

# Columbia University Department of Physics Seminar



## “Harnessing additional degrees of freedom and the environment to experimentally enable quantum applications and simulations”

Quantum simulations and applications of quantum information usually have experimentally demanding requirements. I will show how these were circumvented in several experiments with photons and ions by using resources additional to the systems of interest. In particular, we take advantage of other degrees of freedom and the environment, either intrinsic or engineered, through dissipation and decoherence. As an example, although full quantum dense coding is impossible with linear optics, we realized it by using entanglement in an additional degree of freedom of a pair of photons. Another challenging task is quantum error correction. By dissipatively providing fresh ancillas to the algorithm, a qubit was repetitively corrected for in three iterations in a system of trapped ions. In the context of quantum simulations, an auxiliary qubit was engineered as a controlled environment that allowed us to demonstrate a toolbox for the simulation of open systems. Finally, I will discuss how similar approaches can lead to an arbitrary many-body simulator in a system of ultracold atoms in optical lattices.



**Julio Barreiro,**  
Max Planck Institute of Quantum Optics &  
University of Munich, Germany

**When: Wednesday, May 1, 2013, 2:15 PM**

**Where: 831 Pupin Hall**