IQST

IQST Colloquium @Ulm University

Time: Thursday, 21 May 2026 (13:00 – 16:00)
Location: ZQB, Meyerhofstraße, M26, 89081 Ulm

Program:
14:15 – 14:30: Welcome & Opening Remarks
14:30 – 15:00: IQST Graduate School @QuantumBW Presentation - Julia Zolg (Ulm University) - *Organic Light-Emitting Diradicals for Quantum Applications*
15:00 – 15:55: Networking Coffee
15:55 – 17:10: Invited Talk - Prof. Nobuhiro Yanai (University of Tokyo) – *Molecular Quantum Sensors Enabled by Materials Chemistry*
17:10 – 17:15: Closing Remarks

Invited Talk: Molecular Quantum Sensors Enabled by Materials Chemistry

Prof. Nobuhiro Yanai (University of Tokyo)

Abstract
This century is witnessing a second quantum revolution, and quantum sensing represents an area in which chemists can make significant contributions. Chemically engineered molecular quantum sensors are compact and allow for precise control of their structure. Achieving quantum sensing requires more than precise control of quantum states at the molecular level; it is also crucial to organize molecular qubits so that they function effectively in complex environments. In this seminar, I will discuss materials chemistry approaches to molecular quantum sensors, focusing on their extension from biological systems to engineered materials.
We have recently enabled intracellular quantum sensing by developing a molecular quantum nanosensor (MoQN). By encapsulating atomically optimized molecular spin qubits within biocompatible nanocrystals, MoQNs achieve highly uniform spin energy levels and enable room-temperature optical detection of molecular spin states inside living cells. Compared with existing nanoscale quantum sensors, MoQNs exhibit superior uniformity, making absolute temperature sensing within cells possible—an achievement that has been challenging to realize with conventional platforms.
I will then show how molecular quantum sensing can be extended into chemically programmable materials. By incorporating photoactive chromophores as components of metal–organic frameworks (MOFs), these MOFs enable spatial organization and chemical accessibility of molecular qubits. This design allows quantum sensors whose spin coherence times respond to surrounding chemical species at room temperature. Finally, I will discuss how controlled molecular assembly leads to multilevel quantum states (qudits). Through precise chromophore arrangement, singlet fission generates spin-correlated quintet triplet pairs with submicrosecond quantum coherence, expanding molecular quantum sensing beyond two-level systems.
Together, these examples illustrate how materials chemistry transforms molecular qubits from isolated spin systems into versatile sensing platforms that function across biological and materials environments.