**Motivation**

- Quantum atom-light interfaces are important foundation for quantum technologies
- Key limitation: large, uncontrolled dissipation in state-of-the-art platforms
- Errors/infidelities tend to decrease very slowly as function of improving cooperativity in known protocols

**Novel approach**

- Independent photon emission rate $\Gamma_0$ is an assumption
- Wave interference implies that emission is complicated function of atom number, positions, and wave function
- Exploit subspace of strong correlated dissipation $\Gamma(N, \{r_i\}, |\psi\rangle) \rightarrow 0$?
- Polynomial or exponential improvements in errors/infidelities versus cooperativity?

**Challenges**

Requirements to succeed:

- Achieve deterministic atomic spatial configurations with strong interference in emission (sub-wavelength arrays)
- Robust experimental means to tailor interactions and interface with light
- New theoretical tools and approaches for the challenging problem of many-body correlated dissipation
- Find interesting protocols and dynamics protected and enabled by correlated dissipation

**Key objectives**

**Novel phase transitions and dynamical phases**

- Modified Dicke phase transitions w/correlated dissipation
- Controlling time crystals w/dissipation and feedback
- Universality classes in dissipative dynamics
- Stabilization of quantum many-body scars

**Novel experimental platforms of QuSiED**

- New, integrated cavity / Yb tweezer array
- BEC / Mott insulator coupled to cavity

**New theoretical methods**

- Machine learning, neural network modeling
- Non-equilibrium Green’s function techniques
- Tensor networks
- Weakly interacting fermion mappings

**Theory/Expt interfaces**

- Experimental characterization of quantum Fisher information
- Spin squeezing enabled by correlated dissipation
- New correlated dark states

**Consortium**

- **Jožef Stefan Institute**
  - PI/Coordinator: Zala Lenarčič
- **ICFO**
  - PI: Darrick Chang
- **Budapest Univ. of Technology and Economics**
  - PIs: Gergely Zaránd, Géza Tóth
- **Johannes Gutenberg Univ. Mainz**
  - PI: Jamir Marino
- **University of Innsbruck**
  - PIs: Hanns-Christoph Nügerl, Manuele Landini
- **Hamburg University / ILP**
  - PI: Andreas Hemmerich

This project was funded within the QuantERA II Programme that has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement No 101017733.