SAMURAI Monte Carlo

Subatomic physics thesis project

General description

Simulations play a crucial role in understanding and interpreting data from large-scale subatomic physics experiments. Measured data are influenced by detector properties such as resolution and efficiency. Especially large-scale experiments consisting of many detectors, most of which are divided into smaller subdetectors, are challenging to interpret. The tool of choice to simulate known processes occurring in such detectors is Monte-Carlo codes. The input of such codes are the probabilities for known physics processes that particles may undergo, thereby describing the output of the detectors. The detectors are not the object of interest, but a tool, which is used to study the nuclear reactions in the target. The most-frequently used Monte-Carlo code for nuclear and particle physics is GEANT4, developed at CERN. It allows to study the interaction of particles in matter and their trajectories in the presence of magnetic fields.

This project centres on how the structure of atomic nuclei changes for nuclei with an excess of neutrons with respect to protons. It is now known that the nuclear shell structure, which can be compared to atomic shell structure, changes for nuclei with a large excess of neutrons. In atomic physics, the number of electrons (and protons) determines if the atom is in a noble gas configuration. The equivalent numbers for protons and neutrons in the nucleus curiously also depend on the proton-to-neutron ratio. Currently, this *evolution of nuclear shell structure* is investigated by many experimental and theoretical groups in order to understand the underlying physics.

Project description

This project aims to help understand data on the neutron-rich isotope ^{29}Ne. For that, it is necessary to simulate the experiment, performed at the SAMURAI set-up at the RIKEN laboratory in Japan. In the experiment, a beam of unstable ^{30}Ne impinged on a hydrogen target to produce ^{29}Ne. The setup allows to detect all reaction products and to measure their momenta. To extract the physics of the collision, it is necessary to understand the momentum resolution of the experiment. This will be extracted from the measured data together with simulations, using the GEANT4 library with either the Chalmers-made GGLAND wrapper program or the ANAROOT tool from the RIKEN laborartory, which is also based on this library.

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