On the steady compressible Navier–Stokes–Fourier system with temperature dependent viscosities

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Abstract

We consider in $\Omega \subset R^3$

$$\operatorname{div}(\varrho \mathbf{u}) = 0, \tag{1}$$

$$\operatorname{div}(\varrho \mathbf{u} \otimes \mathbf{u}) - \operatorname{div}\mathbf{S} + \nabla p = \varrho \mathbf{f}, \tag{2}$$

$$\operatorname{div}(\varrho E \mathbf{u}) = \varrho \mathbf{f} \cdot \mathbf{u} - \operatorname{div}(p\mathbf{u}) + \operatorname{div}(\mathbf{S}\mathbf{u}) - \operatorname{div}\mathbf{q} \tag{3}$$

which models steady flow of a heat conducting compressible fluid. We consider (1)–(3) together with the boundary conditions at $\partial\Omega$

$$\mathbf{u} = \mathbf{0}, \tag{4}$$

$$-\mathbf{q} \cdot \mathbf{n} + L(\vartheta - \Theta_0) = 0. \tag{5}$$

We consider Newtonian fluids, i.e. $\mathbf{S} = \mu(\vartheta)(\nabla \mathbf{u} + \nabla \mathbf{u}^T - \frac{2}{3}\operatorname{div}\,\mathbf{u}\mathbf{I}) + \xi(\vartheta)\operatorname{div}\mathbf{u}\mathbf{I}$, with the pressure $p \sim \varrho\vartheta + \varrho^\gamma$ and the heat flux $\mathbf{q} = -\kappa(\vartheta)\nabla\vartheta$. We study existence of a solution to our problem (1)–(5) in dependence on γ, α and m, where $\mu(\vartheta)$, $\xi(\vartheta) \sim (1+\vartheta)^\alpha$, $\kappa(\vartheta) \sim (1+\vartheta)^m$.

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