SRE Inter-Departmental Science Workshop

23-25 November 2011

Toledo, SPAIN

ABSTRACT PROGRAMME

Organising Committee:
Alba Alcol
Jean Clavel
Nick Hanowski
Patrick Martin
Olivier Witasse

Herschel's Far-infrared and Sub-millimetre View of Ongoing Star Formation in the Eagle Nebula (M16)

A.P. Marston[1], G. White[2,3], T. Hill[4], F. Motte[4] and the HOBYS consortium

[1] Herschel Science Centre, ESAC, 28691 Villanueva de la Cañada, Madrid, SPAIN

[2] Department of Physics and Astronomy, The Open University, Milton Keynes, UNITED KINGDOM

[3] The Rutherford Appleton Laboratory, Chilton, Didcot, OX11 0NL,UNITED KINGDOM

[4] Laboratoire AIM, CEA/IRFU CNRS/INSU Universit´e Paris Diderot, CEA-Saclay, 91191 Gif-sur-Yvette Cedex, France

The M16 (Eagle nebula) region is a classic star forming region containing a large number of known young stellar objects (YSOs) and the young stellar cluster, NGC6611. The region contains significant dust and gas that appears shaped by interactions with newly-formed stars. We present analysis of new Herschel Observatory images of an area of 1.5 x 1.5 degrees at five far-infrared wavelengths between 70 and 500 microns. Combining the data in the images we are able to reveal the distribution and nature of the small source (clumped) emission as well as the large-scale structure of the cool dust materials in the region. Maps at multiple infrared wavelengths are used to reveal the general dust temperature variations across the region and density of dust. We also extract the multi-wavelength fluxes for clumps of far-infrared/sub-millimetre emission in the field using a multi-resolution analysis technique, since the resolution of the images varies by a factor of eight over the wavelength range considered.

We show that gas and dust is strongly aggregated into shells and filaments, including the famous pillars of the M16 region. Approximately 1370 clumps are revealed with many only being visible at the longer wavelengths, indicating very cold starless cores and class 0 sources. Source clumps are associated with the strongly emitting, more filamentary structures of M16, with the coolest clumps being more embedded within the densest regions. Typically the Herschel sources are of class 0 and I and therefore the very earliest phases of star formation.

Chamaeleon I: Cores and Cold Disks with Herschel

E. Winston1, L. Spezzi2, T. Prusti1, B. Merin3, A. Ribas3, P. Royer4, N. Cox4, R. Vavrek3, P. Andre5 and the Herschel Gould Belt consortium

1 ESA-ESTEC, Noordwijk, The Netherlands., 2 ESO, Garching bei Munchen, Germany., 3 ESA-ESAC, Madrid, Spain. 4 Catholic University of Leuven, Leuven, Belgium. 5 CEA Saclay, France

The Herschel Gould Belt survey of nearby star forming regions is providing great insights into the early stages of the formation and evolution of stars and their disks. The Chamaeloen I region consists of a North and a South cluster which is itself subdivided into two groups. The PACS and SPIRE observations clearly show that the young stars are forming coincident with the filaments of cold dust and gas. The Herschel detected YSOs are located in the three known clusters. Using the getSources routine developed in Saclay especially for Herschel data, we have detected 73 sources over the five available PACS and SPIRE bands, of which 37 are previously identified YSOs and the remainder are candidate prestellar cores and dense filamentary structures. We will present comparisons with the Spitzer observations and model fits to the identified sources to determine the fraction of protostars and their distribution across Chamaeleon I.

LYRA Occultation Data Analysis in Search for Ablation Signals from the GEMINID meteor shower 2010

J. Zender[1], D. Koschny[1], A. Knoefel[2], F. Bettonvil[3], M. Dominique[4]

1. ESA/ESTEC/SRE-OS+SRE-SO
2. International Meteor Organization, Am Observatorium 2, D-15848 Lindenberg
3. University of Utrecht, Astronomy Institute
1. Royal Observatory of Belgium, Brussels

The PROBA2 spacecraft is undergoing an occultation period once every year from October to January. The Large Yield Radiometer (LYRA) on-board PROBA2 is commanded such that one occultation per day is observed using two out of the three units of the instrument.

During the Geminid meteor shower in December 2010, a combined campaign at the Andoya Rocket Range, Norway, obtained meteor related data in various ways:

- ECOMA Experiment: 3 rocket flights, before - during - after the predicted meteor peak measured the meteoric dust particles;
- Radar Experiment: Middle Atmosphere Alomar Radar System (MAARSY) measured the head-echos of the meteors and derive location and velocity
- Visual and spectral on-ground observations.

We present the retrieval of instrument and ancillary data from the PROBA2 archive from October 2010 to January 2011. The data are reformatted to obtain the atmospheric response over Earth altitude over time. The data is analyzed for changes in the response at altitudes from 40 km to 80 km and compared to the meteor fluxes from the visual meteor observations.

Constraining the luminous efficiency of meteors

D. V. Koschny[1], M. Gritsevich[2] SRE-SM, [2]Inst. Of Mech. Moscow State Univ.

Fireballs are very bright meteors, which are produced by meteoroids in the size range of centimeters to decimeters. Their detailed size and number distribution in the Earth's vicinity is still poorly constrained. To better understand these parameters, one can model the light production of the meteoroid as it enters the atmosphere and compare it with measured data (see e.g. Campbell-Brown and Koschny 2004). An alternative solution is to model the deceleration of the meteoroid (e.g. Gritsevich 2007).

We have developed a new analytical dependence of the meteor's brightness on its initial conditions, taking recent results in fireball aerodynamics into account. This dependence shows that the fireball luminosity in general is proportional to the body pre-entry mass value, its initial velocity to the power of 3, and the sine of the slope between the horizon and the trajectory. From these studies, we can better constrain one of the important questions of meteor physics, namely which fraction of the fireball kinetic energy is transformed into light during the meteoroid's entry in the atmosphere.

In this presentation we will give an overview of the used approach. To illustrate the results, we compare the measured meteor luminosity of some fireballs from the fireball database of Halliday et al. 1996 (the so-called MORP database) to our model results, see e.g. Figure 1, showing the validity of the approach. This work has been published recently in Icarus, see Gritsevich and Koschny 2011.

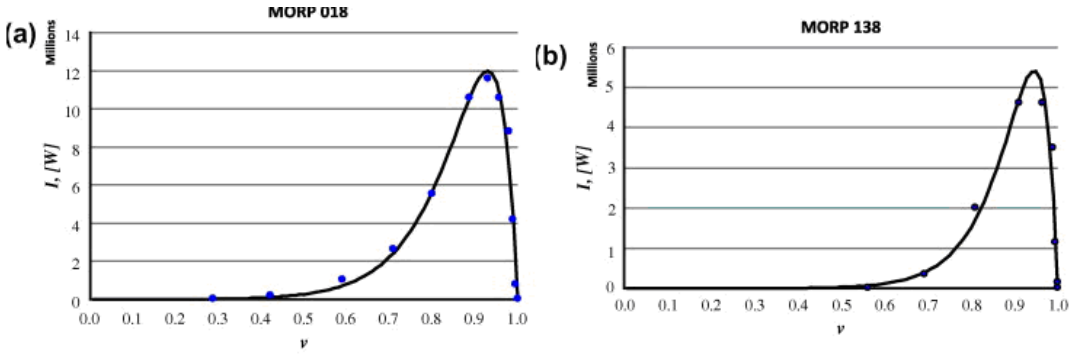


Figure 1: Brightness of two fireballs from the MORB database - black line = measurement, blue dots = our model.

References

Campbell-Brown, Koschny (2004), Model of the ablation of faint meteors. Astron. Astrophys. 418, 751-758.

Gritsevich (2007), Approximation of the observed motion of bolides by the analytical solution of the equations of meteor physics. Solar Syst. Res. 41 (6), 509-514.

Gritsevich, Koschny (2011), Constraining the luminous efficiency of metoers. Icarus 212, 877-884.

Halliday, Griffin, Blackwell (1996). Detailed data for 259 fireballs from the Canadian Camera Network, Meteorit. Planet. Sci. 31, 185-217.

Measuring Gravity with an Atom Interferometer

L. Cacciapuoti *, Y. H. Lien, G. Rosi, M. Prevedelli #, F. Sorrentino, and G. M. Tino

Department of Physics and Astronomy, University of Firenze, 50019 Sesto Fiorentino, Italy
European Laboratory for Nonlinear Spectroscopy (LENS), 50019 Sesto Fiorentino, Italy
Istituto Nazionale di Fisica Nucleare (INFN), 50019 Sesto Fiorentino, Italy
 # Department of Physics, University of Bologna, 40126 Bologna, Italy
** Research and Scientific Support Department, ESTEC, 2201 AZ Noordwijk, The Netherlands*

Email: Luigi.Cacciapuoti@esa.int

Cold-atom interferometers have demonstrated outstanding performance for the absolute meas-urement of tiny rotations and accelerations. These instruments are now becoming important for many metrological applications, including precision measurements of gravity, gravity gradient and rotation of the Earth, tests of the Einstein's Weak Equivalence Principle and of the Newton's law at short distances, as well as measurement of fundamental physical constants.

MAGIA is a gravity gradiometer based on a ^{87}Rb cold-atom interferometer operating at the Uni-versity of Firenze. The instrument is designed to perform a measurement of the Newtonian gravi-tational constant G to 100 ppm. MAGIA can currently reach a sensitivity of 300 ppm in 1 day of integration time. The instrument is also being used for absolute gravity and gravity gradient measurements.

We will present the recent progress of the MAGIA experiment and discuss the potential of atom interferometry for fundamental physics tests in space.

The evolution of feedback and star formation in distant galaxy clusters

J.S. Santos[1], [1]ESAC

Galaxy clusters are dynamical environments hosting complex astrophysical phenomena, that provide us with a wealth of information on the intricate processes that shape the cosmic large-scale structure and galaxy evolution. High-resolution multi-wavelength observations are required to study the dynamical state and evolution effects in distant clusters, and to reach their epoch of assembly and formation.

Using the deepest Chandra observation of a distant galaxy cluster, WARPJ1415 at z=1, we investigate the properties of the hot intra-cluster medium and measure several diagnostics to quantify the strength of the cluster cool-core. In addition to the X-ray data we use optical and radio data to study the properties of the central, star-forming galaxy, and we trace a connection between these components. Our work confirms WARPJ1415, as an evolved cool-core cluster, with clear evidence of AGN feedback at work (Santos et al 2011a).

We also present the discovery of one of the most distant, massive galaxy clusters detected in X-rays, XMM0044. This system at redshift z=1.6 already shows a well defined red-sequence although a reversal of star-formation is present, with core galaxies forming stars (Santos et al 2011b). The high mass of XMM0044 may create tension with the current cosmological model, however further observations are required to confirm it.

Lastly, we show the most recent results obtained with a GT1 Herschel program aimed to study the star-formation properties of a sample of high-z clusters and proto-clusters (PI B. Altieri) using PACS and SPIRE imaging.

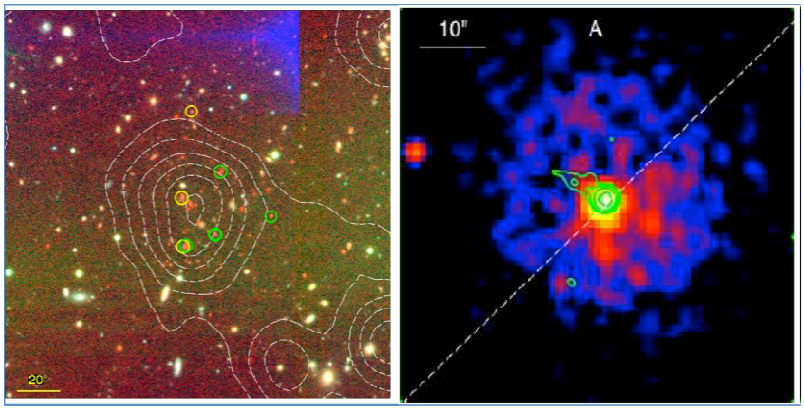


Fig1. *Left:* Optical/NIR image of the distant cluster XMM0044 at z=1.58, with X-contours overlaid in white. The yellow circles refer to the 3 spectroscopic members. *Right panel*: Chandra image of the galaxy cluster WARPJ1415 at z=1, indicating morphological asymmetries in the intra-cluster medium. The green contours refer to the VLA radio emission comprising a central compact source and an extended jet-like structure with a size of 80 kpc.

References:

Santos, J.S., Tozzi, P., 2011, Nonino, M., Rosati, P., Giovannini, G., A&A submitted

Santos, J.S., Fassbender, R., et al. 2011, A&A, 531L, 15S

The star formation activity in the universe since 11 Gyr, as revealed by Herschel deep surveys

Bruno Altieri, SRE/OAH, ESAC

Analysis of deep surveys carried out in Herschel Key Programs, both in guaranteed time (PEP, PACS Extragalactic Probe, PI D.Lutz) and open time (GOODS-Herschel, PI D.Elbaz) has revealed a scaling law for star forming galaxies between their 8μm luminosity and the far-infrared bolometric luminosity, hence star formation rate (SFR) up to redshift 2.5. (Fig.1). This defines an infrared main sequence of galaxies, where the main mode of star formation is relatively steadily, in disk-like galaxies (Elbaz+2011). Outliers from this main sequence are found in a starburst mode, experiencing more compact star formation, driven by merging. The merger driven starburst would then play a relatively minor role (~10%) in the formation of star in galaxies (Rodigiero+2011) (Fig. 2). In this scenario the fall in cosmic SFR is driven by the decrease in dust mass rather than merger rate.

It is also found that far-infrared emission of X-ray AGNs is dominated by star formation, without correlation between the X-ray and the infrared luminosities at any redshift, suggesting that AGN activity is decoupled from star formation (Mullaney+ 2011). On the other hand, a reversal of SFR activity versus environment is evidenced above z~1.5 (Popesso+ 2011) as expected from processes of downsizing and star-formation quenching.

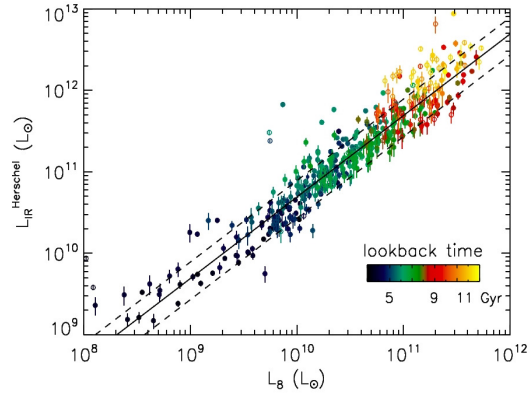


Fig.1: The infrared main sequence of star forming galaxies

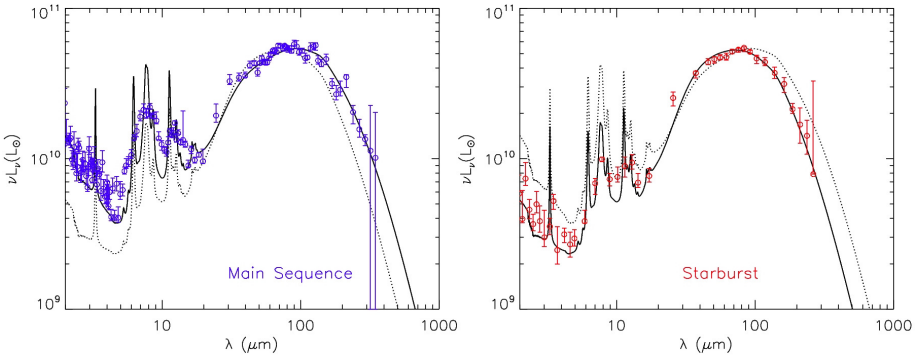


Fig.2 : universal SED of 90% of star forming galaxies (left) while for 10% of them (right) the starburstiness and compactness is higher in starburst mode.

SCALE-INTEGRATED SPECTRAL CHARACTERISATION OF MINERALOGICAL ANALOGUES TO MARS SITES OF HIGH EXOBIOLOGICAL POTENTIAL

D. F. Gleeson[1], P. D. Martin[2], D. C. Fernandez-Remolar[1] and R. Moissl[2],
[1]CAB, Torrejon de Ardoz, [2]ESAC, Madrid.

Orbital and in situ missions such as Mars Global Surveyor, Mars Odyssey, Mars Express, Mars Reconnaissance Orbiter and the Mars Exploration Rovers have collected a wealth of spectral datasets providing insights into surface properties and conditions on Mars, revealing suites of minerals whose formation is consistent with the presence of liquid water in the past. Such mineralogies point to sites of past habitability and could represent paleobiological repositories. The development of a scale-integrated (orbital to in-situ) approach to exobiological investigations and the design of effective surface science in planetary environments are facilitated by investigation of terrestrial analogues and biosignatures, which can inform our view of how microbiological activities are tied to macroscopic mineral deposits (Gleeson et al., 2011).

Depositional environments of interest on the surface of Mars include the sulfate- and hematite-rich sedimentary deposits characterised by Opportunity at Meridiani Planum, and the extensive phyllosilicate deposits of the early Noachian detected by the OMEGA instrument onboard Mars Express, the formation of which are consistent with aqueous (and consequently potentially habitable) conditions. Partial environmental analogues to both mineralogies may be found within the Rio Tinto Basin in southwestern Spain. During the dry season, ferric sulfates form from the precipitation and evaporation of Rio Tinto headwaters rich in sulfuric acid and ferric iron, generated by biologically mediated oxidation of pyritic orebodies. Hydrolysis of sulfates during the wet season leads to the precipitation of nanophase goethite, subject to increasing crystallinity and replacement with hematite in ancient river terraces (Fernandez-Remolar et al., 2005). Phyllosilicates generated from acidic weathering of volcanosedimentary bedrock are also present within the system, and co-precipitate in the dry season as nanophase oxyhydroxides with sulfates.

The purpose of the undertaken study is to characterise mineralogy across various scales of a specific planetary surface site to determine how accurately ground conditions are represented in orbital datasets. In particular, this research poses the following scientific questions:

- Under the low pH and seasonally dry environmental conditions that predominate at Rio Tinto, how accurately are iron oxide/ferric-sulfate and phyllosilicate mixtures represented in field to orbital scale datasets?
- Are spectral interactions masking certain constituents at certain scales?
- Can we identify gaps in mineralogical coverage due to the interactions between mixtures of these materials at the field or orbital scale?
- What minerals could be masked or obscured?
- How could this knowledge refine our view of the Meridiani (Mars) assemblages to which Rio Tinto mineralogies are analogous?

References:

- Gleeson, D.F., et al. (2011). Low temperature S^0 biomineralization at a supraglacial spring system in the Canadian High Arctic. Geobiology, 9, 360-375.

- Fernandez-Remolar, D.C., et al. (2005). The Rio Tinto basin, Spain: Mineralogy, sedimentary geobiology, and implications for interpretation of outcrop rocks at Meridiani Planum, Mars. EPSL, 240, 149-167.

ASTROBIOLOGY IN MARS ANALOGUES: GEOCHEMICAL HABITATS AND BIODIVERSITY

B.H. Foing[1,2,8], C. Stoker[3], P. Ehrenfreund[4,5], Z. Martins[6], S.O.L. Direito[2], L. Rodrigues[2], W.F. Röling[2], G.R. Davies[2], C.S. Thiel[7,8], D. Loizeau[1], D. Blake[3], J.M. Kotler[4], G.E. Orzechowska[9], R.D. Kidd[9], J.D.A. Clarke[10], V. Pletser[1], A. Borst[2,8], S.T. Peters[2], L. Wendt[11], C. Gross[11], M.B. Wilhelm[3,12](EuroGeoMars2009)

[1]ESA/ESTEC, [2]Vrije Universiteit, Amsterdam, Faculty of Earth & Life Sciences, De Boelelaan 1085, 1081 HV Amsterdam, NL; [3]NASA Ames Research Centre; US; [4]Leiden Institute of Chemistry, NL; [5]Space Policy Institute, George Washington University, Washington D.C., USA; [6]Imperial College London, South Kensington Campus, London UK; [7]Institute of Medical Physics and Biophysics, University of Muenster, Germany; [8]ILEWG, [9]Jet Propulsion Laboratory, CalTech, Pasadena; [10]Geoscience Australia; [11]FU Berlin, [12]Cornell University

We have performed field campaigns in the Utah desert to study the habitability and biodiversity in relation to geochemical and extreme environmental parameters. The EuroGeoMars2009 and DOMMEX campaigns [1, 2, 9] were conducted at Mars Desert Research station (with the support of NASA Ames, ILEWG, ESA/ESTEC, and partners). The desert near Hanksville in Utah provides a diversity of sites analogous to Mars including ancient fluvial sandstone; gullies; lacustrine and fluvial clays; carbonaceous pyritic units; paleochannels; small scale mineral and subsurface niches; concretions & endolith environments.

We deployed a suite of instruments and techniques [1, 2, 9] relevant to habitability and astrobiology research (including sample collection, context imaging from remote to local and microscale, drilling, spectrometers and Polymerase Chain Reaction PCR). A number of soil and rock samples were selected from diverse geological habitats, documented and analysed *in situ*. Subsequently, they were sent for detailed analysis in remote laboratories using XRD/XRF, Infrared spectrometry, amino acid analysis, Solid Phase Microextraction and Organic solvent Extraction with GC-MS analysis, composition and organics analysis, and biota diversity studies using culture-independent molecular analyses directed at ribosomal RNA genes [1-9].

We shall present the in situ and laboratory analysis relevant to habitability and biodiversity under extreme environments. We shall discuss how transient geological and geochemical episodes have affected local parameters (mineralogy, organics content, environment variations) and therefore the habitability and the signature of organics and biota. Among the important findings of this field research campaign are the diversity in the mineralogical composition of soil samples even when collected in close proximity, the low abundances of detectable polycyclic aromatic hydrocarbons and amino acids and the presence of biota of all three domains of life with significant heterogeneity. An extraordinary variety of putative extremophiles, mainly Bacteria but also Archaea and Eukarya was observed [3, 4, 9]. A dominant factor in measurable bacterial abundance seems to be soil porosity and lower clay-sized particle content [6-8].

Keywords: astrobiology, habitability, life detection, field analog research, Earth-Mars, organics

References

"A*strobiology Field Research in Moon/Mars Analogue Environments*", (Foing, Stoker & Ehrenfreund, Editors), Special Issue of International Journal of Astrobiology (IJA) 2011, Vol 10, issue 3, pp 137-305 [1] Foing et al. (2011) Field astrobiology research at Moon-Mars analogue site: Instruments and methods, IJA 10, 141-160 [2] Clarke, J., Stoker, C. Concretions in exhumed & inverted channels near Hanksville Utah: implications for Mars, IJA 10, 161-175 [3] Thiel et al., (2011) PCR-based analysis of microbial communities during the EuroGeoMars campaign at Mars Desert Research Station, Utah. IJA 10, 177-190 [4] Direito et al. (2011) A wide variety of putative extremophiles and large beta-diversity at the Mars Desert Research Station (Utah). IJA 10, 191-207 [5] Orzechowska, G. et al (20110 analysis of Mars Analog soils using solid Phase Microextraction, Organics solvent extraction and GCMS, IJA 10, 209-219 [6] Kotler et al. (2011). Analysis of mineral matrices of planetary soils analogs from the Utah Desert. IJA 10, 221-229 [7] Martins et al. (2011) Extraction of amino acids from soils close to the Mars Desert Research Station (MDRS), Utah, IJA. 10, 231-238 [8] Ehrenfreund et al. (2011) Astrobiology and habitability studies in preparation for future Mars missions: trends from investigating minerals, organics and biota. IJA 10, 239-253 [9] Stoker C. et al Mineralogical, Chemical, Organic & Microbial Properties of Subsurface Soil Cores from Mars Desert Research Station, a Phyllosilicate and Sulfate Rich Mars Analog Site, IJA 10, 269-289

Stopping and looking at the way we do statistics in Astronomy

A. G. Belanger[1], [1]ESAC

The use of statistics and statistical methods for data processing and analysis in astronomy as in all fields of science is inevitable. Unfortunately, learning and understanding statistical methods well is not only difficult, but it is time consuming and unappealing to most. The result is that most are inadequately prepared to carry out statistically appropriate analysis of their data. Over time certain standard practices in data analysis are established, transmitted and then cherished by those who use them, remaining unquestioned by almost everyone.

I have spent a considerable amount of time looking at various details of time series analysis in X-ray astronomy, and have come to the conclusion that we must completely revise the way we calculate and use error bars, and the way that we bin and treat binned data as we resample them or combine more than one overlapping time series. I would like to share some of these findings that affect some of the most basic things we do with the audience in the hopes of setting new, statistically robust standards for future generations of astronomers.

Cold Disks Around Nearby Stars – News from Herschel

G.L. Pilbratt
ESTEC/SRE-SA

Abstract. In two previous Inter-Departmental Science Workshops (IDSWs) held in August 2008 and November 2010 I have presented the background and first results from the exciting prospects of conducting observations of infrared excess associated with 'normal' sun-like stars using *Herschel*.

All observations in the *Herschel* Open Time Key Programme 'DUNES' ('DUst around NEarby Stars') have now been obtained. The observations constitute a volume-limited sample of 133 of FGK stars with the aim of studying cold dust debris disks. In addition, as part of the *Herschel* Guaranteed Time Key Programme 'Stellar Disk Evolution', observations have been conducted of the 'fab four' (Vega, Fomalhaut, ε Eri, and β Pic).

New results from these two programmes, including spectacular resolved images of prominentobjects, have recently been submitted for publication in various journals. The timing of the IDSW is very good for offering an opportunity to presenting these results, catering for the interest generated by my talk in the IDSW a year ago.

Debris Disks and Planets: New Evidence for Dynamical Stirring

D. A. Ardila[1] , B. Merín[2], A. Ribas[2], and H Buoy[3]
[1]NASA Herschel Science Center

[2]ESAC

[3]LAEFF

The dust observed in debris disks is due to collisions among, or evaporation of, planetesimals. In turn, planetesimals are the remnants of the planet formation process. Searches for correlations between the presence of planets and the presence of debris disks have not revealed any relationship between the two phenomena. Here we present evidence for the presence of warm debris disks around stars known to have planets. In particular, we have band-merged all known and suspected transiting planets, produced by the Kepler spacecraft as well as by ground-based surveys, with the all-sky catalog from the Wide-field Infrared Survey Explorer. We find 13 objects with excesses at 12 or 22 mic. Without longer wavelength observations it is not possible to determine the nature of the excesses, although we argue that they are likely due to debris disks around the stars. The ratios between the measured fluxes and the stellar photospheres are generally larger than expected for Gyr-old stars, such as these planetary hosts. Assuming temperature limits for the dust, and emission from large dust particles, we derive estimates for the disk radii. These values are comparable to the planets' semi-major axis, suggesting that the planets may be stirring the planetesimals in the system.

Study of elongated craters on Mars, the Moon and Mercury

O. Witasse[1], B. Buchenberger[2], D. Loizeau[1], A. Chicarro[1], J. Benkhoff[1], E. Martellato[1], B. Foing[1], L. Colangeli[1], C. Popa[3], and P. Rosenblatt[4]

[1]ESA/ESTEC, [2] Leuven University, [3]Osservatorio Astronomico di Capodimonte, Napoli, [4]Royal Observatory of Belgium, Brussels

Elongated craters are formed by oblique impacts. Detailed surveys of those features have been performed for some of the inner planets. Especially for Mars, target of many planetary missions, a dataset was compiled based on NASA/Viking images. Our motivation for studying these craters on Mars comes from the hypothesis proposed in 1982 that they may have been formed by impact of decaying Phobos-type moonlets. If confirmed, this would further constrain the question of the origin of the Martian moons.

We revisit here the dataset of elongated craters with most recent, color and high-resolution images acquired by the HRSC camera aboard Mars Express. The Figure shows an example of elongated crater. We discuss the characteristics of this crater population (location, size, age, orientation, composition) and link with the results of models of decaying moons originating from a debris disk around Mars. We envisage to expand this study to two planetary bodies whose surface is highly cratered: the Moon and Mercury.

THE PHYLLOSIAN ERA OF MARS: THE TWO DIFFERENT CASES OF MAWRTH VALLIS AND TYRRHENA TERRA

D. Loizeau[1], N. Mangold[2], J. Carter[3] and J. Vago[1], [1]ESTEC, [2]LPGN, Nantes, France, [3]IAS, Orsay, France

Liquid water alteration on rocks often forms phyllosilicate minerals. Phyllosilicates have been detected in many outcrops of the oldest Martian rocks with the near-infrared imaging spectrometers OMEGA/MEx and CRISM/MRO. This led to propose to name the first era of Mars, the *Phyllosian* [1]. Of the phyllosilicate-rich rocks, clays particularly are considered to favor the preservation of biosignatures [2], thus are particular target for future Martian mission exploring the habitability of the planet.

We propose to compare here two very different cases of phyllosilicate detection, through the mineralogy, the stratigraphy and the morphology: Mawrth Vallis, and Tyrrhena Terra.

The plateaus around Mawrth Vallis expose a thick (>150 m), finely layered (thickness ~1 m), light-toned clay-rich unit [3,4]. While the largest outcrops of this unit are spread over a region of ~300 km by 400 km, smaller detections of clays are found aver a ~1000 km by ~1000 km region [5]. Formation processes likely involved long-term aqueous alteration, at low temperature, near surface, and changing conditions in time and/or depth.

The Tyrrhena Terra region we consider lies between two of the largest basins on Mars (~1000 km by ~2000 km). The mineralogy of the crust is revealed by ~150 crater ejecta, bearing hydrated silicates. The craters excavated rocks from a few tens of meters to few kilometers depth. Hydration signatures are weak, and outcrops are generally small (few hundreds of meters maximum), with generally non-layered rocks [6]. The origin of these minerals is likely an *in-situ* alteration of the rocks at higher temperature and depth, by hydrothermal fluid circulation in the crust, enhanced locally by large impacts.

We will present how these two cases can provide typical or exceptional windows into the early Mars.

[1] Bibring et al. (2006) Science 312, 400-404. [2] Farmer & Des Marais (1999) JGR 104, 26977-26995. [3] Loizeau et al. (2007), JGR, 112, E08S04. [4] Loizeau et al. (2010) Icarus 205, 396-418. [5] Noe Dobrea et al. (2010) JGR 115, E00D19. [6] Loizeau et al. (2009) AGU Fall Meeting, P12A-03.

Combining and comparing astrometric data from different epochs: a case study with Hipparcos and Nano-JASMINE

D. Michalik[1], L. Lindegren[1], D. Hobbs[1], U. Lammers[2], Y. Yamada[3]

[1]Lund Observatory, [2]ESAC, [3]Kyoto University

The Hipparcos mission (1989-1993) resulted in the first space-based stellar catalogue including measurements of positions, parallaxes and annual proper motions accurate to about one milli-arcsecond. Two space astrometry missions will follow in the near future: The ultra-small Japanese mission Nano-JASMINE is expected to be launched early 2012 for its nominal mission duration of two years. It will determine positions and annual proper motions with an accuracy comparable to Hipparcos. In mid 2013 the next-generation ESA mission Gaia will deliver some tens of micro-arcseconds accurate positions, parallaxes and proper motions during its five years mission. Data from both missions will be reduced using the Astrometric Global Iterative Solution (AGIS) of the Gaia mission, developed by teams at ESA/ESAC and Lund Observatory.

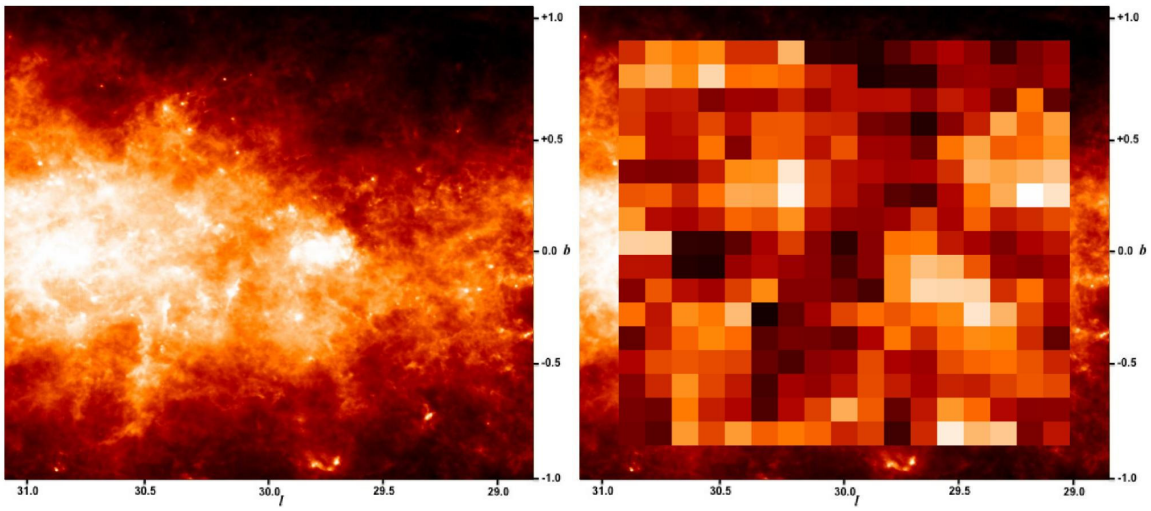
Until the final Gaia catalogue is published in early 2020 the best way of improving proper motion values is the combination of positions from different missions separated by long time intervals. Rather than comparing positions from separately reduced catalogues, we have developed a method to combine the information from the different data sets in a statistically optimal way by making a joint astrometric solution. This allows to obtain good results also where each data set alone is insufficient for an accurate reduction. As a demonstration of the method we have extended AGIS to incorporate prior information from the Hipparcos catalogue in the least squares solution of the astrometric parameters when reducing the Nano-JASMINE data. We present preliminary results of simulations showing a very significant improvement of the proper motion values.

The goodness-of-fit of the combined solution is sensitive to small deviations of the stellar motions from the assumed (rectilinear) model. We are investigating how this can be used to identify binary candidates with orbital periods of decades to centuries. This will contribute to the census of the binary population within a few hundred parsecs from the sun by filling a difficult-to-observe gap between the shorter period spectroscopic binaries and the longer period visually resolved systems.

Complexity of the diffuse interstellar medium in large-scale Herschel imaging surveys

R. Vavrek[1] T.H. Collado[1] and D. Elia[2], [1]ESA/ESAC, Madrid, Spain, [2]IFSI, Rome, Italy

We report a first look at the results of complexity analysis of multi-wavelength maps of diffuse Galactic dust emission from Hi-GAL observations. Structural analysis of filamentary structure is essential (1) to understand the link between the diffuse ISM and the distribution of embedded prestellar cores, (2) to provide a statistical basis for comparison of various SF complexes, and (3) for comparison of observed vs. simulated maps. In this study we apply the Wavelet Transform Modulus Maxima chain (WTMM) technique to locally characterize the singularity strength of the densest parts of the filaments. In essence, image complexity is related to intensity- and number density variations of singularities which can be directly translated to multifractal (MFR) measures. MFR information is used to create complexity maps down to ~24 arcmin resolution. Complexity can be correlated with the spatial distribution of physical measures, such as SF rate, column-density and dust temperature.



Figures show the Hi-GAL survey tile at Galactic longitude 30 degrees, on the left the band emission map is shown, the right hand side image is the derived complexity map of 24 arcminutes respectively. Higher intensity pixels indicate regions where the underlying diffuse emission is highly structured. These complex areas are found not obviously correlated to surface brightness of the could dust emission.

Pre-Perihelion Monitoring of Rosetta Target Comet 67P/Churyumov-Gerasimenko

Rita Schulz[1], Gian Paolo Tozzi[2], Joachim A. Stüwe[1]

[1]ESA Research and Scientific Support Department
[2]INAF – Osservatorio Astrofisico di Arcetri, Firenze, Italy

In 2008 Comet 67P/Churyumov-Gerasimenko approached perihelion (28 Feb. 2009) moving along that part of its orbit that will be covered by the Rosetta mission in 2014/15. We therefore regularly monitored the evolution of the comet in terms of gas and dust activity as well as coma morphology to obtain these characteristics as a function of decreasing heliocentric distance. 67P/Churyumov-Gerasimenko was observed with the FORS1 instrument on the ESO VLT2 (Kueyen) telescope. Broad-band filter images and low-resolution spectro-photometric measurements were obtained between 29 May 2008 and 16 September 2008 at heliocentric distances of about 2.99 AU, 2.75 AU, 2.48 AU, and 2.22 AU. These were used to determine the evolution of the nucleus activity and coma composition as a function of heliocentric distance. We present upper limits for the production rates of the CN-radical as well as Afρ values as a measure of the dust production. The comet appears to be less active during this perihelion approach, than it has been at similar heliocentric distances post-perihelion in 2003.

Modelling the trajectories of cm to meter sized chunks in the vicinity of comet 67P/Churyumov-Gerasimenko

B. Grieger, N. Altobelli, M. Kueppers, A. Schmidt and S. Voelk, ESAC

The Rosetta mission will reach its target comet 67P/Churyumov-Gerasimenko in 2014. In order to support Rosetta mission analysis studies, the trajectory propagation and visualization system ROVIS is being developed. ROVIS provides several capabilities: spacecraft trajectory propagation, modelling of spacecraft attitude and also the attitude of movable components, simulation of instrument fields of view, ground track and coverage analysis, visualization, and the creation of SPICE kernels for spacecraft position and attitude. For the trajectory propagation, the (non-spherical) comet's gravitational attraction, third body gravitational attraction, solar radiation pressure, and the cometary coma outgassing force are taken into account.

Ground based radar observations of Comet 103P/Hartley 2 indicated an ensemble of particles larger than a few cm. The EPOXI mission could indeed observe such chunks with sizes in the cm to meter range. While the forces on small dust particles in cometary comae are dominated by outgassing and solar radiation pressure, the trajectory of larger particles would be more influenced by gravity. The ratio between gravitational forces and pressure forces (solar radiation and comet outgassing) for such chunks is of the same order of magnitude as for the Rosetta spacecraft. Like for Rosetta, gravitational and pressure forces are similarly important in determining the trajectory. We use ROVIS to model trajectories for chunks of different sizes and dynamical states in order to assess the possibility to encounter an ensemble as found at 103P/Hartley 2 also at 67P/Churyumov-Gerasimenko.

DISCOVERY OF ~15 Myr OLD PRE-MAIN SEQUENCE STARS WITH ACTIVE ACCRETION AND SIZEABLE DISCS IN THE EAGLE NEBULA

Guido De Marchi (ESTEC), Nino Panagia (STScI), M. Guarcello (Harvard-CfA)

Attention is given to a population of 110 stars with prominent near- infrared excess in the NGC 6611 cluster of the Eagle Nebula that have optical colours typical of pre-main sequence (PMS) stars older than 10 Myr. In principle, their optical V-I colours would be consistent with those of young PMS objects (< 1 Myr), whose radiation is heavily obscured by a circumstellar disc seen at high inclination and in small part scattered towards the observer by the back side of the disc. However, using theoretical models it is shown here that objects of this type can only account for a few percent of this population. In fact, the spatial distribution of these objects, their X-ray luminosities, their optical brightness and their positions in the colour-magnitude diagram unambiguously indicate that most of these stars are intrinsically older than 10 Myr. The derived range from ~8 to ~30 Myr with a median value of ~15 Myr. This is the largest homogeneous sample to date of Galactic PMS stars considerably older than 10 Myr that are still actively accreting from a circumstellar disc and it allows us to set a lower limit of 5% to the disc frequency at ~15 Myr in NGC 6611. These values imply a characteristic exponential lifetime of ~5 Myr for disc dissipation.

AGN AND STAR FORMATION ACTIVITY AND THE NATURE OF THE DUSTY TORUS: THE HERSCHEL'S VIEW

Miguel Sánchez-Portal[1], Manuel Castillo[2], Cristina Ramos-Almeida[3], Pilar Esquej[4], Ana Pérez García[5], Almudena Alonso Herrero[4] and the AGN-FIR proposal team.

[1]Herschel Science Centre, ESAC, [2]European Space Astronomy Centre (ESAC), [3]Department of Physics and Astronomy, [4]University of Sheffield, Centro de Astrobiología, INTA-CSIC, [5]Instituto de Astrofísica de Canarias

We present results from a Herschel Guaranteed Time program aimed to perform PACS & SPIRE imaging photometry in the 70, 100, 160, 250, 350 and 500 micron bands of a sample of 18 nearby Seyfert 1 and 2 galaxies. The goals of the project include:

a) Star formation in AGN hosts: AGN and starburst activities, being among the most energetic extragalactic processes, have been studied separately until the past decade, when evidence that the two phenomena are related and, most frequently, coexistent started to accumulate. The FIR peak of cold dust emission constitute a powerful tracer of star formation. However, the study of such an important feature in the innermost regions of nearby AGN hosts has been, until the advent of Herschel, seriously limited by the low spatial resolution and limited spectral coverage of the existing facilities. Our new data, given the unprecedented angular resolution and spectral coverage of the Herschel Space Observatory start to overcome this limitation, allowing us to probe the cold and very cold dust components across the galaxy and even in the nuclear and circum-nuclear regions.

(b) Characterising the physical nature of AGN infrared emission: we are performing multi-component SED fitting (AGN, starburst and host galaxy), combining existing ground and space-based data from UV to MIR with Herschel FIR observations. The new, high resolution Herschel data are allowing us to unveil the nature of the dusty torus (e.g. clumpy vs. smooth, flared disc), breaking model degeneracies.

Gravity waves at the Venus cloud tops as observed by the Venus Monitoring Camera

A. Piccialli (1), D. Titov (1), H. Svedhem (1), W.J. Markiewicz (2)
(1) ESA, ESTEC (2) Max Planck Institute for Solar System Research

Since 2006 the European mission Venus Express (VEx) [1] is studying Venus atmosphere with a special regard to atmospheric dynamics and circulation. High resolution images of Venus Northern hemisphere obtained with the Venus Monitoring Camera (VMC/Vex) allow to study small scale features like wave trains. Venus Monitoring Camera (VMC) is a CCD-based camera specifically designed to take images of Venus in four narrow band filters in UV (365 nm), visible (513 nm), and near-IR (965 and 1000 nm) [2]. Venus Express orbit allows VMC to capture at the pericentre high resolution images of the planet that are used to study small-scale dynamical phenomena at the cloud tops (~70 km altitude). [3] distinguished three types of waves in VMC images: long straight features, short wave trains and irregular wave fields (Fig. 1). The waves are often identified in all channels, thus excluding to be caused by the UV absorbers. They could be the results of variation in cloud opacity or in the solar illumination angle. We performed a systematic search of waves in VMC images; more than 1700 orbits were analyzed and wave patterns were observed in about 150 images. Waves are located at high latitudes (60–80ºN) in the Northern hemisphere and seem to be concentrated above Ishtar Terra, a continental size highland that includes the highest mountain belts of the planet, thus suggesting a possible orographic origin of the waves. However, at the moment it is not possible to rule out a bias in the observations due to the spacecraft orbit that prevents waves to be seen at lower latitudes, because of lower resolution, and on the night side of the planet. We measured wave properties such as location (latitude and longitude), local time, solar zenith angle, packet length and width, orientation relative to the north and wavelength. Long waves generally extend more than a few hundreds kilometers, short wave packets have a width of several tens of kilometers and extends to few hundreds kilometers.

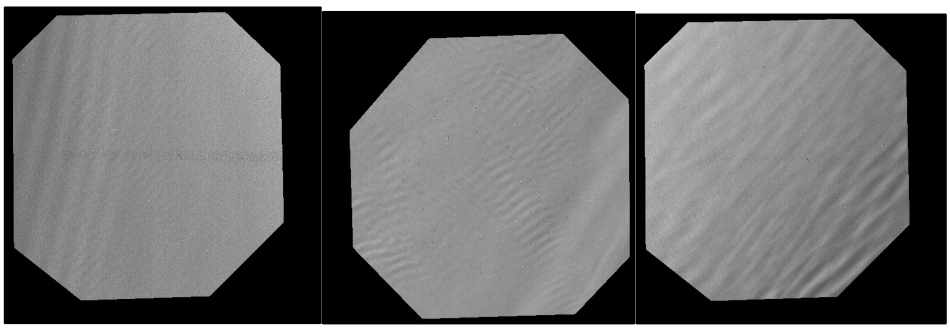


Fig.1: VMC types of waves

[1] Svedhem, H. et al., PSS, Vol. 55, 1636–1652, 2007.

[2] Markiewicz, W. J. et al., PSS, Vol. 55, 1701-1711, 2007.

[3] Titov, D.V. et al., Icarus, accepted.

THE BEXRB OUTBURST ZOO

P. Kretschmar[1] and F. Anders[2], [1]ESA/ESAC, [2]Technical Univ. Dresden, Germany

Be X-ray binaries are among the best known transient high-energy sources. Their outbursts are commonly classified into a simple scheme of 'normal' and 'giant' outbursts, but a closer look shows that actual outbursts do not always follow this simple scheme. Recent data show a variety of properties, like pre-flares, shifts of the outburst peaks with respect to the periastron, multi-peaked outbursts etc. In this brief overview I present results from a systematic study started as ESAC trainee project and now on the way towards a review paper, involving data from various satellites.

MOLECULAR GAS AROUND LOW-LUMINOSITY AGN IN LATE-TYPE SPIRAL GALAXIES

T. Böker[1] [1]ESTEC

I will present recent observations of the molecular gas in the vicinity of low-luminosity active galactic nuclei (AGN) in three bulge-less spiral galaxies: NGC 1042, NGC 4178, and NGC 4395. The presence of an AGN in the absence of a stellar spheroid provides an important boundary condition for theories of the co-evolution of supermassive black holes (SMBH) and galaxy bulges. Studying these objects therefore promises new insights into the long-standing question of how SMBH and galaxy bulge influence each other's growth. In all three galaxies, the (1-0) and (2-1) transitions of gaseous carbon monoxide (CO) are clearly detected within the central kpc. In the case of NGC 4395, this constitutes the first reported detection of CO. In general, the CO emission is faint, as may be expected from their less-than-spectacular star formation activity. Interestingly, however, both of the face-on galaxies in our sample (which allow an unimpeded view of their nucleus) show an elevated intensity ratio CO(2-1)/CO(1- 0) when compared to late-type spirals without an AGN. I will discuss that this is unlikely due to a very compact CO source. Instead, it seems likely that even an energetically weak AGN can impact the physical state of the surrounding gas. This opens the possibility of using the CO line ratio as a new tool in the search for faint AGN that are otherwise very difficult to identify.

X-raying the Mach Cones of Virgo Cluster Spiral Galaxies

M. Ehle[1] , M. Weżgowiec[2] and B. Vollmer[3], [1]ESAC, XMM-Newton SOC, [2]Uni. Bochum, Germany, [3]Observatoire astronomique de Strasbourg, France

The detailed comparison between HI observations and simulations of ram-pressure stripped Virgo Cluster spiral galaxies allows a construction of a 3D view of their orbits within the hot intracluster medium. The velocities and Mach numbers derived provide simple Mach cone geometries for the studied galaxies.

With XMM-Newton we searched for hot gas within the Mach cones of selected Virgo Cluster spiral galaxies: NGC 4569, NGC 4388, and NGC 4501. Low-resolution maps show extra-planar diffuse extended X-ray emission. Hot gas tails in NGC 4388 and NGC 4501, situated within their Mach cones, are most likely due to the mixing of the stripped galactic ISM and the hot ICM of the Virgo Cluster. In NGC 4569 the hot gas from a galactic superwind fills the entire Mach cone.

XMM-Newton results allow us a direct proof of the dynamical model predictions. Based on the Mach cone opening angle it is even possible to estimate the strength of the intracluster magnetic field.

Ref: Weżgowiec et al. A&A 531, 44, 2011

Wave activity at the Earth's magnetopause under northward Interplanetary Magnetic Field conditions

M. G.G.T. Taylor

The magnetopause is a boundary in pressure balance between the dominance of the Earth's magnetic and plasma environment and that of the Solar wind. The Kelvin Helmholtz Instability can drive waves at this interface and these waves can grow to form rolled up vortices and facilitate transfer of plasma into the magnetosphere. We have used a multi-spacecraft approach to investigate the evolution of such activity and more recently have carried out a survey from single spacecraft measurements from Double Star 1 to determine the frequency and distribution of such events.

This work was initiated as part of an International Space Science Institute (ISSI) working group examining multi-spacecraft conjunctions and their utility in examining the behaviour of the dayside magnetopause and flanks under various driving conditions.

Extremely asymmetric Stokes V profiles and their formation in the quiet Sun

B. Viticchie[1], N. Vitas[2], D. Mueller[1]

[1]ESA/ESTEC, [2]SRON

The interpretation of polarimetric measurements emerging from the solar photosphere is still an open problem in solar physics.

Quiet Sun MHD MURaM simulations with average unsigned flux density of 30 G are exploited to produce synthetic polarimetric observations at high spectral resolution (1.2 pm) and spatial resolution (21 km grid scale). We focus on single-lobed profiles emerging from coherent patches in MURaM snapshots with dimensions comparable to the scale of the pixel of HINODE SOT/SP in order to point out the atmospheric properties which might produce such asymmetric profiles in quiet Sun observations.

Single-lobed Stokes V are present in quiet Sun MURaM snapshots over scales comparable to the pixel of SOT/SP. These emerge from regions in which an increase of the magnetic field with the continuum optical depth is found. More in detail, these are produced by linear variations of both the magnetic field intensity and the line-of-sight (LOS) velocity with the logarithm of the continuum optical depth. When considering HINODE SOT/SP synthetic observations we find that a large fraction of the polarimetric signatures emerging from the single-lobed patches are erased by the degradation effects; moreover, the degradation itself produces single-lobed profiles at locations in which these are not found in full resolution data.

The interpretation of single-lobed profiles can be tackled adopting 1D stratifications by assuming a high degree of coherence in the physical properties in the pixel under investigation. The results obtained in this work need to be complemented by analyses of spectro-polarimetric signatures emerging from alternative MHD simulations.

DUST ORBITS NEAR JUPITER'S GALILEAN SATELLITES

R. H. Soja[1], N. Altobelli[1] and D. P. Hamilton[2] [1]ESAC, [2]Department of Physics and Astronomy, University of Maryland

We present results from our re-analysis of the complete Galileo Dust Detection System (DDS) data set in the Galilean satellite region. Knowledge of the dust populations within the Jovian system contributes to our understanding of dynamical behaviour, impact hazards, dust sources and contamination of satellite and ring surfaces. This is of particular interest due to the previous claim of Thiessenhusen et. al. (2000) of detection of retrograde particles, which would have profound implications for the dominant sources of dust in this region.

We determine the set of impacts that can be described by each of six modelled populations: Galilean satellite ejecta; outer satellite ejecta; expelled Jovian ring particles; magnetospherically captured interplanetary particles; interplanetary particles on fly-by through Jovian space; and interstellar particles. We find a proportion of impacts cannot be the result of prograde or retrograde circular planar orbits (in agreement with Colwell et. al. (1998)). Due to large uncertainties, most particles have multiple possible sources.

However, previous studies have shown that we expect Galilean satellites to be a source of prograde near-circular planar dust in this region (Krüger et. al. 2003, Krivov et. al. (2002)). We find evidence that interstellar dust is the best explanation to most remaining low-charge impacts. Higher-charge impacts do not demonstrate a strong interstellar component, though >90% of these impacts can be explained by a combination of Galilean satellite ejecta and interstellar particles. However, the distribution of these impacts may better match a source of magnetospherically captured interplanetary particles, which includes a retrograde component. Other sources are possible but do not match well with the observed distribution.

References:

[1] K.-U Thiessenhusen, H. Krüger, F. Spahn and E. Grün,. Dust Grains around Jupiter - The Observations of the Galileo dust detector, *Icarus*, 2000, 144, 89-98.

[2] J. E. Colwell and M. Horányi and E. Grün. Capture of Interplanetary and Interstellar Dust by the Jovian Magnetosphere, *Science*, 1998, 280, 88-91.

[3] H. Krüger, M. Landgraf, M. Roy, A. V. Krivov, M. Sremčević and E Grün. Impact-generated dust clouds surrounding the Galilean moons, Icarus, 2003, 164, 170-187.

[4]A. V. Krivov, H. Krüger, E. Grün, K.-U Thiessenhusen and D. P. Hamilton, A tenuous dust ring of Jupiter formed by escaping ejecta from the Galilean satellites, *Journal of Geophysical Research*, 2002, 107.

DETECTION OF POLARIZATION EFFECTS IN GAIA DATA

F. Raison[1], [1]ESAC

The Gaia satellite will observe about one billion stars and other point-like sources. The astrometric core solution will determine the astrometric parameters (position, parallax, and proper motion) for a subset of these sources, using a global solution approach which must also include a large number of parameters for the satellite attitude and optical instrument. The quality of the astrometric solution will depend on the validity of the instrument model.

Optical simulations have showed that Gaia mirrors will be sensitive to light polarization because of their coating properties. This sensitivity results in a shift of the source image on the Gaia detectors, depending on its polarization. These microarsecond shifts can be in the order of magnitude of the expected accuracy of the instrument.

Our simulations have showed that the global solution can be improved by including into the global solution approach additional parameters related to the apparent polarization of the sources. We discuss the possibility of deriving the apparent source polarization degree and angle from the global solution approach. Finally, some possible applications will be presented.

Synchrotron Radiation Studies of Spectral Response Features Caused by Te Inclusions in a Large Volume Coplanar Grid CdZnTe Detector

C.C.T. Hansson [1], A. Owens [2], F. Quarati[3], A .Kozorezov[4], D.Lumb[5], [1] Solar System Missions Division ESA/ESTEC, Noordwijk, Netherlands, [2] Office for Support to New Member States, ESA/ESTEC, Noordwijk, Netherlands, [3] Faculty of Applied Sciences, Technical University of Delft, Delft, Netherlands, [4] Department of Physics, University of Lancaster, Lancaster, England, UK, [5] Astrophysics & Fundamental Physics Mission Division, ESA/ESTEC, Noordwijk, Netherlands.

Abstract: We report preliminary results from a synchrotron radiation study of Te inclusions in a large volume single crystal CdZnTe (CZT) coplanar-grid detector. The experiment was carried out by probing individual inclusions with highly collimated monochromatic X-and γ-ray beams. It was found that for shallow X-ray interaction depths, the effect of an inclusion on measured energy loss spectra is to introduce a ~10% shift in the peak centroid energy towards lower channel numbers. The total efficiency is however not affected, showing that the net result of inclusions is a reduction in the Charge Collection Efficiency (CCE). For deeper interaction depths, the energy-loss spectra shows the emergence of two distinct peaks, both downshifted in channel number. We note that the observed spectral behavior shows strong similarities with that reported in semiconductors which exhibit polarization effects, suggesting that the underlying mechanism is common.

Listening for NEOs

O. Jennrich[1] and D. Koschny[2], [1]ESTEC, [2]ESTEC

The detection and observation of Near-Earth Objects is currently carried out through a range of electromagnetic observations. It is, however, in principle possible to detect NEO through their gravitational interaction i.e. by carefully tracking the orbit of a 'test body' that comes sufficiently close to an NEO to be gravitationally deflected and eliminating all other forces on the test body, such as solar radiation pressure, magnetic interactions etc.

By necessity, the test masses used for NGO are perfect examples of such test bodies - they follow as good as possible purely gravitational orbits and the distance between them is monitored to cm-precision, the change of the distance to ~ 100 picometer/s, which allows to detect objects with diameters ~100m to withinin a distance of ~10^6 km from the NGO constellation.

Low-mass stars in Westerlund 1, the most massive young Galactic star cluster known in the Galaxy

M. Andersen[1], G. de Marchi[1], H. Zinnecker[2] , M. R. Meyer[3] , M. Gennaro[4] , W. Brandner[4] [1]ESTEC, SRE-OD, [2]SOFIA, [3]ETH-Zurich, [4]MPIA

Abstract The Initial Mass Function (IMF) is a crucial component in our understanding of star formation and in the interpretation of the integrated light from stellar populations. In recent years advances have been made on the observational knowledge of the brown dwarf and low-mass stellar IMF both in the field and and in nearby star forming regions. Most nearby clusters only cover a narrow range of cluster masses and metalicities and it is thus important to expand the determination of the IMF to massive star clusters. However, limitations on field of view, spatial resolution and sensitivity has precluded attempt to derive the global IMF in massive star clusters to low masses.

Here we present new HST WFC3/IR observations of the most massive young star cluster known in the Galaxy, Westerlund 1. The observations are capable of detecting brown dwarf cluster members, almost an order of magnitude lower mass than previous studies. We discuss the derived mass function for the cluster and the evidence for mass segregation. The mass of the cluster determined through individual star counts is further compared with the dynamical mass determined from the massive stars in the cluster. The ratio of the dynamical to photometric mass will help determine if the cluster will remain bound and evolve into a low-mass globular cluster of it it will disperse and become a part of the field star population.

FULLERENES EVERYWHERE!

COMPLEX CARBONACEOUS COMPOUNDS AROUND DYING STARS

P. García-Lario[1]

[1]Herschel Science Centre, ESAC

In 1985, almost exactly 25 years ago, the science world was shaken by a new discovery that has, and is still transforming our understanding of carbon: the discovery of a family of carbon cage molecules called "Fullerenes", a new allotropic form of carbon -together with graphite and diamond- with very exotic and interesting properties, with potential applications in superconducting materials, optical devices, medicine, water purification and more. The most simple, spherical version of fullerenes, also known as 'buckyballs', are soccer-ball shaped molecules comprising 60 carbon atomos, named after the architect Richard Buckminster Fuller, famous by his geodesic dome structures ressembling the shape of these molecules. In 1996 the chemistry Nobel Prize was awarded to sir Harold W. Kroto for its discovery.

Nowadays, fullerenes can easily be produced on Earth in high school laboratories with very simple techniques. You can even buy samples via internet. However, it was not until last July that the infrared Spitzer Space Telescope was able to provide the first confirmed proof of their existence in space (Cami et al.; Science 329, 1180). At that time, scientists believed that they had been lucky to find a rare supply, formed only under very exotic, hydrogen-depleted enviromental conditions.

However. more recently, our research group (Garcia-Hernandez et al.; ApJL 724, L39) has identified the presence of substantial amounts of fullerenes in the circumstellar shells of at least 3 H-rich planetary nebulae in our Galaxy and another one in the Small Magellanic Cloud, suggesting that the formation of fullerenes can take place under much more standard conditions in quite common stars at the end of their lives.

How these fullerenes formed, how they survived, where else they can be found, and what might be found inside these tiny cosmic time capsules is developing into an exciting area of research.

The Central Crater Region on (21) Lutetia

M. Küppers (1), R. Moissl (1), P. J. Gutiérrez (2), J.-B. Vincent (3), S. Besse (4), L. Jorda (5), H. Sierks (3), B. Carry (1) and the OSIRIS Team

(1) ESAC (2) IAA, Granada, Spain (3) MPS, Katlenburg-Lindau, Germany (4) University of Maryland, USA (5) LAM, Marseille, France.

1. Introduction

When Rosetta flew by asteroid Lutetia in July 2010, the OSIRIS cameras imaged about half of its surface with a resolution of up to 60 m/pixel [1]. The most prominent structure is a crater complex close to the North Pole of the asteroid.

2. Boulders

There are about 200 boulders larger than 60 m (the approximate detection limit) visible in and around the crater, with only a few scattered to larger distances. We model the trajectories of boulders ejected from the central crater. The launch velocities were taken from semi-empirical size-velocity distributions of impact fragments [2], and the gravity of Lutetia was calculated from the shape model of the asteroid described in [1], using the analytical formula for the gravity of a polyhedron [3]. The model results are consistent with the observations, suggesting that indeed most of the boulders visible on Lutetia are resulting from the impact that created the central crater. Some of the boulders are visible in smaller craters, indicating that the central crater is younger than these impact features that surround it. Additional evidence for a young age is provided from the boulder size distribution that is less steep than expected from scaling laws [2]. The age of the crater is estimated from the analysis of boulder destruction mechanisms (impact destruction, burying by regolith, thermal stress).

3. Landslides and Colours

Landslides may either be material having moved down the newly formed crater or may have been caused by the impact creating the crater. The material in the landslides is darker and bluer than its surroundings, even after illumination corrections are applied. Either the material sliding down consists of smaller particles (possibly through impact comminution), or its composition is different from that of the surrounding material.

4. Summary and Conclusions

The presence and distribution of many boulders shows that Lutetia's interior is made at least partly of solid rock. The boulders are concentrated at the central crater, the youngest geological region of the observed hemisphere of Lutetia. At the same time this region shows the largest observed colour variations, with material that moved down in landslides being bluer than its surroundings. The large variation within a region may indicate some global scale regolith transport on the asteroid.

References

[1] Sierks, H. et al., Images of Asteroid 21 Lutetia: A Remnant Planetesimal from the Early Solar System, Science, submitted.

[2] O'Keefe, J. D. and Ahrens, T. J.: The Size Distribution of Fragments Ejected at a Given Velocity from Impact Craters, Int. J. Impact Engineering 5, pp. 493-499, 1987.

[3] Werner, R. A.: The Gravitational Potential of a Homogenous Polyhedron or Don't Cut Corners, Cel. Mech. and Dyn. Astron. 59, pp. 253-278, 1994.

Herschel´s quest to find the ghost of Comet Elenin

Mark Kidger, ESAC

HSC

Thomas Mueller, MPE Garching

We report Herschel observations of defunct Comet C/2010 X1 (Elenin), aimed at detecting its infrared ghost: the debris cloud and any remaining inert cometessimals that may have been released in the break-up of the nucleus, taking advantage of the comet's very close pass to Earth in mid-October 2011. This will allow us to detect both individual surviving fragments of the nucleus of ≈100m diameter and the expanding dust cloud, being particularly sensitive to coarse dust and boulders in the millimetre to metre size range.

Although most comets exhibit a (relatively) predictable behaviour, a minority of objects deviate considerably from the norm, either by showing sudden outbursts in brightness or, more rarely, by fading unexpectedly. The archetypal event in this latter category has been the intensely observed sudden disruption of Comet C/1999 S4 (LINEAR) in July 2000 (Kidger, 2002, EM&P, 90, 157), as it passed perihelion. The nucleus of C/1999 S4 (LINEAR) was found to have disintegrated into a cloud of cometessimals plus an expanding dust cloud, which faded rapidly, becoming undetectable within 20 days of disruption. Observations of Comet C/2010 X1 (Elenin) in August 2011 showed a similar pattern of evolution of coma morphology into an expanding, amorphous cloud of rapidly decreasing surface brightness (Mattiazzo & McNaught, 2011, CBET 2801) shortly before perihelion passage. However, the comet's difficult viewing geometry at the time of disruption made it impossible to study the event using high-resolution imaging techniques and, in particular, to measure the ratio of dust to cometessimals which gives information on the internal structure of the nucleus before disruption. Our observations will, at very least, allow us to put a strong upper limit on the maximum size of the building blocks of the nucleus and to contrast this with the predictions of the rubble pile model (Weissman, P.R.: 1986, Nature, 320, 242; Samarasintha, N.H.: 2001, Icarus, 154, 540), while at the same time measuring directly the amount of coarse dust released on disruption.

New HErschel Multi-wavelength Extragalactic Survey of Edge-on Spirals (NHEMESES)

B.W. Holwerda[1]. Bianchi[2], M. Baes[3], R. S. de Jong[4], J.J. Dalcanton[5], D. Radburn-Smith[5], K. Gordon[6] and M. Xilouris[7]

1 European Space Agency (ESTEC) email: benne.holwerda@esa.int,

2 INAF-Arcetri Astrophysical Observatory, Florence,

3 University of Gent,

4 Astronomisch Insitüt Potsdam,

5 University of Washington,

6 Space Telescope Science Institute,

7 National Observatory of Athens

Abstract

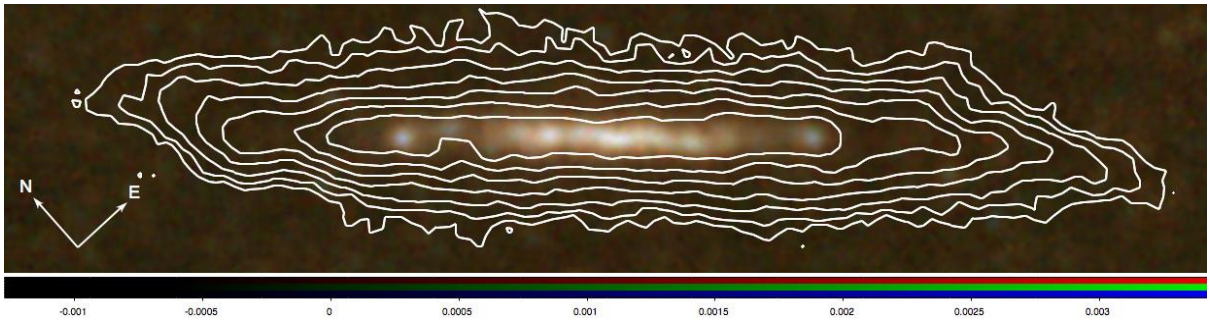
Edge-on spiral galaxies offer a unique perspective on the vertical structure of spiral disks, both stars and the iconic dark dustlanes. The thickness of these dustlanes can now be resolved for the first time with *Herschel* in far-infrared and sub-mm emission. We present NHEMESES, an ongoing project that targets 12 edge-on spiral galaxies with the PACS and SPIRE instruments on *Herschel*. These vertically resolved observations of edge-on spirals will impact on several current topics.

First and foremost, these *Herschel* observations will settle whether or not there is a phase change in the vertical structure of the ISM with disk mass. Previously, a dramatic change in dustlane morphology was observed as in massive disks the dust collapses into a thin lane. If this is the case, the vertical balance between turbulence and gravity dictates the ISM structure and consequently star-formation and related phenomena (spiral arms, bars etc.). We specifically target lower mass nearby edge-ons to complement existing *Herschel* observations of high-mass edge-on spirals (the HEROES project).

Secondly, the combined data-set, together with existing Spitzer observations, will drive a new generation of spiral disk Spectral Energy Distribution models. These will model how dust reprocesses starlight to thermal emission but the dust geometry remains the critical unknown.

And thirdly, the observations will provide an accurate and unbiased census of the cold dusty structures occasionally seen extending out of the plane of the disk, when backlit by the stellar disk. To illustrate the NHEMESES project, we present early results on NGC 4244 and NGC 891, two well studies examples of a low and high-mass edge-on spiral.

Figure 2; a color image of NGC 4244, a small, edge-on spiral galaxy with the atomic hydrogen (HI) contours overlaid. Cold dust observed with Herschel/SPIRE is limited to the inner thin gas disk and in discrete clouds. This clumpiness is in contrast to what Spectral Energy Distribution models find for much more massive disks.



Doppler tomography of transiting exoplanets: a prograde, low-inclined orbit for the hot-Jupiter CoRoT-11b

D. Gandolfi, A. Collier Cameron, M. Endl, M. Fridlund, A. Hatzes, A. F. Lanza

Time-series spectroscopy of planetary transits allows us to measure the sky-projected system obliquity, i.e., the angle in the plane of the sky between the projections of the planet's orbital momentum and the star's rotation spin. We report the detection of the Doppler shadow of the transiting hot-Jupiter CoRoT-11b. Our analysis is based on line-profile tomography of time-series, high-resolution spectra acquired during the transit of the planet. We measured a sky-projected spin-orbit angle of 5.25 +/- 1.75 degrees, consistent with a low-inclined orbit with respect to the stellar rotation axis. A backwards integration of the tidal evolution equations shows how the current measured obliquity translates into an initial value of about 10 degrees on the zero-age main sequence. Taking into account the effective temperature and mass of the planet host star (Teff=6440 K, M=1.27 Msun), the system can be considered a new telling exception to the recently proposed trend, according to which relatively hot and massive stars (Teff>6250 K, M>1.2 Msun) seem to be preferentially orbited by hot-Jupiters with high obliquity.

SPITZER RESULTS ON DISK EVOLUTION: MATCHING STELLAR PROPERTIES OF DISKS AND EXOPLANET HOSTS

Bruno Merín[1], Hervé Bouy[2], Luke Maud[3], Marta García Rivas[1], Loredana Spezzi[4], Neal J. Evans II[5], Ewine F. van Dishoeck[6], Lucas Cieza[7], Karl Stapelfeldt[8], Paul M. Harvey[5], Lori E. Allen[9]

[1] ESA/ESAC/Herschel Science Centre, [2] CAB, [3] Leeds, [4] ESA/ESTEC, [5] Austin, [6] Leiden, [7] Hawaii, [8] JPL, [9] NOAO

Abstract: The Spitzer data offers an exceptional tool for studying the status and evolution of the inner several AUs in the disks around young stars, were planets eventually form. This paper complements the general results from the Spitzer c2d Legacy program by Evans et al. (2009) with the analysis of the disk properties of a combined sample of close to 1700 disks with spectral types and Spitzer detections up to 24 microns in most known nearby star-forming regions. This constitutes the largest ever published sample of disks with available information to a couple of AUs from the central star and with ages ranging from a few to several hundreds Myrs. Therefore they represent a perfect laboratory to determine what are the statistical initial conditions available to form planetary systems in the first few hundred parsecs around the Sun. We classify all the SEDs as primordial, settled, transitional and diskless and study their frequencies as a function of stellar mass and stellar age. The resulting ratios are then compared with the potential planet formation mechanisms and with the Nice model for the formation of the Solar System to put our system in galactic context.

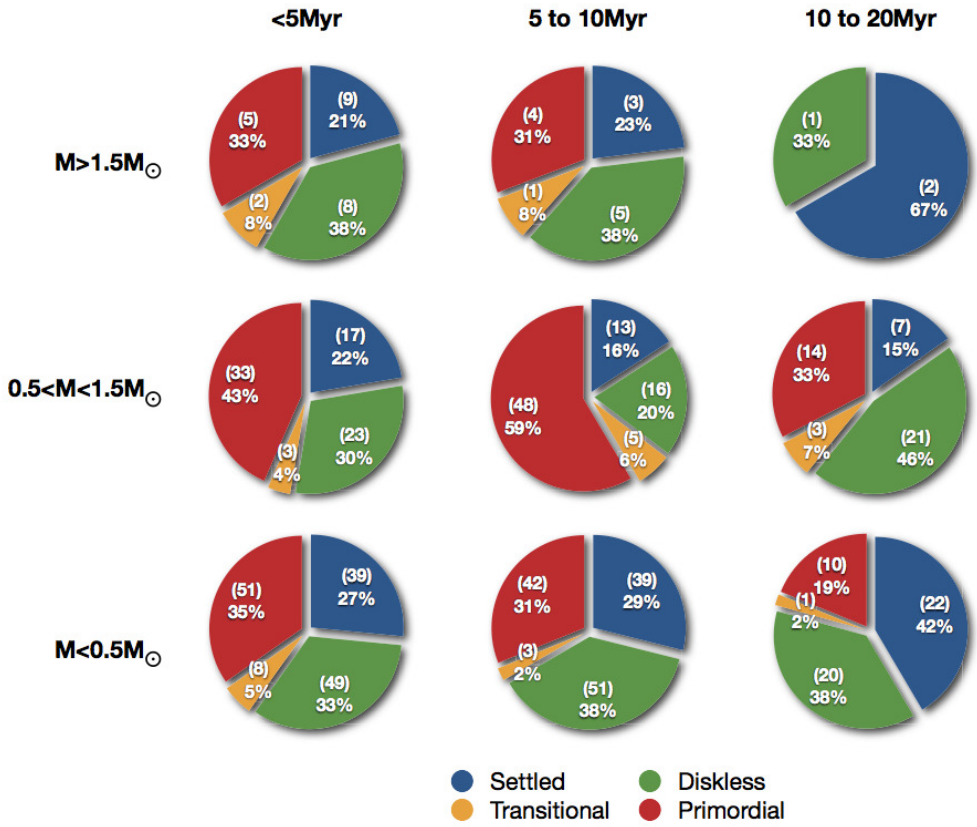


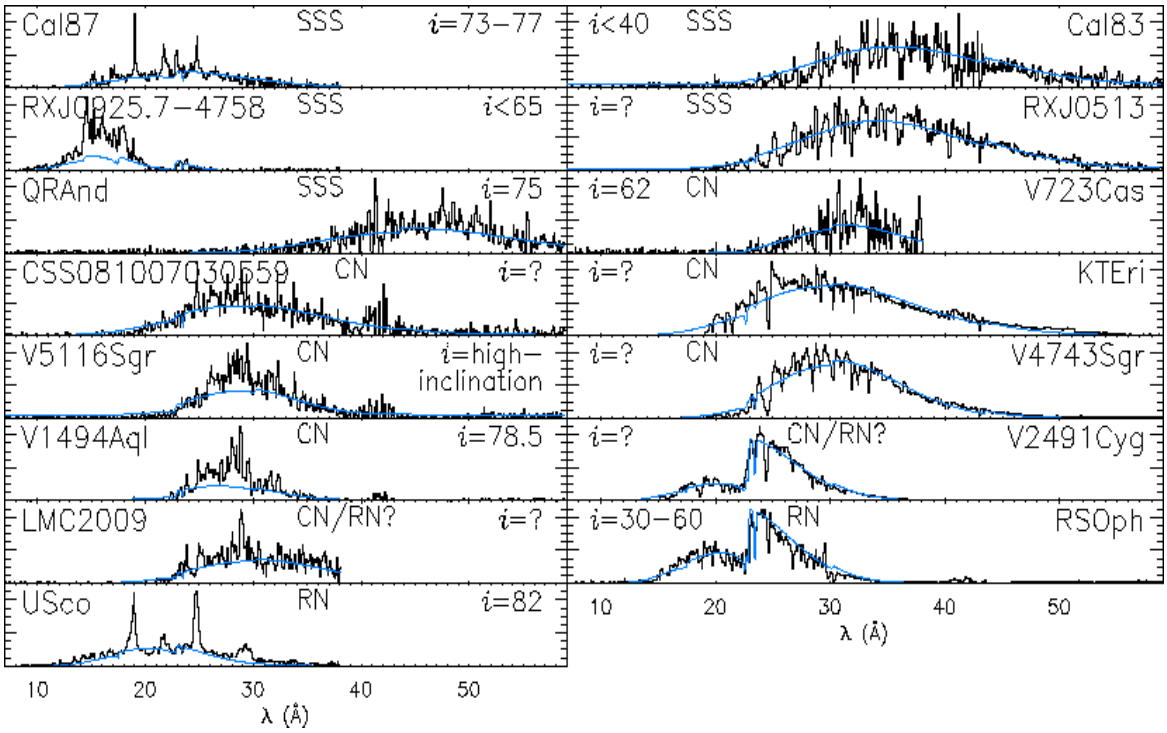
Figure 3: Preliminary pie charts showing the frequency of the three main types of as a function of the stellar mass and age. Fisher's statistical tests on the significance of the differences reveals that the distributions are indistinguishable at early and intermediate ages (0-5 and 5-10 Myrs) but that low and very-low mass stars differ from massive stars in the late ages (>10 Myrs) at the 71% confidence level.

Effect of Viewing Angle on Super-Soft-Source X-Ray Spectra

A. J.-U. Ness[1] , [1]ESAC
B.

Abstract

The advent of the X-ray grating spectrometers has given new momentum to the studies of Super-Soft-Source (SSS) X-ray spectra in high resolution. Earlier CCD-type spectra only allow determinations of effective temperatures while in the grating spectra, lines and continuum can be resolved. I have studied the X-ray grating spectra of eight classical novae during their SSS phase, two of them candidates for recurrent novae, two established recurrent novae, and four permanent SSSs including the prototypes Cal 83 and Cal 87. I discovered two categories of SSSs: those dominated by emission lines (SSSe) and by absorption line (SSSa). All spectra contain photospheric continuum emission, indicated by the shape of a blackbody. For the majority of SSSe, the inclination angle is known, which are all greater than 75 degrees. I argue that the SSSe are high-inclination systems in which photospheric X-ray emission from the central source is partially blocked and scattered via Thompson scattering, that preserves the spectral shape of the continuum. Since the electrons in the scattering medium move at high velocities, photospheric absorption lines are smeared out and are therefore not seen. Additional emission lines are produced by resonant line scattering. The fact that only high inclination systems show these effects of scattering, the scattering material must be concentrated to the ecliptic plane. While in permanent SSSs, the accretion disk can explain this behaviour, this result implies that in novae, the reformation of the accretion disk has already progressed to an advanced stage during their SSS phase. I argue that also the novae in low-inclination angle systems possess a reformed accretion disk. The viewing angle dependence requires non-symmetrical modeling approaches. Early disk reformation can also explain high-amplitude variations that have frequently been observed during during the early SSS phase.



Resolving the Inner Regions of Circumstellar Disks with VLT/NACO Polarimetric Differential Imaging

S. M. Birkmann[1] and S. P. Quanz[2], [1]ESA/ESTEC, [2]ETH/Zürich

Circumstellar disks are the cradles of planetary systems and their physical and chemical properties directly influence the planet formation process. As most planets are supposed to form in the inner disk regions, i.e. within several tens of AU, it is crucial to study disks on these scales. Polarimetric differential imaging with VLT/NACO offers high-contrast capabilities at very small inner working angles and probes the dust grains on the surface layer of the disk. I will report on results for the circumstellar disk around the Herbig Ae/Be star HD 97048, where we resolve the innermost ~20 to 160 AU of the disk in scattered light in the NIR.

MULTI-SPACECRAFT ANALYSIS OF LARGE SCALE PLASMA VARIATIONS WITHIN EARTH'S MAGNETOSHEATH

J. Soucek and C. P. Escoubet, ESTEC

We present a multi-spacecraft statistical study of plasma in terrestrial magnetosheath, focusing on dawn-dusk asymmetry in plasma temperature and properties of low frequency plasma waves. The study is based on conjunction events when Cluster and THEMIS spacecraft were simultaneously sampling opposite sides of the magnetosheath. We show that close to the bow shock, a significant asymmetry is observed in ion temperature and its anisotropy. As the plasma flow approaches closer to the magnetopause, the plasma properties become more homogeneous. We demonstrate that the asymmetry is due to the difference in plasma heating at the planetary bow shock: the angle between shock normal and interplanetary magnetic field determines the character of this heating process. We also investigate the asymmetry and spatial distribution of the occurrence of low frequency waves ($f < 1$ Hz) in different regions of the magnetosheath. The ion-cyclotron waves are found to be the dominant low frequency mode in the magnetosheath region close to to the bow shock; mirror mode structures are more frequently observed deeper inside the magnetosheath. Statistical results as well as several examples of joint Cluster-THEMIS observations are shown.

Developing a new model for peak intensity and fluence predictions of solar energetic proton events within 1.6 AU

A. Aran[1]

[1] ESTEC

Abstract

Particle radiation during large solar energetic particle (SEP) events may constitute a hazard for space missions. The underlying physics of the origin and development of SEP events is still being studied, and no scientific model can account for all processes involved in SEP events. This rends difficult to cope with the need of having tools to characterize and quantify the fluence and the peak intensity during SEP events. Together with colleagues at the University of Barcelona, K.U. Leuven and at ESTEC, we have developed a model for gradual SEP events easy to transitionate to a tool able to provide proton intensity-time profiles of 5-200 MeV protons, as seen by different observers placed along the same interplanetary magnetic field line (from 0.2 to 1.6 AU). Also, we have developed a method to couple a statistical model of Solar Energetic Particles (SEP) at 1 AU with this tool. The physics-based model combines 2D MHD simulations of shocks driven by coronal mass ejections (CMEs), from 4 solar radii, with a particle transport model via a semi-empirical relation between the plasma radial velocity jump and the injection rate of shock-accelerated particles at the point of the shock front where a given observer is magnetically connected to. We have compared the proton intensity-time profiles of a few SEP events in the event list of the statistical model with the synthetic profiles of the physical model to calibrate them. For these studied events, we derive the variation of the peak intensity and fluence with the radial distance from the Sun by placing several observers along the same interplanetary magnetic field line as the observer at 1 AU.

From Data to Equations: Inferring the laws governing Saturn's ring temperature with Cassini-CIRS

N. Altobelli[1] , D. Lopez [1;3], L. Spilker[2], S. Pilorz[2]
E-mail: nicolas.altobelli@sciops.esa.int

[1] ESA/ESAC, Madrid, Spain
[2] NASA/JPL, Pasadena, USA
[3] Max-Planck Institut for Intelligent Systems, Tuebingen, Germany

October 4, 2011

Six years after Saturn Orbit Insertion (SOI), the Composite Infrared Spectrometer (CIRS) onboard the Cassini Spacecraft has been performing a thermal mapping of Saturn's main rings, by measuring the thermal radiance in the far-infrared ([10-600] cm□1) for different viewing geometries. So far, more than 2.5 millions individual spectra have been recorded, from Saturn's northern winter solstice till Saturn's northern spring. We present a first attempt of treating the data set globally by using various data mining techniques.

Previous analysis has shown that the measured Saturn's main ring temperature is a non linear function of multiple geometrical parameters, that represents the thermal response of Saturn Rings to time dependent illumination conditions and varying observation geometry. The different values measured for the temperature function contain mixed information on physical properties of the ring at different scales, from large scale reflecting collective thermal behaviour of particles (mutual shadowing, mutual heating, heat transport through vertical motion), to microscopic scale (regolith thermal properties on individual particles surfaces).

Disentangling the physical implications of ring temperature variations is a major undertaking that has been attempted in the past years. Thermo-physical models have been developed, however generally constrained by subsets of measurements reflecting temperature variations with a limited number of geometrical parameters at a time. We propose in this work a global data mining approach of the data, following two approaches, one related to regression analysis using neural network type algorithms, and one using parameterized analytical functions as building blocks to reproduce temperature variations with observation geometry. In this later approach, we use only functions that are good approximations of the physical processes involved. The major a-priori unknown component in our formulas is the term describing the amount of shadow in the ring, either resulting from interparticles shadowing or surface regolith shadowing. We present a first analytical description of this component, that we aim at comparing with shadow models obtained from ray tracing on realistic ring dynamical simulations.

Herschel Observation of OSIRIS-REx Asteroid target – 1999 RQ36

Laurence O'Rourke, ESAC
Thomas Mueller, MPE, Garching
Beatriz Gonzalez-Garcia, ESAC
Bruno Altieri, ESAC
Antonella Barucci, LESIA Observatoire de Paris
Rosario Lorente, ESAC

On May 25th this year, NASA announced the selection of OSIRIS-REx as part of its New Frontiers Programme. The OSIRIS-REx mission will be launched in September, 2016, fly by the Earth for a gravity assist in September, 2017, and encounter the carbonaceous asteroid 1999 RQ36 in November, 2019. Proximity operations at the asteroid last through March 2021, acquiring up to 60 g sample of its surface material. The Sample Return Capsule shall return to the Earth surface on September 25, 2023.

Herschel observed this asteroid in September 2011. The results of this observation serves to allow the following key properties to be derived which are considered vital for the planning & preparation of the OSIRIS-REx mission

- Determination of the asteroids albedo and thermal inertia
- Provide confirmation of its shape
- Obtain light curve information (2 hours is half its rotation)
- Obtain a better understanding of the surface properties – light or very rough surface regolith.
- Identify whether this asteroid is a rubble pile (like Itokawa) or more solid in structure.

The initial results from the analysis of the Herschel observations shall be presented at this workshop.

CLUSTER MULTI-POINT LOOK AT DENSITY CAVITIES IN THE AURORAL ACCELERATION REGION

A. Masson[1], V. Genot[2], J. Pickett[3], G. Marklund[4], M. Taylor[1], C. P. Escoubet[5], H. Laakso[1], P. Décréau[6], A. Fazakerley[7], [1]Science Ops Dpt, European Space Agency, [2]IRAP - CNRS - Université Paul Sabatier, Toulouse, France, [3]Iowa University, Iowa, IA, USA, [4]KTH, Stockholm, Sweden, [5]Space Sci Dpt, European Space Agency, [6]LPC2E - CNRS - Université d'Orléans, Orléans, France, [7]MSSL, Didcot, United Kingdom.

Abstract. 2010 marked the 10th anniversary of the ESA/NASA Cluster mission in space. During this decade, the Cluster mission has crossed a number of key regions of the Earth's magnetosphere, enabling to study the Sun-Earth connection for the first time with four point measurements. Since 2006, the orbits of the Cluster satellites are slowly evolving from a nominal polar orbit to an oblique one. Meanwhile, the perigees of their orbits are going down from 19,000 km to just a few hundred kilometres.

During spring 2009, early winter 2009/2010 and late 2011, Cluster scientists could make use of this natural orbital drift to target a new key region of the magnetosphere: the Auroral Acceleration Region (AAR).

We present new observations of density cavities captured simultaneously by multiple satellites in the AAR region. The estimation of the electron density itself will be first presented. The quantitative estimation of the density in these cavities is of crucial importance for different physical auroral processes. For instance, auroral kilometric radiation sources emit from plasma cavities filled by a hot and tenuous plasma.

Thanks to the multiple point nature of these observations, new information can be extracted including: the size extent parallel to the magnetic field, the perpendicular density gradient on the sides of these cavities but also their association with AKR and solitary structures. Last but not least some indication about their temporal evolution will be presented. All these new physical parameters are key to better model density cavities and the role they play in the AAR.

THE HORSEHEAD NEBULA AS SEEN BY HERSCHEL

D. Teyssier[1], J. Goicoechea[2], M. Gerin[3], V. Ossenkopf[4], and the WADI team
[1]ESAC, ESA Spain, [2]CSIC-CAB, Madrid, Spain, [3]LERMA, Paris, France, [4]Univ. Cologne, Germany

Photodissociation regions (PDRs) are the transition layers between the warm ionized gas irradiated by intense far-UV (<13.6eV) radiation fields from nearby OB stars, and the cold neutral gas shielded from radiation. PDRs thus constitute a large fraction of the neutral gas in a galaxy and their physics (e.g., thermal balance and dynamics) and chemistry (gas dissociation and ionization, photo-processing of dust, etc.) are driven by the presence of far-UV photons.

PDR modelers have traditionally considered only pure gas-phase chemistry to determine the abundances of the major gas reservoirs. In the recent years, however, it has been recognized that grain surface processes can play a substantial role in the chemistry. In particular, the low abundance of water vapour in the cold ISM, one of the first species to freeze onto dust grains when Tdust <~ 100K, can only be understood if significant depletion from the gas phase takes place, and most of the available oxygen ultimately ends up locked as water ice mantles.

The Horsehead nebula is particularly well-suited to investigate grain surface chemistry in a FUV irradiated environment. The PDR is illuminated by the O9.5V star sigma Ori and viewed nearly edge-on. This offers the opportunity to study at small linear scales the physics and chemistry of a PDR with a simple geometry, very close to the prototypical kind of source needed to serve as model benchmark.

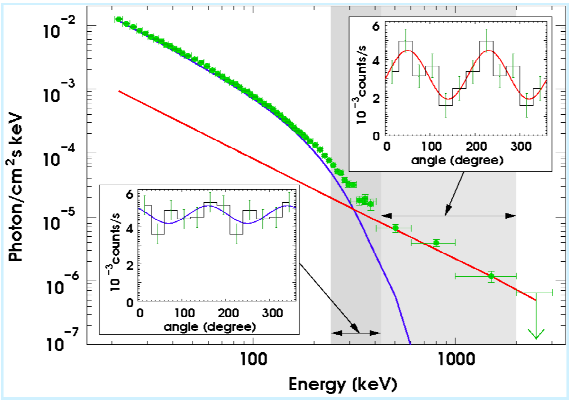
In this contribution I will review some of the results obtained on this particular PDR, and present recent observations obtained with the Herschel observatory.

GAMMA-RAY POLARIZATION IN CYGNUS X-1

M. Cadolle Bel[1], V. Grinberg[2], P. Laurent[3], K. Pottschmidt[4], J. Rodriguez[5] and J. Wilms[2]

[1] ISOC/ESAC (Spain), [2] ECAP (Germany), [3] APC & CEA-Saclay (France), [4]GSFC (USA) and [5] AIM & CEA-Saclay (France)

Because of their inherently high flux allowing the detection of clear signals, black hole x-ray binaries are interesting candidates for polarization studies, even if no polarization signals have been observed from them before. Such measurements would provide further detailed insight into these sources' emission mechanisms. We measured the polarization of the gamma-ray emission from the black hole binary system Cygnus X-1 with the INTEGRAL/IBIS telescope. Spectral modeling of the data reveals two emission mechanisms: the 250 - 400 keV data are consistent with emission dominated by Compton scattering on thermal electrons and are weakly polarized. The second spectral component seen in the 400 keV - 2 MeV band is by contrast strongly polarized, revealing that the MeV emission is probably related to the jet first detected in the radio band.

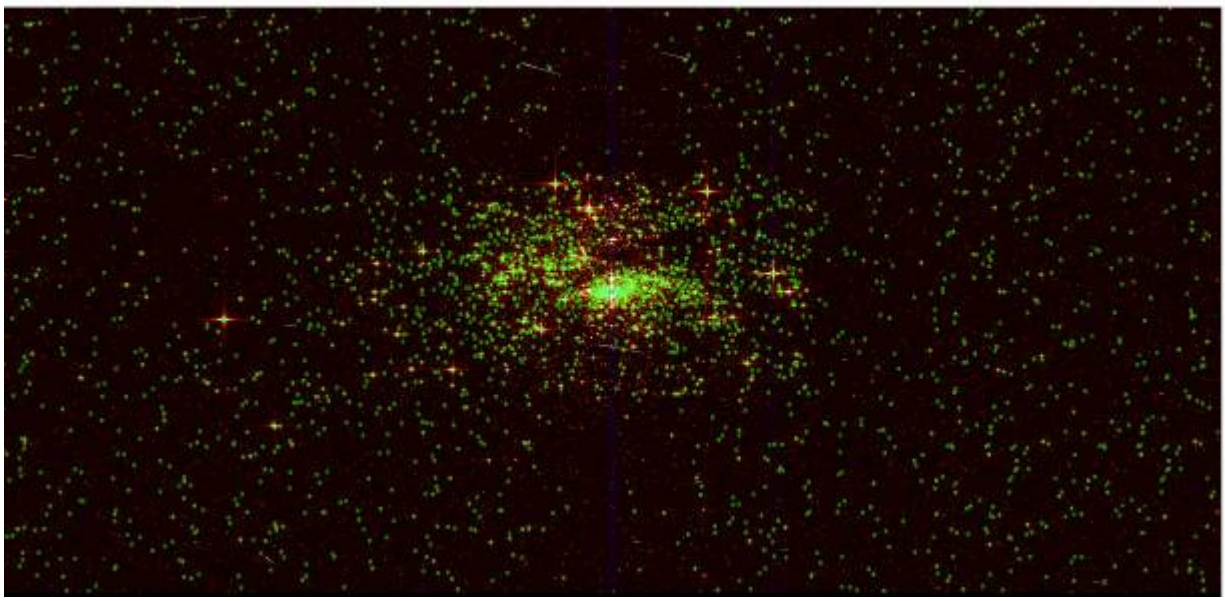


Cygnus X-1 spectra and polarimetry in the 200 - 400 keV and 0.4 - 2 MeV energy ranges. From Laurent et al. 2011, Science, 332, 438L

Gaia's view of open clusters: a case study of R136 in the Large Magellanic Cloud

J.H.J. de Bruijne[1] and G. De Marchi[1], [1]ESTEC

Gaia is the next space astrometry mission of the European Space Agency, building on the heritage of its predecessor Hipparcos. With a CCD-based focal plane containing ~1 billion pixels, Gaia will survey the sky and repeatedly observe the brightest ~1,000 million objects during its 5-year lifetime, down to 20th magnitude. Gaia's science data comprises absolute astrometry, broad-band photometry, and low-resolution spectro-photometry. Medium-resolution spectroscopic data will be obtained for the brightest ~150 million sources, down to 17th magnitude. Stellar parallaxes (distances) will be measured with standard errors below 10 micro-arcsecond (μas) for stars brighter than 13th magnitude, ~25 μas for stars at 15th magnitude, and ~300 μas at magnitude 20. Photometric standard errors are in the milli-magnitude regime. The spectroscopic data will allow the measurement of mission-averaged radial velocities with errors at the level of 15 km s^{-1} at magnitude 17. Gaia's primary science goal is to unravel the kinematical, dynamical, and chemical structure and evolution of the Milky Way. In addition, Gaia's data will touch many other areas of research, for instance stellar evolution and physics, solar-system bodies, fundamental physics, and exo-planets. Gaia will observe thousands of open clusters in the galactic disk but will also reach clusters in the Magellanic Clouds. This contribution presents a case study of the massive cluster R136 in the Large Magellanic Cloud. Through simulations using the on-board object-detection software in combination with a cluster membership list based on deep HST images, we find that, even in this massively dense and crowded environment, Gaia is capable of detecting stars down to 20th magnitude. The main sequence of the cluster, as well as the field-star red clump, is representatively sampled.



THE JEM-X CATALOGUE OF GALACTIC X-RAY BURSTERS

C. Sanchez-Fernandez[1] and E. Kuulkers[2], [12] INTEGRAL Science Operations Center (ISOC), ESAC, ESA

Type I X-ray bursts are thermonuclear explosions on the surface of weakly magnetized accreting neutron stars (NS) in Low-Mass X-ray Binary (LMXB) systems. During an X-ray burst, Hydrogen or Hellium--rich material, accreted from the companion star, and piled on the solid surface of the NS over hours or days, is burnt in a few seconds as the result of a thermonuclear runaway produced by the themonuclear fusion of the accreted material in degenerated conditions.

We have carried out a systematic search of Type-I X-ray bursts in the light curves of Galactic X-ray bursters, using the data acquired by the JEM-X monitor onboard INTEGRAL. All the public data available in the INTEGRAL archive have been analyzed. We present here the preliminary results of this ongoing work.

TRANSITING EXOPLANETS FROM THE COROT MISSION: STATUS OF THE DETECTION OF CANDIDATES AND CONFIRMED PLANETS

S. Carpano[1] (on behalf of the CoRoT detection group), [1]ESTEC

Abstract.

CoRoT has been designed to detect extrasolar planets around stars of magnitude V=[11,16], by the transit method. It monitors the optical flux of thousands of stars in several fields of view in the galactic plane, towards the galactic center (at 18^h50^m) or in the opposite direction (at 6^h50^m). For stars brighter than magnitude 15, the flux is integrated in 3 different colours: red, green and blue (that have however no direct correspondence to any standard photometric system). The integration time on board is 32 sec but, except for a selected number of targets, the flux of 16 read-outs is co-added before being downloaded.

The data of 16 fields have been analyzed so far. This corresponds to ~130000 light curves with lengths varying from 20 days to 150 days, for the "short" and "long" runs respectively. I present here the results of the detection teams who have reported more than 3500 transiting objects (clear binaries or planet candidates). Thanks to ground-based follow-up observations, 24 planets have been confirmed so far including CoRoT-7b, the first Super-Earth with measured radius.

YOUNG STARS SPECTROSCOPIC LIBRARY FOR GAIA

A. Mora[1], S. Mejido[2], B. Montesinos[3], C. Eiroa[2], R. Kohley[1] and N. Huelamo[3],

[1]ESAC, [2]Universidad Autónoma de Madrid. [3]Centro de Astrobiología (INTA-CSIC)

The Radial Velocity, Spectrometer (RVS) onboard Gaia will provide spectra for several million stars in the CaII IR triplet region: 847-874 nm. In addition to radial velocities, high precision stellar parameters (Teff, log g, v sin i, $L_\star$, $R_\star$) will be determined for several hundred thousand stars.This information is key to determine the evolutionary status of pre-main sequence (PMS) stars. However, there are no general purpose automatic classification codes applicable to PMS stars in the RVS range, because the most interesting lines are affected by emission or profile variability.

VLT-Xshooter provides the same spectral resolution R~10000 than RVS. Science verification data plus Herschel GASPS ancillary data have been used. The data has been reduced with the ESO pipeline, being tested at that time. The sample comprises Herbig Ae/Be and T Tauri stars of varius ages, spanning the mass range ~ 0.5-2.5 $M_\odot$.

Approximate physical parameters (Teff, v_{rad}, v sin i) have been obtained for each star comparing the observed spectra to Kurucz synthetic models in the RVS spectral range. Good stellar parameters were determined for all solar type stars (FGK spectral types). Photospheric lines from different ions, useful for spectral fitting were identified. The Herbig Ae/Be sample is currently under analysis.

This work is the basis for a future automatic physical parameters fitting tool, that could be useful for the analysis of PMS stars in the frameworks of Gaia or the recently approved Gaia-ESO survey.

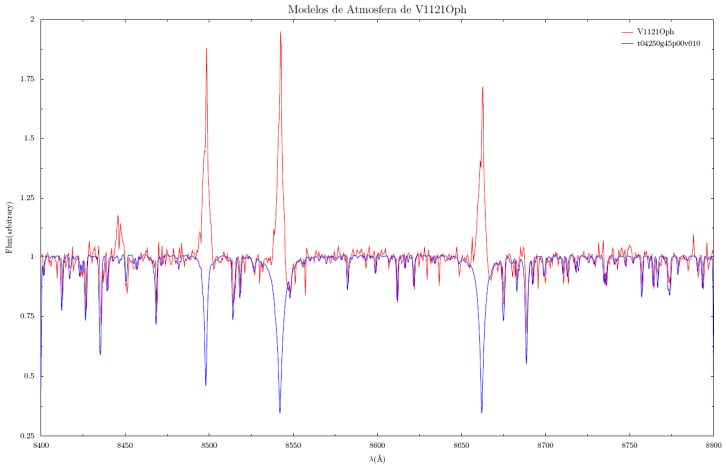


Fig. Comparison between observed and synthetic spectra. for: the highly variable V1121 Oph (Teff ~ 4250 K). The photosperic fit is good for faint lines, even though the CaII IR triplet (the best lines for main sequence lines) lines are not useful because they are in emission.

Limb observations of CO_2 non-LTE emission in Mars atmosphere by OMEGA/MEx

A. Piccialli (1), P. Drossart (2), M.A. Lopez-Valverde (3), A. Määttänen (4), B. Gondet (5), F. Altieri (6), O. Witasse (1), J. P. Bibring (5)

(1) ESTEC, Noordwijk, The Netherlands, (2) LESIA, Meudon, France, (3) IAA/CSIC, Granada, Spain, (4) LATMOS/CNRS, Guyancourt, France, (5) IAS, Orsay, France, (6) IFSI/INAF, Rome, Italy.

The OMEGA experiment on board the ESA mission Mars Express is a visible and near-infrared imaging spectrometer functioning in two channels in the wavelength range 0.38-5.1 μm [1]. Since January 2004 OMEGA/MEx has provided limb observations of CO_2 emission on the dayside of Mars. The CO_2 emission observed at 4.3 μm is interpreted as non-LTE fluorescent emission in the upper atmosphere (Fig. 1). Non-local thermodynamic equilibrium (non-LTE) is a condition typical of the upper atmosphere of a planet and it occurs when collisions between atmospheric species are not enough efficient in transferring energy. Two distinct emission peaks are observed (Fig. 1), one around 4.3 μm, produced by a combination of several CO_2 bands of the main isotope (626), and another one around 4.4 μm, mostly due to the 636 isotopic bands. The variability of the non-LTE emission with latitude, altitude, solar illumination and season was analyzed and compared to predictions derived by non-LTE model. The variations of the emission with geophysical parameters, like the emission height and the solar illumination (SZA), are analyzed in detail. Two strong variations can be observed in the radiances: (1) the emission reach a peak at the altitude of ~70 km, (2) the intensity of the emission decreases with increasing solar zenith angle. Both variations are well explained by the non-LTE model [2, 3], as a solar driven pumping of multiple CO_2 bands in the 4.3 μm region. Similar results have also been obtained by the Planetary Fourier Spectrometer, on board Mars Express [4]. We are currently analyzing the whole OMEGA dataset with a double goal: to validate the non-LTE model and to describe the variability of the Martian upper atmosphere, for the first time using this emission.

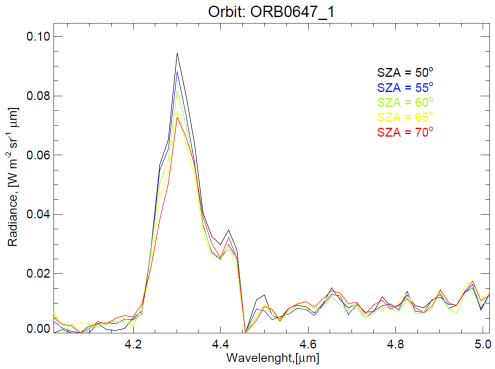


Figure 1: Omega spectra taken at the limb at an altitude of ~68 km and at different solar zenith angles: (black) 50º; (blue) 55º; (green) 60º; (yellow) 65º; and (red) 70º. The non-LTE emission at 4.3 μm is clearly visible.

[1] Bibring, J. P., et al., ESA SP 1240, pp. 37-49, 2004.

[2] López-Valverde, M. A. et al., PSS, Vol. 53, pp. 1079-1087, 2005.

[3] López-Valverde, M. A. et al., PSS, 2011.

[4] Formisano, V. et al., Icarus, Vol. 182, pp. 51-67, 2006.

Interdisciplinary study of the methane on Mars

O. Witasse[1], J. Benkhoff[1], J. Vago[1], and G. Etiope[2]

[1]ESA/ESTEC, [2] Istituto Nazionale di Geofisica e Vulcanologia, Roma

Methane was detected in the atmosphere of Mars by the Mars Express and Mars Global Surveyor spacecraft, and with ground-based telescopes. The reported methane variability (from zero to about 40-50 parts per billion in term of mixing ratio) cannot be explained or reproduced by atmospheric models so far. In this activity, partly funded by the faculty, we carry out independent and complementary studies: (1) Numerical modelling of the transport of methane from the subsurface to the atmosphere of Mars; (2) in-situ measurements of methane in a Mars analogue site. We will explain the motivations and give the current status of these studies, show the organization of a field trip in California (planned in December 2011) and discuss our future plans.

Unsupervised Analysis of Hyperspectral Data

A. Schmidt and E. Treguier , ESAC

Imaging spectrometers deliver very large amounts are data which are candidates for automatic summarisation for exploratory data analysis. In the frequent absence of ground truth for planetary data, unsupervised analysis methods can provide relatively unbiased information about the processes which are reflected in the data [1]. We investigate the use of unsupervised analysis based on non-negative matrix approximation [3, 4] combined with subsequent classification [2] to provide scientists with succinct summaries. Since typically there often is no ground truth to com- pare to, unsupervised rather than supervised methods allow to extract new information from data sets. We designed particularly efficient methods to cope with the large data volumes which are typical for this type of instrument.

The methods we use are divided into two steps: (1) Using non-negative matrix factorisation, we extract candidate sources for further analysis in an unsupervised fashion. (2) The candidates are then subject to classification via clustering and k-means algorithms to group them into categories according to similarity. We note that all of these methods are fully transparent and do not preclude the application of conventional hyperspectral methods.

References

[1] Cichocki, A., Amari, S.-I.: Adaptive blind signal and image processing – Learning algorithms and applications, Wiley Interscience, 2002

[2] Hastie, T., Tibshirani, R. ,Friedman, J.:The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Springer, 2009

[3] Lee, D.D., Seung, H.S.: Algorithms for non-negative matrix factorization, Advances in neural information processing systems, 2001

[4] Schmidt, F., Schmidt, A., Tréguier, E., Guiheneuf, M., Moussaoui, S., Dobigeon, N.: Implementation strategies for hyperspectral unmixing using Bayesian source separation, IEEE Transactions on Geoscience and Remote Sensing, vol. 48, no. 11, pp. 4003–4013, Nov. 2010

Star forming galaxies vs AGNs in Galaxy Cluster CL0024+1654

Ricardo Pérez-Martínez[1], Miguel Sáchez Portal[2], Irene Pintos Castro [3], Jordi Cepa Nogué[3,4].

1: ESAC: XMM-newton SOC / INSA S.A.

2: ESAC: HSC / INSA S.A.

3: I.A.C.

4: Universidad de La Laguna.

Both stellar formation and AGN abundance is known to be sensitive to environment, being generally accepted that the ratio of star forming galaxies and AGNs versus quiescent members of Galaxy Clusters are smaller than that in the field at similar redshift. Carefully mapping both populations will distinguish among the different processes involved and the connection between those affecting the stellar formation activity and those acting on the AGN. We have performed a deep H\alpha/[NII] survey on CL0024+1654 using the Tunable Filters of OSIRIS at GTC, what allow us to differentiate both lines as well as fully cover two virial radii of the cluster projected area. This technique poses no selection bias since all the objects in the FOV are observed with a resolution difficult to obtain with integral field spectroscopy. The 3D spatial distribution of both AGNs and SB galaxies will be analysed in the talk as well as the different implications of their grouping. CL0024+1654 is a rich, non relaxed Galaxy Cluster at z~0.4.

CLOUD MORPHOLOGY AND DYNAMICS OF THE VENUS ATMOSPHERE

D.V. Titov, A. Piccialli, and H. Svedhem, ESA/ESTEC

Since April 2006 Venus Express has been performing a global survey of the remarkably dense, cloudy, and dynamic atmosphere of our near neighbour. More than 300 radio-occultation experiments covering all latitudes and local times had been acquired so far. They reveal highly variable temperature structure in the mesosphere and within the clouds. Temperature sounding suggests that the cloud deck at 50-60 km is convectively unstable, in agreement with the patterns seen in UV images. Joint analysis of several experiments indicated latitudinal changes of the cloud top structure. The cloud top altitude varies from ~72 km in the low and middle latitudes to ~64 km in the polar region, marking vast polar depressions. UV imaging monitors strongly variable cloud patterns showing for the first time the middle latitudes and polar regions in unprecedented detail.

Tracking of the cloud features at both UV and thermal infrared wavelengths characterizes the global wind field and its variations. Low and middle latitudes show an almost constant zonal wind speed of 90 ± 20 m/s at the cloud tops and vertical wind sheer of 2-3 m/s/km. Towards the pole, the wind speed drops quickly and the vertical shear vanishes. The meridional poleward wind ranges from 0 to about 15 m/s and there is some indication that it may change its direction at high latitudes. The global zonal circulation converges to giant vortices at the poles. Comparison of the thermal wind field derived from temperature sounding to the cloud tracked winds confirms the approximate validity of cyclostrophic balance, at least in the latitude range from 30 S to 70S. The observations are supported by development of General Circulation Models.

Hidden warm absorber in the Seyfert 1 Mrk 335: A high-velocity ionized wind uncovered by XMM-Newton and Swift

Anna Lia Longinotti[1], Yair Krongold[2], Dirk Grupe[3]

[1] ESAC, Madrid

[2] Instituto de Astronomia, Universidad Nacional Autonoma de Mexico, Mexico

[3] Pennsylvania State University (US)

I will present the discovery of a multi-component ionized wind in the Seyfert 1 Mrk 335. This bright source was not known to host outflowing ionized gas until we analysed several high resolution XMM-Newton spectra in combination with a long-term Swift monitoring program that shows extreme flux and spectral variability. Multi-epoch RGS spectra reveal that the wind consists of three ionization components, all outflowing at a velocity of ~5000 km/s. For the lowest ionization component photoionization equilibrium is ruled out since the absorber is detected at any flux state with constant ionization and with less coverage at higher flux. The other two components may vary either in ionization state or covering factor, depending on the level of continuum. I will discuss possible physical scenarios that may explain these properties.

Science with the VO: Spectroscopic studies of Herbig Ae/Be stars

Author: D. 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. Using the tool VOSpec, a multi-wavelength spectral analysis tool, developed by the ESA-VO Team at ESAC, and new developments on scripting with VOSpec (VOScript), we have started to undertake a comprehensive study of spectral and photometric data in the VO on Herbig Ae/Be stars. By studying the line strengths, variabilities and spectral energy distributions, from the X-ray to sub-mm, we aim to gain insights into the processes and disk properties of a large sample of these objects. This presentation will show the initial findings of the spectroscopic analysis and the initial Spectral Energy Distribution classifications.

High time-resolution observations of the flare star EQ Pegasi – preliminary results

C.V.M. Fridlund and A. Stankov

We present preliminary results of the analysis of high time-resolution data of a flare event of EQ Pegasi. The EQ Peg A/B system was observed at the Nordic Optical Telescope for 5 nights with a long slit spectrograph with millisecond time-resolution. The temporal evolution of 5 spectral lines was analysed in more detail and compared to the continuum behaviour. The analysis of the differences of the temporal behaviour of the spectral lines can shed a light on the propagation of the flare's kinetic energy through the layers of the star.

The balloon-borne far-infrared polarisation mapping experiment PILOT

R.J. Laureijs, S. Grabarnik, J. Tauber (ESTEC)

Jean-Philippe Bernard (IRAP, Toulouse)

X. Dupac, L. Mendes (ESAC)

PILOT (*Polarised Instrument for Long wavelength Observation of the Tenuous interstellar medium*) is a balloon-borne astronomy experiment led by IRAP in Toulouse. The first PILOT flight is scheduled for late 2012 (from Kiruna). PILOT carries a 1m class telescope to map polarized emission at 240 and 550 micron arising from dust grains present in the diffuse ISM. The observations constrain the large scale geometry of the magnetic field in our Galaxy and provide the magnetic field alignment properties of dust grains. In this domain, the measurements of PILOT are complementary to those of Planck, which has also polarisation capabilities. In addition, PILOT will measure polarized dust emission towards very diffuse regions, where the measurements can be interpreted only in terms of the physics of the dust. PILOT will provide a knowledge base of galactic foreground data and methods to subtract the contribution of polarized foreground emission for future cosmology missions, which aim at measuring the polarization of the Cosmic Microwave Background. RSSD has supported payload design studies in the past, and we are presently working on an optics straylight study to fully understand the instrument design for polarisation measurements. We present the experiment, the RSSD involvement and the status of the project.

AUTOMATED CRATER DETECTION IN MARS EXPRESS HRSC IMAGES

A. M. Mera[1], D. J. Heather[2], J. L. Vazquez[2], and F. Martin[1]; [1] Universidade de Vigo, [2] ESAC, ESA.

As part of our continuing efforts to provide the scientific community with means to easily access the data they are interested in, ESA's Planetary Science Archive (PSA) is trying to classify the geographical features that appear in the HRSC images. The sheer amount of images available in the PSA database makes manual classification impossible in practice. Therefore, the PSA is interested in investigating the application of automated classification tools using image-processing techniques.

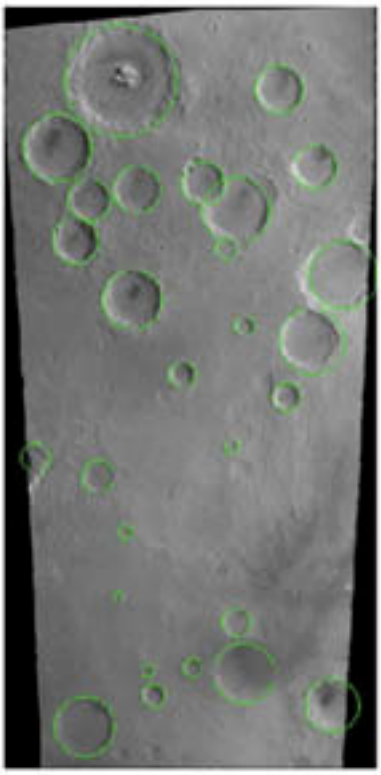


Figure 4: Results of the Hough Transform algorithm

This project, run in collaboration with Universidade de Vigo, has resulted in the development of a prototype that can automatically scan the HRSC images and detect the location of impact craters and calderas. Two algorithms were studied, one based on the *Hough Transform* and another based on the *Viola-Jones* algorithm. Initial tests showed that the *Viola Jones* algorithm requires significant computing resources that were not available in this study. The focus to date has therefore been on implementation of the *Hough Transform* algorithm. The table below shows the results of the initial study.

The algorithms output centre co-ordinates and radii for all features found. The results are very promising, and the algorithm can easily be modified to detect any circular object in a gray-scale image. It could therefore be applied to detecting craters on any planetary body.

It is hoped that the algorithms from this study can be improved and further developed to detect other geographical features such as volcanoes, valleys, rifts etc. These could in future be used to enhance the meta-data in the PSA and allow for end-users to search for feature types on any planetary body for which image data are available.

	Nearest neighbour interpolation	Bilinear interpolation	Bicubic interpolation
False Acceptance Ratio	12.10%	15.13%	34.53%
False Rejection Ratio	33.7%	32.32%	37.69%
True Acceptance Ratio	66.3%	67.68%	62.31%

Table 1: Statistical results from the Hough Transform algorithm.

Pattern recognition for the creation of synthetic flat fields

M. Almeida1, J. M. Fonseca2, 1ESAC, 2 Universidade Nova de Lisboa

The VMC camera on board of Venus Express was damaged on route to Venus and presents some patterns on the image that are similar to a dirty window. The patterns make it impossible to use the ground calibration data and even the use of a generic flat field obtained in Venus as the patterns are not stable.
Currently the correction is done acquiring pericenter data as the scenery is very homogeneous. This way it is possible to create flat fields and correct the data for a given orbit. However the flat fields are not always perfect as the homogeneity of the image can not be guaranteed and many times are even inexistent as the pericenter can be occupied by observations not compatible with the flat field acquisition.
The work that we just started has the objective of finding the spurious patterns in non homogenous images using pattern finding algorithms, in order to produce synthetic flat fields. This work can also be of interest in the identification of planetary morphology.

SCIENCE OPPORTUNITY ANALYSIS AND OBSERVATION GEOMETRY FOR SOLAR SYSTEM OPERATIONS AND SCIENCE PLANNING

M. Costa i Sitjà[1,2], A. Cardesín Moinelo[2,4], M. Almeida[3,4], N. Altobelli[4]
[1] *Universidad Politécnica de Madrid, Ramiro de Maeztu, 7, 28040, Madrid, Spain*

[2] *INSA, Pintor Rosales, 3, 28008 Madrid, Spain*

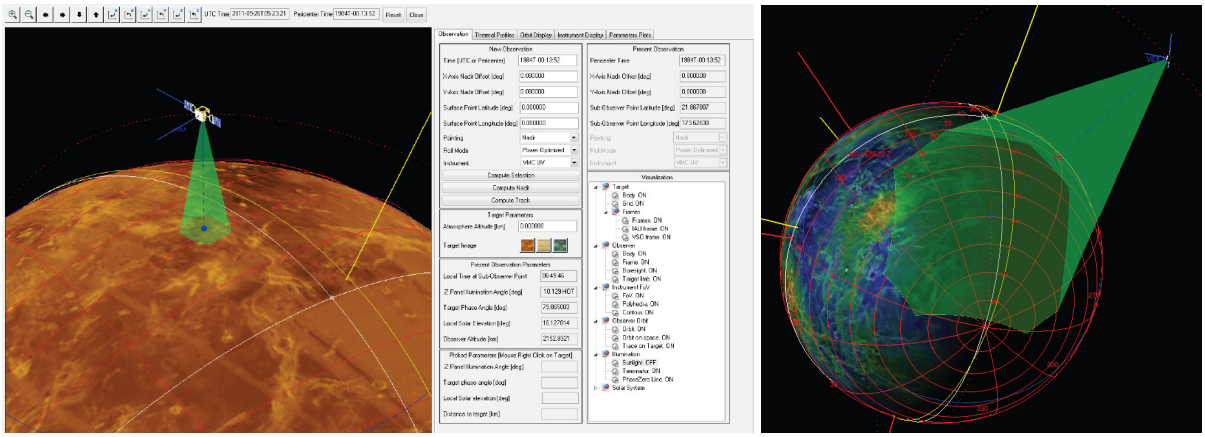
[3] *VEGA, PO Box 78 E-28691 Villanueva de la Cañada, Madrid, Spain*

[4] *ESAC/ESA, PO Box 78 E-28691 Villanueva de la Cañada, Madrid, Spain*

In planetary missions the geometry of the observations is of key importance. The observations can be characterized by all types of positions and attitudes of the spacecraft with respect to the planet, various illumination angles, or even positions of other bodies such as stars, comets, moons, etc. Observation requirements from different payloads are not always compatible and decisions have to be made on which experiments take priority. Given the large amount of geometric conditions and scientific or engineering constraints, the conflict resolution process can be long and hard to optimize. Therefore the full knowledge of the observation opportunities is extremely important in the decision-making process.

The purpose of our research project is to develop a system for science opportunity analysis for a generic mission scenario, including methods to analyze the different observation options available for a given mission scenario. A first prototype has been developed in the frame of Venus Express allowing the user to visualize in a dynamic three-dimensional environment a requested pointing for a given instrument, spacecraft attitude at a certain time. In addition to the visualization engine, the tools supports the generation of a large and tailored list of outputs such as the field of view of the instrument, the thermal constraints of the spacecraft, the complete geometry of the observation and enables the user to plot and export many geometrical parameters of interest. This prototype is implemented in IDL (Interactive Data Language) and based on SPICE, a planetary data information system developed by the Jet Propulsion Laboratory.

The objective in the near future is to further investigate the possibilities of the concept and its application to other planetary missions in operations such as Mars Express and Rosetta, under development as Bepi-Colombo or in study phase as JUICE. The development will continue to include computation of events and windows of interest, to be used for preliminary mission design, improvement of the planning process and enhancement of the modularity to include new and more advanced capabilities.



INFRARED EXCESS IN SYSTEMS WITH TRANSITING PLANETS: EVIDENCE FOR PLANETESIMALS COLLISIONS?

Álvaro Ribas[1], Bruno Merín[1], David Ardila[2], Hervé Bouy[3]

[1] ESA/ESAC/Herschel Science Centre, [2]NASA Herschel Science Center, [3]LAEFF-CAB

Abstract: The existence of warm infrared excess around young stars (≤ 300 Myrs) is properly explained as infrared reprocessed light from their protoplanetary disks. However, this feature is not commonly found in planet-hosting Main Sequence stars, which have typically cleaned all the rest of their parental protoplanetary disks at orbits of a few AU. We present a sample of 21 stars with transiting planets selected from the Kepler Input Catalog (KIC) of planetary host candidates with warm infrared excesses at 12 and 24-micron bands of the Wide-Field Infrared Survey Explorer Preliminary Release Catalog (WISE PRC). The sample was selected from ~500 objects from the Kepler Planet-hosting candidate catalog, which have both 2MASS and WISE counterparts. This excess emission reveals the existence of close dusty debris belts at distances closer than a few AU from the stars and potentially caused by planetesimal collisions in phenomena potentially similar to the Late Heavy Bombardment (LHB) event in our early Solar System. We compare our results with previous works and propose possible explanations for their warm infrared excess, which is very surprising given the very likely old Main Sequence ages of the parent stars.

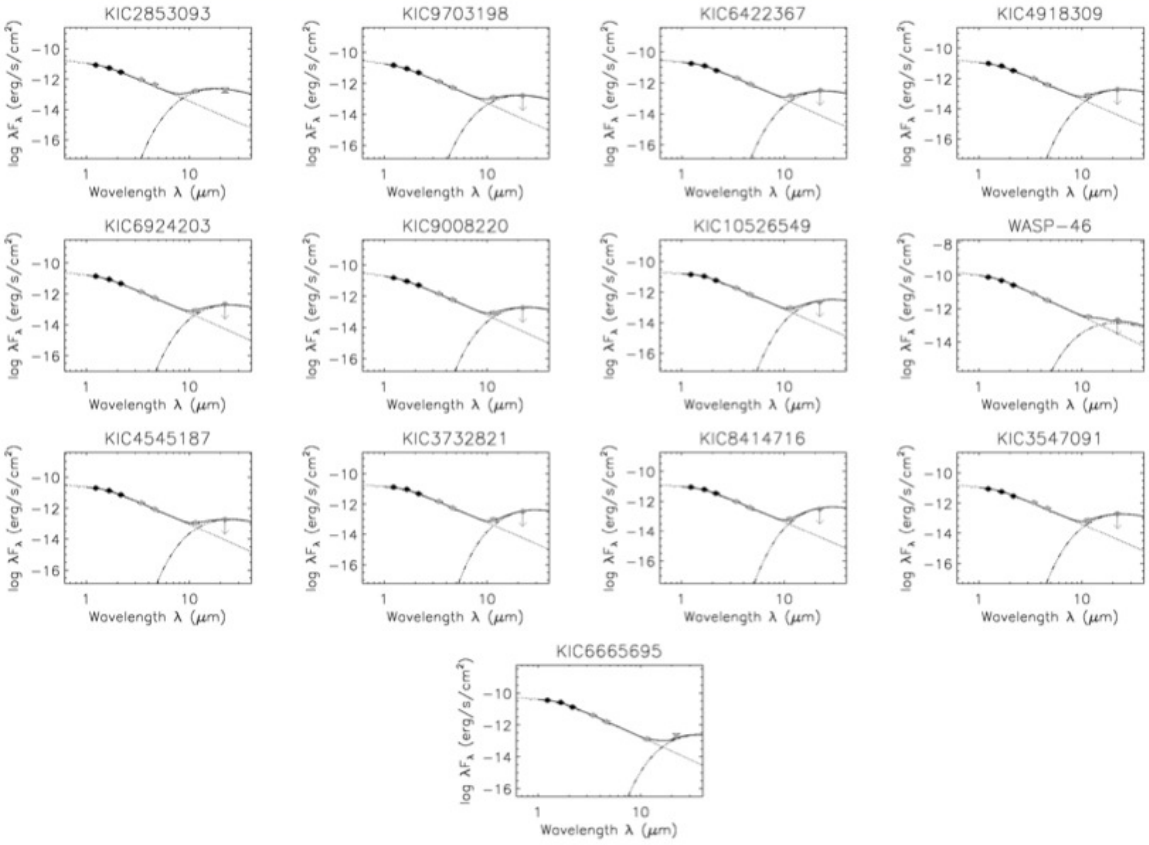


Figure 3: SEDs of the selected candidates. The fitted photosphere (solid line), 2MASS (black dots) and WISE (grey dots) photometry are represented. A photosphere (dotted line) is fitted to the 2MASS and W1 and W2 bands. The fitted blackbody is also shown (dashed-dotted line). Arrows represent W4 upper limits.

PROBA2: two years in orbit

J. Zender[1], A. De Groof[2], D. Berghmans[3], M. Dominique[3] ,G. Schwehm[1]

4. ESA/ESTEC/SRE-OS
5. Royal Observatory of Belgium, Brussels, SRE-OS
6. Royal Observatory of Belgium, Brussels

PROBA2 is an ESA micro-satellite, launched on November 2, 2009 from Russia. It carries two solar monitoring instruments, the LYRA UV radiometer and the SWAP telescope for coronal imaging and space weather monitoring.

This poster presents the mission and spacecraft and gives examples of multi-instrument and multi-spacecraft analysis obtained from several campaigns during campaigns in the first two years of operations.

The list of examples given is not exhaustive but presents a subset of the activities. It demonstrates the manifold of data analysis be possible from small spacecraft. Most cases represent ongoing studies.

The availability of the different data products and their distribution is discussed.

2011 Draconid Observation Campaign: Predictions, Observations, Results

J. Mc Auliffe[1], J. J. Zender[2], D. V. Koschny[2], Jeremie Vaubaillon[3]

On the night of October 8th 2011, meteors from comet 21P/Giacobini-Zinner were predicted to outburst with expected rates of several 100 meteors per hour [Vaubaillon et al., 2011]. An airborne observing campaign using two small jet aircraft was deployed from Kiruna, Sweden to an altitude of 13 km. This allowed the observation of the meteor shower under good sky conditions without clouds. A large array of cameras were employed in the campaign, including ESA's wide FOV SPOSH camera [Oberst et al., 2011]. Double-station observations were performed between the two aircraft. With these observations, the atmospheric trajectories and the light curves of the meteors can be calculated, which subsequently allow the determination of heliocentric orbits and constraint of the physical properties of the particles. Here an overview of the campaign and first results are be presented.

Vauballion, J.; Watanabe, J.; Sato, M.,; Horii, S.; Koten, P. – The Coming 2011 Draconids meteor shower. WGN, Journal of the International Meteor Organization, vol. 39, no. 3, p. 59-63.

Oberst, J.; Flohrer, J.; Elgner, S.; Maue, T.; Margonis, A.; Schrödter, R.; Tost, W.; Buhl, M.; Ehrich, J.; Christou, A.; Koschny, D. – The Smart Panoramic Optical Sensor Head (SPOSH)—A camera for observations of transient luminous events on planetary night sides. Planetary and Space Science, vol. 59, iss. 1, p. 1-9.

Contact: jonathan.mcauliffe@esa.int

1: ESA/ESAC, Villafranca del Castillo, Madrid.

2: ESA/ESTEC, Nordwijk, The Netherlands.

3: IMCCE, 77 Av. Denfert Rochereau, 75014 PARIS, FRANCE

Herschel Observation of (21) Lutetia around the Rosetta Flyby

Laurence O'Rourke, ESAC
Thomas Mueller, MPE Garching
Ivan Valtchanov, ESAC
Bruno Altieri, ESAC
Beatriz Gonzalez-Garcia, ESAC,
Laurent Jorda, LAM Marseille,
Benoit Carry, ESAC
Michael Kueppers, ESAC
Olivier Groussin, LAM Marseille,
Antonella Barucci, LESIA Observatoire de Paris

Prior to and around ESA Rosetta's flyby of (21) Lutetia, the ESA Herschel Space Observatory imaged the asteroid using the PACS & SPIRE photometer instruments in the range of 70um to 500um. The Herschel observations, fed into a thermophysical model (TPM) using as input a flyby image based shape model (built upon Rosetta OSIRIS instrument observations) were further correlated with ~70 multi-wavelength (IRAS, ISO-VISIR, IRTF, Akari, ESO-TIMMI2, Spitzer-IRAC) observations of Lutetia. We confirm the albedo measured by Rosetta (pV of 0.20 +/- 0.01), derive the "true" H-mag value (7.48+/- 0.03) based upon the cross-sections of the asteroid observed from all aspect angles & find that (21) Lutetia has an extremely low thermal inertia (*5 Jm-2s-0.5K-1*) as well as a very low surface temperature (<50K). Finally, with our results, we have identified a hill/crater surface feature located on the asteroids southern region not observed by Rosetta.

An instrument for the detection of fast transient phenomena in planetary atmospheres: SPOSH-IR

H. Svedhem, D. Koschny, J. Ter Haar, ESTEC

An initial development phase covering sensor qualification and front end electronics design for an eventual flight model of the SPOSH-IR (Smart Panoramic Optical Sensor Head- Infra Red) is presently being funded by the RSSD research programme budget. The Sposh-IR is an infrared video rate imager with built in event detection and pattern recognition software, intended for general use for the detection of transient atmospheric phenomena from space. The first application will be detection of bolides (fireballs). Bolides are generated when meteoroids in the meter class enter the Earth's atmosphere. The largest meteoroids sometimes (depending on velocity, entry angle and composition) survive the pass through the atmosphere and end up as meteorites on the surface of the Earth. Meteoroids in the meter class and larger are too infrequent to be observed from the Earth with good statistics, and a space based camera has clear advantages due to the coverage of a much larger area. In addition cloud cover is avoided, and for an IR camera like the Sposh-IR day time observation may be possible. Candidate flight opportunities include ISS and Russian geostationary s/c.

Other applications for the Sposh-IR instrument include detection of sprites, blue jets and elves (lightning like discharges in the stratosphere and between the stratosphere and the ionosphere) mostly occurring above thunderstorms. Detection of impacts on airless bodies is an additional potential application.

A fully operational bread-board of this instrument was developed by Jena Optronics and delivered to RSSD in 2009. This unit has been used for several filed campaigns and its basic design serves as a reference for the present work.

The work within the present funding phase covers sensor characterisation and flight qualification. For this purpose ten Sofradir Mars detectors have been purchased and a test programme has been defined. The detectors are 320 x 256 pixel HgCdTe sensors mounted on top of four stage thermoelectric coolers in hermitically sealed packages. The operational temperature is 200K and the useful wavelength range is between 0.8 and 2.5 micrometer. The detector is capable of operating at a frame rate of 150Hz. The work further covers the design, manufacturing and functional testing of a flight like front end electronics assembly and initial design and testing of an instrument controller/processor. The processor will most likely be one of the most recent dual core LEON3 versions. This presentation will cover the technical aspects of the work to be performed within this qualification and development.

CLEANING DOUBLE STAR MAGNETIC FIELD DATA

T. Klos[1] and H. Laakso[1], [1]ESA/ESTEC, Netherlands

Double Star was the first scientific mission done in collaboration between ESA and Chinese National Space Agency. Half of the instruments are flight spares of the Cluster instruments. The purpose of the mission was to study, together with Cluster, physical processes in the Earth's magnetosphere. Two Double Star satellites (TC-1 and TC-2), launched in Dec 2003 and Jul 2004, were operational for almost four years. Each spacecraft carries 8 experiments including a dual Flux-Gate Magnetometer.

Due to a wrong wiring of the solar panels, large magnetic interferences occur on TC-1 while for TC-2 the solar array wiring was corrected. On both spacecraft there are plenty of telemetry errors particularly when the data were collected through Chinese ground stations (data through ESAC antennas were much cleaner) that affect the quality of the measurements.

Due to these two problems the magnetic field measurements available until now to the community are spin averaged products. The goal of the project is to clean high resolution observations and archive them in Cluster Active Archive (CAA).

The poster shows the main processing steps developed in the CAA:
1. removing the highly varying magnetic interference of the solar arrays from the magnetic field measurements and
2. detecting and removing bad data points.

Both are based on the usage of dual-magnetometer technique and all processing software has been written in C.

The Importance of Being a Crater

E. Martellato[1], J. Benkhoff[1], B. Foing[1], L. Colangeli[1], and G. Cremonese[2]
[1]ESA/ESTEC, [2]Osservatorio Astronomico di Padova

Impact craters are an *important tool* in investigating a variety of aspects of planetary bodies, whose remote sensing data is the only available information. Earth as well can take advantage from studying such a rarely occurring, complicated and highly dynamic process, as the combining effects of erosion, tectonics and volcanism can hide impact structures.
Impact craters could be addressed either as a "population" of objects or as an "individual" entity. In the first case, cratering records, being the result of a long–repeated meteorite bombardment history, can be used to infer surface age after the application of a chronological model to statistical analysis. Here, we will present the crater retention age analysis performed on the data recently acquired by the MESSENGER mission during its fly-bys with Mercury.
In the second case, the observed morphology of an impact structure allows to give some constraints on the physics and dynamics of the related impact process, as well as some inferences on the environment the event takes place. The current understanding of impact craters comes from a suite of experimental, morphological, and numerical studies. However, shocks codes represent one of the only feasible methods for studying impact craters, as they can simulate a large span of conditions beyond the reach of experiments, in addition to analyze the individual effect of any parameters acting during the impact event. Here, we will present the results of the numerical modelling performed on three impact structures, located in very different bodies: Earth, Mercury and the recently visited asteroid (21) Lutetia.

INFLUENCE OF COMETARY GAS PRESSURE ON S/C TRAJECTORIES

S. Völk[1], A. Schmidt[1], B. Grieger[1] and V.M. Tenishev[2]

[1]ESAC

[2]University of Michigan, College of Engineering

One of the main goals of the Rosetta mission is to investigate the gas environment around comet 67P/Churyumov-Gerasimenko. From a scientific and operational point of view, detailed knowledge about the gas production is needed. Depending on the comet activity, momentum exchange between gas particles and s/c can be significant and competes with gravitational forces.

In order to plan trajectories for the orbital and fly-by trajectories, these forces have to be considered carefully. Therefore, different gas models for the cometary environment are studied. These models provide spatially resolved distributions of densities and velocities of each gas species which can be used to calculate total gas pressures and as a next step drag forces acting on the s/c.