On a compatibility condition for oscillating flow past a rotating body

Thomas Eiter
Freie Universität Berlin & Weierstrass Institute Berlin, Germany.
thomas.eiter@wias-berlin.de

Abstract

We consider the time-periodic viscous flow around a rotating rigid body. Since the linearization of this problem is not well-posed in a setting of classical Sobolev spaces, we introduce a framework of homogeneous Sobolev spaces where the corresponding resolvent problems are uniquely solvable. In the case of a pure rotation, one can derive uniform resolvent estimates, which lead to the existence of solutions to the time-periodic problem. In the case of a rotating and translating body, the uniformity of the resolvent estimates requires additional restrictions, and the existence of time-periodic solutions merely follows if the two present oscillating processes are compatible: The rotational velocity of the body and the angular velocity of the time-periodic forcing are rational multiples of each other. A counterexample suggests that this restriction is even necessary for existence of time-periodic solutions in the proposed functional framework.

Keywords: Stokes flow, Oseen flow, rotating obstacle, resolvent problem, time-periodic solutions.

References

[1] T. Eiter. On the Oseen-type resolvent problem associated with time-periodic flow past a rotating body. *SIAM J. Math. Anal.*, 54(4):4987–5012, 2022.

[2] T. Eiter. On the Stokes-type resolvent problem associated with time-periodic flow around a rotating obstacle. *J. Math. Fluid Mech.*, 24(2): Paper No. 52, 17 pages, 2022.