Proposal for the experimental separation of electromagnetic and nuclear components of nuclear projectile charge changing cross section

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Introduction

- Total and partial charge changing cross sections (CCC) of relativistic nuclei are parameters which have direct relevance with nuclear structure. They also have applications in understanding astrophysical issues like propagation of cosmic rays through matter.

- Separate measurement of electromagnetic and nuclear parts of charge changing cross-sections would further enhance their utility, especially for the understanding of the nuclear structure.

[Rana et al., IJMPE 19 (2010) 1993-2007]

Proposal

- Fragmentation of nuclear projectiles (like 158A GeV ^{207}Pb nuclei) along channeling directions in a crystal target is suppressed due to absence of nuclear interactions with target nuclei.

- Measurements along channeling directions provide a chance for experimental measurement of pure electromagnetic component of the total charge changing cross sections.

- For this, we may make two measurements of total charge changing cross sections: one under random and other under appropriate channeling condition in the target.

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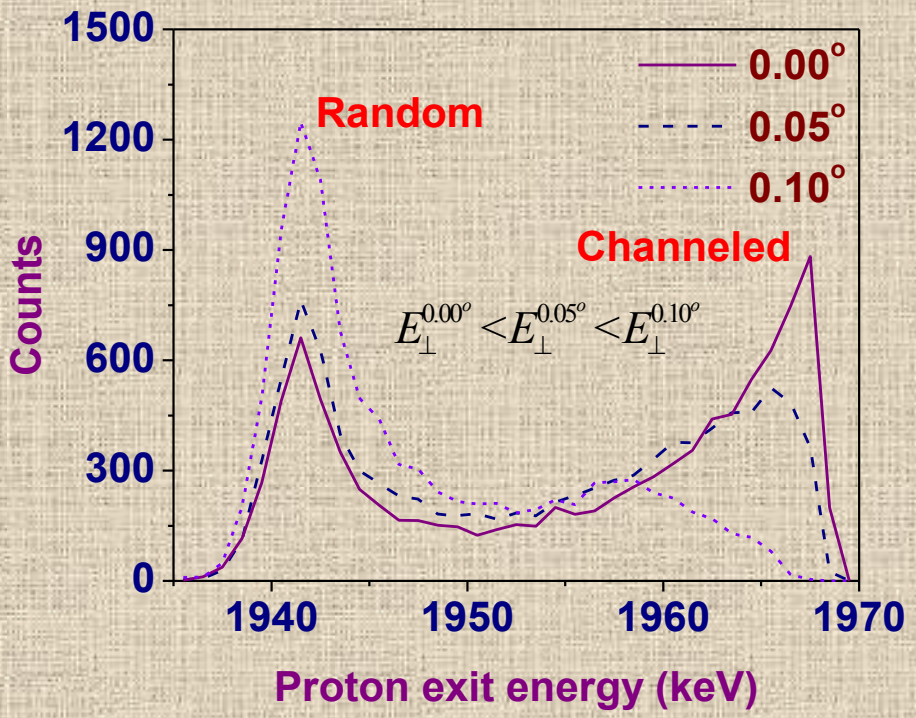
- Major issue will the selection/realization of a specific value of transverse energy of channeled projectiles.

- Channeling simulations of channeled protons are shown just to convey the idea. The same argument would be true for heavy projectiles (e.g., 158A GeV Pb projectiles).

Transverse Energy of Channeled particle

❖ Initial transverse energy of channeled projectiles will determine their channeling length in the crystal (or the time they spend in the channeled state) and whether they would interact purely electromagnetically or their interactions will be a mixture of electromagnetic and nuclear parts?

❖Correct selection of transverse energy in experiment will be crucial !



Simulated energy spectra of 2 MeV protons incident along (110) planes of Si at different injection angles traveled through 3 μm thick crystal using code FLUX7. Right peak correspond to protons still channeled and left to randomized after passing through 3 mm thick Si crystal.

Transverse Energy of Channeled Projectiles

(1) Transverse energy of channeled projectile should be low so that it only interacts with the target electromagnetically. AND

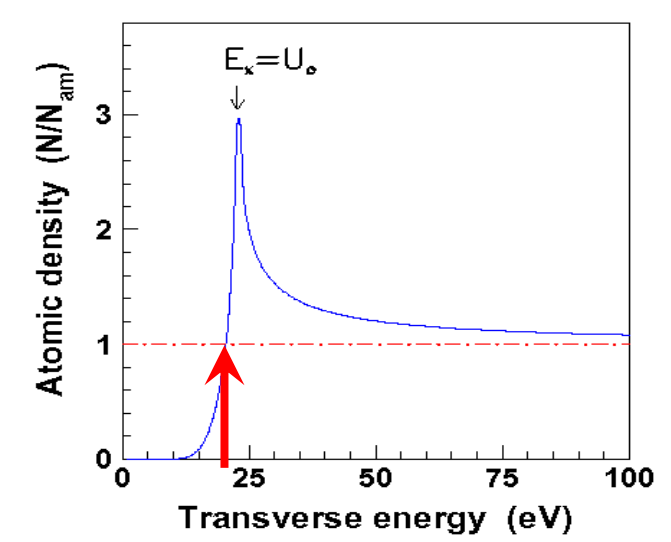
(2) Transverse energy of the channeled projectile should also mimic the electromagnetic interaction part for the amorphous or non-channeled case.

What should be the transverse energy of channeled projectiles?

Solution comes from a recent paper by Scandale et el. (2010)

- Channeling condition is described by the thick red arrow in the plot on right.

- We call such channeling condition in which atomic density (N/N_{am}) is 1 as "Electromagnetic Channeling Condition"



The dependence of the atomic density averaged along the particle trajectory in the (1 1 0) silicon crystal on the particle transverse energy.

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Separation of Electromagnetic Parts of CCC

- Two measurements of charge changing cross sections will be needed, ONE under "electromagnetic channeling condition" defined before and SECOND under non-channeled or random condition.

- First will be a direct electromagnetic part of CCC while difference of above two measurements will be the nuclear