Proposition d'un Projet de Recherche en Laboratoire

Title: **Polarimetric Imaging and Dynamic Speckle Coherence**

Hosting Laboratory: *Laboratoire de Physique des Interfaces et des Couches Minces* (LPICM)

Short summary: In collaboration with ONERA-Palaiseau, the challenge of this research project is to **develop innovative image processing for unconventional data processing**. When a **coherent beam of radiation** illuminates a surface, a **speckle pattern appears** in the recorded image resulting from **coherent interference** of waves originating from the different scattering elements of the sample being imaged. **Dynamic Speckle** (DS) is a technique for imaging **time-varying activity**. When the scatterers are in motion, the speckle pattern's properties fluctuate, and the **image contrast** can thus be related to the **field's decorrelation time**: this is the DSI technique, which aims to provide a way to **visualize motion in samples**. A **recent startup** exploits the idea of **combining polarization** with **dynamic speckle** to improve image quality and the information extracted from scenes. When polarized light interacts with a dynamic speckle, it can lose some of its initial degree of polarization and become partially polarized. In this project, **we want to explore** the ability of **depolarization to sense the various properties of sample motion beyond that of conventional DSI**.

Many **existing applications** at either radar or optical frequencies can **benefit from the use of polarization** to enhance the information obtained from DSI: In optics, we can mention applications for leaf sap monitoring (Fig. 1.a), **medical imaging** (Fig. 1.b), or materials inspection. In **radar imaging**, DSI is used to detect changes and **anomalies on Earth or planetary landscapes** (vegetation fire, presence of a vehicle under vegetation (Fig1.c), effects of a cataclysmic volcano or earthquake...).
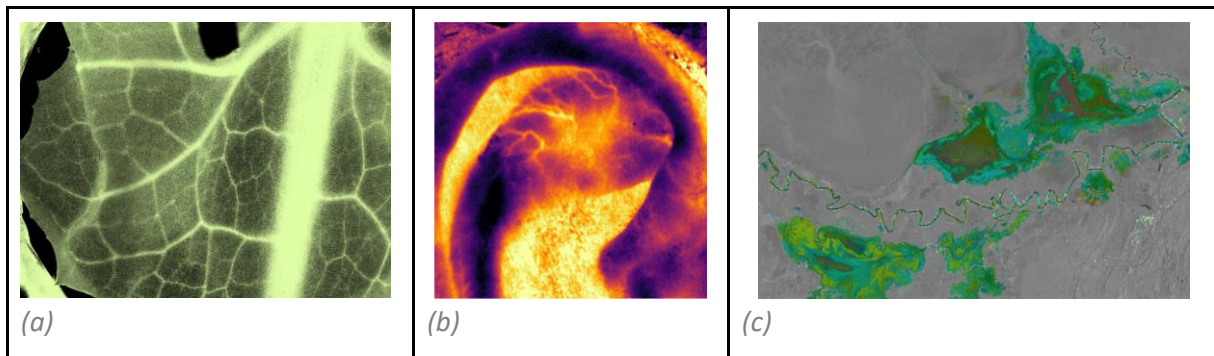

(a)   *(b)*   *(c)*

Fig 2- DSI imaging (a): slow motion of sap in the veins of a leaf (b): quick motion of a microcirculation of blood vessels in the ear, (c): Radar Imaging of deforestation for palm oil production (Indonesia).

Keywords: Speckle optics, Polarization, Radar, Biomecial imaging, Multiscale Digital Image Processing

Nature: Multimodal approach combining physical interpretation of light-matter interaction, numerical modeling - simulation methods, and digital image processing

Accueil d'un binôme possible: Yes,   **Languages:** French and English

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