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Quantum many-body dynamics with driven Bose condensates: Kibble-Zurek mechanism and Bose fireworks

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In recent years, ultracold atomic gases have provided a platform for stunning advancements in the study of quantum many-body dynamics. My thesis focuses on developing paradigmatic experimental examples, from which we can derive universal principles connecting many far-from-equilibrium, quantum many-body systems; in this talk, I will focus on two key studies. First, I will present our study of the dynamics of bosons undergoing a quantum phase transition in a shaken optical lattice. The dynamics are almost completely independent of the rate at which the transition is crossed, exhibiting a space-time scaling symmetry which can be understood using the universal Kibble-Zurek mechanism. Second, I will discuss our serendipitous discovery of "Bose fireworks": the sudden emission of many bright, narrow jets of atoms from Bose-Einstein condensates with oscillating interaction strength. This structure arises from collective, inelastic collisions in the condensate, which are seeded by quantum fluctuations and then strongly stimulated in a manner analogous to superradiant systems. I will also briefly discuss our new scheme for spatiotemporally modulating the interactions between atoms. I will conclude by exploring the exciting future prospects for each of these efforts. [1]

[1]This thesis work was supervised by Professor Cheng Chin at the University of Chicago