Physics Department Seminar

11 am April 12, 2024 Science Building Room 126

Chaotic Behavior in Stellar Evolution Models

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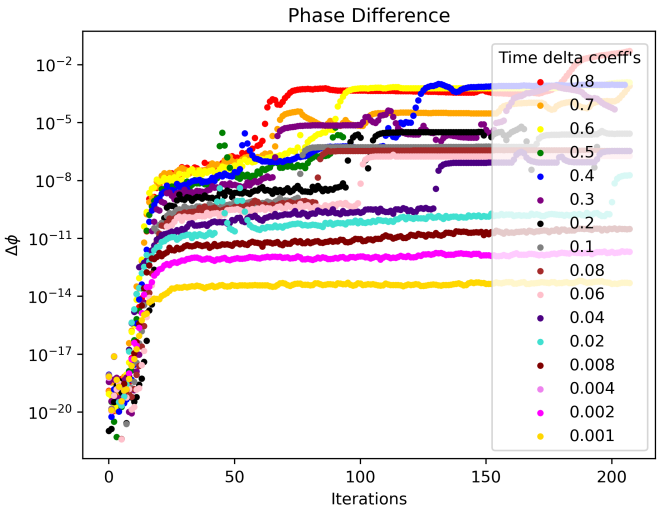

Stellar structure and evolution models (SSEM's) are an important part of astrophysical research because they allow physicists to simulate the evolution and life cycle of stars and other stellar objects. Therefore, much effort has been made to improve their accuracy and mitigate the uncertainties associated with complex mathematical models. The equations governing the evolution of stars allow for the possibility to exhibit chaotic behavior, though no evidence of chaos had previously been found. If stellar models were to behave chaotically under any condition it would constitute a fundamental limit on the accuracy of these models. To test for the presence of chaotic behavior in SSEM's, we create two identical rotating stellar models and introduce a minute perturbation to one of the models before letting them both evolve through the main sequence of their lives.

Afterwards we compare how the two models have diverged through the course of the simulation. This paper will cover the process and assumptions we used to test for chaotic behavior, as well as the relevance of our findings, and show how certain conditions will cause chaotic behavior in SSEM's. This constitutes a fundamental limit to the precision of these models, which had previously been overlooked. While these findings do not discredit the accuracy of SSEM's, they do need to be taken into consideration for anyone using SSEM's to conduct astrophysical research. While our work has shown that current SSEM's can exhibit chaotic behavior under specific conditions, there may be other characteristics of these models that further increase or affect the chaotic behavior of the models, a project for future research.