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On photographing the corona spectrum during total solar eclipses,

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1. Among the many problems in solar physics the greatest riddle, perhaps, is offered by the corona. Its emission spectrum is still quite enigmatical; neither the ideas of NICHOLSON on the constitution of the emitting atoms and their electron rings, based on remarkable numerical relations, nor the hypothesis of the author that the emission is due to doubly ionized calcium atoms, could till now be confirmed or refuted by laboratory results. Therefore the only way left us is to study more thoroughly the coronal spectrum itself. We may presume that it contains many more faint lines than have been detected, apparently irregularly distributed. By discovering more and fainter lines and by determining the wave lengths with greater precision, we may hope to find regularities that will open the way to a knowledge of their origin. Thus it will be necessary to consider the conditions for visibility and exactness in photographs of the coronal emission spectrum.

2. We denote by d_1 and f_1 the diameter and focal distance of the objective throwing a solar image on the slit, d_2 and f_2 the diameter and focal distance of the collimater, d_3 and f_3 of the camera. The width of the slit will be called s_1, that of its geometrical image $s_3 = s_1 f_3/f_2$. We suppose ideal, simplified conditions viz: $d_1/f_1 = d_2/f_2$ and $d_2 = d_3$; the dimensions of the prisms correspond to d_2 and d_3. The angular dispersion of the prism train is indicated by D (a function of the number of prisms, their refracting angle and the specific dispersion of the glas).

The surface brightness of the image thrown on the slit is $B_1 = d_1^2/f_1^2 = d_2^2/f_2^2$. The quantity of light L_1 falling through unit height of the slit is $L_1 = s_1 d_2^2/f_2^2$. In the case of monochromatic light this quantity, if there were no diffraction or expansion of the photographic action on the plate, would fall upon the geometrical image of the slit, measuring $s_1 f_3/f_2$ in width and f_3/f_2 in height. The quantity falling on unit height of the image consequently is $L_3 = L_1 f_2/f_3 = s_1 d_2^2/f_2 f_3$; its surface illumination is $B = B_1 f_2^2/f_3^2 = d_2^2/f_3^2$. In the case of white light the quantity L_1 is spread over a length of spectrum, given by Df_3 and breadth f_3/f_2; thus the surface illumination of the continuous spectrum will be $B_3' = L_1 f_2/Df_3^2 = s_1 d_2^2/Df_2 f_3^2$

By diffraction the image of the slit is broadened. For a point source the diameter of the diffraction image is, according to Lord RAYLEIGH, $1.22\,\lambda f_3/d_3$; for an infinitely narrow line the width of the image may be put cf_3/d_3, where c is a constant (i. e. not depending on the instrument) of the order of λ. If the slit is widened the quantity of light, increasing with s_1, is spread over this breadth, eventually increased by s_3 itself. The surface brightness thus increases at first rapidly, afterwards more slowly. Moreover, when the slit is narrower than cf_2/d_2 (i. e. $s_3 < cf_3/d_3$) only part of the light diffracted by the slit falls upon the collimator lens, so that also for this reason the brightness of the image is diminished. Thus in every case the width of the slit s_1 should be greater than cf_2/d_2; for these greater widths the breadth of the image is found by adding s_3 and cf_3/d_3, which are of the same order of magnitude. For visual observations the surface brightness of a monochromatic line becomes $B = L_3/(S_3 + cf_3/d_3)$. The ratio of this value to B_3', the brightness of the continuous spectrum, determines the visibility of the emission line against the continuous background.

In photographing the spectrum the light falling on a small strip spreads to both sides, reducing the silver salt and producing black silver grains on a broader strip. We assume that the line is broadened by a constant amount e (i. e. not depending on the dimensions of the instrument, though it varies with the plate and the intensity of the light). Then the total breadth of the image of a line becomes $b_3 = s_1 f_3/f_2 + cf_3/d_3 + e$. The quantity of light falling on unit height L_3 is used to reduce the silver salt over this breadth;