Contribution ID: **238** Type: **Oral Presentation**

Shock Wave Propagation in Core-Collapse Supernovae: A One-Dimensional Study with Magnetic Fields

Core-collapse supernovae involve extreme conditions where gravity, nuclear physics, and shock hydrodynamics interact to drive the explosive disruption of a massive star. In this study, we investigate shock wave propagation using a one-dimensional piston-driven model as a proxy for the bounce shock that forms during core collapse. A polytropic equation of state is employed to represent thermodynamic behavior, and magnetic fields are included to examine their role in modifying shock dynamics and matter compression. Numerical simulations, complemented by analytical estimates, reveal how magnetic effects alter post-shock structures and energy transport.

This model offers a simplified but physically insightful framework for studying magnetically influenced shocks in astrophysical environments. It also provides conceptual parallels with shock propagation in high-energy nuclear collisions, where similar compressional dynamics are observed. By combining tractable fluid models with magnetic fields, the study contributes to the theoretical and computational understanding of both stellar collapse and strongly interacting matter under extreme conditions.

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Session Classification: Theoretical and Computational Physics

Track Classification: Track G - Theoretical and Computational Physics