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Modeling Mass Transfer in AGB Binaries

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The nucleosynthetic s-process occurring in AGB stars from ~ 1–6M⊙ is responsible for creating half of the heavy elements in the universe, the chemical imprint of which can be studied by observing the material on the surface of binary barium (Ba), CH, and carbon-enhanced metal-poor (CEMP) stars. We simulate the results of AGB mass transfer in binaries by computing a grid of binary stellar evolution models using the STARS code (Pols et al. 1995), using stellar yields from the FUll-Network Repository of Updated Isotopic Tables & Yields (FRUITY) database (Cristallo et al. 2011). We compare 1D-LTE abundance patterns (including C, Sr, Y, Zr, Mo, (Ru), Ba, La, Ce, Nd, (Sm), Pb, Eu) and surface parameters of Ba stars from de Castro et al. (2016); Roriz et al. (2021, 2024), and a small number of Ba, CH, and CEMP-s from Dimoff et al. (2024) to the grid. We find correlations between AGB masses and the abundance patterns of their polluted companions, and we estimate accretion masses. We find the most frequently chosen scenario to explain heavy element enhancement in Ba stars is a small amount of material (≤ 0.2 M⊙) accreted onto a ≥ 2.3 M⊙ binary companion to a 2.50 M⊙ AGB star near the onset of core He burning. We compute mass-transfer efficiencies, and find overall agreement with the slow AGB wind regime. We also find scenarios with higher efficiencies, which may indicate other mass-transfer mechanisms.

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