and their environment**
  - Jovian In-situ Planetary Observer (JEP)
  - Jupiter Magnetospheric Explorer (JEP)
  - Europa Orbiting Surveyor (JEP)
- **Asteroids and small bodies**
  - Kuiper belt Explorer
  - Near Earth Asteroid sample & return

What are the conditions for life & planetary formation ?

- **From dust and gas to stars and planets**
  - Far Infrared Interferometer
- **From exo-planets to biomarkers**
  - Near Infrared Terrestrial Planet Interferometer
- **Life & habitability in the solar system**
  - Europa Orbiting Surveyor (JEP)
  - Mars In-situ Programme (Rovers & sub-surface)
  - Mars sample and return
- **Looking for life beyond the solar system**
  - Terrestrial Planet Astrometric Surveyor
  - Terrestrial-Planet Spectroscopic Observer
  - Terrestrial Planet Imaging Observer

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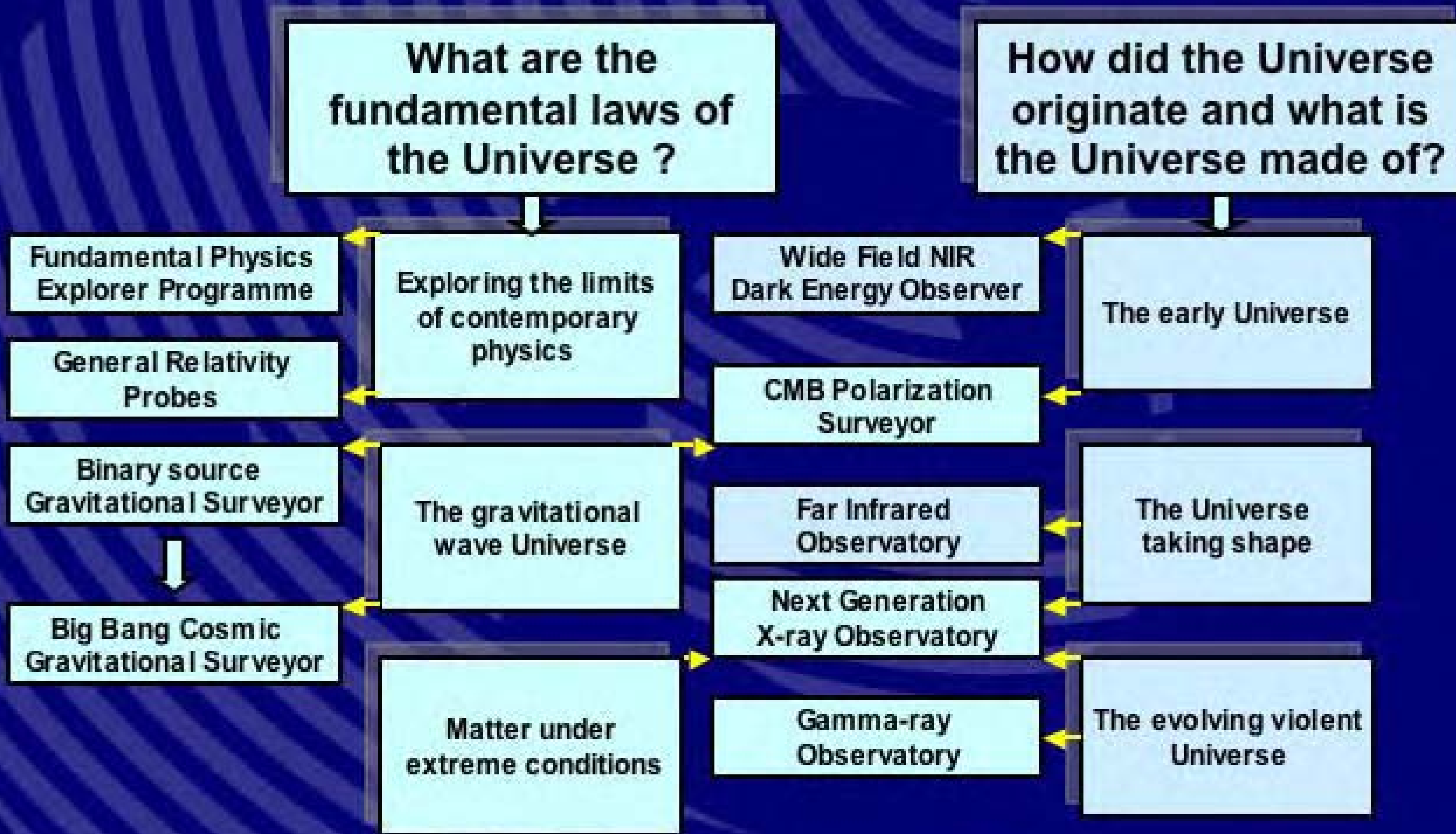
From themes to proto-missions



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CONCLUSIONS

- Cosmic Vision 2015-2025 provides a great opportunity for international collaboration

- a joint ESA/NASA working group will look at requirements for a Europa mission and potential areas of collaboration (actually the first meeting is today);
NASA members: R. Beebe, B. Pappalardo, J. Schubert, M. McGrath, M. Kivelson;
ESA members: A. Coradini, M. Blanc, M. Roos-Serote, F. Westall, J. Zarnecki

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COSMIC VISION 2015 – 2025

Potential implementation

Proposal for increased Level of Resources (LoR)

In preparation of next ESA Council meeting at Ministerial level in December 2005 and after concurrence by ESA DG, it is proposed to:

- Maintain the present Science Programme LoR with inflation correction to 2006
- From 2007, seek a 5 year annual increase of 2.4% over the current LoR

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Programme Slices

- To implement the major objectives of Cosmic Vision 2015-2025 while keeping flexibility of planning, slices of 1 to 1.5 B€ each can be identified for missions to be launched in 2015-2025.
- Flexibility within each slice will depend on size, number and order of missions and inclusion of international cooperation.
- Flexibility within each slice allows to maintain a good balance of scientific disciplines
- The first Call for Mission Proposals to cover first slice (2015 – 2018). Next slices to be implemented through subsequent Calls.

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Importance of proposed LoR increase

- Enables early support of Aurora programme by Science Directorate in areas of scientific payloads and science operations.

- Opens a programme wedge in 2010 to start industrial development for timely implementation (2015 launch) of initial mission of first Cosmic Vision slice.

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Conclusions

let's start soon dishing out the first slice !

a launch in 2015 requires a phase B start at the beginning of '08

Phase A in '07

Call for mission proposals early '06