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Shock generated vorticity in the interstellar medium and the origin of the stellar initial mass function

We examine the density and velocity structure of interstellar gas traversed by curved shock waves. We demonstrate mathematically that just a few passages of curved shock waves generically produces a log-normal density PDF. This explains the ubiquity of the log-normal PDF in many different numerical simulations. We also show that subsequent interaction with a spherical blast wave generates a power-law mass distribution at high densities, similar to the Salpeter index for the IMF. Finally, we show that a focused shock produces a *downstream* flow with energy spectrum exponent $\alpha = -2$. Subsequent shock passages reduce this slope, achieving $\alpha \approx -5/3$ after a few passages. These results suggest that fully-developed turbulence may *not* be required to explain the observed energy spectrum and density PDF.

On the basis of these mathematical results, we argue that the self-similar spherical blast wave arising from expanding HII regions or stellar winds from massive stars may ultimately be responsible for creating the high mass, power-law, Salpeter-like tail on an otherwise a log-normal density PDF for gas in star forming regions. The IMF arises from the gravitational collapse of sufficiently overdense regions within this PDF. Thus, the composite nature of the IMF—a log-normal plus power-law distribution—is shown to be a natural consequence of shock interaction and feedback from the most massive stars that form in most regions of star formation in the galaxy.