

## SEMINAR

# Theory and Simulation of High Conductance in Proteins

**Dr Eszter Papp (Eötvös Loránd University, Hungary)**

Friday, 13 February 2026 @ 14h00-15h00 SAST

**Venues:** Online and NITheCS Seminar Room, Stellenbosch University

### ABSTRACT

In the past two decades, experiments have revealed that, contrary to earlier expectations, proteins can exhibit high electrical conductance in the nanoSiemens range, with several interesting features. The measured conductance shows only a weak dependence on protein size, remains finite at low temperatures, even down to 4 K, and can vary with contact placement on the same protein, indicating the presence of highly conducting regions. These observations cannot be explained within standard charge transport pictures such as tunnelling or hopping.

Motivated by this, we introduced a theoretical approach that combines the density matrix of the Liouville quantum master equation describing quantum transport in nanoscale systems, with a phenomenological model of electronic conductance in molecular junctions. The resulting formulas allow the calculation of conductance between any pair of atomic orbitals of a protein, the study of its temperature and distance dependence, and the visualisation of highly conducting regions within the molecular structure.

We demonstrated the efficacy of this new approach on extracellular cytochrome nanowires, proteins known to exhibit high conductance and to support long-range electron transport. We also analysed the temperature and distance dependence of their conductance, showing that the behaviour is in agreement with what has been observed for several other proteins.

### BIOGRAPHY



Eszter Papp is a postdoctoral researcher at Eötvös Loránd University (Hungary), where she recently defended her PhD in Physics. She completed her Bachelor's degree in Physics with a specialisation in Biophysics, followed by a Master's degree with a Research Physicist specialisation. Her PhD work focused on the theory and simulation of electron transport in proteins.

She has presented her research at several international conferences, including QuEBS 2023, where she received the Best Poster Award, and the Gordon Research Conference on Quantum Biology in 2025. She is passionate about quantum biology and aims to continue exploring this field during her postdoctoral years.

In parallel with her research, she is active in science communication. She hosts the Faculty's Science Podcast, serves as a National Science Ambassador, and works as Dissemination Manager for a Horizon Europe Twinning project.

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