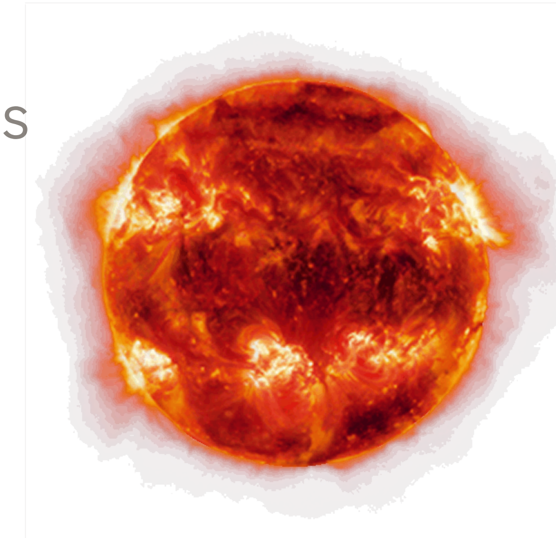
Physics Department Seminar

Apr. 4, Friday at 2 PM in Science Building Room 250



Evidence of Dynamical Chaos in Stellar Evolution Models

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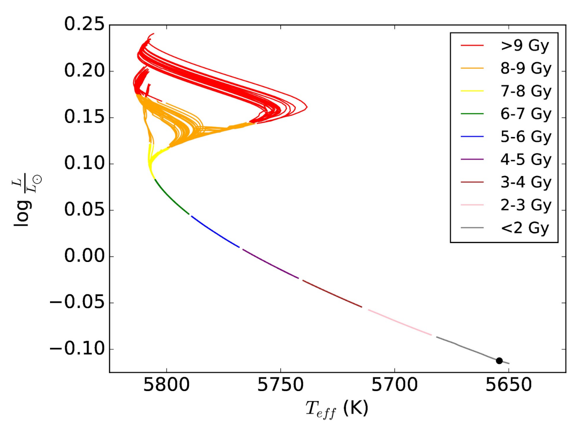
Stellar evolution models are essential tools in astrophysics, enabling researchers to simulate and analyze stellar processes that cannot be directly observed. However, the complex and dynamic nature of stellar evolution leaves room for chaotic behavior, which may limit the accuracy of these models. To investigate the presence and extent of dynamical chaos, we simulated pairs of nearly identical stars with slight perturbations in hydrogen composition and measured the divergence in phase space between the models. This paper briefly outlines the fundamental equations governing stellar evolution and chaos, the methods used to test for chaos in the MESA stellar evolution model, and our experimental results. We found clear evidence of chaotic behavior, characterized by exponential growth in phase space divergence, which we quantified using the Lyapunov exponent. Additionally, this chaotic behavior correlated with the spatial resolution of the simulation, with divergence growth dependent on the number of time steps taken. While we have quantified aspects of chaos within MESA, its full nature and underlying causes remain undetermined, necessitating further research.



HR diagram of an ensemble of many stars with minor, random perturbations depicting effects of chaotic behavior on temperature and luminosity of the star. Temperature differences of approximately 50 Kelvin are measured between certain same age stars.