WATER IN THE ENVELOPES OF LOW-MASS PROTOSTARS. T.A. van Kempen, M.R. Hogerheijde, E.F. van Dishoeck, *Leiden Observatory, P.O. Box 9513, 2300 RA Leiden, The Netherlands (kempen@strw.leidenuniv.nl)*, J.K. Jørgensen, *Center for Astrophysics, Cambridge, MA 02138, USA*.

We present models for the emission of H_2O and its isotopes from the envelopes around low-mass protostars, as preparatory science for observations to be performed with the Herschel Space Observatory. Water is one of the most abundant and important molecules in star-forming regions. Although water is only a trace species in general molecular clouds, it becomes the third most abundant species —after the mostly unobservable H_2 and He—, in the warm regions close to newly-formed stars. This enormous variation in abundance makes water a unique probe of the physical structure of the region, and of the fundamental chemical processes within the gas and between the gas and the grains. Moreover, its level of deuteration provides an important record of the temperature history of the object and the conditions during grain surface formation. Water also plays an active role in the energy balance. Because it has a very large dipole moment, its emission lines can be efficient coolants of the gas. In all these aspects, H_2O provides highly complementary information to that derived from the commonly studied CO molecule.

Far-infrared lines of water have been detected from low-mass protostars by the ISO-LWS instrument, but their origin is still subject to discussion, in particular whether they arise in the outflow or in the quiescent infalling envelope [1,2]. The ESA Herschel mission with the HIFI and PACS instruments provides a large step forward in sensitivity, spectral and spatial resolution compared with previous satellites and an unique opportunity to study water [3].

As a typical example, the Class 0 protostar L483mm (L_{bol}=9 $L_\odot$, $M_{env,10K}$=4.4 $M_\odot$, D=200 pc) is taken. The temperature and density profiles for this envelope have been determined in previous studies [4]. The line radiative transfer is calculated with the RATRAN code [5], which has been tested extensively against other codes. Special care has to be taken in the case of H_2O, since the lines are highly optically thick and convergence is very slow.

To simulate the water chemistry, trial abundances are used assuming that water freezes out onto dust grains below 90 K and evaporates into the gas at higher temperatures in the 'hot core'. The adopted abundances range from $10^{-6} - 10^{-4}$ for the inner warm envelope and $10^{-8} - 10^{-6}$ for the outer cold envelope. The $H_2{}^{18}O$ abundances are scaled down by a factor of ~500. Line profiles and fluxes are predicted convolved with the Herschel beam at the appropriate frequency.

Results from a large range of models will be presented in the poster. Generally, it is found that the ground-state lines of ortho- and para-$H_2{}^{18}O$ are mainly sensitive to the outer abundance, whereas higher excitation lines have a stronger dependence on the inner abundance. Because of their high optical depths, the H_2O lines show a more complex behavior with the inner and outer abundances. Thus, observations of the weaker $H_2^{18}O$ will be crucial to constrain the models.

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