SUMMER LECTURE | Dark states, bright futures: Quantum many-body complexity with atoms and light

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12:00 to 13:00
Blue Lecture Room

What would you do if you realized one day that everything you ever learned about your field was based on a wrong assumption? And what would you do with that new-found knowledge??

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Within the field of quantum optics, the Maxwell-Bloch equations constitute the standard model to understand how atoms and light interact in free space. For example, they form the foundation by which we understand how to use such systems to implement quantum technologies. Unfortunately, they also tell us a lot about what we cannot do. For example, they hint that atom-light interfaces are very susceptible to being describable by large-spin dynamics, which prevents one from accessing the full richness of quantum Hilbert space. Furthermore, they predict spontaneous emission of light by atoms into unwanted directions imposes insurmountable errors, to be able to carry out many exciting quantum applications.?

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Surprisingly though, the Maxwell-Bloch equations do not account for one of the fundamental principles of optics -- that light waves interfere. This revelation opens up exciting routes to address the limitations described above. For example, by using destructive interference in dense ordered arrays, one might be able to suppress unwanted emission of light, thus significantly reducing errors in quantum protocols and allowing richer quantum correlations to build up. In this talk, I will discuss how this "mistake" snuck into the conventional theory, how one can develop a new theory to account for wave interference effects in quantum atom-light interactions, and how this revelation presents a grand opportunity to reimagine what is possible with atoms and light.

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