Molecular Spin Qubits: Harnessing Chemistry Versatility for Quantum Technologies

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Quantum technologies are poised to revolutionize current methods for large-scale computations and solving complex quantum physics and chemistry problems. The fundamental units of quantum technologies, *qubits*, can be realized in a multitude of systems bearing two levels and exhibiting long quantum coherence times, such as superconducting circuits, nitrogen vacancies in diamonds, or electronic spins in molecules. Molecular Spin Qubits (MSQs), based on the spin levels of metal ions or organic radicals, appear to be natural candidates for this role, given their inherently quantum nature. Molecules offer a high degree of versatility in their composition: synthetic chemistry enables a broad spectrum of modifications, including fine-tuning the interaction between multiple qubits or altering the ligand shell to meet specific practical demands, such as the transfer of qubits onto a solid substrate or into a device.

Despite the promising potential of MSQs in quantum technologies, several challenges still need to be addressed. These include the deposition of the molecules on a surface without negatively impacting quantum coherence, and the need to develop a more effective read-out scheme beyond microwave magnetic fields.

In my talk, I will address these issues and suggest prospective strategies for overcoming them. In the first part, I will demonstrate how *click chemistry*, a technique recognized with the 2022 Nobel Prize in Chemistry, can be utilized to prepare a self-assembled monolayer of MSQs. The second part will be devoted to the integration of MSQs into polymeric-based organic semiconductors, aiming not only to achieve an electrical read-out of the qubit states but also to explore potential applications in the field of spintronics.