Effects of Large-Scale Upstream Turbulence on a Supernova Blast Wave

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Abstract: We consider the effect of pre-existing turbulent fluctuations in the fluid upstream of a propagating hydromagnetic shock wave, in the limit of high enough Alfén mach number that the magnetic field stresses can be neglected. We find the expected effects on transverse diffusion, and show that particles can be readily accelerated up to the knee in the spectrum at a perpendicular shock. We also find that pre-existing turbulent density fluctuations not only distort the shock front, but also produce a number of changes in the postshock fluid, the most noteworthy of which are to the postshock magnetic field. The average magnetic-field intensity is increased siginificantly, and large fluctuations in the magnetic vector occur. Also, for a radially propagating blast wave, we show that the large radial expansion of the postshock fluid causes the magnetic field to have a predominantly radial orientation (either outward or inward). These effects of the density fluctuations are similar to those observed in strong astrophysical shock waves and suggest that the density fluctuations may play an important and possibly dominant role in creating the observed properties of astrophysical shocks.

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