Micro-objets déformables sous écoulement: Dynamique de vésicules et capsules

Gwenn Boëdec et Julien Deschamps









Vesicles and capsules



Background and motivations

Encapsulation and vectorization



Protection, transport and release Food industry, cosmetology, medical therapy...



Encapsulation of living cells within double emulsion droplets produced by flow focusing



Choi et al., Lab on Chip, 2016

Rheology of suspensions



Lac et al, JFM, 2007

Fahraeus-Lindqvist effect



Pries et al., American Journal of Physiology, 1992

HD 15, D 7 µm



HD 30



HD 45



HD 75



HD ca. 15, D ca. 8 µm



HD ca. 35, D ca. 12.6 µm



Pries et al., American Journal of Physiology, 2005

Model system for red blood cells



Blood in vessels

RBC membrane constitution





Schematic view of RBC membrane



Vesicle: model system for cells



Modelization of living cells behavior

Static equilibrium shapes



Seifert, Advances in physics, 1997

Bud formation of vesicle while subjected to elongation flow



Kantsler et al., 2005

Short selection of actual topics



Müller, Fedosov, Gompper, Nature, 2014

Cell free layer, Margination



Tahiri et al., Microvascular research, 2013 Shapes and migration in Poiseuille flow

Self diffusion of RBC jet



Peyresq du 29/05/17 au 02/06/17



Lecture 1: Basic notions, modelization

Fluid and flow descriptions Interfacial mechanics for vesicles and capsules Coupling conditions





How to describe such complex system?

Lecture 2: Dynamics of vesicles and capsules in unbounded shear flow

Keller Skalak Model —> tumbling and tank-treading dynamics



Lecture 2: Dynamics of vesicles and capsules in unbounded shear flow

Real phase diagram for vesicles



Phase diagram for vesicles

Lecture 2: Dynamics of vesicles and capsules in unbounded shear flow

Real phase diagram for capsules



Phase diagram for capsules

Lecture 3: Lift velocity and pearling instability

Vesicle/capsule dynamics near a plane wall



Lift of a vesicle with gravity



Abkarian et al., PRL, 2002

Lecture 3: Lift velocity and pearling instability

Tubular vesicle pearling instability

Pearling instability Destabilization of a tubular vesicle



Kantsler, et al. PRL, 2008