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ON THE HISTORY OF THE DIFFRACTION GRATING

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It is taught in the history of physics that Joseph Fraunhofer created the diffraction grating in 1821. Actually, the first diffraction grating was constructed in 1786 (i.e., 35 years before Fraunhofer) by the astronomer David Rittenhouse (1732–1796).

Rittenhouse's priority is mentioned, albeit very cautiously, in Landsberg's known optics text [1], and also in Born and Wolf's monograph "Principles of Optics"[2]. Rittenhouse is not mentioned in other optics texts, including those by the Americans Jenkins and White[3], Wood[4], and Morgan[5], by the British Longhurst[6] and Ditchburn[7], and by the French Fleury and Mathieu[8].

Nor is Rittenhouse mentioned in books on the history of physics and optics by Rosenberger[9], Hoppe[10], Mach[11], Kudryavtsev[12], Spasskiĭ[13], Gliozzi[14], and others.

In 1932, in connection with Rittenhouse's 200th birthday, Cope[15] published a paper on Rittenhouse's diffraction grating. He confined himself, however, to publication of several documents and to a brief historical review of Rittenhouse's predecessors and followers. He also noted that Rittenhouse's name is not mentioned in many widely known books on the history of physics. However, Cope's article did not change the treatment of this question in either the monographs or in the textbooks on optics. It is therefore most appropriate to mention this interesting page in the history of optics.

David Rittenhouse is known as an outstanding American astronomer[16,17]. From among his optical researches, particular attention is deserved by the article[18] in which he reports the results of construction and investigation of the operation of the first diffraction grating in the 18th century.

Credit for the initiative for organizing systematic experiments leading to the discovery of diffraction of light by a periodic structure is due to the jurist F. Hopkinson. In a letter of 16 March 1785 he asked Rittenhouse to verify the following observation: "Sitting at my door one evening last summer, I took a silk handkerchief out of my pocket, and stretching a portion of it tight between my two hands, I held it before my face and viewed, through the handkerchief, one of the street lamps, which was about 100 yards distant; expecting to see the threads of the handkerchief much magnified. Agreeably to my expectation, I observed the silk threads magnified to the size of very coarse wires; but was much surprised to find that although I moved the handkerchief to the right and left before my eyes, the dark bars did not seem to move at all, but remained parmanent before the eye. If these dark bars were occasioned by the interposition of the magnified threads between the eye and the flame of the lamp, I should have supposed that they would move and succeed each other, as the threads were made to move and pass in succession before the eye; but the facts were otherwise..."[19]

Rittenhouse became interested in the phenomenon reported to him by Hopkinson, and decided to repeat the observation. He improved the method and arrived, in essence, at the discovery of the diffraction grating. He wrote;

"In order to make my experiments with more accuracy, I made a square of parallel hairs about half an inch each way. And to have them nearly parallel and equidistant, I got a watchmaker to cut a very fine screw on two pieces of small brass wire. In the threads of these screws, 106 of which made one inch, the hairs were laid 50 or 60 in number..." ([18], p. 203).

Rittenhouse was not satisfied with the initial results of observation through such a grating, and intuitively reached the conclusion that the dispersion of the grating increases with increasing number of hairs per unit length. Raising their number to 190 per inch, he obtained more satisfactory results:

"The three middle lines of light were now not so bright as they had been before, but the others were stronger and more distinct, and I could count six on each side of the middle line, seeming to be equally distant from each other... The middle line was still well defined and colorless, the next two were likewise pretty well defined, but somewhat broader, having their inner edges tinged with blue and their outer edges with red. The others were more indistinct and consisted each of the prismatic colors, in the same order, which by spreading more and more seemed to touch each other at the fifth and sixth line, but those nearest the middle were separated from each other by very dark lines, much broader than the bright lines... ([18], p. 204).

Rittenhouse then called attention to the difference between the diffraction spectra and the prismatic ones: "...the red rays are more bent out of their first direction, and the blue rays less, as if the hairs acted with more force on the red than on the blue rays..." ([18], p. 205).

Rittenhouse then proceeds to determine the angles at which the diffraction spectra are seen behind a grating illuminated through a narrow slit in a window shutter. To this end he measured, with the aid of a small telescope and a micrometer, the angles between the first diffraction maxima for several colors, and obtained the following results: ..."[I found] the angular distance between their inner edges to be 13′15″; from the middle of one to the middle of the other 15′30″, and from the outer edge of one to the outer edge of the other 17′45″..." ([18], p. 205).

It follows from the foregoing that Rittenhouse is the first experimenter who investigated quantitatively the action of a diffraction grating.

Rittenhouse was unable to provide the correct ex-

planation of the diffraction phenomenon and of the action of a grating on light. He, like all the scientists at the end of the 18th century, adhered to Newton's views concerning the nature of light, which of course could not be used to explain the operation of a diffraction grating.

Rittenhouse did not continue his research. In a letter to Hopkinson he wrote:"... By pursuing these experiments it is probable that new and interesting discoveries may be made respecting the properties of this wonderful substance, light... But want of leisure obliges me to quit the subject for the present..."([18], p. 206).

Rittenhouse's discovery, although published, did not attract attention at that time. And when the diffraction grating was constructed again by Franhofer[20] and its theory was later developed[21], no one remembered Rittenhouse's work.

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