Unexpectedly long-range effects of hydrophilic surfaces on the contiguous aqueous phase

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The impact of surfaces on the contiguous aqueous phase is generally thought to extend no more than a few water-molecule layers. We find, however, that colloidal and molecular solutes are profoundly excluded from the vicinity of hydrophilic surfaces, to distances typically several *hundred* micrometers. Such large exclusion zones have been observed next to many different hydrophilic surfaces, and many diverse solutes are excluded. Hence, the exclusion phenomenon appears to be quite general. Others have confirmed its existence.

To test whether the physical properties of the exclusion zone differ from those of bulk water, a variety of different spectroscopic, physical, and imaging methods have been applied. The results, now including IR-absorption spectra, collectively reveal that the solute-free zone is a physically distinct, ordered phase of water that can co-exist essentially indefinitely with the contiguous solute-containing phase. This unexpectedly extensive zone may be a candidate for the long-postulated "fourth phase" of water earlier postulated by others.

The energy responsible for building this charged, low entropy zone comes from light. We found that incident radiant energy including all visible and near-infrared wavelengths induce exclusion-zone growth in a spectrally sensitive manner. IR is particularly effective. Five-minute exposure to weak LED radiation at 3.1 μm (corresponding to OH stretch) causes exclusion-zone-width increase up to three times. Apparently, incident photons cause some change in bulk water that predisposes constituent molecules to reorganize and build the charged, ordered exclusion zone.

Photons from sunlight, then, may have a powerful effect on water that goes beyond mere heating. Solar energy apparently builds order and separates charge between the exclusion zone and the bulk water beyond — the separation effectively creating a battery. Such a light-driven separation of charge bears resemblance to the process of photosynthesis. Indeed, this light-induced energy production would seem relevant not only for photosynthesis-like actions, but also for many realms of nature and engineering involving water and interfaces. The implications are amply discussed in a public lecture http://uwtv.org/programs/displayevent.aspx?rID=22222 and will be presented at the meeting.