Motivation
Desalination, removal of salts and minerals, is required to make water from the oceans, and brackish sources accessible for use in industry, agriculture and delivered to our homes. Experimental data and theory models seem to indicate that water confined by solid walls to spaces smaller than a few tens of nanometers is strikingly different from those of bulk water. This can influence function and operation of biological systems (cells, membranes, water pockets in proteins), geological structures (percolation, ion adsorption and mineral dissolution) and human devices (polyelectrolyte membranes, ion-exchange resins, xerogels, nanotubes etc.). Here we propose to study the properties of water in these confining conditions, to prepare the groundwork for technologies that would be transformative in desalination and other separation techniques.

Research
To probe this requires novel tools and strategies that allows chemical sensitivity and access to kinetics and dynamics within these spaces. We propose to visualize the hydrogen bond network dynamics of water in a variety of confining geometries (squeezed water) that become accessible in carbon nanotubes, mesoporous silica shells, gels and membranes. A key component of the proposal is to develop Infrared/terahertz (IR/THz) spectroscopy, and X-Ray spectroscopies to access the structure and dynamics of water in some of the world’s smallest test tubes. The results obtained can be directly tested against theoretical predictions and will guide implementation into technology.

References:

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