Distant activity of comet C/2006 W3 (Christensen) as observed with Herschel

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We aimed to measure the H_2O and dust production rates in C/2006 W3 (Christensen) with the Herschel Space Observatory at a heliocentric distance of $\sim$ 5 au and compare these data with previous post-perihelion Herschel and ground-based observations at $\sim$ 3.3 au from the Sun (Bockelée-Morvan et al. 2010b). We have searched for emission in the H_2O and NH_3 ground-state rotational transitions at 557 GHz and 572 GHz, simultaneously, toward comet C/2006 W3 (Christensen) with the Heterodyne Instrument for the Far Infrared (HIFI) onboard Herschel on UT 1.5 September 2010. Photometric observations of the dust coma in the 70 µm to 160 µm channels were acquired with the Photodetector Array Camera and Spectrometer (PACS) instrument on UT 26.5 August 2010. A tentative 4-σ H_2O line emission feature was found in the spectra obtained with the HIFI wide-band and high-resolution spectrometers, from which we derive a water production rate of $2.0(5)\times10^{27}$ molec. s^{-1}. A 3-σ upper limit for the ammonia production rate of $< 1.5\times10^{27}$ molec. s^{-1} is obtained taking into account the contribution from all hyperfine components (Biver et al. 2012). The dust thermal emission was detected in the 70-µm to 160-µm filters, with a more extended emission in the blue channel. We fit the radial dependence of the surface brightness with radially symmetric profiles for the blue and red bands. The dust production rates, obtained for a dust size distribution index that explains the fluxes at the photocenters of the PACS images, lie in the range 70–110 kg s^{-1}. Scaling the CO production rate measured post-perihelion at 3.20–3.32 au, these values correspond to a dust-to-gas production rate ratio in the range 0.3–0.4. The blueshift of the water line detected by HIFI suggests preferential emission from the subsolar point. However, it is also possible that water sublimation occurs in small ice-bearing grains that are emitted from an active region on the nucleus surface at a speed of $\sim$ 0.2 km s^{-1}. The dust production rates derived in August 2010 are roughly one order of magnitude lower than in September 2009, suggesting that the dust-to-gas production rate ratio remained approximately constant during the period when the activity became increasingly dominated by CO outgassing. These data will complement available Herschel observations of the distant activity of other comets such as 29P/Schwassmann-Wachmann 1 (Bockelée-Morvan et al. 2010a) and main-belt comets 176P/LINEAR and P/2012 T1 (PANSTARRS) (de Val-Borro et al. 2012, O'Rourke et al. 2013).

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