Chapter 2

Mathematical problem and main results

2.1 Intial boundary value problem for hydrodynamic model

By assuming the physical coefficients in (1.9) are positive constants and letting $\varepsilon' = 1$, we have a system of equations

$$\rho_s + m_x = 0, \tag{2.1a}$$

$$m_s + \left(\frac{m^2}{\rho} + \rho\theta \right)_x = \rho\phi_x - \frac{m}{\tau_m}, \tag{2.1b}$$

$$\rho\theta_s + m\theta_x + \frac{2}{3}\left(\frac{m}{\rho}\right)_x \rho\theta - \frac{2}{3}\left(\tau_m\kappa_0\theta_x\right)_x = \frac{2\tau_e - \tau_m}{3\tau_m\tau_e}\frac{m^2}{\rho} - \frac{\rho}{\tau_e}(\theta - 1), \tag{2.1c}$$

$$\phi_{xx} = \rho - D. \tag{2.1d}$$

We study the initial boundary value problem for (2.1) with a spatial variable $x \in \Omega := (0,1)$ and a time variable $s > 0$. The unknown functions ρ, m, θ and ϕ stand for the electron density, the current density, the electron temperature and the electrostatic potential, respectively. Positive constants τ_m and τ_e are the momentum relaxation time and the energy relaxation time, respectively. From the physical point of view, it holds that $0 < \tau_m \leq \tau_e$. Positive constant $\tau_m\kappa_0$ corresponds to the thermal conductivity. A doping profile $D(x)$, which determines the electric property of semiconductors, is assumed to be a bounded continuous and positive function of the spatial variable x, that is,

$$D \in \mathcal{B}^0(\overline{\Omega}), \quad \inf_{x\in\overline{\Omega}} D(x) > 0. \tag{2.2}$$