Exploring the palette of *Femme lisant* (1922) by Henri Matisse using hyperspectral imaging techniques

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Introduction

As part of the project *Face to Face*, which consists of the technical study of the representation of faces in European painting from the 15th to the 20th century, *Femme lisant* (1922) by Henri Matisse (1869-1954) (**Fig.1**) , was studied in situ using the mobile laboratory of the European Centre for Archaeometry (CEA) of the University of Liège, composed of imaging methods (high resolution photography, infrared reflectography and digital microscopes) and analysis techniques (MA-XRF, Raman spectroscopy and hyperspectral imaging in the visible range (400-1000nm)) as well as short wave infrared hyperspectral imaging (1000-2500nm). All these techniques are non-invasive and complementary.



Fig. 1 Henri Matisse, *Femme lisant*, 192, oil on canvas, 46 x 38 cm, MRBAB inv.4402.

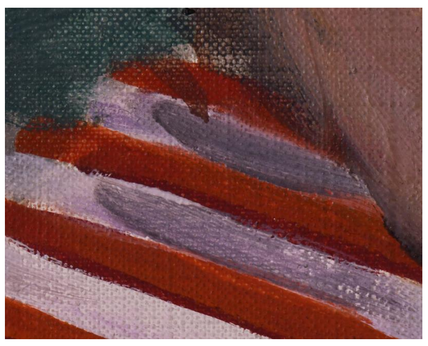


Fig. 2 Details of the photography

Layering Practice

In 1908, Matisse described one of these practices in his notes [1]: *« If at first glance, and perhaps without my being aware of it, a tone seduced or stopped me, I will most often realize, once my painting is finished, that I have respected this tone, while I have progressively modified and transformed the others »*. The red stripes on the tablecloth illustrate this practice. Originally red, they were later covered with orange paint (**Fig.2**). Photography under UV light also reveals that the green wall conceals an underlying pattern (**Fig. 3**).

No preparatory drawing are visible in the IR reflectography, which is consistent with the Fauvist movement of which Matisse is a major figure. However, it shows the artist's hesitation by revealing numerous pentimenti, such as the vase, the elbow, and the hairstyle. There are also some changes on the left shoulder, the right hand, and the bracelet (**Fig.4**).
This study aims to identify all the pigments that make up the palette of this canvas, including those in underlying layers.

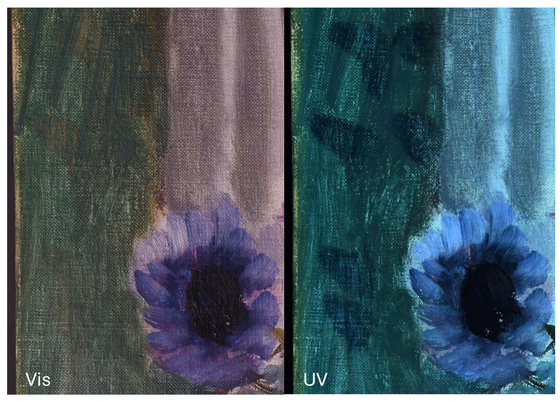


Fig. 3 Details of the photography (left) and under UV light (right)

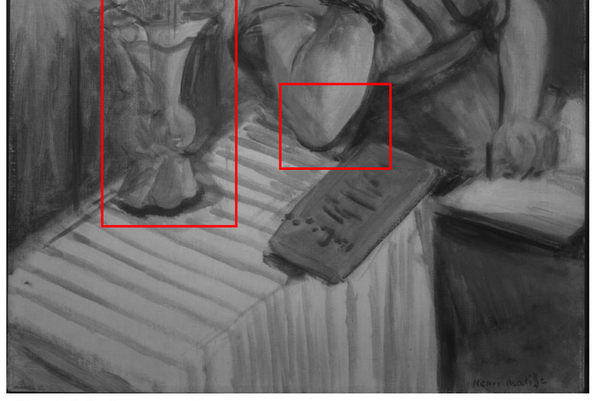


Fig. 4 IR Reflectography

Pictorial layer

PW1 | PW4 | PV14 | $Co_3(AsO_4)_2$ | PB29 | PB28 | PG18 | PY37 | Ochre | PR108 | Madder lake | Ochre | Bone Black

PW1

SWIR spectrum of the white (**Fig.5**) composed of lead is hydrocerrusite ($2Pb(CO_3)_2.Pb(OH)_2$), given the absorption bands associated with the OH group located at 1440, 1940 and 2320 cm^{-1}.

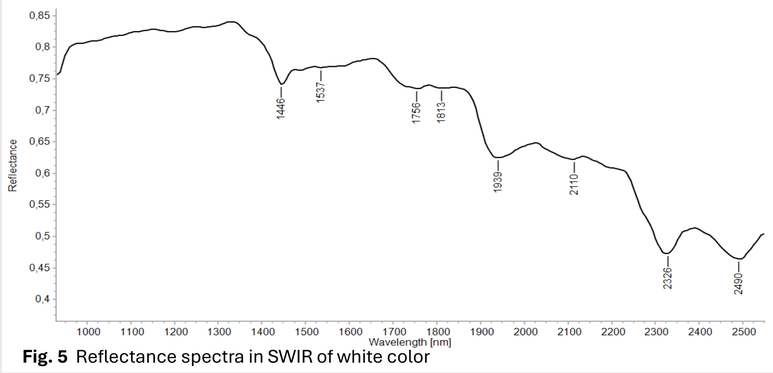


Fig. 5 Reflectance spectra in SWIR of white color

PW4

As shown in **Fig. 6**, the zinc mapping is perfectly correlated with the areas of the painting that fluoresce when exposed to UV light. The fluorescence is green for the yellow paint in visible light. The absence of chromium for this color indicates that it is not zinc yellow (PY36), and this fluorescence suggests instead a yellow pigment mixed with zinc white (PW4) [2].

Furthermore, the zinc mapping correlates perfectly with the underlying patterns of the green wall color (**Fig. 3**). We can therefore assume that the yellow color of the clothe of the woman was used in the original composition of the wall.

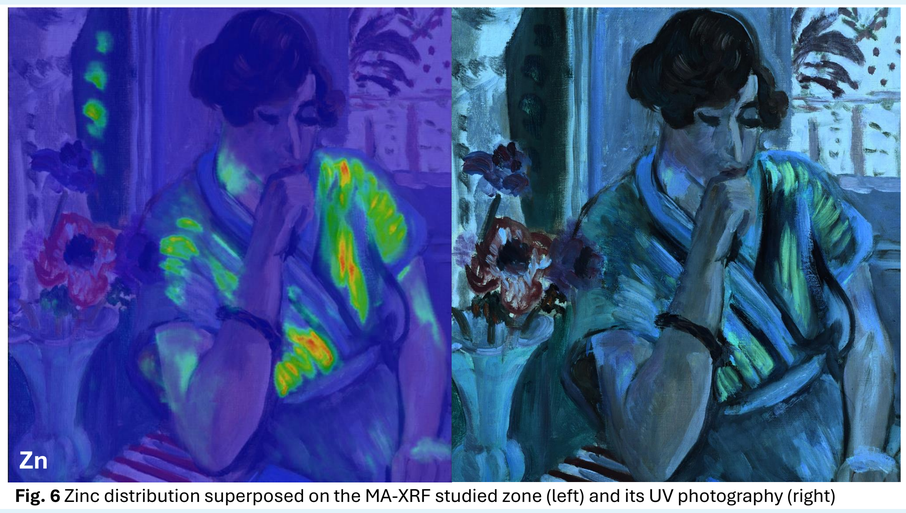


Fig. 6 Zinc distribution superposed on the MA-XRF studied zone (left) and its UV photography (right)

PB29

This pigment was only identified in a detail of the paint in the bracelet (**Fig.7**) using Vis and SWIR spectroscopy techniques (**Fig.8**).

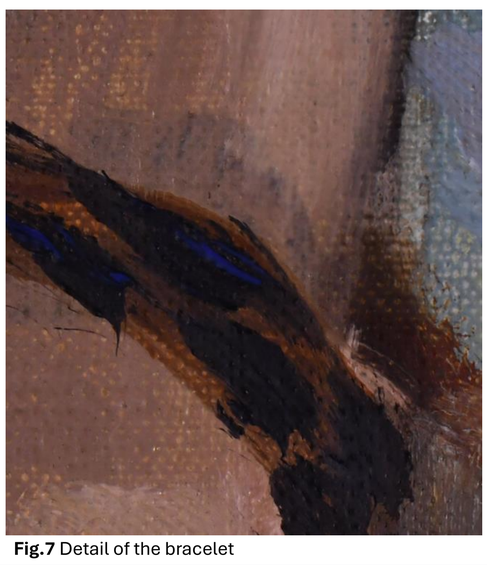


Fig.7 Detail of the bracelet

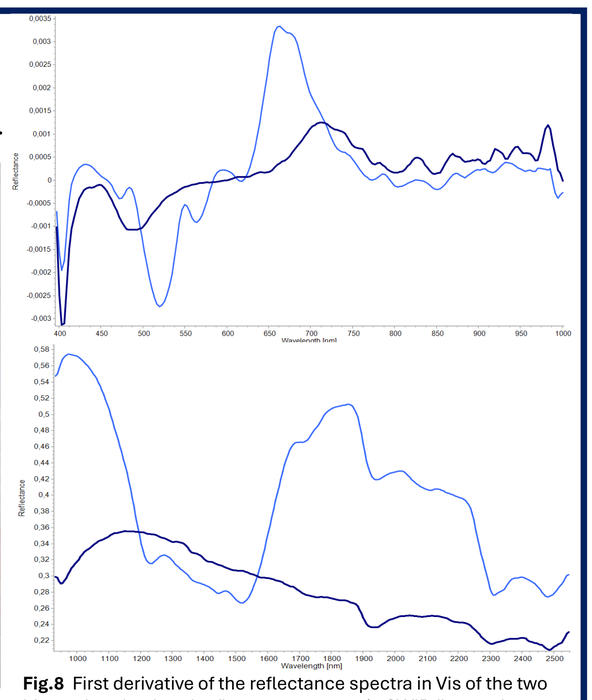


Fig.8 First derivative of the reflectance spectra in Vis of the two blue colors (top) and reflectance spectra in SWIR (bottom)

Madder Lake

Two reds are present in the palette. Cadmium red (PR108) was identified through MA-XRF analysis in the flower due to the combined presence of cadmium and selenium. Observation of the photograph under UV light reveals a second red that exhibits a pinker fluorescence under this light exposure (**Fig.9**). Reflectance spectra show that this second red has absorption bands at 430 and 510 nm (**Fig.10**), suggesting that it is a madder lake based on purpurin.

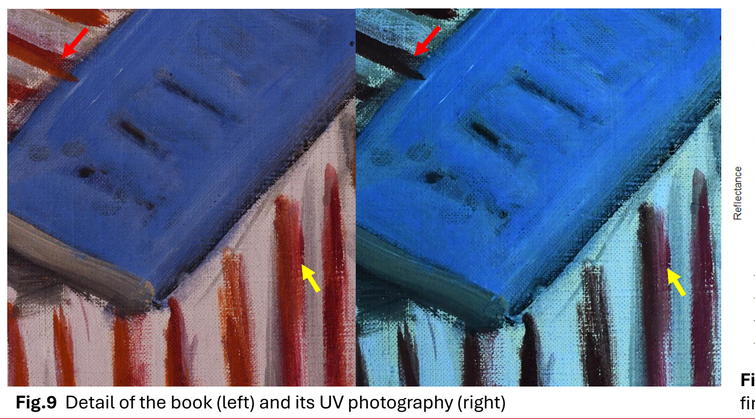


Fig.9 Detail of the book (left) and its UV photography (right)

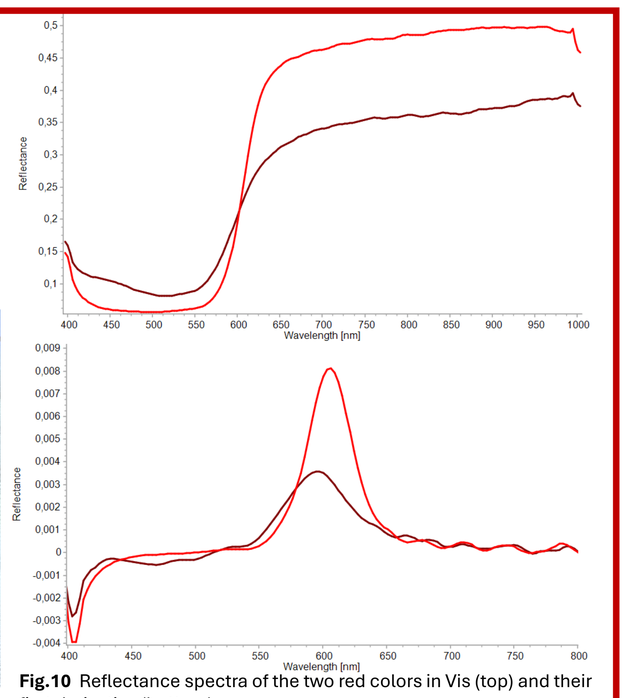


Fig.10 Reflectance spectra of the two red colors in Vis (top) and their first derivative (bottom)

Violet Pigments

MA-XRF analysis reveals the presence of two violet pigments. As shown in **Fig.11** , cobalt and phosphorus are correlated, which characterizes the cobalt violet pigment (PV14, $Co_3(PO_4)_2$). The correlation between cobalt and arsenic indicates the presence of arsenate cobalt ($Co_3(AsO_4)_2$).



Fig.11 Arsenic, cobalt and phosphorus distributions superposed on the MA-XRF studied zone)

Conclusion

- **13 pigments** have been identified in this painting.
- By comparing our results with those obtained in identifying the palette of 6 oil paintings by the artist dated between 1906 and 1911 [3], we observe a continuity in the pigments used Matisse :
  - The use of these two blue pigments and two purple pigments was already observed in the painting *Young Sailor II* from 1906
  - Cobalt blue was used in all paintings
  - Chromium-based green pigment is consistent across the palette; no other green pigment has been identified.
  - Bone black pigment is the only black identified
  - Unlike the other paintings studied, which all contain vermilion (PR106) in the red pigments used, this work is the first where the study of the palette shows the absence of vermilion and the presence of cadmium red (PR108).
  - The use of red lakes seems to be common among the artist.

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