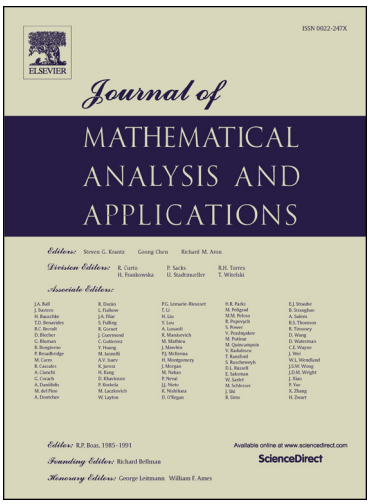
Accepted Manuscript



Flows of incompressible viscous liquids with anisotropic wall slip

C. Le Roux

PII: S0022-247X(18)30413-X
DOI: https://doi.org/10.1016/j.jmaa.2018.05.020
Reference: YJMAA 22252

To appear in: *Journal of Mathematical Analysis and Applications*

Received date: 21 October 2017

Please cite this article in press as: C. Le Roux, Flows of incompressible viscous liquids with anisotropic wall slip, *J. Math. Anal. Appl.* (2018), https://doi.org/10.1016/j.jmaa.2018.05.020

Flows of incompressible viscous liquids with anisotropic wall slip

C. Le Roux

Department of Mathematics and Applied Mathematics, University of Pretoria, Private Bag X20, Hatfield 0028, South Africa

Abstract

This paper deals with a boundary-value problem for the Stokes equations with a general direction-dependent Navier type slip boundary condition. This problem models the steady laminar flow of an incompressible linearly viscous liquid in a bounded domain with an impermeable rough boundary with variable and anisotropic roughness. It is proved that the problem has a unique weak solution.

Keywords: Stokes equations, slip boundary condition, rough boundary
2010 MSC: 76D03, 76D07

1. Introduction

During the past twenty years significant progress was made in the analysis of laminar flows of Newtonian liquids (e.g. water) over complex surfaces. The numerical simulation of such flows is greatly simplified if the complex boundary surface and microscopic boundary conditions are approximated by a smooth boundary and an effective boundary condition. Lee *et al.* [1] review physical experiments and computational studies conducted to deduce effective boundary conditions for flows over rough or structured surfaces, surfaces with chemical patterns, nano-bubbles or polymer layers, and superhydrophobic surfaces. In many of these situations, the proposed effective boundary condition is a partial slip boundary condition of the form introduced by Navier [2]. Lee *et al.* [1] discuss the progress and difficulties in deriving the effective Navier slip length in these situations.

During the same period several mathematical studies of flows over rough surfaces, involving various assumptions and techniques, yielded Navier type slip conditions as effective boundary conditions. These works deal with flows over one-dimensional boundaries with periodic irregularities, e.g. [3, 4, 5, 6], flows over two-dimensional boundaries with periodic irregularities, e.g. [7, 8, 9, 10, 11, 12], and flows over one-dimensional boundaries with random irregularities,

URL: ianleroux@yahoo.com (C. Le Roux)