THE HERSCHEL MISSION, SCIENTIFIC OBJECTIVES, AND THIS MEETING

Göran L. Pilbratt

ESA Astrophysics Division, Space Science Department, ESTEC / SCI-SA, Keplerlaan 1, NL-2201 AZ Noordwijk, The Netherlands; email: GPilbratt@astro.estec.esa.nl

Abstract

The 'Herschel Space Observatory' (formerly known as the 'Far InfraRed and Submillimetre Telescope' – FIRST) is the fourth cornerstone mission in the European Space Agency (ESA) science programme. It will perform imaging photometry and spectroscopy in the far infrared and submillimetre part of the spectrum, covering approximately the 60−670 μm range.

The key science objectives emphasize current questions connected to the formation of galaxies and stars, however, having unique capabilities in several ways, Herschel will be a facility available to the entire astronomical community. Because Herschel to some extent will be its own pathfinder, the issue of instrument calibration and data processing timescales has special importance.

Herschel will carry a 3.5 metre diameter passively cooled telescope. The science payload complement – two cameras/medium resolution spectrometers (PACS and SPIRE) and a very high resolution heterodyne spectrometer (HIFI) – will be housed in a superfluid helium cryostat. Herschel will be placed in a transfer trajectory towards its operational orbit around the Earth-Sun L2 point by an Ariane 5 (shared with the ESA cosmic background mapping mission Planck) in early 2007.

Once operational Herschel will offer a minimum of 3 years of routine observations; roughly 2/3 of the available observing time is open to the general astronomical community through a standard competitive proposal procedure. The 'rules' applicable as laid down in the 'Science Management Plan' governing the observing time, proprietary times, data products, as well as the purpose of this meeting are outlined.

Key words: Space observatories, ESA, Herschel, FIRST, PACS, SPIRE, HIFI, far infrared, submillimetre, galaxy formation, star formation, interstellar medium, solar system objects, bolometers, photoconductors, mixers, science management, data products, key projects, surveys

1. Introduction

The 'Herschel Space Observatory' (formerly known as the 'Far InfraRed and Submillimetre Telescope' – FIRST, see Fig. 1) is a multi-user 'observatory type' mission that targets approximately the 60−670 μm wavelength range in the far infrared and submillimetre part of the electromagnetic spectrum, providing observation opportunities for the entire astronomical community. Herschel is the fourth of the 'cornerstone' missions in the ESA science 'Horizon 2000' plan.

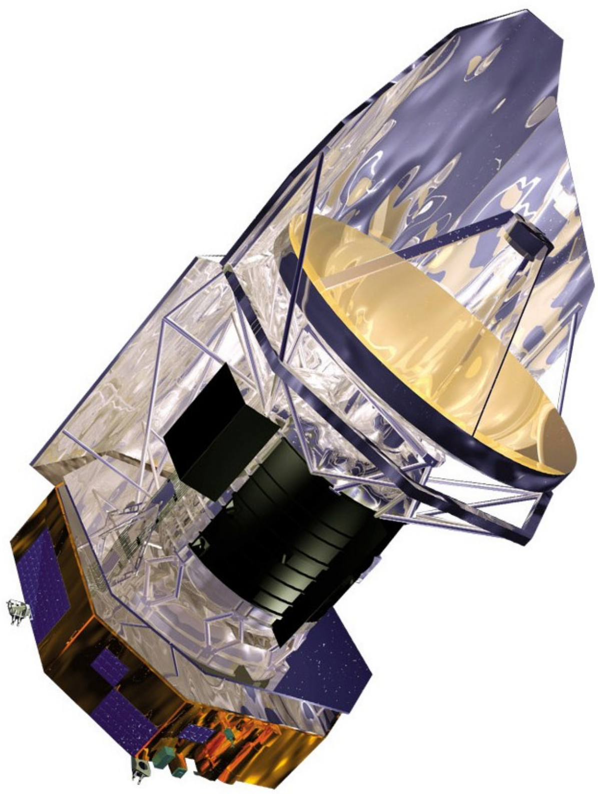

Figure 1. The Herschel satellite in orbit. The passively cooled telescope behind the protective sunshade, the superfluid helium cryostat containing the science instruments with its black radiator and the local oscillator unit mounted onto its side, and the hexagonal service module can all be seen. (Courtesy Alcatel Space.)

Herschel is the only space facility dedicated to the submillimetre and far infrared part of the spectrum. Its vantage point in space provides several decisive advantages. The telescope will be passively cooled, which together with

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a low emissivity and the total absence of (even residual) atmospheric emission offers a very low and stable background that enables very sensitive photometric observations. Furthermore, the absence of atmospheric absorption gives full access to the entire range of this elusive part of the spectrum, which offers the capability to perform completely uninterrupted spectral surveys.

2. Science objectives

Herschel will complement other available facilities by offering space observatory capabilities in the far infrared and submillimetre for the first time. This will enable unique observing programmes to be conducted, but also places special requirements on the instruments calibration and data processing.

2.1. The cool universe

The Herschel science objectives (Rowan-Robinson et al. (eds.) 1997; Pilbratt et al. (eds.) 2001 = this volume) target the 'cold' universe; black-bodies with temperatures between 5 K and 50 K peak in the Herschel wavelength range, and gases with temperatures between 10 K and a few hundred K emit their brightest molecular and atomic emission lines here. Broadband thermal radiation from small dust grains is the most common continuum emission process in this band. These conditions are widespread everywhere from within our own solar system to the most distant reaches of the Universe!

Herschel has the potential of discovering the earliest epoch proto-galaxies, revealing the cosmologically evolving AGN-starburst symbiosis, and unraveling the mechanisms involved in the formation of stars and planetary system bodies. The key science objectives emphasise specifically the formation of stars and galaxies, and the interrelation between the two. Examples of potential observing programmes with Herschel include:

- Deep extragalactic broadband photometric surveys in the 100−600 μm Herschel 'prime' wavelength band and related research. The main goals will be a detailed investigation of the formation and evolution of galaxy bulges and elliptical galaxies in the first third of the present age of the Universe.
- Follow-up spectroscopy of especially interesting objects discovered in the survey. The far infrared/submillimetre band contains the brightest cooling lines of interstellar gas, which give very important information on the physical processes and energy production mechanisms (e.g. AGN vs. star formation) in galaxies.
- Detailed studies of the physics and chemistry of the interstellar medium in galaxies, both locally in our own Galaxy as well as in external galaxies, by means of photometric and spectroscopic surveys and detailed observations. This includes implicitly the important question of how stars form out of molecular clouds in various environments.
- Observational astrochemistry (of gas and dust) as a quantitative tool for understanding the stellar/interstellar lifecycle and investigating the physical and chemical processes involved in star formation and early stellar evolution in our own Galaxy. Herschel will provide unique information on most phases of this lifecycle.
- Detailed high resolution spectroscopy of a number of comets and the atmospheres of the cool outer planets and their satellites.

All astronomy missions and observatories – ground, air, and space based – to varying degrees rely on, and complement, each other; in this respect Herschel is not an exception. A major strength of Herschel is its photometric mapping capability for performing unbiased surveys related to galaxy and star formation. Redshifted ultraluminous IRAS galaxies (with spectral energy distributions (SEDs) that 'peak' in the 50−100 μm range in their rest frames) as well as class 0 proto-stars and pre-stellar objects peak in the Herschel 'prime' band (Fig. 2). Herschel is also well equipped to perform spectroscopic follow-up observations to further characterise particularly interesting individual objects.

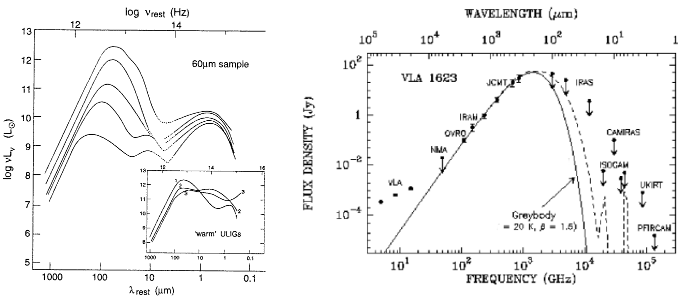

Figure 2. The Herschel wavelength coverage is ideally suited to for observing redshifted luminous IRAS galaxies (left) and class 0 protostars (right). Observations with PACS and SPIRE will enable large-scale unbiased searches for such sources to be made, and are important in determining their bolometric luminosities.

From past experience, it is also clear that the 'discovery potential' is significant when a new capability is being implemented for the first time. Observations have never been performed in space in the 'prime band' of Herschel. The total absence of (even residual) atmospheric effects – enabling both a much lower background for photometry and full wavelength coverage for spectroscopy – and a cool low emissivity telescope open up a new part of the phase-space of observations. Thus, a space facility is essential in this wavelength range and Herschel will be breaking new ground!

2.2. Timescales – a special Herschel challenge

It has already been mentioned that Herschel will bring far infrared and submillimetre observatory capabilities into space for the first time. This has an important consequence, which can easily be seen by making a comparison with the ISO situation. When the ISO observing programmes were being planned by the various future observers the data resulting from the all sky survey performed by IRAS, in its four photometric bands all within the ISO spectral coverage, were available. With ISO one could thus plan to build on the IRAS observations when extending the coverage in phase-space offered by the much more powerful ISO capabilities.

Simply put, Herschel has no IRAS. At least to a certain degree it will need to be its own pathfinder, while benefitting from IRAS itself and ISO, and hopefully by SIRTF observations and the Japanese Astro-F all sky survey to be conducted, as well as other space and ground based work. The fact that Herschel observers will want to build on and follow-up their own observations put stringent timescale implications on being able to successfully process Herschel data in a timely manner, and thus by implication, on the calibration of Herschel instruments.

Obviously, in order to build on its own observations, it must be possible to properly calibrate and process Herschel data on a timescale significantly shorter than the mission lifetime. But the real requirement is actually even much more stringent. It is currently planned to carry out unbiased 'large' observing programmes early on in the Herschel mission. To follow up on these observations, it is necessary not only to have the capability to process these data immediately, but in order to collect them in an optimal fashion it must be possible to properly process and assess the data collected in the performance verification phase (see Section 4), before proceeding to decide just how to perform these large programmes.

We are thus requiring being able to process the data – at least for the observing modes to be selected for performing the large unbiased programmes – just a few months into the in-orbit phase of the mission. This is a challenging task, especially considering the wide range of Herschel instrument detector technologies (see Section 3), and this is where the legacy of ISO will be crucial for Herschel in providing a guideline, complemented by 'do's' and 'don't's', on how to successfully accomplish this task.

3. Telescope and science payload

In order to fully exploit the favourable conditions offered by being in space Herschel will need a precise, stable, very low background telescope, and a complement of very sensitive scientific instruments. The Herschel telescope will be passively cooled – to maximise size – while the instruments will be housed inside a superfluid helium cryostat.

3.1. Telescope

The Herschel telescope must have a total wavefront error (WFE) of less than 6 μm – corresponding to 'diffraction-limited' operation at 90 μm – during operations, and a very low emissivity. Being protected by a fixed sunshade, it will radiatively cool to an operational temperature of around 80 K in orbit.

The baseline is a Cassegrain design with a 3.5 m diameter primary and an 'undersized' secondary. The telescope is foreseen to be provided by Astrium and will be constructed of silicon carbide (SiC). It will have a primary mirror made made out of segments that are 'brazed' together to form a monolithic mirror that can be polished to 'any' required accuracy. Since the accuracy of the manufacturing of the primary mirror is the driver in the overall telescope WFE budget, the control of this parameter is important.

3.2. Scientific instruments

The Herschel science payload complement has been conceived and optimised with the prime science goals in mind, but in addition it offers a wide range of capabilities for the 'general' observer. It was selected by the ESA Science Programme Committee (SPC) in May 1998 and approved in February 1999, based on the response to an Announcement of Opportunity (AO) issued in October 1997.

It consists of the following three instruments which will be provided by consortia led by Principal Investigators (PIs):

- The Photodetector Array Camera and Spectrometer (PACS) instrument will be built by a consortium led by A. Poglitsch, MPE, Garching, Germany.
- The Spectral and Photometric Imaging REceiver (SPIRE) instrument will be built by a consortium led by M. Griffin, QMW, London, (now Cardiff University, Cardiff,) UK.
- The Heterodyne Instrument for Herschel (HIFI) instrument will be built by a consortium led by Th. de Graauw, SRON, Groningen, The Netherlands.

The PI consortia provide the instruments to ESA under their own funding, in return for guaranteed observing time.

3.2.1. PACS - a camera and spectrometer

PACS (for a full description see Poglitsch et al. 2001 = this volume) is a camera and low to medium resolution spectrometer for wavelengths up to $\sim$210 μm. It employs four detector arrays, two bolometer arrays and two Ge:Ga photoconductor arrays. The bolometer arrays are dedicated for photometry, while the photoconductor arrays are to be employed exclusively for spectroscopy (Fig. 3). PACS can be operated either as an imaging photometer, or as an integral field line spectrometer.

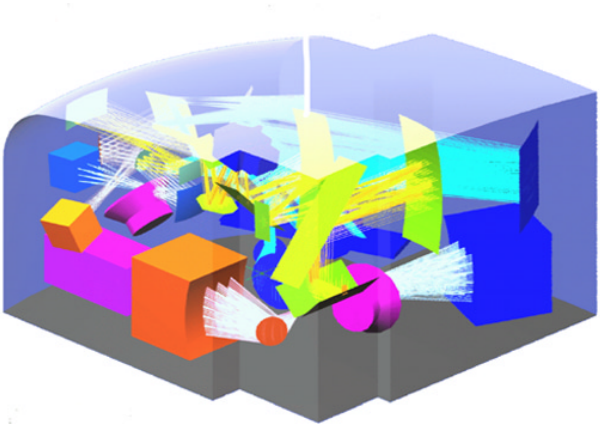

Figure 3. Computer rendering of the PACS focal plane unit optics. The bolometer arrays are visible towards the extreme left, the photoconductor arrays are the large red and blue 'cubes' respectively.

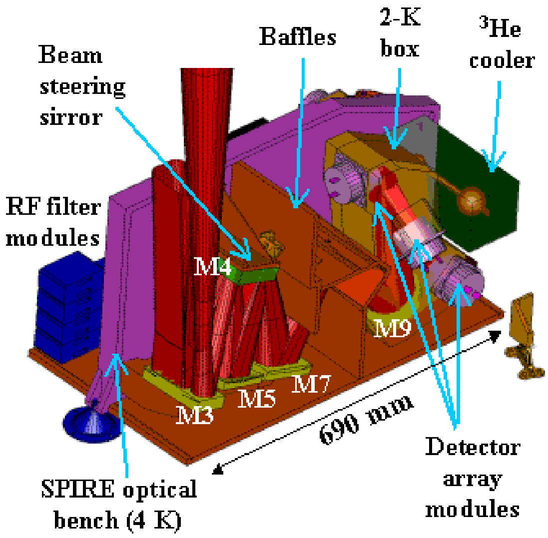

Figure 4. The SPIRE photometer layout. The internal ^{3}He sorption cooler provides the 300 mK operating temperature.

PACS has three photometric bands with $R \sim 2$. The short wavelength 'blue' array covers the 60−90 and 90−130 μm bands, while the 'red' array covers the 130−210 μm band. In photometric mode one of the 'blue' bands and the 'red' band are observed simultaneously. The two bolometer arrays both fully sample the same $1'.75 \times 3'.5$ field of view on the sky, and provide a predicted point source detection limit of $\sim$3 mJy (5σ, 1 hr) in all three bands. An internal ^{3}He sorption cooler will provide the 300 mK environment needed by the bolometers.

For spectroscopy PACS covers 57−210 μm in three contiguous bands, providing a velocity resolution in the range 150−200 km^{-1} and an instantaneous coverage of $\sim$1500 km^{-1}. The two Ge:Ga arrays are appropriately stressed and operated at slightly different temperatures – cooled by being 'strapped' to the liquid helium – in order to optimise sensitivity for their respective wavelength coverage. The predicted point source detection limit is $\sim 3 \times 10^{-18}$ Wm^{-2} (5σ, 1 hr) over most of the band, rising to $\sim 8 \times 10^{-18}$ Wm^{-2} for the shortest wavelengths.

3.2.2. SPIRE - a camera and spectrometer

SPIRE (for a full description see Griffin et al. 2001 = this volume) is a camera and low to medium resolution spectrometer for wavelengths above $\sim$200 μm (Fig. 4). It comprises an imaging photometer and a Fourier Transform Spectrometer (FTS), both of which use bolometer detector arrays. There are a total of five arrays, three dedicated for photometry and two for spectroscopy. All employ 'spider-web' bolometers with NTD Ge temperature sensors, with each pixel being fed by a single-mode 2Fλ feedhorn, and JFET readout electronics. The bolometers are cooled to 300 mK by an internal ^{3}He sorption cooler.

SPIRE has been designed to maximise mapping speed. In its broadband ($R \sim 3$) photometry mode it simultaneously images a $4' \times 8'$ field on the sky in three colours centred on 250, 350, and 500 μm. Since the telescope beam is not instantaneously fully sampled, it will be required either to scan along a preferred angle, or to 'fill in' by 'jiggling' with the internal beam steering mirror. The SPIRE point source sensitivity for mapping is predicted to be in the range 7−9 mJy (5σ, 1 hr). Since the confusion limit for extragalactic surveys is estimated to lie in the range 10−20 mJy, SPIRE will be able to map $\sim$0.5 square degree on the sky per day to its confusion limit.

The SPIRE spectrometer is based on a Mach-Zender configuration with novel broad-band beam dividers. Both input ports are used at all times, the signal port accepts the beam from the telescope while the second port accepts a signal from a calibration source, the level of which is chosen to balance the power from the telescope in the signal beam. The two output ports have detector arrays dedicated for 200−300 and 300−600 μm respectively. The maximum resolution will be in the range 100−1000 at a wavelength of 250 μm, and the field of view $\sim 2.6'$.

3.2.3. HIFI - a very high resolution spectrometer

HIFI (for a full description see de Graauw & Helmich 2001 = this volume) is a very high resolution heterodyne spectrometer. It offers velocity resolution in the range 0.3−300 kms^{-1}, combined with low noise detection using superconductor-insulator-superconductor (SIS) and hot electron bolometer (HEB) mixers. HIFI is not an imaging instrument, it provides a single pixel on the sky.

The focal plane unit (FPU, Fig. 5), houses seven mixer assemblies, each one equipped with two orthogonally polarised mixers. Bands 1−5 utilise SIS mixers that together cover approximately 500−1250 GHz without any gaps in the frequency coverage. Bands 6Low and 6High utilise HEB mixers, and together target the 1410−1910 band. The FPU also houses the optics that feeds the mixers the

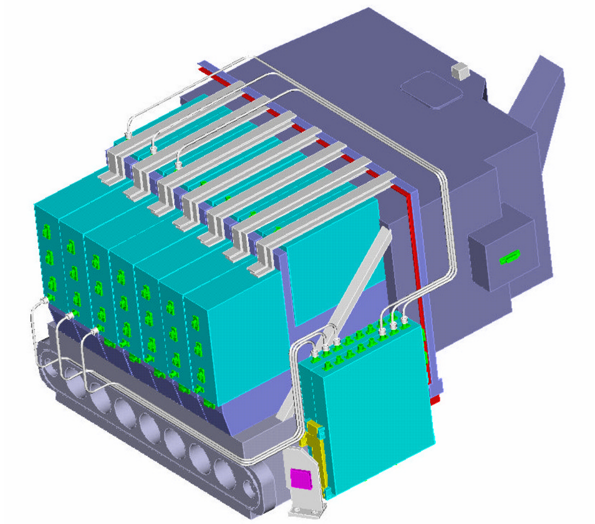

Figure 5. The HIFI focal plane unit with the seven mixer assemblies in the foreground.

signal from the telescope and combines it with the appropriate local oscillator (LO) signal, as well as provides a chopper and the capability to view internal calibration loads.

The LO signal is generated by a source unit located in the spacecraft service module (SVM, see Section 4). By means of waveguides it is fed to the LO unit, located on the outside of the cryostat vessel, where it is amplified, multiplied and subsequently quasioptically fed to the FPU. The SVM also houses the complement of autocorrelator and acousto-optical backend spectrometers.

4. Spacecraft and orbit

The Herschel configuration shown in Fig. 1 envisages a payload module based on the now well proven ISO cryostat technology. This configuration has been used to establish payload interfaces and study mission design. It is modular, consisting of a payload module (PLM, Collaudin et al. 2000) comprising the superfluid helium cryostat – housing the optical bench with the instrument FPUs (Fig. 6) – which supports the telescope, star trackers, and some payload associated equipment; and the service module (SVM), which provides the 'infrastructure' and houses the 'warm' payload electronics.

This Herschel concept measures 9.3 m in height, 4.5 m in width, and has an approximate launch mass of 3000 kg. The 3.5 m diameter Herschel telescope is protected by the sunshade, and will cool passively to around 80 K. The Herschel science payload focal plane units are housed inside the cryostat, which contains superfluid helium at below 1.7 K. Fixed solar panels on the sunshade deliver in excess of 1 kW power. Three startrackers in a skewed configuration and the local oscillator unit for the heterodyne instrument are visible on the outside of the cryostat vacuum vessel.

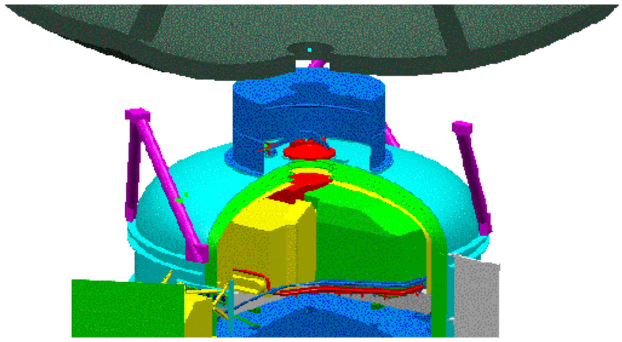

Figure 6. Exploded view of the upper part of the Herschel payload module, showing the three instrument focal plane units on the optical bench on top of the superfluid helium tank inside the cryostat vacuum vessel. (Courtesy Astrium.)

An Ariane 5 launcher (Fig. 7 left), shared by the ESA cosmic microwave background mapping mission Planck and Herschel, will inject both satellites into a transfer trajectory towards the second Lagrangian point (L2) in the Sun-Earth system. They will then separate from the launcher, and subsequently operate independently from orbits of different amplitude around L2.

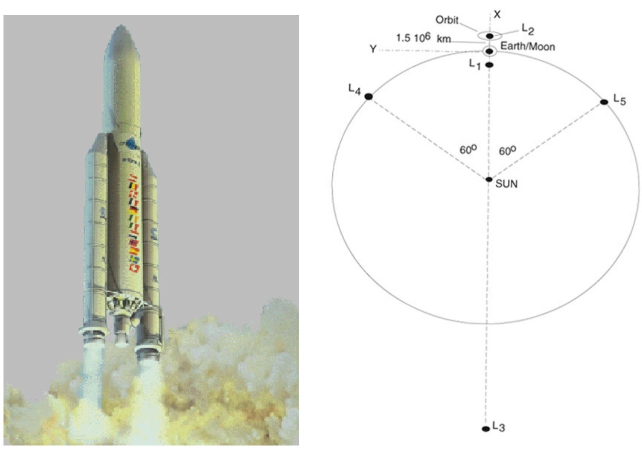

Figure 7. Left: A single Ariane 5 launcher will place both Herschel and Planck in transfer trajectories towards L2. Right: L2 is situated 0.01 AU from the Earth in the anti-sunward direction, providing a thermally stable favourable vantage point for performing observations.

The L2 point is situated 1.5 million km away from the Earth in the anti-sunward direction (Fig. 7 right). It offers a stable thermal environment with good sky visibility. Since Herschel will be in a large orbit around L2, which has the advantage of not costing any 'orbit injection' Δv, its distance to the Earth will vary between 1.2 and 1.8 million km. The transfer to the operational orbit will last approximately 4 months. After cooldown and outgassing have taken place, it is planned to use this time for commissioning and performance verifications. Once these crucial mission phases have been successfully accomplished, Herschel will go into the routine science operations phase for a minimum duration of 3 years.

5. Science operations

The scientific operations of Herschel will be conducted in a novel 'decentralised' manner. The proposed ground segment concept (see also Bauer et al. 1998) comprises five elements:

- a Herschel Science Centre (HSC), provided by ESA,
- three dedicated Instrument Control Centres (ICCs), one for each instrument, provided by their PIs,
- a Mission Operations Centre (MOC), provided by ESA.

In addition it is foreseen that a NASA Herschel Science Center (NHSC), to be located at the Infrared Processing and Analysis Center (IPAC), will become a sixth element.

The HSC acts as the single-point interface to the science community and outside world in general. The HSC provides information and user support related to the entire life-cycle of an observation, from calls for observing time, the proposing procedure, proposal tracking, data access and data processing, as well as general and specific information about 'using' Herschel and its instruments.

6. Science management

The 'rules of the road' for the science management of the Herschel mission are laid down in the (then FIRST) Science Management Plan (SMP). The SMP was approved by the SPC in August 1997; an approved SMP was a prerequisite for issuing the AO for PIs and Mission Scientists (MSs) which took place in October 1997 (see Section 3.2).

The SMP is a top-level document with the scope of outlining the mission with special emphasis on science operations, external participation, and science management. First of all the SMP explains that the scientific community will be invited to get involved in the Herschel mission in several ways:

- by providing science instruments and their associated ICCs, through an Announcement of Opportunity (AO) process
- by becoming Mission Scientists (MSs), through an Announcement of Opportunity (AO) process
- by becoming observers, through submission of observing proposals in response to calls for observing proposals to be issued
- by accessing data in the Herschel database after the proprietary period of time has expired
- by accessing 'final' data products in the Herschel database after completion of the postoperational phase

The SMP then gives an overview of the how the mission is envisaged to be managed, and what the responsibilities of the various involved parties are. In particular it states the responsibilities of the Project Manager, the Project Scientist, and of the Science Team:

- Project Manager (PM)
  - manages the project until successfully commissioned in orbit
- Project Scientist (PS)
  - has the responsibility to manage the scientific programme
  - represents the interests of the scientific community at all times, and is ESA's interface to this community
  - liases with PM and project team, co-ordinates all scientific issues
  - manages the project in routine and later phases
- Herschel Science Team
  - safeguards the scientific interests (there is a long list of tasks to this effect) and advises the PM on all aspects which affect scientific performance
  - composition: PS (chair), PI teams, MSs, project team

In the spring of 2001 the Herschel Optical System Scientist, who can be regarded an additional MS with very specific duties, was added to the Science Team composition. The SMP also introdues the Herschel Observing Time Allocation Committee and its tasks.

It then describes in detail the AO cycle for the selection of PIs and MSs, which was accomplished in the period 1997–99.

The last three of the five bullets of external participation all relate to the scientific data to be produced. Herschel will be a multi-user observatory open to the general astronomical community. The observation time will be shared between guaranteed and open time.

The guaranteed time (approximately one third of the total time) is 'owned' by contributors to the Herschel mission as follows:

– Principal Investigator teams	3×30 %
– Herschel Science Centre team	7 %
– Mission Scientists	3 %

The open time will be allocated to the general community (including the guaranteed time holders) on the basis of competitive calls for observing time. A small amount of the open time (discretionary time) will be reserved for targets that could not have been foreseen at the time of a proposal deadline.

All scientific data will be archived and made available to the data owners. The data products strategy adopted was to:

- enable observers to generate products with best available means (software)
  - where 'enable' is the responsibility of the HSC
  - where 'best available means' is the responsibility of the PIs (ICCs)

– in post-operational phase populate archive with 'final' products using the 'final' best means

The data rights policy adopted was described as follows:

- Herschel data will become public when
  - two (2) years has elapsed since the successful completion of the performance validation phase, or when
  - one (1) year has elapsed since the data of the observation, whichever is later
  - one (1) year has elapsed since the data of the observation for all 'survey' observations

After the proprietary time has expired for a given data set, the data will become available to the entire community in the same manner they were previously available only to the original owner.

7. Purpose of this meeting

It has already been mentioned that Herschel will bring observatory capabilities for its wavelength band into space for the first time. It was recognised very early that most likely 'large' observing programmes would be important, and the SMP states that 'it is anticipated that key projects in the form of large spatial and spectral surveys will constitute very important elements of the observing programme, requiring a substantial fraction of the available time of the overall mission'. It goes on to say that these programmes should be performed early, so that they can be followed up by Herschel itself; this is referred to as 'a phased approach'.

The SMP foresees an intial call for these 'key programmes', and charges the guaranteed time holders to spend at least half of their guaranteed time on these programmes. Importantly, the SMP foresees an intial call for proposals for 'key programmes' at an early stage, open to the entire community, and that these programmes should be established before the rest of the guaranteed time programmes are. However, the SMP does not go into details, but entrusts this responsiblity to the Science Team.

In addition to the SMP, the Science Team also got a directive from the committee evaluating the instrument proposals to organise a meeting – or series of meetings – to discuss what the optimum amount of 'key programme' time is. In starting to ponder this issue it became clear that issue at stake really is:

On the assumption that beginning summer 2007 (see Section 8) there are three years of Herschel facility time available, *how should this time best be spent in order to maximise the scientific return and impact of the mission as a whole?*

As already mentioned the Science Team is the body that is charged with assuming the responsibility to find an answer to this question, and to implement an appropriate strategy. Notwithstanding that it is a very difficult task, the Science Team do not even want to address such a

Figure 8. The symposium poster announced the meeting and its beautiful venue.

major issue in isolation. On the contrary, it seeks to have a dialogue and receive input and feedback from the entire future Herschel user community.

Recognising that it is necessary and appropriate already now to address this very important issue, the Toledo meeting was organised to:

- announce Herschel and its foreseen science capabilities to the astronomical community
- identify areas of astronomy where the impact of Herschel will be the greatest
- consider the issue of large 'key' programmes versus smaller 'traditional' programmes
- establish complementarity to other facilities

as a starting point to address the overall question discussed above.

In addition to the usual oral and poster presentations, it was also decided to organise panel discussions to attempt directly addressing the latter three bullets in various areas in smaller groups. From the start there was a dedicated effort to try attract members of the astronomical community not necessarily considering themselves 'infrared' astronomers to attend.

8. Status and schedule

The Herschel spacecraft has recently (April 2001) entered the detailed design phase – phase B. Following evaluation of the proposals received in response to the Invitation to Tender (ITT) for phases B, C/D, and E1 (issued on 1 September 2000 with a deadline for proposals of 1 December 2000), Alcatel Space has been selected as the prime contractor for the space segment of the Herschel (as well as the Planck) mission(s). Astrium GmbH (PLM) and Alenia Spazio (SVM) are the major subcontractors.

The instrument consortia are in the process of finalising the instrument designs in order to start building the first test models. The second formal review cycle, the Instrument Intermediate Design Review (IIDR), has been successfully conducted. The science ground segment is being developed, and will support instrument testing.

The current planning (for more details see Paßvogel 2001 = this volume) envisages a series of milestones, including instrument and telescope flight model deliveries in 2004, to be followed by spacecraft integration and extensive system level ground testing, leading to a launch nominally on 15 February 2007.

Additional information – including online versions of some of the references listed below, the SMP, and eventually also these proceedings – can be found on the ESA Herschel Science Centre World Wide Web site at the following URL: `http://astro.esa.int/herschel/`.

Acknowledgements

This paper has been written on behalf of the large number of people who are working on one or more of the many aspects of the Herschel mission – in ESA and national space agencies, the instrument consortia, scientific community, and industry – or who contributed to where we are now by doing so in the past.

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