# Water in Star-Forming Regions with Herschel

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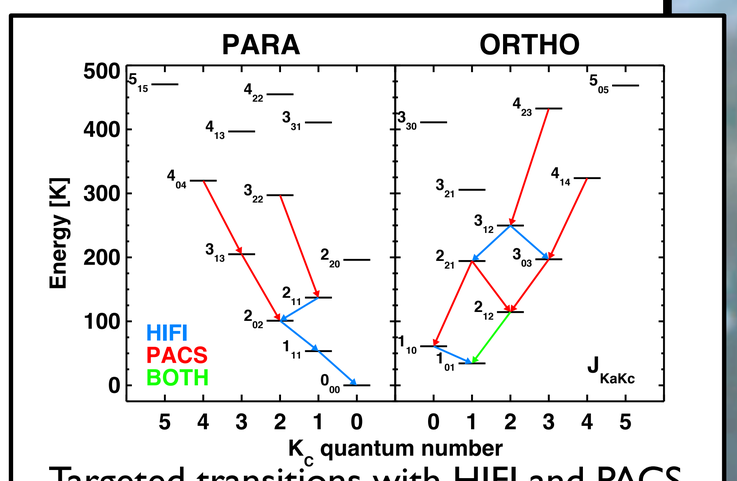
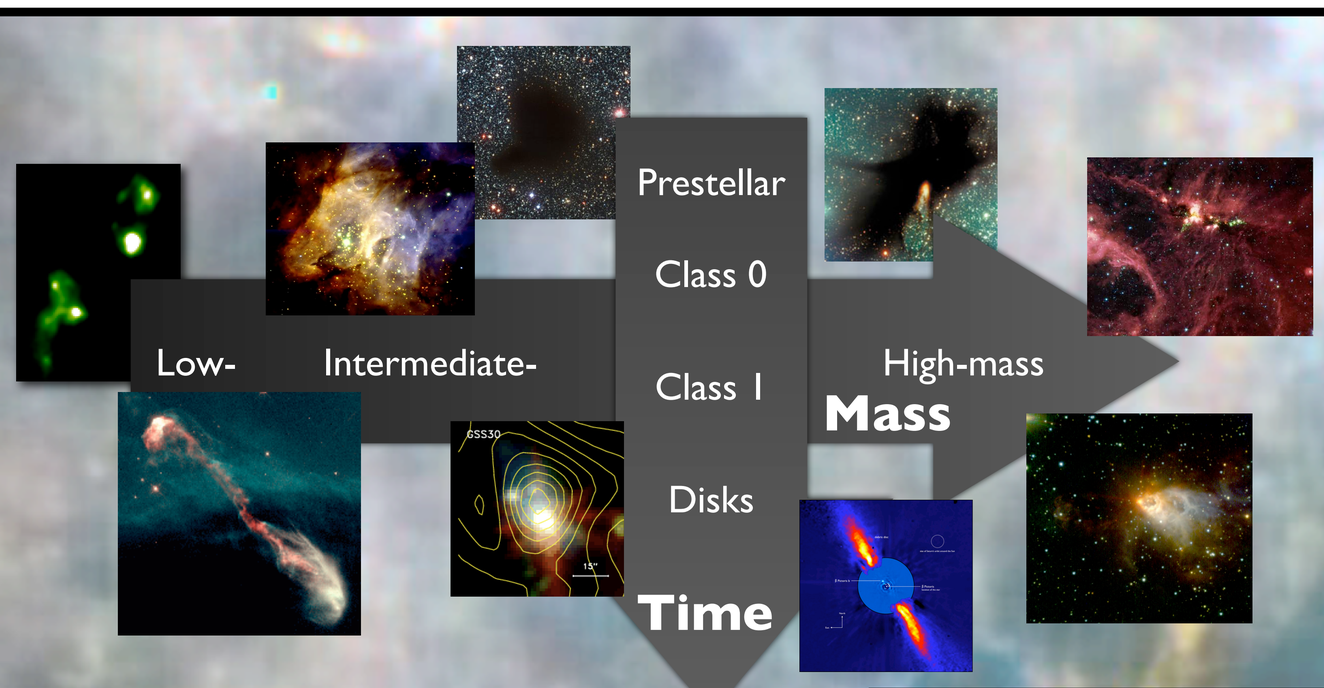
## Water

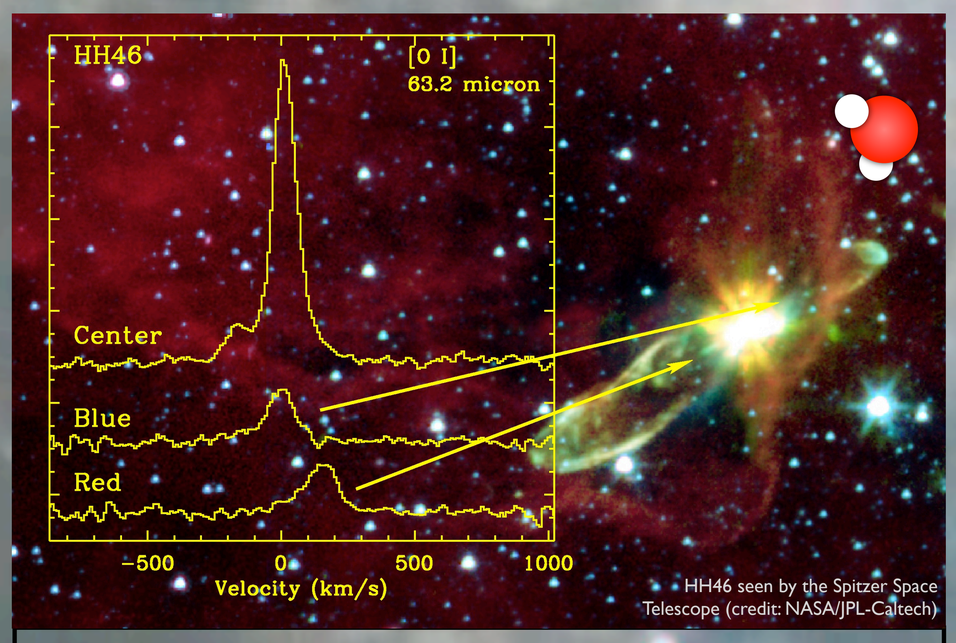
- Key molecule for probing the physics and chemistry of star-forming regions
- Large abundance variations between warm and cold regions
- Capable of highlighting key episodes of stellar birth such as gravitational collapse, outflow injection, and stellar heating of envelopes and disk
- Chemical importance as one of the main oxygen reservoirs
- Direct association with life on Earth

**Water** is a prime target for Herschel observations. The "Water in Star Forming Regions with Herschel" (WISH) and "Dust, Ice and Gas in Time" (DIGIT) key programs are using PACS and HIFI to follow the water 'trail' from prestellar cores to planet-forming disks.

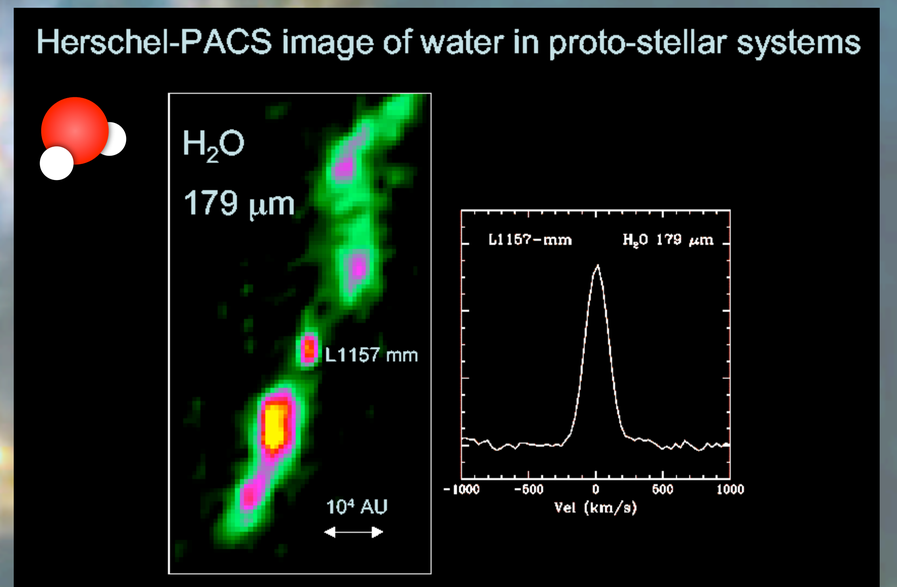


Targeted transitions with HIFI and PACS

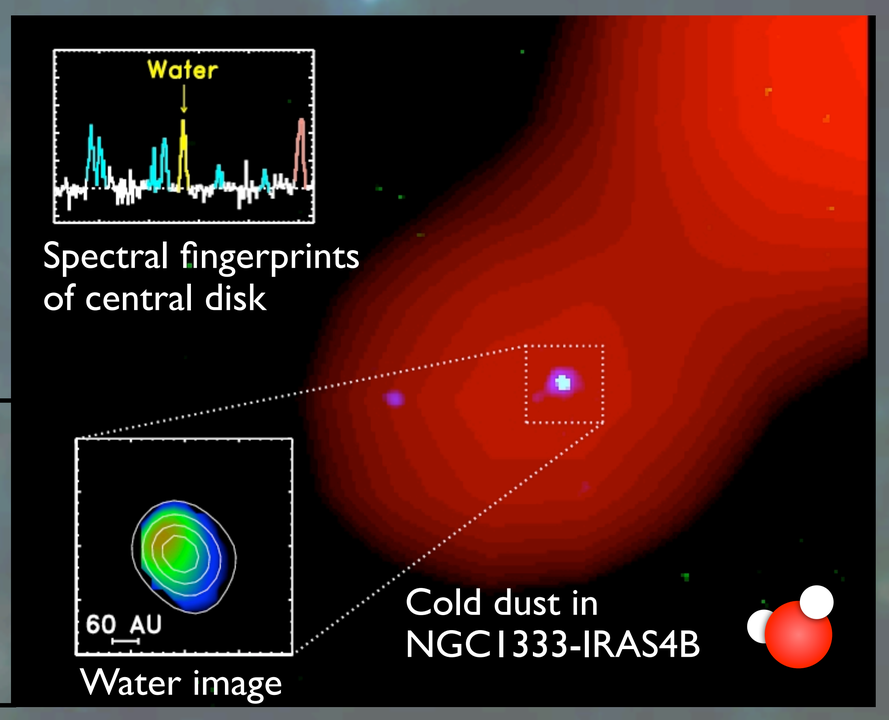



PACS first result spectra of the low-mass protostar HH46. PACS data reveal a strong line of atomic oxygen at 63μm toward the source position and the outflow. Note the presence of very high velocity material (~200 km/s) in the jet itself, and low velocity gas swept up by the jet. The oxygen and water lines directly probe the energetics (van Kempen et al. 2010).




PACS first results image of the 179μm line of water toward the young solar analog L1157, lighting up the 'hot spots' in the bipolar outflow where the shock dumps energy into the cloud (Nisini et al. 2010).




Under exceptional conditions, a line of $H_2{}^{18}O$ can be imaged from the ground with IRAM PdBI with much higher angular resolution than possible from space. The blue color indicates the location of two protoplanetary disks in the region (PdBI mm-continuum). The scale-bar in the water image corresponds to the size of the solar-system, showing that the IRAM data allow to pinpoint the location of the hot water gas to the inner 25 AU of the disk, i.e., comparable to the orbit of Neptune around the Sun (Jørgensen & van Dishoeck 2010).

Background image: From the Herschel Observatory revealing some of the coldest and darkest material in our galaxy. Infrared light with a wavelength of 250 microns is represented in blue; 350-micron light in green; and 500-micron light in red. This image was taken by Herschel's spectral and photometric imaging receiver (SPIRE); credit: ESA/NASA/JPL-Caltech