45 ISA 2026
18-22 MAY TURIN ITALY
INTERNATIONAL SYMPOSIUM ON ARCHAEOMETRY

MODIFIED NIGHT VISION GOGGLES (MNVG): A TRANSFORMATIVE, ACCESSIBLE PLATFORM FOR REAL-TIME VIL IMAGING AND FIELD-BASED IR ARCHAEOMETRY

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INTRODUCTION

Visible-Induced Luminescence imaging (VIL) detects Egyptian blue ($CaCuSi_4O_{10}$) and few other pigments via their specific near-infrared emission in the range 900-1000 nm. This study presents Modified Night Vision Goggles (MNVG) a simplified system to obtain VIL. It is an accessible method built from commercial devices (<150 USD) with IR filters, enabling real-time, in-situ pigment visualization under ambient light.

OBJECTIVES

This technique enhances the traditional VIL imaging method (normally dependent on modified cameras) by making it more user-friendly, versatile, and cost-effective. As it can be used directly in museum settings, the MNVG system also serves as an immersive educational tool, allowing visitors to see pigments normally invisible to the naked eye.

METHODOLOGY

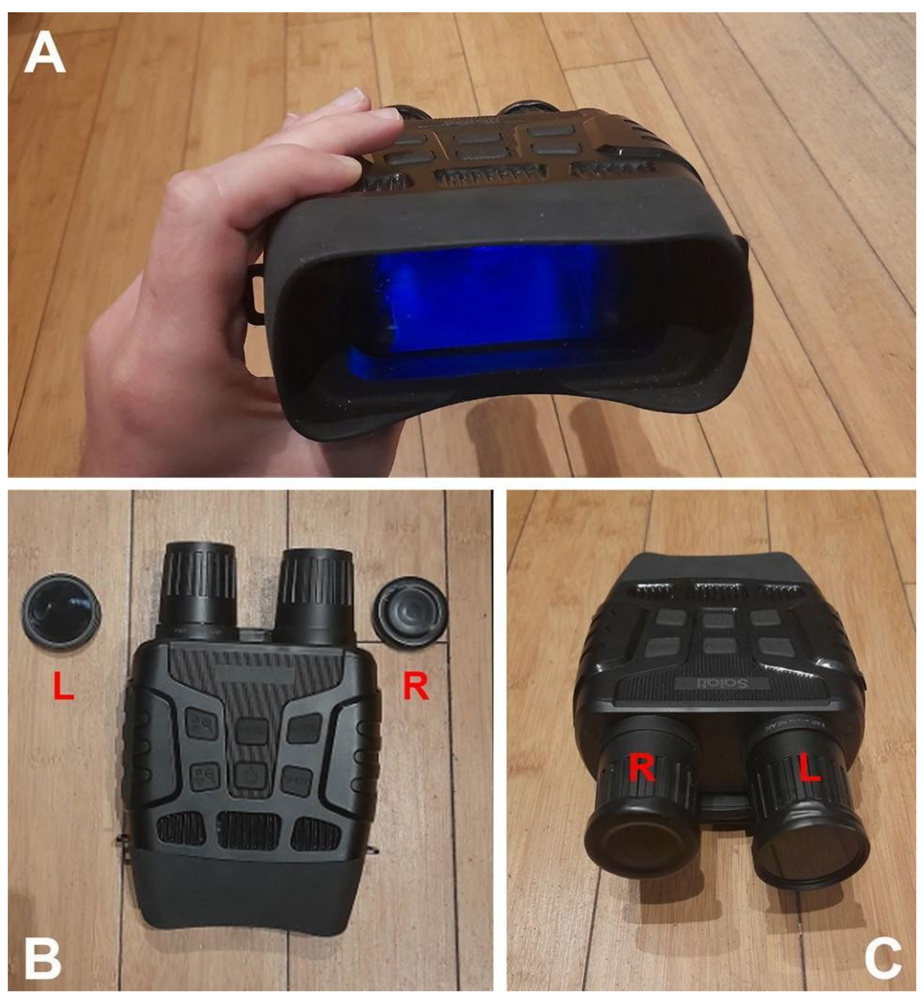

Fig. 1. Night vision goggles (**A**) with highlighted modifications on the left and right oculars

MNVG (Modified night vision goggle) has been developed starting from a commercial digital NVG (trademark Salati). The NIR illuminator (right ocular) has been excluded by covering it with a standard 43 mm twist-off lid shown in Fig. 1 as R. The filter has simply been placed in front of the objective (left ocular) An NVG becomes able to detect EB luminescence by simply adding the two lids L and R as shown in Fig. 1. When they are off, it fully turns back to its original function.

RESULTS & DISCUSSIONS

The images presented have been acquired at the following sites:

- The Renaissance frescoes painted by Raphael ("Triumph of Galatea" and "Loggia of Cupid and Psyche") at Villa Farnesina in Rome (Fig. 2, 3)
- Underground Roman frescoes at the Domus Aurea (Rome) (Fig. 4)
- Some Egyptian objects at the Egyptian Museum (Turin) (Fig. 5)

RAPHAEL AT VILLA FARNESINA

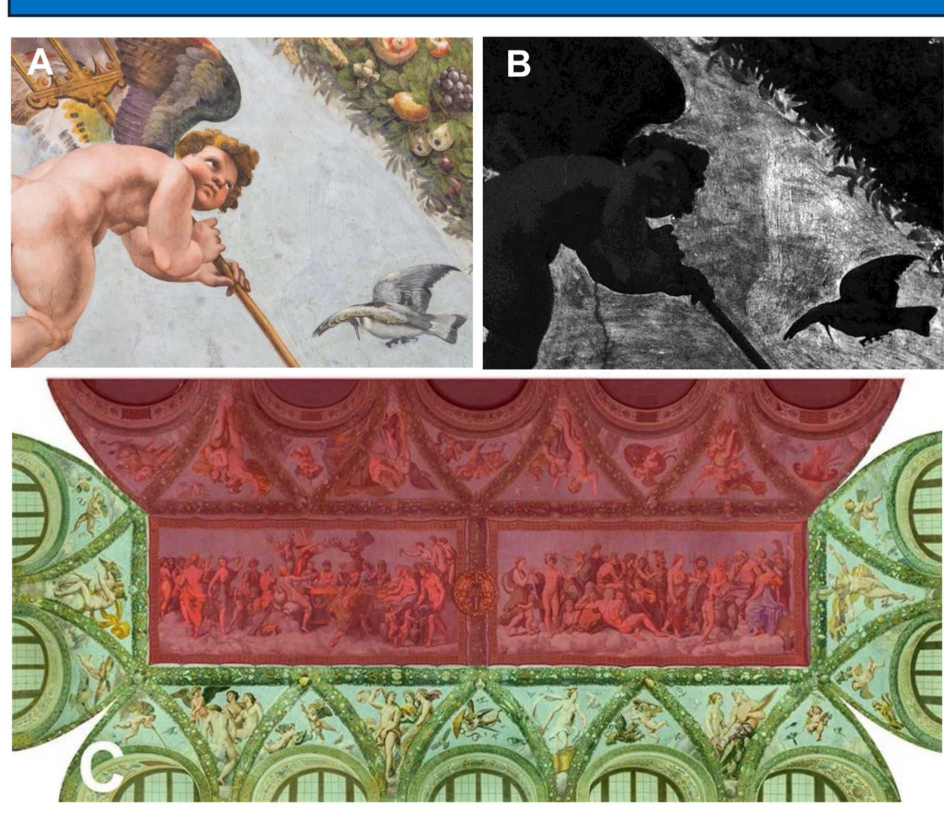

Fig. 2. The Loggia of Cupid and Psyche. Visible of a detail (A), corresponding MNVG NIR image (B), and scheme of EB distribution obtained by using MNVG (C). The green area corresponds to the zone where EB is present within the skies.

The images from Loggia of Cupid and Psyche (Fig. 2) show how MNVG allows for surprising results by distinguishing even the individual brushstrokes of EB. Despite the need to work at night and with LED light, MNVG performs well at long distances, without the need of scaffoldings. This demonstrates how the systematic use of a simple and non-destructive tool allows for the unprecedented discovery of a widespread diffusion of EB even on works that in the past had been analysed over and over again with invasive and destructive spot analysis that obtained only limited results.

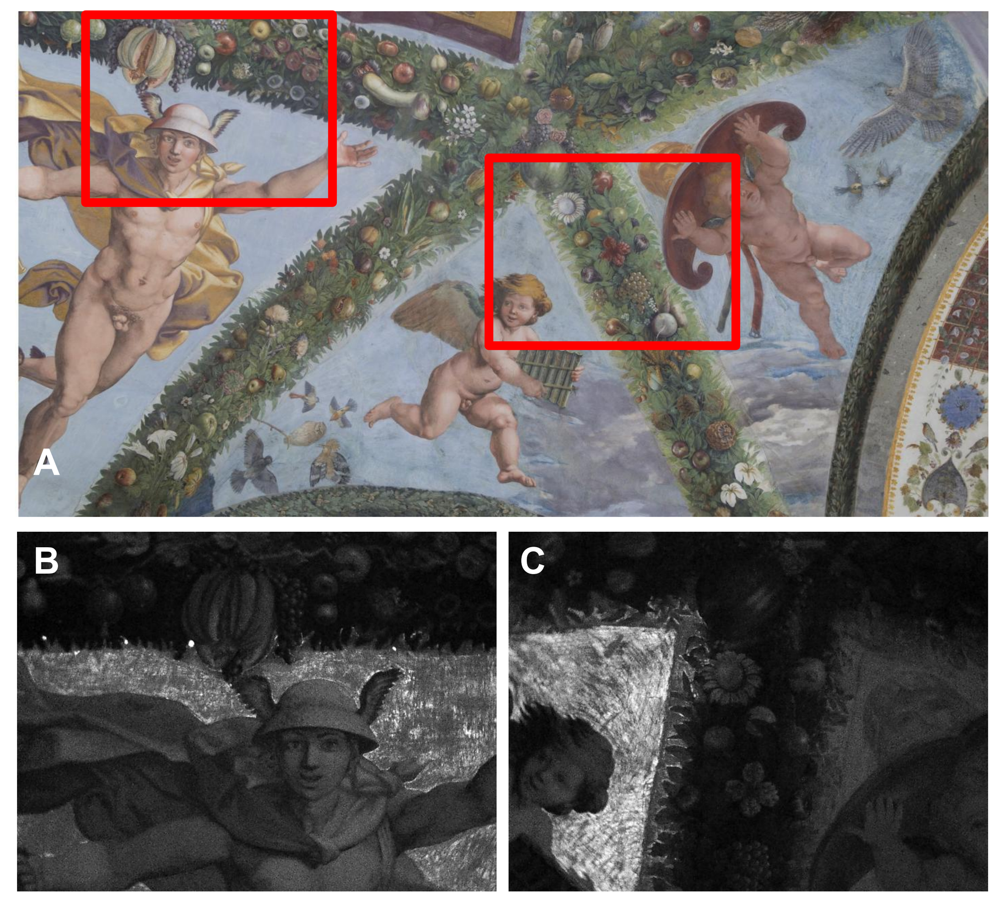

Fig. 3. Loggia of Cupid and Psyche. Visible image (A) and corresponding MNVG NIR details (B, C).

Fig. 3A shows that EB has detached or has been scraped away from extensive areas where clear visible traces remain. In Fig. 3B, brackets and other restoration interventions are visible, among which the different contouring of the border with the leaves stands out. The right side of Fig. 3B shows one of the most singular aspects that have been discovered: the fact that for more than half of the vault EB is completely absent (see also Fig. 2C). Interpretation of this data is left to future studies of a multidisciplinary nature with historians and restorers.

DOMUS AUREA

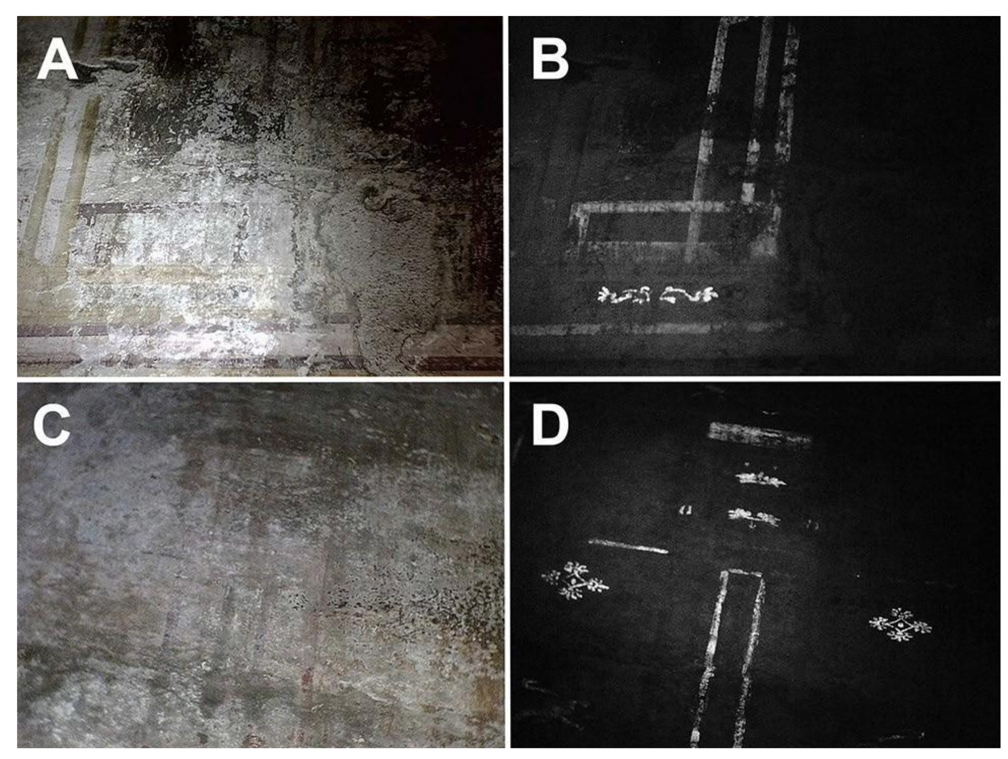

Fig. 4 Two examples of hidden decorations on the wall of the Grande Criptoportico. Due to the presence of a thick layer of carbonation, they are practically invisible. MNVG visible image (A and C) and corresponding MNVG NIR image (B and C)

For the analyses carried out at the Domus Aurea there was no need to operate at night since the underground site is free from sunlight. We made use of the LED lighting that already served the site. The self-optimizing internal algorithms of the MNVG lets indeed to operate even in poor light conditions. The technique allows to see even very far away hidden details such as the decorations shown in Fig. 4 that are almost completely invisible to the naked eye since they are covered by layers of carbonation.

EGYPTIAN MUSEUM

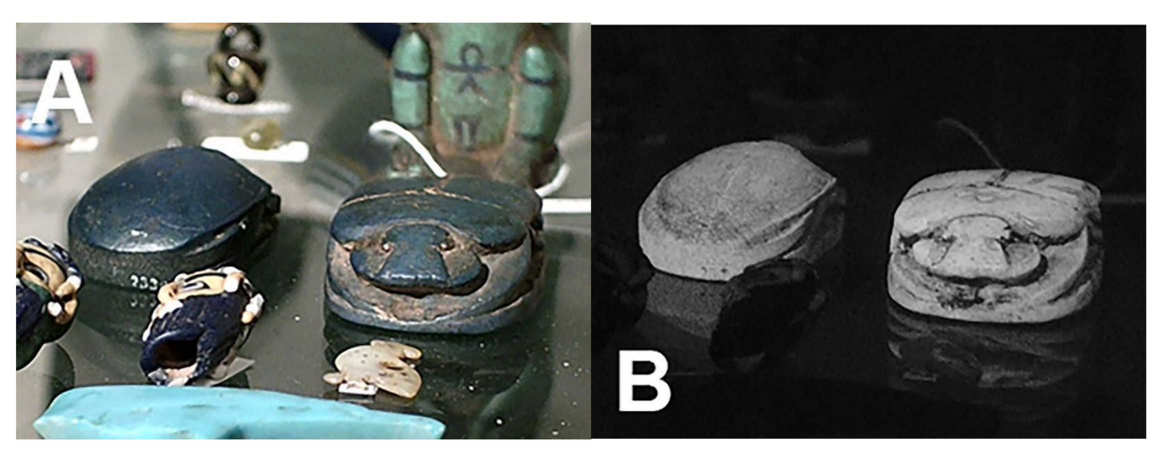

Fig. 5. MNVG visible image (A) and MNVG NIR image (B) of two scarabs (ME—C. 6016, C. 6037), Egyptian Museum (Turin).

The technique can be used directly in museums with the visible light present in the exhibition rooms. In the case of this image recorded on a showcase within the Egyptian Museum of Turin, the EB nature of the amulets can be immediately spotted (Fig. 5). Thanks to the very easy nature and user- friendliness of the MNVG, new perspectives will arise from these results, and we can glimpse the possibility of enjoyment not only by an audience of specialists but also by visitors

CONCLUSIONS

In conclusion, MNVG breaks down barriers in conservation science by establishing a common, user-friendly entry point for IR imaging. This common reference platform not only enables immediate discoveries but also strategically directs the subsequent development and application of more complex, specialized IR-based techniques in field conservation.

ACKNOWLEDGMENTS

The activities have been performed within the BLUENET project. We express our deep gratitude to Accademia Nazionale dei Lincei, Villa Farnesina, Centro linceo di ricerca sui beni culturali Villa Farnesina (CERIF), Parco Archeologico del Colosseo, Museo Egizio di Torino.

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