English translation of [1]

Comment on: An Explanation of Dayton Miller's Anomalous "Ether Drift" Result

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Thomas J. Roberts published an article [2] in 2006 in which he claims, that Dayton C. Miller did not measure a real signal in his experiments. In this paper, the methods used are examined and it is shown that all claims are false.

1. Introduction

Roberts claims in his article that he can fully explain Miller's anomalous results [3]. He claims: a) Miller's results are not significant, b) Miller's data reduction algorithm produced a signal of only noise, c) a systematic error model can show that there is no real signal in the data.

We will examine Roberts' methods to test his claims. The Aetherise project 1.1 is used in this work.[1] This project also contains the data sheets from Miller's experiments on Mount Wilson. Individual data sheets are indicated by an epoch abbreviation (month name) and a number. For example, Sep-79 stands for data sheet number 79 from the September epoch.

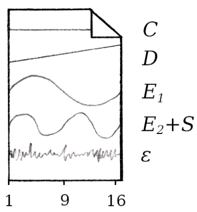

Figure 1: Signal components

2. Analysis of the methods

In this analysis it is assumed that a measured signal can be composed of the following components: The offset C, the drift D, the single-period systematic error E_1, the double-period systematic error E_2, the also double-period theoretical signal S and a statistical error ε.

Figure 1 symbolically shows a data sheet from Miller. The components of a single measurement are shown, which are superimposed. The lower three marks indicate an azimuth. Azimuth 1 is in the north, azimuth 9 in the south.

2.1. Data reduction

Miller's data reduction algorithm works like a frequency filter. The lowest signal that passes through the filter has the frequency 2. *Frequency* here means the number of periods per revolution of the interferometer.

Roberts now argues that Miller's algorithm would isolate from 1/f noise a signal with a frequency ~ 2. This is not wrong, but only a very general argument. Whether there really is a signal in the data can be determined with a Fourier analysis.

Roberts creates a spectrum with the raw data, which still contains the drift. The result is the spectrum in Figure 2. He recognises a similarity with the 1/f noise.[2]

In Figure 3, the spectrum was created only after the errors C and D were removed from the measured values of each turn. Which is what Miller's algorithm does. One can see the prominent amplitudes of the signals E_1 and $E_2 + S$ with the corresponding frequencies 1 and 2.

In Figure 4 the measurement of Sep-79 was simulated. The signal consists only of the components as described in section 2. The original drift was retained.

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[1] https://github.com/aetherise/aetherise

[2] Why in data sheet Sep-79 and in all data sheets 75–83 of September 1925 the frequency 1 in the spectrum of the raw data has a strikingly small amplitude is not clear to me. It is a peculiarity which other data sheets do not show.

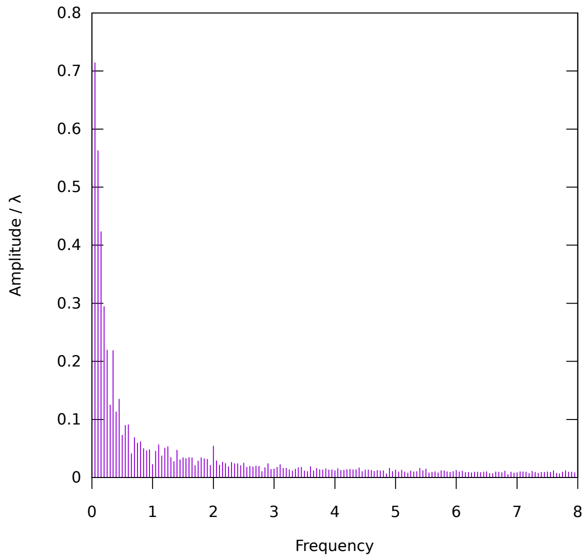

Figure 2: Spectrum of Sep-79 with drift [A1]

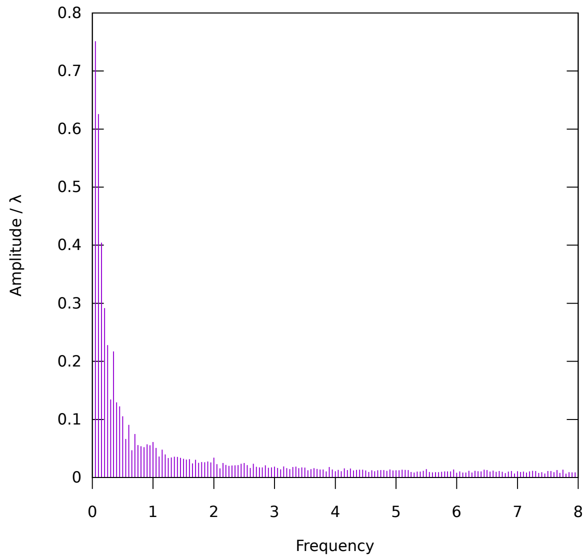

Figure 4: Spectrum of a simulation [A3]

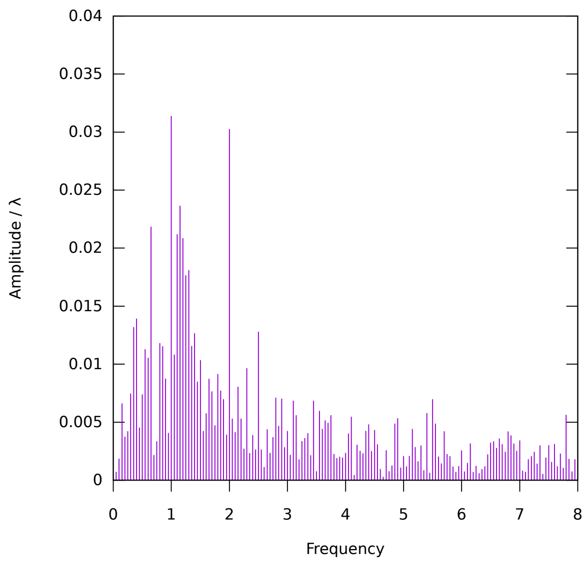

Figure 3: Spectrum of Sep-79 without drift [A2]

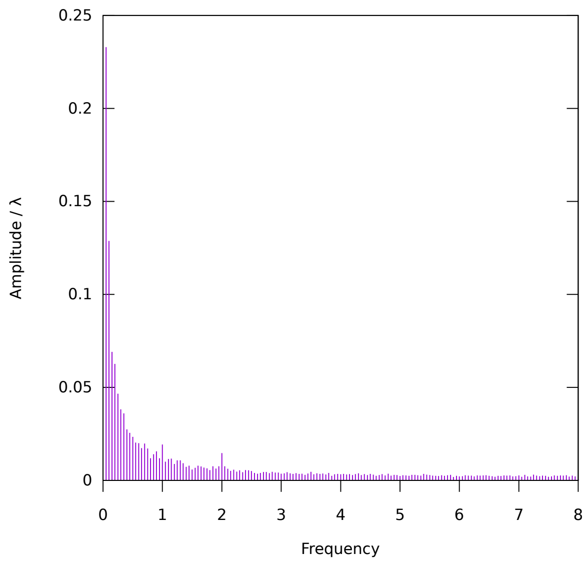

Figure 5: Averaged spectra of data sheets with smallest drift [A4]

The approximate linear drift in the data is recognised by the Fourier analysis as low-frequency signals and a spectrum is produced which resembles the spectrum of 1/f noise. This spectrum also prevents that signals with frequency 1 can be recognised well.

If this is so, then the 1/f noise should be lower for data sheets with low drift. Thus, one should then see the signals with frequencies 1 and 2 more clearly in the spectrum. This is exactly the case, as can be seen in Figure 5.

In Figure 5 the averaged spectrum of the raw data of 9 data sheets with the smallest mean absolute drift is shown. The data sheets found are: Apr-108, Aug-51, Aug-52, Sep-2, Sep-16, Sep-18, Sep-23, Feb-56, Feb-57.

Figure 6 shows the averaged spectra of nearly all the data sheets from the experiments at Mount Wilson in 1925–1926. Of the 316 data sheets, 242 were used. The data sheets not used were measured under poor temperature conditions or are apparent outliers.[3] The signals of such data sheets typically contain an extraordinarily large amplitude, which would

[3] The data sheets in the directories `dcm/error/`, `dcm/outlier/`, `dcm/unusual/` and `dcm/canceled/` were not used.

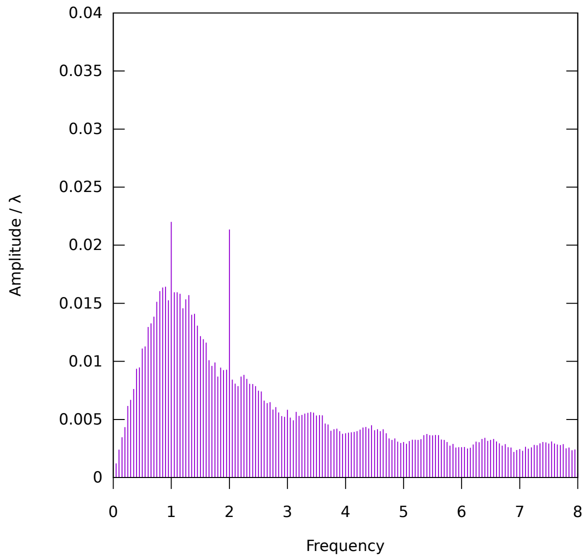

Figure 6: Averaged spectra [A5]

distort the spectrum. As in Figure 3, the errors C and D were previously removed. The standard uncertainty of the amplitudes is $\sim 0.001\ \lambda$.

One can clearly see the prominent amplitudes at frequencies 1 and 2. The results of the Fourier analysis in this work are in agreement with the results of other authors [4][5].

2.2. Significance

Roberts criticises Miller for not giving error bars.[4] He now calculates error bars and argues that Miller's signals are not significant.

Roberts creates a histogram from the measured values at the azimuths 1 and 9 and determines the error bars from them. The drift D is removed from the measured values beforehand and Roberts now thinks that the values of one turn at azimuths 1 and 9 must be the same. This is not the case if there is a signal E_1. We know from the previous analysis that E_1 is present.

If one forms the mean value of two opposite azimuths, then E_1 interferes with itself and is completely removed. The histogram thus shows an error that cannot occur in the result of Miller's algorithm.

Other authors come to the same conclusions [6].

2.3. Model

Roberts apparently considers the E_1 error to be nonlinear drift and wants to model it. If his model yields the same amplitude for the signal $E_2 + S$ in a Fourier analysis as Miller's data, then the signal is said to be explained by the model alone. In this way, Roberts wants to show that Miller did not measure a real signal at all.

There is not much point in dealing with the model, because we know from the previous analysis that the signal is real. So the model and/or the inferences from the model must be wrong.

Simulations can be used to show that the model does not work. The simulations produce measurement data consisting only of the components as described in section 2. Even with real signals, the model provides an exact match with the result of Miller's algorithm and the amplitude of $E_2 + S$, which, according to Roberts, disproves the authenticity of the signal.[A6]

3. Conclusions

All of Roberts' claims are false because:

a) The error bars contain a systematic error. This error is false if it contains E_1. Roberts seems to assume *a priori* that a signal E_1 is not present. He does not provide a proof. A Fourier analysis provides evidence of an existing E_1 signal. The error bars therefore make no statement about the statistical significance of $E_2 + S$.

b) Real signals in conjunction with a drift also produce a spectrum similar to 1/f noise. A Fourier analysis without linear drift D finds significant peaks at frequencies 1 and 2. So there is a real signal and Miller's algorithm may be used.

c) A genuine significant signal is not rendered spurious by any model. The model is also refuted by counterexamples.

[4] Roberts writes that Miller estimates a statistical error in the order of 0.1 fringe. This is wrong. Miller mentions in connection with data reduction an accuracy of 0.01 fringe. He writes '... approaches an accuracy of a hundredth of a fringe'.

A. Commands

List of commands used to generate data for tables and diagrams. The operating system is a Linux-like one.

A1. `aetherise -ignore all dcm/csv/*.csv -raw_spectrum -month [9,9] -no [79,79] > s.dat`

  a) `plot_spectrum.sh s.dat "" image.svg`

A2. `aetherise -ignore all dcm/csv/*.csv -spectrum -month [9,9] -no [79,79] > s.dat`

  a) `plot_spectrum.sh s.dat "" image.svg`

A3. `aetherise dcm/csv/*.csv -raw_spectrum -month [9,9] -no [79,79] -simulation -sim_sys -sim_seed 1565247718 > s.dat`

  a) `plot_spectrum.sh s.dat "" image.svg`

A4. `aetherise -ignore all dcm/csv/*.csv dcm/csv/bad/*.csv -abs_drift [0,1.5] -raw_spectrum -aggregate mean > s.dat`

  a) `plot_spectrum.sh s.dat "" image.svg`

A5. `aetherise -ignore all dcm/csv/*.csv dcm/csv/bad/*.csv -spectrum -aggregate mean > s.dat`

  a) `plot_spectrum.sh s.dat "" image.svg`

A6. Example of how to test Roberts' model. One compares the values of the second column of the outputs of *a* and *b*, or one compares the amplitudes of frequency 2 of the outputs of *b* and *c*. The value for '1/2 turn DFT amplitude' at *b* is the amplitude of frequency 2. The value for the option `-sim_seed` is chosen arbitrarily. The method `Roberts2006` is not documented in the manual. This method generates the model data as described by Roberts and then runs Miller's algorithm on it.

  a) `aetherise dcm/csv/*.csv -month [9,9] -no [49,49] -reduce -reduction Miller -simulation -sim_sys -sim_simple -sim_seed 1843128673`

  b) `aetherise dcm/csv/*.csv -month [9,9] -no [49,49] -reduce -reduction Roberts2006 -simulation -sim_sys -sim_simple -sim_seed 1843128673`

  c) `aetherise dcm/csv/*.csv -month [9,9] -no [49,49] -raw_spectrum -simulation -sim_sys -sim_simple -sim_seed 1843128673`

References

[1] Sebastian Pliet. *Kommentar zu: An Explanation of Dayton Miller's Anomalous "Ether Drift" Result.* 2021. DOI: 10.5281/zenodo.5544171.

[2] Thomas J. Roberts. 'An Explanation of Dayton Miller's Anomalous "Ether Drift" Result'. 2006. URL: https://arxiv.org/abs/physics/0608238.

[3] Dayton C. Miller. 'The Ether-Drift Experiment and the Determination of the Absolute Motion of the Earth'. In: *Reviews of Modern Physics* 5 (1933), pp. 203–242.

[4] R. S. Shankland et al. 'New Analysis of the Interferometer Observations of Dayton C. Miller'. In: *Reviews of Modern Physics* 27 (1955), pp. 167–178.

[5] Simon Manley. 'Machine Systematics in Dayton Miller's Ether Drift Interferometer Revealed by Analysis of Variance'. 2019. URL: https://vixra.org/abs/1905.0207.

[6] M. Consoli et al. 'The classical ether-drift experiments: A modern re-interpretation'. In: *The European Physical Journal Plus* 128, 71 (2013). URL: https://arxiv.org/abs/1302.3508.