Why researchers look for white stains on Edvard Munch's masterpiece with DESY's X-rays

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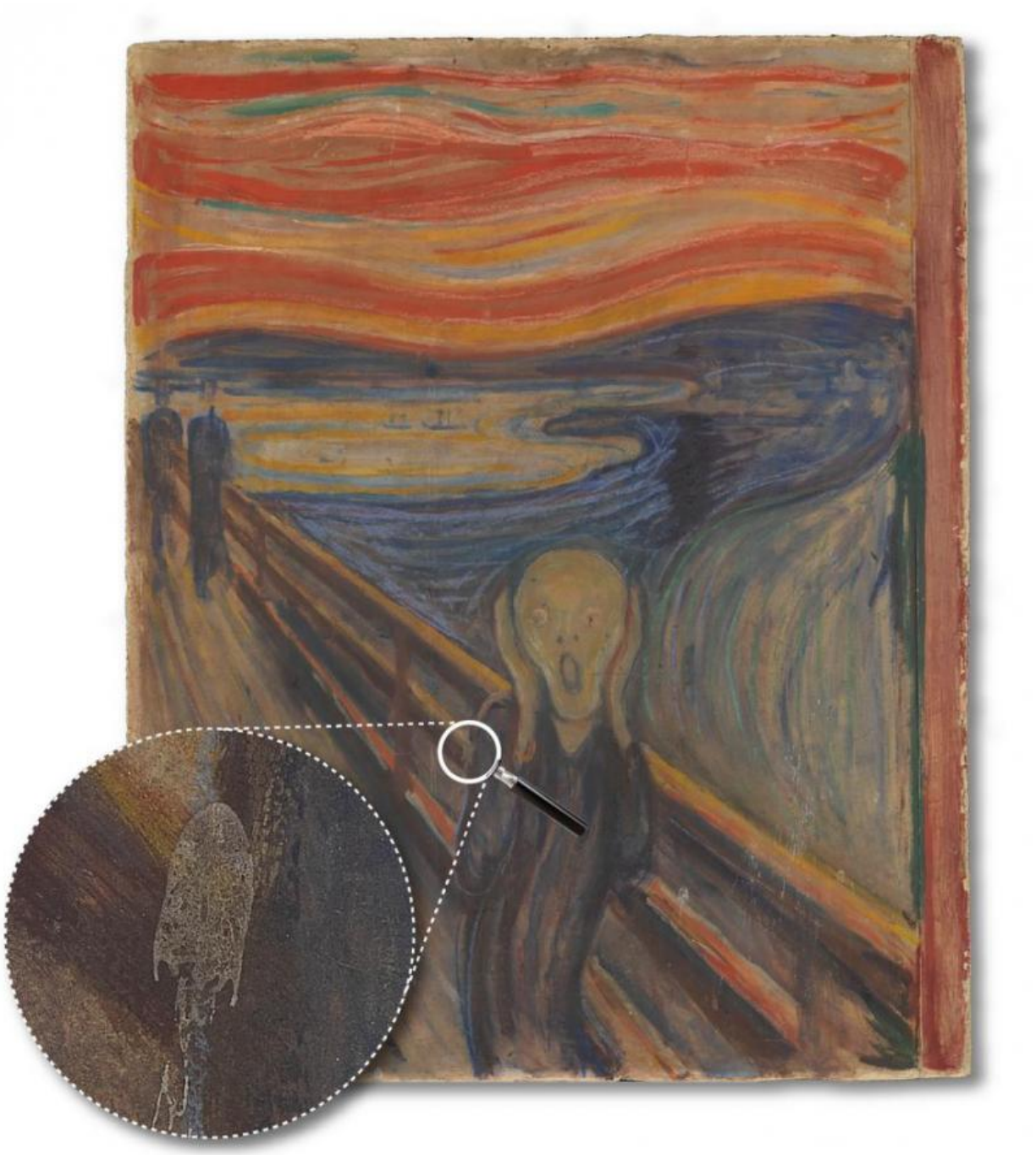


The 'Scream' by Edvard Munch is stained by mysterious white spots. Credit: Norwegian National Museum

With the help of the brilliant X-ray radiation from DESY's research light source PETRA III, scientists have solved a decades-old mystery from the world of art: A team led by Dr. Geert Van der Snickt of the University of Antwerp unravelled the nature of mysterious white spots on the famous painting "The Scream" by the Norwegian artist Edvard Munch. Contrary to popular assumption the stains are not bird droppings - and neither simply white color. Instead, the X-ray examination shows that the patches are made of wax, which probably dripped from a candle in Munch's studio on the painting.

It is known that Munch painted several of his large drafts outdoors and that he liked to expose his paintings to the forces of nature. As seen on the right, photographs were conserved showing the artist in the snow midst a series of paintings, merely sheltered by a wooden shed. The painting entered the National Museum's collection directly from the artist's studio and the white splatters have always been present. All of this resulted in a theory that Munch would have left the Scream outside and that birds flying by literally added another layer of meaning to Munch's Masterpiece. "Bird droppings can pose a significant threat for monuments, outdoor statues ... and brand new cars", says Van der Snickt, cultural heritage scientist at the University of Antwerp. "But I did not associate it with easel paintings, and certainly not with quintessential masterpieces that are valued over 100 million dollars."

The "Scream" has become an icon of the European art canon. "In the final years of the nineteenth century, Edvard Munch made four versions of the Scream, a painting that is nowadays considered as vital for the later development of Expressionism," explains Dr Nils Ohlsen, Director of Old Masters and Modern Art at the National Museum in Oslo. Although one of the versions was sold in 2012 for a staggering 119 million dollars, the most renowned version is undoubtedly the painting that is part of the collection of the Norwegian National Museum. This work differs from the others not only in the fact that it is considered as

the earliest version, but also because it features a series of enigmatic white splatters on the surface.

However, Prof. Tine Frøysaker (University of Oslo), who has been recurrently confronted with bird excrements in the Norwegian Stave churches where she worked throughout her career as conservator, was less convinced by the bird droppings theory as the white spots do not look anything like bird droppings under the microscope. Thierry Ford, Paintings Conservator at the National Museum, subscribes to that opinion as "bird excrements are known to have a corroding or macerating effect on many materials, a statement that most car owners can confirm".

Close-up of a white spot. Credit: Norwegian National Museum

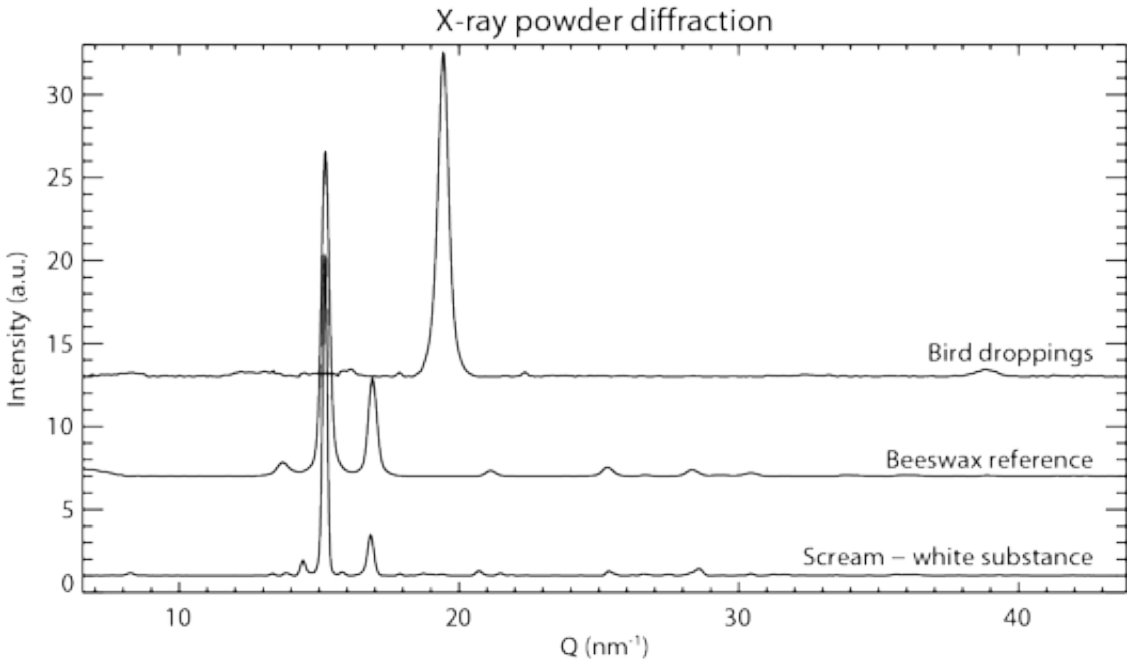
In this case, the white substance seems to lie on top of the paint. Moreover, in some areas, the white matter seems to have flaked off through the years without leaving any sign of damage. A last technical argument opposing this theory is the fact that Munch employed a cardboard substrate to paint the Scream, a material that is particularly fragile and hygroscopic and would have suffered severe damage when left outdoors.

"It seemed more plausible that the splatters were actually white paint or chalk that had accidently dripped on to the Scream while Munch was working on other paintings in his studio", says Frøysaker. However, in spite of logic arguments, urban legends can prove hard to erase especially as this aspect of the national treasure would dovetail nicely with the Norwegian spirit of nature-bonding.

In May 2016, Frøysaker invited the Antwerp team to Oslo with the aim of characterising the painting materials and techniques used by Munch. According to Dr Geert Van der Snickt, the bird droppings were certainly not the primary aim, "but it would have been a mistake not to exploit the passage of the Antwerp state-of-the-art equipment to try and settle the long standing bird droppings dispute". The Scream was therefore submitted to the renowned Macro X-ray fluorescence scanner (MA-XRF), an instrument developed by the AXES research group that supplied pivotal arguments for many pending issues concerning key works of art by Van Eyck, Rubens, Van Gogh, etc. Surprisingly, these non-invasive scans ruled out the readiest paint option as no white pigments nor calcium was detected inside the enigmatic smudges.

Undaunted by this negative result, the interdisciplinary team decided to

take the research to the next level by extracting a micro sample from the white stains. This tiny sample was then analysed at DESY's synchrotron facility PETRA III in Hamburg by the Antwerp team. At PETRA III, fast particles from a particle accelerator produce particularly brilliant X-ray light. "From the X-ray scattering pattern that is produced by the sample under investigation, its internal structure can be determined down to the atomic scale", explains DESY researchers Dr. Gerald Falkenberg, head of the measuring station P06 at PETRA III, where the examinations took place.



X-ray diffraction data from bird droppings, the mysterious white spots and beeswax. Credit: University of Antwerp

"The introduction of particle accelerators for the investigation of paint materials has caused a revolution in our understanding of how historical paint systems behave", says chemistry professor Koen Janssens from Antwerp. "In the last few years, we were able to unravel various complex

chemical degradation processes that cause paintings to discolour or flake, knowledge that will eventually lead to an improved conservation."

PhD student Frederik Vanmeert who analysed the sample at the micro scale using X-ray diffraction had a surprise in store. "I immediately recognised the diffraction pattern of wax crystals as I encountered this material several times upon measuring paintings." In the past, unstable paintings were often impregnated with bees wax (or a similar waxy material) in order to consolidate flaking paint or to attach a new canvas to the back of a degraded old one. In this case, it is most likely that the white spots are in fact splatters of molten wax that accidently dripped from a candle in Munch's studio.

...and what about the bird droppings? "Initially, I planned to go sightseeing on my last day in Oslo", recalls Geert Van der Snickt. "It turned out that I spent most of my time looking down, searching for bird droppings on the ground that could serve as reference material. After some time, I found a perfect specimen right in front of the opera building. I must admit I was a little embarrassed collecting this sample material in front of groups of tourists. For a second sample, I decided to look for a more quiet place, around the castle."

"It can be seen at first glance that the measurement data of bird droppings do not match the material of the white spots, which match the data of beeswax," says Falkenberg. "It is true that the bird droppings that I collected in the streets of Oslo can hardly be considered as a statistical relevant sounding and that the composition of droppings is strongly dependant of the nutrition of the bird, but I sincerely doubt that Munch's painting was sprayed by birds that happened to be fond of wax', concluded Geert Van der Snickt. As such, I think we can close the case on the bird droppings."

Provided by Deutsches Elektronen-Synchrotron