

**MOLECULAR DIPOLAR CRYSTALS: PROTECTED QUANTUM
MEMORIES FOR HYBRID QUANTUM INFORMATION PROCESSING**

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In the context of hybrid quantum computing polar molecules combine the exceptional features of a large electric dipole moment and long-lived rotational states with level splittings in the GHz regime. By encoding quantum information in collective rotational or spin excitations of an ensemble of molecules (ensemble qubits) the resulting coupling strength with a stripline cavity is compatible with decoherence processes in a solid state environment and allows a coherent transfer of quantum information between the molecules and superconducting qubits. In this talk I present some theoretical ideas on molecular ensemble qubits for hybrid quantum computing. I will especially focus on molecules prepared in a 1D/2D crystalline phase where ensemble qubits are protected against collisional dephasing and therefore form a ultra long-lived quantum memory. I will discuss the main physical processes in a molecular dipolar crystal and show how such a configuration could be experimentally implemented.