Mystery solved: The origin of the colors in the first color photographs

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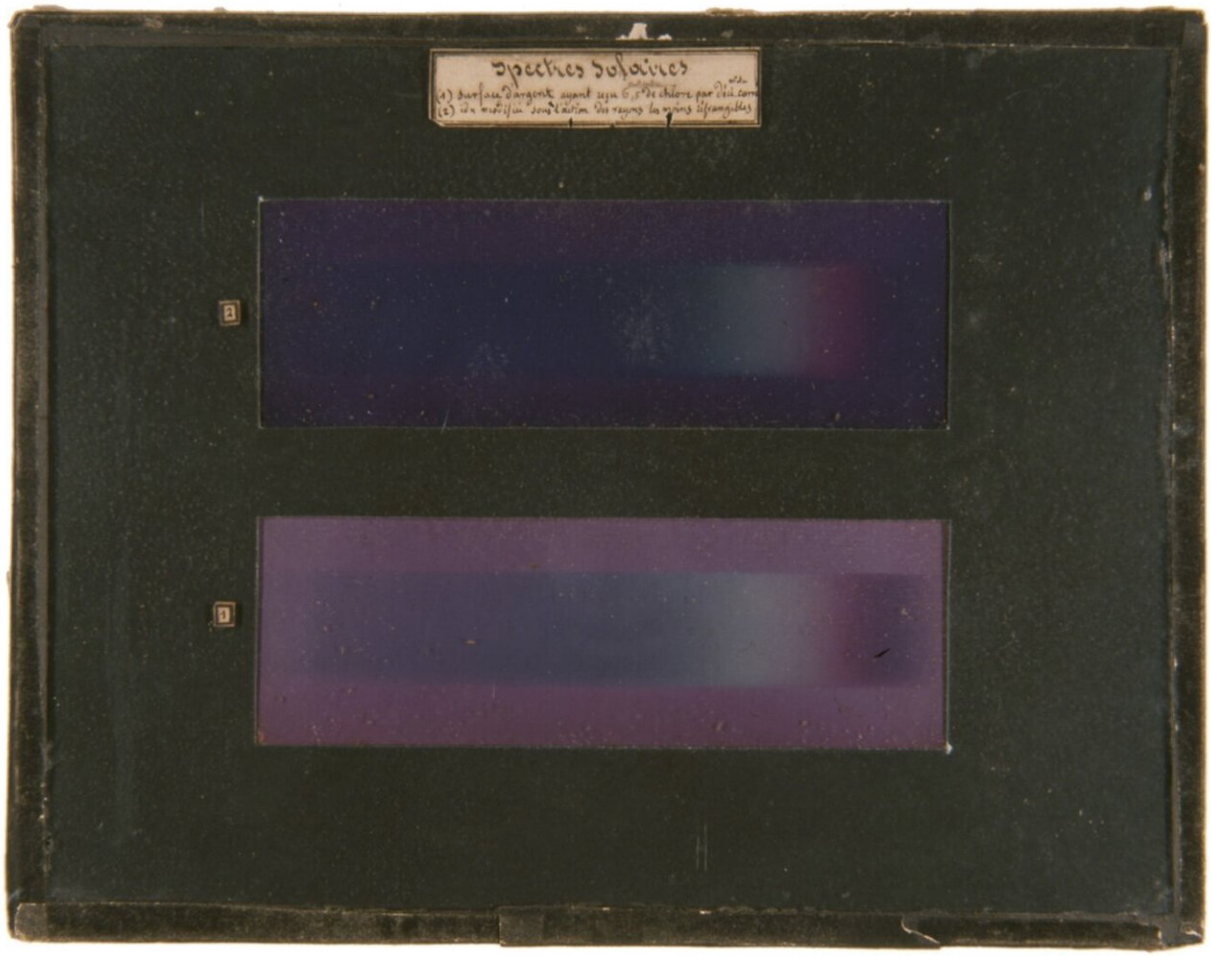

Edmond Becquerel, Solar spectra, 1848, photochromatic images, Musée Nicéphore Niépce, Chalon-sur-Saône.

A palette of colors on a silver plate: That is what the world's first color photograph looks like. It was taken by French physicist Edmond Becquerel in 1848. His process was empirical, never explained, and quickly abandoned. Now, a team at the Centre de recherche sur la conservation (CNRS/Muséum National d'Histoire Naturelle/Ministère de la Culture), in collaboration with the SOLEIL synchrotron and the Laboratoire de Physique des Solides (CNRS/Université Paris-Saclay), reports that the colors obtained by Edmond Becquerel were due to the presence of metallic silver nanoparticles. Their study was published on 30 March 2020 in *Angewandte Chemie International Edition*.

In 1848, in the Muséum d'Histoire Naturelle in Paris, Edmond Becquerel managed to produce a color photograph of the solar spectrum. These photographs, which he called "photochromatic images," are considered to be the world's first color photographs. Few of these have survived because they are light-sensitive and because very few were produced in the first place. It took the introduction of other processes for color photography to become popular in society.

For more than 170 years, the nature of these colors has been debated in the scientific community, without resolution. Now we know the answer, thanks to a team at the Centre de recherche sur la conservation (CNRS/Muséum National d'Histoire Naturelle/Ministère de la Culture) in collaboration with the SOLEIL synchrotron and the Laboratoire de Physique des Solides (CNRS/Université Paris-Saclay). After having reproduced Edmond Becquerel's process to make samples of different colors, the team started by re-examining 19th-century hypotheses using 21st century tools. If the colors were due to pigments formed during the reaction with light, there should have been variations in chemical composition from one color to another, which no spectroscopy method has shown. If they were the result of interference, like the shades of some butterflies, the colored surface should have shown regular microstructures about the size of the wavelength of the color in question.

Yet no periodic structure was observed using electron microscopy.

However, when the colored plates were examined, metallic silver nanoparticles were revealed in the matrix made of silver chloride grains—and the distributions of sizes and locations of these nanoparticles vary according to color. The scientists assume that according to the light's color (and therefore its energy), the nanoparticles present in the sensitized plate reorganize: Some fragment and others coalesce. The new configuration gives the material the ability to absorb all colors of light, with the exception of the color that caused it, thereby producing the color that we see. Nanoparticles having properties related to color are known as surface plasmons, electron vibrations (here, those of the metallic silver nanoparticles) that propagate in the material. A spectrometer in an electron microscope measured the energies of these vibrations to confirm this hypothesis.

More information: Victor de Seauve et al, Spectroscopies and electron microscopies unravel the origin of the first colour photographs, *Angewandte Chemie* (2020). DOI: 10.1002/ange.202001241

Replication and study of the colouration of Edmond Becquerel's photochromatic images, Victor de Seauve, Marie-Angélique Languille, Saskia Vanpeene, Christine Andraud, Chantal Garnier, Bertrand Lavédrine, *Journal of Cultural Heritage*, 2020 (in press). arxiv.org/abs/2001.05250

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