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Kelvin wake pattern and wave resistance at large Froude numbers
MICHAEL BENZAQUEN, ALEXANDRE DARMON, ELIE RAPHAËL, UMR CNRS 7083 Gulliver, ESPCI ParisTech — Recently, M. Rabaud and F. Moisy provided an analysis of airborne observations of ship wakes [1]. Their conclusion that the angle of the wake was no longer constant when varying the hull Froude number Fr drew the attention of the scientific community, as it was in contradiction with Kelvin's century old theory of ship waves. We perform a mathematical study to understand these surprising observations [2]. Modelling the moving object by a pressure field symmetrical about a point, we analytically show that the angle delimiting the wake region outside which the surface is essentially flat actually remains constant and equal to the Kelvin angle, whereas the angle corresponding to the maximum amplitude of the waves indeed decreases with the Froude number, scaling as $1/Fr$ for large Froude numbers. To correctly reflect the elongated geometry of boats, we extend our calculations to anisotropic objects and show that the angle corresponding to the maximum amplitude of the waves also depends on the aspect ratio W of the object and scales as $\sqrt{W}/Fr$ for large Froude numbers [3].

[1] M. Rabaud and F. Moisy, PRL 110, 214503.
[2] A. Darmon, M. Benzaquen and E. Raphael, JFM 738, 2014, R3.
[3] M. Benzaquen, A. Darmon and E. Raphael, (accepted in PoF) arXiv:1404.1699.

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