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Conformable Fractional Models of the Stellar Helium Burning via Artificial Neural Networks

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Abstract

The helium burning phase represents the second stage that the star used to consume nuclear fuel in its interior. In this stage, the three elements carbon, oxygen, and neon are synthesized. The present paper has two folds, the first is to develop an analytical solution to the system of the conformable fractional differential equations of the helium burning network, where we used for this purpose the series expansion method and obtained recurrence relations for the product abundances i.e. helium, carbon, oxygen, and neon. Using four different initial abundances, we calculated 44 gas models covering the range of the fractional parameter with step . We found that the effects of the fractional parameter on the product abundances are small which coincides with the results obtained by a previous study. Second, we introduced the mathematical model of the neural network (NN) and developed a neural network algorithm to simulate the helium burning network using its feed-forward model that is trained by the back propagation (BP) gradient descent delta rule algorithm. A comparison between the NN and the analytical models revealed very good agreement for all gas models. We found that NN could be considered as a powerful tool to solve and model nuclear burning networks and could be applied to the other nuclear stellar burning networks.

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