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**Victoria Barygina[1]**
Enrico Baria[1], Elena Cravero[2,3,4], Francesco Goretti[2], Francesco S. Pavone[1,2,3]
[1]University of Florence, piazza San Marco 4, Florence, Italy
[2]European Laboratory for Non-Linear Spectroscopy (LENS), Via Nello Carrara 1, Sesto Fiorentino, Italy
[3]The National Institute of Optics, Largo Enrico Fermi 6, Florence, Italia
[4]L'Università Campus Bio-Medico di Roma, Via Álvaro del Portillo 21, Roma, Italy

Victoria.barygina@unifi.it

# Multispectral Optical Sensing of Stress Responses in Human Skin

A number of skin matrices—such as skin tissue, interstitial fluid, and sweat—represent important sources of molecular biomarkers for physiological and psychological states. Moreover, several unique biomarkers are found exclusively in skin interstitial fluid. Currently, the analysis of the molecular composition of interstitial fluid is a time-consuming, invasive or semi-invasive, and costly process.

In this study, we aimed to identify stress-related skin responses using a high-throughput, multimodal combination of optical techniques [1]. Raman, reflectance, fluorescence, and fluorescence lifetime spectra—a total of 21 different spectra per sample—were recorded from the palm skin of healthy volunteers using a multimodal fiber-probe device. To induce psychological stress, participants underwent the Montreal Imaging Stress Task (MIST), after which a second set of spectral data was collected. Electrodermal activity, heart rate, and heart rate variability were monitored throughout the experiment to validate the induction of psychological stress.

The multimodal approach achieved 100% accuracy in classifying “no-stress” versus “stress” conditions. Several Raman spectral shifts were observed in the stress (STR) group compared to the control (CTRL) under our experimental conditions. To correlate these spectral changes with specific stress-related biomolecules, we began constructing a reference database of Raman, reflectance, fluorescence, and fluorescence lifetime spectra for key molecular targets. Spectral data were acquired from pure molecules including IL-1α, IL-1β, IL-6, IL-8, TNF-α, cortisol, and neuropeptide Y. We are currently evaluating the use of a convolutional neural network (CNN) for spectral unmixing. Preliminary results confirm the potential of our multispectral optical sensor for the non-invasive detection of psychological stress.

## References

[1] Baria E, Giordano F, Guerrini R, Caporalini C, Buccoliero AM, Cicchi R, Pavone FS. Dysplasia and tumor discrimination in brain tissues by combined fluorescence, Raman, and diffuse reflectance spectroscopies. Biomed Opt Express. 2023 Feb 24;14(3):1256-1275. doi: 10.1364/BOE.477035.