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INSTITUTO DE CIENCIAS MATEMÁTICAS

SPECIAL SESSION ON VORTICES IN CLASSICAL AND QUANTUM FLUIDS

DATE: Wednesday, 18 March 2020

VENUE: Aula Naranja, ICMAT

LECTURES:

10:30-11:30. **Dynamics of nearly-parallel vortex filaments in the Gross-Pitaevskii equations**, Robert Jerrard (Toronto)

11:45-12:45. **Dynamics and collisions of nearly parallel vortex filaments**, Evelyne Miot (Grenoble)

15:00-16:00. **On the energy of critical solutions of the binormal flow**, Luis Vega (BCAM y EHU)

16:15-17:15. **Gravitating vortices with positive curvature,** Mario Garcia-Fernandez (ICMAT)

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Abstracts

Dynamics of nearly-parallel vortex filaments in the Gross-Pitaevskii equations, Robert Jerrard (Toronto)

We study the motion of thin, nearly parallel vortex filaments in 3D solutions of the Gross-Pitaevskii equations. In particular, we show that in a certain scaling limit, these filaments are governed by a system of nonlinear Schrodinger equations formally derived by Klein, Majda and Damodaran in the mid 90s, in the context of the Euler equations. This is the first rigorous justification of the Klein-Majda-Damodaran model in any setting. This is joint work with Didier Smets.

Dynamics and collisions of nearly parallel vortex filaments, Evelyne Miot (Grenoble)

We focus on the issue of collisions in finite time for vortex filaments in 3D incompressible fluids, according to a model introduced by Klein, Majda and Damodaran. We also introduce and study some basic properties for another more precise model for the dynamics of one filament introduced by Zhakarov. This is joint work with Valeria Banica and Erwan Faou.

On the energy of critical solutions of the binormal flow, Luis Vega (BCAM y EHU)

The binormal flow is a model for the dynamics of a vortex filament in a 3D inviscid incompressible fluid. The flow is also related with the classical continuous Heisenberg model in ferromagnetism, and the 1D cubic Schrödinger equation. We consider a class of solutions at the critical level of regularity that generate singularities in finite time. One of our main results is to prove the existence of a natural energy associated to these solutions. This energy remains constant except at the time of the formation of the singularity when it has a jump discontinuity. This is based on joint work with Valeria Banica.

Gravitating vortices with positive curvature, Mario Garcia-Fernandez (ICMAT)

We give a complete solution to the existence problem for gravitating vortices on the Riemann sphere with positive topological constant c>0, as introduced in arXiv:1510.03810. Our main result establishes the existence of solutions provided that an algebro-geometric numerical condition for the location of the vortex is satisfied. To this end, we use a continuity path starting from Yang's solution with c=0, and deform the coupling constant \alpha towards 0. A salient feature of our argument is a new bound S_g \geq c for the scalar curvature of gravitating vortices, which we apply to construct a limiting solution along the path via Cheeger-Gromov theory. Joint work with V.Pingali and C. Yao (arXiv:1911.09616).