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# Chapter 1

# Introduction

Every day, everyone is used to grasping the difference between a solid material and a liquid substance intuitively. However, giving a proper physical definition of what a fluid actually is is not that simple. Starting with an easy argument, a fluid is something which cannot support shear forces at equilibrium. You cannot deny it and it also does make sense. Despite this, following this definition you start having trouble when comes up to your mind that there are lots of fluids which act like fluids or solids depending on the magnitude of the force applied on their surface or on the time scale. These are what we call non-Newtonian fluids and their behaviour is always stunning, no matter for how many years someone has studied them. More specifically, non-Newtonian fluids can be easily classified as shear thinning fluids, whose viscosity decreases with increased stress, or shear thickening fluids, whose viscosity increases with decreased stress. They are actually pretty common even in our daily life and you sure have seen some of them. Think about the tomato souce, it is what we can call shear thinning fluids. In fact, when you try to make it flow from the bottle it acts like a fluid, however, once on the plate it turns out to be solid. Nevertheless, regardless of how unique non-Newtnian fluids are, we will leave them alone and we will keep talking only about Newtonian fluids, whose viscosity is linear with respect to the stress applied.

The main subject of this work is fluid dynamics, that field of physics which worries about describing the motion of fluids in different situations, some more complex than others. We can analyse the motion of a fluid using two different approaches: the Eulerian approach and the Lagrangian approach. The initial one chooses a fixed point in space and focuses on how the flow properties change on a fixed interval of time. The latter, instead, chooses an ”element” of fluid and analyzes its change over time and space. Both of them are valid depending on the conditions given and what we want to achieve with the available resources.

**laminar and turbolent flow””

(da aggiustare)

# Chapter 2

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## Chapter 6

# Application of LBM and results