Western University
DEPARTMENT OF PHYSICS AND ASTRONOMY

PHYSICS & ASTRONOMY COLLOQUIUM

Date: **Thursday, 27th October 2016**
Time: **1:30 p.m.**
Location: **Physics & Astronomy Seminar Room 100**

Dr. Robert A. Marshall

Department of Aerospace Engineering Sciences
University of Colorado Boulder

"The Earth's Atmosphere as a Natural Source of X-ray Radiation"

ABSTRACT

A variety of processes in the Earth's atmosphere generate X-rays and even gamma-rays. In the troposphere, the initial development of lightning discharges, known as leaders, emit X-rays and gamma-rays, and the photon spectrum depends on the altitude and orientation of the leader. X-rays emitted by lightning leaders can be detected on the ground, and gamma-rays are now regularly detected by low Earth orbit (LEO) spacecraft. In the upper layers of the atmosphere, X- and gamma-rays are produced by energetic particles (electrons and protons) colliding with the neutral atmosphere. The energetic particles can include solar energetic particles (SEP), galactic cosmic rays (GCR), and radiation belt electrons and protons. The physics that produces X- and gamma-rays from these different sources is the same; but the resulting photon spectra, and their propagation in the atmosphere, can be very different. These photons provide a unique method of indirectly measuring the effects of the particles themselves on the atmosphere.

In this talk I will describe the production of X-rays and gamma-rays in lightning leaders and by energetic particle precipitation, presenting an overview of naturally-occurring high-energy photons in the Earth's atmosphere. I will describe X-ray and gamma-ray production in lightning leaders, including recent observations of X-ray images on the ground. I will then describe recent work modeling X- and gamma-ray production in the upper atmosphere due to energetic particle precipitation. We use a Monte Carlo model of electron and photon propagation in the atmosphere, together with a model of bremsstrahlung radiation production, to calculate X-ray fluxes and spectra resulting from different precipitating particle spectra. These modeling results can be used to relate measured X-ray fluxes and spectra, either on high-altitude balloons or LEO spacecraft, back to the precipitating particle distributions. Measurements of X-rays produced in the atmosphere thus form a useful diagnostic for particle precipitation, which is imperative to understanding both radiation belt dynamics and atmospheric effects of precipitation.

COFFEE + light snacks will be available in the Atrium, 2nd floor, at 1:15 p.m.