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Title: **Quantum temporal orders from real Floquet to imaginary time crystal**
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Abstract:
Quantum time crystal has been an intriguing many-body "time" state that has received much attention and debate since its early prediction. In this talk, first, I will construct a class of "clean" Floquet quasi-one-dimensional models to answer the open question on the role of disorder and many-body localization. It is found that a time crystal phase can generally exist in systems without disorder and can be stabilized by a mechanism other than MBL. Cold atom experimental schemes are introduced to realize the clean Floquet time crystals. Second, by observing the equivalent role of space and imaginary time in the Euclidean path integral formalism, I will present the finding that hard-core bosons coupled to a thermal bath may exhibit "imaginary spacetime crystal" long-range order. It manifests an unexpected temperature-periodic oscillation in its macroscopic observables, forming a temperature crystal. *References: B. Huang, Y.H. Wu, W. V. Liu, Phys. Rev. Lett. 120, 110603 (2018); Z. Cai, Y. Huang, W. V. Liu, Chin. Phys. Lett. (Express) 37, 050503 (2020).*