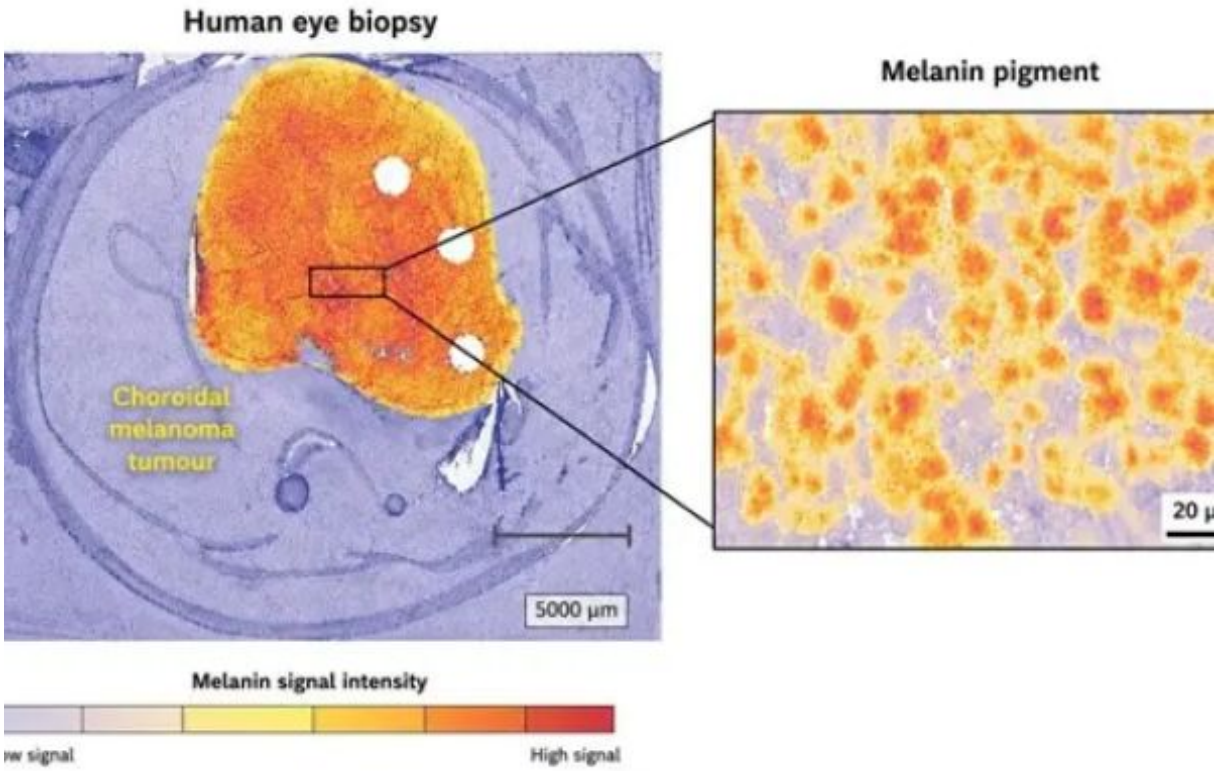

Researchers refine Raman spectroscopy to characterize melanin more reliably

ICFO researchers have developed a strategy that overcomes the challenges associated with Raman spectroscopy when characterizing the two main forms of melanin. The methodology, published in Microchemical Journal, reduces signal distortions and facilitates comparisons between differently pigmentated samples and across varying experimental conditions. These results could guide future research on melanoma disease.

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Melanin, the pigment that gives color to our skin, hair and eyes, is also believed to play a role in melanoma disease -the most dangerous form of skin cancer. To date, two main forms of melanin have been identified: eumelanin, which is photoprotective and antioxidant, and pheomelanin, which is phototoxic and prooxidant. Being able to correctly identify and quantify them could advance melanoma research, either by deepening our understanding of

how the cancer works or by providing insights into effective treatment strategies. However, gold-standard methods for melanin characterization are destructive and require extensive sample preparation. Therefore, there is growing interest in developing non-destructive optical approaches for melanin analysis.

Raman spectroscopy is one of the non-destructive optical approaches currently being explored for melanin analysis, as it provides molecular fingerprints of samples when illuminated by a laser. However, melanin analysis by Raman spectroscopy remains challenging due to the strong autofluorescence background and instrumental artefacts that can distort the measured spectra. Now, ICFO researchers, **Jose Javier Ruiz** and **Dr. Pablo Loza-Alvarez**, Chief of the SLN Facility, together with **Ismael Galvan** from the National Museum of Natural Sciences (CSIC), have developed a strategy to overcome the challenges it presents. Published in Microchemical Journal, the strategy -which was tested using hairs and feathers with different pigmentation- has shown that Raman imaging can **reliably retrieve and characterize** melanin information from intact biological samples.?

There are two main difficulties that the proposal overcomes. First, it corrects a commo distortion that complicates the interpretation of data, whose instrumental origin had no been clearly identified and corrected until now. i¿½Several previous studies had observe a sinusoidal interference, which led to divergent results,i¿½ explains Jose Javier Ruiz, irst author of the article. i¿½In our study, we describe how to characterize and correct it.i¿½ Secondly, it addresses the broad and intense background signal aused by autofluorescence, which often masks the weaker Raman signals of interest. Ra her than treating this autofluorescence solely as an unwanted interference, the proposal a so takes advantage of it to provide complementary information about sample pigm ntation. i¿½We anticipate that these **advances may support future Raman and in general optically-based studies of different biological samples containing melanin, including research into melanocytic tumorsi¿½**, says Dr. Pablo Loza-Alvarez, lead researcher of the study. i¿½Improving the reliability and comparability of melanin spectral analysis, and maki g it more robust across different imaging platforms, could help to better understand h w melanin composition and organization relate to different biological and pathologic l conditions.i

Reference:

Jose Javier Ruiz, Ismael Galvan, Pablo Loza-Alvarez, Correction of Rayleigh filter ripple and fluorescence background to enable reliable Raman analysis of melanin, Microchemical Journal, 225, 2026, 118178.
DOI: https://doi.org/10.1016/j.microc.2026.118178

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