

WPCF 2023 - XVI Workshop on Particle Correlations and Femtoscopy & IV Resonance Workshop 2023



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Investigating clustering in ^{12}C using gamma-beams and a TPC detector

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Alpha particle clustering is thought to be widespread throughout the nuclear chart, and light nuclei provide an ideal testing ground for state-of-the-art theoretical calculations, such as the Algebraic Cluster Model (ACM) [1]. The predicted $2+$ rotational excitation of the Hoyle State was first unambiguously measured using gamma beams and an Optical TPC detector [2]. To explore further rotational states built on the Hoyle state in carbon-12, a similar experiment was performed using the HI γ S gamma-beam facility at Duke University in 2022. Gamma beams from 8.6 to 13.9 MeV were incident on a CO $_2$ active target contained within a new electronic TPC, built by the university of Warsaw [3]. By examining the photo-dissociation of ^{12}C through an intermediate state in ^8Be , $^{12}\text{C}(\alpha,\gamma)^8\text{Be}$, we search for new states predicted by the ACM.

Three-alpha-particle events, corresponding to ^{12}C photodissociation, form a fraction of all measured events. This presents a significant data analysis challenge, since typical experimental signatures, such as total charge deposition and track lengths, strongly overlap with those of competing reaction channels, e.g. $^{16}\text{O}(\alpha,\gamma)^{12}\text{C}$. This paper discusses the use of convolutional neural networks for event classification – ResNet-18/ResNet-50 [4] and ResNeXt [5] – alongside more traditional data analysis techniques. The performance of these neural networks is discussed and preliminary results such as angular distributions and Dalitz plots are presented.

[1]

[4] He, Kaiming, Xiangyu Zhang, Shaoqing Ren, and Jian Sun. (2016) “Deep residual learning for image recognition.” Proceedings of the IEEE conference on computer vision and pattern recognition, pp. 770-778.

[5] S. Xie, R. Girshick, P. Dollar, Z. Tu, and K. He. (2017) “Aggregated residual transformations for deep neural networks”. Proceedings of the IEEE conference on computer vision and pattern recognition, 1492-1500.

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