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News

Fundamental Research

Complex fluids, colloids and condensed matter | Fluid mechanics

Numerical methods and optimization

Nicolas Fintzi , winner of the 2025 Yves Chauvin* prize, received his award at a ceremony held at IFPEN's Rueil-Malmaison site on 27 November. The award was in recognition of Nicolas' research focusing on gaining a better understanding of the buoyancy-driven droplet flows found in many chemical engineering processes, such as gravity separators and liquid-liquid extractors. Interview with the winner.

Can you tell us a little about your background?

I grew up in Lyon. After graduating high school, I enrolled in a university institute of technology (IUT) to study mechanical and industrial engineering, before going on to study mechanical engineering at the INSA engineering school in Lyon. I did my Master's degree at one of the school's affiliated partners, specializing in plastics and composite materials. My knowledge of homogenization then enabled me to move naturally on to my PhD thesis, also focusing on homogenization, this time applied not to composites but to continuous media such as droplet or bubble flows. These types of media are not locally homogeneous, and we are attempting to describe these phenomena on a global level.

What are you doing now?

I was offered a position at IFPEN where I am conducting research that is quite similar to what I was doing during my thesis. I divide my time between two projects. Much of my work is related to a fundamental research project, looking at dispersed phase flows and multiscale modeling, following on from my thesis. The rest of my time is devoted to the CleanWash flotation water treatment project, where I directly apply the results of my thesis. The practical application of my earlier work is very exciting.

Can you explain the objective of your PhD research in a few words?

I set about trying to model dispersed-phase flows, where particles, bubbles, or droplets are suspended in a fluid, such as bubbles in water or red blood cells in blood. Although they appear homogeneous to the naked eye, in reality these media exhibit local inhomogeneities. To study them, we use Navier-Stokes and other such equations, which are well suited to the local scale of each phase but need to be

averaged at the macroscopic scale.

I particularly focused on emulsions**, studying the movement of droplets in water. The objective was to predict their movements and shape, taking into account interactions between the phases. A key challenge lay in defining “closure terms” to describe local-scale flow without directly resolving it, enabling efficient modeling of droplet environments.

Can you give us an example of how your research can be applied?

One application relates to the flotation process, used to purify water. Microbubbles are injected into a tank of water containing microplastics. As they rise, they attach themselves to microplastic fibers and bring them to the surface, allowing them to be removed. I use averaged equations to calculate parameters such as bubble rise velocity, fiber collision frequency, and the required height of the flotation column to effectively purify the mixture, for example to 80%.

What memories do you have of the scientific supervision you received?

I had regular contact with my supervisor, Stéphane Popinet, throughout my thesis work. Daniel Lhuillier and other researchers in his entourage also offered valuable advice. Moreover, I would like to underline the crucial role played by my supervisor at IFPEN, Jean-Lou Pierson. His support greatly contributed to the successs of my thesis and the significant results obtained.

What did you gain by carrying out your research at IFPEN?

These three years of PhD study gave me the time I needed to thoroughly master my research topic, giving me access to reference works and specialized scientific literature. This period also allowed me to develop greater scientific rigor by writing articles meeting the demanding standards of the academic community. So my thesis experience was extremely formative, effectively preparing me for a career in research.

* Each year, the Yves Chauvin prize is awarded to a PhD student at IFPEN in recognition of the excellence and originality of their research work. It is awarded by IFPEN’s Scientific Board.

** A heterogeneous medium created by the dispersion of a liquid in another liquid in the form of very fine particles.

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