# International Conference on Micro Nano Fluidics
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**Speaker/affiliation:** Prof. Satarupa Dutta, Indian Institute of Technology (BHU) Varanasi.

**Tentative topic of the invited talk**

*Temperature-modulated Nanoscale Ion Transport: A Pathway to Next-Generation Iontronic Sensors*

**Abstract of the invited talk**

The transduction mechanism in biological ion channels has inspired researchers to fabricate biomimetic synthetic nanopore arrays for ion pumps, nano-gating, energy conversion, ion sorting and separations, and biosensing. Nanopore sensors are gaining traction for amplification-free, label-free, and high-throughput detection capabilities. Ionic selectivity within nanopores gives rise to ion concentration polarization (CP) zones near the pore openings under an applied electric field. When the pore geometry (e.g., conical or funnel-shaped), surface charge distribution (e.g., bi-polar), or buffer conditions are asymmetric, unequal enrichment and depletion zones form, resulting in ionic current rectification (ICR) and diode-like current–voltage behavior. In ICR-based sensing, the detection sensitivity is governed by the rectification ratio, defined as the ratio of currents measured under positive and negative bias conditions. Achieving high rectification ratios is often difficult due to limitations in nanofabrication and pore functionalization techniques. Rectification is most prominent when the pore mouth dimension is comparable to the Debye length; however, such conditions often lead to increased measurement noise and reduced signal stability because of the inherently low current levels. Herein, we investigate the feasibility of inducing ICR in uniformly charged straight nanopores by applying an axial temperature gradient. The thermophoresis of ions under such conditions generates thermoelectricity via the Soret effect, the ionic analogue of the Seebeck effect. In charged nanopores, an applied thermal gradient also produces a non-uniform electrical double layer (EDL) and a corresponding thermoelectric voltage. When an external electric field is applied, the coupled thermoelectric effects modulate CP zones, potentially leading to rectification inversion. The ICR ratio is highly sensitive to factors such as pH, Dukhin number, and the geometry of the nanopore. These insights suggest that thermal-gradient-driven rectification can synergize with geometric or surface- charge asymmetries, offering new design avenues for nanofluidic diodes and sensing devices.