Title:[1] Mathematical connection between two classes of 2-D free boundary problems in inviscid fluid mechanics.

Abstract:

Two-dimensional vortex dynamics is relevant in geophysical fluid dynamics. Equilibrium shapes are of particular interest. A problem arising in a very different physical context that of a translating bubble with surface tension. These are just two examples of two classes of 2-D free boundary problems–one with surface tension and no vorticity, and the other with vorticity and no surface tension. There are other examples, for instance, 2-D water waves with surface tension and no shear, and with shear and no surface tension. Though these problems arise in very different physical contexts and at first sight have differing mathematical formulation, it wasn't realized until recently that these problems have a common mathematical formulation.

For instance, the translating bubble and the hollow vortex is mathematically equivalent to *Problem 1*: *Determine a simple closed curve* $z = \mathcal{Z}(s) \subset \mathbb{C}$, *parametrized by arclength* s, *that satisfies*

$$\frac{\partial}{\partial s}\overline{\mathcal{Z}} = -i\gamma\overline{\mathcal{Z}} + \xi\left(\mathcal{Z}(s)\right)$$

for some a priori unknown analytic function ξ *in the domain* Ω *exterior of* $z = \mathcal{Z}(s)$, *except at* ∞, *where we have*

$$\xi(z) \sim -ibz + O(1) \text{ , as } z \to \infty$$

where (γ, b) *is specified.* A number of results for this problem will be presented, including existence of solutions and the meromorphic nature of the conformal map that maps unit disk $\mathbb{D}$ to the exterior of Ω.

[1] Joint work with Darren Crowdy, Imperial College