The Colours of the Skies of Impressionism

The Re-Discovery of Meteorology and Colour in the 19th century

Franz Ossing, Dipl.Met. February 2025

What is colour? This key question has pervaded the history of painting for centuries. However, it was only with the cognitive revolution in knowledge in science of the 19th century that it could be precisely posed and answered.

With the emergence of the modern (natural) sciences in the 17th century – not coincidentally at the same time – the close-to-nature reproduction of pictorial subjects in painting gained paramount importance. Dutch painting of the 17th century is revolutionary for precisely this reason.

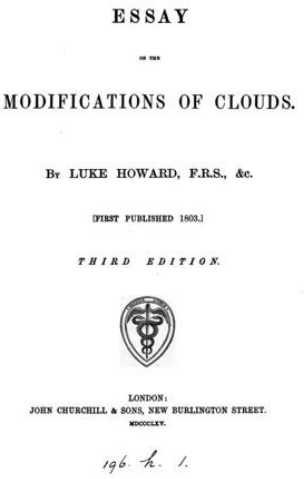
In the 19th century, modern science experienced a surge of renewal. The knowledge of the world gained since the 17th century led to a new systematisation, especially in physics. Naturally, this was also reflected in the arts, especially in painting.

Two processes were important for cloud painting. Firstly, methodical and physically based meteorology developed. Secondly, the physical explanation of the colour spectrum was formulated and the physiological basis of colour perception was researched.

Meteorology: from empiricism to the physics of the atmosphere

At the beginning of the 19th century, the British Luke Howard, the inventor of cloud classification, stood at the interface between purely empirical observation and the shift towards the physics of the atmosphere (Fig. 1). Goethe saw him as an empirical scientist, but Howard was more than that, for with his vertical classification of cloud types he surmised that the laws of physics also apply to the atmosphere.

FORMS ASSUMED BY CLOUDS WHEN GATHERING FOR A THUNDERSTORM.



ESSAY

ON THE

MODIFICATIONS OF CLOUDS.

By LUKE HOWARD, F.R.S., &c.

[FIRST PUBLISHED 1803.]

THIRD EDITION.

LONDON:
JOHN CHURCHILL & SONS, NEW BURLINGTON STREET.
MDCCCLXV.

196. h. 1.

Fig. 1: *Luke Howard's cloud catalogue (1803/1832)*

But it was only with the formulation of thermodynamics, the conservation of energy and the complete formulation of the gas laws in the 19th century that meteorology was able to develop from a collection of empirical findings into a well-founded science.

What is colour?

The cultural-anthropological dispute about Newton's explanation of colour and Goethe's polemic arose from the fact that neither of them was able to ask or answer this question correctly. Newton did not discover the spectrum, but that white light is made up of all the colours of the visible spectrum. Goethe, on the other hand, formulated fundamental ideas on the human perception of light.

The answer to the question of the character of colour was only made possible by the sciences of the 19th century, because it was only then that it could be posed in a precisel form. Colour is a sensory impression conveyed by the eye and processed by the brain, which is caused by light, or more precisely by the perception of electromagnetic radiation. We are therefore talking about two different issues, physics and physiology.

In physics colour is a part of the electromagnetic spectrum, which was first discovered by James Clark Maxwell in 1864. Our eyes can only perceive this part of the spectrum (Fig. 2).

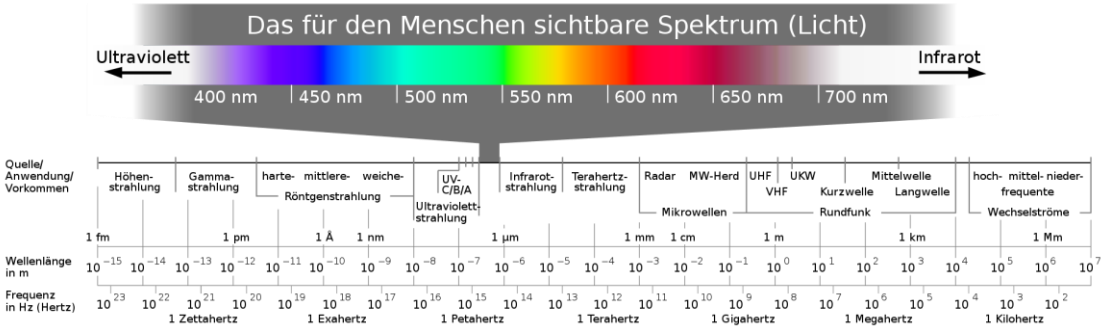


Fig. 2: *The electromagnetic spectrum (Source: https://commons.wikimedia.org/wiki/File:Electromagnetic_spectrum_-de_c.svg, Horst Frank / Phrood / Anony)*

This in turn prompted Hermann von Helmholtz to investigate how the eye sees this part of the spectrum. His groundbreaking discoveries from around 1850: light is physiologically a sensory stimulus that the eye/brain see and process together: Black and white through rods, colour through cones as RGB (red, green, blue).

Colour spectrum or colour wheel?

"Colour" is therefore both physics and physiology. Newton did not see a colour circle, yet he bent the spectrum he had created with a prism into a circle. The division of colours he proposed corresponded to his idea of an analogy between audible sounds and colours. He therefore divided the spectrum of visible light into seven colours according to the notes of the Dorian scale. The contradiction here is that the spectrum has no complementary colours. This posed a problem for him: if you bend the linear spectrum into a circle, the complementary colours are not directly opposite each other.

This problem was solved by reducing the colour wheel to six main colours, three cardinal colours and three secondary colours (Fig. 3).

Fig. 3: *Chevreul's colour wheel (left) and today's colour wheel (right) (Source left: Chevreul: "Des couleurs et de leurs applications aux arts industriels à l'aide des cercles chromatiques", Paris, 1864)*

Complementary or contrasting colours?

Newton's discovery was that the sum of the colours and their complementary colours results in the non-colour white. Two colour spectra complement each other if the sum of their full spectra results in white light. Maxwell's equations underpinned this insight theoretically.

On the other hand, Helmholtz came to the physiologically coherent explanation that the sensory perception of the individual colours with the greatest complement as "contrast

colours" is based on a physico-chemical reaction in the eye and the processing of the sensory stimulus in the brain.

In terms of physics, the solution came with Maxwell, in terms of perception theory with Helmholtz' discovery that our eye "sees" in RGB.

Conclusion: colour spectrum and colour wheel

Therefore, the actual question is not Goethe vs. Newton (as at the beginning of the 19th century), but spectrum vs. colour wheel: these are not two ways of representing colours, but two different facts. The spectrum is the representation of the physical process, the colour circle is the representation of the physiological perception of colour, i.e. not Newton *versus* Goethe, but Maxwell *and* Helmholtz. It was only possible to pose and answer the question in this form with the findings of modern science in the 19th century.

The Impressionist new approach to colour

The Impressionists, first and foremost Signac, grappled with the new view of the world and intensively discussed the discoveries of Maxwell and Helmholtz. As painters, however, they were primarily concerned with the impression of colour on our brain. So they translated this new knowledge into their paintings.

If we focus entirely on the sensory impression, then the impressionist style of pointillism is a radical example of the implementation of physiological knowledge into painting: dots are processed in the brain to form an image, and the colours intensify this effect. Contours are sometimes painted sharply as colour edges according to Chevreul's complementary colours ("Grande Jatte").

In this sense, Impressionism stands for the cross-cultural realisation of modern physiological knowledge and its physical foundations into paintings.

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