The Herschel ATLAS

Steve Eales on behalf of the H-ATLAS team

• Largest Open Time Key Project (600 hours)
• A survey of 550 square degrees of the sky, four times larger than all other Herschel extragalactic surveys combined
• Five bands: 110, 170, 250, 350 and 500 microns, with 5σ limit at 250 μm of 45 mJy
The fields

- Southern fields: 2dF, VISTA (VIKING), VST (KIDS), DES
- Equatorial fields: 2dF, SDSS, GAMA, VISTA (VIKING), UKIDSS, VST (KIDS), GALEX, GMRT
- Northern fields: SDSS, LOFAR, UKIDSS
- We predict 35,000 sources will already have redshifts, including 90% of those at $z<0.1$, and in the GAMA fields 90% at $z<0.3$
Far-IR/submm version of the Sloan photometric survey.

We aim to measure the dust content and dust obscured star formation in \( \approx 30,000 \) galaxies in the nearby \((z<0.3)\) universe.

- How does star formation depend on environment?
- How does dust mass depend on galaxy type and environment
- How much evolution has there been in the last three billion years?
Programme B – High-Resolution Observations of Planck Sources

We will survey one eightieth of the sky in two of the same bands as Planck

• empirical test of Planck point-source extraction (positions, fluxes etc.)
• high-resolution observations of Planck point sources
• a clean ‘SZ’ sample of high-redshift clusters
• joint Herschel-Planck study of high-latitude dust

BOLOCAM image at 1.1 mm of Abell 1835, showing the SZ effect and two dusty galaxies
Programme C: Lensing

• Existing lensing samples typically contain \( \approx 10 \) sources

• Models suggest that 500 \( \mu \text{m} \) is the golden spot for finding lensed systems, and that the ATLAS should contain several hundred lenses.

• Possible projects: (i) investigations of the cosmic evolution of dark-matter halos, (ii) a study of submm sources well below the Herschel confusion limit, (iii) measurement of cosmological parameters.

Blue – nearby galaxies; green – blazars; red – unlensed high-z galaxies; dashed red – lensed high-z galaxies
• Programme D: studies of high-z AGN (e.g. stacking analysis on 10,000 SDSS quasars)

• Programme E: evolution and clustering of submillimetre galaxies

• Programme F: study of prestellar cores and protostars at high latitude

When we look at high latitude, the dust is close!

IRAS map at 100 \( \mu \text{m} \) of 10x10 deg\(^2\) around the SGP
Science Demonstration
Observations

• Herschel observed a 4x4 deg$^2$ region of one of our fields on the celestial equator on 22 November 2009 in parallel mode
• SPIRE data reduction fairly complete
• PACS data reduction less advanced
Hard-Core SPIRE Data Reduction

- New temperature correction module designed by Enzo Pascale (low-pass filter of temperature time streams, fifth-order polynomial fit to temperature time streams and then normalize and subtract from detector time streams).
- At 250 and 350 μm, no correlation between noise of different bolometers and 1/f knee is at a scale of ≈ 5.5 deg
- At 500 μm, some correlation between bolometers, and 1/f knee is at a scale of 1.7 deg
- High-pass the time streams at the 1/f knee for each array
Hspot noise estimates in the three bands: 9.1, 12.4 and 10.5 mJy

*Measured noise: 9.4, 7.6 and 10.6 mJy*
First PACS Images

PACS at 160 microns
- Current estimates of the noise are 30 mJy (1 sigma) at 110 μm and 46 mJy (1 sigma) at 170 μm.
- Hspot estimates: 13.4 mJy and 18.9 mJy
- Estimates of the point spread function from stacking suggest that the beam has not been smeared by fast-scanning
- Watch this space!
Source Extraction and Identifications

- We are currently trying five source-extraction packages, including two (MADX and the Matrix Filter Multi-Frequency Method) designed to operate at several frequencies simultaneously.
- Counterparts are currently being found by a Bayesian method that uses both the positions and spectral energy distributions of the potential counterparts.
How Well Will We Do?  
Programme A

- MADX finds 14900 sources detected at >5σ, including 5053 detected at >5σ at 250 µm, 7178 at 350 µm and 479 at 500 µm
- Predicted total for survey is 521,000
- Predicted total at z < 0.3 (assuming redshift distribution is the same as models) is 80,000
Programme B

Herschel at 350 microns

Planck at 350 microns
Programme C: Are the Bright 500-μm Sources Lensed

- There are eight SDP sources with flux at 500 μm above 100 mJy
- Two are galaxies at z<0.1
- One is a blazar
• But five are either unlensed high-z galaxies or lensed high-z galaxies
Programme 5: AGN

- Two blazars detected, including one which is one of the 200 brightest gamma-ray sources in the sky
Programme F: Galactic Science

- If ‘blob’ is galactic, it is likely to be at a distance of less than 1 kpc.
- We estimate that its mass (gas plus dust) is less than 1 solar mass.
- Possible isolated prestellar core
Conclusions

• SPIRE survey is reaching our target noise limits
• PACS survey is a factor of 2-3 above the required sensitivity
• We are detecting 2-3 more sources than we expected
• The current 9-hour limit on AORS is a major problem for our maps of the SGP and NGP
• Other than that, are no major obstacles for any of the six H-ATLAS science programmes.
Ten Years in Submm Astronomy

1998: SCUBA
observations of the HDF – five sources after 20 nights

2009: Herschel – 15000 sources after 16 hours