SRE Science Workshop
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Abstracts

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Talks

Herschel survey of brown dwarf disks in Rho Ophiuchi

Catarina Alves de Oliveira

Young brown dwarfs are known to possess circumstellar disks, a characteristic that is fundamental to the understanding of their formation process, and raises the possibility of these objects harboring planets. Observations of the Rho Ophiuchi cluster (1 Myr) with the Herschel Space Observatory, allow us to probe the spectral energy distribution (SED) of the clusters' brown dwarf population at the far-IR, where the disk emission peaks. We will present the results of the comparison between the new observations and a grid of synthetic disks produced with a radiative transfer code. The structural parameters constrained by the extended SED coverage show a narrow distribution for all the young brown dwarfs in this cluster, suggesting that these objects share the same disk evolution and, perhaps, formation.

Detection of Ultra Faint Dwarf Galaxies with Gaia

Teresa Antoja

We aim to explore the limits of detectability of Ultra Faint Dwarf Galaxies in the Galactic halo as a function of luminosity, velocity dispersion, distance and other properties of the galaxies using the future Gaia data. We are developing an identification technique that works entirely using direct Gaia observables, namely position in the sky, proper motions, and photometric and spectroscopic information. We are currently testing the method on mock Gaia catalogues.

Gaia going to 21 magnitude

Samy Azaz

Gaia's on-board object detection capability allows extending the faint end of the survey from $G = 20$ mag to 21 mag, thus increasing the number of objects which would be observed by the Gaia instrument. Among these objects, there are the ones of interest such as single stars and binary stars and the spurious ones such as cosmic rays, solar protons and sky-background-induced false detections. This presentation will show how we proceed to optimise the detection and the confirmation parameters inside Gaia's on-board detection software.

67P Churyumov-Gerasimenko observed by OSIRIS

Sebastien Besse

Observations of the OSIRIS camera (the real camera, not the navigation camera ;-) are showing an astonishing new word with many active and past processes on the surface. I will discuss the morphology of the nucleus in the frame of past and future activity.

Comparison of two high-resolution gamma-ray spectrometer (scintillator crystals) for planetary remote sensing applications

Johannes Benkhoff

Global mapping of nuclear gamma-ray line emission is known to provide knowledge of the composition of soil-constituting elements over surfaces of such thin/no-atmosphere planets, as the Moon, Mars and Mercury. A new generation of remote sensing gamma-ray spectrometers has been developed for planetary missions where resources (e. g., mass and power) are limited and environments sufficiently harsh to preclude low temperature sensors. These instruments measure gamma-ray emanations from planetary surfaces remotely from orbit. The data they collect is essential to determine the chemical composition of the regolith and in turn, interpret surface geology and ultimately planetary evolution. Although, scintillators have a number of advantages over traditional Si and Ge technologies (good stopping powers, large volumes, room temperature operation), up till the development of the lanthanum halides (LaX_3) they were routinely excluded from instrument selection because of their poor energy resolution. All this changed with the development of Ce-doped $LaBr_3$ crystals, which have excellent energy resolutions and proportionality of response over traditional scintillating materials. As a result a 3-inch $LaBr_3$ crystal currently forms the central detection element of the MGNS on BepiColombo. Very recently low noise, high-resolution scintillators, such as CeBr3 have become available. $CeBr_3$ has the advantage that it is part of the same rare earth family of halides and thus has similar properties than La, but contains no naturally occurring radioisotopes. As a consequence much less dark counts in the detector can be expected. We want to compare the new detector with the existing $LaBr_3$ crystal used on BepiColombo. Currently (up to the end of 2014) there are two almost identical models of the BepiColombo MGNS instrument available. The flight-spare Model with a $LaBr_3$ crystal for gamma ray detection and the qualification model. The plan is to re-package the new $CeBr_3$ crystal and exchange them with the one of the existing MGNS Qualification Model. After this tasked is performed one has two identical instruments available, which could be used to perform these comparisons. First results will be given.

Combined chemical/elemental analysis and charging properties of Itokawa grains returned by the Hayabusa mission

Luigi Colangeli

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The Hayabusa spacecraft collected submillimeter particles from the Muses Sea region on asteroid (25143) Itokawa on 19th and 25th of November 2005 [1,2]. We proposed to use Micro-Infrared spectroscopy, Micro-Raman spectroscopy, Energy Dispersive X-Ray spectroscopy, and FE-SEM imaging to measure not only elemental abundances and chemical characteristics of grains but also their charging properties. Four grains, RB-QD04-0083, RB-QD04-0072, RA-QD02-0136-14, and RA-QD02-0126-12, were competitively assigned to us for this project.

Ad-hoc sample holders have been designed to meet the constrains of this unique series of measurements. In preparation of measurements with actual Itokawa grains, validation of the grains attachment procedure, holder mounting and measurements chain have been carried out with 10 to 30 microns Fosterite grains. Micro-Raman measurements are performed at ESTEC with grains kept in the original JAXA containers using a confocal Micro-Raman spectroscopic system using an Ar ion laser beam at 514.5nm for excitation, and a long working distance objective. Micro-IR analysis will then be performed at INAF/ Osservatorio Astronomico di Capodimonte (OAC, Naples) in transmission mode in the range $7000\,\mathrm{cm}^{-1} - 600\,\mathrm{cm}^{-1}$ (spectral resolution $4\,\mathrm{cm}^{-1}$). A Quanta FEG 650 scanning electron microscope at low voltage beam is used to 1) observe the grains morphology and 2) map the steady state electrostatic potential at the grain surface subject to charging by the incident electron beam. The beam energy is varied between 500 eV and 2 keV at this stage, while the combination of FE-SEM images of the grain and underlying substrate and an electrostatic model of the charging occurring in the FE-SEM chamber allows to retrieve the grain surface potential distribution where the surface is not covered by the conductive glue. In addition, low voltage morphological observations are performed at OAC with a Zeiss Supra 25 equipped with an Oxford Inca Energy 350 with a Si(Li) INCA X-Sight detector followed by elemental analysis.

1 Fujiwara, A. et al, Hayabusa Mission to Asteroid Itokawa: In-Situ Observation and Sample Return, Dust in Planetary Systems, Proceedings, September 26-28, 2005 in Kaua'i, Hawaii. LPI Contribution No. 1280., p.50,
2 Yano, H. et al, 2006, Science, 312, 1350

Karstification processes on Titan and on Earth: Towards the age of Titan's landscapes

Thomas Cornet

Saturn's largest moon, Titan, is the only planetary body of the Solar System (with the Earth) able to bear liquids at its surface under the form of seas, lakes and rivers, as observed by the Cassini spacecraft instruments since 2006 in the polar regions. These landforms result from an active cycle based on methane (instead of water), involving condensation, precipitation and evaporation processes under Titan's cryogenic surface temperatures ($90\,\mathrm{K} - 95\,\mathrm{K}$). Polar lacustrine depressions (lakes and empty depressions) are typically a few tens to a few hundreds of kilometers in width and a few tens to a few hundreds of meters in depth. They seem to

grow by coalescence from small rounded depression towards irregularly lobated depressions. On Earth, such morphologies are typical of karstic depressions, developed thanks to surface or subsurface dissolution processes, generally in carbonate or evaporite-dominated bedrocks.

A simple approach based on the calculation of dissolution rates of minerals in liquid water under a given climate can be used to estimate rough formation timescales of terrestrial karstic features. This approach relies on three parameters: the solubility of solids in liquids (evaluated from thermodynamics and experiments), the density of solids and liquids (evaluated from thermodynamics and experiments), and the net rainfall rates (evaluated from climate records or modelling). We first tested this simple thermodynamics-climatic model on several terrestrial examples located under various climates. Then, we performed similar calculations for Titan's solid organic compounds (hydrocarbons, nitriles, tholins and ices) in Titan's liquids (methane and ethane).

On average, most of Titan's pure organic solids are quite soluble in Titan's liquids (carbonate-like to salt-like materials). We then assume a more likely scenario where Titan's surface is composed of a superficial layer of several organic compounds exposed to methane rainfalls. As emphasized by observations and climate modelling, these rainfalls are organized in sporadic but intense rainstorms occurring during the summer season only (a season spanning over 7 Earth years on Titan). Under these present conditions, a 100 meters-deep depression would form by dissolution in only a few tens of millions years at high polar latitudes, which is consistent with the presumed youth of Titan's surface

The Interplay of Hot Gas and Magnetic Fields in the Fireworks Galaxy NGC 6946

Matthias Ehle

The grand-design spiral galaxy NGC 6946 is remarkable due to its high star formation activity, its massive northern spiral arm and the "magnetic arms", visible in radio continuum polarization and located between the optical arms. Strong Faraday depolarization of the polarized radio emission from the disk indicates an extended halo of ionized gas around NGC 6946. We use X-ray observations of NGC 6946 performed with XMM-Newton to disentangle and characterize emission from point-like sources and extended hot gas from the disk, the "magnetic arms" and the halo. We are studying relations between thermal and magnetic energy densities in different regions, allowing us to start mapping the energy budget of NGC 6946.

Planet phase curves

Antonio García Muñoz

Planets reflect the stellar light incident upon them in specific ways that are informative about the structure and composition of their atmospheres and cloud covers. Indeed, planet phase curves, i. e. the signal integrated over the planet disk, enabled some of the earliest quantitative investigations into the solar system planets. These ideas are now beginning to be investigated in the nascent field of exoplanets. Foreseeably, the characterization of exoplanets

will depend on our capacity to unveil the planets' main atmosphere/cloud properties from their phase curves. It is thus important to have a clear understanding of the information content in exoplanet phase curves that can help us devise observation strategies and interpret future observations. In this talk, I will present some of my recent and ongoing work that goes along these lines. In particular, I will show how the combination of modeling and solar system planet observations can guide us to acquire that fundamental knowledge.

Update on the project for identification and classification of SSOs in Euclid Data

Pedro Gomez-Alvarez

As the Identification and classification of Solar System Objects (SSOs) in Euclid data has been officially approved as an ESA-driven science case for the Euclid project, an update of the recent developments in this science case will be presented. As part of the Euclid legacy science, we expect to detect and characterize $\sim 10^5$ Main Belt Asteroids (MBAs) and many other SSOs outside the main belt such as Centaurs, Trans-Neptunian Objects (TNOs) and Near Earth Objects (NEOs), as well as potentially planetary Trojans. As it is not mainly targeted on the Ecliptic Plane, the Euclid survey will focus on a relatively poorly explored discovery space, opening the possibility to potentially exotic and interesting discoveries.

Aggregate Results from the Venus Express Aerodynamic Drag Experiments

Emmanuel Grotheer

For the past 4 years, the Venus Express (VEx) mission has periodically conducted aerodynamic drag experiments (ADE). These ADE campaigns do not utilize a scientific instrument. Instead, the control signals from the attitude control system are used to derive the atmospheric density. As VEx approaches the pericenter of its orbit during an ADE, it is allowed to descend to an altitude of 165-190 km. During such passes, the spacecraft is commanded to maintain a 3-axis stabilized attitude. While VEx passes through Venus' upper atmosphere, the atmospheric constituents push on the two solar array panels. The solar arrays are purposefully rotated to asymmetric positions, due to which the atmosphere's push will induce a torque on the spacecraft as a whole. As a result, the attitude control system commands the reaction wheels to counteract this aerodynamic drag torque. Note that this does not include the recent aerobraking (AB) campaign from May to July 2014. During AB, the main focus was not the measurement of torques but rather an alteration of the spacecraft's orbit. Thus, the solar array panels were commanded into a symmetric mode, which also diminishes our ability to measure the torques due to atmospheric drag via this method. Over 170 ADE passes have been made, though this includes some test runs in the beginning, which did not use the more asymmetric rotation settings on the solar array panels. This asymmetry is needed to ensure that the atmospheric density can be measured via this technique. These datasets have been cleaned to reduce the noise present in the raw data. Thereafter, the results from the different passes were combined to form density maps versus different parameters, such as time, altitude, latitude and longitude. Here we will discuss these aggregate results, and their future inclusion in the Planetary Science Archive.

On the interactions between X-ray bursting neutron stars and the accretion discs surrounding them

Jari Kajava

Low-mass X-ray binary stars may consist of a neutron star (NS) and a low-mass companion star. When they are in close contact, matter from the companion star starts accumulating on the NS surface through an accretion disc. Once the matter settles on the NS surface, under certain conditions, rapid and unstable thermonuclear burning of helium and/or hydrogen may occur, which observationally looks like a burst of X-rays. A fraction of these X-ray bursts are so energetic, that the radiation pressure lifts the entire photosphere off the NS surface. These X-ray bursts can be used to measure NS masses and radii and, therefore, provide an indirect way of determining properties of ultra-dense matter found in the cores of NSs. In this talk I will present recent results where have shown that the cooling of NS atmospheres do not follow theoretical models during X-ray bursts when the X-ray binary is in the "soft" spectral state. Because the bursts cool as models predict in the "hard" state, we take this finding as evidence that the accretion flow influences the cooling of the NS photospheres during X-ray bursts. I will argue that changes in the accretion geometry between these two states can explain the data. I will also show how this finding affects NS mass-radius measurements. Finally, I will present our ongoing work, where we are using INTEGRAL data to study how X-ray bursts affect the accretion flow in the two spectral states.

Multi-Spacecraft Observations of Interplanetary Shocks Near Earth

Primoz Kajdic

Space observatories in orbit around the Earth have been continuously monitoring solar wind and interplanetary magnetic field for many years now. Among other things, they have also detected a large number of interplanetary (IP) shocks. IP shocks have therefore been observed with multiple spacecraft at separations ranging from several tens of km to several hundreds of Earth radii. Time delays between the shock detections at different spacecraft range from fractions of a second (Cluster) to about 20 minutes. Comparing observations of IP shocks at different locations in space can provide us with important insights on microphysical processes that take place near or within the shock transitions that are responsible for accelerating particles and the exciting different instabilities. We have compiled a database of about 80 IP shocks detected between the years 2001 and 2014 with Cluster, Themis, ACE, Wind and SOHO missions. In the first part of our research we calculated local normals of IP shocks by using different one-spacecraft methods and also the 4-spacecraft method, when possible. This is the first time that comparison of IP shock profiles is performed systematically on such small inter-spacecraft separations. This is possible primarily due to Cluster missions. We find that different spacecraft observed different shock profiles even in cases when the inter-spacecraft separations were smaller than 1000 km and the detection times at different spacecraft differed by less than a second. Finally we study the regions upstream and downstream of IP shocks – we analyze the properties of suprathermal particles and magnetic perturbations there.

PSF centroiding system on FPGA

Ralf Kohley

The aim of the talk is to describe a prototype of a PSF centroiding system developed with reconfigurable hardware (FPGA). Special emphasis has been placed on the system architecture, because this prototype can be the kernel of a larger scale, one suitable for adaptive optics.

The used algorithm has the potential to achieve a precision very close to the Cramer-Rao limit, which means that it is nearly optimal in terms of performance. Nevertheless, to be useful in adaptive optics it also needs a duty cycle of microseconds, reason for which the prototype is to be implemented in hardware.

METHOD

A full, embedded system will be developed using both new devices created from high level language synthesis and available IP cores. The use of pre-existing hardware devices as framework allows us to focus on the most important and specific part of the system, which is the hardware implementation that performs the centroiding algorithm.

This work receives SRE-OO Divisional Research funding and is still in progress. The current status is presented at this workshop.

Meteoroid fluxes determined with CILBO

Detlef Koschny

Using faculty funding, we have set up a double-station meteor camera observatory in the Canary Islands called CILBO. We now look back to about 1.5 years of operations with the full setup. We have used the observations to compute the meteoroid flux outside the atmosphere. The flux agrees well with previous models. For example, there is about one particle of 1 g mass in a cube of $1000 \times 1000 \times 1000\,\mathrm{km}^3$ in the Earth's vicinity.

The BeXRB outburst zoo

Peter Kretschmar

We present a catalogue of X-ray outbursts of 16 different Be X-ray binaries (BeXRBs) as observed by INTEGRAL-ISGRI and -JEM-X, CGRO-BATSE, RXTE-ASM, Swift-BAT, and MAXI. Such a a catalogue has not been published before, but is of relevance to the study of BeXRB outburst mechanisms and accretion physics. To obtain basic outburst properties in a consistent manner, all outbursts were fitted by a simple phenomenological model describing the outburst's long-term flux evolution. We find that a large fraction of all catalogued outbursts can be described well with this model. Some of the resulting parameters, such as the outburst length and the peak flux, show clear correlations for individual sources. The correlation coefficients, however, differ between the various BeXRBs, and are therefore specific properties of a system. To understand what determines these properties and how

they depend on other quantities of the binary, e. g. the orbital parameters or the neutron star's magnetic field, will improve our understanding of BeXRBs in the future.

Balloon-borne far-infrared polarisation mapping experiment (PILOT): status

René Laureijs

PILOT (Polarised Instrument for Long wavelength Observation of the Tenuous inter-stellar medium) is a balloon-borne astronomy experiment led by IRAP in Toulouse. PILOT carries a 1m class telescope with the ability to map polarized emission at 240 and 550 micron arising from dust grains in the diffuse interstellar medium. The observations will constrain the large scale geometry of the magnetic field in our Galaxy and provide the magnetic field alignment properties of dust grains. We are finalising a study to assess the straylight in the system, where we recommend the most practical design of the optical baffle of the telescope. We will present the status of the work done in ESTEC.

Disk evolution and planet formation studies with Herschel data

Bruno Merin

This contribution summarizes three papers prepared by our ESAC research group analyzing the Herschel PACS and SPIRE maps of nearby star-forming regions, obtained as part of the Gould's Belt Herschel Key Program. The first two papers are funded with department research funds and the third one by the ESAC trainee programme.

1) Ribas et al. (2014b, submitted) shows statistically for the first time that more massive stars loose their disks faster than low mass stars. This might explain the paucity of hot-Jupiter around high-mass stars and impose constrains on the global exoplanet population in the Galaxy.
2) Bustamante et al. (2014, submitted) analyzes the Herschel data of the young stars with disks in the Lupus region, provides their PACS and SPIRE point source fluxes and finds a number of new transitional disk candidates with large inner holes.
3) Rebollido et al. (2014, in prep.) analyzes the Herschel data of rho Ophiuchi, provides their PACS and SPIRE fluxes for all known objects and finds a new transitional disk in the region, optimal for ALMA follow-up.

All this investigations are a showcase of our current exploitation of the rich Herschel maps for star and planet formation studies.

The X-ray variability of HD 150136

Jean-Christophe Leyder

HD 150136 is a triple system harboring the nearest O3-type star. Its X-ray lightcurve shows variability, that could be due to the stellar winds colliding. The first X-ray observation of HD 150136 over an entire orbital period of 2.7 days was recently secured by our team, with

the main purpose of definitively identifying the origin of the X-ray variability. We will share the first results of our in-depth X-ray study of HD 150136.

Intermediate-mass black holes in globular clusters

Nora Lützgendorf

The study of intermediate-mass black holes is a young and promising field of research. If they exist, they could explain the rapid growth of supermassive black holes by acting as seeds in the early stage of galaxy formation. Formed by runaway collisions of massive stars in young and dense stellar clusters, intermediate-mass black holes could still be present in the centers of globular clusters, today. Our group investigated the presence of intermediate-mass black holes for a sample of 10 galactic globular clusters. We measured the inner kinematic profiles with integral-field spectroscopy and determined masses or upper limits of central black holes in each cluster. In combination with literature data we further studied the positions of our results on known black-hole scaling relations (such as $M - \sigma$) and found a similar but flatter correlation for intermediate-mass black holes. Applying cluster evolution codes, the change in the slope could easily be explained with the stellar mass loss occurring in clusters in a tidal field over its life time. Furthermore, I will present results from N-body simulations of globular clusters containing intermediate-mass black holes in a tidal field and their effects on mass-loss rates and remnant fractions as well as simulations on the accretion of IMBHs from surrounding stellar winds.

Fixing Planck Cosmology using 0.1 mm of XMM

David Lumb

Disturbing fact #1: There is an annoying tension in cosmological constraints reported by the Planck team between their SZ-selected cluster counts and Cosmic Microwave Background (CMB) temperature anisotropies. Disturbing fact #2: Nearly fifteen years after their launch, important effective area mis-calibrations between Chandra and XMM-Newton and between XMM instruments remain unresolved. I describe how heroic archaeology of stacks of old paper notes and application of legacy software leads to a suspicion that a large piece of metal may be 1/10th of a mm out of position. This may contribute in large measure to explaining away the aforementioned disturbing facts! This exercise also highlights the tensions involved in our daily work of Project Scientists worrying about TRLs, calibration vs. timely launch and maintaining long-lived mission knowledge base.

Wolf-Rayet Ring Nebulae Revisited

Anthony Marston

We present the conclusions of a study of the nature and morphology of nebulae associated with Wolf-Rayet stars in the southern galactic plane. Using the Southern Halpha Survey (SHS) imaging in narrow-band Hα and short-red wavelengths we perform difference image

analysis for 30 stars previously known to have associated nebulosity in their environments. The red subtracted images are then used to characterize the ionized gas morphology of the observed nebulae. The study has allowed us to go deeper over more extended fields than has been possible in past work. Previously undetected features are observed towards nebula, G2.4+1.4 associated with Wolf-Rayet star WR 102 plus extensive ejecta around the star WR 16. For G2.4+1.4, the emission profile in the Hα has been compared to those obtained in the infrared regime. Good feature correlation appears to be present at 24 µm and at 22 µm with the MIPSGAL and WISE survey, respectively. The carbon monoxide concentration map at 13 km s^{-}1 has been compared with the subtracted image and gives strong evidence of significant stellar material loss through earlier mass-loss phases of WR 102. Together with the presence of a HI bubble, this suggests that the structure of the observed nebula is closely related to the evolution of the central star, which is one of the very rare Wolf-Rayet stars with a WO subtype. A larger sample of southern galactic Wolf-Rayet stars have been surveyed to extend and/or confirm earlier digital survey work done in the 1990's. In our conclusions we revisit the nature of Wolf-Rayet ring nebulae in terms of their origins and classification.

Scale-integrated spectral characterisation of mineralogical analogues to Mars

Patrick Martin

The global picture of Mars surface environments is resolution-limited, and additional layers of spectral information available for terrestrial analogue sites may aid interpretation of orbital data. Hyperspectral visible-near infrared (400 nm – 2500 nm) datasets collected for six sites within the Rio Tinto basin in southern Spain document iron and sulfur-rich minerals associated with past and present-day river activities, spanning timescales from 2 Ma to ephemeral seasonal deposits. These sites show mineralogical similarities to locations on the surface of Mars as determined by orbital and lander datasets. We show how surface compositions of these materials are expressed in Vis-NIR data across different levels of spatial resolution; from laboratory spectra of materials returned from the study sites, to spectra collected in the field using an ASD field spectrometer, to orbital datasets collected using the Hyperion instrument onboard EO-1. Spectral interpretations were evaluated with respect to mineralogy of returned samples obtained from X-ray diffraction measurements. Our results show that ferric iron dominates the signal over all spatial scales for all sites studied, with a range of sulfate signatures emerging at laboratory to field scales. Fe^{3+} absorptions in astrobiologically relevant minerals such as hematite, goethite and jarosite were detected were detected at wavelengths of 350 nm – 950 nm in orbital data for deposits equal or greater than 30 m × 30 m (the extent of a single Hyperion pixel). Averaging out field spectra collected across each individual site provided a generalised picture of mineralogical differences between the sites in the absence of the wide atmospheric absorptions typical of terrestrial satellite datasets, revealing longer wavelength sulfate absorption features.

Exploring the position of Fe^{3+} absorption features within the averaged field spectra of older sites provided a means of exploring the state of mineralogical alteration, relating to age of the deposits. In younger field sites site averages revealed the dominant sulfate mineralogy as either jarosite or copiapite, influenced by seasonal effects within the deposits. Averaged field spectra were also utilised as targets for spectral searches within the Hyperion scenes, providing better

results than the use of pure library spectra alone and allowing us to map recent deposits of mineral mixtures of interest along the river. Incorporating well characterised laboratory samples into our study demonstrated at what spatial scale short-lived minor constituents such as schwertmannite and gypsum appeared, and identified minerals which were partially or entirely masked such as in the case of phyllosilicates or carbonates. Comparisons between mineralogical characterisation from laboratory Vis-NIR and XRD highlighted differences which arose between the two techniques. Scale-integrated studies of Rio Tinto materials demonstrate that orbital to field scale datasets can be used to probe the presence, distribution, alteration states and depositional contexts of ferric-iron mineral deposits relevant to Mars.

Observing naked-eye stars with Gaia, commissioning results and beyond

Juan-Manuel Martin-Fleitas

Gaia's bright magnitude limit for nominal operation has been extended from$G = 5.7$ to $G = 3.0$ thanks to an optimised configuration of the on-board observing algorithms. We have developed complementary targeted observations to observe stars with $G < 3.0$, thereby making Gaia astrometry complete at the bright end. We will present the performances obtained during the commissioning phase, discuss further improvements to these techniques and the remaining challenges related to the data analysis. We will outline the science cases enabled by these developments and show how they increase the mission's scientific output.

Cluster-SWARM: scientific objectives, 2014 data campaign and preliminary results

Arnaud Masson

The main purpose here is to highlight the new science enabled by the recent launch of the ESA SWARM mission, in conjunction with the Cluster mission. The SWARM mission launched in November 2013 is composed of three spacecraft orbiting Earth at around 450 km altitude. It is dedicated to the most detailed study of the Earth's core magnetic field. However, the measure of this magnetic field is perturbed by external electric currents flowing in the magnetosphere and the ionosphere. One of the SWARM prime scientific objectives is to investigate the influence of these currents, including the ring current and field aligned currents (FAC). To help disentangle their effects, special operations have been designed and coordinated with the ESA Cluster mission.

Cluster is a unique constellation of four satellites enabling the measure of these currents at higher altitudes, better than any previous mission. The complementarity of these two missions was foreseen at the beginning of the SWARM mission design, about 10 years ago. The 2014 special operations in support of SWARM is in other words a forward-looking idea becoming reality.

We will first briefly recall a few scientific highlights of the Cluster mission, related to the first measure of currents in space by a constellation of four satellites. We will then talk about the 2014 special operations designed and executed in support of SWARM. Finally, we will present

preliminary results and future opportunities of special operations that could be executed by Cluster in the years to come.

Herschel/PACS photometry of transiting-planet host stars with candidate warm debris disks

Bruno Merin

Dust in debris disks is produced by colliding or evaporating planetesimals, remnants of the planet formation process. Warm dust disks, known by their emission at < 24 micron, are rare (4 % of FGK main sequence stars) and especially interesting because they trace material in the region likely to host terrestrial planets, where the dust has a very short dynamical lifetime. Statistical analyses of the source counts of excesses as found with the mid-IR Wide Field Infrared Survey Explorer (WISE) suggest that warm-dust candidates found for the Kepler transiting-planet host-star candidates can be explained by extragalactic or galactic background emission aligned by chance with the target stars. These statistical analyses do not exclude the possibility that a given WISE excess could be due to a transient dust population associated with the target. Here we report Herschel/PACS 100 and 160 micron follow-up observations of a sample of Kepler and non-Kepler transiting-planet candidates' host stars, with candidate WISE warm debris disks, aimed at detecting a possible cold debris disk in any of them. No clear detections were found in any one of the objects at either wavelength. Our upper limits confirm that most objects in the sample do not have a massive debris disk like that in beta Pic. We also show that the planet-hosting star WASP-33 does not have a debris disk comparable to the one around eta Crv. Although the data cannot be used to rule out rare warm disks around the Kepler planet-hosting candidates, the lack of detections and the characteristics of neighboring emission found at far-IR wavelengths support an earlier result suggesting that most of the WISE-selected IR excesses around Kepler candidate host stars are likely due to either chance alignment with background IR-bright galaxies and/or to interstellar emission. `http://arxiv.org/abs/1409.0572`

MESSENGER disappearing dayside magnetosphere events: Evidence for severe dayside erosion and/or compression?

Helen Middleton

During northward passes over Mercury's dayside hemisphere the MESSENGER spacecraft normally enters the dayside magnetosphere before it descends to below ~ 500 km altitude. However, for some of these dayside passes the dayside magnetosphere is completely absent in the magnetometer (MAG) and Fast Imaging Plasma Spectrometer (FIPS) observations. During these "disappearing" dayside magnetosphere passes the MESSENGER measurements indicate that the spacecraft passed directly from the magnetosheath into the northern magnetospheric cusp and, finally, the high latitude nightside magnetosphere. The likely causes of these unusual events is severe reconnection-driven erosion and/or solar wind compression of the dayside magnetosphere, to the point where the closed field line dayside magnetosphere lies equator ward and/or below the orbit of MESSENGER. A survey of these disappearing magnetosphere events in the the MESSENGER observations is presented. The

hypothesis that these events are produced by extreme dayside magnetosphere reconnection and/or solar wind compression is tested using ENLIL predictions of solar wind conditions at Mercury orbit and analysis of the MESSENGER measurements in the cusp and high-latitude nightside magnetosphere.

Geometrical constraints on the origin of timing signals from black holes

Sara Elisa Motta

I will present the results of a systematic study of the effect of the orbital inclination on the fast time-variability properties of black-hole transients. I found that the amplitude of low-frequency quasi periodic oscillations (QPOs) depends on the orbital inclination. Type-C QPOs are stronger for nearly edge-on systems (high inclination), while type-B QPOs are stronger when the accretion disk is closer to face-on (low inclination). These results also suggest that the noise associated with type-C QPOs is consistent with being stronger for low-inclination sources, while the noise associated to type-B QPOs seems inclination independent. These results are consistent with a geometric origin of the type-C QPOs - for instance arising from relativistic precession of the inner flow within a truncated disk - while the noise would correspond to intrinsic brightness variability from mass accretion rate fluctuations in the accretion flow.

The opposite behavior of type-B QPOs – stronger in low inclinations sources – supports the hypothesis that type-B QPOs are related to the jet, the power of which is the most obvious measurable parameter expected to be stronger in nearly face-on sources.

3D Visualisation of Solar Data: Preparing for Solar Orbiter and Solar Probe Plus

Daniel Müller

The next generation of ESA/NASA heliophysics missions, Solar Orbiter and Solar Probe Plus, will focus on exploring the linkage between the Sun and the heliosphere. These new missions will collect unique data that will allow us to study, e. g., the coupling between macroscopic physical processes to those on kinetic scales, the generation of solar energetic particles and their propagation into the heliosphere and the origin and acceleration of solar wind plasma. Since 2010, NASA's Solar Dynamics Observatory returns 1.4 TB/day of high-resolution solar images, magnetograms and EUV irradiance data. Within a few years, the scientific community will thus have access to petabytes of multi-dimensional remote-sensing and complex in-situ observations from different vantage points, complemented by petabytes of simulation data.

Answering overarching science questions like "How do solar transients drive heliospheric variability and space weather?" will only be possible if the community has the necessary tools at hand. As of today, there is an obvious lack of capability to both visualise these data and assimilate them into sophisticated models to advance our knowledge. A key piece needed to bridge the gap between observables, derived quantities like magnetic field extrapolations and model output is a tool to routinely and intuitively visualise large heterogeneous, multidimensional, time-dependent data sets. As of today, the space science community is

lacking the means to do this (i) on a routine basis, (ii) for complex multi-dimensional data sets from various instruments and vantage points and (iii) in an extensible and modular way that is open for future improvements and interdisciplinary usage. In this contribution, we will present recent progress in visualising the Sun and its magnetic field in 3D using the open-source JHelioviewer framework, which is part of the ESA/NASA Helioviewer Project. Among other features, JHelioviewer offers efficient region-of-interest-based data streaming, metadata and event catalog integration, as well as an interface to access science-quality data. In addition to its usage by the solar physics community, JHelioviewer has already been successfully adapted for application in planetary sciences and medical imaging.

Part of this work has been funded by ESA RSSD/SSO/Science Faculty.

Short-period oscillations during nuclear burning on white dwarfs

Jan-Uwe Ness

X-ray observations of a small number of white dwarfs that host surface nuclear burning have revealed short-period transient oscillations. The fuel for nuclear burning is obtained via accretion from a companion star and can either happen steadily at the accretion rate or explosively after a history of accumulation of hydrogen-rich material on the surface of the white dwarf (aka nova outbursts). I have produced dynamical power spectra that graphically illustrate the time evolution of periodic signals for all XMM-Newton and Chandra observations of such systems and found 5 systems with clear modulation in the range 33 s – 67 s. I will present these maps and studies between period parameters. Further I discuss possible origins.

A homogeneous Transit Timing analysis with combined ground- and space-based photometry

Stefanie Raetz

The analysis of the timing variations of transiting exoplanets allows one to discover additional planets in the system. Such bodies can be very low in mass and radius, so that they remain undetected by transit or radial velocity methods.The CoRoT satellite looks back on six years of high precision photometry of a very high number of stars. Thousands of transiting events are detected from which 25 were confirmed to be transiting planets so far.

In my research I search and analyze Transit Timing Variations in the CoRoT sample and combine the unprecedented precision of the light curves with ground-based follow-up photometry. Because CoRoT can observe transiting planets only for a maximum duration of 150 days the ground-based follow-up can help to refine the ephemeris. First examples are presented here.

TrES-2 is one of the few exoplanets, which offers the unique possibility to combine long-term ground-based observations with continuous satellite data. The homogeneous analysis of 31 individual ground-based transits of TrES-2 together with 435 high-precision light curves of

the Kepler space telescope and 11 publicly available ground-based light curves is described as an example for the analysis of the CoRoT planets.

The Influence of Cluster Mergers on Galaxy Formation

Tim Rawle

Cluster mergers are the most massive dynamic processes in the Universe, yet their influence on the evolution of constituent galaxies remains poorly understood. I present detailed multi-wavelength analysis of the total star formation rate and morphology of galaxies within one spectacular cluster merger, the HST Frontier Field known as Pandora's cluster (Abell 2744). Examination of individual cluster galaxies reveals striking evidence for morphological transformation and enhanced star formation ("Jellyfish galaxies"), triggered by the passage of a merger-induced shock front. I also discuss the bulk star formation properties of the cluster in the context of the general population at intermediate redshift ($z \sim 0.2-0.8$), including well known examples of both relaxed and merging massive systems.

($< 1\,\mathrm{Gyr}$) and also with the general youth of karstic landforms on Earth.

Semi-Automatic Georeferencing of Astronaut Auroral Photography: Providing a New Dataset for Space Physics

Maik Riechert

Astronauts aboard the International Space Station (ISS) have taken tens of thousands of photographs showing the aurora in high temporal and spatial resolution. The use of these images in research though is limited as they often miss accurate pointing and scale information. In this work we develop techniques and software libraries to semi-automatically georeference such images, and provide a database and website of those images for the scientific community.

Aurora photographs very often include a visible starfield due to the necessarily long camera exposure times. We extend on the proof-of-concept of Walsh et al. (2012) who used starfield recognition software to reconstruct the pointing and scale information. Once the pointing and scale of an image are known, latitudes and longitudes can be calculated for each pixel corner for an assumed auroral emission height. Additional corrections are performed related to the lens distortion and the slightly inaccurate camera timestamps.

As part of this work, the open-source Python library AUROMAT is developed which automates the georeferencing process and aids in visualization tasks. A preliminary version of the database and website is publicly accessible and enables the community to provide feedback.

Through this work, georeferenced auroral ISS photography is made available as a continously extended and easily accessible dataset. This provides potential not only for new studies on the aurora australis, as there are few all-sky imagers in the southern hemisphere, but also for multi-point observations of the aurora borealis by combining with THEMIS and other imager arrays.

O stars in the Outer Galaxy

Kazi Rygl

It is in the less dense Outer Galaxy where Gaia can contribute much to stellar studies of the Galactic Plane. Using Herschel column density maps of the Galactic Plane we estimate the extinction in the Outer Galaxy and derive the farthest accurate Gaia astrometry for O-stars. As O stars are by definition young ($\sim$ Myr) objects their positions and kinematics can still be related to their formation site and history, making the Gaia O star astrometry an interesting complement to the radio maser astrometry of star-forming regions. We find that the Outer Galaxy extinction is such that Gaia astrometry will be able to transgress the Perseus arm.

Astrometric planet search around the faintest and the brightest stars

Johannes Sahlmann

Measuring the positions of nearby stars can inform us on the presence and properties of extrasolar planets around them, because planets induce an orbital reflex motion of the host star. I will first show results from an ongoing astrometric planet search around very low-mass stars using an 8-metre optical telescope. Second, I will discuss the potential for astrometric planet detection with ESA's Gaia mission and I will present a project that aims at exploiting this potential for the brightest stars in the sky.

A knowledge database of 9.5 Gyrs of evolution of galaxies in clusters: project presentation and current status

Miguel Sánchez-Portal

The Galaxy Clusters Group at ESAC is currently undertaking an ambitious project to trace the evolution of galaxies in clusters in the last 9.5 Gyr, i. e. from young clusters at $z \sim 1.5$ to mature, evolved clusters at low redshift. In particular, we aim to perform a robust characterization of the star formation properties of galaxies: how the SFR evolves with both the cosmic time and the local environment (e. g. cluster-centric distance or local density). To this end, two complementary approaches are being applied: on the one hand, the GaLAxy Cluster Evolution survey (GLACE), a deep optical survey of emission line galaxies in clusters at intermediate redshift is being implemented using narrow band Tunable Filters (TF) at the Spanish 10.4 m Gran Telescopio Canarias (GTC). And, on the other, a complete FIR imaging survey has been carried out using the PACS and SPIRE instruments on-board the Herschel Space Observatory, targeting several clusters at intermediate to high redshift (up to z$\sim$3 including some proto-clusters). Both surveys are producing an impressive wealth of data that is currently being processed and analysed, to be eventually put at the disposal of the scientific community. The final catalogue will include photometric or spectroscopic redshifts, line luminosities, IR luminosities, SFR and AGN properties, morphology, environmental properties, etc. The project has been approved to receive SRE-O funds, being endorsed by the ESAC Faculty. We report on the work performed since the official kick-off of the activity that took place on April, 23rd. Some science highlights are outlined.

Results of the Venus Express Aerobraking campaign

Håkan Svedhem

After a very successful mission orbiting Venus for more than 8 years, slowly the fuel is running out and the spacecraft will inevitably one day end up in the hot and acid atmosphere of the planet. Being near the end of the mission and in a position to accept some risk to the spacecraft we decided to take the opportunity to dip down deep into the atmosphere, to around 130 km, in a controlled manner, in order to make detailed in situ investigations of this for remote sensing instruments difficult to access region. The on board accelerometers gave direct measurements of the deceleration which in turn is directly proportional to the local atmospheric density. This provided an excellent way to study both the total density profile throughout the orbital arc in the atmosphere and small scale density variations in the region of the pericentre. The spacecraft behaved perfectly well throughout the whole campaign and provided a wealth of data both on the atmosphere and on the response of the spacecraft to the harsh environment with strong heat loads and some dynamic stress. At the time of the campaign the pericentre was located near the terminator at about 75 degrees Northern latitude. Aerobraking is a very efficient method of reducing the pericentre velocity and thereby reducing the apocentre altitude and the orbital period. The so called "walk-in" phase started at an altitude of 190 km on 17 May and the campaign ended on 11 July, after having reached a lowest altitude of 129.2 km. Subsequently, a series of orbit control manoeuvres lifted up the pericentre to 460 km altitude and the science activities were resumed after a thorough check-out of the spacecraft. We have detected a highly variable atmosphere, both on a day to day basis and within the individual pericentre passes. The duration of each pass was approximately 100 s and the maximum dynamic pressure achieved was more than $0.75\,\mathrm{N/m^2}$, probably a record for a spacecraft that continued its operation afterwards. The orbital period was reduced over the duration of the campaign changing from 24 hours to 22 hours 20 minutes.

Cloud level winds from the Venus Express observations

Dmitrij Titov

Dynamics of the Venus atmosphere is one of the vividly evolving areas of the planetary sciences. The Venus Monitoring Camera onboard Venus Express provided a long-term series of UV observations (2006-2014) of the upper cloud of Venus thus covering about 13 Venusian years. The UV images enable a study of the cloud level circulation by tracking motion of cloud features. Total number of wind vectors derived from the images exceeds half a million. The mean circulation at the cloud tops was established including mean zonal and meridional wind fields, long-term and diurnal trends, orbit-to-orbit variations and short term periodicities. Low and middle latitudes show almost constant with latitude zonal wind speed of $90(20)\,\mathrm{m/s}$ at the cloud tops and vertical wind sheer of $2\,\mathrm{m/s/km} - 3\,\mathrm{m/s/km}$. Towards the pole, the wind speed drops quickly and the vertical shear vanishes. The meridional poleward wind ranges from $0\,\mathrm{m/s}$ to about $15\,\mathrm{m/s}$ and there is some indication of that it may change its direction at high latitudes. The global zonal circulation converges to giant vortices at the poles. The VMC observations indicate a long term trend for the zonal speed at low

latitudes to increase from 85 m/s in 2006 to 107 m/s by the end of 2013. The observations also demonstrated clear diurnal solar related dependences with maxima of the zonal speed at 8 – 9 h and 16 – 17 h. The meridional wind component peaks in the early afternoon (13 – 15 h) at around 50 °S latitude. Comparison of the cloud tracked winds with the thermal wind field derived from the temperature sounding confirms approximate validity of cyclostrophic balance at least in the middle latitudes. The observations are supported by development of General Circulation Models.

Study of the ionosphere of Mars: a new approach for data analysis

Olivier Witasse

Radio-occultation and radar sounding are two very useful methods to study the ionosphere of Mars. With Mars Express in particular, a huge amount of data acquired with these two techniques is now available. The data processing tools used to obtain the electron density are based on the resolution of a complex inverse problem. The solution to such a problem is obtained under assumptions which limit the domain of validity of the techniques. For example, in the case of radio-occultation data, one has to assume that the atmosphere is spherically symmetric. In the case of the radar sounding, the retrieval technique absolutely requires the knowledge of the local electron density, which is not always possible to measure. I will discuss here a new analysis method based on a direct approach which overcomes the difficulties related to the standard data inversion. This new method is based on a numerical model of the atmosphere and the ionosphere of Mars computing the propagation of the radio waves in the case of radio-occultation (signal frequency of a few GHz) and radar sounding (few MHz). I will show the results of this novel method.

Study of Solar Corona with data from MEX, VEX, Rosetta, and Messenger

Joe Zender

Remote radio-sounding of the solar corona is complementary to in-situ measurements and imaging. The purpose of radio science in the context of ESA's existing missions such as Mars Express (MEX), Venus Express (VEX) and Rosetta consists in benefiting from the communication system of the spacecraft to get the opportunity to learn more about the structure and dynamics of the outer atmosphere of the sun. The interaction of the coronal plasma with the radio signals received and emitted by the spacecraft during a solar conjunction leads to a frequency shift that can be measured and processed to retrieve the temporal variations of the electron content in the corona at a given heliocentric distance. By combining imaging data from LASCO and/or SWAP instruments with radio science data from MEX, VEX or Rosetta, good correlations can be made between radio science data and events occurring in the corona like streamers or Coronal Mass Ejections. If radio data carry the signature of CMEs, we will see that they also can be useful to determine some of their features such as their speed in function of the distance from the sun. Movies gathering pictures from the sun and variations of the electron density deriving from radio data will be shown to illustrate those correlations.

Probing the inner heliosphere and solar corona with electric antennas: quasi-thermal noise spectroscopy on Solar Orbiter and Solar Probe Plus

Yannis Zouganelis

Solar wind electrons are expected to play an important role for energy transport in the solar corona and wind. Solar wind electron velocity distributions exhibit three components: a thermal core, a suprathermal halo, and a magnetic field aligned strahl, which is usually moving away from the Sun. The origin of these non-thermal distributions is unknown. Are such distributions already present in the solar corona or are they only a consequence of the solar wind transport in the interplanetary medium? The answer to these questions is of paramount importance to understand the origin of the solar wind. It requires accurate in situ measurements of the electron properties. Traditional electron analysers generally suffer from spacecraft charging and photoelectron perturbations, but the alternative method of Quasi-Thermal Noise Spectroscopy (QTN), which has been successfully used in various space plasma environments, is immune to these limitations. This method is based on the electrostatic fluctuations induced by the thermal motion of the ambient plasma particles, which can be measured with a sensitive radio wave receiver connected to a wire dipole antenna. As this quasi-thermal noise is completely determined by the particle velocity distributions in the frame of the antenna, QTN is a high-accuracy robust method for determining electron moments together with some non-thermal features. After a short review of the QTN method, we describe its recent developments and how it will be implemented on the upcoming missions Solar Orbiter and Solar Probe Plus. New simulations of QTN measurements in the inner heliosphere are presented for typical expected corona, solar wind and ICMEs conditions down to 9.5 solar radii.

Posters

Broad Strokes Across Time Domain Astronomy

Guillaume Belanger

Time domain astronomy concerns itself with the study of the temporal properties of astrophysical sources. In this day, astronomy and astrophysics are subdivided into a wide range of fields and subfields that distinguish themselves from one another mostly based on the instrumentation and everything that stems from that, but also on the science topics that can be addressed and thus of interest in a particular branch. The expression "time domain astronomy" is, for this reason, understood differently by different people working in different areas. In this paper we approach time domain astronomy as seeking to characterise one of three things – constancy (or transience), periodicity, and intrinsic variability – and present methods to treat and explore the data based on the statistical likelihood. For each of these three facets of time domain astronomy, examples are taken from different branches and wavelength scales, from ground-based radio and near-infrared (VLA and VLT) telescopes, to X-ray and γ-ray (XMM-Newton and INTEGRAL) observatories. We show how a range of different methods, whose shared fundamental characteristic is the use of the statistical framework of likelihood analysis, can be applied with different aims to different kinds of data in different branches of astronomy to explore the properties of the data in the time domain.

Identification of new transitional disks in Lupus with Herschel

Ignacio Bustamante

Context. New data from the Herschel Space Observatory are broadening our understanding of the physics and evolution of the outer regions of protoplanetary disks in star forming regions. In particular they prove to be useful to identify transitional disk candidates. Aims. The goals of this work are to complement the detections of disks and the identification of transitional disk candidates in the Lupus clouds with data from the Herschel Gould Belt Survey. Methods. We extracted photometry at 70, 100, 160, 250, 350 and 500 micron of all spectroscopically confirmed Class II members previously identified in the Lupus regions and analyzed their updated spectral energy distributions.

Results. We have detected 33 young disks in Lupus in at least one Herschel band, from an initial sample of 123 known members in the observed fields. Using the criteria defined in Ribas et al. (2013) we have identified six transitional disk candidates falling in the region, out of which five are new. Their PACS-70 micron fluxes are systematically higher than those of normal T Tauri stars, as already found in T Cha and in the transitional disks in the Chamaeleon molecular cloud.

Conclusions. Herschel efficiently complements mid-infrared surveys for identifying transitional disk candidates and confirms that these objects seem to have substantially different outer disks than the T Tauri stars in the same molecular clouds.

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Titan's surface as seen from the Cassini Visual and Infrared Mapping Spectrometer (VIMS)

Thomas Cornet

The Visual and Infrared Mapping Spectrometer (VIMS) is the imaging spectrometer of the Cassini spacecraft, orbiting in the Saturn system since 10 years now and regularly performing flybys of Titan. VIMS is able to image Titan at 352 wavelengths comprised between 0.3 and 5.1 micrometers. However, due to the presence of methane (1 % – 5 %) in the atmosphere, Titan's surface is only visible at a few wavelengths called atmospheric windows in the infrared, where the atmospheric transmission is the highest, and centered at 0.93, 1.08, 1.27, 1.59, 2.01, 2.7 – 2.8 and 5 microns. Despite the view of the surface in these windows, the derivation of surface properties (and mainly the surface albedo) is not straightforward. Photodissociation processes taking place in atmosphere result in the production of a thick haze (aerosols or tholins) responsible for intense scattering effects at wavelengths shorter than 3 microns. Besides, the signal-to-noise ratio in the atmospheric scattering-free 5 microns window is very low. Finally, due to the variable viewing geometry between each flyby, surface and atmospheric photometric effects are amplified at all wavelengths between each observation of Titan. We are currently investigating simple and fast empirical methods, alternative to complex radiative transfer models still under development, in order to reduce the atmospheric scattering and absorption effects as well as surface photometric effects with the aims at constraining at least locally Titan's surface optical properties.

Tracing lee waves above the Madrid area – a pilot study of stereoscopic imaging of clouds, to better understand and predict these atmospheric effects

Sebastian Els

N. Cheek, T. Lock, J. FleitasThe region of Madrid is prone for the occurrence of lenticular clouds. Those are typical indicators of the presence of atmospheric waves on the lee side of mountain ranges. To quantitatively assess and monitor the spatial behaviour of such waves, a pilot study has been started in early 2014 at ESAC to conduct a stereoscopic monitoring of clouds above the region East of ESAC. Using two off the shelf cameras, which are mounted with a few kilometers distance and having largely overlapping field of views, it is aimed to determine the location and altitude of clouds in the common field of view of the cameras. In this poster we show the experiment setup, data taking, as well as a number of example images demonstrating the potential of such stereoscopic cloud monitoring.

Observing transiting exoplanets with JWST/NIRSpec

Pierre Ferruit

S. Birkmann, G. Giardino, J. Valenti, B. Dorner and the ESA JWST team

Recent publications resulting from observations conducted with the Hubble Space Telescope

(HST) have highlighted the diagnostic power of near-infrared spectroscopy for the study of the atmospheric properties of transiting exoplanets. In this context, we give a preview of the (future) capabilities of the near-infrared spectrograph NIRSpec on board JWST. For transit spectroscopy, NIRSpec will offer an aperture spectroscopy mode covering the 0.6-5.3 micron spectral domain with 3 ranges of spectral resolution (R 100, 1000 and 2700). The predicted noise floor (photon noise and detector noise only, no systematics included) is lower than 100 ppm for a single 1-hour in-transit observation of a 7th magnitude star, indicating that transit spectroscopy programs with NIRSpec will routinely have photon-noise limited noise floors of a few tens of ppm. In terms of brightness limits, at high spectral resolution, NIRSpec will be able to observe planets transiting stars with J-band magnitudes up to 6.5 in the worst case and 4.5 in the best case.

Exo-planets observations: the contribution of pointing instability and detector intra-pixel sensitivity to NIRSpec noise budget

Giovanna Giardino

The JWST near-infrared spectrometer NIRSpec has the capability to observe the atmospheric features of a super-Earth/sub-Neptune planet, transiting a nearby star, with unprecedented sensitivity. In terms of shot- and read-noise only, a spectrum with S/N better than 2000 (per spectral element) can be obtained for a star with J-band magnitude brighter than 12, in one hour of integration (at a resolution of 1000). However, one source of additional systematic noise will be due to the interplay of the telescope pointing instability and the intra-pixel sensitivity of NIRSpec detectors. Here we present a preliminary analysis showing that for a predicted long-term telescope pointing instability smaller than 7 mas (1-sigma), typical intra-pixel sensitivity variations would result in a systematic noise component of about 0.04 % of the signal level. This is a significant component but not one that undermines NIRSpec's potential to deliver ground-breaking observations of exoplanets.

Recognition of Cluster bow shock crossings

Tomasz Kłos

The purpose of Cluster mission is to study the small-scale structures of Earth's plasma environment. The four Cluster spacecraft, each equipped with 11 scientific instruments, fly in formation separated by few tens to 10 000 kilometers. The Cluster spacecraft provide a 3-dimentional data of, among others, bow shock, magnetopause, polar cusp and auroral zone regions. The bow shock is a collisionless shock front formed due to the supersonic solar wind stream hitting the Earths magnetic field. As a result, the supersonic solar wind is rapidly decelerated, being subsonic in the downstream side of the shock, called the magnetosheath. The nature of the bow shock and the regions upstream and downstream of the bow shock depends strongly on the direction of the interplanetary magnetic field with respect to the local normal of the bow shock.

A spacecraft leaving solar wind region and entering magnetosheath (and vice versa) detects sudden changes in total magnetic field and electron and ion densities and velocities, among

other parameters. Most parameters, although changing at the shock front, do not change in any consistent manner that they could be used for the automatic detection of the shock. There are two main difficulties in detecting the bow shock crossings. Firstly, the sudden jumps don't occur at exactly the same time in all physical parameters. They can be separated by up to a few minutes. The second difficulty comes from the fact that solar wind is much faster than the spacecraft itself (400 km/s on average compared to around 3 km/s). As a consequence, even a small change in solar wind velocity causes the bow shock to move with high speed. This results in multiple crossings within one orbit and, quite often, within a couple of minutes.

The algorithm developed in the CAA searches for the bow shock crossings by identifying sudden jumps in data from six variables coming from four instruments. If these jumps occur at approximately the same time in at least 3 variables, a bow shock crossing is detected. Some additional checks are performed to ensure consistency of the results. A GUI application has also been developed to provide an easy method for manual corrections of the detected boundaries.

Gaia astrometry for stars with too few observations – a Bayesian approach

Uwe Lammers

The astrometric solution for Gaia needs to determine at least five parameters for each star, representing its position, parallax, and proper motion. This requires at least five distinct observations per star. In the early data reductions the number of observations may be insufficient, and even after the full mission there will be some stars (e. g. variables, supernovae) that could be under-observed.

We need a general recipe to handle such stars. It should allow all five astrometric parameters to be determined and provide formal error estimates that correctly characterize the solution. The aim here is to explore how our current knowledge of the Galaxy can be used to constrain the range of parallaxes and proper motions in an astrometric solution leading to a more stable solution with better error estimates.

The expected distribution of parallaxes and proper motions is derived from the Gaia Universe Model Snapshot (GUMS) and incorporated as prior information in the Astrometric Global Iterative Solution (AGIS) using Bayes' rule. We simulate Gaia observations and their processing in AGIS to demonstrate the feasibility of the approach.

The Bayesian approach allows us to obtain a sensible five parameter astrometric solution with as little as three Gaia observations per star. Although the posterior error distribution may be far from Gaussian in such cases, we find that it is always possible to derive realistic error estimates, for example in the form of 90% confidence intervals. We give a simple analytical expression to compute a suitable prior as a function of apparent magnitude and Galactic coordinates, based on GUMS statistics. As more Gaia observations are accumulated the results become increasingly independent of the prior. Eventually, stars with sufficient information need to be processed without a prior in order to avoid the risk of introducing biases.

Upcoming ESA Ground Segments

William O'Mullane

A poster with a short overview of the seven missions in development.

A knowledge database of 9.5 Gyr of evolution of galaxies in clusters

Irene Pintos Castro

The Galaxy Clusters Group at ESAC is currently undertaking an ambitious project to trace the evolution of galaxies in clusters in the last 9.5 Gyr, i. e. from young clusters at $z \sim 1.5$ to mature, evolved clusters at low redshift. In particular, we aim to perform a robust characterization of the star formation properties of galaxies: how the SFR evolves with both the cosmic time and the local environment (e. g. cluster-centric distance or local density). To this end, two complementary approaches are being applied: on the one hand, the GaLAxy Cluster Evolution survey (GLACE), a deep optical survey of emission line galaxies in clusters at intermediate redshift is being implemented using narrow band Tunable Filters (TF) at the Spanish 10.4m Gran Telescopio Canarias (GTC). And, on the other, a complete FIR imaging survey has been carried out using the PACS and SPIRE instruments on-board the Herschel Space Observatory, targeting several clusters at intermediate to high redshift (up to z$\sim$3 including some proto-clusters). Both surveys are producing an impressive wealth of data that is currently being processed and analysed, to be eventually put at the disposal of the scientific community. The final catalogue will include photometric or spectroscopic redshifts, line luminosities, IR luminosities, SFR and AGN properties, morphology, environmental properties, etc. The work in the cluster RXJ1257 at redshift $z = 0.866$ represent the potential of the data provided by these two surveys. We have found that FIR and [OII] emitters, i. e. star-forming galaxies, are predominant at intermediate density (outskirts/group environment) even although the two sample do not trace the same star-forming population (they do not overlap completely). We concluded that this young massive cluster is still under the process of formation, with a filamentary-like structure and many sub-structures still merging.

HROES: A caTalogue of HeRschel Observations of Evolved Stars (PACS Spectroscopy)

Jesus Ramos-Medina

In this project, we carry out a comprehensive and systematic study of the far infrared (FIR) properties of low- and intermediate-mass evolved stars using Herschel archival data with the ultimate goal of better understanding the important physical processes and dramatic chemical and morphological changes that take place in these stars at the end of their evolution. In particular, we concentrate our analysis on the spectroscopic information obtained by Herschel/PACS in the 55-210 micron range on more than 200 sources, a total of 546 observations now publicly available in the Herschel Science Archive (HSA).

Identifying new transitional disks in Ophiuchus with Herschel data

Isabel Rebollido Vázquez

Context: The data from the Herschel Space Observatory of nearby star-forming regions allows to identify new transitional disk candidates, which are disks with inner holes that may be produced by the formation of planets or substellar companions.

Aims: The main goal of this project is to identify new transitional disks in the region of ρ-Ophiuchi with data from the Herschel Gould Belt Survey Key Programme, which was obtained mainly with other objectives.

Methods: By extracting photometry with the PACS instrument at 70 μ m and 160 μm and with SPIRE at 250 μm,350 μm and 500 μm we analyzed the spectral energy distribution of all the Class II objects previously identified in the region, and applied a slope-slope diagram to identify transitional disks.

Results: From an initial sample of 258 objects, we have detected up to 30 disks in the ρ-Ophiuchi region in at least one band. From those, at least one of them is a new transitional disk candidate. We also can confirm the trend seen in other regions as Chameleon and Lupus of higher PACS 70 μm fluxes observed for transitional disks, as compared with the other disks in the region.

Conclusions: The Herschel data provides a good means to identify new transitional disk candidates in nearby star forming regions.

Protoplanetary disk lifetimes as a function of stellar mass and possible implications for giant planet populations

Álvaro Ribas

Aims. We study the dependence of protoplanetary disk evolution with stellar mass using a large sample of Young Stellar Objects (YSO) in nearby young star-forming regions. Methods. We update the protoplanetary disk fractions presented in Ribas et al. (2014, paper I of this series) derived for 22 nearby (< 500 pc) associations between 1 Myr and 11 Myr. We use a subsample of 1428 spectroscopically confirmed members from eleven of these association to study the impact of stellar mass on protoplanetary disk evolution. We divide this sample in two stellar mass bins (1.5 $M_\odot$ boundary) and two age bins (3 Myr boundary), and use infrared excesses over the photospheric emission to classify objects in three groups: protoplanetary disks, evolved disks, and diskless. The homogeneous analysis and bias corrections allow for a statistically significant inter-comparison of the obtained results.

Results. We find robust statistical evidence of disk evolution dependence with stellar mass. The fraction of protoplanetary disks decreases with time, but also shows a dependence with stellar mass. Our results, combined with previous studies on disk evolution, confirm that protoplanetary disks evolve faster and/or earlier around high-mass ($> 1.5\,M_\odot$) stars. We also find a roughly constant level of evolved disks throughout the whole age and stellar mass spectra.

Conclusions. We conclude that protoplanetary disk evolution depends on stellar mass. Such a dependence could have important implications for gas giant planet formation and migration, and could contribute to explain the apparent paucity of hot Jupiters around high-mass stars.

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The Herschel Dynamic Mode of High-Mass Star Formation and Evolution

Alana Rivera Ingraham

High-mass OB stars are key for determining the state and evolution of structures ranging from Galactic scales to planetary systems. However, the formation and early evolution of these stars and their associated massive clusters remain poorly constrained. Here I present the work being carried out on the so-called 'Dynamic Mode' of High-Mass Star Formation, the only process so far capable of addressing all major theoretical challenges in this area. This new Herschel-based project, being developed at ESAC in collaboration with various international Herschel Programmes, makes use of the latest multi-resolution continuum techniques in order to create the most complete observational model based on examples of "dynamic feeding" in our Galaxy. The model will constrain theoretical simulations focusing on the earliest stages of high-mass star and cloud/filament evolution. I will also describe the implications and relevance of this work for the exploitation of Herschel data and future upcoming missions.

A model for soft X-ray flares from AGN

Richard Saxton

A handful of persistent Active Galactic Nuclei (AGN) have exhibited X-ray flares which reach factors of 100 s higher than previous quiescent measurements. The black hole mass in these sources is invariably low, less than a few times 10^6 solar masses, and the X-ray spectrum unusually soft, indicating thermal emission with $T = 10^5\,\mathrm{K} - 10^6\,\mathrm{K}$ and/or comptonisation by a low-energy electron population. We look at some basic accretion disk physics to identify mechanisms which may be responsible for these events.

Forecast of predictability in galactic models

Juan C. Vallejo

The predictability of a system indicates how much time a computed orbit is close to an actual orbit of the system, independent of its stability or chaotic nature. We derive a predictability index from the distributions of finite-time Lyapunov exponents of several prototypical orbits, both regular and irregular, in a variety of galactic potentials. In addition, by analysing the evolution of the shapes of the distributions with the finite-time intervals sizes, we get an

insight into the timescales of the model when the flow dynamics evolve from the local to the global regime.

boloSource() for the analysis of diffuse emission and crowded-field photometry

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An extraordinary feature exhibited by the Herschel maps of star forming complexes is the ubiquitous pattern of filaments never seen before in the far-infrared down to 6 arcseconds spatial resolution. Morphological and complexity analysis of large fields is essential to understand the link between diffuse ISM structure and ebedded star formation (SF). Preserving statistical properties of the diffuse background while a large number of "disturbing" foreground- and embedded sources are present is a non-trivial task. Source-free clean maps provided by the novel boloSource() package enable us to study the spatial properties of background emission not being biased by the sharp fingerprint of embedded features. The boloSource() algorithm works on the flux calibrated Herschel/PACS detector timeline, it aims to separate sky signal from detector 1/f noise and applies an adaptive interpolation method which simulates the power spectrum of instrument noise reconstructed from the observation itself. These interpolated source-free timelines are re-projected onto a map using inversion algorithms standard for Herschel data processing (e. g. JScanam, Unimap, Scanamorphos). Besides the good quality of point-source subtracted maps, the boloSource algorithm provides an alternative way of source photometry in crowded fields, and can mitigate the impact of reconstruction artifacts of mapping algorithms.