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Electron Solvation Dynamics at D_2O Ice and Na/D_2O/Metal Interfaces

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Electron transfer (ET) across interfaces is of vital importance in different areas of physics, chemistry and biology. Using time-resolved two-photon-photoemission spectroscopy we have studied the ultrafast dynamics of interfacial ET and solvation processes in amorphous and crystalline D_2O layers on single crystal metal substrates and the influence of coadsorbed Na ions. In these experiments, photoinjection of electrons from the metal into the adsorbate conduction band is followed by ultrafast localization and solvation of the excess electrons. The subsequent energetic stabilization of these solvated electrons due to nuclear rearrangements of the polar molecular environment is accompanied by an increasing degree of localization. The observed ET rates strongly depend on the local structure of the ice. In crystalline D_2O layers we monitor the stabilization of trapped electrons at the ice vacuum interface continuously from femtoseconds up to minutes. This behavior observed for crystalline ice is fundamentally different from amorphous D_2O layers where the excess electrons have a much lower survival probability, which lifetimes of the order of 100 fs, which extend to several 10 ps if Na ions are coadsorbed at the ice surface.