European Research Council
Established by the European Commission

Università di Roma Tor Vergata
Dipartimento di Fisica

Seminar

Thursday, 29th November 2018 --- h. 14:30

Sala Struttura della Materia (Dipartimento di Fisica)

Prof. Roberto Rusconi

Department of Biomedical Sciences,
Humanitas University,
Milan

"The importance of fluid mechanics in the microbial world: From the transport of bacteria to the formation of biofilms"

Abstract

The vast majority of microorganisms are exposed to fluid flow, whether in natural environments, the human body, or artificial systems. Flow plays an important role in a broad variety of microbial processes, including nutrient uptake and fertilization, as well as in many industrial applications, ranging from wastewater treatment to the production of biofuels. However, despite the pervasive occurrence and implications of a fluid dynamic environment, its influence on the transport and attachment of bacteria to surfaces and the formation of biofilms remains poorly investigated and understood. This challenge can be efficiently addressed using microfluidics, which allows for accurate control and manipulation of the physical and chemical environment experienced by the cells, greatly facilitating parallelization and replication to minimize artifacts or contaminations.
In this talk, I will present a novel and counterintuitive phenomenon by which the coupling of flow with bacterial motility and morphology creates strong heterogeneity in the spatial distribution of bacteria by "trapping" them near the walls of a channel, thus increasing the likelihood of colonizing those areas. In addition, the topography of the surface can enhance bacterial attachment in specific regions, as shown by microfluidic experiments and numerical modelling of bacterial transport around pillars and over corrugated boundaries. I will then discuss the effect of flow and geometric constraints on the formation and structure of biofilms, namely the occurrence of suspended filamentous aggregates called streamers. I will show that streamers form as consequence of secondary vortical flows that drive the accumulation and extrusion of the polymeric substances secreted by the bacteria and have much higher potential for causing clogging and spreading infections. These studies underscore the importance of fluid flow in triggering bacterial attachment and biofilm formation under common environmental conditions, with significant consequences in a broad range of ecological, industrial, and medical problems.

ERC Advanced Grant (N. 339032) "NewTURB"
(P.I. Prof. Luca Biferale)