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REMOTE REFLECTANCE SPECTROSCOPY ON THE PAINTING 'SAINTS PETER AND STEPHEN' CONSERVED AT THE FONDAZIONE GIORGIO CINI

1. Introduction

The preservation of Venice's cultural legacy, as emphasized by the Cini Foundation's motto, is not the worship of ashes but the stewardship of fire. This stewardship aims to pass down traditions, expertise, and the beauty of Venetian culture to future generations. The growing awareness of cultural heritage and technological advancements have driven the development of Heritage Science, a multidisciplinary field dedicated to improving «the understanding, care, sustainable use, and management of tangible and intangible heritage to enrich people's lives today and in the future» (ICCROM). Applied globally, Heritage Science highlights that effective conservation and preservation rely on understanding the material, historical, and artistic characteristics of artworks, along with their condition and degradation processes (Soldovieri *et al.* 2024). These factors are crucial for characterizing heritage items – be they objects, buildings, or sites – offering insights into historical contexts and craftsmanship while enabling precise restoration and long-term documentation.

Material characterization focuses on identifying materials, assessing their conservation state, and understanding degradation processes to guide restoration efforts. Several scientific disciplines can contribute to this goal: particularly physics (Mosca Conte *et al.* 2014) and, more specifically, the Science of Complexity, which has the appropriate scientific method to face the challenges of real complex objects such as ancient artworks (Marchant 2025). Among diagnostic techniques, non-destructive and non-invasive methods are preferred. These approaches, based on the interaction of electromagnetic radiation with matter, include imaging and portable spectroscopic systems. Techniques are classified by the specific electromagnetic spectral regions used or generated during measurement.

Multispectral and hyperspectral imaging capture objects across defined wavelength ranges beyond human vision (Vasco *et al.* 2024). Optical spectroscopy explores electromagnetic interactions with matter in the UV (200-380 nm), visible (Vis) (380-750 nm), NIR (750-1100 nm), and SWIR (1100-2500 nm) regions, typically in transmittance or reflectance modes. Photoluminescence, in turn, measures visible radiation emitted by materials under UV stimulation. These methods provide qualitative and quantitative data and are widely used in cultural heritage for pigment and dye analysis and for monitoring artwork cleaning processes (Picollo *et al.* 2019). The advent of Fiber Optic Reflectance Spectroscopy (FORS) introduced a non-invasive technique, further refined with portable instruments capable of spanning UV to SWIR wavelengths. However, FORS is traditionally limited to cases where the probe can be placed in contact or near-contact with the artwork (Missori *et al.* 2019; Titubante *et al.* 2022). This study addresses that limitation by introducing a novel approach for remote FORS measurements.

Inspired by astronomical techniques, earlier attempts to achieve remote diagnostic reflectance measurements include the PRISMS system, which imaged wall and ceiling paintings from ground-level distances of tens of meters (Liang *et al.* 2007). More recently, advanced stand-off systems, including Raman spectroscopy, LIBS, hyperspectral imaging, and others, have expanded spectral range and resolution for remote sensing at distances of approximately 10 meters (Li *et al.* 2024). Additionally, Fourier-transform infrared spectroscopy has been adapted for remote applications, exemplified by the TWINS FT-HSI portable hyperspectral camera, which enables rapid investigation of paintings with enhanced spectral capabilities (Perri *et al.* 2019).

In this article, we present a method for remote FORS and apply it to the study of the colorants in the painting on a wooden panel, *Saints Peter and Stephen*, tentatively attributed to Antonio del Massaro da Viterbo (circa 1450-1516) and dated to the late 15th-early 16th century. The painting is conserved at the Fondazione Giorgio Cini on the island of San Giorgio in Venice, Italy. To demonstrate the validity of the remote method, the analyses were conducted both in contact using a standard FORS setup and at an 8-meter distance from the painting using a specifically designed optical setup.

2. The Painting of *Saints Peter and Stephen*: attribution, historical context, and restoration interventions

The painting depicting *Saints Peter and Stephen* (Fig. 1), an artwork of debated attribution – with proposed names including the Faenza-born painter Giovanni Battista Bertucci the Elder (ca. 1465/1470-1516), Cola dell'Amatrice (ca. 1480/1489-1547/1559), and, more recently and still tentatively, the Viterbo artist Antonio del Massaro, known as Pastura (ca. 1450–before 1516) – can be linked to the figurative culture of early Renaissance Central Italy (late 15th/early 16th century), characterized by a lexicon rooted in the Perugian style. The painting, a precious tempera on panel (dimensions: 152.5×66 cm^2, with frame: 178×94×8.5 cm^2), was part of the collection of the Marquess of Lothian (Newbattle Abbey, Dalkeith, Scotland) and entered the Cini collections in 1958 as part of a group of ancient works intended to decorate the Castle of Monselice. It was housed in the Sala del Castelletto, as evidenced by documentation preserved in the Giorgio Cini Foundation (a letter from Bruno Visentin to Adolfo Cattin, custodian of the Castle of Monselice, dated May 9, 1980).

Fig. 1 – The painting depicting saints Peter and Stephen (late 15th/early 16th century) recently and tentatively attributed to Antonio del Massaro, known as Pastura (ca. 1450-before 1516). In the image, the measurement points are indicated.

The «large panel with a sculpted and gilded frame» was undoubtedly part of an altarpiece polyptych and portrays the two saints, Peter on the left and Stephen on the right, standing with their respective, prominently displayed iconographic attributes: a pair of large keys for the former, signifying his preeminence within the ecclesiastical hierarchy, along with the book he holds and his intense gaze; stones – the instruments of martyrdom – for the latter, conspicuously displayed on his halo, with his upward gaze situating him in a superior, contemplative dimension achieved through Christian sacrifice. Additional stones are scattered on the ground beneath their bare feet, resting on a stony terrain dotted with sparse tufts of grass. Behind the saints unfolds a hint of landscape against an intensely blue sky, signalling the master's adoption of the harmonious manner of the Central Italian tradition. The artwork, currently housed in the Council Room of the Giorgio Cini Foundation, underwent restoration in 2011 due to several losses of colour on the lower part of the painted surface and a general dullness caused by dust deposits and altered past treatments, which impeded its full readability. The conservation and aesthetic intervention allowed the painting to recover clarity and legibility.

3. The Fondazione Giorgio Cini

The Fondazione Giorgio Cini, established in 1951 by Vittorio Cini in memory of his son Giorgio, is dedicated to promoting dialogue between cultures, fostering humanistic and scientific research, and advancing knowledge. Its primary goal was to restore the dilapidated San Giorgio Maggiore Island in Venice, transforming it into an international centre for cultural, research, and scholarly activities. Over the decades, the Fondazione has hosted numerous events, seminars, and conferences on contemporary challenges in technology, ethics, philosophy, and global issues, attracting top researchers and experts worldwide. It has also played a significant role as a meeting place for East and West during the Cold War and has collaborated with major organizations such as UNESCO and the G7. The Fondazione houses seven institutes and three research centres focused on theatre, music, spirituality, art, and cultural heritage preservation through digital technologies. Notably, the Vittore Branca Center provides residential scholarships for scholars from around the world.

San Giorgio Maggiore island, the Fondazione's home, boasts a rich history, evolving from a medieval monastic centre to a Renaissance landmark. Architects like Andrea Palladio and Baldassare Longhena shaped its iconic structures, while thanks to restoration efforts led by Vittorio Cini after the Second World War, the complex was returned to its ancient splendour. In addition to preserving historical architecture, the Foundation has repurposed spaces like the Manica Lunga as a modern art history library and created new landmarks such as the Teatro Verde amphitheatre and Le Stanze del Vetro for glass art exhibitions. The Foundation continues to be a hub for cultural preservation, artistic innovation, and scholarly exchange.

4. Remote set-up description

Reflectance spectra in the visible (Vis) and near-infrared (NIR) regions of the spots of interest in the painting Saints Peter and Stephen were measured in contact using a standard Fiber Optic Reflectance Spectroscopy (FORS) set-up, and at a remote distance using the innovative method described below. The contact reflectance of the colourants of the painting were measured by a standard FORS set-up from Avantes (The Netherlands), composed of an AvaLight-DH-S-BAL ultraviolet (UV), Vis and NIR radiation source, connected through an

800 µm diameter solarized optical fibre (model FC-UV800-2-SR) to a 50 mm diameter AvaSphere-50-REFL integrating sphere with sample-port of 10 mm in diameter. A gloss trap, coated with black absorbing material, was used in the sphere to avoid measuring specular reflection from the surface of the painting. The integrating sphere was connected to a 600 µm diameter optical fibre (model FC-UV600-2) that transferred the radiation to the AvaSpec-2048×14-USB2 spectrometer. This spectrometer used a diffraction grating enabling applications in the 248-1050-nm range and a fixed 100-micron slit to achieve a spectral resolution of 4.3 nm. Contact FORS measurements were calibrated using a Spectralon® (Labsphere, USA) reflectance standard (model SRS-99-010) with a nominal reflectance of 0.99 over the UV-VIS-NIR spectrum.

The remote reflectance spectra in the Vis and NIR regions were measured by a setup formed by an achromatic refractor telescope from Celestron, model AC 70/400 TravelScope AZ, with 70 mm aperture and 400 mm focal length, with a 45° diagonal erecting prism (Fig. 1). The telescope was mounted by using a suitable connector support on a photographic tripod equipped with a head that can be rotated in three directions to allow aiming towards the region of interest of the painting. The painting was about 8 m from the telescope: at such distance, the collected region is a spot about 2 cm in diameter, therefore it has double the diameter of the sample port of the integrating sphere. The collected region in the painting was illuminated by a light projector using an 18 W GE1649 incandescent lamp focalized by a convergent lens with a diameter of 8 cm and f-number 1. The lens can be moved relative to the lamp to allow the image of the filament to be focused on the painting. Inserted in the 45° diagonal erecting prism was a connector for the 800-µm-diameter optical fibre enabling the transmission of the radiation to the AvaSpec-2048×14-USB2 spectrometer used for the contact set-up. A personal computer was used for spectrometer control and data recording. Remote reflectance calibration was achieved by measuring the reflectance of a white cardboard placed at the same distance as the painting. The contact reflectance of the white cardboard was measured separately by the standard FORS set-up allowing the calibration of the remote reflectance measurements.

The telescope was positioned perpendicular to the painted surface, while the radiation from the light projector had an incidence angle of approximately 20 degrees with respect to it. In this configuration, most of the specular reflection is excluded, as in the contact measurements. Additionally, assuming that the painted surface is a Lambertian surface that reflects light uniformly in all directions, according to Lambert's law of diffuse reflection the intensity I of the radiation collected by the telescope varies as:

$$I \propto \frac{I_0 \cos \alpha}{d^2}$$

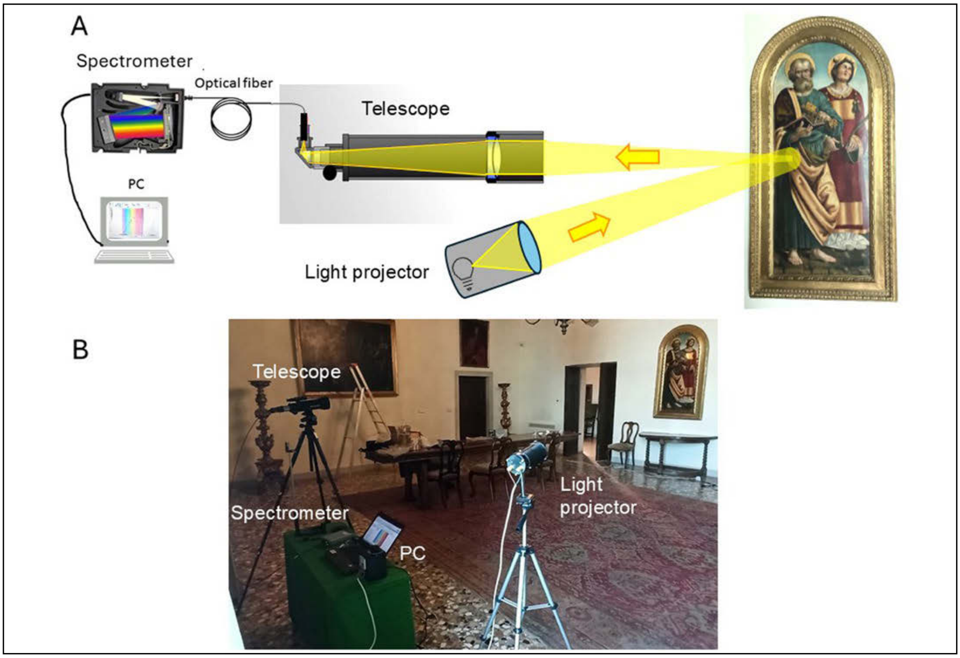

Fig. 2 – A) Schematic of remote reflectance spectroscopy; B) image of the setup during the measurement session of the painting of saints Peter and Stephen.

where I_0 is the intensity of the incident illumination within the area of the fiber projected onto the painting, α is the angle of observation relative to the normal, and *d* is the distance between the painting surface and the telescope (Kortum 1969). For all measured points on the painting and the calibration white cardboard, α and *d* were carefully maintained within a range that ensured that the intensity of the radiation collected by the telescope varied less than ±1.5%. Contact and remote measurements were carried out on 6 points shown in Fig. 2, in correspondence with specific coloured features of the painting: Saint Stephen's white robe (a), Saint Peter's yellow robe (b), Saint Stephen's red robe (c), Saint Peter's green/blue robe (d), Saint Stephen's yellow robe (e), and cyan sky (f).

5. Results and discussion

The reflectance spectra collected at contact and remote distances are shown in Figs. 3-5. The spectra for point a, acquired at the location of Saint Stephen's white robe, are shown in the left panel of Fig. 3. The spectra in the two acquisition modes show very similar trends, with higher reflectance values of about

0.5-0.6 in the NIR region and a decrease in reflectance values for wavelengths below approximately 600 nm, reaching about 0.2 at 400 nm. The reflectance spectrum acquired in the contact mode overall shows lower reflectance values, with differences ranging from 5% to 10% less than those acquired in the remote mode, depending on the wavelength. This trend can be interpreted as being due to chromatic inhomogeneities in the paint layer at point a of the painting. These chromatic inhomogeneities are visible in this point in Fig. 2 and are caused by the use of a dark pigment for depicting the drapery of Saint Stephen's white robe. Therefore, while the overall spectral behaviour of reflectance in the two modes is qualitatively similar, the lower overall values in the contact mode are likely due to slight differences in the measurement point between the two techniques in an area of the painting that exhibits inhomogeneities in the brightness of the white colour. In fact, in Renaissance paintings, white was often combined with dark pigments (e.g., umber, charcoal black) to create chiaroscuro effects and detailed drapery (Martin Kemp 1992).

Concerning the identification of the kind of colorant used for the white robe, the lack of evident spectral features makes these materials difficult to identify using reflectance spectroscopy. Pure white corresponds to almost total reflection of visible radiation, so reflectance spectra of typical white pigments, such as lead white, bone white, and gypsum, are very similar in the visible range, showing an unshaped and relatively flat spectral curve line at high reflectance values. However, the decrease in reflectance below approximately 600 nm, specifically in the violet, blue, and green spectral regions, and the relatively higher reflectance values above 600 nm, specifically in the yellow and red spectral regions, suggest that the white pigment could be white lead, which is subject to yellowing with aging (Pastorelli *et al.* 2024). The reflectance spectra for point b, acquired at the location of Saint Peter's yellow robe, are shown in the right panel of Fig. 3.

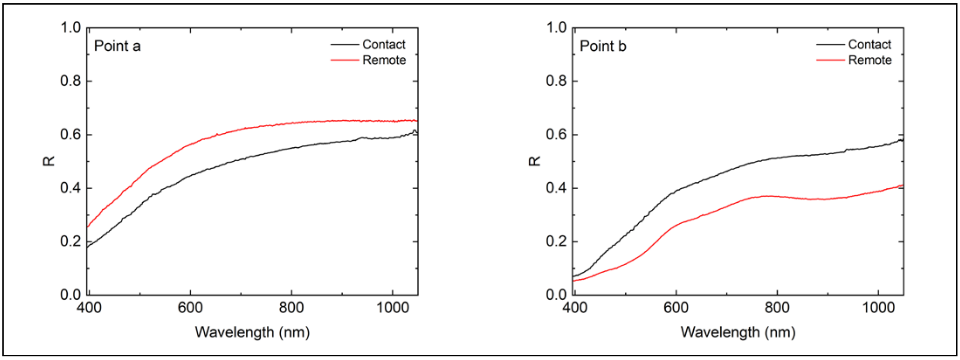

Fig. 3 – The contact and remote reflectance spectra in the Vis and NIR of points a (left) and b (right).

The spectra in the two acquisition modes show similar trends and spectral features even if the remote reflectance appears more structured. Even in this case, a general difference in the intensity of the reflectance spectra is noticeable, with the spectrum acquired in contact mode showing values up to 17% higher than those acquired in remote mode. However, the same considerations made previously for point a can also be applied to this spectrum for point b: the difference can be interpreted as being due to chromatic inhomogeneities in the paint layer at point b. These chromatic inhomogeneities are visible in this point in Fig. 2 and are caused by the use of a dark pigment for depicting the drapery of Saint Peter's yellow robe, as in Renaissance paintings, yellow was often combined with dark pigments (e.g., umber, charcoal black) to create chiaroscuro effects and detailed drapery (Martin Kemp 1992). Therefore, while the overall spectral behaviour of reflectance in the two modes is qualitatively similar, the lower overall values in the contact mode are likely due to slight differences in the measurement point between the two techniques in an area of the painting that exhibits inhomogeneities in the brightness of the yellow colour.

In the spectra, starting from the lower wavelength, are evident an increasing of the reflectance, a flex (more evident for the contact mode spectrum) at about 550 nm, two shoulders at about 600 and 770 nm with a central reflectance minimum (which correspond to absorption maxima of the material) at about 640-650 nm, and another absorption at about 900 nm. These features can be easily identified in the different yellow iron-based pigments, such as yellow ochre, goethite, natural sienna and natural umber earths (Aceto *et al.* 2014). Based on the results of the contact or remote reflectance, it is not possible to discriminate among the different yellow iron-based pigments mentioned.

The reflectance spectra for point c, acquired at the location of Saint Stephen's red robe, are shown in the left panel of Fig. 4. The spectra in the two acquisition modes are superimposed in a large part of the spectral range and show reflectance intensity differences as small as 5%, particularly above 900 nm. This very good coincidence may also be due to the homogeneity of the paint application for point c, as observed in Fig. 1. The two acquisition modes give spectra consisting of a non-zero reflectance at 400 nm, small features in the blue-green region followed by a steady increase in reflectance before 600 nm, an inflection point at about 600 nm, and a smaller increase in the NIR region. Overall, this spectrum is compatible with that of a red lake. Since many of the absorption features of red lakes vary depending on their preparation method, the identification of red organic compounds is difficult by using reflectance spectroscopy (Fonseca *et al.* 2019). However, considering the period of the painting, it can be suggested that the red lacquer used was likely derived from natural dyes, common in the Italian Renaissance, such as:

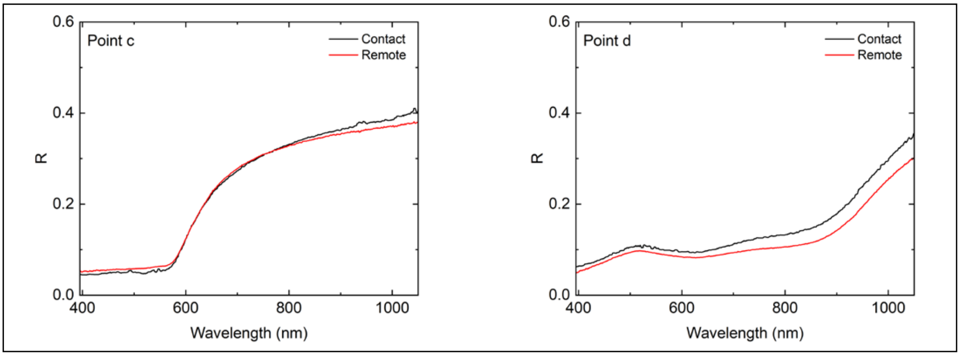

Fig. 4 – The contact and remote reflectance spectra in the Vis and NIR of points c (left) and d (right).

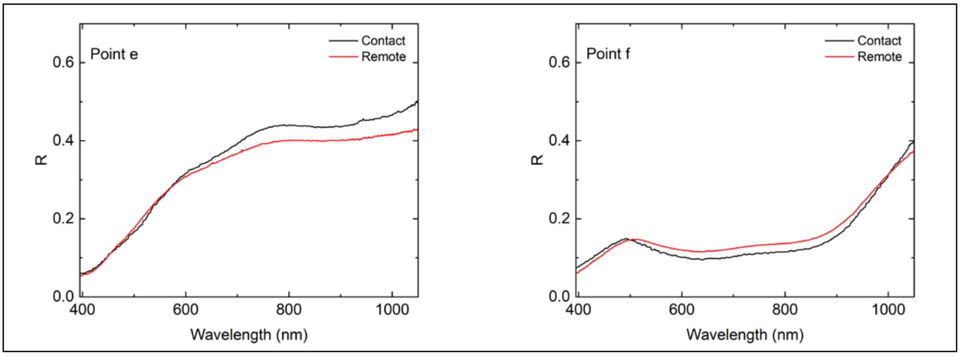

Fig. 5 – The contact and remote reflectance spectra in the Vis and NIR of points e (left) and f (right).

i) madder lacquer (Rubia tinctorum), a widely used pigment that produced various red tones, from deep red to pink, with alizarin as the main component extracted from the root; ii) carmine, derived from insects like cochineal.

The reflectance spectra for point d, acquired at the location of Saint Peter's green/blue robe, are shown in the right panel of Fig. 4. The spectra acquired in the two modes show low values of the reflectance up to about 800 nm. They show the same spectral features, namely a first reflectance peak at around 520 nm, a minimum (absorption) at approximately 630 nm, a maximum at around 760 nm, and another absorption at approximately 850 nm. At longer wavelengths, a consistent increase in reflectance is observed, reaching values above 0.5 at 1050 nm. These spectral features suggest the combination of two pigments to achieve the green/blue colour observed with the naked eye. They are consistent with the presence of malachite (a green pigment also made from copper carbonate) mixed with azurite (a blue pigment made from copper carbonate), which exhibit absorptions at approximately 640 nm and around 800-850 nm, respectively. During the Italian Renaissance, artists sometimes mixed azurite and malachite to create green-blue shades. This combination allowed for customized tones, ranging from green to blue, ideal for depicting natural elements like skies, clothing, and vegetation, offering more realistic and harmonious nuances. The choice to mix these pigments stemmed from their chemical compatibility (both are copper carbonates) and availability as natural materials, though their use often depended on the desired colour effect, artistic technique, and the artist's financial resources, as both pigments were quite expensive.

The reflectance spectra for point e, acquired at the location of Saint Stephen's yellow robe, are shown in the left panel of Fig. 5. The spectra in the two acquisition modes show similar trends and spectral features. Up to about 600 nm, the spectra acquired in the two modes overlap and then separate at longer wavelengths, where the contact spectrum shows a higher reflectance, up to 10%. The spectra exhibit spectral features similar to those of point b (Fig. 3 right), with an inflection at about 520-530 nm, two shoulders at about 600 and 770 nm, with an absorption at about 660-670 nm at their centre, and another absorption at about 900 nm. Therefore, it can be stated that these features can again be identified in different yellow iron-based pigments, such as yellow ochre, goethite, natural sienna, and natural umber earths (Aceto *et al.* 2014). Again, it is not possible to distinguish between these materials using reflectance spectroscopy. Finally, the reflectance spectra for point f, acquired at the location of cyan sky, are shown in the right panel of Fig. 5. These two spectra are very close to each other showing a reflectance intensity difference that can reach a maximum of 0.02. The spectral features are remarkably like those of point d, with absorptions at approximately 630 nm and 840 nm. Therefore, it can also be stated that the artist used the same malachite and azurite mixture to achieve the green/blue colour of the sky filling.

6. Conclusion

We present a novel approach for remote FORS measurements using a telescope connected by optical fibres to a multichannel Vis-NIR spectrometer. This setup was employed to study the colourants in the painting Saints Peter and Stephen, conserved at the Fondazione Giorgio Cini and tentatively attributed to Antonio del Massaro da Viterbo (circa 1450-1516). To assess the accuracy of the remote FORS measurements, a comparison was made with standard FORS measurements carried out with a contact integrating sphere. The reflectance spectra collected at contact and remote distances show excellent agreement and enable the identification of the colorants used by the artist. For point a, corresponding to Saint Stephen's white robe, the spectra exhibit similar features, suggesting the use of white lead. For point b, corresponding to Saint Peter's yellow robe, the spectral features align with yellow iron-based pigments such as yellow ochre or goethite. For these two points, the different overall reflectance intensities are attributed to chromatic inhomogeneities in the paint, likely caused by the use of dark pigments for chiaroscuro effects in the robes. At point c, the spectra for Saint Stephen's red robe are well-matched between the two modes, with minimal reflectance intensity differences, suggesting homogeneity in the paint. The spectral features are consistent with red lake pigments, such as madder lacquer or carmine. For point d, depicting Saint Peter's green/blue robe, the spectral data indicate a mixture of malachite and azurite, which were commonly combined during the Renaissance to create varied green-blue hues. For points e and f, corresponding to Saint Stephen's yellow robes and the cyan sky, the spectra are similar to those of points b and d, indicating the use of yellow iron-based pigments and the same malachite-azurite mixture, respectively. These findings provide insights into the materials and techniques used by the Renaissance artist to achieve specific colours.

We intend to further develop the remote FORS setup by improving the optical set-up to optimize the overlap between the points measured in contact mode and those measured remotely. Additional information regarding the coloured materials of Saints Peter and Stephen could be obtained through other non-destructive investigative methods, such as X-ray fluorescence spectroscopy and infrared and Raman vibrational spectroscopies.

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REFERENCES

Aceto M., Agostino A., Fenoglio G., Idone A., Gulmini M., Picollo M., Ricciardi P., Delaney J.K. 2014, *Characterisation of colourants on illuminated manuscripts by portable fibre optic UV-visible-NIR reflectance spectrophotometry*, «Analytical Methods», 6, 5, 1488 (https://doi.org/10.1039/c3ay41904e).

Fonseca B., Schmidt Patterson C., Ganio M., MacLennan D., Trentelman K. 2019, *Seeing red: Towards an improved protocol for the identification of madder- and cochineal-based pigments by fiber optics reflectance spectroscopy (FORS)*, «Heritage Science», 7,1 (https://doi.org/10.1186/s40494-019-0335-1).

Kortum G. 1969, *Reflectance Spectroscopy (Principles, Methods, Applications)*, Berlin, Springer.

Li Y., Suzuki A., Cheung C.S., Kogou S., Liang H. 2024, *Ground-based remote standoff laser spectroscopies and reflectance spectral imaging for multimodal analysis of wall painting stratigraphy*, «Analytical Chemistry» (https://doi.org/10.1021/acs.analchem.4c05264).

Liang H., Keita K., Vajzovic T. 2007, *PRISMS: A portable multispectral imaging system for remote in situ examination of wall paintings*, in *O3A: Optics for Arts, Architecture, and Archaeology*, SPIE, 661815 (https://doi.org/10.1117/12.726034).

Marchant J. 2025, *How AI is unlocking ancient texts-and could rewrite history*, «Nature», 637.8044, 14-17 (https://doi.org/10.1038/d41586-024-04161-z).

Martin Kemp 1992, *The Science of Art: Optical Themes in Western Art from Brunelleschi to Seurat*, Paperback, Yale University Press.

Missori M., Mosca Conte A., Pulci O., Teodonio L., Dominijanni S., Puteo S., Iannuccelli S., Sotgiu S., Sebastiani M.L. 2019, *Non-destructive monitoring of molecular modifications in the restoration of works of art on paper: Application of theoretical and experimental optical spectroscopy*, «European Physical Journal Plus», 134, 3 (https://doi.org/10.1140/epjp/i2019-12524-3).

Mosca Conte A., Pulci O., Misiti M., Lojewska J., Teodonio L., Violante C., Missori M. 2014, *Visual degradation in Leonardo da Vinci's iconic self-portrait: A nanoscale study*, «Applied Physics Letters», 104.22, 224101 (https://doi.org/10.1063/1.4879838).

Pastorelli G., Miranda A.S.O., Clerici E.A., d'Imporzano P., Hansen B.V., Janssens K., Davies G.R., Borring N. 2024, *Darkening of lead white in old master drawings and historic prints: A multi-analytical investigation*, «Microchemical Journal», 199, 109912 (https://doi.org/10.1016/j.microc.2024.109912).

Perri A., Nogueira de Faria B.E., Ferreira D.C.T., Comelli D., Valentini G., Preda F., Polli D., de Paula A.M., Cerullo G., Manzoni C. 2019, *Hyperspectral imaging with a twins birefringent interferometer*, «Optics Express», 27, 11, 15956 (https://doi.org/10.1364/oe.27.015956).

Picollo M., Aceto M., Vitorino T. 2019, *UV-Vis spectroscopy*, «Physical Sciences Reviews», 4, 4 (https://doi.org/10.1515/psr-2018-0008).

Soldovieri F., Kennedy C.J., Penman M., Watkinson D., Emmerson N., Thickett D., Bosché F., Forster A.M., Grau-Bové J., Cassar M. 2024, *Beyond Heritage Science: A review*, «Heritage», 7, 3 (https://doi.org/10.3390/heritage7030073).

Titubante M., Marconi C., Citiulo L., Mosca Conte A., Mazzuca C., Petrucci F., Pulci O., Tumiati M., Wang S., Micheli L., Missori M. 2022, *Analysis and diagnosis of the state of conservation and restoration of paper-based artifacts: A non-invasive approach*, «Journal of Cultural Heritage», 55 (https://doi.org/10.1016/j.culher.2022.04.003).

Vasco G., Aureli H., Fernández-Lizaranzu I., Moreno-Soto J., Križnar A., Parrilla-Giraldez R., Gómez-González E., Respaldiza Galisteo M.A. 2024, *Development of a Hyperspectral Imaging Protocol for Painting Applications at the University of Seville*, «Heritage», 7, 11, 5986-6007 (https://doi.org/10.3390/heritage7110281).

ABSTRACT

This study presents a novel approach for remote Fiber Optic Reflectance Spectroscopy (FORS) applied to the Renaissance painting Saints Peter and Stephen, tentatively attributed to Antonio del Massaro da Viterbo. The painting, housed at the Fondazione Giorgio Cini in Venice, was analyzed using both contact and remote FORS, with the latter performed at an 8 meter distance using a custom optical setup inspired by astronomical techniques. The reflectance spectra obtained in both configurations showed strong agreement, enabling the identification of pigments such as iron-based yellows, red lake, malachite, and azurite. The findings offer new insights into the artist's material choices and techniques, while also demonstrating the feasibility of remote FORS as a non-invasive diagnostic tool for cultural heritage. Future developments will focus on refining the optical setup to further improve measurement accuracy and expand the applicability of remote FORS in heritage science.