Two-dimensional supersonic nonlinear Schrödinger flows past obstacles

Gennady El

Department of Mathematical Sciences, Loughborough University,
Loughborough, LE11 3TU, UK
Tel: +44 1509 222869, email: g.el@lboro.ac.uk

Abstract:

I will present recent results on the analytic description of the waves generated by a two-dimensional supersonic flow of a superfluid past a large slender obstacle [1]. If the speed of the oncoming flow is sufficiently high, the generated wave pattern in each half-plane generally represents a combination of two steady oblique dispersive shock waves (DSWs) having contrasting asymptotic properties. The front DSW transforms into a linear Kelvin-Bogoliubov "ship-wave" [2] at sufficiently large distances from the obstacle, while the rear one assumes the form of a "fan" of convectively stable oblique dark solitons [3], [4]. Detailed modulation description of the generated waves is obtained in the hypersonic approximation when the original 2+0 boundary problem for the nonlinear Schrödinger equation (defocussing) can be asymptotically reduced to a 1+1 dispersive piston problem [5], [6]. The analytic results are supported by full 2D unsteady numerical simulations.

References:

1. G.A. El, A.M. Kamchatnov, V.V. Khodorovskii, E.S. Annibale and A. Gammal, Phys. Rev. E 80, 046317 (2009).
2. Yu. G. Gladush, G. A. El, A. Gammal, and A. M. Kamchatnov, Phys. Rev. A 75, 033619 (2007).
3. G.A. El, A. Gammal, and A.M. Kamchatnov, Phys. Rev. Lett. 97, 180405 (2006).
4. A.M. Kamchatnov and L.P. Pitaevskii, Phys. Rev. Lett. 100, 160402 (2008).
5. G.A. El, V.V. Khodorovskii and A.V. Tyurina, Phys. Lett. A 333, 334-340 (2004).
6. M.A. Hoefer, M.J. Ablowitz and P.Engels, Phys. Rev. Lett. 100, 084504 (2008).