2019 Physics/Theoretical Colloquium

Thursday, September 26th , 2019

3:45 – 4:45 p.m.

Rosen Auditorium (TA-53, Bldg. 001)

Refreshments at 3:15pm

Speaker: Prof. Wendell T. Hill, III

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"Precision measurements of the quantum vacuum at the petawatt level: What is required and what might we learn? "

Abstract:

Since the invention of the laser, physicists have been salivating over ways to exploit super-intense lasers to explore new physics and develop new technologies that the relativistic intensity regime offers. The threshold for this regime, where the motion

of free electrons becomes relativistic, occurs at $I \sim 2 \times 10^{18}$ W/cm^2. This is defined by the normalized vector potential, $a_0 = eE\lambda_0/2\pi m_e c^2$, reaching unity. Arguably, the most fundamental ideas center on the nature of the quantum vacuum. The *holy grail*, if you will, is reaching $I \sim 2 \times 10^{29}$ W/cm^2, at which point some calculations predict the vacuum will breakdown and release copious pairs of real electrons and positrons. While today's technology falls short of this intensity by orders of magnitude, there is much to learn about the vacuum at intensities of 10^{22} or 10^{23} W/cm^2, which is just around the corner with petawatt-class lasers of short duration either currently under construction or just beginning operation. Consequently, we are on the cusp of being able to examine nonlinear aspects of electrodynamics, photon-photon interaction and precursor processes to pair production, which comprise tests of one of our most cherished theories, quantum electrodynamics (QED), in ways never before possible. Critical tests of QED require accurate knowledge of the intensity and density of real particles in the focal volume without which precision measurements are not possible. In this talk we will look at what we can learn through precision measurements of the vacuum and present the results of our first steps toward developing a diagnostic for direct measurement of relativistic intensities in real time at full power [1].

[1] "Towards an *in situ*, full-power gauge of the focal-volume intensity of petawatt-class

lasers," C. Z. He, *et al.*, arXiv:1908.00110v2; *Opt. Express* (In Press).