Chapter 4 : 4.4 & 4.6
Hydrodynamics

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Problem 1: Consider matter which initially has uniform temperature $\boldsymbol{T_0}$ and a two-dimensional density profile,

$$\rho\,(r, t = 0) = \rho_0 e^{-r^2/2R_0^2}\,,$$

Show the condition for entropy conservation if the subsequent evolution of the density and temperature are parameterized by

$$\rho\,(r, t) = \rho_0 \frac{R_0^2}{R(t)^2} e^{-r^2/2R(t)^2}\,, T(r, t) = T(t)$$

Problem 2 :Assuming the velocity profile is linear, (ie $\vec{v}(r, t) = A(t)\vec{r}$) , find A(t) and R(t) that satisfy the hydrodynamic equations of motion and current conservation.

Hydrodynamic Equations (P = ρ T) :

$$\frac{D\vec{v}}{Dt} = \frac{-1}{\rho_m}\nabla \mathrm{P}$$

$$\frac{D\epsilon}{Dt} = -(P + \epsilon)\nabla \cdot \vec{v}$$

$$\frac{D\rho}{Dt} = -\rho\,\nabla \cdot \vec{v}$$