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The turbulent hydrodynamics and nuclear astrophysics of anomalous stars from the early universe

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The anomalous abundances that can be found in the most metal-poor stars reflect the evidently large diversity of nuclear production sites in stars and stellar explosions, as well as the cosmological conditions for the formation and evolution of the first generations of stars. Significant progress in our predictive understanding of nuclear production in the early universe comes now within reach through advancing capabilities to perform large-scale 3D stellar hydrodynamic simulations of the violent outbursts of advanced nuclear burning. When complemented with comprehensive nucleosynthesis simulations we can characterize the chemical evolution of stellar populations. Nuclear production sites in the early universe involves unstable species on the p- and n-rich side of the valley of stability, and nuclear data in key cases is presently too uncertain to enable the required predictive simulation capability. These are the underpinnings to decipher the messages from the early universe hidden in the anomalous abundances of metal poor stars.

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