Beyond the Visible: Terahertz Spectral Impact on Heritage and Airborne Environment monitoring

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Colouring materials, including organic dyes and pigments, often exhibit distinct absorption modes at terahertz (THz) frequencies. Furthermore, the low non-ionizing photon energy (approximately 4.2 meV at 1 THz) cannot cause any damage to the artworks under investigation while penetrating through several stratigraphic layers, therefore, THz spectroscopy represents a useful analytical tool in conservation science.

In this talk, I will present a practical approach and methodology based on THz spectral-reflection configuration to perform the chemical mapping of pictorial materials. The results show that by multispectral imaging it is possible to simultaneously identify pigments on different layers of pictorial materials and reconstruct hidden text in superimposed pictorial layers at different penetration depth with better contrast compared to conventional time-domain analysis.

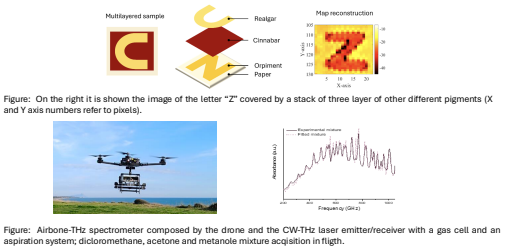

Figure: On the right it is shown the image of the letter "Z" covered by a stack of three layer of other different pigments (X and Y axis numbers refer to pixels).

Figure: Airbone-THz spectrometer composed by the drone and the CW-THz laser emitter/receiver with a gas cell and an aspiration system; dicloromethane, acetone and metanole mixture acqisition in fligth.

Figure 1: On top on the right it is shown the image of the letter "Z" covered by a stack of three layer of other different pigments (X and Y axis numbers refer to pixels). Airbone-THz spectrometer composed by the drone and the CW-THz laser emitter/receiver with a gas cell and an aspiration system; dicloromethane, acetone and metanole mixture acqisition in fligth

Morevoer, since at terahertz frequencies, many compounds considered asmpollutants have spectral fingerprints in this talk, I will also present a novel proof-of-concept airborne terahertz spectrometer capable of real-time, remote air quality monitoring. The prototype presented integrates a highly stable unmanned aerial system (UAS, drone) with THz continuous-wave (CW) laser technology. This innovative combination enables flexible, high-resolution remote spectroscopic measurements in situ, demonstrating the feasibility of utilizing drone technology and THz electromagnetic radiation for detecting airborne pollutants, such as volatile organic compounds (VOCs) within a gaseous mixture.The prototype represents a significant advancement, demonstrating the potential of combined UAS-THz-CW technology for the detection of gaseous atmospheric pollutants and can be used to monitor air quality, providing valuable information for environmental protection and public health.