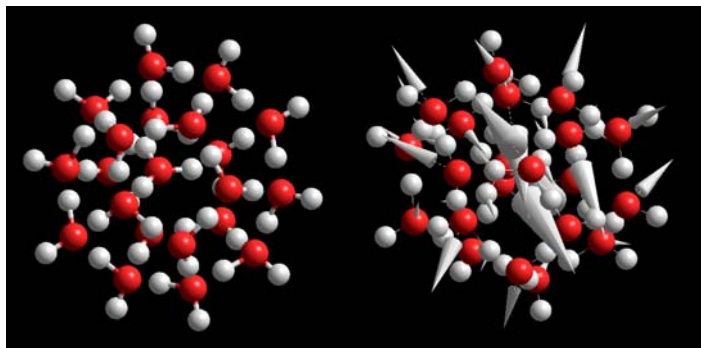


Vibronic Interactions of Water Clusters in Physics, Chemistry, and Biology

Alt. Title: “*The Fourth Phase*”

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Scientific interest in water clusters has been motivated by their possible roles in atmospheric and environmental phenomena, as well as by their relevance to the structure and properties of liquid water and ice. Experiment and theory agree that not only can such clusters be produced, but also that they exist optimally in certain “magic numbers” and configurations of water molecules such as the dodecahedral protonated $(\text{H}_2\text{O})_{21}\text{H}^+$ cluster shown above. Water clusters are present in a broad range of natural environments. They form in interstellar gas nebulae by cosmic-ray heating of dust grains, and it is speculated that interstellar water clusters may catalyze accretion of carbon-based clusters and organic molecules. Water clusters may play leading roles in the chemistry of global warming and the annual depletion of stratospheric ozone over the Antarctic. They have also been found to congregate in the confined cavities of proteins and other biomolecules. Coupling of the water-cluster molecular orbitals to their unique terahertz-frequency vibrational modes, such as the 1.5 THz mode shown above by the oxygen atomic displacement vectors for the protonated cluster, $(\text{H}_2\text{O})_{21}\text{H}^+$ promotes water clusters as vibronically active, dynamically resonant agents in molecular biology, *e.g.* in protein folding, DNA replication, and cell nano-structure. At *Hydroelectron Ventures*, the science of water clusters is being inventively applied to environmental and biomedical nanotechnologies, including the use of water vapor, a natural source of water clusters, as a recently-demonstrated (in collaboration with X.-C. Zhang) strong, optically-stimulated source of terahertz radiation.