Results of the HssO Key Programme with the Herschel Space Observatory

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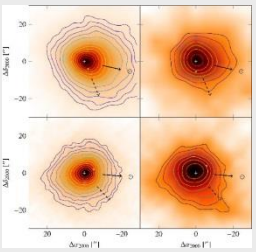
Abstract: *The HssO (**H**erschel **s**olar **s**ystem **O**bservations) programme (Hartogh et al., 2009) aims at determining the distribution, the evolution and the origin of water in Mars, the Outer Planets, Titan, and comets, using the three Herschel instruments HIFI, PACS and SPIRE. It addresses the broad topic of water and its isotopologues in planetary and cometary atmospheres.*

Comets

In a sample of comets including one mail-belt comet:

- Nature of cometary activity and the thermodynamics of cometary comae by studying dust/gas properties (Bockelée-Morvan et al. 2010),
- Composition (Biver et al, 2012, Bockelée-Morvan et al. 2014)
- Water production and excitation (Hartogh et al. 2010a, de Val-Borro et al., 2010, 2012,2014, Lis et al. 2013)



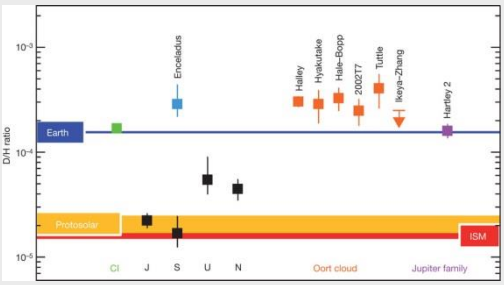
Maps at 70 and 160 μm of comet C/2006 W3 (Christensen) with PACS

D/H ratio

The D/H ratio, the key parameter for constraining the origin and evolution of solar system materials, in:

- Jupiter family comet (Hartogh et al, 2011a).
- in an Oort cloud comet, not compatible with former observations (Bockelée et al, 2012).
- New measurements of D/H in Giant Planets, similarly to comets constraining the composition of proto-planetary ices(Lellouch et al, 2010, Feuchtgruber et al, 2013).

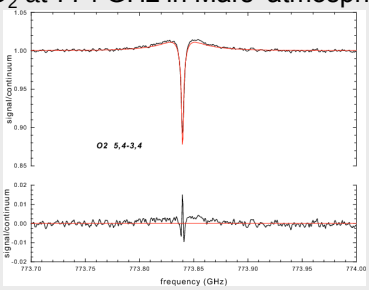
D/H ratio in comets



Isotopic ratios- Mars

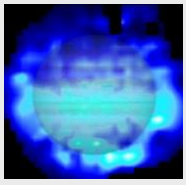
- Isotopic ratios, diagnostics of the evolution of Mars' atmosphere, accurately measured in H_2O and CO.
- Role of water vapour in the atmospheric chemistry of Mars based on monitoring vertical profiles of H_2O and HDO.
- Seasonal changes in H_2O_2, upper limits of HCl
- First submm determination of molecular oxygen in the martian atmosphere (Hartogh et al, 2010 b/c) and a SPIRE full range spectrum (Swinyard et al, 2010).

O_2 at 774 GHz in Mars' atmosphere



Jupiter

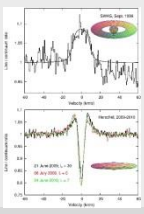
A cometary origin of Jupiter's stratospheric water based on measuring its spatial distribution (Cavalié et al, 2013)



Distribution map of water in Jupiter's stratosphere

Enceladus Water Torus

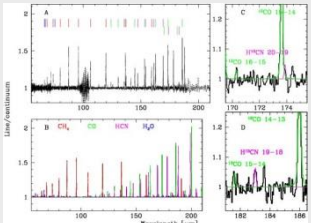
The Enceladus water torus directly detected/characterized for the first time and is probably the main source of water in Saturn's and Titan's upper atmospheres. (Hartogh et al. 2011b, Moreno et al. 2012).



Herschel/HIFI water line at 557 GHz

Titan

The composition of Titan's atmosphere with high accuracy with SPIRE (Courtin et al, 2011), PACS (Rengel et al. 2014) and HIFI and includes the first detection of hydrogen isocyanide (HNC) (Moreno et al. 2011).



PACS spectrum of Titan's atmosphere

Etc.