ON THE HYDROSTATIC APPROXIMATION OF NAVIER-STOKES-MAXWELL SYSTEM WITH 2D ELECTRONIC FIELDS

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Abstract. In this paper, we prove the local well-posedness of a scaled anisotropic Navier-Stokes-Maxwell system in a two-dimensional striped domain with a transverse magnetic field around $(0,0,1)$ in Gevrey-2 class. We also justify the limit from the scaled anisotropic equations to the associated hydrostatic system and obtain the precise convergence rate. Then, we prove the global well-posedness for the system and show that small perturbations near $(0,0,1)$ decay exponentially in time. Finally, we show the optimality of the Gevrey-2 regularity by proving the solution to linearized hydrostatic system around shear flows $(V(y),0,0)=(y(1-y),0,0)$ with some initial data (ζ,ζ^1) grows exponentially. More precisely, for some large parameter $|k|>M\gg 1$ corresponding to the frequency in x, there exists a solution $h_k(t,x,y)$ of the system

$$\begin{cases}\partial_{tt}h_k+\partial_t h_k-\partial_{yy}h_k+V(y)\partial_x h_k=0,\\ h_k(0,x,y)=\zeta,\quad \partial_t h_k(0,x,y)=\zeta^1,\\ h_k(t,x,0)=h_k(t,x,1)=0,\end{cases}$$

such that for any $s\in[0,\frac{1}{2})$ and $t\in[T_k,T_0)$ with $T_k\approx|k|^{s-\frac{1}{2}}\to 0$ as $|k|\to\infty$ and some T_0 small and independent of k, it satisfies

$$\|h_k(t)\|_{L^2}\geq C\,e^{\sqrt{|k|}t}(\|\zeta\|_{L^2}+\|\zeta^1\|_{L^2}),$$

for some $C>0$ independent of k.

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