Citation for the 2020 (the 8th) Nishina Asia Award

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For his seminal contributions to the understanding of structure and dynamics of interfacial water on the atomic scale

Water is one of the most familiar materials existing around us, and it has decisive roles for the evolution of life on the earth. Nevertheless, the understanding of the nature of water is far from satisfactory, and many challenges remain. One of the key elements in the issue is the property of the hydrogen bond (the importance of which could be understood by reminding of, e.g., the ones in DNA, etc.), where the quantum mechanical effects of hydrogen atoms play significant roles. This is in contrast to the case of heavier atoms, for which the Born-Oppenheimer approximation has often been successfully applied.

The nuclear quantum effects on the strength of hydrogen bond have been investigated by experimentally studying the structure and dynamics of protons in water (or ice), in combination with theory and simulations. Experimental methods include the spectroscopy, neutron scattering, scanning tunneling microscopy (STM), atomic-force microscopy (AFM), and others, and have been advanced by researchers worldwide, and the frontier of the physics of water has been expanded. Dr. Ying Jiang has steadily and patiently continued to improve accuracies of various experimental methods (like tip-enhanced inelastic electron tunneling spectroscopy based on an STM, high resolution imaging with a noncontact AFM with a CO-terminated tip). With these dependable experimental methods, he has measured directly what has been imagined by simulations and has given firm bases for the future of the expanding research area of water.

Some of the highlights in his achievements include the following: He made a quantitative assessment of nuclear quantum effects on the strength of a single hydrogen

bond formed at a water-salt interface, using tip-enhanced inelastic electron tunneling spectroscopy based on an STM. Observing the hydrogen-bonding strength with high accuracy, combined with quantum simulations, he found that the anharmonic quantum fluctuations of hydrogen nuclei influences the strength of hydrogen bonds [1]. He also achieved atomic-resolution imaging of ion hydrates. He illustrated the microscopic structures of Na^+ hydrates at interfaces and discovered a magic-number effect on the transport of ion hydrate [2]. The fact that the ion transport at interface is influenced by the number of water molecules will have future impacts in a wide range of technologically and biologically relevant fields. Very recently, he has successfully grown a 2D bilayer hexagonal ice on a hydrophobic Au surface and imaged the 2D ice growth at the edges with atomic resolution by using noncontact AFM with a CO-terminated tip [3]. He has proposed different dynamics in the growth for zigzag and armchair edges. This will strongly stimulate the studies on material in confined space. It can be concluded that these innovative works opened up a new area of science of water and will have a wider impact in the future.

He has been successful in establishing his group in his institute, fostering young people, and thereby collecting international attentions and reputations. Based on his scientific achievements, and his leadership in expanding the research field and nurturing young researchers, Dr. Ying Jiang deserves the Nishina Asia Award.

References

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