Asteroids & Satellites

Summary of HCal workshop session

Asteroids - Spitzer

- Spitzer/MIPS survey data – several new objects identified – 24, 70, 160μm – might be other data not yet analysed for asteroids – e.g. flat field data
- Asteroid sample identified – always visible, main belt, slower spin rates
- MIPS calibration based on STM – typical accuracy currently ~20%
- Asteroids only used for colour calibration, not flux.
- No cross-check yet between TM and BB list, but TM list brighter
- Spitzer may observe brighter asteroids only at 70 & 160μm
- Insufficient calibration time for light curves
- KBOs – Sedna not detected……

Asteroids – ASTRO-F

- Astro-F/FIS – 50-180μm in 4 bands
- Astro-F initial list of 150 sources reduced to 49 candidates
- Ceres at upper limit of flux range – OK >100μm (survey mode)
- Will use Mueller/Lagerros TPM for analysis
- Absolute accuracy goal – 10% point sources, 20% diffuse sources
- Some have no IR data – used as focus of Subaru/COMICS proposal, also included were those which had only poor quality IRAS data.
- Five of these observed @ 8.6, 11.7, 18.7μm – four good, one had poor S/N (Hector)
- Themis & Cava had typ. ~5% photometry error (c.f. 10% Astro-F req.)
- Cava & Ludmilla – fits obtained for first time – diameter & albedo

Asteroids – ASTRO-F

- Three more observed since – analysis ongoing
- Seven more targets for ongoing work…….
- N & Q band observations will constrain physical size & thermal inertia
- Will not measure MIR light curve
- IRTF observations? IRTF has poorly documented calibration scheme, but proposal may be considered.

Asteroids – preparatory programme for Herschel, ASTRO-F, ALMA

- Light curves give spin vector & shape solution, but not diameter
- Larger (>100km), slowly spinning lumps preferred – more spherical, dust layer – easier modelling
- Need independent diameter & albedo information
- Brighter asteroids should nicely fill flux gap between Neptune & stellar calibrators
- Asteroids visible from Herschel twice yearly for 10±2 weeks at a time
- T_b variations with distance from Earth/Sun
- Apparent movements during visibility periods – 0-80”/Hr

Asteroids – preparatory programme for Herschel, ASTRO-F, ALMA

- List of 49 asteroids selected
  - no extreme thermal lightcurve variations expected – max. 10-20% over several hours (typ. <5%, many <1%)
  - Observation programme in progress with Subaru/COMICS
  - Kaasalainen light curve inversion method helps constrain shape – very good agreement with e.g. Gaspra.
  - Large light curve database
- Lagerros/Mueller model used for analysis
  - Main uncertainties in model come from poor knowledge of $\varepsilon(\lambda)$ and of light curves (hence shape & spin vector)
  - TM will give observing recommendations to anyone with spare observing time!
  - TPM fits observations much better than STM – STM derives false wavelength dependent diameters & albedoe

Asteroids – preparatory programme for Herschel, ASTRO-F, ALMA

- Issues / discussions
  - Tool for Herschel-centric position calculations – Herschel orbit parameters will go into JPL HORIZONS system
  - Clean calibration of asteroids vs planets / stars needed
  - Software licensing! – MPI no longer does research!
  - Access to TPM may be useful, but at present needs expert to “drive” it. Large amount of work to document & make user friendly. Conversion to e.g. IDL is a long job. Catalogue of SEDs vs time may be better.
  - Lab-based solid state measurements will be useful to help constrain $\varepsilon(\lambda)$ – no programmes in place at present.
  - Spin vector variation with time considered negligible (unless collision detected!)
  - Alma may be able to provide maps to constrain shape parameters

Satellites

- Galilean satellites
  - flux estimate @ 2000GHz – 350Jy (T_b=120K)
  - T_b poorly known in FIR/Sub-mm
  - Observations of Callisto & Ganymede would be good
    - Icy satellites – calibration accuracy ~5-10%.
  - Used Mars thermal model – Ganymede not consistent with this model

Satellites

- Titan
  - Thermal structure known from Voyager / Cassini
  - Should obtain better radiative transfer model constraints post-Cassini – same model as used for giant planets
  - Flux ~100-300Jy in HIFI range
  - Continuum known to ~5%, and lines to ~5-10%

Satellites

- Discussion
  - Side-lobe contamination / stray light from giant planet
    - Imaging capabilities of PACS & SPIRE will help
    - Herschel commanding & tracking much better than ISO
    - Smaller beams than ISO
  - B. Butler has mm→radio models for Titan
  - Contributions of Uranian & Neptunian satellites to overall planetary flux? Considered negligible – ratio of areas.
  - South polar cloud (Titan) contribution/variation? – considered negligible c.f. global average.
  - Contribution from Jupiter to energy balance (Callisto / Ganymede)? – considered negligible.

What now?

- Coordinated effort essential, and beneficial to all
  - Use of same sources by different instruments
  - Use of same models by different instruments
- Suggestion:-
  - Use links set up at this workshop to maintain coordinated effort (e.g informal asteroid/satellites group)
  - Session chairs could act as points of contact to HCalSG
  - Initially, speakers could outline thoughts on future activities in model development, pre-Herschel observations, and on in-orbit Herschel observations which would aid calibration (in their areas)