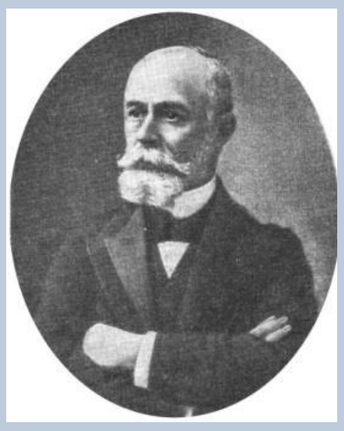

Investigation of Alpha Particle Emission in Nuclear Track Emulsion Irradiated by Relativistic Muons (BECQUEREL Experiment)

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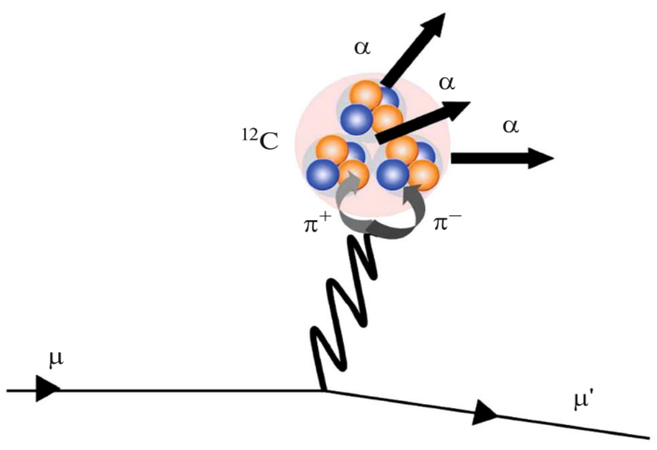
Introduction

This study explores nuclear fragmentation induced by relativistic muons using nuclear track emulsion (NTE) as part of the BECQUEREL experiment. The focus is on identifying short-range alpha particle tracks from the reaction $\mu + {}^{12}\mathrm{C} \rightarrow \mu' + 3\alpha$. SRIM simulations enabled precise energy loss and kinetic energy reconstructions, while track geometry analysis provided emission angles and invariant mass spectra.

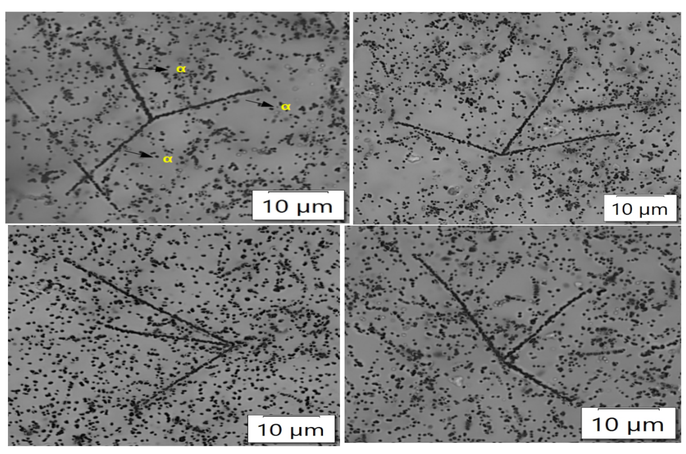
Exposure to muons

- As part of the BECQUEREL experiment NTE samples were transversely exposed to relativistic muons at 160 GeV.
- Irradiation of track emulsions with relativistic muons enables the simultaneous study of nuclear multifragmentation induced by a purely electromagnetic probe.

$^{12}\mathrm{C} \rightarrow 3\alpha$



$\mu + {}^{12}\mathrm{C} \rightarrow 3\alpha$ in NTE



Summary

Alpha-particles ranges and emission angles were determined from track coordinate measurements, revealing a mean range of 26.78 ± 0.67 μm (RMS = 7.7 μm); energy was estimated using the SRIM model, with a mean value of 5.2 ± 0.09 MeV (RMS = 1.03 MeV). Future work will calculate the reaction cross section for $^{12}\mathrm{C}$–μ interactions relevant to natural gas field analysis. While helium is typically linked to U/Th decay, it can also arise from muon-induced reactions with $^{12}\mathrm{C}$ in natural gas. Accurate cross sections enable estimating gas field age and volume.

References

[1] D. A. Artemenkov et al., Phys. At. Nucl. 78, 579 (2015).
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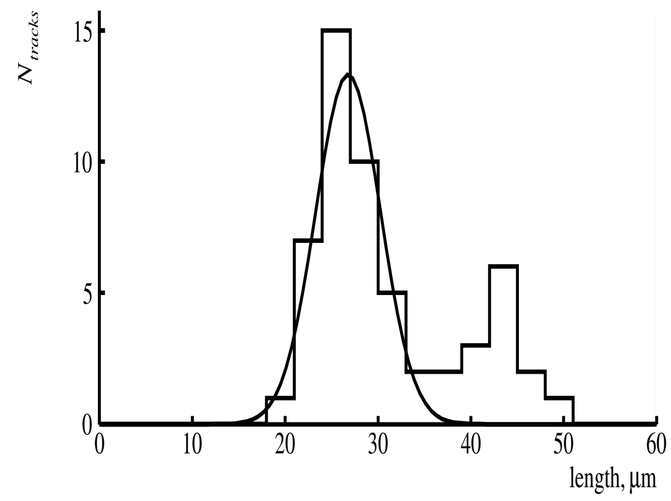
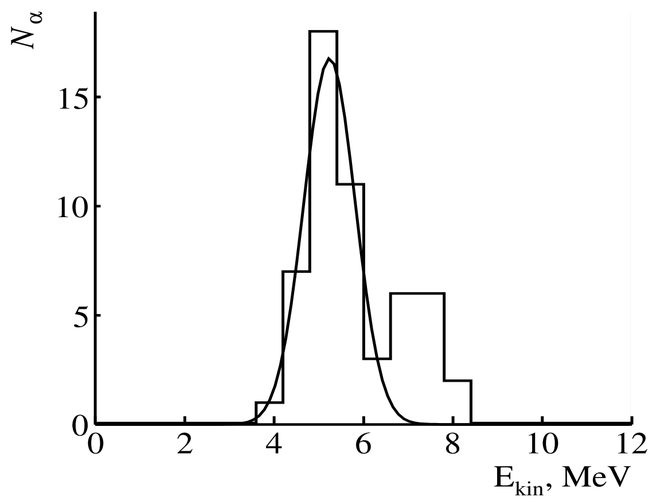
[3] A. M. Gorin et al. Phys. of At. Nucl. 86, 2478 (2023).

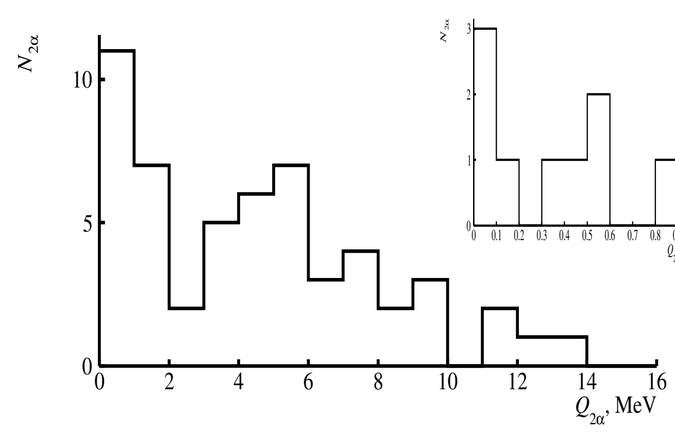
α Particle Range



α KE Distribution



$Q_{2\alpha}$ Energy



$Q_{3\alpha}$ Energy