# TGF electron avalanches and gamma-ray emission with LEPTRACK - a new detailed simulation software package

Paul Connell

University of Valencia, Image Processing Laboratory, Astronomy and Space Physics, Valencia, Spain (Paul.Connell@uv.es)

In designing the MXGS coded mask imager of the ASIM mission on the ISS, to detect and locate gamma-rays from Terrestrial Gamma-ray Flashes, it was necessary to write software to simulate the expansion of gamma-ray photons from 15-20 km altitudes for an initial estimate of TGF spectra and diffuse beam structure likely to be observed at orbital altitudes.

From this a new detailed LEPTRACK simulation software package has been developed to track all electron-photon scattering via Bremsstrahlung and ionization, and via any spatial electric-magnetic field geometies which will drive the Relativistic Runaway Electron Avalanche (RREA) process at the heart of TGF origin.

LEPTRACK uses the standard physics of keV-MeV photon interactions, Bremsstrahlung scattering, Binary-Electron-Bethe models of electron ionization-scattering, positron Bhabha scattering and annihilation. Unlike simulation packages GEANT4, EGS, etc, the physics of these processes is transferred outside the software and controlled by a standard database of text files of total scattering cross sections, differential energy transfer and deflection angle PDFs - easy to read and plot - but which can also be changed, if the user understands the physics involved and wishes to create their own modified database. It also uses a superparticle spatial mesh system to control particle density and flux fields, electric field evolution, and exponential avalanche growth.

Results will be presented of TGF simulations using macro electric field geometries expected in storm clouds and micro field geometries expected around streamer tips - and combinations of both - and will include video displays showing the evolving ionization structure of electron trajectories, the time evolution of photon-electron-positron density and flux fields, local molecular ion densities, the dielectric effect of induced local electric fields - and the important effect of the local earth magnetic field on circular lepton feedback and TGF beam direction - sometimes escaping into orbit or diffusing into the cloud or to ground.

The second aim of the LEPTRACK package is as a step in creating open source software which could evolve into a standard research software package, approved by the RREA-TGF research community, to correctly simulate all the relevant physical processes involved in the complex phenomenon of RREA in thunderstorms.