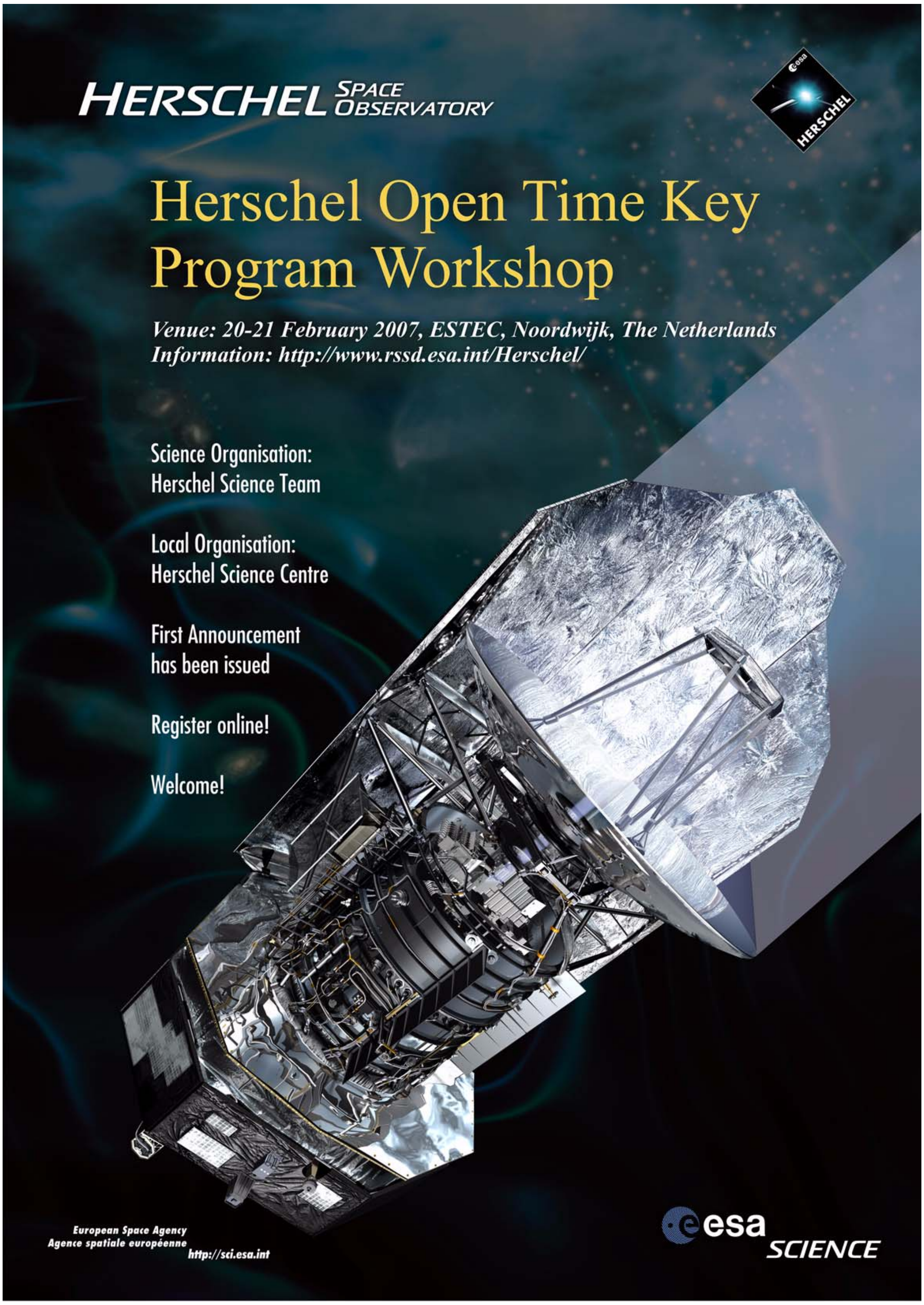

Poster Abstracts

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SPIRE Guaranteed Time Key Programme Poster Abstracts (7)

The Herschel galaxy reference survey (GT Key project)
A.Boselli and the SPIRE EXTRAGALACTIC Group

In order to study the dust properties of different galaxies in the nearby Universe, the SPIRE extragalactic group (SAG2) selected a volume limited (15< Dist <25 Mpc), complete sample of 323 galaxies spanning the whole range in morphological type (from ellipticals to late-type spirals) and luminosity ($8.5 < \log L\_H < 12\ L_{Ho}$, $-22 < M_B < -16$) extracted from 2MASS, to be observed in guaranteed time with Herschel.

The 250-360-520 micron SPIRE data, combined with those collected at other frequencies, will be used to trace the dust properties of normal galaxies and provide a reference sample for studies at high redshift.

The ISM in Low Metallicity Environments: Bridging the Gap Between Local universe Universe and Primordial Galaxies

A Proposal for a Herschel Guaranteed Time Key Program by the SPIRE (SAG2)

While much of what we have gleaned of the details of dust and gas properties and the processes of dust recycling and heating and cooling in galaxies has been limited to Galactic studies, with Herschel we will be able to explore these issues in low metallicity dwarf galaxies which are known by now to exhibit dust and gas properties different from more metal-rich galaxies Because these objects are relatively nearby, it is possible to relate the observed variations in the SEDs to the actual physical phenomena occuring within the ISM of the galaxy, allowing the construction of a rich interpretative framework for unresolved, more distant galaxies in the early universe.

Using the SPIRE , PACS and HIFI instruments on Herschel, we propose to map the dust and gas in 55 dwarf galaxies, sampling a broad metallicity range of 1/50 to 1/3 solar. These data, in conjunction with other ancillary data, will be used to construct the emission spectrum of the dust plus that of the gas in the most important cooling lines. The combination of these instruments on Herschel will provide the first opportunity to study the dust and gas in extremely low metallicity (ELM) environments that have not yet experienced repeated recycling through the ISM. The interpretation of this data will open the door to comprehending primordial ISM conditions.

Physical Processes in the Interstellar Medium of Very Nearby Galaxies

A Proposal for a Herschel Guaranteed Time Key Project by SPIRE (SAG-2) and PACS (Ghent, Vienna, Lyon)

This key program will produce comprehensive data sets on the continuum and spectral line emission for a very diverse sample of nearby galaxies that are already extremely well studied from X-ray and optical through to radio wavelengths. The primary goal of this project is to obtain detailed understanding of the physical processes at work in the ISM of galaxies, including how these processes may depend on the wider galaxian environment. A secondary goal of this project is to provide a detailed understanding of several resolved galaxies of any galaxy class that can act as an anchor between the detailed physical modeling from this study and the more statistical studies of larger samples of various galaxy classes. This will provide a link between other extragalactic programs and the very detailed studies that are possible in the Milky Way, by sampling a larger range of environments than can be found in the Milky Way. Specific scientific goals include: (1) determining the physical properties (size, temperature, composition) of the various dust components; (2) searching for evidence of very cold dust grains; (3) determining the heating and cooling parameters of the ISM and (4) determining the effects of unusual galactic environments on the gas and dust properties.

The sample contains 13 galaxies that will be completely mapped in all photometric bands of PACS and SPIRE, with a goal of including the low surface-brightness diffuse extended emission. To study the heating and cooling processes in the galaxies, the FIR and submm fine-structure lines will also be mapped, using the PACS spectrometer, the SPIRE FTS and HIFI to include the CI lines.

Probing the origin of the stellar initial mass function:
A wide-field *Herschel* photometric survey of nearby star-forming cloud complexes

A SPIRE/PACS GT Key Project prepared by:

SPIRE SAG 3,
CEA Saclay, IFSI Rome and INAF-Arcetri, KU Leuven, MPIA Heidelberg,
and the Herschel Science Center

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Abstract

Herschel provides a unique opportunity to study the earliest stages of star formation and address one of the most important questions in astrophysics today: What is the origin of the stellar initial mass function (IMF) ? Not only is this issue central in local star formation research, but it is also crucial for understanding whether the IMF is truly universal, including in starburst galaxies and at high redshift, or is likely to depend on metallicity, pressure, or temperature. As prestellar condensations and young (Class 0) protostars emit the bulk of their luminosity between ~ 80 and $\sim 400\,\mu$m, the two *Herschel* imaging instruments SPIRE and PACS are ideally suited for taking a census of such objects down to $M_{proto} \sim 0.01$–$0.1\ M_\odot$ in the nearby ($d \leq 0.5$ kpc) molecular cloud complexes of our Galaxy.

We propose an extensive imaging survey of the densest portion of the Gould Belt complexes with SPIRE at 250–500 μm and PACS 110–170 μm down to a 5σ column-density sensitivity $N_{\rm H2} \sim 10^{21}\,{\rm cm}^{-2}$ or $A_V \sim 1$. Our baseline proposal is to carry out a complete, homogeneous mapping of the $A_V \gtrsim 3$ regions with SPIRE and a complete mapping of the $A_V \gtrsim 6$ regions with PACS, as well as representative, selected areas at lower ($A_V \sim 1-3$) extinction levels, with both instruments. The nominal sensitivity of the survey is well matched to the expected cirrus confusion limit and is such that we should detect dust emission/structure throughout the maps. The target clouds span a range of physical and environmental conditions from 'active', cluster-forming complexes to 'quiescent' regions with no or only distributed star formation activity. Based on current estimates of the local star formation rate in the Galaxy, we should detect a few hundred Class 0 protostars and several thousand prestellar condensations in the entire $\sim 140\,{\rm deg}^2$ SPIRE survey, i.e., an order of magnitude more cold protostellar objects than already identified from the ground. With ~ 20 prestellar condensations expected per 0.15 dex mass bin around $0.01\,M_\odot$ and $5\,M_\odot$, the predicted numbers of objects are both adequate and necessary to derive an accurate prestellar core mass function from the substellar to the intermediate-mass regime. On small scales, the temperature and density structure of the nearest (≤ 0.2 kpc) condensations will be resolved, setting detailed constraints on the initial conditions for individual protostellar collapse. On a more global level, the large spatial dynamic range of the proposed SPIRE/PACS survey will provide a unique view of the formation of dense cores and protoclusters within molecular cloud complexes, by probing the link between diffuse cirrus-like structures and compact self-gravitating condensations. Our main scientific goal is to elucidate the physical mechanisms responsible for the formation of prestellar condensations out of the diffuse interstellar medium, which appears to be the key to understanding the origin of stellar masses.

WATER AND RELATED CHEMISTRY IN THE SOLAR SYSTEM

A GT-KP planetary program proposed for Herschel

Paul Hartogh *et al*.

Abstract: Water is ubiquitous in the Solar System, being present in gaseous form in all planetary and cometary atmospheres, in the form of ice on the surface and subsurface of Mars, comets, most planetary satellites and distant bodies, and in the liquid phase on Earth. Water plays an important or dominant role in the chemistry of planetary and cometary atmospheres, and comets may be sources of water for planets. The knowledge of the history of water and its cycle in the Solar System is thus the main goal. The way to get a comprehensive picture is to observe water, its isotopes and some chemically related species over all heliocentric distances accessible by Herschel. This constraint determines the three related science areas the proposal is composed of: Mars, the outer planets including Titan, and comets.

Evolution of interstellar dust

A Guaranteed Time Key Project prepared by the SPIRE consortium

Alain Abergel, IAS, Universite Paris-Sud, Orsay, France

Jean-Paul Baluteau, Laboratoire d'Astrophysique de Marseille, Marseille, France

and the SPIRE consortium

Abstract: The scientific motivation of this project is to trace the evolution of dust grains in relation to changes of the physical, dynamical and chemical properties of the interstellar medium. Our goal is to build with Herschel a coherent database on interstellar dust emission extending to much smaller angular scales than the IRAS and DIRBE surveys and covering a wide range of ISM physical conditions, from diffuse clouds to the sites of star formation and protostars. The Herschel observations will benefit from ground-based ancillary data, and also Spitzer, Akari and Planck observations yielding a full description of the spectral energy distribution of interstellar dust from the near-infrared to the millimeter.

This project will take full advantage of four unique characteristics of SPIRE and PACS: brightness sensitivity, wavelength coverage, angular resolution, and mapping efficiency. The brightness sensitivity is essential to measure the faint infrared emission from the diffuse regions. The spectrometers will provide the necessary information to derive the physical properties of the atomic and molecular gas and completely characterize dust evolution. The angular resolution is critical for tracing the dominant processes in grain evolution which takes place on all scales down to a few arcseconds. The data statistics will allow us to span a wide range of physical conditions and to probe the impact of extreme conditions, e.g., high densities, intense vortices or illumination, on the dust evolution.

Stellar disk evolution

Coordinator: G. Olofsson, Stockholm Observatory

Abstract

The SPIRE consortium propose, together with the PACS consortium, the Herschel Project Scientist G. Pilbratt, and the Herschel Mission Scientist P. Harvey a key programme for Herschel GTO exploiting the unique capabilities of the mission in the topic of circumstellar disk evolution. This is a field of research in rapid evolution as a result of recent observational advances, in particular the Spitzer mission but also HST and groundbased observations. We take advantage of an ambitious Spitzer “legacy” programme that currently is identifying IR-excess stars out of a large, well defined sample of stars with close to solar masses and spanning the whole range of ages, from the PMS phase to that of the sun. Spitzer provides for most of the IR-excess stars only one photometric point (at 70 µm) of the dust emission. PACS + SPIRE will together provide 6 photometric points at wavelengths that cover the peak of the dust emission, and will therefore allow a much better definition of the disks.

The scientific interest in disks is closely related to planet formation and one special aspect on disk emission is that it can, if excessive, make future detections of earth-like planets very difficult. We therefore include a sample of nearby stars out of candidate list for Darwin observations.

We also propose deep imaging of a few well known disks (rings) that Herschel can resolve, exploiting the excellent surface brightness sensitivity of the instrument and allowing us to trace spatial variations of the dust properties.

We also propose spectroscopy: Using both the PACS spectrometer for full scans and the SPIRE FTS at full resolution we propose observations of a few bright, representative disks mainly for searching new solid-state features. Finally, we address the question of how the gas component evolves with time by observing the [OI] 63 µm line with the PACS spectrometer.

PACS Guaranteed Time Key Programme Poster Abstracts (5)

The PACS-SPIRE Guaranteed Time Key Program on Evolved Stars

Groenewegen M.A.T., Barlow M., Kerschbaum F., et al.

Abstract

The main aim of this Key Program is three-fold. First to study the asymmetries in circumstellar envelopes, second to study the time-dependence of the mass-loss process and total mass in the circumstellar envelopes, and third to study the dust- and molecular chemistry in evolved stars.

To this end, a sample of 78 Asymptotic Giant Branch and Red Super Giants, 15 post-AGB and Planetary Nebulae, 8 Luminous Blue Variables and Wolf-Rayet stars, and 4 Super Novae remnants will be imaged with PACS at 70 + 110 micron, and a sub-set of, respectively, 21, 8, 0, 4 stars will be imaged at all three wavelengths with SPIRE.

Regarding spectroscopy, a sample of, respectively, 26, 20, 2, 4 stars will be observed over the full wavelength range of PACS with the ``SED" mode, and, respectively, 10, 12, 2, 4 stars will be observed with the SPIRE FTS. All numbers above are based on our current baseline sample (end-January). Small changes may occur when detailed modelling is carried out using the final release of HSPOT.

The sample of AGB stars has been selected to cover all chemical types (M-, S-, C-stars), variability types (irregular, semi-regular, Miras) and periods, and mass-loss rates. Stars have been selected to be bright in IRAS colours and typically have low IRAS CIRR3 background levels.

The targets for spectroscopy are typically the brightest among the targets for the mapping (typically IRAS 100 micron fluxes above 40 Jy).

The contributors to this KP are, one PACS side, Belgium (led by the University of Leuven), Austria (University of Vienna), with contributions from the HSC (P. Garcia-Lario) and the Mission Scientist P. Cernicharo, and on SPIRE side, SAG-6 (coordinated by Barlow).

The Dusty Young Universe : Far-Infrared / Sub-millimetre Photometry and Spectroscopy of High-Redshift Sources

Abstract:

A Herschel Guaranteed Time Key (GTK) project is proposed which is targeted towards far-infrared and sub-millimetre photometric and spectroscopic observations of high redshift objects in the early universe. Their properties will be studied in the wavelength range where the spectral energy distribution is dominated by dust emission. It is a coordinated project with separate target lists and comprises three parts : (i) photometry of known QSOs with the highest redshifts ($z \gtrsim 5$); (ii) photometry of the special class of Broad Absorption Line (BAL) QSOs ; (iii) spectroscopy of high-redshift QSOs and galaxies lensed by foreground clusters. Both the PACS and SPIRE instruments will be used for the photometric observations, while the spectroscopy will use the PACS spectrometer. A total of 175 hours of Herschel PACS Guaranteed Time will be devoted, where 95 hours is provided by MPIA Heidelberg, 30 hours by Institut d'Astrophysique, Liege, and 50 hours by MPE Garching, corresponding to the three parts.

PACS Evolutionary Probe: Deep extragalactic GT surveys with Herschel-PACs

Dieter Lutz, Albrecht Poglitsch, Reinhard Genzel, Linda Tacconi, Natascha Förster Schreiber, Eckhard Sturm (MPE)
David Elbaz, Hervé Aussel, Pierre-Alain Duc (CEA)
Jordi Cepa, Ismael Pérez Fournon, Hector Castañeda (IAC)
Paola Andreani, Andrea Cimatti, Roberto Maiolino (INAF)
Bruno Altieri, Miguel Sanchez-Portal, Ivan Valtchanov (HSC)
Martin Harwit

Abstract

We present guaranteed time plans for deep surveys with Herschel-PACS, designed to resolve the Cosmic Infrared Background and to study galaxy evolution over a wide range of redhsifts and environments, in coordination with plans by the SPIRE consortium. Implementation issues for such observations are discussed.

The earliest phases of star formation: From low– to high–mass objects

Proposal for a Herschel–PACS GT Key Project

Prepared by:

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H. Beuther, M. Hennemann, M. Nielbock (all MPIA Heidelberg)
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It is generally agreed that present–day Galactic star formation starts in the coldest and densest cores of molecular clouds. However, our knowledge about the very early stages of star formation is still quite limited. Such objects emit most of their luminosity at far–infrared wavelengths(roughly 60 – 400 μm), thus not (or not easily) observable from the ground. Hence, up to now our view in this wavelength range remains fuzzy at best, since all available information generally come from small aperture satellite and airborne missions which severely lack spatial resolution. This is a major drawback for detailed studies of young low–mass cores, and it has severely hampered almost any progress in identifying and thoroughfully characterizing young and cold high–mass cores which are, on average, far more distant. Still, detailed knowledge about these early pre- and proto–stellar stages is indispensable if we want to answer fundamental questions about the physics of the early collapse phase, the core fragmentation and the principle ways to finally form stars of all masses.

With the advent of the Herschel satellite, we will have the unique opportunity to deeply scrutinize such cold cradles of stars with unprecedented sensitivity and angular resolution. We therefore propose to use the PACS and SPIRE instruments to perform deep and directed multi–wavelength mapping of individual objects and confined regions. We have compiled a unique sample of low– and high–mass targets that we identified, based on careful preparatory studies (including ISO and Spitzer observations), as very promising sources for the study of initial conditions of star formation. The Herschel data will allow us to reconstruct the (3D) density and temperature structure, to assess the energy budget of the cores and to unveil potential substructures. Furthermore, Herschel observations will render it possible for the first time to perform an advanced modeling of such cold cores that is meaningful and not plagued by simplifications and parameter ambiguities.

Star formation and activity in infrared bright galaxies at 0<z<1

E. Sturm (on behalf of the PACS GT Consortium)

Abstract

We propose a comprehensive far-infrared spectroscopic and photometric survey of infrared bright galaxies - starburst galaxies, AGN, (U)LIRGs and low metallicity galaxies - at local and intermediate redshifts. An important fraction of star formation and AGN activity in the universe takes place in dusty, infrared bright galaxies. Much remains to be learned, though, even about the most nearby examples, and previous far-infrared observations have left many questions open. Our goal is to use the superior sensitivity, spatial and spectral resolution of Herschel to study with minimal extinction effects star formation and activity in dusty galaxies. We aim to obtain a comprehensive view of the physical processes at work in the interstellar medium of local galaxies ranging from objects with moderately enhanced star formation to the most dense, energetic, and obscured environments in ultra-luminous infrared galaxies and around AGN. Including objects with a wide range of metal enrichment, provides a means to try to speculate conditions for star formation in early universe environments. In a second step, we want to compare key spectral properties to more distant systems at more active epochs of star formation. In particular we plan to elucidate the energetics, obscuration, and physical conditions of the central regions of infrared galaxies, by obtaining full 60-670mm spectra of five template starbursts, AGN and ultra-luminous infrared galaxies, and by characterising for a larger local sample the state of the ionised medium and of photo-dissociation regions through observation of eight key diagnostic fine-structure lines. The densest and warmest region near AGN will be studied by probing for highly excited molecular emission.

· Determine the role of metallicity in star formation processes through a PACS spectroscopic study of a range of low metallicity galaxies from the nearby LMC/SMC to more distant, less resolved galaxies, sampling a range of star formation activity. Star formation processes and the interplay with the ISM in low metallicity regions compared to those associated with the more metal rich starburst environments are also explored here in order to elucidate what role star formation history and activity, metallicity, morphology, etc play in the physical properties shaping galaxies.

· search for evolution from the intermediate redshift population close to the peak of cosmic star formation till the present time, by comparing the far-infrared line emission of z~1 infrared galaxies to the local analogues.

· study the triggering mechanisms and temporal evolution of infrared activity by photometric mapping of a large sample of interacting galaxies.

· determine the structure of a few local templates by spectroscopic mapping along characteristic axes. These line maps will establish the physical conditions of nuclear region, spiral arms/disk, and wind regions and will be essential for a comprehensive view of the spatial and temporal evolution of infrared activity.

HIFI Guaranteed Time Key Programme Poster Abstracts (8)

WATER AND RELATED CHEMISTRY IN THE SOLAR SYSTEM

Prepared by Paul Hartogh, Emmanuel Lellouch and Jacques Crovisier
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On behalf of:
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3 University of Michigan, Ann Arbor – USA
4 Observatoire de Bordeaux - France
5 LESIA, Observatoire de Paris – France
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Abstract
Water is ubiquitous in the Solar System, being present in gaseous form in all planetary and cometary atmospheres, in the form of ice on the surface and subsurface of Mars, comets, most planetary satellites and distant bodies, and in the liquid phase on Earth. Water plays an important or dominant role in the chemistry of planetary and cometary atmospheres, and comets may be sources of water for planets. The knowledge of the history of water and its cycle in the Solar System is thus the main goal. The way to get a comprehensive picture is to observe water, its isotopes and some chemically related species over all heliocentric distances accessible by
Herschel. This constraint determines the three related science areas the proposal is composed of: Mars, the outer planets including Titan and comets.

H2O AND CO OBSERVATIONS OF AGB ENVELOPES, PPNe AND PNe (HIFISTARS)

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Abstract
This project represents the HIFI core program on circumstellar envelopes around evolved stars. The proposed GTKP consists of observations of various CO and H2O lines probing different excitation regimes in a wide sample of Asymptotic Giant Branch (AGB) envelopes, proto-planetary and planetary nebulae. The ultimate goal is to get deeper insight in the structure, dynamics, thermodynamics and chemistry of such objects.
We propose to observe in the whole sample three lines of both 12CO and 13CO covering various excitation and opacity regimes. Complementary PACS observations will provide higher-J data. CO is ideal to probe the conditions in these nebulae due to its simple chemistry, intense lines and the straightforward interpretation of its emission. These FIR observations will in particular trace the intermediate-excitation regions, between _ 100 and _ 2000K.
A unique set of H2O observations will be performed. A well-selected large H2O line list will be observed in five stars known to be intense in H2O. This list includes lines of different excitation, of ortho- and para-water and isotopic substitutions, vibrationally excited transitions, masers, etc. These data will serve as a template for other sources, for which we will only observe a reduced line list sampling the main H2O emission regimes. H2O is a key molecule to understand circumstellar chemistry (being a major reservoir of oxygen) and thermodynamics (being the main coolant in O-rich environments). In addition, a few H2O lines will be observed in some C-rich AGBs to study the origin of water vapor in these sources.
The high spectral resolution of HIFI enables us to resolve the different nebular components, which is necessary to understand the nature and evolution of the sources.

Molecular Line Carriers in the ISM

Acronym : MOLIS

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ABSTRACT

We will carry out a comprehensive spectroscopic study of key molecular line carriers, probing interstellar hydrides and carbon chains and rings. Our investigation will entail high-resolution HIFI spectroscopy of some 20 molecules towards 8 sources, and several spectral scans with PACS. The target hydrides contain the elements H, D, C, N, O, F and Cl. We will take advantage of the strong dust emission from massive star forming regions to detect multiple absorption components from foreground clouds of diverse properties that are known to intersect the selected sight-lines, along with emission and absorption intrinsic to the background sources. Our investigation will provide a wealth of new information about interstellar hydrides - addressing key puzzles posed by previous observations from the ground since the 1940's, and recently with ISO, SWAS, and ODIN - and leaving an important Herschel legacy to astrochemistry and ISM science. We will address the role of high temperature chemical reactions in the formation of interstellar molecules, and the question of how such reactions might be driven. We will also investigate the role of grain surface reactions in interstellar chemistry, and the growth of carbon molecules, bridging the gap between molecules and aggregates, as unique spectroscopic signatures of carbon chains and rings, are accessible in the FIR.

Many of the lines that are detectable with Herschel in the local Universe become accessible to ground-based observatories for redshifted sources. Our programme will provide an unique benchmark for the studies of molecular gas at high redshift with ALMA.

HERSCHEL-HIFI KEY PROGRAM : HS3F
(HIFI SPECTRAL SURVEYS OF STAR FORMING REGIONS)

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Abstract

The study of the molecular content in the outer Solar System has hugely evolved in the last few decades, from the first detections of biatomic molecules to the discovery of multi-atomic, complex organic molecules. Nowadays, one major goal of Astrochemistry is to have the most accurate census of the molecular content (and complexity) in Star Forming Regions (SFRs). In the era of the molecular content census, unbiased surveys in the radio to Infrared of SFRs become a valuable, if not unavoidable tool.
In this context, the frequency range covered by HSO-HIFI, 500-2000 GHz, is of P articular importance.
It is in this frequency range that light molecules have ground and low energy transitions, whereas heavier molecules have higher energy transitions. The latter are excited in the warm gas, whereas the former probe the gas at low temperatures too. It is therefore in the HIFI frequency range that the major gas coolants (notably H_2O) and some key molecules in the chemistry composition emit.
We propose to obtain Spectral Surveys in the HSO-HIFI range of a representative sample of SFRs. To have a meaningful coverage of the different evolutionary stages and different masses requires a large amount of time, about 300 hrs. The proposed observations will provide a large dataset of general interest for the entire astronomical community, and, particularly for the studies of star formation.
These two basic aspects, a large requested observing time and an output of high archival value, make the present proposal suitable for a HSO Key Program.

The Physical and Chemical Conditions of the ISM in Galactic Nuclei

PI Rolf Güsten (1) ; Andrew Harris[2], Carsten Kramer[3], Frank Israel[4],
Sabine Philipp[1], Jesus Martin-Pintado[5] Andreas Eckart[3], Santiago Garcia-Burillo[6], Thomas Klein[1], Steve Lord[7], Pere Planesas[6], Markus Röllig[3], Jürgen Stutzki[3], Ryszard Szczerba[9], Paul van der Werf[4], Nick Whyborn[8], Harold Yorke[10]; Wolfgang Wild[8], Axel Weiss[1]

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Abstract:

Herschel/HIFI's unique spectroscopic capabilities will allow us to make a representative velocityresolved inventory of important cooling lines in nearby galaxies, AGN and starburst nuclei. Such observations explore the physical conditions within regions of active star formation in low and high metallicity environments, shedding light on the physics of large scale star formation in the contemporary and early universe. Multi-line data combined with numerical radiative transfer models quantitatively constrain the various phases of the interstellar medium (ISM). Key lines in Herschel/HIFI's spectral range include the bright fine-structure lines of neutral and ionized atomic carbon, nitrogen and oxygen, a unique set of water lines, and the high-excitation CO transitions. The far-infrared spectra of many galaxies reflect the gas energy balance through atomic cooling lines from photo-dissociation regions (PDRs) and forbidden fine-structure lines from HII-regions. In normal and star-forming galaxies, [CII] 158µm and [OI] 63µm are by far the strongest, containing 0.2-0.7% of the total FIR luminosity. Within the beam of an extragalactic observation, any of the ISM components (dense warm PDRs on the surfaces of UV-exposed molecular clouds, low-density warm atomic clouds will contribute to the brightness of a fine-structure line. Our high spectral resolution studies will unravel the structure of the ISM by analysis of their main cooling lines. In addition, water is a key molecule for our understanding of the chemistry and energy balance in the denser ISM. Herschel/HIFI will measure the brightness of the ground-state transitions to determine the gas temperature of the ISM via line ratios.

HEXOS: Herschel observations of EXtra-Ordinary Sources:
The Orion and Sgr B2 Star-Forming Regions

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Abstract
As a GT Key Program we propose to perform full HIFI line surveys of 5 sources in the giant molecular clouds Orion and Sagittarius B2. These extraordinary star-forming regions contain the best studied examples of physical and chemical processes prevalent in the interstellar medium, including gravitational compression, thermal and turbulent pressure support, photo-dissociation, gas and grain chemistry in dense and diffuse quiescent gas, and shocks. With high excitation, rich chemistry, and large H2 column they give the highest chance for new detections in a sensitive search for new molecules. Line surveys of sources (Orion KL, Orion S, Orion Bar, Sgr B2 N+M) defined by these phenomena form the backbone of this proposed program. The HIFI line surveys will be supplemented by deeper line searches, water maps, and, in at least 3 sources, full spectrum PACS scans.
Herschel offers unprecedented sensitivity and relative calibration accuracy, as well as continuous spectral coverage across the gaps imposed by the atmosphere, opening up a largely unexplored wavelength regime to high resolution spectroscopy. These data will take line surveys to a new level and we will use them to comprehensively characterize the physics (density, thermal balance, kinematics, radiation field) and chemistry (chemical assay, ionization, deuterium fractionation, water ortho/para ratio) of star-forming molecular gas in a manner not previously possible. The opening of this spectral range is also an opportunity to detect the bending transitions of carbon chains and polycyclic aromatic hydrocarbons, along with the rotational transitions of complex organics.
Given that these sources have the richest emission spectra seen for star-forming regions in the Galaxy, we anticipate that the proposed observationswill define the sub-millimeter/far infrared region of the spectrum and that these data will form a lasting Herschel legacy.

WATER IN STAR-FORMING REGIONS WITH HERSCHEL (WISH)

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See http://www.strw.leidenuniv.nl/_kempen/HIFI/persons.php

Abstract
Water is a key molecule for determining the physical and chemical structure of star-forming regions because of its large abundance variations, –both in the gas and in the ice–, between warm and cold regions. In this HIFI-led Key Program, we propose a comprehensive set of water observations toward a large sample of well-characterized protostars, covering a wide range of masses and luminosities -from the lowest to the highest mass protostars-, and a large range of evolutionary stages -from the first stages represented by the pre-stellar cores to the last stages represented by the pre-main sequence stars surrounded only by their protostellar disks. Lines of H2O, H2 18O, H217O and chemically related hydrides will be observed. In addition, selected high-frequency lines of CO isotopes, [O I] as well as dust continuum maps will be obtained with HIFI and PACS, and will be complemented by ground-based HDO, CO and continuum maps to ensure a self-consistent data set for analysis. Limited mapping information on arcmin scale provides information on local variations due to outflows and clustered star formation. Together, the data will allow a major step forward in our understanding of the physical processes responsible for the warm gas, on dynamical processes associated with forming stars and planets, on the chemical evolution of water and the oxygen-reservoir, and on basic gas-grain chemical interactions. They will form an unique legacy for the community for current science and for planning future space missions.

The warm and dense interstellar medium observed with Herschel/HIFI

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The combination of HIFI and PACS observations provide a unique way to study the chemical inventory and the energy balance in dense interstellar clouds heated by UV radiation (PDRs) or by shocks from massive stars.

The wide spectral coverage of the instruments allows to observe the key species in the chemical network, like hydrides or H_3O^+, in their ground states. This will solve many of today's puzzles in the interstellar chemistry. With the spectral resolution of HIFI it will be possible to separate the role of shocks and PDRs, to study the dynamical structure of evaporating molecular clouds, and to resolve the three-dimensional abundance distribution of species. The combination of line and continuum observations will allow to test the available models on the energy balance in the interstellar medium and the systematic observation of OH and water lines provides a clue to current contradictions in our understanding of the shock water chemistry. The Herschel observations will be accompanied by ground-based observations for the CI, mid-J CO, and H_2 lines, the sub-mm continuum and other species that can be detected through the atmospheric windows.

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Contributed Poster Abstracts (43) in alphabethical order

A Herschel survey of the most luminous star forming regions in the Galaxy

F. Wyrowski, R. Güsten, K. Menten, P.Schilke, A.Weiss (MPIfR), M.Walmsley (Arcetri), S.Bontemps, A.Baudry, J.Braine, F.Herpin (Bordeaux), F.van der Tak (Groningen)

We propose to image the most luminous star forming regions in our Galaxy with Herschel in water, high-J CO, and several hydrides and fine-structure lines. The most luminous, young OB clusters interact in many ways with their molecular environments, thereby shaping the appearance of whole galaxies. Galactic examples of such regions with luminosities well above 10^6 solar luminosities are W43, W49, the Eta Carinae region, and NGC3603. The study of such regions with Herschel will be essential, since Herschel enables access to their main cooling lines. In particular, water vapour lines will be unique targets that can *only* be addressed from space. The relatively high spatial resolution which can be reached in these "Galactic starbursts" makes them ideal templates for our understanding of extragalactic starbursts. Furthermore, with ALMA one can expect to detect some of these main cooling lines in starbursts at considerable redshifts with very high angular resolution. The availability of results from local laboratories to test various interpretations of the high redshift results is then of vital importance.

Physical Conditions and Dynamical Status of Pre-stellar Cores

T. Velusamy, C.D. Dowell, P.F. Goldsmith, W.D. Langer, D. Li, K.A. Marsh

(JPL/Caltech)

We propose to use Herschel SPIRE scan mapping to carry out a survey of prestellar cores in molecular clouds. The SPIRE data will be combined with ground-based continuum data at longer wavelengths and with spectral line data chosen to determine critical physical parameters. Our primary goal is to obtain the core mass spectra of prestellar cores in a variety of environment and evolutionary states. We will use this information to make a detailed comparison with the stellar IMF, and to test theories of formation of cores and stars in the ISM triggered by interstellar turbulent compression, shocks and the after effects of previously occurring star formation.

Extragalactic Confusion Limits in Herschel Key Programs

M. Vaccari & A. Franceschini & G. Rodighiero & S. Berta

Department of Astronomy – University of Padova

We discuss the extragalactic confusion levels to be expected in Herschel broad-band photometric channels on the basis of models of extragalactic source populations fitting all available data (number counts, z-distributions, L-functions and CIRB levels) from ISO, SCUBA and Spitzer. Estimates are provided both through the analysis of fluctuations due to unresolved sources and applying the criterion of a maximum number of resolved sources, yielding results in good agreement. Sensitivities currently envisaged by Herschel GT extragalactic blank-field surveys are discussed and recommendations for OT Key Programs are outlined.

IRAS, ISO, Spitzer/MIRIAD, Akari/MLHES, and beyond: Herschel OT KP Evolved Star CSE Mapping Survey Concepts

T. Ueta, University of Denver

Abstract

Evolved stars of low to intermediate initial mass (less than about 8 M_sun) are major contributors to the interstellar medium. However, we have not yet fully understood the physics of mass loss processes by which these stars eject their surface matter into the surrounding space. The circumstellar shells of evolved stars (particularly of AGB and post-AGB stars) retain the fossil record of their mass loss in the form of dust/gas density distributions, and therefore, have the potential to verify/constrain many theoretical aspects of stellar evolution and mass loss. IRAS detected far-IR dust emission from a number of such extended shells and ISO was able to detect density variation in some of these shells which correlate with evolutionary changes in the central star. Recently, there have been two initiatives, the Spitzer/MIRIAD project and the Akari/MLHES mission program, probing the last 10^5 years of mass loss history with a 10^3- year time resolution and yielding results. Exploiting the unprecedented spatial resolution and previously unexplored sub-mm capabilities of Herschel we can construct the most detailed maps of these circumstellar shells which will allow us to (1) constrain/test theories of stellar evolution and mass loss, (2) determine the effects of dust/gas chemistry on mass loss, (3) determine how the shell structure development proceeds.

A Herschel survey of local galaxies activity (HERLOGAL)

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Abstract

The key project HERLOGAL to be proposed for the Herschel mission is aimed to provide an homogeneous data set on local active galaxies that could be the reference for further studies on the interplay between star formation processes and accretion onto massive black holes in galactic nuclei. The selected sample will be the overlap between the 12micron sample and an all-sky hard-X ray selected sample of AGNs. The Herschel data will follow extensive observational work that is already available from radio to X-rays frequencies and will provide the baseline of zero-redshift objects for comparison with the high redshift Universe which will be revealed by the Herschel cosmological surveys.

Herschel Exploration of The Cloud-Core Connection

Sébastien Maret, Edwin A. Bergin et al.

Abstract. We propose an open time key program to explore the relation between star forming cores and the natal cloud. Stars are born from the gravitational collapse of dense cores in molecular clouds. During this process, the gas undergoes important physical and chemical changes. The cold initial phases are initially characterized by a transition in UV shielding leading low density atomic gas at cloud edges, such as C II, to transition to molecular form. As the cloud condenses into dense core the increasing central density is accompanied by the freeze-out of gas-phase molecules and subsequently high levels of deuteration. After stellar birth the warm central core and energetic outflows heat the surrounding material and further alter the gas physics and chemistry. Herschel-HIFI offers a unique opportunity to probe the cloud-core connections and the capability to track the evolution from cloud to protostar. With HIFI we can observe and spectrally resolve lines that are difficult or impossible to detect from the ground and are unique probes of the gas within each stage. Thus we will map the large-scale cloud surface and probe successively deeper with transitions of [C II], H_2O, and CO. Clouds associated with "clustered" star formation, e.g. Perseus and Ophiucus, and portions of a cloud with a more quiescent nature, e.g. Taurus , will be examined. Within these clouds select cores and protostars will be mapped with species which are chemically selected to trace the densest gas (NH_3, D_2H^+, ...). These observations aim to characterize the chemical and physical (e.g. density, temperature, kinematics) between the large scale structure of molecular clouds of disparate nature, the condensing molecular cores, and the effects of stellar birth on the natal cloud.

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HERSCHEL FOLLOW-UP OF THE SCUBA-2 ALL-SKY SURVEY

Stephen Serjeant on behalf of the SCUBA-2 All-Sky Survey team: Mark Thompson, Douglas Scott, Tim Jenness, Dave Clements, Harold Butner, Antonio Chrysostomou, Jim Collett, Kristen Coppin, Iain Coulson, Bill Dent, Frossie Economou, Nye Evans, Per Friberg, Gary Fuller, Andy Gibb, Jane Greaves, Jennifer Hatchell, Wayne Holland, Mike Hudson, Andrew Jaffee, Hugh Jones, Johan Knapen, Jamie Leech, Bob Mann, Henry Matthews, Toby Moore, Angela Mortier, Mattia Negrello, Dave Nutter, Michele Pestalozzi, Alexandra Pope, John Richer, Russell Shipman, Mattia Vaccari, Ludovic Van Waerbeke, Serena Viti, Bernd Weferling, Glenn White, Jan Wouterloot, Ming Zhu

Abstract: The SCUBA-2 All-Sky Survey (SASSy) is one of the largest Legacy Surveys on the James Clerk Maxwell Telescope, and will map the JCMT-accessible sky to a 5σ 850μm depth of 150mJy from late 2007 with a rapid public release to the JCMT community. The catalogue will be more timely for Herschel than the Planck ERCSC and with better astrometry (14" beam). Extragalactic non-detections by the AKARI all-sky survey are very likely to be hyperluminous galaxies at redshifts z>3. We plan a Herschel OTKP photometric and spectroscopic legacy follow-up of SASSy sources.

HIMASSS - HIfi MAssive Star forming regions Spectral Study

P.Schilke, C.Comito, F.Wyrowski, K.Menten, R.Güsten (MPIfR), E.Bergin (UMich), D.Lis, T.Phillips (CalTech) and others

The Herschel Satellite can provide unique observations, crucial for understanding the structure of star forming regions, particularly through observations of the highest frequencies with the HIFI instrument, and particularly for high mass star forming regions.

There are two reasons for this:
(i) Many lines observable in the high bands of HIFI require extremely high temperatures and densities to be excited, and therefore provide a glimpse into the very inner core of these objects, close to the powering source. Only high mass star forming regions tend to have enough column density in this hot and dense gas to emit lines with observable strengths. Not only can the physical structure be thus determined, but by observing such lines from a variety of molecules, the chemical structure, and thereby the thermal history, can be modeled.
(ii) The large column densities in these objects create very high dust optical depths at the highest frequencies. This, while the dust can hide the innermost regions from view, also creates a valuable opportunity, by way of absorption line studies, to investigate the structure along the line of sight, i.e. in the third dimension, which is not easily available through studies of emission lines only. It can be shown that the line shape is very sensitive to geometry (i.e. deviations from a spherical shape), so that these studies, in concert with high resolution interferometric observations at lower frequencies, can be used to create a three-dimensional model of massive star forming regions.

This potential can be exploited in the sources that will enjoy a full HIFI line survey, among the high mass star forming regions that will be Orion-KL, SgrB2(M) and (N), W51e1, NGC6334 and, for somewhat earlier stages, GL2591, in the HEXOS and HS3F GT key projects. These sources have been selected to be as representative as possible for high mass star forming regions. However, since high mass star forming regions are not simple objects - one should remember that one is looking at massive clusters forming - they display a very pronounced individuality. The reason is the spread of masses/luminosities, the influence of the environment, and of course of age. These six sources, while extremely valuable, therefore hardly represent a sample which is even remotely statistically relevant. On the other hand, full spectral surveys are very costly, in terms of time, so it seems prohibitive to do the same exercise for a larger number of sources.

The solution then, is to do partial line surveys or even single settings in a larger number of sources, observing lines essential for reaching the goal above in sources sampling a significantly larger portion of the Mass/Luminosity - Age - Environment space. The source list will contain classical hot core sources spanning a large range from Starburst Template sources like W49 to smallish hot cores of the Orion type like W3(H_2O), from a variety of galactocentric distances, also in the outer Galaxy, but also stages prior to that, often known as High Mass Protostellar Objects. The line list will contain key lines for structure research such as HCN and its isotopologues, and key chemical species, such as methanol and all the light hydrides accessible from HIFI.

In particular will HIFI allow unique access to a range of transitions from water vapor. The ISO and SWAS missions have shown that H_2O is an abundant constituent of the dense, warm gas in our target regions that provides some of the main cooling lines.

The study will be complemented by both single dish (APEX, CSO) and interferometric studies (Plateau de Bure, SMA, CARMA and eventually ALMA), as well as studies in other wavelengths, if not already available, to study the IR and Radio properties.

Fitting spectral energy distributions of debris disks observed by the Herschel Space Observatory

Jens Rodmann & Sebastian Wolf

We present an analysis tool aimed at modelling and fitting the optically thin emission of circumstellar debris disks. The program consists of two parts: a multi-parameter debris disk model and a sophisticated minimization method to find a best-fit solution to observational data, as provided by Herschel or other infrared/(sub)mm facilities. The fitting capabilities will allow the user to constrain important disk parameters, e.g. the inner radius of the disk, the characteristic dust grain size, or the total mass of emitting dust.

Nested shells around LBV nebulae detected in sub-millimeter and mid-IR wavelengths

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Abstract

By means of their strong winds, high UV fields and violent mass ejections, evolved massive stars are the fastest and more energetic sources in shaping the galactic interstellar medium. So far, we can learn about the star evolution itself, and the dynamical and chemical galactic evolution, by observing the whole phases of the interstellar material. This work summarizes the combined results of CO sub-millimeter rotational lines from SMT, together with GLIMPSE and MIPSGAL data from Spitzer, in the environment of an ionized ring nebula around the LBV star G79.29+0.46. The combined analysis of the data have shown a complex structure in the molecular gas and the dust, where two dense (10^5 cm^{-3}) CO shells are embedded in a low-density envelope of the ring nebula. In addition, high temperature dust (up to 200 K) is recognized in the interface between the molecular and the ionized gas.

Finally, we report the first detection of an external, nearly circular, warmer shell. The CO emission seems confined between the two dust shells. The observed scenario is compatible with the picture of multiple shocks and mass ejections from the current LBV stage, and possibly other previous phases after main sequence.

Herschel Open Time Proposal on Line Surveys in Evolved Stars

J. Pardo

Abstract

In order to study the evolutionary stages from Asymptotic Giant Branch (AGB) to Planetary Nebulae (PN), multiwavelength and multi-object data are necessary to reveal the key changes in physical conditions and chemical composition as completely as possible. Molecular spectroscopy at millimeter, submillimeter and FIR wavelengths is a useful tool to study the early stages of this evolution. Several frequency ranges accessible by HIFI and PACS remain largely unexplored and should provide precious spectroscopic information that can be efficiently analyzed due to the spectacular progress in ab-initio calculations, laboratory work, radiative transfer models and line catalogs achieved in recent years. The ultimate goal will be to understand some of the most efficient molecular laboratories in space.

Properties of proto-Brown Dwarfs

Barrado y Navascués et al.

Abstract

We propose to carry out observations with the Herschel telescope of a sample of very faint Spitzer objects located around the Class 0/I protostars of intermediate mass belonging to several nearby star forming regions. Spitzer color-color, color-magnitude diagrams, as well as the infrared spectral index alpha(IR) in the range 3.6-24 micron suggest that the sources could be substellar Class 0/Class I objects.

The proposed observations will help us to elucidate the nature of the objects and to study their disk/envelopes properties. If these data data strongly support the identification as proto-BDs, the foreseen results will impact directly in the different competing scenarios concerning the formation of brown dwarfs. In addition, these objects will constitute natural targets for high resolution and sensitivity proto-BD studies with ALMA.

Herschel Open Time Key Programme: Dwarf planets and other icy bodies in the outer solar system: Basic physical properties

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In the outer solar system beyond Neptune nearly a thousand objects have been discovered. The largest ones, Pluto and Eris, are classified as dwarf-planets and about one dozen are meanwhile discussed as possible dwarf planets. Recently, Spitzer studies in combination with ground-based projects revealed an unexpected diversity in their physical characteristics. Their colors range from neutral to very red, indications for different surface compositions and/or surface alterations during their lifetime. The albedos vary between a few percent up to values larger than 60%. Near-IR spectroscopy indicates surface ices of H_20, N_2 and CH_4 for some objects, while others have no clear signatures in their spectra. Mid-IR thermal emission spectra suggest the presence of silicate minerals. The few diameters which are known reliably span a range between less than 100 km up to about 2500 km. More than 20 Trans-Neptunian-Objects (TNO) are known to be multiple systems.

Most of the energy the TNOs receive from the Sun is emitted as thermal emission. The measurements around the peak thermal emissions plays therefore a key role for the thorough characterisation of these cold objects beyond Neptune: photometric observations lead to precise albedo and size determinations, the fundamental parameters for further studies. Spectroscopic measurements of the main representatives is required for the determination of the surface composition. ISO produced only marginal detections of two TNOs. Thermal emission from a very small sample of TNOs has been detected using Spitzer (at 24 and 70 μm), and ground-based millimeter-wave observatories. But most of the Spitzer observations produced either non-detections or only marginal detections in one band. Consequently, the key TNO properties are still very uncertain and a precise thermophysical modeling of these objects is not possible. Consequently, formation and evolution theories are so far based on very weak grounds.

TNOs have the peak of their emission in the Herschel-PACS range. Moreover, simple calculations show that almost half of the currently known population would be detectable with Herschel. A combined PACS/SPIRE programme will therefore allow for the first time to characterise and model not only the very largest bodies, but a representative sample of each family. Spitzer conducted the first steps and established the frame work, but Herschel has the potential to fully color the picture of the outer regions of our solar system, the world of dwarf planets and icy bodies.

SPIRE observations of the most isolated galaxies

L. Verdes-Montenegro, U. Lisenfeld, J. Sulentic, S. Verley, S. Leon, D. Espada, G. Bergond, E. García, J. Sabater, J. D. Santander-Vela

We propose to perform photometry at 250, 360 and 520 μm with SPIRE on HERSCHEL of a well defined sample of 89 isolated galaxies in the context of the AMIGA project. This sample belongs to the Catalogue of Isolated Galaxies, being studied in the AMIGA project, hence providing a wealth of additional data and information, including FIR, CO, radiocontinuum and HI fluxes as well as Hα and SDSS images. Furthermore, we applied for SPITZER photometry for the same sample, covering the MIR and FIR part of the dust SED.

The strict isolation selection of the sample together with the large amount of ancillary data makes it ideally suited to characterize the dust emission of the most nurture-free galaxies and provides a baseline for environmental studies as well as high-z galaxies.

Herschel Survey of the Large and Small Magellanic Clouds (LMC & SMC)

Meixner, M., Hony, S., Madden, S., & Spitzer SAGE team

Abstract

We present an open time key programme to study the full Magellanic Clouds using Herschel. The proposal builds on the team's experience from the Spitzer legacy programme (SAGE). Within the framework of SAGE the full Large Magellanic Cloud has been imaged at all available Spitzer wavelengths (3.6 - 160 micrometre). The Clouds are at a favourables distance to study all the main ingredients of galaxy evolution - from the various phases of the ISM, through star-forming cores and individual YSOs to mass-losing stars and SNe - without being hampered by the uncertain distances and line-of-sight confusion that complicates Milky-way studies.

HERSCHEL SCIENCE DRIVERS:

Cold Dust)
Spitzer SAGE project gets the warm half of the SED for the diffuse ISM, we only have half the picture. We need Herschel to complete it. The dust SEDs generally peaks at 100 micrometres. Spitzer SAGE went to 160 micrometres. Herschel will go to 600 micrometres and sample well out to the Rayleigh-Jeans tail of the diffuse SED. These long wavelengths are critical to discerning the nature of the grain composition. Degeneracy of the temperature, and optical properties can be lifted and we can quantify the mass of dust throughout the Clouds. Is there a significant very cold dust component in the ISM that is undetected at FIR wavelengths?

Young Stellar Objects)
YSO SEDs peak at 70 or 100 micrometres or even longer, depending on their stage of development. Edge-on Class 1 stars, for example, might go undetected at the Spitzer IRAC bands but would be revealed and characterised at the Herschel bands. The earliest stages of star formation, Class 0 sources or younger, would be detected for the first time.

Irradiated Gas in Active Galaxies

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Gas in galaxy centers is exposed to strong radiation fields, originating from starburst regions and/or accreting black holes (AGN) or both. The radiation from starburst regions is dominated by FUV radiation ($6 < E < 13.6$ eV) and creates photon dominated regions (PDRs), while AGN emit radiation in the 1-100 keV range leading to X-ray dominated regions (XDRs). The resulting thermal and chemical gas properties differ significantly for both cases and as a consequence also the line intensities for the finestructure lines ([SiII], [CII], [CI], [OI], etc.). Not only are the line intensities generally brighter in XDRs, but their ratios are different as well. Ratios of molecular species such as CO, 13CO, HCN, HNC, and HCO+ are also very helpful in constraining the properties of the ISM ([1],[2],[3]). Unfortunately, current telescopes are only able to observe the lower rotational transitions of these molecules. However, large amounts of CO are produced in the warm layers of XDRs, which leads to high-J CO line emission, e.g. J=16-15. Herschel (HIFI) will be able to detect these high-J CO lines in active galaxies, and will be very useeful in determining the PDR and XDR components in these objects. There are also enhanced abundances of warm H2O produced in XDRs ([1]) and the far-infrared emission lines of water that are accessible to HIFI are especially useful in the study of dense clouds in the interstellar medium ([4],[5],[6]).

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Observing the Galactic Center

Dr. Chris Martin
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To understand the strongly excited gas near the center of our own galaxy, detailed surveys in a variety of higher excitation states are required. For the past few years, my colleagues and I have used the Antarctic Sub-millimeter Telescope and Remote Observatory (AST/RO, a 1.7m diameter sub-millimeter-wave telescope at the geographic South Pole) to complete a fully sampled survey of CO(7-6), CO(4-3), [CI] 3P2-3P1 and [CI] 3P1-3P0 in a three square degree region around the Galactic Center (Martin et al., ApJS, 150, 239 (2004)).

While this data-set has a number of fascinating features, Herschel will provide a platform to discover far more about the dynamics and structure of the region around the Galactic Center. Using frequencies inaccessible from the ground, Herschel will enable detailed studies and surveys of the highly excited gas in this intriguing region.

Herschel Exploration of The Cloud-Core Connection

S. Maret

Abstract

We propose an open time key program to explore the relation between star forming cores and the natal cloud. Stars are born from the gravitational collapse of dense cores in molecular clouds. During this process, the gas undergoes important physical and chemical changes. The cold initial phases are initially characterized by a transition in UV shielding leading low density atomic gas at cloud edges, such as C II, to transition to molecular form. As the cloud condenses into dense core the increasing central density is accompanied by the freeze-out of gas-phase molecules and subsequently high levels of deuteration. After stellar birth the warm central core and energetic outflows heat the surrounding material and further alter the gas physics and chemistry.

Herschel-HIFI offers a unique opportunity to probe the cloud-core connections and the capability to track the evolution from cloud to protostar. With HIFI we can observe and spectrally resolve lines that are difficult or impossible to detect from the ground and are unique probes of the gas within each stage. Thus we will map the large-scale cloud surface and probe successively deeper with transitions of [C II], H2O, and CO. Clouds associated with "clustered" star formation, e.g. Perseus and Ophiucus, and portions of a cloud with a more quiescent nature, e.g. Taurus , will be examined. Within these clouds select cores and protostars will be mapped with species which are chemically selected to trace the densest gas (NH3, D2H+, ...). These observations aim to characterize the chemical and physical (e.g. density, temperature, kinematics) between the large scale structure of molecular clouds of disparate nature, the condensing molecular cores, and the effects of stellar birth on the natal cloud.

Title: **The metal content of galaxies**

Proposers: R. Maiolino et al.
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Abstract

Currently, our knowledge of the metallicity in galaxies is mostly based on diagnostics at optical wavelengths and it is likely incomplete and biased because of dust obscuration. Extinction prevents optical observations to probe the regions of active star formation, where the bulk of the energy production and of the metals processing occurs, therefore yielding information on the metal content only in the outer, less obscured regions. As a consequence, fundamental relations involving the metallicity of galaxies (e.g. mass-metallicity and age-metallicity relations), which have been extensively used to constrain the evolution of galaxies, may be subject to strong, systemic uncertainties.

HSO will provide, for the first time, the sensitivity and spectral coverage to study the metal content of galaxies in a spectral band essentially free of dust extinction and for a sizeable sample of galaxies. In particular we propose to observe the nebular lines [NIII]57μm, [OIII]52μm and [OIII]88μm (and for the brightest objects [NII]121μm) which are proven to be good tracers of the gas metallicity. We have selected a sample of 30 (nearly local) galaxies, at z~0.15. This redshift will allow [NIII]57um and [OIII]52um to be observed within the PACS band. The projected sizes of these galaxies at z~0.15 (D~7") is such that they match the HSO beam, thus maximizing the sensitivity and allowing us to obtain their integrated information (in contrast to nearby galaxies which either require expensive mapping or provide information only on the nuclear region).

We will also observe the stronger [OI]63μm and [CII]158μm PDR lines, which will provide additional information on the carbon abundance.

These data will also have high archival and legacy value, since they will provide the astronomical community with a relatively large sample of galaxies with a complete set of fluxes for the most important far-IR nebular lines.

Results from the Spitzer Survey of the Small Magellanic Cloud and the Promise of Studying Very Nearby Galaxies with Herschel

Adam Leroy, MPIA

We present recent results from the Spitzer Survey of the Small Magellanic Cloud (S3MC) and discuss the promise of Herschel broad band mapping of very nearby (<1 Mpc) galaxies to address a number of outstanding questions regarding dust and the neutral ISM. The ability to isolate star forming regions is unique to nearby galaxies and allows several important tests to be carried out. The ability to isolate emission from individual star forming regions makes it possible to use dust emission as a probe of the molecular gas. We have applied this method to *Spitzer* data in the SMC and derived a map of H2 that is more complete than that from CO. Even at long wavelengths, Herschel will be able to resolve nearby galaxies into arm and interarm regions, making it possible to probe directly for the presence of cold dust in the diffuse ISM and to measure the effects of dust processing in the spiral arms. We discuss the possible Herschel mapping of three nearby galaxies - the SMC, M31 and M33 - that may serve as stepping stones to intepret Herschel surveys of more distant galaxies and mention the related observational challenges of mapping large areas on the sky.

The Environment of Young Massive Stars

Lefloch, B.; Cernicharo, J.; Ceccarelli, C.; Goicoechea, J.

Abstract

M20 is the prototype of a young HII region which formed in a turbulent environment, and is currently undergoing a burst of star formation. It is excited by an O7 V star, located at 1.7kpc. Its small size (10 arcmin) and its simple geometry (an almost Stromgren sphere) make a privileged object for systematic studies, easier to model than complex regions like Orion.

The goal of this project is to provide the community with a complete database of M20 in many molecular, ionic, atomic fine-structure lines and in the dust continuum emission, using the three instruments onboard Herschel.

Such a database will be used to address the following topics:

- the dynamics of a molecular cloud and the impact of turbulence.

- the physics and chemistry of the gas and dust in the Photon-Dominated Region at the interface with the molecular cloud and in the Shock regions.

- the whole star formation sequence in a turbulent environment, from the very early phases (pre-stellar and Class 0) to the late protoplanetary phase, the formation of massive star clusters, the role of triggering mechanisms.

The Chemical Evolution of the ISM in nearby Galaxies

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HIFI/Herschel offers the unique possibility to study the line profiles of the most important cooling lines in the interstellar medium of nearby galaxies, not only in their centers but also in their spiral arms, their inter-arm regions, bars, and outer halo. Together with its unprecedented spatial resolution at far-infrared wavelengths, this gives the opportunity to seperate the contributions from the different components and phases of the ISM and study their input to the energy balance.

Among the key questions to be addressed are:

- Gas cooling: What is the relative importance of emission from [CII], [OI], [C], and CO to the gas cooling in different environments?
- Gas heating mechanisms: What is the relative importanc of heating via FUV photons, X-rays, cosmic rays, shocks in different environments?
- ISM phases: What is the origin of [CII] ? How much do the various ISM phases contribute?
- The outer disks of spirals: How much gas is present in the outer disks?

Galaxy evolution in the accretion zone of galaxy clusters

E. van Kampen

Abstract

We propose to image the infall regions of well-studied galaxy clusters at redshifts of z=0.1, 0.4 and 0.8, for which data at other wavelengths is already available. At each redshift we will observe at least 5 clusters, to provide good statistics in a range of environments.

The aim is to quantify star formation activity in galaxies that are in the process of being accreted by galaxy clusters. The accretion process brings galaxies together (radial infall), thus increasing their probability to interact and merge with each other. This leads to increased star formation activity, including star-bursting, and this increase dust production.

We will measure the abundance of dusty star-forming galaxies in the accretion zone, and their star formation rate. This will also provide a measurement of the overall total star formation activity in the cluster infall region as compared to the cluster core and to the field, which are obtained as part of the GT-time projects. We will do this as a function of redshift for a sufficient number of clusters per redshift interval.

Cold Cores in the Galaxy:
proposal for a Planck - Herschel OT Key Programme

M.Juvela (Helsinki University Observatory), I.Ristorcelli (CESR-Toulouse) et al.

Cold cores represent the first step in the process of star formation which is still today poorly understood. Dense clumps form inside molecular clouds and, before the infall leads to the birth of protostellar objects, gas and dust temperatures can drop very low, even below 10K. It is now clear that many of the fundamental aspects of the star formation (stellar mass distribution, formation efficiency, clustered or isolated modes, evolution timescales…) are closely linked to the initial properties of the cold prestellar cores. Exploring the Submm range with a unique sensitivity, spectral and spatial coverage, Planck and Herschel satellites will offer the best opportunity for a statistical and detailed study of cold cores at small and large scales in the Galaxy.
In this OT key programme, we propose to carry out a systematic study of Galactic cold cores with combined Planck and Herschel observations. We will first use data from the Planck satellite during its proprietary period to construct an unbiased catalog of cold cores that will cover the whole sky.
A large number of cold condensations are expected to be detected in this survey: prestellar cores of molecular clouds, compact isolated clouds such as globules, Jupiter mass clouds, and thousands of dark clouds in the Galactic plane (like the objects observed in extinction in the Isogal and MSX surveys, plus those at larger distances d>1kpc). In addition, many cold cores may be discovered at intermediate and high latitudes, as can be expected from the large scale distribution of the cold dust component as deduced from COBE-DIRBE data analysis and the ISOPHOT serendipity survey. We estimate to several thousands the number of cold cores to be detected in the Galaxy including a large number of new objects (especially those with very low temperatures) and likely some objects of previously unknown type.
Some one hundred representative and particularly interesting sources will be selected from this catalog for deep mapping with the PACS and SPIRE instruments. This follow-up with Herschel will be essential both for the extension of the spectral coverage to constrain accurately the SEDs, and for studies of the temperature distribution and the density structure of the cores (including the extended halo which cannot be observed from the ground). This statistical study will allow to characterize the nature of the different populations of cold cores in the various environments of the Galaxy. We will address the key questions related to the cold cores formation, its mass spectrum and relationship to the stellar IMF, the properties of dust (emissivity and polarisation) and its possible evolution toward the inner part of the cores, and the search for objects containing very cold dust (T<10 K). We present in the poster some of the preparatory work and plans for the source detection and extraction on Planck data, the selection criteria for the source sample to be followed-up with Herschel, and the planned analysis of the observations.

Dust and gas in the hosts of the most powerful radio sources during the peak of cosmic activity.

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Clive Tadhunter (Sheffield)
Axel Weiss (MPIfR Bonn)
Steve Willner (Cambridge, USA)

Abstract

We propose to make Herschel observations of the host galaxies of large extended 3C and 4C radio sources in the redshift range $1.5<z<3.5$, the epoch when the cosmic star formation peaked. The radio selection provides us with the most powerful and most massive active galaxies, the properties of which are well known throughout the electromagnetic spectrum, EXCEPT in the rest frame mid- and far-IR where these distant objects were hitherto outside the reach of space missions. Herschel photometry will for the first time permit measurement of their full spectral energy distributions. Herschel spectroscopy will in addition enable assessment of the star-formation rate in these objects.

Eta Carinae: an opportunity to study a massive binary in transition and to explore nitrogen chemistry

T. Gull, NASA/GSFC

Abstract

Eta Carinae and its massive ejecta, the Homunculus, provides an opportunity to study a massive stellar system at the end of its hydrogen burning state. With ~$3x10^6$ solar luminosities, ~100 solar masses, and a mass loss of ~10^{-3} solar masses/year at 500 km/s, plus 10 to 30 solar masses ejected in the historical past, there is much to explore.

The Homunculus, a neutral, dusty bipolar shell was ejected in the 1840s and contains at least 10 solar masses. Interior to it is the Little Homunculus, an ionized bipolar shell ejected in the 1890s and about a half solar mass. Between the lobes is a dusty skirt, part of which is the Strontium Filament, a metal-ionized, hydrogen neutral structure seen in Ti II, Fe I, Fe II, Ni II, V II, Sr II, Sc II. Ti/Ni abundance ratio is about 80 solar. Cr/Ni is about 20 solar.

In line of sight, we view through the wall of the foreground lobe of the Homunculus. Over twenty absorption velocity systems are identified. Molecular hydrogen, CH, OH, CH+ and NH have been found at -513 km/s, the Homunculus velocity, along with Fe I, Fe II, Ti II, V II, etc. The Little Homunculus is identified with -146 km/s ionized gas.

Eta Carinae is an X-ray and spectroscopic variable. Every 5.54 years, it goes through a several month long minimum during which the X-ray flux disappears, [Ar III], [Fe III]. [Ne III], [S III] and many Lyman alpha pumped Fe II and Cr II lines drop or disappear completely. He I wind lines are blue shifted, as are the doubly-ionized wind lines, relative to H I and Fe II wind lines. Recently Nielsen et al (Ap J 2007 May 10) showed that the He I emission originates from an He+ zone in the massive primary wind just beyond the wind-wind interface of the carved out cavity by the hot FUV-emitting secondary. The massive primary wind basically smothers the FUV flux of the secondary during periastron (30AU major axis, e~0.9) when the two stars appear to be within about 1 AU of each other.

The next minimum will be in January 2009. Planned launch of Herschel is well timed to begin following Eta Carinae as the minimum is approached and then track the recovery. Not only does the central source change, but the excitation/ionization of the ejecta relaxes, then returns.

Moreover, N and He are overabundant; C and O are nearly non-existent (< 1/80 solar) in the Homunculus and the Little Homunculus. Likely the gas to dust ratio is much larger based upon the many metals, normally tied up in dust grains, remain in gaseous phase as no C nor O to form molecules. Likely the chemistry is strongly nitrogen-based, very different from the ISM.

Hence, Eta Carinae is a prime object to study with Herschel as it is a massive binary that changes with time and indeed drives the nitrogen-rich, metal-rich ejecta. Indeed it is a true astrophysical laboratory.

Piercing through the Dust: Unveiling Obscured Accretion at High Redshift

C. Gruppioni et al.

Abstract

The observational signatures of super-massive black hole driven activity is widespread over the entire electromagnetic spectrum. While the X-ray band provides the best observational window to efficiently select large and relatively unbiased samples of unobscured and moderately obscured active galactic nuclei (AGN), it misses the majority of highly obscured AGN (Compton Thick, Nh > 10^{24} cm-2).

For this reason, several pressing questions still need to be answered:
1) A robust estimate of the space density and physical properties of obscured (Compton Thick) AGN.
2) The first determination of the AGN evolutionary properties as a function of the black hole mass and accretion rate. Such a goal can be reached only by means of a solid estimate of the AGN bolometric output as a function of the nuclear luminosity and redshift.
3) A self consistent time dependent modelling of the AGN evolution and in particular of the interaction/feedback between the nuclear activity and the formation and evolution of their host galaxies within the context of the large scale structure.

Such an ambitious program requires on the one hand the analysis of multi-wavelength data of large well defined samples of AGN and on the other hand the development of theoretical models to interpret the observational data.

Since the nuclear radiation absorbed by dust and gas is thermally re-emitted in the infrared domain, sensitive measurements in the IR range provide an opportunity to look for obscured AGN not identified in X-ray surveys. In particular, using a Spitzer/Optical colour selection it is possible to efficiently select potential highly obscured candidates at high redshift.

While Spitzer is fundamental for selecting such extreme objects in the Universe, Herschel will be of fundamental importance in detecting their redshifted peak of dust emission, in characterising their broad-band spectrum, thus discriminating between AGN-dominated and starburst-dominated, and in determining their bolometric output.

Here we propose to observe with Herschel/PACS+SPIRE a statistically significant sample of high-z highly obscured candidates selected in the fields covered by both the SWIRE survey and deep optical observations (~30 sq. deg.) on the basis of their MIPS-24micron -to- optical ratios (extremely bright at 24 micron but with faint optical counterparts), combined with Spitzer colours. We will take advantage of the SWIRE extremely large area coverage to select extreme sources. Their very low space density will make them extremely rare in the fields targeted in the GT time. Therefore our proposed program is complementary to the planned GT surveys, in that it covers a different part of the parameter space: high luminosity highly obscured AGN and starburst galaxies at high redshift.

THE CASE FOR AN OPEN-TIME KEY SURVEY PROGRAM OVER THE COSMOS FIELD

A. Franceschini and the *COSMOS Team*
Padova University

The COSMOS field, a 1.4x1.4 sq.degree contiguous sky region at RA~10h DEC~+02d being targeted by all major observatories on ground and in space, offers ideal opportunities for deep investigations with Herschel over a cosmic volume large enough to allow the study in the greatest possible detail of the evolution of starforming galaxies and the effects on them of environment and cosmic structures.

Due to time constraints, this field will be observed to only shallow depths in the Herschel GT program. We will argue that a combined PACS/SPIRE mapping of at least a major fraction of the area down to fundamental limits set by source confusion would make an essential, mandatory complement to the the multiwavelength data already publicly available over the COSMOS field (from X-Ray to Radio). The general design of an Herschel Key Program over the COSMOS field is presented in this poster.

Odin observations of eventual spectral features on the CMB

Pierre Encrenaz, Carina Persson, Ake Hjalmorsen, Jean Yves Daniel and the Odin team

Abstract

Using the unique frequency coverage of the Odin satellite, a strategy has been developed to try to detect redshifted rovibrational lines of primordial molecules (made of the light elements synthesized in the classical Big-Bang nucleosynthesis). Ab initio calculations have been performed to predict their spectrum. The actual state of the project will be presented.

The evolution of protoplanetary and planetary disks: From the primordial disks associated with PMS stars to Kuipert-belt structures.

Eiroa et al. (Universidad Autonoma de Madrid)

Abstract

Our intention is to present a Herschel Open Time Key program to study the evolution of circumstellar protoplanetary and planetary disks around pre- and main-sequence stars. Circumstellar disks are natural by-products of the star formation process and are the places where planetary systems form. Roughly, the evolution of circumstellar disks can be grouped in three different phases: i) Primordial circumstellar disks observed around protostellar sources and PMS stars. The disks evolve from optically thick entities, associated with Class 0/I protostars, to less dense structures associated with Class II and Class III objects. The gas and dust components of the primordial disks disappear after some 10^6 - 10^7 years. During that period of time, the formation of planetesimals, planetary embryos, or even planets have to take place. So far, the observations do not show clear evidences of the evolution in the dust and gas mass content of the primordial disks with the age of the star. We plan to approach the evolution of these primordial disks from a slightly different point of view; specifically, relating directly dust and gas observable quantities for a sample of PMS HAe and T Tauri stars, independently of any model dependent assumption, as e.g. stellar age estimates based on isochrones. ii) Debris disks around MS stars. These are secondary disks formed by collisions and evaporation of large grains and bodies formed in the previous evolutionary phase. Infrared excesses at wavelengths around approximately 60 microns are signatures of the debris. Debris disks are present at the early main-sequence evolution of star and disappear after approx 10^8 years. iii) Zodi andKuiper-belt disks. They constitute the latest stages of the disks, after the phase of large activity represented by the debris phase. The Solar system is the only well known case for the existence of such structures. The detection of such Zodi and Kuiper-belt disks would be a good signature of mature planetary systems. Herschel has unique capabilities to study the aformentioned phases of the evolution of circumstellar disks. Our project will have two diferenciated parts, which could eventually evolve into two different Open Time Key programs: a) A first part will consist of studying the evolution of the dust-to-gas ratio in protoplanetary disks. Our sample will mainly be based on the EXPORT sample, which consists of around 70 PMS and Vega-type objects. We already have a considerable amount of astrophysical information on the properties and characteristics of this sample. b) A second part will concentrate in the study of the Kuipert-belt structures around nearby MS stars (distances less than approximately 25 pc). The stars to be observed will consist of an enlarged sample of the stars included in the Darwin stellar catalogue. These stars have ages in the range of approx. 0.1 – 10 Gyr. We have already analysed a large amount of their properties by means of ad-hoc observations and data in public archives and catalogues.

Herschel Imaging of Massive Cluster Cores with Bright Spitzer/24um Sources

Herschel Open-Time Key Program Proposal

Eiichi Egami (Steward Observatory, University of Arizona)

Abstract

Since cluster cores are dominated by early-type galaxies with little infrared emission, bright Spitzer/24um sources detected in cluster cores are either (1) strongly-lensed high-redshift galaxies in the background, or (2) infrared-luminous brightest cluster galaxies (BCGs). Although these two types of objects are extremely interesting to observe with Herschel, our Spitzer GTO survey of ~30 massive clusters (z=0.15-0.5) shows that such bright 24um sources are rather rare in cluster cores, and therefore that a much larger survey is needed to find a significant number of them.

To identify a much larger number of bright 24um sources in cluster cores, we are currently designing a Spitzer/24um snapshot survey of massive clusters. Here, we will describe the design of a Herschel Key program to image massive cluster cores in conjunction with such a Spitzer survey.

The AKARI FIR All-Sky Survey

Yasuo Doi and the AKARI/FIS team

The Infrared Astronomy Satellite AKARI (formerly ASTRO-F) is now conducting an all-sky survey in mid- and far-infrared wavebands. In this presentation, status of the AKARI FIR survey, which wavebands are completely overlapping with those of Herschel/PACS, is presented.

The AKARI FIR All-Sky Survey is going to cover virtually (>90%) the whole sky in 50--180um wavelength range with 4 continuous photometric bands centering at 65 um, 90 um, 140 um, and 160 um. Its spatial resolution is 60"--80" and sensitivity is 200--1000 mJy. With its high spatial resolution and high sensitivity, this survey can be a revolutionizer of the former IRAS survey done in two decades ago. Now ~80% of the sky has been surveyed and eventually, >90% of the sky will be covered by later this year.

After the completion of the mission, it's observational data will be opened to astronomical community. Firstly a FIR bright source catalog will be released and more complete catalogs will follow. In addition to the all-sky survey, pointing observations have been carried out for better sensitivity of an order of magnitude. These data will also be opened to the public after a proprietary time of one year.

Expected outcomes of the AKARI FIR survey and its possible influence to the Herschel mission is discussed.

Star Formation Rates from [CII] 158um, or, How Herschel will pave the road for ALMA

A. Gil de Paz (UCM,Spain) et al.

ABSTRACT

We present a Herschel Open Time Key Program aimed to calibrate the fine-structure [CII] 158um line as a measure of the current Star Formation Rate (SFR) in galaxies. Being one of the brightest features in the FIR, this line will be routinely observed at low redshift with Herschel and at z=8-10 with ALMA. We will propose to obtain Herschel/PACS line maps centered in the [CII] line for a representative sample of local star-forming galaxies. These data will be compared with ground-based IFU observations in the entire optical range, including Hbeta and Halpha (the best estimator of the current SFR after proper corrections for extinction and underlying absorption). SFR estimates based on [CII] 158um will be calibrated against variations in the infrared continuum luminosity (from Spitzer 24+70+160um + Herschel/PACS 110+170um to be also obtained as part of this project & Herschel/SPIRE 250+360+520um from GT programs), dust extinction, and metallicity (from ground-based IFU data), all with spatial resolution.

This project is intended to fill the gap between the proposed GT Key Program on [CII] line mapping on dwarf galaxies and other programs on AGN and starburst galaxies. It includes mostly spiral and irregular galaxies showing a wide range of properties (morphological types, total IR luminosities, metallicities, etc.), all having GALEX, Spitzer 24+70+160um, and soon Herschel/SPIRE and ground-based IFU data available.

SPIRE nearby cluster survey

J. Davies and S. Eales, Dept. Physics and Astronomy, Cardiff University

Abstract

We are proposing to use SPIRE to carry out a deep survey of three nearby promient and previously well studied (at other wavelengths) galaxy clusters (Virgo, Coma and Abell1367). Virgo is the nearest large grouping of galaxies and will enable us to study galaxies in a wide range of environments at good spatial resolution. Coma and Abell1367 lie at about the same distance and are strongly contrasting cluster types as Coma is evolved dynamically and contains many early type galaxies while Abell1367 is dynamically young and dominated by late types. Our prime scientific objectives are to extend our detailed knowledge of the star formation history of the cluster galaxies so that they can be compared to those derived for other nearby galaxies (studied as part of the GO program), compare our observations with expectations of theoretical models of galaxy formation, learn more about how the environment gives rise to morphological segregation, map the dynamical structure of the clusters to study how they are being assembled, measure dust extinction compared to emission within individual galaxies and put constraints on dust in the inter-galactic medium.

The Wide-Field Infrared Survey Explorer (WISE)

Roc Cutri (IPAC/Caltech) and the WISE Team

The Wide-Field Infrared Survey Explorer (WISE) is a NASA mid-size Explorer Mission scheduled for launch in November 2009 that will map the entire sky with unprecedented sensitivity at 3.3, 4.7, 12 and 23μm at a spatial resolution between 6" and 12". WISE will produce and release to the world astronomical community a digital Image Atlas covering the entire sky in the four survey bands, and an extracted Source Catalog containing photometry and positions of approximately 300 million objects. The WISE Catalogand Image Atlas will enable a broad variety of research ranging from the search for the closest stars to the Sun to the most luminous galaxies in the Universe, and will serve as an important reference data set for planning Herschel observations and for analyzing and interpreting measurements made during the second half of the Herschel mission.

WISE is currently entering its final design and construction phase. WISE will make use of a 40cm cryogenically cooled-telescope equipped with a camera containing four mid-infrared focal plane detectors that simultaneously image a 47'x47' field-of-view on the sky. The spacecraft will fly in a sun-synchronous 525 km polar orbit and use a freeze-frame scanning technique to obtain a minimum of eight independent 8.8 sec exposures on each point of the sky. The number of samples increases towards the ecliptic poles as the orbital scans converge. During its 6 month mission, WISE will achieve a minimum point source sensitivity on the ecliptic corresponding to signal-to-noise ratio >=5 at flux densities of 0.12/0.16/0.65/2.6mJy in the 3.3/4.7/12/23μm bands, respectively, in regions of the sky not confused by Milky Way stars and diffuse emission. The astrometric precision of the WISE catalog will be <=0.5" rms with respect to the 2MASS Point Source Catalog. Preliminary data products constructed from the first 50% of the sky surveyed will be released six months after the end of on-orbit operations, approximately in December 2010. The final Atlas and Catalog including all surveyed sky will be released 17 months after the end of data collection, approximately in November 2011. The WISE Image Atlas and Source Catalog will be distributed via the VO-compatible web services of the NASA/IPAC Infrared Science Archive (IRSA).

Anisotropy Studies of Far-IR Background with a SPIRE Wide-Field Survey

Asantha Cooray, Alexandre Amblard (UC Irvine), James J. Bock (JPL)

We will present requirements for a high confidence detection of far-IR background anisotropy power spectrum using a wide-field survey with Herschel-SPIRE. These measurements can be used to understand the nature of sources below the point-source detection level, to constrain cosmological parameters when combined with CMB measurements, and to extract parameters on the far-IR halo occupation distribution that connect these sources to the dark matter halo distribution (e.g., number of sources as a function of the dark matter halo mass). When combined with source counts, luminosity functions, and resolved source clustering statistics, unresolved fluctuations can also be used to address the fraction of far-IR background intensity associated with all sources and to establish if there is an additional component. We also discuss issues related to the removal of foreground Galactic dust using multi-wavelength data, impact of scan pattern on fluctuation studies, and a way to optimize a survey for an anisotropy power spectrum measurement (basically depth and area). Due to high source confusion, a fluctuation study of the unresolved component is necessary to establish certain properties of sources that form a large fraction of the far-IR background intensity.

MAPSO: Mapping Sgr B2 and Orion star forming regions
(*A Herschel Open Time Key Program*)

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We propose an OT Key Program to map the most prominent star forming regions in the Galaxy with the three instruments which are on board Herschel (HIFI, PACS and SPIRE). We aim to determine the extended distribution of gas and dust around Sgr B2 (~7'x7') and Orion (~8'x20') clouds. Unique spectral diagnostics of the chemistry (water and hydrides) and of the physics (atomic and ionic main cooling lines) can not be observed by ground-based telescopes but will be detected and fastly mapped with Herschel. Understanding the large scale molecular content (abundances of the simplest species) and gas properties (thermal balance, dynamics and neutral/ionized gas filling factors) is of crucial importance. It is the widespread gas and dust that sets the initial conditions for star formation. As a Key Program, our objective is to provide the community with an unprecedented view of the physical and chemical conditions in Orion and Sgr B2, the two most important templates of high mass star forming regions in the galactic disk and nuclei.

A preliminary list of submillimeter molecular and atomic lines to be observed at high spectral resolution with HIFI has been selected. The molecular line list includes: saturated species such as water and ammonia, molecular ions such as CH^+ and H_3O^+, radicals such as OH and NH_2, and atomic ions such as C^+ and N^+.

HIFI polarization observations will be pursued in some strong maser lines (water) or lines from paramagnetic species (OH). In addition, large scale maps of the O, O^{++}, N^{++} and N^+ line emission, and several full coverage far-IR line surveys with PACS will be carried out. Finally, we propose to obtain complete spectral energy distributions (SEDs) and medium resolution spectra with SPIRE at every cloud position.

Herschel offers for the first time the required sensitivity, resolving power and spatial resolution in the far-IR to determine the role of these species over entire molecular complexes. The proposed continuum and line tracers are essential probes of the wide range of excitation conditions displayed by these exceptional sources (from photodissociation and shocked regions to the widespread and quiescent gas).

Based in our best knowledge of the instrumentation, we estimate that the “MAPSO” project requires ~350 hours of observing time. This OT Key Program will also provide decisive information to place in context the “HEXOS” HIFI GT-KP line surveys at the core positions of Sgr B2 and Orion.

The proposed line maps and SEDs will be a legacy for astrochemical studies. Therefore, we plan to provide the specific tools to analyze the observations (e.g. software to handle OTF maps) and to interpret them (radiative transfer codes and collisional rates for the observed molecules). A large international consortium (from Spain, France, US, UK, Germany, Canada, Sweden, Holland and Italy) has been formed to support this OT-KP and two meetings have been already held in Madrid during July and November 2006. The team includes co-investigators of HIFI and SPIRE instruments, Herschel's mission scientists and experts from observational and theoretical astrochemistry as well as from the field of collisional-cross section calculations. The project has been divided in several sections and different coordinators have been agreed.

CO in the stratospheres of Saturn, Uranus and Neptune

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The question of the origin of oxygenated compounds in the atmosphere of the giant planets was raised since the detection of H_2O and CO_2 in the stratospheres of the four planets (Feuchtgruber et al. 1997, 1999, Lellouch et al. 1999, Burgdorf et al. 2006). The tropospheric cold trap implies an external origin for both molecules.

CO was also detected on these planets (Beer et al. 1975 on Jupiter, Noll et al. 1986, Encrenaz et al. 2004, Marten et al. 1991). The case of CO is different from H_2O and CO_2 as it does not condensate at the tropopause level. Therefore, its origin can be either internal (stratospheric CO due to upward mixing), external (sputtering from the rings and/or satellites, interplanetary dust particles, large meteoritic infall) or both. Bézard et al. (2002) argued in favor of a dual origin of CO on Jupiter. The vertical mixing ratio profile of CO retrieved by Marten et al. (2005) on Neptune is uniform implying CO would have an internal origin. Lellouch et al. (2005) showed with a broadband spectra analysis that a dual origin cannot be ruled out. Herschel-HIFI observations would provide improved line shapes and the CO vertical profile would be better constrained. As the abundance of CO derived from observations of Saturn and Uranus (10^{-9} - 10^{-8}) is lower than the one on Jupiter and Neptune (typically 10^{-6} in the stratosphere), its detection did not allow a precise retrieval of its vertical profile.

In this work, we propose a program dedicated to observation of CO lines on Saturn, Uranus and Neptune with the Herschel-HIFI instrument. We therefore sort out the lines that should be observed on both planets in order to have a good retrieval of its vertical profile and give integration time estimates to fulfill this program, according to the latest telescope status report.

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The evolution of the dust-to-ultraviolet ratio with redshift

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Abstract

Ultraviolet (UV) photons from young stars can be harvested directly in ultraviolet or, when stars are embedded into dust, in the far-infrared (FIR) through a processing of UV photons. These two emissions therefore compete and are complementary to estimate total star formation rates. They are also the most widely used star formation tracers at all redshifts. However, can we estimate these total star formations rates from UV and/or FIR emissions? What is the proportion of the star formation density in UV and in FIR? In the local universe, we find about 50% of the star formation in UV and in FIR. Then the UV contribution declines and the FIR takes over up to z ~ 1 (e.g. Takeuchi, Buat & Burgarella 2005). Sometimes in the history of the universe, we should witness the inverse phenomenon related to the first formation of dust grains.

In the IR wavelength range, Spitzer and Akari allow to study the total star formation rates and its UV/FIR contributions up to z ~ 1 for luminous IR galaxies (LIRGs). However, a larger telescope would allow to reach fainter galaxies and/or higher redshift ones to follow the evolution of the FIR/UV ratio. Moreover, knowing this evolution for several luminosity bins relevant for the universe star formation density and, more globally, in the universe would permit to estimate total star formation densities as a function of redshift.

We plan to observe, in the FIR with Herschel, fields for which deep UV/optical photometry is already available and for which redshifts are known for large galaxy samples to enlarge the present GALEX/Spitzer database (e.g. Buat et al. 2007, subm. to A&A, Burgarella et al. 2007, subm. to MNRAS) at z ~ 0.7 and z ~ 1. We will define a UV-selected sample and a FIR-selected sample and study their similarities/differences and the evolution with z.

A tool for chemical modelling of young stellar objects depending on high-energy radiation

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Young stellar objects (YSOs) start to emit X-rays at a not yet known stage of their evolution. Still deeply embedded in their natal cloud, most or all of the radiation is absorbed and not accessible to direct measurements. However, the chemistry of the envelope and accretion disk is affected by high-energy irradiation (X-rays and far UV) through additional ionization. A chemical model by Stäuber et al. (2004, 2005) has shown that several molecules can act as tracers for X-rays (e.g. SH^+, NH, N_2H^+,H_2O^+, H_3O^+) whereas others are more influenced by far UV radiation (e.g. C, OH, CH^+, HOC^+). Internal UV photons are mostly absorbed by dust and affect the chemistry on scales of a few 100 AUs (for high-mass YSOs). X-rays, mostly absorbed by H_2, can penetrate deeper into the cloud, up to $\geq$ 1000 AUs. The rest of the envelope is dominated by cosmic-ray induced ionizations. A detailed non-LTE calculation of line intensities has shown, that several high-J lines are more sensitive to high-energy radiation than low-J lines of the same molecule due to the higher critical density. Many of the enhanced hydride lines lie outside of the range of ground based telescopes and will be observable with HIFI-Herschel for the first time.

We present a grid of chemical models which allows a fast calculation of chemical abundances in the envelope of YSOs. Depending on physical properties (density, temperature, X-ray and UV radiation field), the abundance of a molecule is interpolated on a database of pre-calculated values as a function of time. We find, that even with a modest number of interpolation points, the accuracy of the interpolation lies within the expected error due to uncertainties in the reaction coefficients. One possible application of the chemical grid is the extension of the spherical symmetric models by Stäuber et al. (2004, 2005) to 2D models. This chemical grid will further allow fast fitting of observed column densities to models.

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A Novel calibration technique for measuring the PACS photometer performances

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Abstract

The PACS Photometer Focal Plane Unit (PhFPU) is the first instrument equipped with filled bolometer arrays containing over 2500 pixels. The camera, designed and developed by CEA/LETI and CEA/ DAPNIA , is the first of its kind. It is made up of collectively manufactured sub-arrays of 16 by 16 bolometers closely packed in the focal plane achieving Nyquist sampling of the field of view, plus a cold readout multiplexed electronics working at 300 mK. This new generation of bolometer arrays actually combines an IR detector architecture with the detection principle at work in the majority of submm continuum instruments. We give an overview of the PhFPU general characteristics and describe the functioning of CEA bolometer arrays insisting on the calibration procedure we especially developed for measuring the performances of this very promising detector.

Meanwhile the PACS calibration campaign is underway. It started in October 2006 and the first results are already coming out. The data available after the first run of performance measurements allowed the computation of the photometer sensitivity in different configurations of the system. We discuss sensitivity optimisation under various detector bias settings, readout modes and background flux levels. We also used the PACS simulator to investigate the bolometers time constant effects on scanned AOTs. Finally we will comment on the weak non-linearities of the bolometric signals observed during the sensitivity optimisation procedure.

Studying the connection between star formation and X-ray absorption with Herschel

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Abstract

Recent observations have again proven the connection between AGN cores and the star forming processes in their host galaxies. This is most likely caused by the fact that there is a correlation between the bulge mass of the host galaxy and the mass of the black hole. In many models, the AGN core terminates the star formation in the host galaxy by driving a powerful wind. Herschel offers unprecedented capabilities for mapping the star forming regions in nearby Seyfert galaxies. We have selected a complete sample of nearby Seyfert galaxies, which show bright emission in the hardest X-rays in Swift/BAT and INTEGRAL/IBIS. We propose to map the star forming regions in the brightest, strongly absorbed sources with hydrogen column densities (measured in soft X-rays) larger than 1E23 1/cm**2. These 15 sources show signatures of Compton reflection on the absorbing material. As a comparison we selected from the same complete sample 4 Seyfert galaxies with weak absorption (NH < 1E21). All objects are at redshifts smaller than z = 0.065. Herschel will be able to show the structure of star forming regions in the host galaxies and thus shed light on the connection of starburst activity, the AGN core, and the role of absorbing material as seen in the soft X-ray domain.

Cold Dust in Interacting Galaxies

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Abstract

It is widely accepted that interactions among galaxies are the dominant mechanism responsible for their morphological evolution as well as the principal trigger for the energy production in the universe - via massive star formation or accretion into a supermassive black hole - particularly at high redshifts. Dust grains, produced at the late stages of stellar evolution, constitute just ~1 per cent of the gas mass in a galaxy. However, they do play a critical role in the reprocessing of the ionizing radiation as well as in the formation of complex molecules, further regulating subsequent star formation events. Detailed analysis of samples of interacting galaxies with ISO, Spitzer have enabled for the first time the use of mid-infrared study to probe enshrouded regions in galaxies, to spatially resolve and examine the properties of the warm dust component. Based on the work we have performed with SCUBA/JCMT on the analysis of the global properties of the cold dust component in a sample of interacting systems we explore the new possibilities Herschel will offer on this issue.