Minicolloque n° PMQ31 **X Oral** **☐ Poster**

Disorder-Enhanced and Disorder-Independent Transport with Long-Range Hopping: Application to Molecular Chains in Optical Cavities

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Overcoming the detrimental effect of disorder at the nanoscale is very hard since disorder induces localization and an exponential suppression of transport efficiency. Here we unveil novel and robust quantum transport regimes achievable in nanosystems by exploiting long-range hopping. We demonstrate that in a 1D disordered nanostructure in the presence of long-range hopping, transport efficiency, after decreasing exponentially with disorder at first, is then enhanced by disorder [disorder-enhanced transport (DET) regime] until, counterintuitively, it reaches a disorder-independent transport (DIT) regime, persisting over several orders of disorder magnitude in realistic systems. To enlighten the relevance of our results, we demonstrate that an ensemble of emitters in a cavity can be described by an effective long-range Hamiltonian. The specific case of a disordered molecular wire placed in an optical cavity is discussed, showing that the DIT and DET regimes can be reached with state-of-the-art experimental setups [1,2].

[1] N. C. Chávez, F. Mattiotti, J. A. Méndez-Bermúdez, F. Borgonovi, and G. L. Celardo, Phys. Rev. Lett. **126**, 153201 (2021).
[2] N. C. Chávez, F. Mattiotti, J. A. Méndez-Bermúdez, F. Borgonovi, and G. L. Celardo, Eur. Phys. J. B **92**, 144 (2019).

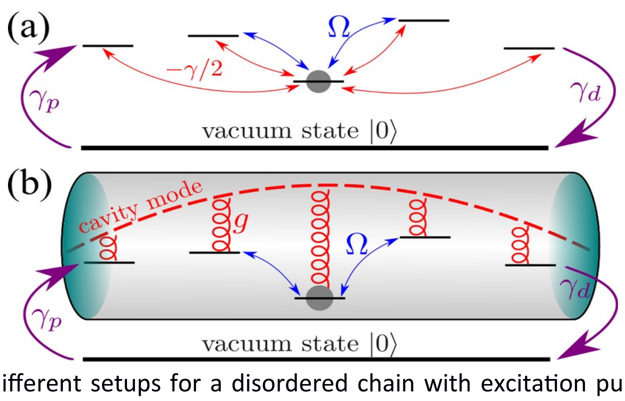

Figure 1 : (a),(b) Two different setups for a disordered chain with excitation pumping γ_p at one edge of the chain and draining γ_d at the opposite edge. Here, Ω is the hopping between nearest-neighbor sites. The arrows indicate the hopping paths available for an excitation (gray circle) present at the center of the chain. The energy of the sites is disordered. (a) A long-range coupling $-\gamma/2$ is present between each pair of sites. (b) The chain is placed inside an optical cavity, where g is the coupling of each site to the cavity mode.