THE VARIATION OF THE DECLINATION DURING THE SOLAR ECLIPSE OF JANUARY 24, 1925, AT URBANA, ILLINOIS

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It is not very often that the path of totality of an eclipse of the sun passes twice successively across the same region. And it is only comparatively recently that the magnetic effects during an eclipse have been studied. The first systematic observations were begun at the time of the solar eclipse of May 28, 1900.[1]

The eclipse of June 8, 1918, offered an exceptional opportunity for astronomical, geophysical, and magnetic observations, since the path of totality passed from the state of Washington in a southeasterly direction through Wyoming, Colorado, Kansas, Arkansas, Alabama, and Florida. The magnetic work was under the direction of Dr. L. A. Bauer of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. It was planned to collect data at a number of stations with reference to the variation, during the time of the eclipse, of the declination of the compass needle. The observations of 1900 had suggested that there is an effect, and the eclipse of 1918 afforded the first opportunity in this country of continuing systematic observations. Accordingly magnetometers designed for declination studies were set up at some 16 stations along the belt of visibility, —seven of these stations were within the path of totality.

The department of physics, University of Illinois, was asked to co-operate, as also were a number of departments at other institutions outside of the belt of totality. The results were worked up by Dr. Bauer and his associates and published in Terrestrial Magnetism and Atmospheric Electricity.[2]

The conclusions, in part, drawn relative to the eclipse of 1918, were:

a) *"That there is an appreciable variation in the earth's magnetic field during a solar eclipse.*

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[1]Terr. Mag., Vol. 5, 1900, pp. 143-165.
[2]Terr. Mag., Vol. XXIII, No. 3, Sept. 1918; Ibid. Vol. XXIII, No. 4, Dec. 1918; Ibid. Vol. XXIV, Nov. 1, Mar. 1919.

b) *"The magnitude in the variation of the declination is about .1 to .2 that caused by the solar diurnal variation on undisturbed days.*

c) *"The general character of the solar-eclipse magnetic variation is the reverse of that causing the day-light solar-diurnal variation."*

At the time the above report was made the thought was expressed that these observations should be repeated whenever an eclipse offered an opportunity. Also, that the results of the 1918 eclipse were convincing, yet much additional information is needed in our attempt to solve the problem of terrestrial magnetism, atmospheric electricity and their relation to, say, the northern lights.

The eclipse of January 24, 1925, furnished the first near at hand opportunity for further observations. This eclipse, as is well remembered, swept across the northeastern section of North America. The totality portion of the eclipse became visible at dawn in Ontario and extended across New York state and Connecticut and out on the Atlantic. The number of stations engaged in making magnetic observations was comparatively few; most observatories were concerned in photographing the corona. Professor A. P. Carman, head of the Department of Physics, University of Illinois, suggested the desirability of again making declination observations, similar to those in 1918,—the position of *Urbana, Illinois,* being about the same distance from the path of totality except that this year the path swept by on the northeast, while in 1918 it was on the southwest.

Fortunately, in preparing for the observations the same magnetometer and accessory apparatus were found that were used in the eclipse of 1918. The magnetometer needle stood suspended by a single silk fiber all this while and hence the suspension exhibited no twist—the zero would remain fixed, absolutely, over a period of at least 24 hours. Two magnetometers were set up, but in this report reference will be made to the data of but one (magnetometer No. 1). The apparatus was set up in a small astronomical observatory on the south campus about one-half mile south of the auditorium. The telescope of the observatory with its heavy iron base had been removed for repairs and the concrete pedestal was used as the support for the magnetometers. Every precaution was taken not to move the position of magnetic materials. Even the observers remained quietly at their respective posts. This station is located about 1000 feet southeast of the 1917 magnetic station established by Wm. W. Merrymon of the Coast and Geodetic Survey. It is about ½ mile east of the Illinois Central Railroad, and about 1/5 mile east of the new stadium. The interurban tracks are about 1 mile to the north. From preliminary observations the magnetometer deflections were not disturbed, other than jarring the needle due to mechanical disturbances transmitted through the ground, by the passing of trains or by automobiles on nearby roads; however the starting and throwing off of the power on the interurbans did have an effect.

The observations were taken at *one minute* intervals from a little after five in the morning until eleven. The first run was made on the day of the eclipse (Saturday, January 24, 1925) and a standardizing run was made on

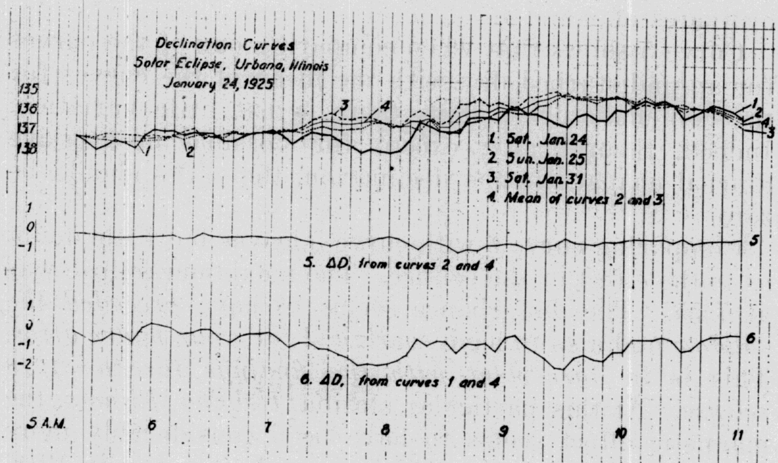

FIG. I.

the following forenoon (Sunday), and again on the following Saturday morning (January 31). The day following the eclipse was considered an *undisturbed* day since the moon passed the sun by 13°. The time (G. M.

T.) was from the observatory clock. A complete log was kept throughout the six hours over which the readings were taken. In reducing the data the deflections in millimeters were plotted against the time in hours. This gave three curves (see Fig. 1), No. 2 for Sunday; No. 3 for the Saturday following; and No. 1 for the eclipse data. Curves 2 and 3 are shown superposed, and the mean, No. 4, drawn. It should be noticed that curves 2 and 3 even though taken six days apart are very similar. It was thought for this reason that a mean curve would represent the undisturbed day with a minimum amount of error. The data for the eclipse curve (No. 1) were next set down on top of 2, 3, and 4. It is evident that new disturbing factors were present in this curve. Some of these may have been due to local disurbances, though not likely to the extent indicated.

It is usual to plot the difference, $\triangle$D, between the ordinates of the eclipse curve and the undisturbed curve. Proceeding thus results in curve 6.

For the purpose of further comparison another curve (5) was plotted in which $\triangle$D is the difference in the ordinates of 2 and 4.

Curve 5 shows that when comparing one of the curves for an undisturbed day with the mean of the curves for the two undisturbed days there is but little variation. Indeed, theoretically, except for possible progressive diurnal changes in the declination, the $\triangle$D's should be zero.

Comparing curve 6 with curve 5 leaves but little doubt as to the effect of the eclipse. The maximum eclipse was at 7:55. The disturbance seems to have *preceded the shadow* and also to have *continued for some hours after*. This is in *agreement with the findings for the 1918 eclipse*. At this particular station, *Urbana, Illinois,* the magnetic effect seems to have been considerably more pronounced during the 1925 eclipse than it was in 1918.

The data herewith submitted *corroborates* conclusions (a) and (b) of Dr. Bauer's report on the 1918 solar eclipse.

The writer was ably assisted by L. P. Garner and A. D. Hummell, graduate students in electrical engineering and in physics respectively, and by A. J. McMaster, a senior in General Engineering Physics.

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