Séminaire Général de Physique

From Wave Physics to Medicine

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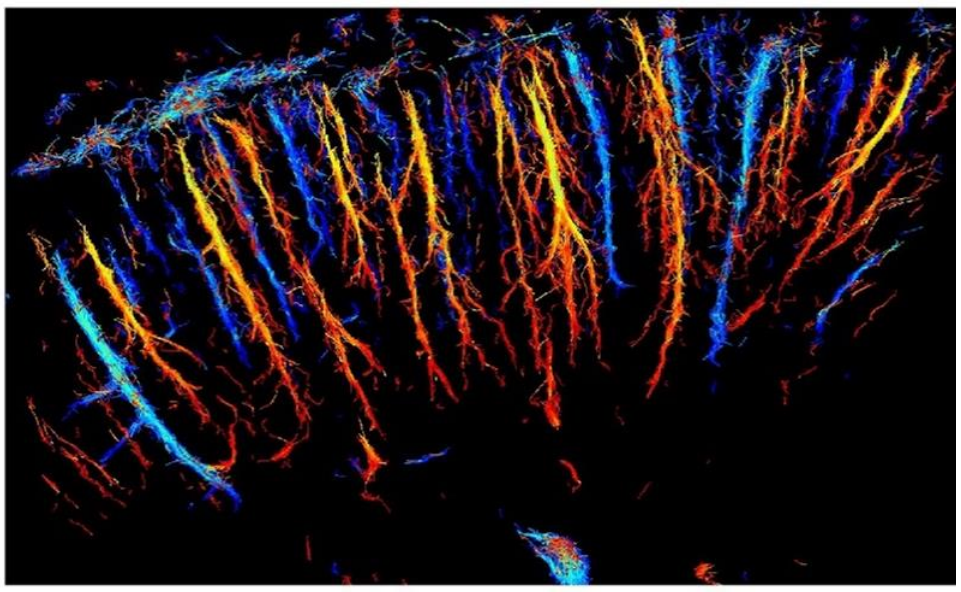
Salle 454A, vendredi 10 mars 2017, 10h

(café-croissants à partir de 9h40)

In the last fifteen years, the introduction of ultrafast ultrasound scanners has been revolutionizing Medical Ultrasound. By reaching thousands of frames per second (fps) contrary to conventional ultrasonics scanners (~50 fps), Ultrasound enters into the world of millisecond imaging. At such ultrafast frame rates, ultrasound imaging became able to track in real time the vast majority of physical phenomena occurring in the human body, including biomechanics, hemodynamics and electrophysiological events.

Far beyond just a technological leap, it permits the advent of completely new ultrasound imaging modes, including the quantitative imaging of stiffness in order to replace the subjective physician palpation, the imaging of muscle fibers contractions, ultrafast Doppler for very sensitive imaging of very small vessels, and even functional ultrasound imaging activity (fUltrasound) of neuronal brain activity.

First of all, at ultrafast frame rates, it becomes possible to track in real time the transient vibrations – known as shear waves – propagating through organs. Such "human body seismology" provides quantitative maps of local tissue stiffness whose added value for diagnosis has been recently demonstrated in many fields of radiology (breast, prostate and liver cancer, cardiovascular imaging, ...). Secondly, for blood flow imaging, ultrafast Doppler permits high-precision characterization of complex vascular and cardiac flows. In the brain, such ultrasensitive Doppler paves the way for fUltrasound of brain activity with unprecedented spatial and temporal resolution compared to fMRI, and providing the first modality for imaging of the whole brain activity working on awake and freely moving animals. Finally, we recently demonstrated that it can be combined with the localization of 3 µm diameter microbubbles injected in the vasculature, in order to provide a first in vivo and non-invasive imaging modality at microscopic scales deep into organs.



Superresolution Ultrasound: Non-invasive Blood flow quantification of the vascular network in the rat brain cortex at micrometric resolution using Ultrasound Superresolution Microscopy (Errico et al, Nature 2015).

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