

Astronomy

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for the Astronomy Working Group

Answers to the call for ideas

Illustration of the strong expectation of the community
from the ESA Science Programme:

1983: Horizon 2000	70 proposals
Astronomy	29
1993: Horizon 2000+	100 proposals
Astronomy	28
2004: Cosmic Vision 2015-2025	151 proposals
Astronomy	47

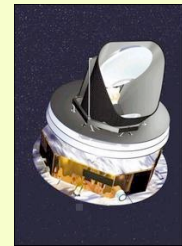
Context, ESA satellites



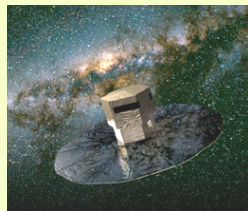
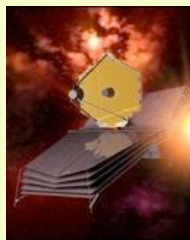
- In operation: HST (with NASA), XMM-Newton, Integral



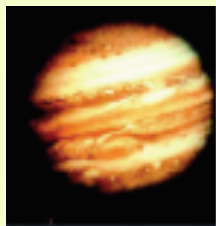
- In development: Herschel, Planck, Corot (with CNES), Astro-F (with JAXA)



- In preparation: GAIA, JWST (with NASA)

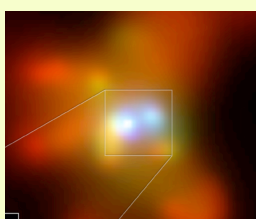


Context, science

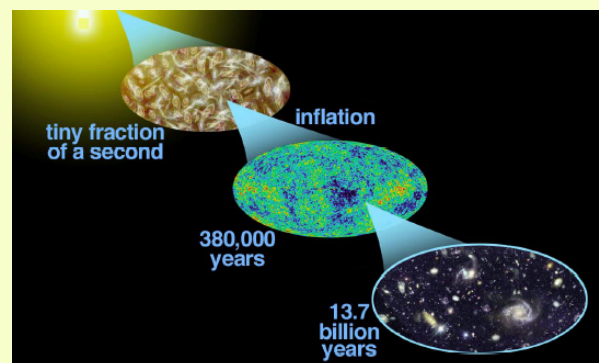


- discovery of 134 exo-planets (118 systems), down to $\sim 15 M_{\text{Earth}}$
- very different from the planets in the Solar System
- high diversity

- observations at higher and higher redshifts
- new cosmological parameters, more and more accurate
- dark energy dominates the Universe, now



- cosmological nature of γ ray bursts
- diagnostics of strong field gravity
- discovery of binary black holes



Evaluation of Cosmic Vision proposals

Proposals evaluated for prime scientific objectives,
by the Astronomy Working Group

- * What is new ?
- * What is the likely impact in the domain ?
- * What is the likely impact on science ?
- * What is the expected range of application ?
- * What is the added value of space ?
- * Short (around 2015), medium (2020), long (2025)
or very long (> 2025) term ?

Three main themes identified in Astronomy

1. Other worlds and life in the Universe
Placing the Solar System into context
 - Formation of stars and planetary systems
 - Detection, census and characterization of exo-planets
 - Search for extraterrestrial life
2. The Early Universe
 - Probing inflation
 - Investigating Dark Energy
 - The observable Universe taking shape
3. The evolving violent Universe
 - Black holes and galaxy evolution
 - Matter under extreme conditions
 - Supernovae and the life cycle of matter

4 grand themes for the Science Programme

Working Groups objectives merged into 4 grand themes by the Space Science Advisory Committee

*** What are the conditions for life and planetary formation?**

- From gas and dust to stars and planets
- From exo-planets to bio-markers
- Life and habitability in the Solar System

*** How does the Solar System work?**

*** What are the fundamental laws of the Universe?**

*** How did the Universe originate and what is it made of?**

- The early Universe
- The Universe taking shape
- The evolving violent Universe

Astronomy roadmap (1)

What are the conditions for life and planetary formation?

Up to 2015

- Search for terrestrial planets: **Corot, (Kepler)**
- Star formation, molecular spectroscopy: **Herschel, JWST**
- Statistical census of extrasolar giant planets: **GAIA, (SIM)**

2015 - 2020

- Direct detection of a planet & search for biomarkers:
Near-mid-IR nulling interferometer - Darwin

2020 - 2025

- Resolve protostars and protoplanetary disks: **Far-IR observatory**

> 2025

- Census of terrestrial planets within 100pc: **Super-GAIA**
- Atmosphere studies: **High resolution optical-UV spectroscopy**
- Imaging of exo-planets & exo-earths: **Large optical interferometer**
(e.g. Hypertelescope)

Astronomy roadmap (2)

How did the Universe originate and what is it made of?

Up to 2015

- The Universe taking shape: **HST, XMM, (Spitzer), Herschel, JWST**
- The evolving violent Universe: **(Chandra), XMM, Integral**
- Initial Density fluctuations: **(WMAP), Planck**

2015 - 2020

- Clusters of galaxies back to their formation epoch, interactions black holes - galaxies **Large-aperture X-ray observatory - XEUS**
- Probing Dark energy: **Optical and near-IR wide-field imager**
- CMB fluctuations: **All-sky CMB polarisation mapper**

2020 - 2025

- Resolve far-IR background: **Far-IR observatory**

> 2025

- Isotope abundances, physics of SN: **Hard-X / γ -ray observatory**
- Warm/hot IGM, physics of SN: **High resolution UV spectroscopy**