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Solvated electrons in thin ice film and their transfer to neighboring trichlorofluoromethane

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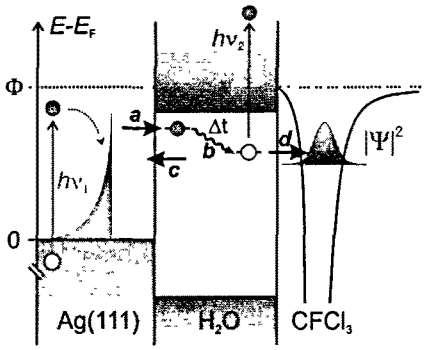
Dissociation of chlorofluorocarbons on polar stratospheric clouds has recently been proposed to occur by capturing low energy electrons generated by cosmic rays. In an effort to examine and assess this proposition, we investigated the photoexcited electron dynamics of $CFCl_3$ adsorbed on ice/Ag(111) by time-resolved two-photon photoemission (2PPE) spectroscopy. After photo-injection (denoted ***a*** in the figure below), the excited electrons were found to be solvated by water molecules in the ice layer at 2.9 eV above the Fermi level. The electrons went through relaxation at a rate of -200 meV/ps during the next several hundred fs (***b***). Owing to the reduced probability of back transfer to the metal (***c***) at higher water coverage, the lifetime increases from 90 fs to 250 fs upon increasing the water coverage from 1 ML to 13 ML. Upon coadsorption of $CFCl_3$, however, electron transfer to $CFCl_3$ (***d***) was found to take place, as indicated by the reduced lifetime of the solvated electrons. The subsequent dissociation of transient anion was confirmed by identifying the reaction products. Water in the ice layer plays an important role as an electron solvent, which comes to affect the ozone chemistry in the polar stratosphere.



Life cycle of solvated electrons in $CFCl_3/H_2O/Ag(111)$