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Studies of Fluorescence Profile Reconstruction Systematics at the Pierre Auger Observatory

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For the degree of Master of Philosophy

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Abstract

In the fluorescence technique employed at the Pierre Auger Observatory, Nitrogen fluorescence at UV wavelengths, due to excitation of atmospheric molecules by charged air shower particles, is used to estimate the energy of incoming cosmic rays. However, due to the relativistic nature of the charged particles in the cascade, direct and scattered Cherenkov light contaminates the isotropically emitted fluorescence light. These 'extra' photons, if not accurately accounted for, will affect the assumed fluorescence emission, thereby altering reconstructed shower energies.

Assuming an isotropic distribution of cosmic ray arrival directions, there should be no preferential arrival direction in which a given fluorescence detector observes an event. However, a misrepresentation of the number of Cherenkov photons assumed to be arriving at the telescope aperture would cause an excess or deficit of events directed towards the telescope above some fixed energy, as these events are highly Cherenkov contaminated. Using Monte Carlo simulations of extensive air showers in the atmosphere mimicking the observed power law energy spectrum, effects on the distribution of arrival directions with respect to the fluorescence telescopes due to changes in the assumed Cherenkov normalisation can be explored. This thesis aims to put a limit on the possible deviation from the currently accepted Cherenkov model based on the current level of statistics at the Pierre Auger Observatory.

An accurate description of Cherenkov light production in extensive air showers is essential for improving our confidence in the energy assignments of the observatory and also serves to further our understanding of cosmic ray air shower physics.

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