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Pushing the limits of direct force measurement in aqueous media: New insights from the extended surface forces apparatus

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Abstract:
Water provides the structural matrix of many bio-molecular mechanisms. Looking at the many remarkable macroscopic properties of plain water, which are often related to the dipole and H-bond interactions of the molecule, the question is justified whether water can form extended transient structures in molecular complexes near interfaces, or, even in plain bulk. Suggested structural models of water - some of which were scandalously disproved - include everything from poly-water to various forms of clustered water. Although we can hardly determine the details of the water structure via a direct force measurement, it is widely accepted that the entropy term of water controls many macromolecular interactions (e.g. hydrophobic attraction). We have investigated a water-soluble polymer grafted to a surface and detect the expected steric repulsion from the polymer brush. High-resolution force measurements, however, allow one to detect an additional fine structure that suggest the !
existence of an extended equilibrium water structure subtly embedded into this the polymer layer. The relevance of this water structure to the phenomenon of protein-resistance is discussed.
With these results in mind additional data are presented that suggest the existence of very-weak long-range structural forces in bulk water. This network force is unlike the known oscillatory hydration forces previously observed in the nanometer vicinity of a mica surface. A speculation about the nature of the network force and the imminent consequences is given.