

# Physics Colloquium

## Michigan Technological University

February 3 (Thursday) 4:00 to 5:00 pm  
Room 139, Fisher Hall

### **Determining Ultra-High Energy Cosmic Ray Primaries**

James D. Chye

Advisor: David F. Nitz

The Auger Observatory detects cosmic ray showers of EeV and greater. Since determination of the shower primary is evidence of the source, interpretation of the data is required to separate different species of primary. I will discuss techniques under refinement for the determination of the primaries through analysis of single station digital signal traces. It will take several years for the observatory to collect sufficient statistics for the final determination and application. The techniques are being tested now through simulation.

### **Effective Growth of Multi-walled Carbon Nanotubes and Their Applications**

Vijaya Kumar Kayastha

Advisor: Dr. Yoke Khin Yap

Effective growth of multi-walled carbon nanotubes (MWCNTs) is crucial for various applications. Ammonia gas was considered to be essential for the growth of high-density vertically aligned (VA) MWCNTs but lead to the formation of bamboo-like structures. Here, we show that VA-MWCNTs with ideal tubular structures can be grown by using various mixed gases such as  $C_2H_2 / Ar$ ,  $C_2H_2 / H_2$  without the use of ammonia. As guided by a growth model that combined the dissociative adsorption of acetylene molecules and the successive vapor-liquid-solid (VLS) growth mechanisms, we prove that the key factor for such an effective growth is a balance between the decomposition of hydrocarbon molecules and the successive absorption, diffusion and segregation processes of carbon species.<sup>1</sup> Applications of MWCNTs in 3D microbatteries and electron field emission will also be discussed.

<sup>1</sup>Kayastha et al., Appl. Phys. Lett. 85, 3265 (2004).