CONSTRAINING OUTGASSING ACTIVITY IN THE MAIN-BELT COMET 176P/LINEAR WITH HERSCHEL. M. de Val-Borro[1], P. Hartogh[1], N. Biver[2], D. Bockelée-Morvan[2], J. Crovisier[2], M. Küppers[3], S. Szutowicz[4], D.C. Lis[5], R. Moreno[2], M. Rengel[1], M. Emprechtinger[5], C. Jarchow[1], E. Jehin[6], L. Lara[7], M. Kidger[8], and the HssO Team, [1]Max-Planck-Institute for Solar System Research, Katlenburg-Lindau, Germany (deval@mps.mpg.de), [2]LESIA, Observatoire de Paris, Meudon, France, [3]Rosetta Science Operations Centre, ESA, Madrid, Spain, [4]Space Research Centre PAS, Warsaw, Poland, [5]California Institute of Technology, Pasadena, CA, USA, [6]Institut d'Astrophysique et de Géophysique, Université de Liège, Belgium, [7]Instituto de Astrofísica de Andalucía (CSIC), Spain, [8]Herschel Science Centre, European Space Astronomy Centre, ESA, Villanueva de la Cañada, Madrid, Spain

Introduction: Comets originate in the outskirts of the solar system, beyond the snow line, where temperatures in the solar nebula were low enough for water to condense onto icy grains. Physically, asteroids are thought to be devoid of volatiles, while comets are icy bodies that become active in the inner solar system due to sublimation of ices, mostly water. Main-belt comets (MBCs) are a newly discovered class of bodies that are dynamically indistinguishable from standard asteroids and display cometary activity during part of their orbit. Theoretical models suggest that the snow line was close to Mars orbit [1,2]. Therefore objects formed in the asteroid belt may have been able to accumulate water ice.

Observations: Comet 176P/LINEAR is an MBC that was discovered in 1999 and originally categorized as asteroid 118401 LINEAR. This object belongs to the Themis asteroid family. Cometary activity was reported for this object around perihelion by the Hawaii Trails project [3]. 176P/LINEAR was observed with the Heterodyne Instrument for the Far Infrared (HIFI), one of the three instruments on-board the *Herschel Space Observatory,* within the framework of the *Herschel* guaranteed time key program "Water and related chemistry in the Solar System" [4]. 176P/LINEAR was the best main-belt comet target in terms of visibility close to the perihelion passage and anticipated line strength. It passed its perihelion on June 30, 2011 at a distance of 2.57 AU from the Sun and was observed by *Herschel* on August 8, 2011 with a total integration time of 6 hours when the comet was at a heliocentric distance of 2.58 AU and a distance of 2.56 AU from *Herschel*. The line emission from the fundamental transition of ortho-water (1_{10}-1_{01}) at 557 GHz was searched for and an upper limit on its production was inferred. The observations were performed in the frequency-switching mode, with both the wide band spectrometer (WBS, resolution 0.58 km s^{-1}) and the high-resolution spectrometer (HRS, resolution 0.074 km s^{-1}). Horizontal and vertical polarizations were averaged, weighted by the root mean square amplitude, to increase the signal-to-noise ratio.

Data analysis: The data analysis was performed using the IRAM CLASS software package. A molecular excitation model based on the publicly available Accelerated Monte Carlo radiative transfer code *ratran* [5] is used to calculate the populations of the rotational levels of water as a function of the distance from the nucleus. The code includes collisional effects and infrared fluorescence by solar radiation to derive the production rates. We used the one-dimensional spherically symmetric version of the code following the description outlined in [6] that has been extensively tested and utilized to interpret Herschel cometary observations [7]. There is no evidence of gas emission in our observations, although it is expected that its activity is driven by the sublimation of subsurface material as the object approaches perihelion rather than triggered by an impact. We derive a sensitive upper limit on the water production rate assuming the standard spherically symmetric Haser distribution. This value is consistent with the upper limit found in other main-belt comets inferred from the spectroscopic search for CN emission, such as in P/2006 VW_{139} [8]. Assuming that cometary activity in MBCs is indicative of ice sublimation, the scaling relation between gas production rates and visual magnitudes from [9] predicts a water production rate of approximately a few times 10^{26} molecules s^{-1}. This correlation has been obtained for a sample of comets with heliocentric distances 0.32–2.8 AU. We conclude that a more detailed study is needed to shed light on the nature of this object.

References:

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