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Hybrid systems: from atoms on squids to diamond on wires

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Controlling and understanding the coupling between different objects lies at the heart of modern quantum mechanics. Limits in our ability to couple and decouple certain object, such as spins in solid-state devices, inevitably translate into fundamental constraints for application of these systems to quantum information science and metrology. However, one can conceive a scenario in which different, disparate objects-hybrid systems—can be used together to overcome these limitations. I will discuss how entangling spins with photons or phonons provides the fundamental building block for any such hybrid system, and enables both quantum communication and quantum computation. Specific examples illustrating this key point and demonstrating some of the difficulties we face in integrating heterogeneous quantum bits will be considered.