Seminários Contínuos do Programa de Pós-Graduação em Matemática

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New Frontiers in Applied Complex Analysis: Solving Problems in Multiply Connected Domains

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ABSTRACT

In recent years a general mathematical framework for solving applied problems in multiply connected domains has been developed based on use of the Schottky-Klein prime function of the compact Riemann surface, known as the Schottky double, associated with the corresponding domain. In the first part of the talk I will introduce the formalism of the Schottky-Klein prime functions and briefly review some of its applications to potential theory, particularly in the context of fluid dynamics. In the second part of the talk I will describe additional function theoretic objects, known as the secondary Schottky-Klein prime functions, which we have recently developed together with collaborators at Imperial College [1]. These new functions are particularly useful to construct slit maps of mixed type, i.e., involving both radial and circular slits, which are useful to tackle problems with mixed boundary conditions. As a first application, I will present analytical solutions [2] for multiple bubbles steadily propagating in a Hele-Shaw cell, where the fluids are confined between two parallel glass plates. The more difficult problem of time-dependent solutions for Hele-Shaw bubbles will also be considered [3]. Possible applications to vortex flows past multiple obstacles will be briefly discussed.

[1] G. L. Vasconcelos, J. S. Marshall, and D. G. Crowdy, Secondary Schottky-Klein prime functions associated with planar multiply connected domains: theory and applications, Proc. Roy. Soc. A 471, 20140688 (2014).
[2] G. L. Vasconcelos, Multiple bubbles and fingers in a Hele-Shaw channel: complete set of steady solutions, J. Fluid Mech. 780, 299 (2015).
[3] M. Mineev-Weinstein and G. L. Vasconcelos, Multiply-connected Laplacian growth: exact time-dependent solutions and the asymptotic velocity selection in the absence of surface tension, to appear in Math. Mod. Nat. Phen. (2019).