

Open Seminar, IINO Group, IMS

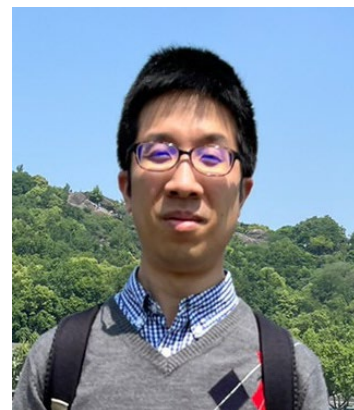
November 16th, 2026, 14:00-15:00

**Large Meeting Room, 2F, 3rd bldg.,
Yamate Campus**

Dr. Shuntaro Amano

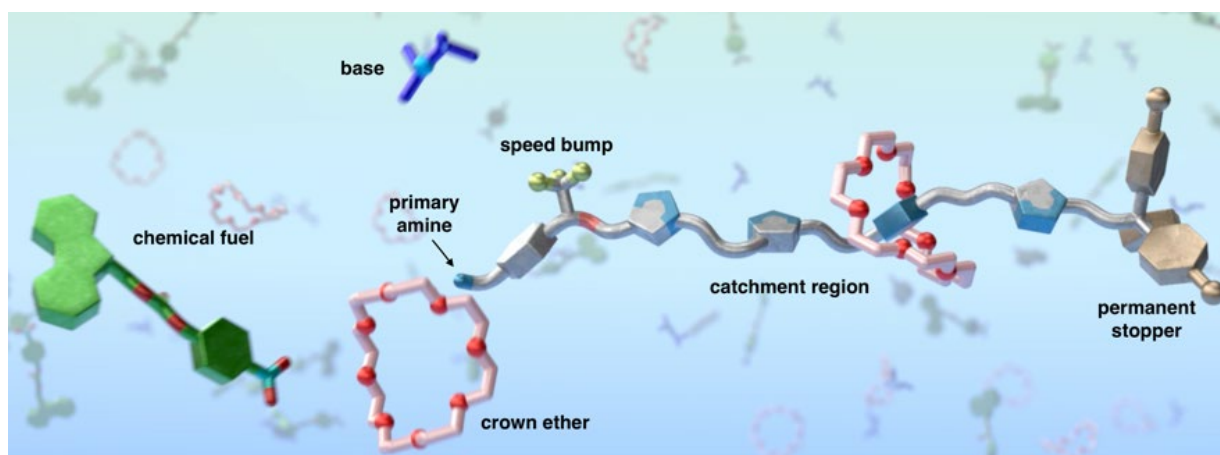
NWO VENI Fellow

**Department of Chemical Engineering
Delft University of Technology (TU Delft)**



Life-inspired (supra)molecular systems out of equilibrium based on Brownian ratchet mechanisms

One of the fundamental questions in chemistry is: how can life-like behaviors emerge from non-living matter? Answering this question is important not only for understanding biology but also for designing functional systems inspired by biology. One key concept in this endeavor is a Brownian ratchet mechanism, which rectifies random thermal motion at the nanoscale to generate directional motion. Brownian ratchet mechanisms are at the foundation of biological molecular machines for various out-of-equilibrium functions, such as intracellular transportation, cellular motility and energy conversion. Inspired by biology, we realized the first example of a synthetic autonomous molecular pump driven by chemical energy. We also analyzed the mechanism of synthetic Brownian ratchets from thermodynamic and kinetic perspectives. These analyses elucidated how energy supplied to Brownian ratchets causes directional motion, and how the kinetics of each process contributes to directionality, clarifying design principles of Brownian ratchets. Furthermore, we realized a simple and general approach for developing chemically driven nonequilibrium systems and applied it to dissipative self-assembly. Recently, we investigated application of Brownian ratchet mechanisms to chemically driven endergonic synthesis and light-driven active transport between two compartments. Our studies will be the basis for applying Brownian ratchet mechanisms in diverse fields ranging from light energy conversion to active matter, organic synthesis away from equilibrium and soft robotics.



Contact: Ryota IINO (iino@ims.ac.jp)