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Model free boundary problem for the parabolic equations with a small parameter

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Let $D_1 = \{x \mid x' \in \mathbb{R}^{n-1},\ x_n < 0\}$, $D_2 = \{x \mid x' \in \mathbb{R}^{n-1},\ x_n > 0\}$, $D_T^{(m)} = D_m \times (0,T)$, $m = 1,2$. $R_T = \{(x,t) \mid x' \in \mathbb{R}^{n-1},\ x_n = 0,\ 0 < t < T\}$. It is required to find functions $u_1(x,t)$ and $u_2(x,t)$ satisfying the conditions

$$\varepsilon\partial_t u_m - a_m \Delta u_m = 0 \quad \text{in} \quad D_T^{(m)},\ m = 1,2,$$
$$u_m\big|_{t=0} = 0 \quad \text{in } D_m, \quad m = 1,2,$$
$$u_1 - u_2\big|_{R_T} = 0, \qquad b\nabla u_1 - c\nabla u_2\big|_{R_T} = \varphi(x',t),$$

where $b = (b_1,\dots,b_n)$, $c = (c_1,\dots,c_n)$, the coefficients a_m, b_i, c_i, $(m = 1,2;\ i = 1,\dots,n)$ are constants, $\varepsilon > 0$ is a small parameter.

The problem are investigated in the Hölder space $C_{x,t}^{l,l/2}(\bar{\Omega}_T)$ with the norm $|u|_{\Omega_T}^{(l)}$, and $\overset{\circ}{C}{}_{x,t}^{l,l/2}(\bar{\Omega}_T)$ is a subset of functions $u \in C_{x,t}^{l,l/2}(\bar{\Omega}_T)$ such that $\frac{\partial^k u}{\partial t^k}\big|_{t=0} = 0$, $k \le \left[\frac{l}{2}\right]$.

Theorem. *Let $b_n > 0$, $c_n > 0$, $\varepsilon > 0$. For every function $\varphi(x',t) \in \overset{\circ}{C}{}_{x'\ \ t}^{1+\alpha,\frac{1+\alpha}{2}}(R_T)$, $\alpha \in (0,1)$, the problem has a unique solution $u_m \in \overset{\circ}{C}{}_{x\ \ t}^{2+\alpha,1+\frac{\alpha}{2}}(D_T^{(m)})$, $m = 1,2$, and this solution satisfies the estimate*

$$\sum_{m=1}^{2}\Big\{[\partial_x^2 u_m]_{x,D_T^{(m)}}^{(\alpha)} + \varepsilon^{\frac{\alpha}{2}}[\partial_x^2 u_m]_{t,D_T^{(m)}}^{(\frac{\alpha}{2})} + \varepsilon[\partial_t u_m]_{x,D_T^{(m)}}^{(\alpha)} + \varepsilon^{1+\frac{\alpha}{2}}[\partial_t u_m]_{t,D_T^{(m)}}^{(\frac{\alpha}{2})} +$$
$$+ \varepsilon^{\frac{1+\alpha}{2}}[\partial_x u_m]_{t,D_T^{(m)}}^{(\frac{1+\alpha}{2})}\Big\} \le C\Big\{[\partial_{x'}\varphi]_{x',R_T}^{(\alpha)} + \varepsilon^{\frac{\alpha}{2}}[\partial_{x'}\varphi]_{t,R_T}^{(\frac{\alpha}{2})} + \varepsilon^{\frac{1+\alpha}{2}}[\varphi]_{t,R_T}^{(\frac{1+\alpha}{2})}\Big\},$$

where the constant C does not depend on ε.

Asymmetrical screw flows which minimize the integral remainder between the sides of the Boltzmann equation

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The Boltzmann equation for the model of hard spheres is considered. This non-linear kinetic integro-differential equation is the main instrument to study the complicated phenomena in the multiple-particle systems, in particular, rarefied gas. The well-known exact solutions of this equation in the form of global and local Maxwellians have been described so far only as equilibrium states of a gas. That is why the search of those or other approximate solutions is topical. This equation has form [1-2]:

$$D(f) = Q(f,f) \tag{1}$$