Herschel Space Observatory Calibration Workshop#2

CSIC, Madrid, Spain

6-8 February 2008

List of Participants

	Name	Institution
1	Altieri, Bruno	ESA/ESAC
2	Barnes, Peter	University of Sydney
3	Bauwens, Eva	University of Leuven
4	Bhattacharya, Bidushi	California Institute of Technology
5	Blommaert, Joris	University of Leuven
6	Braine, Jonathan	LAB - Observatoire Aquitain des Sciences de l'Univers
7	Butler, Bryan	National Radio Astronomy Observatory
8	Cernicharo, José	DAMIR-CSIC
9	Dannerbauer, Helmut	Max-Planck-Institut fűr Astronomie
10	De Graauw, Thijs	SRON - Groningen
11	Decin, Leen	KULeuven
12	Dowell, Darren	Jet Propulsion Laboratory
13	Encrenaz, Pierre	Observatoire de Paris
14	Fernandez Clavero, Alicia	DAMIR-CSIC (secretary)
15	Feuchtgruber, Helmut	MPE, Garching
16	García-Lario, Pedro	ESA/ESAC
17	Gonzalez-Garcia, Beatriz	ESA/ESAC
18	Griffin, Matt	Cardiff University, Dept. of Physics & Astronomy
19	Gurwell, Mark	Harvard-Smithsonian Center for Astrophysics
20	Hargrave, Peter	Cardiff University, Astrophysics Instrumentation Group
21	Hartogh, Paul	Max Planck Institute for Solar System Research
22	Harwit, Martin	Cornell University
23	Heras, Ana	ESA/ESTEC
24	Herpin, Fabrice	LAB - Observatoire Aquitain des Sciences de l'Univers
25	Hofstadter, Mark	Jet Propulsion Laboratory
26	Kiss, Czaba	Konkoly Observatory
27	Klaas, Ulrich	Max Planck Institut fuer Astronomie
28	Kramer, Carsten	KOSMA, Universitaet zu Koeln
29	Lagache, Guilaine	IAS - Université Paris XI
30	Larsson, Bengt	Stockholm Observatory
31	Leeks, Sarah	ESA/ESAC
32	Lellouch, Emmanuel	Observatoire de Paris
33	Lim, Tanya	Rutherford Appleton Laboratory
34	Lorente, Rosario	ESA/ESAC
35	Marston, Tony	ESA/ESAC
36	Metcalfe, Leo	ESA/ESAC
37	Molinari, Sergio	INAF - IFSI
38	Moreno, Raphael	LESIA (LAM - bat. 18) Observatoire de Meudon
39	Mueller, Thomas	MPE, Garching
40	Noriega-Crespo, Alberto	Spitzer Science Center
41	Olberg, Michael	Onsala Space Observatory
42	Orton, Glenn	Jet Propulsion Laboratory
43	Piacentini, Francesco	ESA/ESAC
44	Pilbratt, Göran	ESA/ESTEC
45	Poglitsch, Albrecht	Max Planck Institut fuer E. Physik
46	Polehampton, Edward	Rutherford Appleton Laboratory
47	Ramon Pardo, Juan	DAMIR-CSIC
48	Rengel, Miriam	Max Planck Institute for Solar System Research
49	Rieke, George	University of Arizona
50	Roelfsema, Peter	SRON Netherlands Institute for Space Research
51	Sanchez Contreras, Carmen	DAMIR-CSIC

52	Sanchez-Portal, Miguel	ESA/ESAC
53	Sandell, Göran	NASA Ames Research Center
54	Schulz, Bernhard	IPAC/Caltech
55	Stansberry, John	University of Arizona
56	Teyssier, David	ESA/ESAC
57	Valtchanov, Ivan	ESA/ESAC
58	Vandenbussche, Bart	KULeuven
59	Vavrek, Roland	ESA/ESAC
60	Waelkens, Christoffel	KULeuven
61	Yamamura, Issei	ISAS/JAXA

AGENDA

(updated on 4 February 2008)

Wednesday, February 6th

Room Serrano 121

Session 1: Herschel satellite and instruments (Chair: M. Harwit)

08:30-09:00	Registration	
09:00-09:05	A.M. Heras	Welcome and logistics
09:05-09:35	G.L. Pilbratt	Herschel Overview, Status and Early Mission Phases
09:35-10:05	M.Olberg	HIFI calibration status and plans
10:05-10:35	U. Klaas	PACS calibration status and plans
10:35-11:05	T. Lim	SPIRE calibration strategy
11:05-11:25	*Coffee Break*	

Session 2: Mars and Giant Planets (Chairs: R. Moreno/C. Kramer)

11:25-11:40	R. Moreno/C. Kramer	Introduction
11:40-12:00	E. Lellouch	A Mars continuum model for calibration of the Herschel data
12:00-12:20	B. Butler	Mars models for Herschel
12:20-12:40	P. Hartogh	Calibration of Herschel/HIFI in the CO absorption lines of Mars
12:40-13:10	R. Moreno	Models of the Giant Planets
13:10-14:30	*Lunch*	
14:30-15:00	G. Orton	Uranus and Neptune models for Herschel
15:00-15:20	M.D. Hofstadter	Uranus in the Herschel Time Frame

Session 3: Background and Confusion noise (Chair: M. Harwit)

15:20-15:50	Cs. Kiss	Background and confusion noise
15:50-16:20	*Coffee Break*	

16:20-17:55 HCalSG discussion on: Progress since the November internal Review and next steps in calibration activities

17:55 *End day 1*

Thursday, February 7th
Room Serrano 119

Session 4: Galilean satellites and asteroids (Chairs: P. Hargrave/T. Lim)

09:00- 09:15	P. Hargrave/T. Lim	Introduction
09:15- 09:35	M. Gurwell	Galilean satellites as Herschel calibrators
09:35- 10:05	Th. Müller	The Asteroid Preparatory Programme for Herschel, AKARI and ALMA
10:05-10:25	P. Barnes	Recalibrating the absolute flux scale at 3 mm using planets and asteroids
10:25-10:45	J.A. Stansberry	Asteroids and Spitzer MIPS 160 micron calibration
10:45-11:15	*Coffee Break*	
11:15-11:35	B. Bhattacharya	Asteroids: Spitzer observations and lightcurves

Session 5: Stars and secondary calibrators (Chairs: J. Blommaert/G. Sandell)

11:35-11:50	J. Blommaert/G. Sandell	Introduction
11:50-12:20	E. Bauwens	Stellar calibrators for Herschel and their models
12:20-12:40	Cs. Kiss	ISOPHOT list of standard stars
12:40-13:00	G. Sandell	Secondary calibrators for Herschel
13:00-14:25	Lunch	
14:25-14:45	D. Dowell	Observations of asteroids, secondary calibrators and stellar standards
14:45-15:05	Alberto Noriega-Crespo	Spitzer Calibration at Long Wavelengths. MIPS Calibration at 24 and 70 micron

Splinter meetings*

15:05-18:35 Splinter A: (Chair: M. Griffin)
Selection of the baseline calibration source models for Herschel: Planets

15:05-18:35 Splinter B: (Chairs: P. Hargrave/T.Lim)
Selection of the baseline calibration source models for Herschel: Asteroids and planetary satellites

15:05-18:35 Splinter C: (Chairs: J. Blommaert/G. Sandell)
Selection of the baseline calibration source models for Herschel: Stars and secondary calibrators

16:00-16:30 *Coffee Break*

18:35 *End day 2*

20:00 *Workshop Dinner*

* The main objectives of the splinter meetings are:

a. Define a first cut list of calibration sources that should be adopted for Herschel.
b. Define/select the models to be adopted for the Herschel wavelength range
  - with sufficient detail that computations can be made after the meeting to produce the appropriate models for any given epoch of observation;
  - with appropriate characterisation of uncertainties and any other caveats.
c. Define future work needed to complete, improve on, and extend the above (further modelling, observations - Herschel and/or other, etc.);

Friday, February 8th

Splinter Meetings

Splinter D: (Chairs: A. Marston/A.M. Heras)
Wavelength calibration

Room Serrano 121

09:00- 09:15	A.Marston/A.M. Heras	Introduction
09:15- 09:45	F. Herpin	HIFI Frequency calibration
09:45- 10:15	H. Feuchtgruber	PACS Spectrometer Wavelength calibration
10:15- 10:35	E. Polehampton	Spectral line calibration sources for the SPIRE FTS

10:35-11:05 *Coffee Break*

11:05-12:35 A.Marston/A.M. Heras — Discussion on wavelength calibration preparations

Splinter E: (Chairs: S.J. Leeks/P. García-Lario)
Calibration in other observatories and cross-calibration

Room Serrano 119

09:00- 09:15	S.J. Leeks/P. García-Lario	Introduction
09:15- 09:45	I. Yamamura	Astronomical calibrations of the AKARI Far-Infrared Surveyor
09:45- 10:15	G. Lagache	In-flight photometric calibration of the Planck/HFI instrument
10:15- 10:35	B. Schulz	Planck/HFI vs. Herschel/SPIRE cross-calibration

10:35- 11:05 *Coffee Break*

11:05- 11:35	G. Rieke	An accurate and consistent absolute infrared calibration
11:35- 11:55	P. García-Lario	Herschel cross-calibration strategy
11:55- 13:00	S.J. Leeks/P. García-Lario	Discussion

13:00-14:15 *Lunch*

Session 6: Summary of splinters and conclusions

Room Serrano 119

14:15-14:35	M. Griffin	Summary of splinter A
14:35-14:55	P. Hargrave/T.Lim	Summary of splinter B
14:55-15:15	J. Blommaert/G. Sandell	Summary of splinter C
15:15-15:35	A. Marston/A.M. Heras	Summary of splinter D
15:35-15:55	S.J. Leeks/P. García-Lario	Summary of splinter E

15:55-16:05 A.M. Heras — Conclusions and closure

16:05 *End day 3*

ABSTRACTS

SESSION 1: Herschel satellite and instruments

Herschel Overview, Status, and Early Mission Phases

Göran Pilbratt
Herschel Project Scientist
European Space Agency

The Herschel Space Observatory is the next observatory 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 55-672 micron range. The key science objectives emphasize current questions connected to the formation and evolution of galaxies, stars and stellar systems, including our own planetary system.

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. The ground segment will be jointly developed by the ESA, the three instrument teams, and NASA/IPAC.

After the launch in late 2008, commissioning, performance verification, and science demonstration phases will follow and together constitute an early operations period of 6 months, before Herschel will be operational in orbit around L2. Herschel will offer a minimum of 3 years of routine science observations. Nominally ~20,000 hours will be available for astronomy, 32% is guaranteed time and the remainder is open to the general astronomical community through a standard competitive proposal procedure. The Key Programme AO was issued in Feb 2007, and the contents of both the guaranteed and open time accepted Key Programmes will be outlined.

SESSION 1: Herschel satellite and instruments

HIFI Calibration Status and Plans

Michael Olberg
Onsala Space Observatory

The HIFI instrument and the principles of its observing modes and their calibration are summarised. The major results from the ILT campaign are presented and their effect on instrument calibration and observation planning discussed. Calibration activities in preparation for the upcoming thermal vacuum tests and the planning of the performance verification phase are briefly presented.

PACS Calibration Status and Plans

Ulrich Klaas
Max Planck Institut für Astronomie

Key results of the instrument's ground characterisation and optimisation, which serve as the first reference calibration, are presented. An outline of the in-orbit performance verification activities, which will establish the baseline calibration of the instrument, is given. Attention is paid to the different types of celestial calibration sources needed and the requirements on them. A short outlook on calibration activities and issues during later phases of the mission will complete the presentation.

SESSION 1: Herschel satellite and instruments

SPIRE Calibration Strategy

Tanya Lim
Rutherford Appleton Laboratory

This talk will outline the SPIRE instruments requirements for in-flight calibration and the approaches taken to set up the instrument in flight.

A Mars continuum model for calibration of the Herschel data

Emmanuel Lellouch
Observatoire de Paris
&
Raphael Moreno
LESIA – Observatoire de Meudon

We have constructed a continuum model of the surface emission of Mars, that can be used for calibration of the Herschel data. This model makes use of a seasonally and horizontally variable distribution of surface and subsurface temperatures, and a radiative transfer model of the martian subsurface. Except in periods of unusually large dust activity, the absolute precision of the model (for the temperatures) estimated to be <5 %, and the relative (variation over a few days or with frequency) precision to be 1-2 %. A web-based tool is available at

http://www.lesia.obspm.fr/~lellouch/mars/.

The user specifies the date, a set of four frequencies, the telescope beam, and has a choice for a few physical parameters of the martian surface. In output, the tool provides the total and beam-averaged fluxes and brightness temperatures, as well as maps of the brightness temperature that can be used e.g. for beam profile studies.

Mars models for Herschel

Bryan Butler
LESIA – Observatoire de Meudon

Mars has been identified as a candidate to be a primary flux density scale calibrator for the HIFI instrument on the Herschel telescope. I have in past calibration workshops presented results from an updated version of the Rudy et al. model for thermal emission from Mars at radio wavelengths - extended down into the infrared. I will present recent results on further improvements to the model, and discuss its appropriateness as a primary calibrator for Herschel.

Calibration of Herschel/HIFI in the CO absorption lines of Mars

Paul Hartogh
Max Planck Institute for Solar System Research

In order to achieve an absolute flux calibration accuracy of better than 5 percent for HIFI, it is intended to use Uranus and Mars as primary flux standards for continuum radiation. But especially Mars seems to be a challenging calibration source, because dust storms and numerous rotational absorption lines -- caused by CO and H2O in Mars tenuous atmosphere – disturb the continuum radiation emitted by the surface. So usually these wavelength regions are omitted for an accurate instrument calibration. However, we have studied the emitted radiation especially in the deep core of the CO absorption lines, because the spectral lines are optically thick at these frequencies and Mars can be treated as a pure gas planet without any need to model the surface emission. Using a detailed radiation transfer model and a general circulation model to predict the seasonal variation of Mars' atmosphere we found for several CO lines a variability of Mars' brightness temperature of less than ±5 percent. So we suggest not to avoid the rotational CO absorption lines of Mars, but to observe especially the line center of all observable CO lines in order to increase the accuracy of the absolute flux calibration of HIFI.

Models of the Giant Planets

Raphael Moreno
LESIA – Observatoire de Meudon

We have developed a radiative transfer model to compute the submm spectra of the giant planets' atmosphere. These references spectra can be used to determine the calibration parameters of the Herschel's instruments.

In our model we consider a spherical geometry, a vertical thermal structure, and the absorption due to the major constituents (H_2-He-CH_4) and minor constituent (NH_3-PH_3). We estimate the model absolute uncertainties at the level of 5%, mainly due the thermal structure uncertainty.

The comparisons of our models with ground and spatial measurements, show a good agreement between model and observations, within the measurements uncertainties.

Uranus and Neptune Models for Herschel

Glenn Orton
Jet Propulsion Laboratory

Improvements in the physical models for the radiation emerging from the atmospheres of Uranus and Neptune since the calibration workshop #1 are covered. These consist of two broad areas, one of which is general improvements in the level of absolute calibration and the second is the characterization of time-dependent variability. Input for these comes from considerations of historical observations in the mid-infrared and submillimeter, as well as recent observations with the Spitzer IRS instrument and spatially resolved mid-infrared observations from the ESO Very Large Telescope and AURA's Gemini North and South telescopes. Modeling of these data and comparisons of mid-infrared and submillimeter through radio characterizations of these atmospheres is ongoing.

Uranus in the Herschel Time Frame

Mark Hofstadter, Glenn Orton
Jet Propulsion Laboratory

Mark Gurwell
Harvard Smithsonian Center for Astrophysics

&

Bryan Butler
National Radio Astronomy Observatory

Uranus, due to its size and brightness, is an attractive calibration target for the HiFi instrument on board the Herschel spacecraft. Observations at wavelengths from the visible to radio, however, have shown the planet to be time variable on time scales of years to decades. Recent work indicates that - at least for wavelengths longer than 1 millimeter - much of this variability is due to a combination of strong spatial variations on the planet, and the changing viewing geometry from the Earth. We are currently modeling the atmosphere of Uranus, based on observations from ~1 micron to 20 cm, in order to provide a time-dependent model for the absolute brightness of the planet during the Herschel mission. We believe Uranus will be a stable calibrator to better than 2% at the lower frequencies of HiFi, and 4% for the higher frequencies. Additional work is needed to determine whether its absolute flux can be determined to the desired 5% level.

The work of M. Hofstadter and G. Orton was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.

Background and Confusion Noise

Csaba Kiss
Konkoly Observatory

Despite the beneficially large primary mirror photometric observations with the Herschel Space Observatory are in many cases going to be limited by confusion noise, the uncertainty in the source flux determination due to background fluctuations. To account for this phenomenon the Herschel Confusion Noise Estimator (HCNE) tool was developed, and is operational now as part of HSpot. In this presentation I am going to summarize the main features and concepts applied in the current version of HCNE, as well as the plans for a future, improved version of this tool.

Galilean Satellites as Herschel Calibrators

Mark Gurwell
Harvard Smithsonian Center for Astrophysics

I will discuss the potential role of Galilean satellites, particularly Ganymede and Callisto, as absolute calibration targets for Herschel and other observatories. I will present the results of monitoring of the brightness temperature of these sources using the SMA and other mm/submm facilities as well as what is known from far IR observations, to assess the use of the Galilean moons for cross calibration across the three Herschel instruments.

The Asteroid Preparatory Programme for Herschel, AKARI and ALMA

Thomas Müller
Max Planck Institut für extraterrestrische Physik

&

the members of the AKARI Calibration Team

Celestial standards play a major role in astronomy. They are needed to characterise the performance of instruments and telescopes and they are an important prerequisite for accurate photometry. With the access to the far-IR, submm and mm wavelength range through satellites, airborne telescopes and sophisticated ground-based instruments, it became necessary to establish new calibrators for these wavelengths. The traditional far-IR/submm/mm calibrators, the outer planets, are too bright or cause non-linearity problems for instruments on upcoming sensitive space missions like Herschel or Akari. Stellar standards are quite faint in this range and pose problems of their own. The large flux gap between these two types of calibrators could be successfully filled and complemented by a set of asteroids, which was established during the ISO mission for the ISOPHOT instrument (Mueller & Lagerros, 1998, 2002, 2003). Here we present the status of the "Asteroid Preparatory Programme" which is currently conducted together with the Herschel and Akari calibration teams. We investigate the physical and thermal properties of about 50 asteroids. All of them are large, almost spherical and belong the the main-belt, located between Mars and Jupiter. They cover the flux range between about 1 and several hundred Jansky at 100 micron, at 1 mm they still reach up to 10 Jy. Thermophysical model predictions (light curves, SEDs or monochromatic fluxes) are accurate on the 5-20% level, depending on the object, the observing and the illumination geometry. An overview of the current status of this project with respect to Herschel will be given, including a summary of the products which have been delivered for Akari and Herschel.

Recalibrating the absolute flux scale at 3 mm using planets and asteroids

Peter Barnes
University of Sidney

Thomas Müller
Max Planck Institut für extraterrestrische Physik

&

Michael Dahlem
CSIRO/ATNF

We present new ATCA data of Mars, Uranus, & Neptune observed contemporaneously at several frequencies in the 3mm band. With these data we will not only obtain a robust new flux scale at 3mm, but also 3mm spectral indices of these planets and a new calibration of the ATCA antenna's gain-elevation correction. We also present new 3mm data of Ceres & Pallas observed at the same time, in order to measure their 3mm light curves and emissivities, and discuss implications for their surface properties.

Asteroids and Spitzer MIPS 160 micron calibration

John A. Stansberry
University of Arizona

I will summarize the calibration of the MIPS 160um channel. Unlike the other 2 MIPS channels (24 and 70um), the 160um channel was calibrated using asteroids. The calibration does not rely on detailed thermal models of individual asteroids, rather the 160 micron emission is predicted via extrapolation from nearly simultaneous observations at 70 microns (and sometimes 24 microns). The approach relies on observations of many asteroids, and assumes that on average their emission in the far-IR is free of any strong spectral features. We estimate the calibration to be accurate at the 12% level.

Asteroids: Spitzer observations and lightcurves

Bidushi Bhattacharya
California Institute of Technology

We present a series of thermal 8 um light curves for asteroids measured using the Spitzer Space Telescope. For the five objects we have observed, a dozen points are available over one rotation. Rotational variability will be examined in the context of shape models developed by Mueller and Lagerros. Additionally, variability in surface emissivity as a function of wavelength will be considered, as recent observations of Ceres, Pallas, and Vesta suggest that submm emissivities differ from those at optical wavelength, possibly due to regolith prevalence and density.

SESSION 5: Stars and secondary calibrators

Stellar calibrators for Herschel and their models

Eva Bauwens
University of Leuven

As the launch of Herschel will open up a wavelength range with unprecedented sensitivity, it is essential to dispose a well studied set of standard stars that will serve for calibration purposes. In this talk, we present the stellar sources selected for the PACS calibration and the work done since the first Herschel Calibration Workshop. We present the criteria used for the selection of the specific calibrators and how observations helped optimize our selection. We shall also discuss the theoretical models used to reproduce the Spectral Energy Distribution of the calibrators and finally exhibit a detailed plan concerning the absolute flux calibration.

SESSION 5: Stars and secondary calibrators

ISOPHOT list of standard stars

Csaba Kiss
Konkoly Observatory

Spitzer/MIPS can effectively provide 24 and 70um fluxes for the current list of standard stars for Herschel. In order to constrain the spectral energy distribution of these stars longwards of 100 microns, the available far-IR ISOPHOT observations can be used. In addition, the ISOPHOT archive can be searched for potential standards which could supplement the current "master list" of standards. Here we are going to summarize our results on the long wavelength regime of the objects in the current standard star list, and present an extended list of "secondary" standards.

Secondary calibrators for Herschel

Göran Sandell
NASA Ames Research Center

I have compiled a list of objects suitable as secondary calibrators in the far infrared (FIR) to complement more traditional primary calibrators like planets, asteroids and fiducial stars. This list consists mainly of isolated Herbig Ae/Be (HAEBE) stars and unresolved Vega type stars. However, since these stars only give a marginal all-sky coverage I have also included some luminous and ultra luminous galaxies (LIRGS and ULIRGS) as well as a few protoplanetary nebulae.

Observations of asteroids, secondary calibrators and stellar standards

Darren Dowell
Jet Propulsion Laboratory

I describe an analysis of the archive of 350 micron calibration measurements made with SHARC II at the Caltech Submillimeter Observatory over the period 2003-2007. Measured fluxes of old and new secondary standards are referenced to assumed fluxes for Mars, Uranus, and Neptune. The 350 micron observations of asteroids, evolved stars, compact infrared galaxies, stellar disks, and stellar photospheres have direct relevance to SPIRE. The asteroid and stellar photosphere observations constrain thermal models, with application to all Herschel instruments.

Spitzer Calibration at Long Wavelengths. MIPS Calibration at 24 and 70 microns

Alberto Noriega-Crespo
Spitzer Science Center

MIPS is the long wavelength photometer on board of the Spitzer Space Telescope and has allowed new era of observations at 24, 70 and 160 microns. The overall calibration of MIPS relies on that of 24um and is based on stars. At 24 microns we believe we understand better both the detector and the measurements, as well as the models that are used to determine the astrophysical calibration factor. The calibration at 70 microns is based also on stars, and although is done independently, it satisfies the constrains set by the 24 micron calibration. The 160 micron calibration is carried out using asteroids and is bootstrap to that of 24 and 70 microns, and John Stansberry will describe it in detail in this workshop.

HIFI Wavelength Calibration

Fabrice Herpin
LAB - Observatoire Aquitain des Sciences de l'Univers

HIFI instrument is made of several spectral elements, including HRS and WBS spectrometers. Hence the effective instrument spectral response of the whole instrument is the combination of several spectral element responses along the detection chain. The HIFI frequency calibration approach on ground and in space will be explained (strategy and results). Astronomical calibration sources will be considered.

SPLINTER D: Wavelength calibration

PACS Spectrometer Wavelength Calibration

Helmut Feuchtgruber
Max Planck Institut für extraterrestrische Physik

The initial PACS wavelength calibration at the time of the Herschel launch has been derived from measurements obtained during the PACS instrument level test of the flight model. Methods, results and status of the PACS wavelength calibration will be presented. Accuracies and open work will be discussed. The wavelength calibration plan for PV phase including target and spectral line lists will be given. References to previous observations and further documents will be provided. Observing strategies, target visibilities and constraints for wavelength calibration using PACS are illustrated.

Spectral line calibration sources for the SPIRE FTS

Edward Polehampton
Rutherford Appleton Laboratory

I will describe what is needed for the wave scale calibration for the SPIRE FTS and mention the other planned spectral line calibration observations. I will briefly present the current plans for the sources that we plan to use.

SPLINTER E: Calibration in other observatories and cross-calibration

Astronomical calibrations of the AKARI Far-Infrared Surveyor

Issei Yamamura, Sunao Hasewaga, Mai Shirahata, Shuji Matsuura, Sin'itirou Makiuti
ISAS / JAXA

Thomas Müller
Max Planck Institut für extraterrestrische Physik

&

Martin Cohen
University of California Berkeley

AKARI, the second Japanese space infrared mission, was equipped with a 68.5 cm cooled telescope and two scientific instruments, namely the Far-Infrared Surveyor (FIS; 50 – 180 microns) and the Infrared Camera (IRC; 1.8 – 26 microns). The aim of the mission is to carry out the All-Sky Survey in the far- and mid-infrared wavelengths with the improved spatial resolution from IRAS, and also perform high-sensitivity observations in the pointed observation mode. AKARI was launched in February 2006, and started the routine operation from May 2006. The mid- and far-infrared observations ended on August 26, 2007 according to the liquid Helium boiled off. During the period we successfully covered more than 90 per cent of the entire sky and made more than 5000 pointed observations.

In my presentation I will introduce the AKARI mission, and review the framework and current status of the calibration works for the FIS instruments. Two observation modes, the All-Sky Survey and the pointed observations are mainly concerned. The primary astronomical calibrators for the instruments are asteroids provided by Thomas Mueller and stars by Martin Cohen. The FIS calibration is still ongoing work. I will also talk about difficulties we are tackling. Possible contributions of the AKARI data to the Herschel calibration will also be discussed.

In-flight photometric calibration of the Planck/HFI instrument

Guilaine Lagache
IAS / Université Paris XI

The absolute photometric calibration of Planck/HFI relies mainly on the observations of the modulation (by the orbital motion around the Sun) of the amplitude of the Cosmic Microwave Background dipole for the low-frequency channels and the observations of the brightness of the diffuse galactic dust emission as measured by COBE-FIRAS for the high-frequency channels. Each of the above measures corresponds to a given angular scale; in particular the modulation of the amplitude of the CMB dipole signal is at very large angular scales. We will however calibrate photometrically at all angular scales relevant to Planck, from the largest (all-sky) to the smallest beam size (3.5 arcmin). In this process, the knowledge of each detector angular responsivity over 4π is an important element. In this talk, I will review the photometric calibration procedure of the Planck/HFI instrument. In particular, I will detail the critical aspects and characterize the uncertainties.

Planck/HFI vs. Herschel/SPIRE Cross-Calibration

Bernhard Schulz
IPAC / CALTECH

The contemporaneous missions of Herschel and Planck in conjunction with the legacy of COBE offer a unique opportunity to improve the absolute radiometric calibration of Far-Infrared celestial standards compared to what has been achieved so far for space missions like IRAS, ISO and Spitzer. The basic idea was already pointed out by J.P. Lamarre at the first Herschel Calibration Workshop. Subsequently a dedicated working group was formed to analyze the matter in more detail. This talk is based on the results of this effort and will outline the plan to transfer the calibration of the highly accurate black bodies flown on COBE-FIRAS to Planck-HFI and subsequently to Herschel-SPIRE, the requirements for additional observations and the potential uncertainties.

An accurate and consistent absolute infrared calibration

George Rieke
University of Arizona

We have derived an absolute calibration with an accuracy of 2% or better across the 1 to 30 micron region. This work is also in good agreement with previous absolute calibrations, within the errors. We have put the 2MASS, IRAC, MIPS (24 microns), and IRAS photometry on this scale and can also provide fiducial spectral energy distributions of an A0 star and of the Sun to assist in applying the calibration to any other photometric system. Extrapolation of this calibration to 70 microns is the basis of the MIPS calibration there. Observations are under way with Spitzer to allow accurate cross calibration with NICMOS and with a number of ground-based systems of standard stars, and also to allow direct transfer to the calibration of NIRCam and MIRI on JWST. It would be desirable to put the Herschel calibration on the same scale.

SPLINTER E: Calibration in other observatories and cross-calibration

Herschel cross-calibration strategy

Pedro García-Lario
Herschel Science Centre / ESAC

The need for cross-calibration in general and the strategy envisaged on this area for Herschel in particular throughout the different mission phases will be presented. The selection of suitable targets, the use of appropriate tools and the need of an appropriate characterisation of the instruments being compared will be highlighted. Mutual knowledge of the overall calibration strategy followed by the different missions/instruments under comparison will be shown to be a key ingredient to interpret the results obtained.