DIMENSIONLESS NUMBERS

The dimensionless numbers parameterizing the problem are:

Rayleigh number:

$$R_a(z) = \frac{\theta^2(m_i+1)}{\sigma C_{k_z}^2}\left(1 - \frac{(m_i+1)(\gamma-1)}{\gamma}\right)(1+\theta z)^{2m_i-1}$$

$$\left(C_{k_z} = C_k K_z, \quad K_z = \frac{K_i}{K_1}, \quad C_k = K_1/\{d\rho_o c_p[(c_p - c_v)T_o]^{1/2}\}\right)$$

Prandtl numbers:

$$\sigma = \mu c_p/K_1,$$
$$\zeta = \eta c_p/K_1,$$

Note: Full Prandlt no. $\sigma_z = \mu c_p/K_z$, but $C_{k_z}\sigma_z = C_k\sigma$ is independent of K_z and therefore depth. $C_k\zeta$ is also independent of depth.

Chandrasekhar number:

$$Q = \frac{B_0^2 d^2}{\mu_0 \mu \eta},$$

μ_0 is the magnetic permeability, B_0 is the initial magnetic field strength. Used only for magnetoconvection. Dynamo models do not have this number.

Taylor number:

$$(\mathbf{\Omega} = \Omega_0\hat{\mathbf{\Omega}} = (\Omega_x, \Omega_y, \Omega_z) = (0, \Omega_o \cos\phi, -\Omega_o \sin\phi))$$

$$T_{a_0} = \frac{4\Omega_0^2 d^4}{(\mu/\rho_0)^2} = \left(\frac{\rho}{\rho_0}\right)^2 T_a.$$

Derived quantity of interest:

Rossby number:

$$R_o = \left(\frac{R_a}{T_a\sigma}\right)^{1/2}.$$