Physics Department
MSci Major Project (PH4100)

Royal Holloway
University of London

Simulation of the angular dependence of the cosmic ray muon flux

Brief description

In this project the student will write a computer program to apply the Monte Carlo (MC) method to simulate the production, trajectory and decay of cosmic ray muons. The aim is to estimate the angular dependence of the cosmic muon flux observed at sea level. The results of this model developed by the student can then be compared with the real data obtained with the cosmic ray muon detection equipment in the Lab.

In **Phase I** of the project it will be assumed, for simplicity, that cosmic ray muons are produced

1) at a fixed height h (the "top of the atmosphere") above the Earth's surface,

2) isotropically, and

3) with a common energy, E_μ.

The program will then have to track the muons from their production point to the surface of the Earth, and check if (a) they fall within the solid angle acceptance of the detector and if (b) they do not decay prior to reaching the detector.

Phase II: Upon successful completion of the first phase of the project, the student can then successively drop the approximations made in Phase I to produce more realistic results and thereby check the validity (or not) of the said approximations.

A possible scaling-down of this project (**Phase 0**) would be to start by doing the simulation in a 2D world.

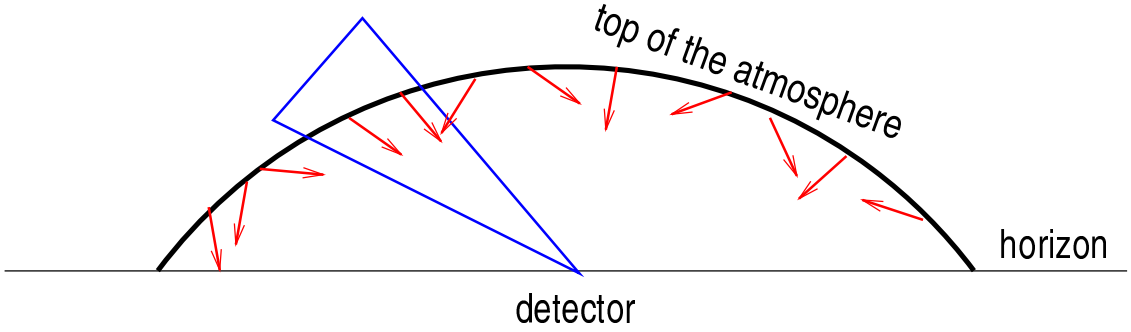

Figure 1: Schematical depiction of the model used for the simulation of the cosmic muon flux at sea level. The detector is at the center of the diagram, and is pointed to the sky at an angle to the vertical. The blue triangle indicates the solid angle acceptance of the detector. Muons (red arrows) produced at the top of the atmosphere and above the horizon may or may not reach the detector depending on their production point, trajectory and decay time.

Requirements

Given the strong computational character of the project, very good programming skills are essential for successful completion of the project.

(p.t.o.)

Project supervisor
Dr. Pedro Teixeira-Dias
Office: Wilson 263 Phone: 3453
e-mail: pedro.teixeira-dias@rhul.ac.uk

Keywords and concepts
Monte Carlo method, acceptance-rejection method, cosmic rays, muons, particle lifetime, relativistic time dilation effect, solid angle.

More information on this project can be found on the web, at

http://www.pp.rhul.ac.uk/~ptd/TEACHING/

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