Grenoble Alliance for Integrated Structural & Cell Biology

INTERNSHIP PROPOSAL

Institute and Group: BIG/LPCV/ Light, Photosynthesis and Metabolism team (lpm-research.com)

Supervisor: Johan Decelle (Giovanni Finazzi co-supervisor)

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Research project title:

Addressing phytoplankton ecophysiology using an integrated imaging approach

5 Keywords to describe the project:

microalgae, symbiosis, photobiology, 3D imaging, chemical imaging

Description of the project (aims, experimental techniques, recommended background):

Eukaryotic microalgae are highly diverse in the ocean, and play a pivotal role in food webs, in the biological CO_2 pump, and by producing half of the oxygen of our atmosphere. Because of their ecological relevance, understanding the responses of microalgae to global change is crucial. For instance, global warming is predicted to decrease the nutrient concentration of the surface ocean, which is challenging for photosynthesis. Most of our knowledge of microalgal acclimation to abiotic stresses relies on cultures maintained in artificial medium, which is exceptionally nutrient-rich contrarily to natural conditions. To tackle this knowledge gap, **this master project aims at investigating the physiology of key oceanic microalgae using single-cell microscopy approaches in three different trophic conditions**: i. in their natural sea water (nutrient-poor condition), ii. in artificially enriched growth media and iii. in symbiosis within a host cell. Ecophysiology responses to the three conditions will be compared based on metal and respiration measurements, and non-invasive imaging of photosynthesis. The candidate, with a background in algal physiology, will also learn and use single-cell microscopy techniques (chemical imaging* and 3D electron microscopy - FIB-SEM**) as these techniques provide pivotal subcellular information about metabolic and structural changes. Chemical imaging will allow visualizing and quantifying the fixation and allocation of carbon inside the cell, and FIB-SEM will highlight the structural features of the photosynthetic machinery and organelle-organelle communication. Overall, this project will provide a complete scenario of the cellular and subcellular responses of microalgae and will pave the way for *omics* studies to further interpret high-resolution imaging.

*: nanoSIMS: Nanoscale Secondary Ion Mass Spectrometry.

**: Focused Ion Beam Scanning Electron Microscopy (collaboration with IBS and INAC).

Justification that the internship's subject fits with the general theme of GRAL:

Using a combination of cellular and subcellular imaging techniques to assess dynamic responses of organisms is a main priority of GRAL. Moreover, this master projects fits within the main goals of the project of Johan Decelle, laureate of the "Impact" Chaire of Excellence funded by GRAL. Note that a master student from the new Master PLANT-INT (UGA) is already interested to apply to this project.

Relevant publications of the team:

- **J Decelle** J, Carradec Q, Pochon X, Henry N, Romac S, Mahé F, Dunthorn M, Kourlaiev A, Voolstra CR, Wincker P, de Vargas C. Worldwide Occurrence and Activity of the Reef-Building Coral Symbiont *Symbiodinium* in the Open Ocean. ***Curr Biol***. 2018 Nov 19;28(22):3625-3633
- Flori S, Jouneau PH, Bailleul B, Gallet B, Estrozi LF, Moriscot C, Bastien O, Eicke S, Schober A, Bártulos CR, Maréchal E, Kroth PG, Petroutsos D, Zeeman S, Breyton C, Schoehn G, Falconet D, **Finazzi G**. Plastid thylakoid architecture optimizes photosynthesis in diatoms. ***Nat Commun***. 2017 8:15885.

- Bailleul B, Berne N, Murik O, Petroutsos D, Prihoda J, Tanaka A, Villanova V, Bligny R, Flori S, Falconet D, Krieger-Liszkay A, Santabarbara S, Rappaport F, Joliot P, Tirichine L, Falkowski PG, Cardol P, Bowler C, **Finazzi G**. Energetic coupling between plastids and mitochondria drives CO2 assimilation in diatoms. ***Nature***. 2015 524:366-9.