High Definition X-ray Fluorescence Elemental Mapping of Historic Paintings with Synchrotron Radiation

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A portrait painted by Edgar Degas (1834-1917) and a self-portrait by Sir Arthur Streeton (1867–1943) have been studied with fast-scanning X-ray fluorescence microscopy using synchrotron radiation. One of the technique's unique strengths is the ability to reveal metal distributions in the pigments of underlying brushstrokes, thus providing information critical to the interpretation of a painting. We have applied the non-destructive technique with the event-mode Maia X-ray detector, which has the capability to record elemental maps at megapixels per hour with the full X-ray fluorescence spectrum collected per pixel. The paintings by Degas and Streeton have proved challenging for conventional imaging techniques due to the artists' materials used. We have recorded 32-megapixel elemental maps in 35 hours to reveal a hidden Degas portrait in extraordinary detail. The painting by Streeton was completely obscured with heavy brushstrokes of highly X-ray absorptive lead white paint, which contributed significant detrimental structure to the elemental maps. A corrective procedure was devised to enhance the visualization of the elemental maps by using the elastic X-ray scatter as a proxy for the lead white overpaint.   We foresee the synchrotron-based technique applied to the most demanding of culturally significant artworks where conventional analytical methods are inadequate.