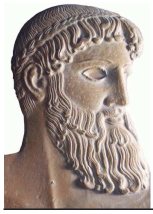
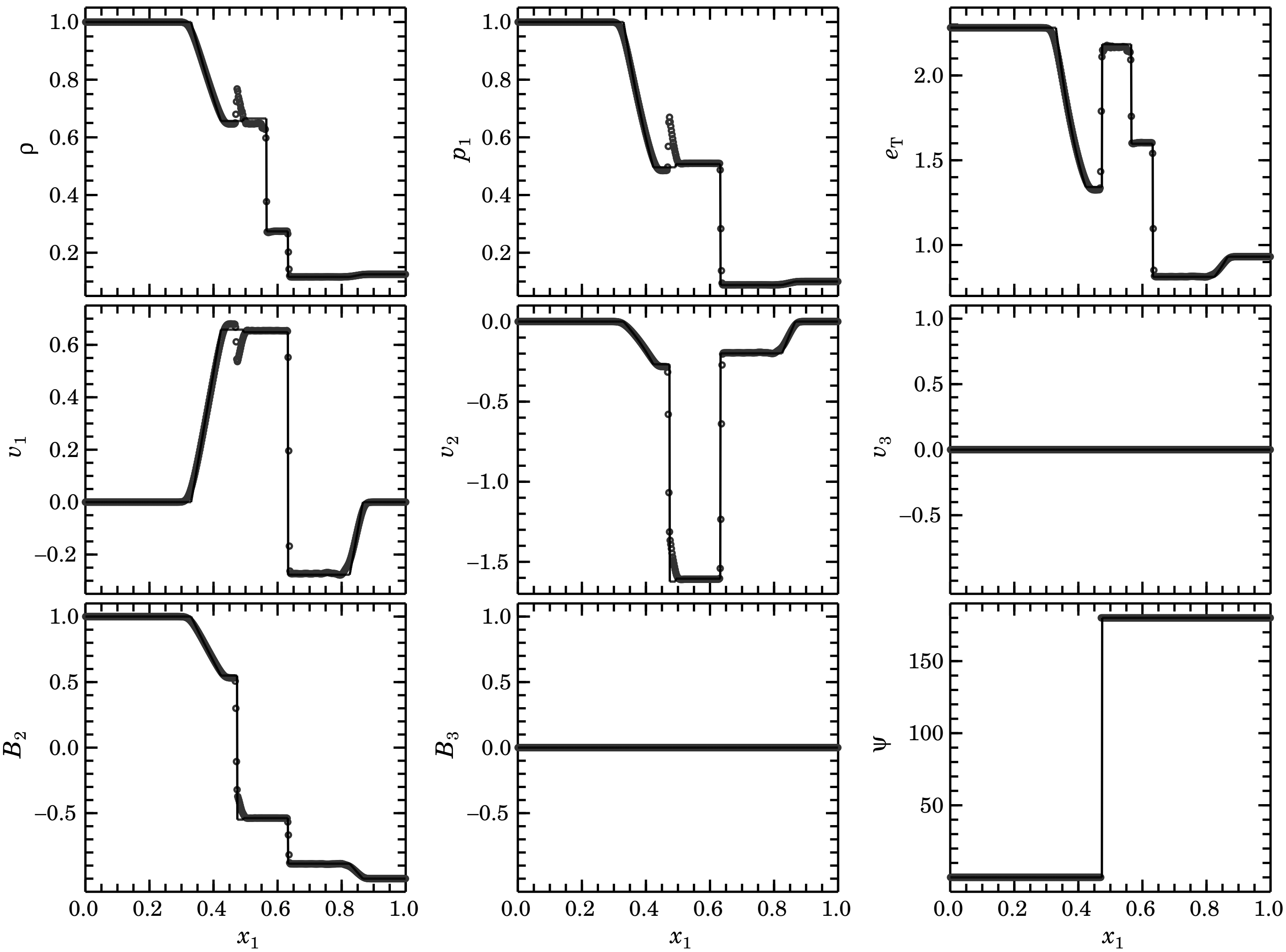


ZEUS-3D 1-D Gallery #19: "Compound" waves



This is Fig. 5*a* from Ryu & Jones (1995, ApJ, 442, 228), showing the solution of the MHD shock tube problem with the left state $(\rho, v_1, v_2, v_3, B_2, B_3, p_1) = [1, 0, 0, 0, 1, 0, 1]$ and the right state $[0.125, 0, 0, 0, -1, 0, 0.1]$ with $B_1 = 0.75$ and $\gamma = 5/3$ (Brio & Wu used $\gamma = 2.0$) at time $t = 0.1$. At $t = 0$, the discontinuity is at $x_1 = 0.5$. Plots show from left to right: (1) fast rarefaction, (2) slow compound wave (at $x_1 \sim 0.47$), (3) contact discontinuity (at $x_1 \sim 0.56$), (4) slow shock (at $x_1 \sim 0.63$), and (5) fast rarefaction.

Open circles are the `dzeus36` solution using 512 zones, `CMoC`, the total energy equation, and third-order interpolation with the contact steepener engaged. `dzeus36` parameters controlling the time step and artificial viscosity are: `courno=0.75`, `qcon=1.0`, and `qlin=0.5`. Lines are the results from the non-linear Riemann solver described in Ryu & Jones.

There are no significant differences between the `dzeus36` and `dzeus35` solutions. The slow compound wave consists of an intermediate shock attached to a slow rarefaction, and is found in virtually all numerical solutions. In a non-dissipative analytical solution, the compound wave is replaced by a rotational discontinuity followed closely by a slow shock. As a consequence of mass conservation, the levels in ρ in the vicinity of the compound wave do not match those in the analytical solution. The higher than normal *linear* viscosity parameter (`qlin=0.5`) is to calm the velocity oscillations at the foot of the fast rarefaction.