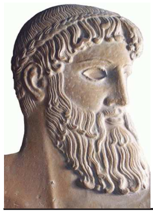
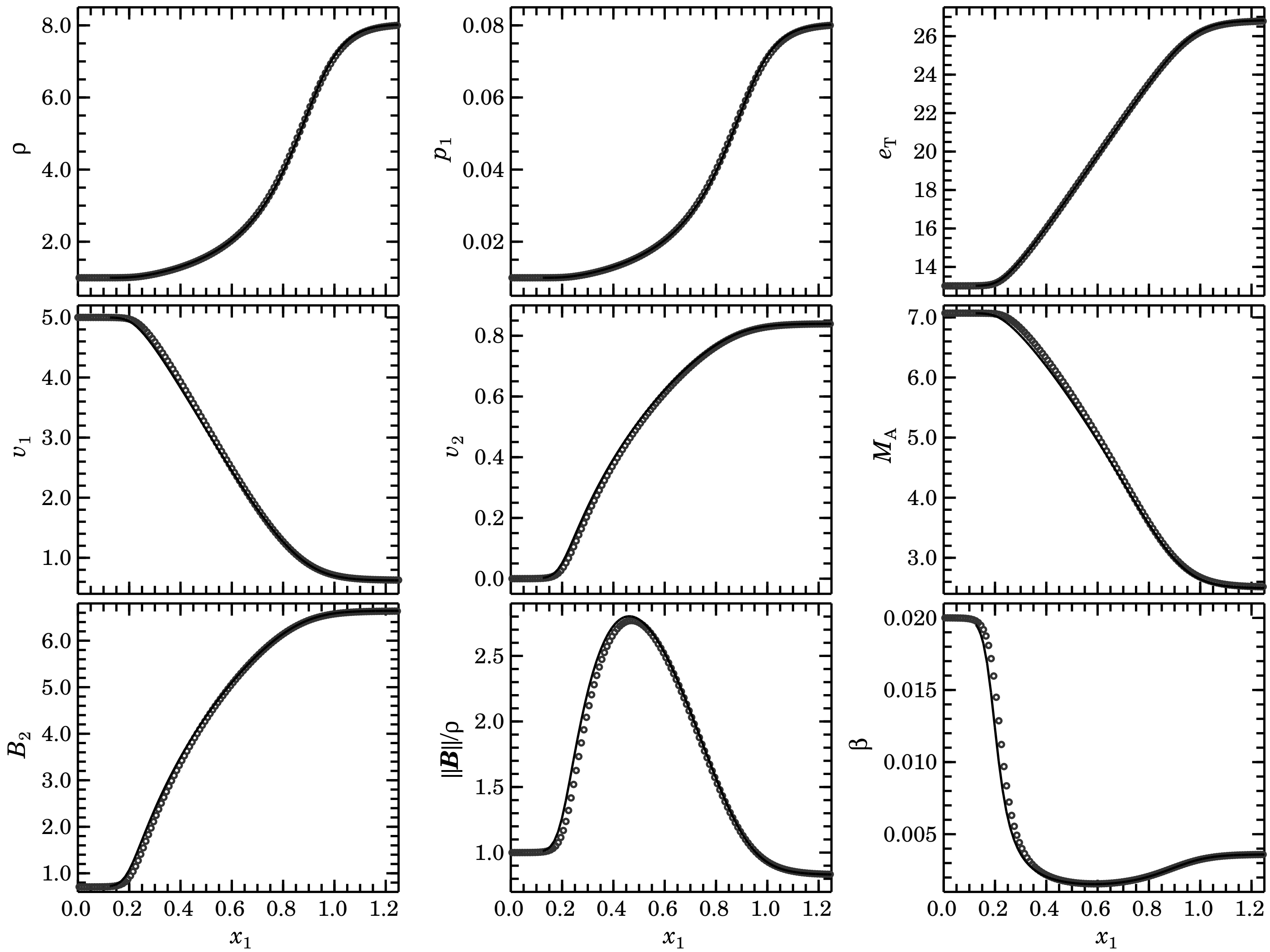


ZEUS-3D 1-D Gallery #24: Isothermal C-shock with Ambipolar Diffusion



See the page for the adiabatic C-shock for a definition and reference for ambipolar diffusion (AD), and a discussion on sub-cycling and super-stepping.

In the panels, open circles represent the `dzeus36` solution for the isothermal AD-MHD shock tube problem with left state $(\rho, v_1, v_2, v_3, B_2, B_3, p_1) = (1, 5, 0, 0, 1/\sqrt{2}, 0, 0.01)$, right state $(8.045, 0.621, 0.840, 0, 6.644, 0, 0.0804)$, $B_1 = 1/\sqrt{2}$ and $\gamma = 5/3$ at $t = 4$. `CMoC` is used with second order interpolation (`iord=2`), artificial viscous parameters `qcon=1`, `qlin=0.2`, Courant number `courno=0.75`, and super-stepping engaged (`iscyad=2`). The domain $0 \le x_1 \le 1.5$ is resolved with 150 zones with only $0 \le x_1 \le 1.25$ shown and, at $t = 0$, the discontinuity is at $x_1 = 0.5$. The units are not scale-free, and additional `dzeus36` parameters needed here are: `gammaad=1.0e6`, `mpnp=1.0`, `ionconst=1`, and `dscale=1.0e-5`.

The initial discontinuity launches numerous transients and, after ∼1,400 MHD cycles, the solution begins to converge to a steady state. The panels shown are after ∼2,800 MHD cycles and exhibit an isothermal *C-shock*, whose continuous nature is a direct consequence of AD.

Semi-analytical solutions generated within `dzeus36` using a sixth-order Runga-Kutta scheme are overlaid; differences between numerical and analytical solutions for no sub-cycling are less than 1% everywhere and in most places, $< 0.1\%$. With sub-cycling, errors can be as high as 2%.