Electrons in Liquid Ammonia and in Water: From Blue Electrolytes to Golden Metals

Pavel Jungwirth

Institute of Organic Chemistry and Biochemistry, Academy of Sciences of the Czech Republic, Flemingovo nám. 2, 16610 Prague 6, Czech Republic
E-mail: pavel.jungwirth@uochb.cas.cz

It would be exciting to have water with metallic properties; however, attempts to convert pure water from a perfect insulator into a metal by pressurizing the system remain in the realm of science fiction. This is because the estimated required pressure of 48 Mbar is an order of magnitude higher than what is accessible in the laboratory nowadays and may only exist in cores of large planets or stars. In this talk, we show that a metallic aqueous solution can be prepared by massively doping water by electrons liberated from alkali metals. Note that metallic solutions of liquid ammonia have been known for decades. However, it is a textbook knowledge that dissolution of alkali metals in water leads to an explosive chemical reaction, thus only low (sub-metallic) electron concentrations have been prepared so far. We have now found a way around the explosive chemistry by adsorbing water vapor at a pressure of about 10^{-4} mbar onto a train of liquid sodium-potassium alloy drops ejected from a nozzle into a vacuum chamber. This leads to a formation of a transient gold-colored layer of water doped with ~5×10^{21} electrons/cm^3, the metallic character of which is demonstrated by a combination of optical reflection and synchrotron x-ray photoelectron spectroscopies.

[1] Mason P.E., Schewe Ch.H., Buttersack T., Košťál V., Vitek M., McMullen R.S., Ali H., Trinter F., Lee Ch., Neumark D.M., Thürmer S., Seidel R., Winter B., Bradforth S.E., Jungwirth P.: Spectroscopic Evidence for a Gold-Coloured Metallic Water Solution. *Nature* **595** (2021) 673.

[2] Buttersack T., Mason P.E., McMullen R.S., Schewe C., Martínek T., Březina K., Crhan M., Gomez A., Hein D., Wartner G., Seidel R., Ali H., Thurmer S., Maršálek O., Winter B., Bradforth S.E., Jungwirth P.: Photoelectron spectra of alkali metal–ammonia microjets: From blue electrolyte to bronze metal. *Science* **368** (2020) 1086.