Mathematical Physics

Supercurrent coupling destabilizes knot solitons

J. M. Speight, J. Jäykkä

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In an influential paper of 2002, Babaev, Faddeev and Niemi conjectured that two-component Ginzburg-Landau (TCGL) theory in three dimensions should support knot solitons, where the projective equivalence class of the pair of complex condensate fields [psi_1,psi_2]:R^3 -> CP^1 has non-zero Hopf degree. The conjecture was motivated by a certain truncation of the TCGL model which reduced it to the Faddeev-Skyrme model, long known to support knot solitons. Physically, the truncation amounts to ignoring the coupling between [psi_1,psi_2] and the supercurrent of the condensates. The current paper presents a direct test of the validity of this truncation by numerically tracking the knot solitons as the supercurrent coupling is turned back on. It is found that the knot solitons shrink and disappear as the true TCGL model is reached. This undermines the reasoning underlying the conjecture and, when combined with other negative numerical studies, suggests the conjecture, in its original form, is very unlikely to be true.

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