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Water in high-mass pre- and proto-stellar cores from Hi-GAL ()

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As a part of our on-going investigation of the earliest phases of massive star formation, we present Herschel-HIFI data of H_2O, NH_3 and N_2H^+ towards a sample of high-mass starless cores and proto-stellar objects in two galactic fields, each containing objects in different evolutionary stages. We observed 17 sources in the l = 30° galactic field, and 35 sources in the l = 59° field. The clumps in the l = 59°region have lower luminosity and mass than the l = 30° objects. We find that the sources with detections have much higher mean luminosities than compared to the sources with no detection of any line, but the mean masses are similar. Most sources with detections are proto-stellar, and at least two of the detected sources in the l = 59° region are in a more advanced stage of evolution. For the l = 30° sources no preferential evolutionary phase is evident. None of these sources, however, appear to belong to the late phase of envelope dispersal.The detections show complex line shapes from the protostellar envelopes, molecular outflows and infall. All detections in the l = 59° field show similar water line profiles with broad outflows, whereas towards l = 30° no outflows are detected and all sources display very different line shapes. Both water and ammonia are also often self-absorbed, sometimes saturated, and some sources show an inverse or a regular P-Cygni line profile. N_2H^+ do not exhibit line asymmetries or absorption. The integrated intensities of the three lines are correlated, and we also find correlations between the water line luminosity and continuum temperature. The typical water luminosity towards the l = 30° sources is lower than compared to l = 59° sources, but their continuum temperature is higher, which may suggest a later evolutionary stage.In the sight-lines towards 11 sources in the l = 30° field, among which four have no detections in the star-forming regions, we also detect H_2O and NH_3 in absorption from interstellar gas. Since ammonia mainly traces the denser components of the interstellar gas, the H_2O/NH_3 ratio varies substantially; when both species are detected the ratio is typically ~2-5.

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