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The vortex-wave system with gyroscopic effects

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Abstract. In this paper, we study the well-posedness for a coupled PDE/ODE system describing the interaction of several massive point vortices moving within a vorticity background in a 2D ideal incompressible fluid. The points are driven by the velocity induced by the background vorticity, by the other vortices, and by a Kutta-Joukowski-type lift force creating an additional gyroscopic effect. This system reduces to the so-called vortex-wave system, introduced by Marchioro and Pulvirenti [13, 14], when the point vortices are massless.

On the one hand, we establish existence of a weak solution before the first collision. We show moreover that the background vorticity is transported by the flow associated to the total velocity field. On the other hand, we establish uniqueness in the case where the vorticity is initially constant in a neighborhood of the point vortices. When all the densities of the point vortices have the same sign, no collision occurs in finite time and our results are then global in time. Our proofs strongly rely on the definition of a suitable energy functional.

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