Discovery of a woman portrait behind *La Violoniste* by Kees Van Dongen through hyperspectral imaging

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ABSTRACT :

Despite the fact that Kees Van Dongen was one of the most famous painter of the 20th century, only little information about his palette and his technique is available. To contribute to the characterization of Van Dongen's painting materials, *La Violoniste*, painted by the artist around 1923, has been analyzed by using three complementary techniques: macro X-ray fluorescence (MA-XRF), Raman spectroscopy and hyperspectral imaging. The elemental repartition given by MA-XRF and the results obtained thanks to Raman spectroscopy help us to complete the identification of pigments contained in *La Violoniste* (lead white, iron oxides, cadmium yellow, vermilion, Prussian blue, titanium white, ultramarine, a chromium pigment and carbon black) while the results obtained via hyperspectral imaging reveal a hidden woman portrait. Besides the fact that Kees Van Dongen was particularly renowned for his female portraits, this hidden composition presents obvious stylistic similarities with the well-known portraits produced by the artist during his Parisian stay (starting from 1899). Thanks to Raman spectroscopy, visual examination and MA-XRF, we show that the original background contains ultramarine, the hidden portrait's clothes are probably made of the same colour as the present violinist's dress and her carnation contains zinc, contrary to the violinist's flesh which is mainly made of lead white.

INTRODUCTION :

Born near Rotterdam in 1877, Kees Van Dongen has taken evening classes at the Fine arts academy of Rotterdam in 1892. During this period, he was close to the anarchist

movement. After a first Parisian exposition in 1897, he decided to move to Paris, where he began working as a drawer in satirical newspapers to denounce social inequality. Nevertheless he came back to painting in 1903-1904 with his "Saltimbanques" series.

His carrier took off with the "Salon des Indépendants", where he exhibited drawings and paintings about Parisian views, the Norman coast, etc. His art studio became a meeting place, where events took place. He acquired a great reputation, especially for his female portraits. He made portraits of lots of well-known people, for instance Brigitte Bardot and Jack Johnson.

These female portraits are characterized by exuberant accessories and over makeup, especially big smoky eyes, which labels his Parisian Life. He said in 1921 "All women have their beauty, their charm that I exalt. Now we have long legs, long legs of Diane the Huntress, arched feet, ... long lines so supple ... and big eyes - I don't know why -, long lashes, satin or matt skin ... , pearls and brilliants. And brilliants have to shine and why would I not make the pearls bigger?". In 1959, he moved to Monaco where he died in 1968. [1]

Although Kees Van Dongen was one of the most famous painters of the 20th century, only few articles concern his work. A *catalogue raisonné* about his Graphic Work has been created by Jan Juffermans in 2002 and another concerning his paintings is in preparation (work of Jacques Chalom des Cordes) [2,3]. Some articles are also available about his particular way to varnish some paintings and about the analysis and treatments of a Van Dongen's painting [4.5]. However, the number of scientific

articles about his technique and his palette is restricted. To overcome this lack of information, investigations were carried on *La Violoniste*, painted by Kees Van Dongen ca. 1923. This painting belongs to the City of Liège since 1939. During this year, thanks to the association "Amis des musées Liégeois", the city of Liège bought nine paintings from the gallery Fisher in Lucerne. The same year, with the rest of this grant, the museum bought nine other paintings in Paris, among them, *La Violoniste* [6]. This painting is currently exhibited in the Museum La Boverie.

To investigate the painting materials of *La Violoniste*, complementary non-invasive techniques were used, including Raman spectroscopy, X-ray fluorescence and hyperspectral imaging thanks to portable instrumentation. All the measurements were performed in situ. [7]

In the present paper, we describe first the instruments used for these analyses and we specify the parameters. Then we present and compare the results of these complementary methods.

EXPERIMENTAL :

Hyperspectral imaging consists in the acquisition of a spectrum of reflectance as a function of the wavelength for each point of the sample. The result is thus a data cube made of two spatial and one spectral dimensions [8,9]. The setup used works in a pushbroom mode, which means that the cube is built line by line, each line containing the spectral information, which is dispersed on the 2D sensor, of the spatial line scanned. To obtain the entire information, the scanned line is displacing

on the sample. The setup used was lended by the LAMS (Laboratoire d'Archéologie Moléculaire et Structurale, Université Pierre et Marie Curie) and consists in the spectral camera SWIR (made by Specim and equipped with a N25E spectrograph), providing spectral information from 1000 to 2500 nm. The parameters used were a scan speed of 3.72 mm/s, a frame rate of 7 Hz and a exposure time of 10 ms.

The second technique applied to *La Violoniste* was Raman spectroscopy [10] : it consists in the detection of the scattered photons coming from a molecule excited by a monochromatic beam. The wavelength shift between these scattered and exciting photons depends on the vibrational energy states of the molecule analyzed and allows thus to identify it. This technique gives us information about the surface pigments. To do that, we used a Enwave Optronics setup (portable Raman analyzer I-Dual-G), characterized by a laser at 785 nm. We used the lowest laser power necessary to obtain valuable results.

The third technique was XRF (X-ray fluorescence) used in a macro scanning mode (MA-XRF). To do that, we used a homemade XRF system, made of a Moxtek MAGNUM tube 50kV with Ag anode, a detector X-123SDD Amptek (25 mm2, resolution of 130 eV to 5.9 keV). The scan step was 1.4 mm (2 s/point), with a tension of 35 kV and a courant of 130 µA. [11]

RESULTS AND DISCUSSION :

Hyperspectral imaging

By scanning the painting with this hyperspectral setup and by displaying this image for different determined wavelength ranges (1000-1400 nm, 1400-1800 nm, 1800-2200 nm and 2250-2500 nm), we highlight features that have anything to do with *La Violoniste* artwork. This hidden composition corresponds to a woman portrait, which is mostly visible in the 2250-2500 nm range (figure 2a). Beside the fact that woman portraits were the trademark of the Van Dongen's work, the freshly discovered portrait presents obvious similarities with the typical Van Dongen's portraits dating from his Parisian stay. By comparing this hidden composition with a well-known Van Dongen's painting, *La femme au chapeau vert* represented in figure 2b, we can notice similar smoky eyes [1,12]. The hidden portrait also presents a hat on which we distinguish a little flower. Her hair falls on her shoulders. The woman probably also holds a flower which reaches her décolletage (see figure 2c). Therefore we can assume that this hidden woman portrait was previously painted by Kees Van Dongen himself.

Thanks to a first visual examination, we could highlight that the primer layer is visible at the violinist leg level. We thus suggest that the shirt of the hidden woman has the same color as the violinist's dress.

Raman spectroscopy

Raman measurements were performed to identify pigments of the surface layers. Location of these punctual analyses were chosen according to the main tones and the heterogeneities observed in the painting.

The Raman spectroscopy results are resumed in figure 3. Those revealed that the violinist's dress is mainly made of Prussian blue, lead white and contains a barium sulphate filler. Her mouth is made of vermilion, which is diluted with lead white for the pinkish hue of her carnation (the filler is barium sulphate). The white background contains lead white (and barium sulphate). The signature and her shoes primary contain carbon black. The vase is made of ultramarine, lead white and barium sulphate, just as the blue part of the piano, while its upper part is made of lead white with barium sulphate. We also noticed that the whitish highlights above the piano are based on titanium white. Raman bands lead to the identification of the anatase form. Its presence in this 1923 painting reveals the avant-garde character of Kees Van Dongen and his desire to try new materials since this form of titanium white was introduced in artists paints in 1919 [13,14]. The bottom right corner of the painting contains blue shades where ultramarine was detected (see figure 4). A discoloured organic pigment or lacquer could also be contained in this area. However the pigments being potentially present in this painting area (lead white, ultramarine, rose madder, zinc white, Prussian blue and vermilion) have a good light fastness or undergo changes very different from the discoloration observed [15-17].

It should be noted that eosin is not easily detected by Raman spectroscopy.

X-ray fluorescence

The area of interest analyzed with MA-XRF is localized in the portrait's eyes region. XRF analysis reveals the presence of lead, zinc, calcium, barium, copper, chromium, iron, cadmium, mercury and cobalt, whose distributions are given in the figure 5. The presence of lead in the entire painting matches with the lead white found thanks to Raman spectroscopy, both in the white background and in the colored parts, when used to soften the tint. The relatively uniform barium distribution probably comes from the barium sulphate filler revealed by Raman spectroscopy. The violinist's dress contains copper, chromium, cobalt and iron. Iron could correspond to the Prussian blue identified by Raman spectroscopy but not the three other elements. The chromium presence being particularly marked, we suggest that the dress is made of a mixture of Prussian blue and a chromium based pigment. Iron is also present in the brown traits of the violin. This suggests that this is made of iron oxide pigments. A cadmium based pigment composes the violin body. This is thus certainly made of cadmium yellow. Mercury was found out in the mouth and the pinkish parts of the violinist's carnation, matching with the use of vermilion to depict these parts. Calcium is mainly contained in the violin body. Concerning the hidden portrait, zinc is the only element reproducing clearly the hidden portrait revealed by hyperspectral imaging. This suggests that the painter used preferentially zinc white for the carnation of the underlying portrait contrary to the violinist's flesh which is mainly based on lead white.

Summary results

Position	Colour	Raman	XRF	Pigment identified
Background	White	Lead white	Pb	Lead white
Violin (outer lines)	Brown	-	Fe	Iron oxide pigments
Violin (inner part)	Yellow	-	Cd, Ca	Cadmium yellow
Mouth	Red	Vermilion	Hg	Vermilion
Flesh colour	Pink	Vermilion and Lead white	Hg	Vermilion and lead white
Dress	Blue	Prussian blue and lead white	Fe, Cr, Co, Cu	Prussian blue, lead white and a chromium pigment
Hidden portrait	-	-	Zn	Zinc oxide?
Top of the piano	White	Lead white and titanium white	-	Lead white and titanium white

Bottom of the piano	Blue	Ultramarine and lead white	-	Ultramarine and lead white
Vase	Blue	Ultramarine and lead white	-	Ultramarine and lead white
Signature	Black	Carbon black	-	Carbon black
Shoes	Black	Carbon black	-	Carbon black

Table 1 Pigments identified in *La violoniste* painting

CONCLUSION :

Hyperspectral imaging allows to highlight a hidden woman portrait behind *La Violoniste* painted by Kees Van Dongen around 1923. This portrait is particularly visible in the 2250-2500 nm wavelength range and has some similar stylistic features with the well-known Van Dongen's portraits dating from his Parisian life (especially it presents comparable smoky eyes). We thus suggest that this hidden composition had been painted by Van Dongen, but no dating could be made. Some pigments of the palette used in *La Violoniste* have been identified thanks to Raman spectroscopy, including lead white, iron oxides, cadmium yellow, vermilion, Prussian blue, chromium pigment, titanium white, ultramarine and carbon black. MA-XRF highlights the presence of lead, zinc, calcium, barium, copper, chromium, iron, cadmium,

mercury and cobalt. The zinc distribution is particularly interesting because it highlights clearly the face of the hidden female portrait and could indicate that her carnation is made of zinc oxide, contrary to the violinist's flesh which contains lead white. The Raman analysis performed in the lower right corner reveals the presence of ultramarine. Moreover, since the primer layer is visible in the violinist's legs level, we suggest that the portrait's shirt has the same colour as the violinist's dress. Future works on this painting will include a XRF mapping of the whole surface and further investigations to probe the pigments mixture and potential discoloration found in the bottom right area.

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AUTHOR CONTRIBUTIONS

DS, CD and EH performed the experiments and interpreted the data. PW lent the hyperspectral setup and helped in its usage and data analysis.

COMPETING INTERESTS

Declaration: none of the authors have any competing interests in the manuscript.

IMAGE CAPTIONS

Fig 1. *La Violoniste* by Kees Van Dongen c.a. 1923

Fig 2. (a) Hidden woman in the 2250-2500 nm wavelength range. (b) "La femme au chapeau vert" by K. Van Dongen around 1910. (c) The hidden woman wears a hat with a flower. She also holds a flower which reaches her décolletage.

Fig 3. Raman spectroscopy results

Fig 4. Discoloration in the bottom right area

Fig 5. Elemental distributions obtained by MA-XRF

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Figure 1

Click here to download Figure 1-Vis.tif

Figure 2

Click here to download Figure 2-comparison_2.png

Figure 3

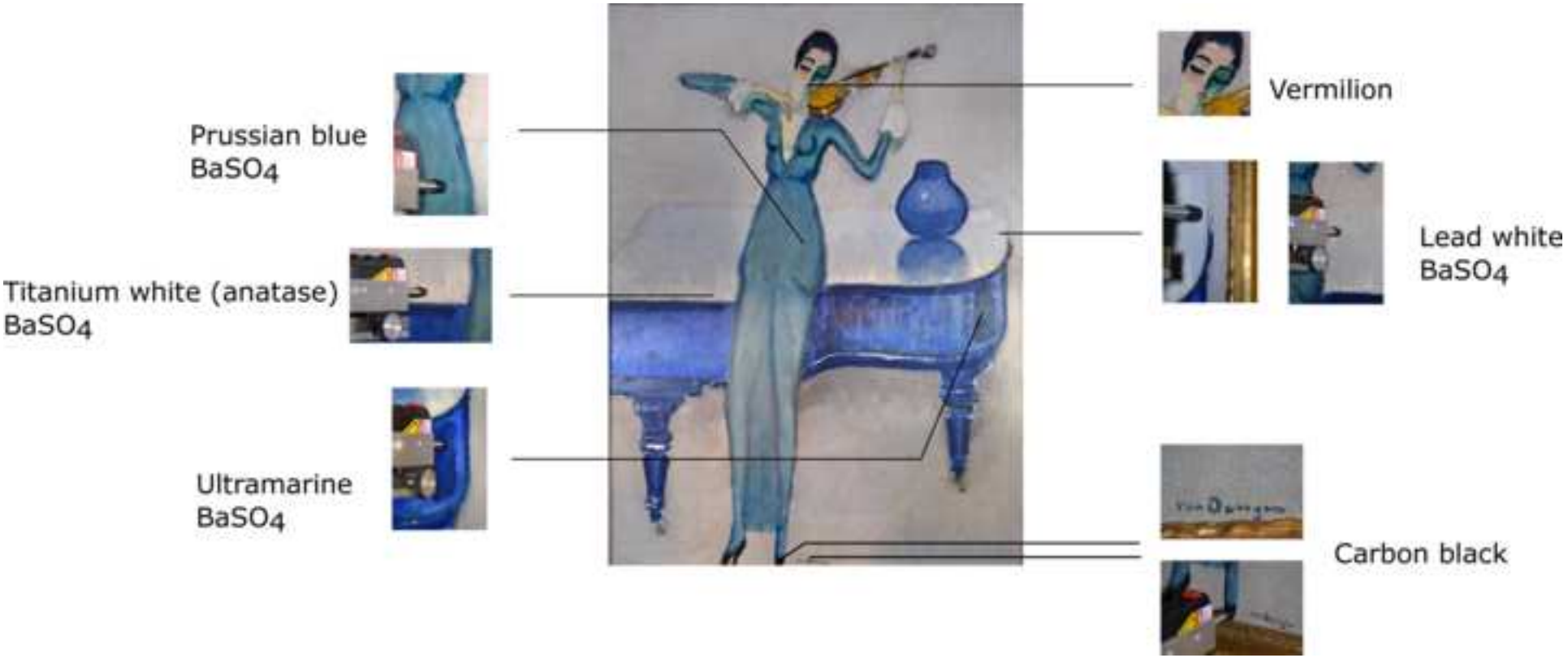

Figure 4

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Figure 5

Click here to download Figure 5-XRF.png