The LF Notebook

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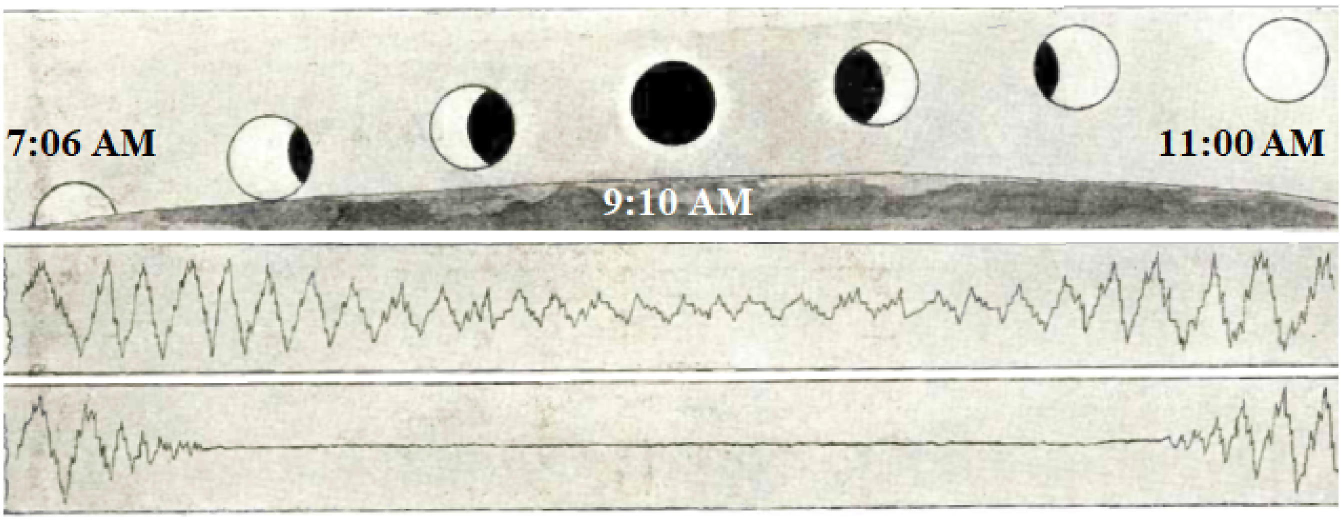
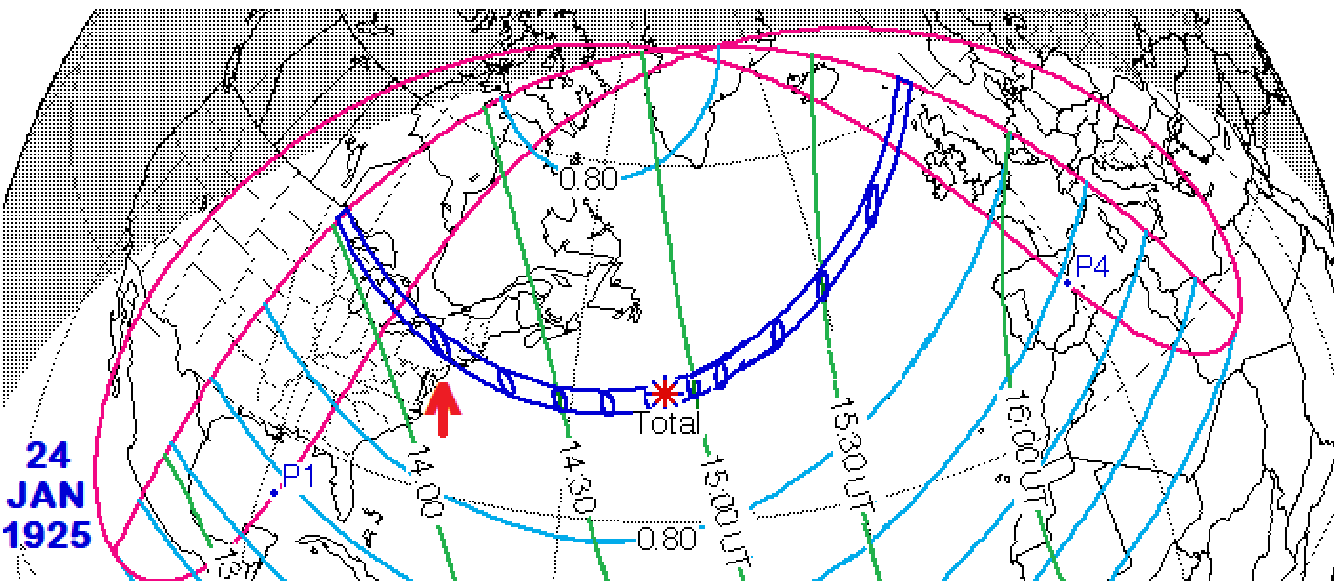


The lead illustration of *Radio News'* preliminary report on the 1925 eclipse is captioned as an artist's "idea of the variations due to the eclipse, the greater the swing of the curve the more fading. The 380-meter wave at top (WGY, ~789 kHz, Schenectady) shows less fading at totality, while the 75-meter wave (co-located SW station 2XI) was lost during the entire eclipse." Added times are E.S.T. (NYC)



The orbital geometry of high latitude solar eclipses makes for relatively short duration events, with fast-moving, obliquely elongated umbral ovals at totality. Totality touched the surface of Earth at 1402 UTC (8;02 AM C.S.T.) over northern Minnesota. Just eight minutes later, the oval, as indicated by the arrow above, conveniently stretched a brief blanket of night exactly between the transmitters in Schenectady and the receivers in NYC. The whole eclipse was done and gone from Earth an hour and a half later.

Eclipse Results Are In...From 99 Years Ago

Best Laid Plans, Part I. This column is one I thought I had in the bag well before deadline, for a change: brief mention of the first report I found in the popular press (*Radio News*, April 1925) concerning effects of an eclipse on radio, followed by an observation that there's nothing new under the sun, a bit on my own greatly reduced plans for the upcoming eclipse, and a generous list of resources and suggestions for observations. Easy enough, right? Hah. Silly me.

First rewrite got it down to my page allotment, but it was dull and sparse on details. Subsequent rewrites did not help. I was leaving out one or another important point every time I changed focus. Finally, I realized that I'd *entirely missed* the significance of the first serious radio study of eclipses 99 years ago. It wasn't just a "gee-whiz, guess what we saw" report. Taken together with two other articles in that same issue, it revealed a shocking ignorance of fundamental principles a full 25 years into the radio era!

L: Apparatus used by engineers at the RCA laboratory in New York City to record signal level variations during the 1925 eclipse.

RADIO NEWS
April 1925

R: Double exposure of Sun during partial phase and totality. In the foreground, a Signal Corps truck broadcasts reports from the eclipse path.

I always assumed E. V. Appleton's elegant 1924 experiment had definitively proven the 1902 Kennelly-Heaviside-Eccles hypotheses about sky wave propagation. It had, in fact, within limits of the data available when those theories were formed (LF and VLF, no HF yet of course). It's fascinating stuff that we'll examine further in future, but for now just remember that Oliver Heaviside never oversimplified his hypothesis to a mere reflection off a conductive layer of ionized gas (the E-layer, apparently still sometimes bearing Heaviside's name), the way many then and now misunderstand it. If one reads the original, it's clear he was expanding transmission line principles into waveguide theory, which remains the accepted explanation for VLF propagation today. What Prof. Appleton proved beyond doubt was that some kind of ionized layer did in fact exist that returned radio waves to earth from the predicted height, along with surface waves.

But the "Heaviside layer" controversy, which basically originated with Marconi's claim to having spanned the Atlantic in 1901, just wouldn't go away. Somehow, people kept coming up with ever more convoluted explanations for how and why the sun and a supposedly "imaginary" ionized layer in the atmosphere "couldn't possibly" have anything to do with it. Interestingly, one such article appears in this same issue of *Radio News*, which I recommend interested readers access at **worldradiohistory.org**. "The Effect of the Atmosphere on Radio Waves" by Prof. J. M. Guinchant is a fine example of the "existing theory, to whatever extent I think I understand it, does not account for all observations and therefore should be scrapped" logical fallacy.

Beware the Dogma. It bites. Poor old Guinchant, sadly, had the academic skills to identify key misunderstandings about the Heaviside layer *and fix them*! If only he had waited for a little more data, he might have ended up a revered footnote in radio history.

Instead, he would've had us believe that the atmosphere accounts for propagation of radio waves through simple air refraction alone (it doesn't, although in fairness to the good prof, refraction rather than true reflection is now the accepted explanation for how tenuous layers of ionized gas bend radio waves of certain wavelengths); that there's no way the sun could ionize gases strongly enough to reflect radio waves anyhow (this isn't rocket science…literally, since no one had yet been able to send instruments up to the necessary altitude to measure levels and effects of solar UV rays…but while subatomic particles and astrophysics were still new fields of study, his ignorance about how the Sun can throw off charged particles without being part of a complete electrical circuit is nearly inexcusable); and, worst of all, he claimed there's "no evidence" of *any* solar effect at all on air ionization. Irony of ironies!

He goes on to mock the work of Eccles and Fleming in adapting Heaviside's explanation to wider ranges of the RF spectrum, throwing in a lot of always-es and "undisputables" along the way; *viz* the following, with my own emphasis added: "During the day reception is **always** weaker, while the ionization produced by the sun's rays should increase the conductivity in the higher atmosphere and accordingly its reflected action. To avoid this objection, one imagines that the electrons of the ultra-violet light (*the **what?***) coming from the sun ionize more the atmospheric layers which are close to the Heaviside layer and under it. These layers, becoming poor conductors, absorb the electromagnetic waves and probably act as a layer of steam upon the surface of a mirror, thus reducing the reflecting action of the Heaviside layer." Talk about heaping coals of irony on your own head! As we say nowadays, "well, DUH!"

That same edition also features "A Year's Work Below Forty Meters," an article summarizing a year of day and night DX experiments at wavelengths of 40, 20. 10, and even 4 meters by HF/VHF amateur pioneer John L. Reinartz, in conjunction with numerous ham colleagues and the Naval Research Laboratory at Bellevue. Reinartz and friends discovered that groundwave attenuation increased dramatically with frequency, until a signal's local range was virtually the same as line of sight at frequencies above, say, 10 meters. But oh, those skywaves! Not only did the skywaves above 13.5 MHz get stronger in the daytime instead of night, they also took longer first hops than lower frequencies…thus confirming ionization well above the E-layer, and demonstrating the energy absorptive properties of the supposedly "fake news" D-layer too.

Conventional wisdom of the day, propped up in part by Guinchant's notions, held that HF signal variations were mainly because of cloud formations. But after beginning serious real-world tests, Reinartz was able to bluntly state "it was due to the sun's influence, and could be put to a useful service." His sound reasoning is in the article.

The brief temporary nighttime of the January 1925 solar eclipse, along with publication of the Reinartz experiments of 1924, pretty much drove the final nail in the coffin of the sun-ionosphere deniers.

New Under the Sun, Part I - 1925. There had been previous solar eclipses in the radio age, of course, but none so conveniently close to major transmit and receive sites. Both RCA and AT&T had a vested interest in better understanding diurnal differences in radio propagation, and what causes signal fading. One guess was random recombining of signals arriving in and out of phase via ground wave and Heaviside layer reflection, so it was hoped the short-term nightfall at mid-morning would confirm that, or else provide new ideas to research. Greenleaf Whittier Pickard (of galena crystal detector and loop antenna fame) headed up the project and gave a very preliminary report at the February IRE meeting in New York. That became the basis for the April *RN* article, "The Eclipse and Radio Reception" by G. C. B. Rowe. I excerpt some of those results below, but will post much more at **lwca.org/mb** soon:

It was found during the five days of the observations that the 380-meter wave was swinging rather badly at sunrise and that the swinging gradually diminished, the signal becoming steady as the sun rose higher. As a general rule, the signal became practically steady between one hour and two hours after sunrise.

During the totality of the eclipse it appeared to cause a reduction of swinging of the signals. However, the (fading) reduction apparently caused by the eclipse was not nearly as great as occurs between night time conditions and full daytime conditions. That is, the eclipse did not change swinging nearly as much as does full sunlight.

While the above effects were noted, the eclipse did not affect the average signal strength at all. This, during the period of the eclipse, was about the same as it would be in full daylight. During the period of totality it was noticed that the static, which was present before this period, was lessened to a great extent.

Observations on the 75-meter wave during the five days when readings were taken showed that over the distance of 160 miles between Schenectady and New York, this wave had very marked swinging every day, and became weaker toward the middle of the day; it never disappeared for more than a second or two, except during the eclipse.

During the entire period of partial and total eclipse, this wave disappeared altogether. In other words, this short wave is very sensitive to the sunlight conditions on the path over which it travels and even the partial darkness of the eclipse was apparently sufficient to prevent it from traveling between the transmitting and receiving stations. It was heard loudly before and after the eclipse period.

Other interesting effects were observed in reception of signals broadcast from England on a wave-length of 12,500 meters (24 kHz). These signals were also observed for two days before and two days after the day of the eclipse. There were two stations in America that were taking readings on these long wave signals, one at Riverhead, Long Island, which was in the path of totality, and the other station was located at Belfast, Maine, which was not in the path of totality. Readings were automatically recorded.

The signal behavior at Riverhead up to a few minutes before totality was the same as the previous two days. There was a sharp drop of strength just after dawn and then the usual daytime diminution. However, just before totality there was another sharp drop in strength which lasted until after the moon had begun its journey off the face of the sun. Then the conditions were approximately the same until the time that the sun was eclipsed to its maximum value in England. At that time there was again a dip in the signal strength.

The signals recorded at Belfast, Maine, were of a different character in that there was no sharp diminution when the sun was totally eclipsed at (Riverhead). However, when the sun had been eclipsed at the transmitting station in England, a drop in strength was noted.

Just what these sudden drops in strength mean is impossible to say at present. The only conclusions so far reached are that the sun has a definite effect on radio waves. Just what wave-lengths are affected and in what degree is as yet undetermined.

New Under the Sun, Part 2 – 2024: Our April 8 total eclipse is the first one over North America since 2017—and the last until 2044. It will be visible as at least a partial eclipse everywhere from Hawaii to the Virgin Islands, in every state and province except Alaska and a sliver of the Yukon; and throughout Central America and the Caribbean. (Soccer fans might even wish to call it the CONCACAF Eclipse. Just sayin'…)

The shadow of totality will come loping ashore at a leisurely 1500 mph near Mazatlán and zoom east off Newfoundland at 4400 mph, an hour and 45 minutes later, picking up speed as the sun angle shifts. The moon is fairly close to perigee on the 8^{th}, meaning totality will last a reasonably long time (almost 4½ minutes at maximum over Mexico) and the track will be up to 110 miles wide. Longest totality will only be at the center line of the track, of course, but anywhere in that strip will give you a show. Try not to be too near the edge, though. Duration of totality is not a linear function.

Best Laid Plans, Part II. Example from one of my possible viewing locations, between Hardy and Ravenden in northeast Arkansas: I'm hoping to be on a hilltop off US-63 with a view to the southwest so I can maybe see the umbra sweep in, doing the two-second mile! I'll then have four minutes and a few seconds of totality, which will be dedicated solely to the lifelong goal of observing the sun's corona with my own eyes. (Radio is entirely incidental this trip, as we'll discuss another time.)

Meanwhile, folks 30 miles southeast in Walnut Ridge will still get a decent three minutes of totality. Fifteen miles farther along, at the northwest corner of Jonesboro, it'll be two minutes. A mere five miles more, on the southeast side of Jonesboro, only one minute! Another five miles, and the north edge of the tiny village of Bay will see around 18 seconds of Bailey's Beads, while the south side of town gets no totality at all, just 90-some percent shadow. Larger cities along the path of totality (Dallas, Indianapolis) will have similar differences from one side of town to the other.

There's a great eclipse atlas in the April 2024 *Astronomy* magazine, and this site:

xjubier.free.fr/en/site_pages/solar_eclipses/TSE_2024_GoogleMapFull.html

features a fully interactive Google map that's truly amazing.

The American Astronomical Society (**eclipse.aas.org**) can help you plan what to do after you have a main and alternate destination in mind. Pay particular heed to their pages on eye safety! Have the right eyewear, and know how to use it correctly.

And to choose between sites as the day draws nearer, College of DuPage (**weather.cod.edu**) can help with radar, weather satellite views, and forecasts. • • •