## Feynman's Quantum Computer

by Dr. Jeffrey Yepez (Maui Air Force Research Laboratory)

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## Description

About 30 years ago, Richard Feynman conjectured that an analog simulation of a many-body Fermi systems of quantum particles could be carried out one day on a special type of computer built out of purely quantum mechanical elements, and that this type of computer could faithfully represent the exponential complexity that is predicted by quantum theory to occur in many-body Fermi systems. Feynman called the device a "quantum computer." About 20 years ago, at the Air Force Research Laboratory, we launched one of the first basic research efforts to experimentally realize a quantum computer useful for simulating a many-body system of strongly-correlated fermions and also useful for dynamical physical modeling in general. The effort to realize a quantum computer quickly became an international one in scope, and even a race, and consequently there has been remarkable experimental progress at a pace well beyond our original expectations.

Today, I would like to tell you about some of the experimental work conducted at the Air Force Research Laboratory and some supported through our laboratory's directorate, the Air Force Office of Scientific Research. Richard Feynman is well known for many contributions, particularly in the area of relativistic quantum electrodynamics. Yet, it is not well known that while he was a young professor at CalTech in 1946 following his service in the Manhattan Project, Feynman discovered the first quantum algorithm to model the motion of a relativistic Dirac particle on a 1+1 dimensional lattice. Today his algorithm is technically called a quantum lattice gas.

In this talk, I will explain Feynman's original quantum algorithm and its extension to 3+1 dimensions. Then, I will explain a nascent and (what I believe to be) the best analog experimental realization of the quantum lattice gas model of quantum computation: an ultra-cold (~nanokelvin) Fermi gas in an optical lattice. Because of this recent experimental advance, we now know that Feynman's conjecture is right.

Dr. Jeffrey Yepez is currently a senior physicist at the Air Force Research Laboratory at Maui. His research interest is quantum computing/quantum information. He will be giving a physics colloquium on September 20 (see abstract above). Dr. Yepez is being considered for an Affiliate Faculty in Physics. Dr. Yepez will be here from Wednesday (9/19) to Friday (9/21). If you are interested in meeting with Dr. Yepez, please let CHairman Pui Lam know (time and date) so that he can arrange a schedule (meetings will mostly be on Thursday and Friday)