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Macroscopic Transport Equations for Rarefied Gas Flows

Approximation Methods in Kinetic Theory

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The terms that were corrected are underlined>.

$$\begin{aligned}\rho^0 &= u^0 = \rho, \quad \rho_i^0 = u_i^0 = 0, \quad \rho^1 = u^1 = \underline{2\rho u} = 3\rho\theta = 3p, \\ \rho_{ij}^0 &= p_{ij}, \quad u_{ij}^0 = p_{\langle ij \rangle} = \sigma_{ij}, \quad \rho_i^1 = 2q_i.\end{aligned}\quad (2.13)$$

$$\omega = \frac{\gamma + 3}{2\gamma - 2} \quad \text{and} \quad \mu_0 = \theta_0^\omega 2^{\frac{5-\gamma}{\gamma-1}} \frac{\Gamma(\frac{7}{2})}{\Gamma(\frac{4\gamma-6}{\gamma-1})} \frac{m}{3\chi^{(2,3)}} \quad (\text{eq. before (4.45)})$$

$$\begin{aligned}\frac{Dq_i}{Dt} + q_k \frac{\partial v_i}{\partial x_k} + \frac{5}{3} q_i \frac{\partial v_k}{\partial x_k} + \chi_1 \sigma_{ik} \frac{\partial \theta}{\partial x_k} - \chi_2 \theta \sigma_{ik} \frac{\partial \ln \rho}{\partial x_k} \\ + \chi_3 \theta \frac{\partial \sigma_{ik}}{\partial x_k} + 2\chi_4 q_k S_{ik} + \chi_5 \frac{\sigma_{ik} q_k}{\mu} = -\chi_6 \rho \theta \left[\frac{q_i}{\kappa} + \frac{\partial \theta}{\partial x_i} \right].\end{aligned}\quad (8.19)$$

$$\begin{aligned}\frac{D\sigma_{ij}}{Dt} + \sigma_{ij} \frac{\partial v_k}{\partial x_k} + 2\sigma_{k\langle i} \frac{\partial v_{j\rangle}}{\partial x_k} + \frac{4}{5} \text{Pr} \frac{\varpi_3}{\varpi_2} \left(\frac{\partial q_{\langle i}}{\partial x_{j\rangle}} - \omega q_{\langle i} \frac{\partial \ln \theta}{\partial x_{j\rangle}} \right) \\ + \frac{4}{5} \text{Pr} \frac{\varpi_4}{\varpi_2} q_{\langle i} \frac{\partial \ln p}{\partial x_{j\rangle}} + \frac{4}{5} \text{Pr} \frac{\varpi_5}{\varpi_2} q_{\langle i} \frac{\partial \ln \theta}{\partial x_{j\rangle}} + \left(\frac{\varpi_6}{\varpi_2} - 4 \right) \sigma_{k\langle i} S_{j\rangle k} \\ + \frac{\psi_5}{\mu \theta} q_{\langle i} (q_{j\rangle} - q_{j\rangle}^{(1)}) + \frac{\psi_6}{\mu} \sigma_{k\langle i} (\sigma_{j\rangle k} - \sigma_{j\rangle k}^{(1)}) = -\frac{2}{\varpi_2} \frac{p}{\mu} \left[\sigma_{ij} + 2\mu \frac{\partial v_{\langle i}}{\partial x_{j\rangle}} \right],\end{aligned}\quad (8.20)$$

$$\begin{aligned}\frac{D\sigma_{ij}}{Dt} + \sigma_{ij} \frac{\partial v_k}{\partial x_k} + 2\sigma_{k\langle i} \frac{\partial v_{j\rangle}}{\partial x_k} + \frac{4}{5} \text{Pr} \frac{\varpi_3}{\varpi_2} \left(\frac{\partial q_{\langle i}}{\partial x_{j\rangle}} - \omega q_{\langle i} \frac{\partial \ln \theta}{\partial x_{j\rangle}} \right) \\ + \frac{4}{5} \text{Pr} \frac{\varpi_4}{\varpi_2} q_{\langle i} \frac{\partial \ln p}{\partial x_{j\rangle}} + \frac{4}{5} \text{Pr} \frac{\varpi_5}{\varpi_2} q_{\langle i} \frac{\partial \ln \theta}{\partial x_{j\rangle}} + \left(\frac{\varpi_6}{\varpi_2} - 4 \right) \sigma_{k\langle i} S_{j\rangle k} \\ = -\frac{2}{\varpi_2} \frac{p}{\mu} \left[\sigma_{ij} + 2\mu \frac{\partial v_{\langle i}}{\partial x_{j\rangle}} \right],\end{aligned}\quad (9.17)$$

$$\frac{1}{2}R + \frac{1}{6}\Delta = -\frac{11}{28} \frac{1}{\rho} \sigma^2 - \frac{18}{5} \frac{\mu}{p} \left[\theta \frac{\partial q}{\partial x} + \frac{11}{6} q \frac{\partial \theta}{\partial x} - \theta q \frac{\partial \ln \rho}{\partial x} + \frac{55}{63} \theta \sigma \frac{\partial v}{\partial x} \right] \quad (9.32)$$

$$\begin{aligned}\frac{D\sigma}{Dt} + \frac{7}{3} \sigma \frac{\partial v}{\partial x} + \frac{4}{5} \text{Pr} \frac{\varpi_3}{\varpi_2} \frac{2}{3} \left(\frac{\partial q}{\partial x} - \omega q \frac{\partial \ln \theta}{\partial x} \right) + \frac{8}{15} \text{Pr} \frac{\varpi_4}{\varpi_2} q \frac{\partial \ln p}{\partial x} \\ + \frac{8}{15} \text{Pr} \frac{\varpi_5}{\varpi_2} q \frac{\partial \ln \theta}{\partial x} + \left(\frac{\varpi_6}{\varpi_2} - 4 \right) \frac{1}{3} \sigma \frac{\partial v}{\partial x} = -\frac{2}{\varpi_2} \frac{p}{\mu} \left[\sigma + \frac{4}{3} \mu \frac{\partial v}{\partial x} - P_3 \right],\end{aligned}\quad (9.36)$$

$$\rho_1 = \rho(x \rightarrow \infty) = \frac{4M_0^2}{M_0^2 + 3}, \quad (11.6)$$

References: (title corrected)

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