Speeding up quantum dynamics: from finite to infinite dimensional systems and back

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Strong interactions between the components of a quantum system are critical for leveraging quantum effects for quantum technologies. In this talk, I present a protocol to enhance such interactions through local controls, thereby speeding up the system's evolution. I first show that although this is impossible for finite dimensional systems, interactions mediated through infinite dimensional systems, such as quantum harmonic oscillators, can be enhanced through local parametric controls of high frequency, creating squeezing of different quadratures. I discuss phase insensitive amplification and speeding up Rabi oscillations as two potential applications of the protocol and report on an experimental demonstration in an ion trapped system. Finally, I show that the developed protocol can be generalized to non-linear interactions that are critical for universal quantum computing in photonic systems. From this observation I argue that quantum algorithm implementations can be arbitrarily sped up in these latter systems as long as strong and fast squeezing is available.