Herschel Mission Status – Star and Planet Formation Over the Most Recent 12 GigaYears

From Atoms Pebbles: Herschel's View of Star and Planet Formation Grenoble, 20-23/03/2012 Göran Pilbratt, Herschel Project Scientist, ESA

Launch on 14 May 2009 1000 days inflight on 8 February 2012 ... today OD#1042 will be commencing!

Topics



- Status overview, observing efficiency
- Data reduction and data products
- Publications and communications

• Pointing evolution

- Optics characteterisation
- Guidestar catalogue
- Performance

Mission lifetime

Prediction, adopted lifetime, execution predictions

• Star formation

- Near ... and far
- Now ... and over cosmic time











Mission overview and general status

HERSCHEL OBSERVATORY

Göran Pilbratt | Herschel's View of Star and Planet Formation | Grenoble | 20 April 2012 | vg #4

Importance of the FIR & submm



HERS



- Half of the energy created in the Universe since the CMB has been reprocessed into the IR
- Herschel covers the IR peak and pushes into the submillimetre



Herschel – the science instruments



SPIRE

250, 350, 500 μm (all simultaneous)

 $\frac{\text{Imaging FT spectrometer}}{194 - 671 \,\mu\text{m} (\text{simultaneously})}$ $\lambda/\Delta\lambda = 1300 - 370 \,(\text{high-res})$ $= 60 - 20 \,(\text{low res})$



3-band camera

3-band camera

70 or 100, 160 µm (2 simultaneous)

Imaging grating spectrometer 55 - 210 μ m (3 orders) $\lambda/\Delta\lambda = 1000 - 4000$ 7-channel heterodyne receiver480 - 1250 GHz (625 - 240 μm)1410 - 1910 GHz (212 - 157 μm) $\lambda/\Delta\lambda = 10^5 - 10^6$ Instantaneous BW: 4 GHz



Herschel – the machine



3 novel science instruments: PACS, SPIRE, HIFI

Detectors working at ~2 K and 300 mK

Warm electronics in SVM Launch Mass: ~3400 kg Power: ~1200 W 3-axis stabilisation





Sunshield and solar array

Telescope (3.5m)

Helium-II cryostat (~ 2400 litres,

3.5 years lifetime)

Service Module

Overall mission status – La vie est belle 🌔 🕒 🖉 🖉 🖉 🖉

Herschel works well and delivers good data

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- Occasional 'SEUs' most of the time without implications, but sometimes some time is lost. Longterm average lost science <4%.
- In DTCP#1029 HIFI was turned off by the spacecraft. Turning it on again will commence in DTCP#1043 (tomorrow!)
- Execution of science observations routinely >18 hr/day, the record is average 21.17 hr/day for a two-week scheduling `cycle'.



Science observing evolution

... since the very first science observation

- 'Early' science due 'lack of HIFI'
- SDP execution mainly in November-December 2009
- Early 2010 HIFI back, PV & SDP
- Spring 2010 SPIRE & PACS spectroscopy modes optimisation

Göran Pilbratt

- From around May 2010 'full' Routine Science Phase operations
- Overall PV duration about 5 months

	Cycle id	OD#s	Start Date	End Date	<science></science>	<net sci=""></net>	Total
	-4	119-132	20090909	20090922	1.01	1.01	282.35
	-3	133-146	20090923	20091006	1.33	1.33	274.07
	-2	147-160	20091007	20091020	8.61	8.61	260.02
	-1	161-174	20091021	20091103	8.02	8.02	294.06
	0	175-188	20091104	20091117	11.01	11.01	292.98
	1	189-202	20091118	20091201	11.47	11,47	297.42
	2	203-216	20091202	20091215	15.39	15,15	302
	3	217-230	20091216	20091229	19.08	18.88	318.03
	4	231-244	20091230	20100112	18.64	18.55	300.61
	5	245-258	20100113	20100126	15.16	15.16	296.22
	6	259-272	20100127	20100209	10.53	10.53	306.17
	7	273-286	20100210	20100223	7.28	7.15	301 17
	8	287-300	20100224	20100309	18.1	18.02	200 73
	ä	301-314	20100310	20100323	10.8	9.27	280.33
	10	315-328	20100324	20100406	15 30	12.53	200.00
	11	329.342	20100324	20100400	15.05	12.00	300.15
	12	343.356	20100407	20100420	16.66	16.66	312 28
	12	357.370	20100421	20100518	17.20	17.1	312.20
	10	371 394	20100505	20100016	15.09	15 50	307.03
	14	371-304	20100519	20100001	10.90	15.59	307.03
	10	303-390	20100002	20100015	10.17	10.01	309.03
	10	399-412	20100616	20100629	10.04	10.40	319.41
	17	413-420	20100630	20100713	17.39	10.43	301.21
	18	427-440	20100714	20100727	17.49	17.49	290.48
	19	441-454	20100728	20100810	18.37	17.98	313.54
	20	455-468	20100811	20100824	17.85	17,29	316.45
	21	469-482	20100825	20100907	20.71	20.34	326.32
	22	483-496	20100908	20100921	18.97	18.37	317.51
	23	497-510	20100922	20101005	19.83	19.83	301.2
	24	511-524	20101006	20101019	18.16	15.41	298.1
	25	525-538	20101020	20101102	19.52	17.7	300.96
	26	539-552	20101103	20101116	18.84	17.01	315.95
	27	553-566	20101117	20101130	19.21	19.21	320.35
	28	567-580	20101201	20101214	18.08	15.32	311.34
	29	581-594	20101215	20101228	19.75	18.38	317.54
	30	595-608	20101229	20110111	18.64	18.64	317.83
	31	609-622	20110112	20110125	20.18	20.18	325.88
	32	623-636	20110126	20110208	19.24	19.12	318.7
	33	637-650	20110209	20110222	19.54	17.92	317.77
	34	651-664	20110223	20110308	20.15	17.16	323.1
	35	665-678	20110309	20110322	21.07	21.07	332.78
	36	679-692	20110323	20110405	20.76	20.76	326.89
	37	693-706	20110406	20110419	19.94	19.94	319.54
	38	707-720	20110420	20110503	18.18	14.61	323.95
	39	721-734	20110504	20110517	19.3	19.11	317.75
	40	735-748	20110518	20110531	17.21	17.21	306.23
	41	749-762	20110601	20110614	20.16	20.05	319.39
	42	763-776	20110615	20110628	19.47	19.47	321.64
	43	777-790	20110629	20110712	20.25	20.25	325.39
	44	791-804	20110713	20110726	20.33	20.33	314 51
	45	805-818	20110727	20110809	19.85	17.35	318 66
	46	819-832	20110810	20110823	20.37	20.37	323.56
	40	833-846	20110824	20110906	20.56	20.56	327
	49	847,860	20110024	20110900	10.70	10.70	321 22
	40	861.974	20110907	20110920	24.47	94.47	227.20
	49	975,000	20110921	20111004	10.02	10.00	227.20
Herse	50	000.002	2011005	2011018	19.63	10.03	322.39
	31	003-902	20111019	20111101	19.27	19.27	322.04

					Cycle id OD	#s Start Date	End Date	<science></science>	<net sci=""></net>	Total
					-4 119	-132 20090	09 20090922	1.01	1.01	282.35
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Science	ohs	ervina	evolu	THOM	0 175	5-188 20091	04 20091117	11.01	11.01	292.98
					1 189	-202 20091	18 20091201	11.47	11.47	297.42
					2 203	3-216 200913	02 20091215	15.39	15.15	302
					3 217	7-230 20091	16 20091229	19.08	18.88	318.03
05 005 070		00440000	04.07	04.07	4 23	5-258 20100	30 20100112	18.04	18.55	296.22
35 665-678	20110309	20110322	21.07	21.07	332.78	-272 20100	27 20100209	10.53	10.53	306.17
36 679-692	20110323	20110405	20.76	20.76	326.89	3-286 20100	10 20100223	7.28	7.15	301.17
37 693-706	20110406	20110419	19.94	19.94	319 54 37	7-300 20100	24 20100309	18.1	18.02	299.73
39 707 730	20110420	20110503	10.10	14.61	222.05	1-314 20100. 5-328 20100	20100323	10.8	9.27	289.33
30 707-720	20110420	20110303	10.10	14.01	323.93	3-342 20100	07 20100420	15.05	12.86	300.15
39 /21-/34	20110504	20110517	19.3	19,11	317.75	3-356 201004	21 20100504	16.66	16.66	312.28
40 735-748	20110518	20110531	17.21	17.21	306.23 57	7-370 20100	05 20100518	17.29	17.1	313.25
41 749-762	20110601	20110614	20.16	20.05	310 30	1-384 20100	19 20100601	15.98	15.59	307.83
40 700 770	20110001	20110014	40.47	40.47	204 64 19	-396 20100	16 20100629	16.54	16.01	319.41
42 /03-//0	20110015	20110020	19.47	19.47	321.04	3-426 20100	30 20100713	17.39	16.43	301.21
43 777-790	20110629	20110712	20.25	20.25	325.39 27	7-440 20100	14 20100727	17.49	17.49	290.48
44 791-804	20110713	20110726	20.33	20.33	314.51	1-454 20100	28 20100810	18.37	17.98	313.54
45 805 818	20110727	20110800	10.85	16.67	318 66	-468 20100	20100824	17.85	20.34	316.45
40 000-010	20110727	20110003	13.00	10,07	310.00 3	3-496 20100	08 20100921	18.97	18.37	317.51
46 819-832	20110810	20110823	20.37	20.37	323.56	7-510 20100	22 20101005	19.83	19.83	301.2
47 833-846	20110824	20110906	20.56	20.56	327 11	1-524 201010	06 20101019	18.16	15.41	298.1
48 847-860	20110907	20110920	19.72	19.72	321.23	5-538 20101	20 20101102	19.52	17.7	300.96
49 861 874	20110021	20111004	21 17	21 17	327 28 53	3-566 20101	17 20101130	19.21	19.21	320.35
43 001-014	20110321	20111004	21.17	21.17	327.20	7-580 20101	01 20101214	18.08	15.32	311.34
50 875-888	20111005	20111018	19.83	19.83	322.39 31	1-594 20101	15 20101228	19.75	18.38	317.54
51 889-902	20111019	20111101	19.27	19.27	322.64	5-608 20101	29 20110111	18.64	18.64	317.83
52 903-916	20111102	20111115	19.75	18.11	322.56	3-636 20110	26 20110208	19.24	19.12	318.7
53 017 030	20111116	20111120	20.98	20.99	328 58 37	7-650 20110	09 20110222	19.54	17.92	317.77
53 917-950	20111110	20111123	20.00	20.00	320.00 1	1-664 20110	23 20110308	20.15	17.16	323.1
54 931-944	20111130	20111213	19.02	16.97	320.32 5	5-678 20110	09 20110322	21.07	21.07	332.78
55 945-958	20111214	20111227	20.19	20.19	326.9	3-706 20110	23 20110405	19.94	20.76	320.89
56 959-972	20111228	20120110	19.64	19.64	324.38 17	7-720 201104	20 20110503	18.18	14.61	323.95
57 073 096	20120111	20120124	21.06	21.06	323 54 21	1-734 20110	04 20110517	19.3	19.11	317.75
57 975-960	20120111	20120124	21.00	21.00	323.04 35	5-748 20110	18 20110531	17.21	17.21	306.23
58 987-1000	20120125	20120207	19.54	19.54	323.26	3-776 20110	20110614	20.10	20.05	321 64
59 1001-1014	20120208	20120221	19.74	18.1	322.28	7-790 20110	29 20110712	20.25	20.25	325.39
60 1015-1028	20120222	20120306	20.58	20.58	326.2	1-804 20110	13 20110726	20.33	20.33	314.51
00 10 10 1020	LOTEOLLE	20120000	20.00	20.00)5	5-818 20110	27 20110809	19.85	17.35	318.66
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Last 13 (48-60) 6 mont	ns			19.62	17	7-860 20110	07 20110920	19.72	19.72	321.23
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East of to obje yours				10.10	39	9-902 20111	19 20111101	19.27	19.27	322.64

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- Status weekly updated on the HSC website under 'Latest News'. Also available are 'Observing Log' and 'Observing Schedule'.

SPACE OBSERVATORI

FRSC

Overall mission status - observing



Herschel works well and delivers good data

Status weekly updated on the HSC website under 'Latest News'. Also • available are 'Observing Log' and 'Observing Schedule' (scheduled but not yet executed observations). Also HSA of course...



IPACE IBSERVA

	18-March-2012 22:51:
Herschel General Information	Herschel Latest News
Herschel Science Centre Home	Status summary: Herschel was successfully launched together with Planck on 14 May 2009. Currently Herschel is conducting routine science phase operations. By the end of OD#1037 (16 March)
Latest News	2012), the approximate completion percentages were: 99% KPGT; 98% KPOT; 94% GT1, 70%
Mission Overview	of magnitude smaller than any of KPGT, KPOT, OT1p1, and OT2p1).
Science Instruments	integritude sindler than any of ki off, offpri, and offpri,
Conferences/Workshops	1039 08 40 34
News & Press Releases	
e-News	Days Hours Minutes Seconds
Herschel Science Team	Elapsed time since launch on 14 May 2009 at 13:12 (UTC).

The KPs have been 'concluded', we are now mainly executing OT1. •

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- Status weekly updated on the HSC website under `Latest News'.
- Data processing software continuously improved (now HIPE 8.1).
- Fourth bulk HSA data re-processing about to commence, and an updated more powerful 'new technology' HSA to be released.
- User provided data products are increasingly made available, and KP `wrap-up' telecons just started.
- Publications and Communications





PACS SPG: HCSS 3.0 - 6.0 - 6.1

SPG HCSS 6.0



SPACE OBSERV

HERSC



SPG HCSS 3.0

HIPE v8.2

PACS browse products



Level 2 PhotProject @scan

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SPIRE SPG – HCSS improvements







- Subtle improvements to normal sources
- Much improved spectral shape for weak sources

Bulk Reprocessing of HSA contents

System Throughput:

- Much improved, a big leap forward:
 - v2.x bulk reprocessing (~ 8 ODs/day)
 - v4.1 bulk reprocessing (< 4 ODs/day)
 - v6.1 bulk reprocessing (~ 20 ODs/day)
 - v8.2 next bulk reprocessing (spring 2012)

Herschel Science Archive:

- Provides data products at several levels of processing
- 'New technology' archive to be rolled out any time now
- User Provided Data Products welcome & wrap-up telecons





User Provided Data Products



User Provided Data Products

The table below provides access to the currently available User Provided Data Products sorted by release date:

Proposal ID	Proposal Name	Release Note	User Provided Data Products Repository	Related Publications	Latest update
KPGT_dlutz_1	PACS Evolutionary Probe (PEP)	PEP Release Note	PEP public data releases	Lutz et al. 2011 A&A 532, A90	[28-Oct-2011]
KPOT_krame01_1	Herschel M33 extended survey (HerM33es)	HerM33es : Herschel M33 extended survey - SPIRE Data Products Delivery User's Guide HerM33es: Herschel M33 extended survey - PACS Data Products Delivery User's Guide	HermesPublicData	PACS and SPIRE photometer maps of M33: First results of the Herschel M33 extended survey (HerM33es) (Kramer et al. 2010) Dust Heating Sources in Galaxies: The Case of M33 (HERM33ES) (Boquien et al. 2011, AJ, 142, 111)	[2-Mar-2012]
KPGT_soliver_1	HerMES	HerMES consortium provides public release of Herschel data HerMES KPGT second early data release	HeDaM: Herschel Database in Marseille	HerMES related publications	[19-5ep-2011]
KPOT_mjuvela_1	Galactic Cold Cores: A Herschel survey of the source populations revealed by Planck	ColdCores Release Note	ColdCores Data Repository	Juvela et al. 2010, 2011	[8-Sep-2011]
KPOT_rkennicu_1	Key Insights on Nearby Galaxies: a Far Infrared Survey with Herschel (KINGFISH)	KINGFISH Data Products Delivery - DR1 User's Guide	KINGFISH Data Products repository	The Emission by Dust and Stars of Nearby Galaxies in the Herschel KINGFISH Survey (Skibba et al. 2011)	[8-Sep-2011]
KPOT_jdavie01_1	The Herschel Virgo Cluster Survey (HeViCS)	Data Reduction for HEVICS Public Data Release of 2 Scan DatA	The first HeViCS public data release	HeViCS SDP papers in the A&A Special feature: Herschel: the first science highlights	[2-Sep-2011]
KPOT_seales01_2	H-ATLAS	First data release of the Herschel ATLAS	H-ATLAS SDP images and files H-ATLAS SDP catalogue	PACS maps (Ibar et al. 2010) SPIRE maps (Pascale et al. 2010) S-band source catalogue (Rigby et al. 2010)	[24-Oct-2010]

Basic guidelines on how to provide your user provided data products, catalogues and atlases are provided in the document "Herschel Data Products Contributor's Guide".

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Publication tracking



Using ADS on 16/03/2012:

• From 07/2010 (publ date of A&A Herschel Special Issue)



- Abstract should include (and/or): Herschel, PACS, SPIRE, HIFI
- All refereed articles, after checking ('weeding'/adding) now 379 papers
- A publication list is being maintained on the HSC website

Research & Science Home	ESA Public Web Site	Sci-Tech Portal	Herschel Public Web Site	Herschel Sci-Tech Portai				
eesa		Herschel Science Centre						
Astrophysics Missions	Planetary Exploration Missions	Solar Terrestrial Science Missions	Fundamental Physics Missions	Science Faculty				
		the second s	the second second second second second	24-October-2011 18:32:				
		Herschel Scienti	fic Publications					
Herschel General Information	-	15.152	and the second second					
Herschel Science Centre Home		Introd	uction					
Latest News			195					
Mission Overview	The de facto way of communicating the scientific results based on Herschel observations is via publications in the refereed scientific literature which is very strongly encouraged. This webpage provides a listing of published refereed Herschel papers, the applicable rules and guidelines							
Science Instruments								
Conferences/Workshops	for publishing can be found in else	ewnere.						
Press Releases		Herschel Pub	lication List					
e-News								
Herschel Science Team	The listing provided here is genera	The listing provided here is generated by searching the ADS followed by manual inspection of the 'hits' using the criteria						
Herschel Users' Group	maintained by the Herschel Project	t Scientist, to whom feedback can be	provided.					
Herschel People		1						
Useful links		Herschel But	lication List					
Herschel Announcement of Opportunity (AO-2)		nerscher Ful	incation List					

Publication tracking



P1 m	rivate Library HerscheiPapers odified 16-Mar-2012) for gpilbr	(Refere	eed papers	s based on H	erschel in	flight measure	ments, las	t	Go to bottom of page
(N	ote: the link on the library name is a public l	ink to this	library)						
Se	lected and retrieved 379 abstracts.							Sort options	:
#	Bibcode	Score	Date	List of Link	S				
	Authors	Title		Access Cont	rol Help				
1	2012MNRAS.420.3557G	1.000	03/2012	AZEF	x	<u>R</u> <u>C</u>	U		
	Gomez, H. L.; Clark, C. J. R.; Nozawa, T.; Krause, O.; Gomez, E. L.; Matsuura, M.; Barlow, M. J.; Besel, MA.; Dunne, L.; Gear, W. K.; and 6 coauthors	Dust in	historical G	alactic Type Ia	supernova r	emnants with Her	schel		
2	2012MNRAS.420.1882A	1.000	03/2012	AZEE	x	RC S	U		
	Auld, R.; Smith, M. W. L.; Bendo, G.; Pohlen, M.; Wilson, C.; Gomez, H.; Cortese, L.; Morganti, R.; Baes, M.; Boselli, A.; and 11 coauthors	Hersch	el observatio	ons of Cen A: st	ellar heating	g of two extragalad	tic dust clo	uds	
3	2012ApJ74837N	1.000	03/2012	AZEE	x	R	U		
	Neufeld, David A.; Roueff, Evelyne; Snell, Ronald L.; Lis, Dariusz; Benz, Arnold O.; Bruderer, Simon; Black, John H.; De Luca, Massimo;	Herschel Observations of Interstellar Chloronium				im			

PR aka Communications

ESA wants to communicate your results

- Provides expertise/resources science writers, image making
- Provides the channels websites, mailing lists, etc
- All material can be used by others
- Wants to create win-win situation

Possibilities

- Web-releases Portal and/or SciTech
- Exceptionally fully fledged press release
 - Press representatives invited in person
 - Done in connection with 'First Results Symp' in May 2010

Project Scientist is your contact point

- PS will initiate process applying for resources
- Web-page providing information







PR aka Communications



Herschel Science Communications and Outreach

Communicating your Herschel results

The importance of publishing scientific results based on Herschel in the scientific literature goes without saying. It is also important and a stated ESA objective to disseminate the achievements of Herschel and its scientific results to a wider audience, including the media and the general public. ESA wants to facilitate this by creating win-win situations with Herschel observers, their institutes, national organisations, and funding agencies (as applicable in each particular case). Here is how.

What ESA can do

The most common form of ESA communications is by means of writing, posting, and widely disseminating web news-releases based on scientific results. These news-releases come in two flavours, one intended for the media and the general public posted on the Herschel Space Science Portal, and another aimed at the special interest community posted on the Herschel SciTech site. For examples of webreleases see the listing on the HSC website.

In addition to webreleases, occasionally containing videos like the multi-wavelength feature on M31 Andromeda's coat of many colours, and dedicated videos like the ESA Euronews Hot from Cold feature, are produced. Fully-fledged press conferences can be also considered, but are reserved for exceptional circumstances.

Additionally, 'image releases' through the Online Showcase of Herschel Images OSHI website are welcome at all times.

The process - how to communicate

For Herschel communications based on science results the Herschel Project Scientist is the contact point to the Herschel observer community. When you have a Herschel result that you think could be interesting to a wider audience, please bring this to his attention. You can do this by raising a Helpdesk ticket (Communications/Outreach department) or by sending and email.

PR aka Communications



News & Press Releases

Herschel Science Centre Home	•
Latest News	
Mission Overview	,
Science Instruments	,
Conferences/Workshops	
News & Press Releases	,
e-News	
Herschel Science Team	
Herschel Users' Group	
Herschel People	
Useful links	



Fledgling stars flicker in the heart of Orion ESA Space Science News - also in-depth on ESA SciTech News 29 February 2012



1	-	
	Layacan	2

Herschel detects abundant water in planet-forming disc ESA Space Science News - also in-depth on ESA SciTech News 20 October 2011

Herschel Publications				
Publishing Rules & Guidelines	•			
Scientific Publications				
Communicating Your Results	- 4			

Previous slide



ESA Space Science News - also in-depth on ESA SciTech New 5 October 2011



Herschel probes the dusty history of a giant star ESA SciTech News 20 September 2011



Herschel paints new story of galaxy evolution ESA Space Science News - also in-depth on ESA SciTech News 13 September 2011





Pointing – a few words



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Pointing evolution

Starting point

 Early in the mission APE ~2" established, but scanmap 'speedbumps' and occasional pointing 'outliers' were being reported

Speedbumps

- Speedbumps attributed to 'warm' STR CCD pixels
- On OD#299 a lower STR temperature was tested (-10°C vs +13°C)
- From OD#320 the STR temperature was lowered to -10°C
 - However, in OD#320-329 an erroneous SIAM was used, corrected a posteriori in downlink (all observations checked)
- The speedbumps were alleviated

Pointing checks and plate scale

- Monitoring of pointing performance indicated STR plate scale errors but results were not straightforward to interpret
- Average OD#385-733 pointing APE ~2.4", but `varying' +/-0.5"
- From spring 2011 the PACS ICC greatly contributed to this effort





Pointing evolution





- 1-dimensional (aka 'focus') focal length correction
 - Implemented for OD#762 (14 June 2011) APE improved from ~2.4 arcsec to ~1.4 arcsec
- 2-dimensional (aka 'tilt') focal length correction
 - Test in OD#858 (18 September 2011), made permanent from OD#866 (26 September 2011) – APE achieved ~1.1 arcsec
- 5-dimensional (aka 'polynomial') focal length correction
 - Test-OD on OD#1005, made permanent from OD#1011 (18 February 2012) – now APE ~0.85 arcsec

Guidestar catalogue update

- Guidestar catalogue 'cleaning'
 - 76 targets flagged (out of 3500+) in DTCP#1032 (10 March 2012) initial check of APE confirmed ~0.85 arcsec





Mission Lifetime – and execution

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Mission (cryostat) lifetime



(i) Thermal modelling, and (ii) He mass measurements





Mission (cryostat) lifetime – ullage corr CSA

(i) Thermal modelling, and (ii) He mass measurements





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Time

Cryocooler analysis OD#90-1000



Cooler Recycling from OD090 to OD1000 (T101)



Cryocooler analysis OD#90-1000



Cooler Recycling from OD090 to OD1000 (T102)



Cryocooler analysis OD#90-1000





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CVV temperature 2009-07 – 2012-01





CVV temperature 2009-07 – 2012-01



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Tel M1/M2 temps 2009-07 – 2012-01





Tel M1/M2 temps 2009-07 – 2012-01





Overall execution status & prediction

Completion of KP:

- KPGT ~99% 11/21 programmes completed
- KPOT ~98% 13/21 programmes completed

Completion of AO1:

- GT1 ~94% 30/33 programmes completed
- OT1p1 ~70% 62/176 programmes completed
- OT1p2 ~2.2% -

Completion of AO2:

- GT2 ~28% 2/32 programmes completed
- OT2p1 ~4.6% -

Prediction:

- All KPGT/OT, GT1/2, and OT1/2p1 completed by end of 2012
- Plus about 585 hr (~10% of total p2) per month until boil-off
- For illustration, in reality no sharp 'border' between p1 and p2







Star Formation – Near and Far, and Over Cosmic Time

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Filaments permeate the ISM on all scales



Herschel SPIRE 500 μm +PACS 160/70 μm

Planck HFI 540/350 μm + IRAS 100 μm



Herschel: IC 5146 filaments





Herschel: IC5146 filaments – origin?



Origin of filaments? Three possible contenders:

Magnetically-regulated star formation



Magnetically-critical condensed sheet, fragmented into filaments and cores (e.g. Nakamura & Li 2008; Basu, Ciolek etal. '09) Turbulent fragmentation



Filaments and coresFilaments isfrom shocks in large-
scale, supersoniccloud colla
Cores from
(e.g. Burker
(e.g. Padoan et al. 2001;
MacLow & Klessen '04)Cores from
'04; Heitsch
also Nagai e
Bate, Bonnell et al. 2003 ...

Gravity-dominated cloud/star formation



Filaments from global cloud collapse Cores from local gravity (e.g. Burkert & Hartmann '04; Heitsch et al. '08; also Nagai et al. '98) et al. 2003 ...



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Herschel: IC5146 filaments – origin!(?)





Arzoumanian et al. 2011

Using the DisPerSE algorithm (Sousbie 2011) to trace the ridge of each filament

Distribution of widths for 90 filaments 50 bin IC5146 Number of filaments per Aquila Polaris 30 Distribution of 20 Jeans lengths $[\lambda_{\rm I} \sim c_{\rm s}^2/(G\Sigma)]$ 00 0.1 02 04 0.6 0.8 1.0 Filament width (FWHM) [pc] Consistent with the view that filaments form as a result of the dissipation of interstellar turbulence (cf. Padoan et al. 2001)

2012 | vg #43

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Herschel: Aquila – stars form in filaments

Protostars and prestellar cores are preferentially found in MC filaments with densities above a critical value

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Suggesting link prestellar CMF & IMF



Könyves et al. 2010 André et al. 2010 A&A special issue

341-541 prestellar cores in Aquila - factor ~ 2-9 better statistics than earlier studies:

e.g. Motte, André, Neri 1998; Johnstone et al. 2000; Beuther & Schilke 2004; Stanke et al. 2006; Enoch et al. 2006; Alves et al. 2007; Nutter & Ward-Thompson 07



Good (~ one-to-one) correspondence between core mass and system mass: $M_* = \varepsilon M_{core}$ with $\varepsilon \sim 0.2-0.4$ in Aquila

The IMF is at least partly determined by pre-collapse cloud fragmentation (cf. models by Padoan & Nordlund 2002, Hennebelle & Chabrier 2008)









Progress in submm observations

- See

1998 SCUBA HDF: 5 sources after 20 exceptional nights

To scale!



~3 arcmin



Herschel-ATLAS SDP field: ~7,000 sources in 16 hours 3% of total => 235,000 !!

Evolution of the 250 um Luminosity Function



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250 µm

GOODS-N (Oliver & Lutz)



PACS 100/160 μm

350 µm

500 µm



10 arcmin

SPIRE 250/350/500 μm

Deep Herschel/PACS blank fields



PEP GOODS-N 30h 100+160µm during Science demonstration phase ~300 sources PEP GOODS-S 113+113h 70+100+160µm ~800 sources



The typical Spectral Energy Distribution of main-sequence and starburst galaxies: two modes of star formation

Two categories of galaxy:

- Main sequence: Extended star forming 90%
- Star bursts: Compact starbursts 10%
- Fall in cosmic SFR over time driven by decrease in gas mass, not merger rate
- Main sequence/extended star forming dominating since z~2.5



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Herschel: SHINING – ULIRG/AGN outflows



Mrk 231:

 $L_{IR} = 3.2 \times 10^{12} L_{\odot}$ (70% AGN)

P-Cygni profile with blue-shifted absorption and redshifted emission

∆v ~ 1,170 km/s

Sturm et al. 2011



Herschel: SHINING – ULIRG/AGN outflows



Mrk 231:

 $L_{IR} = 3.2 \times 10^{12} L_{\odot}$ (70% AGN)

P-Cygni profile with blue-shifted absorption and redshifted emission

∆v ~ 1,170 km/s Depletion time scale(



Herschel: SHINING – ULIRG/AGN outflows

Mrk 231 is but one example

These ULIRG winds will expel the cold gas in the nuclei in $\sim 10^{6}-10^{8}$ yr => halting the starformation activity on this timescale.



Possible molecular gas outflow – AGN negative feedback mechanism



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HERSCHEL OBSERVATOR

Pulling it all together ...





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THANK YOU!