HIFI – Heterodyne Instrument for the Far Infrared

One of the three science instruments on the ESA Herschel Space Observatory

Instrument

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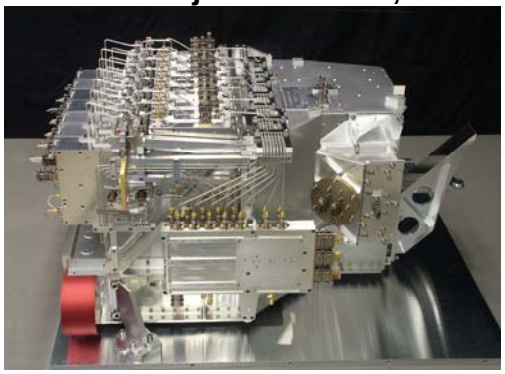


General Features

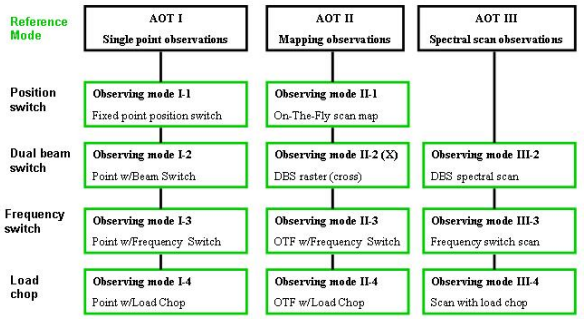
Broad coverage of the FIR and sub-mm

Instantaneous IF bandwidth of 4 GHz

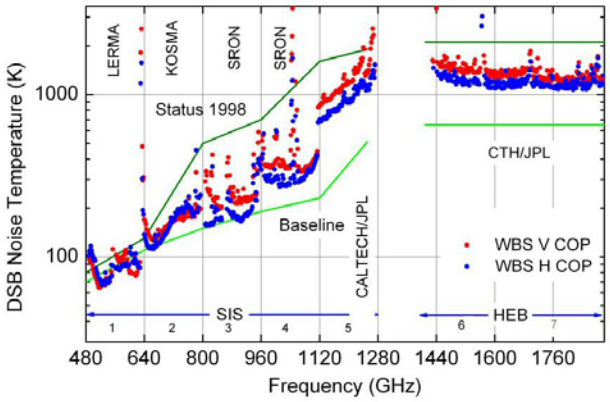
Resolving power of up to 10^7 (0.3-300 km/s)

Diffraction-limited (12" – 47") beam

Seven bands utilizing low-noise dual-polarisation superconducting SIS and HEB mixers



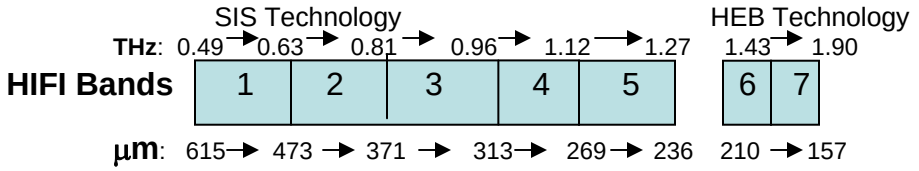
The HIFI Common Optics Assembly containing seven mixer bands – five pairs of SIS mixers and two pairs of HEB (Hot Electron Bolometer) mixers, the calibration assembly, and the Local Oscillator inputs.



(see de Graauw et al, 2010, A&A, Special Herschel Issue)

The Common Optics system combines seven beams and provides a beam chopper for the HIFI Instrument Modes which include: dual beam-switching, position-switching, on-the-fly mapping, frequency-switching, and cold-load switching. Dual acousto-optical (wide band - WBS) and autocorrelator (high resolution - HRS) backend spectrometers provide frequency resolutions of: 140 kHz, 280 kHz, 560 kHz (HRS), and 1.1 MHz (HRS & WBS).

HIFI sensitivity: Near-quantum noise limit sensitivity, except high frequency bands 5, 6 and 7. Typically a 1σ of ~few mK (band 1a) to ~100 mK (band 7b) in 1 hour using the dual beam-switch observing mode at native WBS resolution.



HIFI calibration accuracy: 10% baseline requirement; 3% goal

For more information see: http://herschel.esac.esa.int/ or http://www.herschel.caltech.edu + links provided therein (version May 2010)

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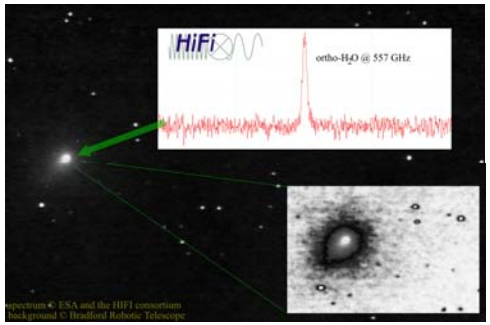
The ***HIFI*** science objectives centre around understanding the cyclic interrelation between the stars and the interstellar medium in galaxies. Stellar systems are formed through the collapse of molecular clouds, and in their lifetimes return copious amounts of atomic and molecular material enriched by nucleosynthesis to the ISM. With HIFI one can observe this process, detecting the many molecular rotational line transitions and fine-structure transitions of atoms, ions and isotopes as the cool ISM reprocesses essentially all central-source radiation to the FIR and sub-mm regime and gives clear indications of its composition and physical conditions.

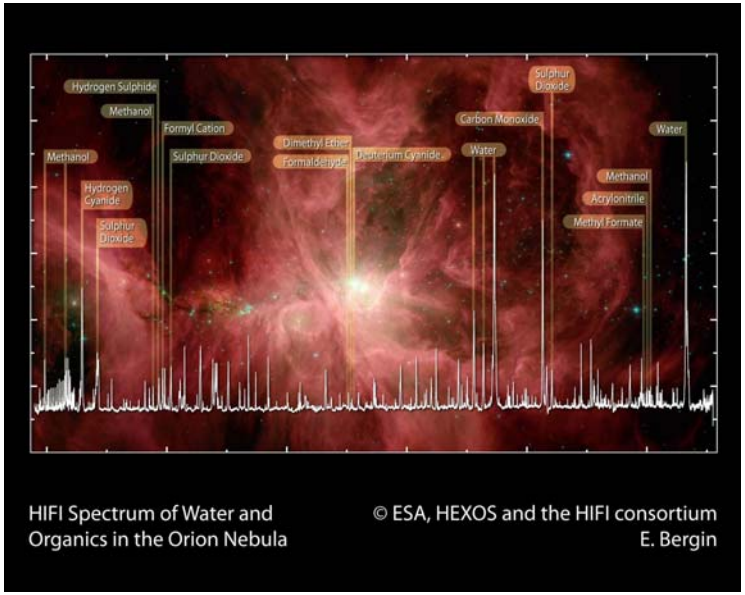
HIFI **is an ideal instrument for:**

- Probing the physics, kinematics, and energetics of star forming regions via their atomic and molecular cooling lines.
- Surveying the molecular inventory of such diverse regions as shocked molecular clouds, PDRs, diffuse atomic clouds, hot cores, proto-planetary disks around new stars, winds of dying stars, and the toroids around AGNs
- Measuring the out-gassing of comets and the vertical distribution in the giant planets of molecules such as H_2O.
- Measuring the mass loss regulating post main-sequence stellar evolution and the gas/dust ISM replenishment.
- Measuring the intense galactic [CII] emission so as to probe the ionized and warm neutral components of the ISM.

HIFI has been designed and built by a consortium of institutes and university departments from across Europe, Canada and the United States under the leadership of SRON Netherlands Institute for Space Research, Groningen, The Netherlands and with major contributions from Germany, France and the US. Consortium members are: Canada: CSA, U.Waterloo; France: CESR, LAB, LERMA, IRAM; Germany: KOSMA, MPIfR, MPS; Ireland, NUI Maynooth; Italy: ASI, IFSI-INAF, Osservatorio Astrofisico di Arcetri-INAF; Netherlands: SRON, TUD; Poland: CAMK, CBK; Spain: Observatorio Astronómico Nacional (IGN), Centro de Astrobiología (CSIC-INTA). Sweden: Chalmers University of Technology - MC2, RSS & GARD; Onsala Space Observatory; Swedish National Space Board, Stockholm University Stockholm Observatory; Switzerland: ETH Zurich, FHNW; USA: Caltech, JPL, NHSC.

Early HIFI spectrum of the 557GHz ground-state water transition toward Comet Garrad. HIFI's higher sensitivity allows isotopic line measurements of many comets.





A single HIFI subband spectral scan on Orion exemplifies a star-forming region where HIFI capabilities can be put to great advantage. Here a rich molecular line survey has been made with HIFI, utilizing its high sensitivity (free from telluric absorption), its high frequency resolution - to resolve blended transitions in emission and absorption - and to rapidly span a very large frequency range (approx. 30 hours are needed to cover all HIFI subbands)..

For more information see: http://herschel.esac.esa.int/ or http://www.herschel.caltech.edu + links provided therein (version May 2010)