Red Blood Cell under Shear: Numerical Simulations for the Investigation of Shapes and Transitions

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ABSTRACT

Blood is a suspension of cells flowing in plasma. Red blood cells (RBCs), which occupy almost half of the blood volume, are the essential element controlling the behavior of blood under flow. A red blood cell is a drop of hemoglobin solution enclosed in a biological elastic membrane. At rest, it has the shape of a biconcave disk of diameter 8 microns, approximately. Thanks to the membrane elasticity and to its low volume-to-surface ratio, the red blood cell is very deformable. Numerical methods for computing its dynamics have to account for these large deformations.

The essential role of RBCs in blood rheology has motivated a rich corpus of studies to understand its behavior under flow. As physiological flows are shear-dominated, the dynamics of an isolated RBC under pure shear flow has been considered as the basic element of blood rheology in circulation. This topic has been investigated for more than 50 years [1], but is still the topic of active research: new dynamics have recently been discovered [2] and the transitions between the dynamics of a RBC under shear are still to be fully explained [3, 4].

In this talk, we will detail how numerical simulations based on the immersed boundary method, together with other numerical simulations based on Smoothed Dissipative Particle Dynamics and microfluidic experiments [4], have enabled to enlighten the mechanisms responsible for the changes of dynamics of a RBC as a function of the imposed shear rate and the viscosity of the external suspending medium. This work has largely contributing in clarifying the phase diagram of a RBC under shear.

REFERENCES

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