

Theoretical-group analysis of the inviscid gravity currents

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Abstract

There are many examples of gravity currents in nature such as river water discharging into the sea and pyroclastic flows. They occur whenever fluid of one density flows horizontally into the another fluid of a different density. In this paper, we consider axisymmetric inviscid gravity current that results when fluid contained between two concentric circular cylinders is suddenly released by the removal of the inner cylinder and we take the shallow water model of this current. And we restrict our investigation to only currents for which there is a balance between the inertia of the current and the driving buoyancy force. Then we investigate the self-similarity solutions of the shallow water equations of axisymmetric gravity currents by applying Lie symmetry groups. And we present the general symmetry groups of the axisymmetric shallow water equations assuming that there exists a variable in flow produced by a source at the origin. In the literature the most general method which is employed for the shallow water equations, is dimensional analysis and there exists only one type of self-similarity variable and to the dimensional analysis method [1,2]. Furthermore, in this study we obtain all possible reduced forms of these equations by using two types of reduction methods of Lie symmetries. And we find different self-similarity variables and self-similarity solutions of these equations for the specific values of the Lie group parameters.

Keywords and phrases : Axisymmetric shallow water equations, Lie symmetry groups, self-similarity solutions, inviscid gravity currents, variable inflow, reduction.

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