Listening to laser light interactions with objects of art: A novel photoacoustic diagnostic approach

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Abstract

Photoacoustic imaging constitutes a novel, rapidly expanding diagnostic technique, which has been predominantly developed in the context of contemporary biomedical research. Recent implementations of various photoacoustic imaging systems have enabled high resolution in vivo imaging of intrinsic biological absorbers such as hemoglobin, melanin and lipids at various spatial scales ranging from cells and tissues to small animals.

In this presentation, I will demonstrate how photoacoustic imaging can break through the barriers of biomedicine, and find innovative applications in cultural heritage (CH) diagnostics. Having over three orders of magnitude higher transmission through strongly scattering media compared to light in the visible and near infrared, the photoacoustic signal offers substantially improved detection sensitivity and achieves excellent optical absorption contrast at high spatial resolution.

In the first part of the talk, I will show that this unique combination of advantages can be exploited to establish a radically new non-destructive methodology for the uncovering and differentiation of well-hidden features in multi-layered CH objects such as paintings and documents. Furthermore, I will demonstrate that the attenuation of the generated photoacoustic signals during their propagation through optically opaque media (e.g. paints) can be used to determine the thickness of thin layers, providing, in this manner, micrometric precision stratigraphic information on the artwork under investigation. Finally, I will present the capabilities of photoacoustic signal detection on the in situ real-time monitoring of laser cleaning interventions, which has the potential to promote an improved conservation outcome by safeguarding artworks' original surfaces.