New analysis method of TPC data using neural network

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^{12}C in the universe was mainly synthesized by the triple-alpha reaction in which an alpha particle is captured by a two alpha resonant state in ^{8}Be to form a 3alpha resonant state as an excited state in ^{12}C. Most of the 3alpha resonant states decay back to three alpha particles, but a tiny fraction of the resonant states decays to the ground state in ^{12}C by emitting γ rays. Under the normal stellar conditions, this reaction proceeds via the 0_2^+ state in ^{12}C as the 3alpha resonant state. Therefore, the γ-decay probability of the 0_2^+ state is a very important parameter, and this probability has been already reported as 4.4×10^{-4}. Recently, it was pointed out that the triple alpha reaction rate might drastically enhance in a hot dense medium because exothermic neutron inelastic scattering de-excites the 0_2^+ state to the ground state [1]. However, the cross section of the $^{12}\mathrm{C}(0_2^+)(\mathrm{n},\mathrm{n}')^{12}\mathrm{C}(\mathrm{g.s.})$ reaction at the astronomical energies has never been measured.

Since the cross section of the $^{12}\mathrm{C}(0_2^+)(\mathrm{n},\mathrm{n}')^{12}\mathrm{C}(\mathrm{g.s.})$ reaction can be determined by measuring the time reversal reaction, we are going to measure the $^{12}\mathrm{C}(\mathrm{g.s.})(\mathrm{n},\mathrm{n}')^{12}\mathrm{C}(0_2^+)$ reaction slightly above the reaction threshold energy. However, it is not easy to measure this reaction because energies of scattered neutron and emitted alpha particles are quite low. In the present work, we will utilize the time projection chamber (TPC). TPC can track low-energy alpha particles emitted from the 0_2^+ state because the detection gas works as the reaction target and the $^{12}\mathrm{C}(\mathrm{g.s})(\mathrm{n},\mathrm{n}')^{12}\mathrm{C}(0_2^+)$ reaction occurs in the sensitive volume of the TPC. Three-dimensional trajectories of alpha particles are recorded as two projection images on to vertical planes along two different perpendicular axes. Conventionally, the Hough transformation was used to extract straight particle trajectories from the images. However, this conventional method involves complex algorithms and requires large computational resources. We will report our development of a new method to analyze track images using a neural network in the present talk.

[1] Mary Beard, Sam M. Austin, and Richar Cburt Phys. Rev. Lett. 119, 112701 **(2017).**