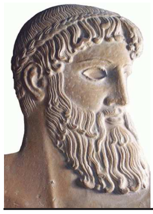
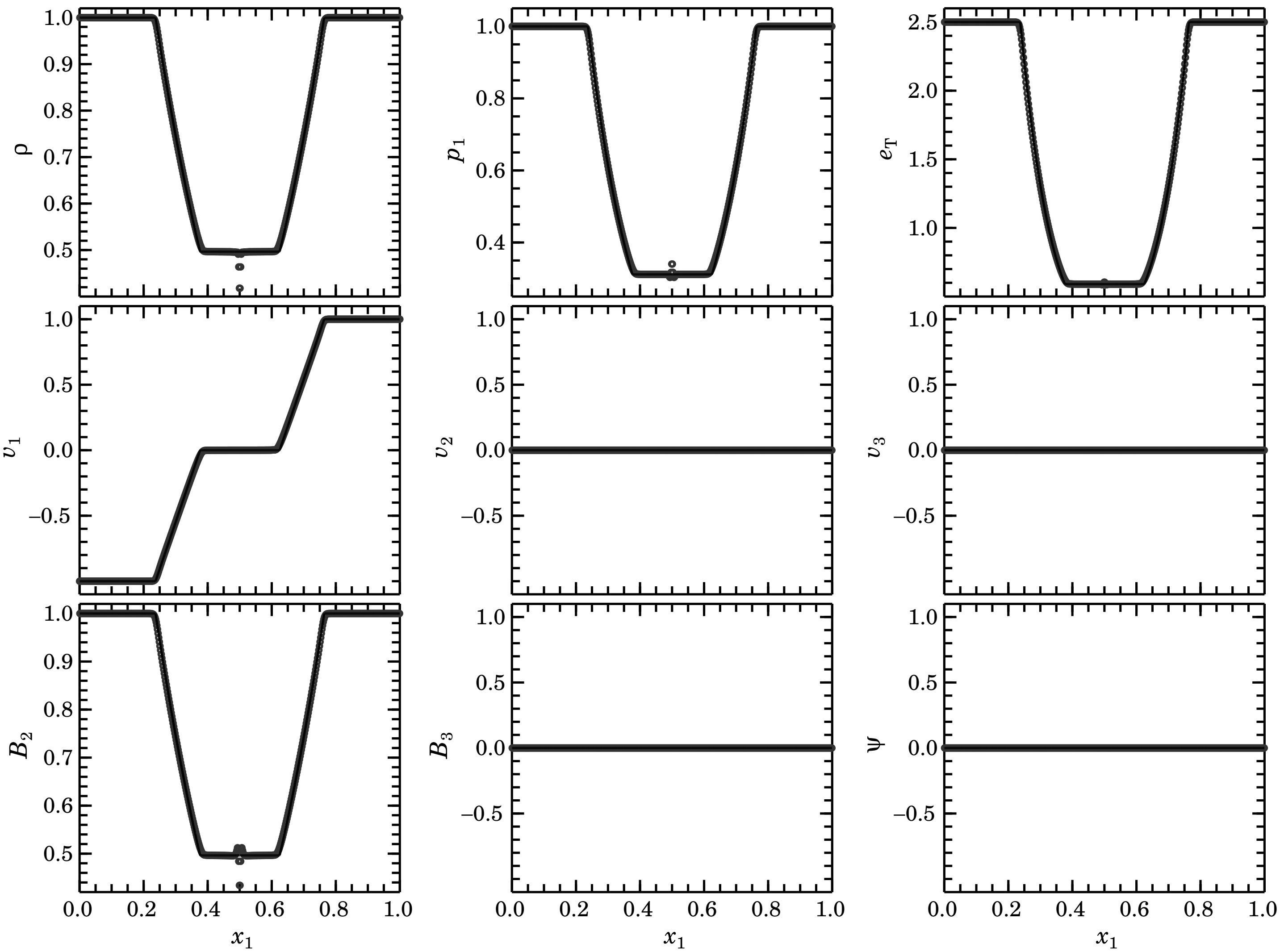


ZEUS-3D 1-D Gallery #14: $v_\perp = 0$; $B_\parallel = 0$



This is Fig. 3*b* from Ryu & Jones (1995, ApJ, 442, 228), showing the solution of the MHD shock tube problem with the left state $(\rho, v_1, v_2, v_3, B_2, B_3, p_1) = [1, -1, 0, 0, 1, 0, 1]$ and the right state $[1, 1, 0, 0, 1, 0, 1]$ with $B_1 = 0$ and $\gamma = 5/3$ at time $t = 0.1$. At $t = 0$, the discontinuity is at $x_1 = 0.5$. Plots show from left to right two oppositely-moving magneto-acoustical ($B_1 = 0$) rarefactions.

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=0.2`. Lines (completely obscured by the circles) are the results from the non-linear Riemann solver described in Ryu & Jones.

The "glitch" in ρ, p_1, and B_2 at $x_1 = 0.5$, which appears somewhat different in the `dzeus36` and `dzeus35` solutions, is numerical in origin, appears in fully upwinded schemes as well, and persists because the location of the original discontinuity is stationary, preventing grid diffusion from dissipating the transients resulting from the initially hyper-resolved (one zone) discontinuity. The principle difference between this and the `dzeus35` solution is there is no longer need for a higher-than-usual linear viscosity (`qlin=0.4`) to prevent the formation of "rarefaction shocks", as the new transport algorithm, `FIT` (*Finely Interleaved Transport*), has more or less eliminated the problem. See problem 21 in the 1-D Gallery for further discussion.