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Vortex sheet solutions for the Ginzburg–Landau system in cylinders

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We consider the Ginzburg-Landau energy E_ϵ for $\mathbb{R}^M$-valued maps defined in a cylinder $B^N \times (0,1)^n$ satisfying the degree-one vortex boundary condition on $\partial B^N \times (0,1)^n$ in dimensions $M \geq N \geq 2$ and $n \geq 1$. The aim is to study the radial symmetry of global minimizers of this variational problem. We prove the following: if $N \geq 7$, then for every $\epsilon > 0$, there exists a unique global minimizer which is given by the non-escaping radially symmetric vortex sheet solution $u_\epsilon(x,z) = (f_\epsilon(|x|)\frac{x}{|x|}, 0_{\mathbb{R}^{M-N}})$, $\forall x \in B^N$ that is invariant in $z \in (0,1)^n$. If $2 \leq N \leq 6$ and $M \geq N+1$, the following dichotomy occurs between escaping and non-escaping solutions: there exists $\epsilon_N > 0$ such that

• if $\epsilon \in (0, \epsilon_N)$, then every global minimizer is an escaping radially symmetric vortex sheet solution of the form $R\tilde{u}_\epsilon$ where $\tilde{u}_\epsilon(x,z) = (\tilde{f}_\epsilon(|x|)\frac{x}{|x|}, 0_{\mathbb{R}^{M-N-1}}, g_\epsilon(|x|))$ is invariant in z-direction with $g_\epsilon > 0$ in $(0,1)$ and $R \in O(M)$ is an orthogonal transformation keeping invariant the space $\mathbb{R}^N \times \{0_{\mathbb{R}^{M-N}}\}$;

• if $\epsilon \geq \epsilon_N$, then the non-escaping radially symmetric vortex sheet solution $u_\epsilon(x,z) = (f_\epsilon(|x|)\frac{x}{|x|}, 0_{\mathbb{R}^{M-N}})$, $\forall x \in B^N, z \in (0,1)^n$ is the unique global minimizer; moreover, there are no bounded escaping solutions in this case.

We also discuss the problem of vortex sheet $\mathbb{S}^{M-1}$-valued harmonic maps.

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