A Perspective for the future:

The ESA Cosmic Vision Programme

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The present: Projects in development
ESA’s new long term plan for space science

COSMIC VISION
2015-2025
Cosmic Vision Process

• Plan covers 10 years, starting from 1st launch in 2017
• It is divided in 3 “slices” with a budget of 950 M€ each
• There will be a “Call for Mission proposals” for each of the 3 slices
• First “Call for Missions” issued in 1st Q 2007
• 50 proposals received by June 2007 deadline (2x than H2000+)
• Selection process by advisory structure on behalf of scientific community during summer 2007
• Selection by Space Science Advisory Committee in October 2007
Cosmic Vision process: 1st slice

- The 1st slice initially foresaw 2 launch opportunities:
  - 1 Medium size mission in 2017: ESA cost capped at 300 M€
  - 1 Large size mission in 2018: ESA cost capped at 650 M€
- Payloads funded separately by Member States
- Other combinations possible depending on programmatic evolution
Cosmic Vision: the selection process

• The selection of a given M mission is in three steps:
  – Selection of 5 Missions for 1-year Assessment Phase (Phase-A)
  – At the end of Assessment Phase, down-selection of 3 M missions for 2-years Definition phase (Phase-B)
  – At the end of Definition phase, down selection of 1 M mission for 5-7 years Implementation & launch (Phases C/D)
• The selection of an L mission is similar but …
Seven Missions were selected for Assessment over 2008-2009:

- 5 M missions (< 300 M €) for launch in 2017:
  - Euclid
  - Plato
  - Spica
  - Marco-Polo
  - Cross-Scale
  + will compete with Solar-Orbiter (studied in H2000+ program)

- 2 L Missions (<650 M€) for launch in 2018:
  - XEUS → IXO
  - Outer-Planet mission Laplace or Tandem (Laplace pre-selected)
  + will compete with LISA (studied in H2000+ program)
Mission selection process

Assessment Phase | Definition Phase | Implementation Phase

L-Class Missions
Laplace
Tangaroa
Xeus
Lisa

M-Class Missions
Dark Energy
Marco Polo
Cross-Scale
Plato
Spica

+ Solar Orbiter

CV Call #1
CV Call #2

Launch 2007 2008 2009 2010 2011 < 2017 < 2018
EUCLID, a dark-energy surveyor

- To constrain Dark Energy equation of state parameter $w$ to $<1\%$
- Imaging & spectroscopic survey of entire extragalactic sky
- Uses 2 probes: *Weak Lensing* & *Baryonic Acoustic Oscillations*
Euclid (2)

- **Weak gravitational Lensing:**
  - Matter in front of galaxies *distort* their shapes
  - This “shear” measures amount of matter along the line of sight (dark & normal) to galaxy
  - Shear ~1%, must be measured accurately
  - Measure shape of $5 \times 10^8$ galaxies to 24.5 mag.
  - Measure distance by photometric redshifts in 3 near IR bands to 24 mag.

- **Baryonic Acoustic Oscillations:**
  - Size & distribution of cosmic structures (ex. clusters) depends on expansion rate & gravity
  - Measure spectroscopic distance to $\sigma_z < 0.001$ of 33% of all galaxies brighter than 22 mag. ($\sim 2 \times 10^8$ to $z = 2$)

- **EUCLID:**
  - 1.2 m telescope with 0.2” PSF; 5 years survey
  - Vis & NIR imager “DUNE”
  - near IR spectrograph “SPACE”
PLATO, the planet finder

- Goal: find & characterise *earth-size* planets in 1-AU orbit around 20,000 Sun-like stars
- Method: *occultation* technique i.e. measure star brightness to **27 p.p.m. accuracy**!
- Also characterise star by astroseismology → size & mass of star & planet
- Need to survey *large* sky area for *long time*
  - Can monitor many stars simultaneously
  - 12 to 54 co-aligned small telescopes
  - Observe 2 directions for 2.5 years each
- May find up to **200 earth analogues**, sufficiently close for follow-up with future spectroscopic mission (~Darwin)
SPICA: the next generation Infrared observatory

- **Goal:** study star & planet formation & the birth of galaxies
- **Because of dust absorption, need to observe in infrared (IR)**
- **A joint Japan/Europe collaboration:**
  - Japan provides spacecraft, launch & 2 instruments
  - Europe provides telescope & 1 instrument “SAFARI”
  - Satellite at Sun-Earth Lagrange point L2
  - Observatory open to Europe & Japan scientists
- **Telescope:**
  - 3.5 m diameter; heritage from Herschel
  - Actively cooled to 6 K → much more sensitive
  - Includes coronagraph for imaging exoplanets (“Jupiter”)
- **SPICA also in assessment in Japan; selection schedule OK**
- **Mission of opportunity: cost to ESA ≤ 100 M€**
Marco-Polo, the asteroid chaser

- Goal: land on a primitive asteroid, collect & return sample
- Will return 30 g of pristine material dating from the time of the formation of the solar system, 4.5 billion years ago
- Follow-up to ROSETTA mission now en route to comet 67P
- Possibly in collaboration with Japan
- Technology for capsule re-entry not mastered yet in Europe
- ~ 10 instruments nationally funded
Cross-scale: the earth magnetosphere in 3-D

- Flotilla of 7 spacecrafts to navigate in the earth magnetosphere and study its composition, electric and magnetic properties in 3 dimension and its interaction with the solar wind
- Follow-up of successful Cluster mission
- Possibly in collaboration with Canada (3 additional spacecrafts) and Japan
- 10 instruments on-board
Status of M-Missions

- Assessment study of 5+1 M-Missions almost complete.
  - No technical show-stopper; at least 2 could be ready for launch in 2017
  - Cost generally higher than 300 M€ (except for SPICA)
  - In January 2010, 3 of them will be selected for 2 years definition phase
  - End 2011, 1 or 2 of them will be selected for development & launch in 2017
- **Goal:** study black-holes at the centre of galaxies and their evolution since they were formed; study the formation & evolution of large scale structures in the Universe
- Follow-up of XMM-Newton observatory
- Imaging X-rays requires long focal length:
  - 25 m deployable bench
  - Light-weight X-ray mirrors at one end
  - 5 X-ray instruments at other extremity
- Status from on-going assessment:
  - Expensive: cost > 650 M€
  → Collaboration with NASA & Japan
  - Light weight mirror technology need long development
  → Cannot be ready for selection in 2010
LISA, the gravitational wave observatory

- Goal: study mergers of black-holes and neutron stars almost since the beginning of the Universe through the gravitational waves they emit.
- Consists of 3 interacting spacecraft in an equilateral triangle with 5 million km arms orbiting the Sun.
- As gravitational waves pass through, they distort space-time and therefore the shape of the triangle.
- LISA measures this tiny distortion ($10^{-12}$ m!) by interferometric measurement of the distance between S/C.

Cost > 650 M€ → Collaboration with NASA
Most technologies will be validated by LISA Pathfinder in 2011 → Can’t be ready for selection in 2010
LAPLACE/EJSM: a mission to the Jupiter system

Main goals:
How did the Jupiter system form?
Are Europa & Ganymede habitable?

ESA/NASA (Japan?): collaboration
Two spacecrafts:
Jupiter-Ganymede Orbiter → ESA
Jupiter-Europa Orbiter → NASA

Status:
JGO phase-0 done; industrial study to start soon
Challenge: protection from particle radiation
Can’t be ready for selection in 2010
Status of L-Missions

• Three L missions are being assessed (Phase-A)
  – IXO: the next generation X-Ray observatory
  – Laplace/EJSM: a mission to the Jupiter system
  – LISA: Gravitational Wave observatory
• 1-year industrial studies are about to start
• All 3 L missions are expensive and can only be done in collaboration
• All 3 L missions are studied in collaboration with NASA (& Japan for IXO)
• The ESA and NASA (Astro-2010 decadal) selection schedules are compatible
• All 3 L missions require strong multi-years technological development
• None of the 3 L missions can be ready for down-selection in 2010
• None can be developed and launched before 2020
Revised down-selection process

L-Class Missions
- Laplace
- Tandem
- Xeus
- Lisa

M-Class Missions
- Dark Energy
- Marco Polo
- Cross-Scale
- Plato
- Spica

+ Solar Orbiter

CV Call #2

Assessment Phase | Definition Phase | Implementation Phase

2013

IXO

Euclid

2013

2020
Thank you for your attention
M-Missions near term schedule

End of 1-year industrial studies: 31-Jul-2009
ESAs internal technical & programmatic review: Aug-Oct 2009
Phase-A study reports ("Yellow Book") available: 15-Nov-2009
Study reports presentation to science community: 8-Dec-2009
AWG, SSWG evaluation of study reports: Nov 2009-Jan 2010
AWG & SSWG selection recommended to SSAC: 13-Jan-2010
SSAC recommendation of 2 M-Mission for Phase-B: 14-Jan-2010
SPC approval of selected missions: 18-Feb-2010