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Knotting of vortex tangle in three-dimensional random waves

ALEXANDER TAYLOR, MARK DENNIS, University of Bristol — Quantised vortices are fundamental to the description of disordered 3D complex scalar fields such as turbulent superfluids or BECs, but also a wide range of other phenomena including optical volume speckle, the quantum eigenfunctions of chaotic 3D cavities, and liquid crystal phases. These systems all exhibit statistically random large scale vortex tangles that are difficult to describe analytically, but certain properties appear universal despite the physically different origin of complexity. We track vortex tangle in numerical simulations of the random wave model of chaotic eigenfunctions [1], where the waves are linear, but the zeros themselves are very nonlinear features forming a dense tangle of filaments whose geometry and topology we analyse numerically. We observe that while many standard quantities reveal only a common statistical scaling on the large scale, the topology - particularly the occurrence of knots in vortex loops - discriminates between tangles with different origins. In fact, knotting is surprisingly rare when compared to standard random walk models.

[1] M V Berry and M R Dennis, *Proc R Soc A* **456**, 2059-79 (2000)

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