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Exploring universal scaling laws in the coherence of an out-of-equilibrium polariton condensate

Revealing universal behaviors in different systems is a hallmark of statistical physics. At equilibrium, simple models, like the Ising model, have been essential in understanding the critical properties of a whole class of systems. Reversely, a clear description of the universal properties of several non-equilibrium systems remains elusive. In this context, the Kardar-Parisi-Zhang (KPZ) equation [1] has emerged as a quintessential model to investigate non-equilibrium phenomena and phase transitions. This equation was originally derived to describe the critical roughening of growing interfaces in classical systems.

Current theoretical and experimental results show that the wavefront of an extended one-dimensional polariton condensate behaves as an interface, whose spatio-temporal evolution is described by the KPZ equation and falls into the one-dimensional KPZ universality class [2]. Recent theoretical works suggest that in a two-dimensional (2D) polariton system, universal KPZ properties can emerge [3, 4], but the experimental evidence is still missing. Those results are also relevant for out-of-equilibrium Bose-Einstein condensates and lasers. Determining if KPZ physics governs the phase correlations in all those systems is of critical importance. For instance, it would set an intrinsic limitation on the achievable coherence of extended solid-state lasers.

In this poster, I will explain how to generate an extended polariton condensate in a 2D polariton lattice made of optical microcavities in semiconductor materials. Then, I will explain how we explore KPZ physics by probing the spatio-temporal coherence of our condensate using standard Michelson measurements. Finally, I will show the first results we obtained on the signature of this universal feature in the 2D polariton condensate.

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