

Colouring our view

The work of spectroscopy's early pioneers continues to influence us today, says **Brian J Ford**, and in more ways than we might think

Joseph Ritter von Fraunhofer seemed destined to revolutionise optics. Born to a family of glassmakers in 1787, and orphaned at 11, he was apprenticed to a Munich glassworker which went well until the building collapsed, burying him in lime and rubble. He was saved by rescuers sent by Prince Maximilian Joseph who was so impressed at the bright mind of the 14-year-old boy that he financed his private education at the Benediktbeuern Monastery, dedicated to the technology of glass manufacture, in 1802.

In England at the same time, experimental chemist William Hyde Wollaston had conjoined a prism and telescope to focus the corona of the sun and noticed dark lines running across the spectrum. Wollaston had made the first major discovery in spectroscopy but, although he noted his observations, he took the subject no further.

By the age of 24, Fraunhofer was director of a glassmaking firm and in 1814 he hitched a prism to his telescope and observed the same characteristic lines. He resolved to find out what they were and went on to map 574 of them. He realised there was more to be discovered; today we have listed over 25,000 Fraunhofer lines with wavelengths between 295 and 1,000 nm.

In Germany in 1860, Gustav Kirchhoff and Robert Bunsen recognised that some of the Fraunhofer lines coincided with emission lines in the spectra of specific elements and harnessed the principle to discover rubidium and caesium.

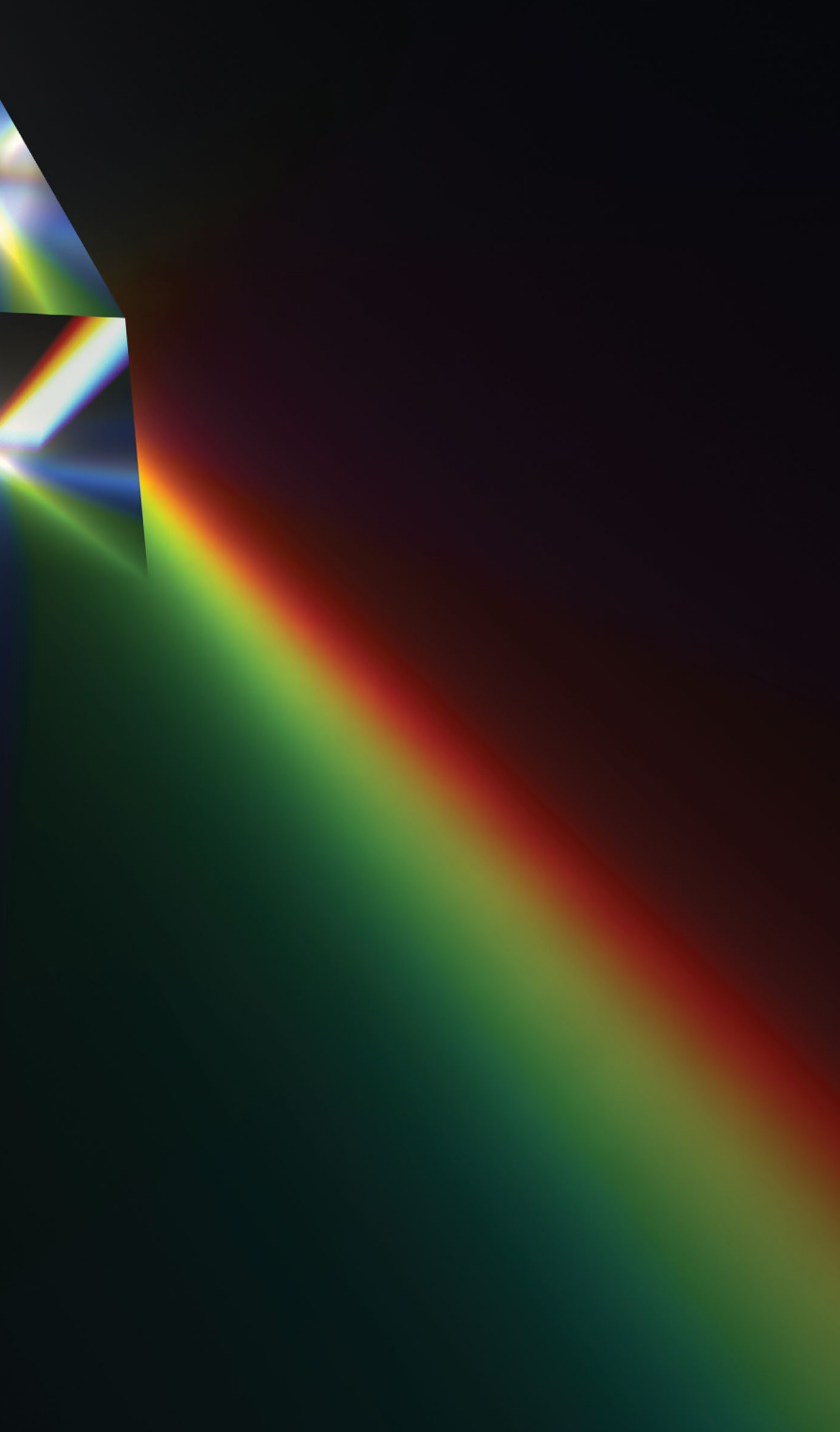


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Pierre Jules César Janssen was observing an eclipse of the sun in India on 18 August 1868 and observed a curious line in the spectrum of the chromosphere with a wavelength of 587.49 nm. He knew at once that it corresponded to no known element.

Sir Joseph Norman Lockyer was also investigating spectroscopy as an analytical tool in astronomy. In October 1868 he attached a prism to his 6¼-inch telescope and saw the same phenomenon; a prominent yellow line he



first took to be characteristic of sodium. But the wavelength, 587.49 nm, was distinct. This must surely represent a new element. He named it helium (from the Greek: ἥλιος, helios, meaning sun) though not until 1882 was helium first detected on Earth, when Luigi Palmieri noted its spectral signature in gases from Vesuvius.

Although Janssen's observations had been recorded two months earlier, his report and Lockyer's both arrived by mail at the Académie Française on the same day where they both

proposed to publish. They are given joint credit for the discovery.

The repercussions of those pioneers are with us today. Fraunhofer's methods influenced the production of optical instruments thereafter; he was first to use a diffraction grating to produce spectra, a technique in widespread use today. Wollaston, first to observe spectral lines, went on to develop the meniscus lens, discover palladium and rhodium, and demonstrated electromagnetic induction a decade before Michael Faraday.

Kirchhoff's observations on the wavelength of caesium gave rise to the present-day standards for the second and the metre, both of which are defined by the emission spectrum of caesium-133. Bunsen not only bequeathed to us his burner, but also harnessed electrolysis to produce a dozen metallic elements in their pure state, including aluminium, manganese, sodium,

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barium and lithium. Later he developed the still-used treatment for arsenical poisoning. Janssen is commemorated by craters, one each on Mars and the Moon, while the Bunsen-Kirchhoff law reminds us that dark absorption lines and bright emission lines are specific to each element.

Lockyer's submission to the Académie Française posed a problem: why did we have to go to Paris? He was conscious of the need for a free, open, independent scientific journal in which discoveries could be recorded in perpetuity, and he discussed it with Alexander MacMillan, the son of crofters on the Isle of Arran, who had set up a book publishing operation in Cambridge. MacMillan had published Charles Kingsley and Lewis Carroll, later to be joined by Yeats, Tennyson and Kipling. MacMillan Publishers are now one of the Top Five in the publishing world. Lockyer's initiative is with us too: he proposed to set up *Nature*, considered by many to be the leading scientific journal of all. ■