Call for two post-doctoral fellowships

ANR Eva-Covid :

Evaporation of virus-loaded respiratory fluid droplets: Impact of their environment, generation and composition

Laboratoire de Génie Chimique de Toulouse, Département Génie des Interfaces et Milieux Divisés

Summary of the Eva-Covid Project

As winter descends upon Europe, the COVID-19 is propagating at alarming speed, which rises the recurring issue of virus seasonality, which is ubiquitous but not well-understood. In this project, we thus propose to systematically investigate the relationship between a respiratory droplet' history (composition, size, relative humidity, temperature) and its contamination efficiency. SARS-CoV-2 is transmitted through virus-loaded aqueous droplets generated through sneezing, coughing, speaking or breathing, which may reach directly the respiratory track of another host or indirectly after being deposited on a surface. These respiratory droplets are composed of a complex fluid containing water, electrolytes, proteins and lipids. Following their generation and expulsion, these droplets undergo drying as water evaporates into air. This process will crucially impact the duration during which droplets may remain suspended in air before settling on the ground. It will also impact the virus location within the droplets, which impacts its subsequent accessibility. However, the complex nature of the respiratory fluid has not been adequately considered so far in the recent attempts to model water evaporation. This is highly problematic to obtain trustworthy quantitative assessments, as water diffusion coefficient may be reduced by several orders of magnitude due to the formation of composition gradients throughout the drying droplet.

We propose to tackle this issue by implementing a dual experimental-theoretical strategy and explicitly considering non-ideal thermodynamics within complex aqueous solutions. We will monitor composition gradients in well-controlled drying setups using Raman confocal microscopy, systematically varying relative humidity, temperature and key composition variables. We will extract water transport coefficient from these experimental data sets using transport equations and a generalized Fick's equation, including non-ideal thermodynamics. We will use a model virus to investigate preferential location effects using fluorescence confocal microscopy. We will map out the osmotic conditions viruses experience throughout drying. We will thus provide a link between interfacial and dynamic experiments, that are complex, and bulk and static experiments, that are much simpler.

This project is coordinated by Kevin Roger, and will benefit from an interdisciplinary team of researchers at the Laboratory of Chemical Engineering, covering the fields of physical chemistry, biophysics, fluid mechanics, with an expertise in complex fluids drying. (Benjamin Lalanne, Yannick Hallez, Micheline Abbas, Clémence Coetsier)

The project will result in a quantitative framework that will describe the impact of droplet environment, composition and size on its transmission efficiency. This framework will notably give keys to impact transmission by monitoring our indoor environment and evaluating separately the transmission likelihood for the different droplet generation pathways.

Practical details

What: Two post-doctoral positions of one year each are opened within the Eva-Covid project.

When: Starting date must be on February 01st 2021 due to the specific nature of the call (RA-COVID). Applications should thus ideally be received before January 08th.

Where: Research will be conducted at Laboratoire de Génie Chimique, on the ENSIACET Campus.

Why: This project stems from several recent results within the team dedicated to complex fluids drying (ANR grant COATING).

How much: The net salary is around 2200 euros per month

Candidates' profiles

Position 1: PhD in experimental Colloidal Chemistry/Soft Matter, preferably focused on drying-related problems. Good notions in Raman spectroscopy/Microscopy/Transport are an advantage.

- ➔ The Post-doc will revolve around experimental studies of respiratory fluid drying using mainly Raman confocal microscopy, drying cells (1D, 3D) and well-chosen model and real fluids.

Position 2: PhD in numerical transport Physics and Hydrodynamics, with good applied mathematics notions to handle transport equations solving. Good notions in drying-related problems are an advantage.

- ➔ The Post-doc will revolve around solving transport equations using the experimental data acquired from experiments and existing theoretical tools developed in the lab. Assessment of hydrodynamic complexity in multidirectional flows will be performed as well as an evaluation of the settling/drying coupling.

The two post-doctoral researchers will work in Tandem under the supervision of the team, which includes specialists within all aspects treated. All aspects of the projects have been already scouted, which should ensure a rapid and smooth start.

Contact

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