Protons and the electrical conduction in a floating water bridge

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When a high-voltage direct-current is applied to two beakers filled with water or polar liquid dielectrica, a horizontal bridge forms between the two beakers. This experiment was first carried out by Lord Armstrong in 1893 and then forgotten until recently. Such bridges are stable by the action of electrohydrodynamic (EHD) forces caused by electric field gradients counteracting gravity. At macroscopic scale several of the properties of a horizontal water bridge can be explained by modern electrohydrodynamics. Much of the phenomenon is already understood, but even more can still be learned from it, since such floating liquid bridges resemble a small high voltage laboratory of their own: The physics of liquids in electric fields of some kV/cm can be studied, even long time experiments like neutron or light scattering are feasible since the bridge is in a steady-state equilibrium and can be kept stable for hours. It is also an electro-chemical reactor where compounds are transported through by the EHD flow, enabling the study of electrochemical reactions under potentials which are otherwise not easily accessible. Lately a proton band conduction mechanism has been suggested for the water bridge based upon non-thermal infrared emission. The present work shows additional supporting evidence for proton conduction, explains origin and fate of the travelling protons, and gives a complete picture of both electronic and protonic currents in this experiment.