
Jean Clavel

The current status of the mandatory scientific programme of ESA will be briefly summarised, focusing on astronomy missions. In the second part of the presentation, I will present the Cosmic Vision 2015-2025 long term plan, the future missions which are currently under study or definition and the process by which these missions are being selected.

The ESA Herschel Space Observatory - first year in-flight and early science highlights

Göran Pilbratt

The Herschel Space Observatory was successfully launched on 14 May 2009, carried into space by an Ariane 5 ECA launcher together with the second passenger Planck, both spacecraft being injected into transfer orbits towards L2 with exquisite precision. Herschel is the most recent observatory mission in the European Space Agency (ESA) science programme. It carries a 3.5 metre diameter Cassegrain passively cooled monolithic silicon carbide telescope. The focal plane units of the science payload complement - two cameras/medium resolution imaging spectrometers, the Photodetector Array Camera and Spectrometer (PACS) and Spectral and Photometric Imaging REceiver (SPIRE), and the very high resolution Heterodyne Instrument for the Far-Infrared (HIFI) spectrometer - are housed in a superfluid helium cryostat.

Herschel is the first large aperture space infrared observatory, it builds on previous infrared space missions including the ESA ISO and NASA Spitzer observatories, by offering a much larger telescope and pushes towards longer wavelengths. It will perform imaging photometry and spectroscopy in the far infrared and submillimetre and its science capabilities putting it into perspective. Herschel is designed to observe the 'cool universe'; the key science objectives include star and galaxy formation and evolution, and in particular the physics, dynamics, and chemistry of the interstellar medium and its molecular clouds, the wombs of the stars and planets.
Herschel is currently opening a new window to study how the universe has evolved to become the universe we see today, and how our star the sun, our planet the earth, and we ourselves fit in. I will outline the early inflight operations of Herschel and the transition from launch and early operational phases into the routine science phase. I will present the demonstrated science capabilities by providing examples of scientific highlights to date.

Herschel has been designed to offer a minimum of 3 years of routine science observations. Nominally ~20,000 hours will be available for astronomy, 32% is guaranteed time (GT) and the remainder is open time (OT) offered to the general astronomical community through a standard competitive proposal procedure. The time allocation for both GT and OT Key Programmes was been concluded before the launch, and the first in-flight AO is underway. I will briefly mention future observing opportunities.

The Rosetta close encounters with two main-belt asteroids

Rita Schulz

ESA’s Planetary Cornerstone Mission Rosetta is on its way to rendezvous with comet 67P/Churyumov-Gerasimenko in 2014 after which it will accompany the comet into the inner solar system, while releasing the Lander Philae onto the surface of the comet nucleus. During the long cruise phase to the main target the spacecraft was scheduled to perform close fly-bys of two main-belt asteroids, (21) Lutetia and (2867) Steins. These asteroids were selected after careful evaluation of the scientific significance of all reachable targets constrained by the available fuel budget. Rosetta has now performed both fly-bys successfully. Closest approach occurred on 5 September 2008 for (2867) Steins and on 10 July 2010 for (21) Lutetia. The fly-by strategy was arranged such that it allowed for continuous observations of each asteroid before, during and after closest approach whilst the spacecraft passed through phase angle zero. Most of the scientific instruments on board Rosetta were switched on for investigations of the asteroid and its surrounding environment, obtaining imaging and spectral observations from the UV to sub-mm wavelengths as well as particle and field measurements. Both targets have turned out to be extraordinarily interesting objects for close inspection. This is not just because (21) Lutetia is the largest asteroid, and (2867) Steins is the only E-type asteroid ever visited by a space mission, but rather the results reveal the complex morphology, dynamics, and composition of both. After completion of the detailed analysis of the data obtained by Rosetta these two objects will be among the best-studied asteroids and as such will add significantly to our understanding of the different types of asteroids. This in itself will help to solve the puzzle of how the solar system formed and has evolved.
Euclid: an ESA mission to map the geometry of the Dark Universe

René Laureijs

Euclid is a high precision cosmology mission under development by the European Space Agency to investigate the properties of Dark Energy and Dark Matter. The mission is optimised for the measurement of two cosmological probes: weak lensing and baryon acoustic oscillations. Euclid will carry out an imaging and spectroscopic survey of the entire extragalactic sky of 20,000 deg². The technical capabilities of Euclid are such that the mission can also address other cosmological and astronomical topics, providing an unprecedented science legacy. Euclid carries a meter class telescope which feeds two instruments: a visible imager (VIS), a near-infrared photometer combined with a medium resolution spectrometer (NISP). The nominal mission period is 5 years. We describe the mission and its present status, the satellite, and the payload and operations concepts.

PLATO: Europe’s Next-Generation Planet Finder

Malcolm Fridlund

PLATO (PLAnetary Transits and Oscillations of stars) is a proposed M-class mission of the Cosmic Vision 2015-2025 program. PLATO is building on the highly successful small CoRoT mission (CNES/ESA/Europe/Brazil), and on NASA’s KEPLER mission, but will offer more than an order of magnitude improvement of the amount and quality of the science product. The prime objective of the PLATO mission is to search for planetary transits (occultations) in front of stars that can be fully characterized in terms of fundamental physical parameters. This characterisation is done using the PLATO data themselves via asteroseismology, and supported from the ground using high resolution spectroscopy and some photometry.

The PLATO proposal was selected for an assessment study as part of the ESA’s Cosmic Vision 2015-2025 scientific plan, and requires ESA to build and construct a satellite that can for the first time observe planetary transits of a large enough sample to be:

- Statistically significant with respect to Earth-mass planets orbiting main sequence F-, G- and K-type (Solar Type) stars in the Habitable Zone. The goal is to detect Earth-analog systems within their habitable zones where the host stars can be fully characterised in terms of ages and size

- Determine the radius and mass of both the parental star and the planet(s) orbiting it, with an accuracy of about 1%, as well as provide an age estimate of the detected exoplanetary systems to better than 10%

- Provide a planetary mass function extending from Brown Dwarfs down to planets smaller than the Earth
The PLATO science objectives will be met using long uninterrupted high precision photometric monitoring of large samples of stars. The number of cool dwarfs and subgiants down to mV=11 must be maximized. These observations will first allow us to detect and characterize planetary transits, allowing us to measure planet sizes and orbital periods, as well as to detect planet satellites and rings.

They will simultaneously provide us as well with measurements of frequencies, amplitudes and lifetimes of oscillation modes of the same sample of stars. The analysis of these asteroseismic measurements will yield precise information about the internal structure and rotation of these stars, and will allow us to determine accurately their masses, radii and ages.

The Spacecraft consist of a platform on which 34 120mm telescopes of a refractive (6 element) design are mounted. Observing the same field in the sky, this construction allow for a very large (> 1800 degree2) field-of-view (FOV), and by adding the signal from each sub-aperture one can also realise a large collecting area (roughly equivalent to a single telescope with 550mm aperture. Two of the telescopes will be dedicated to the brightest of the stars in the sample. The mission is planned to be launched on a Soyuz rocket to the L2 Lagrangian point in the Earth-Sun system. The mission is planned for an in-orbit lifetime of 6 years extendable for several years after this.

PLATO successfully passed a selection after the assessment study in December 2009 – January 2010 and is now in a competitive (with two other Medium class missions) development phase. The development work is also carried out competitively by two industrial contractors. A down select of the missions being developed is expected in late June 2011. In the meantime, an announcement of Opportunity for PLATO Payload and Science Ground Segment Components (Science consortium and payload development) and Independent Legacy Scientists in the PLATO Science Team have been issued with a closing date of 29 October 2010.

SPICA: The Space Infrared Telescope for Cosmology and Astrophysics

Kate Isaak

The infrared waveband plays host to an extensive range of spectroscopic and photometric diagnostics which probe incisively the physical conditions found in a very wide range of different astronomical environments. The last 25 years have marked a golden age in space-based infrared astronomy, with the IRAS, ISO, AKARI and Spitzer satellites advancing fields from planetary science to star formation, and galaxy formation through to galaxy evolution. Early results from the far-infrared/sub-millimetre instrument suite on the Herschel underline the key role of the long-wave end of the infrared toolbox, while much is expected from the NIR/MIR capabilities of JWST. The successes of past missions have raised many key questions in planet formation and galaxy evolution that can only be addressed in the IR/MIR/FIR, yet that are "just" beyond the reach of Herschel and the JWST.
SPICA, the Space Infrared Telescope for Cosmology and Astrophysics will take the next step. Proposed as a Japanese-led mission with a launch date in the 2018 timeframe, SPICA will operate in the mid and far infrared wavelength range (5-210 µm) with unprecedented sensitivity, thanks to its 3 m-class cold telescope (< 6 K) and advanced instrument suite. A proposal for an ESA contribution to SPICA was selected in October 2007 as a candidate M-class mission for the ESA Cosmic Vision 2015-2025 programme, with the character of "mission of opportunity". The proposed contribution from ESA comprises the cryogenic telescope assembly, access to an additional ground station, collaboration on science operations and management of interfaces between JAXA and the European instrument, SAFARI. SAFARI - a far-infrared imaging spectrometer and photometer - will be procured by ESA from a European consortium. US and Korean participation in the mission is also being discussed extensively. The SPICA observatory will be open to the worldwide community. In this talk I will give an overview of the mission, its scientific goals and the capabilities provided by its suite of instruments, as well as an update on the current status of the project.

**ESA Science Archives at the European Space Astronomy Centre (ESAC)**

Pedro Osuna

The Science Archives and VO Team (SAT), part of the Science Operations Department of the European Space Agency, started building Astronomical Data Archives back in 1996. IT standards, tools, languages, etc. have had an evolution which could hardly be foreseen at the time. After more than ten years of the first public version of the Infrared Space Observatory (ISO) Archive, the SAT now hosts the following Science Archives: XMM-Newton, Herschel, ISO, Integral, SOHO, EXOSAT, Planck and ESA's Planetary Science Archive (regrouping data from Rosetta, Mars Express, Venus Express, Smart-1, Huygens and Giotto). In the future, many more ESA Space Based Missions will have their archives located at ESAC, including Gaia and BepiColombo.

The latest developments at the SAT include building a state of the art “Archives Building System Infrastructure” that provides the building blocks for the creation of ESA Space Based Missions archives with renewed technologies and standards. As a demonstration of the goodness of the approach, two Science Archives, coming from two very different research fields, have been created from scratch using the new technology: the SOHO Science Archive and the EXOSAT Science Archive, both made public to the community in April 2009. The latest to be developed with the new technology is the Planck Science Archive (currently only released for the consortium). In this talk, an overview of the Science Archives available at ESAC will be shown, with special attention on the ESA New Generation Archives. Future plans for the Archives will also be discussed, and how the Archives and the Virtual Observatory are all interrelated.
The XMM-Newton Science Archive and its flexible interface to Data and Catalogues

Nora Loiseau

The XMM-Newton Science Archive (XSA) contains raw and processed data of observations performed since the launch of XMM-Newton, ESA's X-ray satellite, in December 1999. In addition, the XSA contains a number of catalogues based on these observations. At present, it is one of the most heavily used astronomical archives, giving access to X-ray data acquired simultaneously with its 6 sensitive, large field of view instruments. In this talk we show the most relevant of the functionalities of the interactive interface (XUI) and the batch job tool (XAIO), including the access to the 2XMM source catalogue, the XMM-OM Optical Monitor (optical/UV) source catalogue, and the XMMSL Slew Survey source catalogue. We will show some recent science cases to highlight how the XSA can be used for a variety of scientific projects. We will also comment on the future developments of the XSA and links to the VO tools.

The Herschel Science Archive

Eva Verdugo, Bruno Merin and Deborah Baines

At present, the Herschel Science Archive (HSA) contains around 9000 scientific observations. Most of them are under proprietary rights protection but there are already around 10% which are public observations. We will present the different capabilities of the HSA User Interface to browse the content of the Archive, to perform queries based on many different observations and proposal parameters and to retrieve full observations and/or single products. One of the most powerful subsystems of the HSA is the scriptable interface, the HAIO. We will show how this interface allows the interaction with other systems, such as the Herschel Interactive Processing Environment (HIPE), through VO protocols. Finally, we will show some examples of spectra and images taken with Herschel and how they are already compatible with standard VO tools, such as VOSpec and Aladin.

Science Using the Virtual Observatory: Probing the disks, accretion and formation of pre-main sequence stars

Deborah Baines

The Virtual Observatory (VO) is opening up new ways of exploiting the huge amount of data provided by the ever-growing number of ground-based and space facilities, as well as by computer simulations. The Science Archives and VO Team (SAT), part of the Science Operations Department of the European Space Agency, has been involved in the VO for many years, and has developed a number of tools to publish data and to access data in the VO. Using the tool VOSpec, a multi-wavelength spectral analysis tool developed by the SAT and new developments on scripting with VOSpec (VOScript), we have started to undertake a comprehensive study of spectral data in the VO on young stars, Herbig Ae/Be and also T Tauri stars.
The Herbig Ae/Be stars are intermediate mass pre-main sequence stars that bridge the gap between the low mass T Tauri stars and the Massive Young Stellar Objects. This is an important mass range for understanding the formation of massive stars, as it is here that the acting star forming mechanism switches from magnetically controlled accretion from disks with inner holes to a not well known mechanism, likely to involve direct disk accretion onto the star. By studying the line strengths, variabilities and spectral energy distributions, from the X-ray to the sub-mm, we aim to gain insights into the accretion rates, processes and disk properties of a large sample of these objects, and to probe the question: Where does the star formation mechanism switch? In this talk I will discuss the initial findings and give a brief overview of the VO Tools developed by the SAT (VOSpec and VOScript).