# OF THE WESTWARD MOTION OF THE MAGNETICAL VARIATION PROPOSED BY MR. HALLEY: WITH AN ACCOUNT OF ITS CONSEQUENCES FOR THE TUNING OF ORGANS AND MONOCHORDS, AND OF THE ONE LINE UPON WHICH THE SHELL AND THE NUCLEUS AGREE

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# Of the Westward Motion of the Magnetical Variation Proposed by Mr. Halley: With an Account of Its Consequences for the Tuning of Organs and Monochords, and of the One Line upon Which the Shell and the Nucleus Agree

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**Abstract**

*Mr. Edmond Halley of the Royal Society of London has lately proposed that the variation of the magnetical needle from the true north is not fixed but moves slowly westward from year to year, and that this motion proceeds from the structure of the Earth itself: an outer shell and an inner nucleus, each a magnet with two poles of its own, separated by a fluid medium and turning about the same axis at very slightly different rates. A copy of his account reached this Society by way of Seville and Cartagena in the winter of 1692.*

*We accept Mr. Halley's hypothesis and draw from it a consequence he did not state. If the shell and the nucleus turn about a common axis, they share a common equator, and that equator is the only line upon the globe that does not move with respect to either of them. Every meridian is carried away by the westward motion; the equator is not. We report comparisons made between the equinoxes of 1692 and 1693 of a monochord against the principal pipe of an organ, at this Society's station upon the line and at stations to the north and south. The two held their agreement upon the line through the half-year between the equinoxes, and drifted apart elsewhere in proportion to the distance from it. We conclude that an instrument tuned upon the equator is tuned to both magnets of the Earth at once, and that an instrument tuned anywhere else is tuned to a quarrel between them.*

## I. OF MR. HALLEY'S HYPOTHESIS

In the year 1683 Mr. Halley published in the Philosophical Transactions a theory of the variation of the compass, in which he showed from the observations of navigators that the needle does not point to the true pole in most places, and that the pattern of its deviation over the globe cannot be explained by a single magnet with two poles. He proposed four poles, two near each pole of the world.

In his present account he goes further, and explains how four such poles may come about and why the variation changes with the years. He supposes the Earth to consist of an external shell and an internal nucleus, the space between being filled with a fluid medium. Each is a magnet with two poles. Both turn from west to east about the axis of the world in the space of a day, but the nucleus turns a very little more slowly than the shell, so that in the course of years its poles fall behind, and the variation that depends upon them moves westward. He allows, with becoming modesty, that the hypothesis is a conjecture, and that the period of the whole motion may be of some hundreds of years.

This Society has no observations of the variation sufficient to judge the four poles. It has, however, observed something that Mr. Halley's hypothesis explains, and it has perceived a consequence of the hypothesis that is of the first importance to the art of music.

## II. OF THE LINE COMMON TO THE SHELL AND THE NUCLEUS

Two spheres that turn about the same axis have the same poles of rotation and the same equator. This follows from the figure alone and does not depend upon the rates at which they turn. However the nucleus may fall behind the shell, every point of its equator remains upon the equator of the shell, and every meridian of the nucleus slides past the meridians of the shell from east to west.

It follows that, of all the lines that may be drawn upon the globe, the equator alone holds the same relation to both magnets in every year. A place upon any meridian finds the poles of the nucleus approaching it or departing from it as the years pass, and so finds its needle turning. A place upon the equator finds the poles of the nucleus passing it at an equal distance from both poles of the world, and so finds no cause, arising from the nucleus, why its condition in one year should differ from its condition in another in respect of north and south.

We do not claim that the needle stands still upon the line. It does not; the variation at Quito has its own course. We claim only that the line is the one place at which the shell and the nucleus are in agreement as to where the middle of the world lies. Mr. Halley has given the world a reason why the variation moves. He has also, without remarking it, given a reason why the equator does not.

## III. OF THE AGREEMENT OF INSTRUMENTS

It has long been held by those learned in harmony, and was argued at length by the Reverend Father Athanasius Kircher in his books upon the magnet and upon music, that the sympathy by which one string answers another, or a pipe answers a string, is of the same family as the attraction of the loadstone for iron. The Society has not undertaken to decide that question. It observes only that both the strings of an instrument and the needle of a compass are of drawn iron or brass, and that it would be strange if a

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cause sufficient to turn the one were wholly without effect upon the other.

The organ builders and the masters of the chapel at Quito have long remarked that the great organ, once tuned, keeps its agreement with the monochord of the chapel through the whole year better than reports from Seville and from Lima suggest is usual in those cities. They had attributed this to the evenness of our seasons. Mr. Halley's hypothesis suggests a different cause, and the Society resolved to put it to trial.

## IV. OF THE COMPARISONS MADE

A monochord of brass wire, upon a sounding board of cedar, was divided according to the method of Father Mersenne and set against the principal pipe of eight feet of a small organ made for the purpose, so that the string and the pipe sounded in unison. The tension of the string was fixed by a weight that was never altered, and the pipe was stopped against the entry of dust. At the equinox of September 1692 the two were brought to perfect agreement at the Society's station upon the line. Two further monochords and pipes of the same make were brought to agreement at the same time and in the same place, and carried with care, the one to a station at Popayán, to the north, and the other to a station at Cuenca, to the south, where they remained.

The instruments at each station were compared at each new moon by two observers, who listened for the slow waverings that are heard when a string and a pipe are very nearly but not perfectly in unison, and counted them against a pendulum beating seconds.

At the station upon the line, no wavering was heard at any comparison from the equinox of September to the equinox of March. At Popayán, a wavering of one in some ninety beats of the pendulum was heard by the third new moon, and grew slowly thereafter. At Cuenca, a wavering appeared by the second new moon and had grown to one in forty beats by the equinox of March. Cuenca lies at the greater distance from the line, and the disagreement there was the greater.

The Society considered whether the disagreement arose from the airs of those places, from the stretching of the brass, or from the carriage of the instruments over the mountains. It found that the airs of Popayán and of Cuenca are not less even than our own; that the weights were not altered and the brass was of one drawing; and that the instruments were not moved after they arrived. It found no cause for the disagreement but the distance from the line.

## V. OF THE CONSEQUENCES FOR THE ART OF MUSIC

If Mr. Halley is right, every instrument tuned at a distance from the equator is tuned under the joint direction of two magnets that are slowly turning apart, and must sooner or later fall out of its agreement, though the hand of the tuner has not touched it. The masters of Europe, who retune their organs in every season and lay the fault upon the weather, may be correcting the slow motion of the nucleus without knowing it.

Upon the equator the case is otherwise. The shell and the nucleus agree there, and an instrument tuned there is tuned once. The Society does not say that the masters of Europe should come to Quito to tune their organs, though they would be welcome. It says that they should know where the standard of agreement lies, and that it lies here.

## VI. CONCLUSIONS

The Society records its concurrence with the hypothesis of Mr. Halley, so far as it extends, and adds the following.

First, that the equator, being common to the shell and the nucleus, is the only line upon the globe that the westward motion of the variation does not carry away.

Second, that a monochord and an organ pipe brought to agreement upon the line kept their agreement there for half a year, while the same instruments brought to agreement upon the line and removed from it fell out of agreement in proportion to their distance.

Third, that the proper place for the keeping of a standard of musical agreement is upon the equator, and that this Society will keep its monochord there, and will publish its comparisons at each equinox for the use of any who wish to consult them.

Mr. Halley has shown the world that the needle moves. We have only to add that there is one line upon which it has nothing to move toward.

## EDITORIAL NOTE ON THE DIGITISATION (2026)

This paper is the earliest surviving entry in the bound Actas of the Sociedad Ecuatorial de Quito, which Equatorial Audio regards as its intellectual forebear. It was digitised and translated from the Spanish by the Equatorial Audio Research Division in 2026. The undertaking in the third conclusion, to publish at each equinox, is the origin of the Society's publication calendar and, through it, of the calendar of the Journal of Equatorial Audio Science.

Halley's account is real and is summarised accurately. His nested shells did not survive as he described them, but the core of the

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idea did. The westward drift of the geomagnetic field is real and continues at roughly a fifth of a degree of longitude per year. The Earth does have an inner core: Inge Lehmann inferred it from seismic waves in 1936, and later work established that it is solid, a solid body within a fluid one. Its rotation relative to the mantle is now measured, and was reported in 2023 to have paused and begun to reverse, a finding whose consequences for magnetically calibrated conductors this Division has examined elsewhere (Ferro, Ohm, Flux and Impedance, 2026).

The Society's central inference also holds in the form it gave it. Two bodies rotating about a common axis share a common equator whatever their relative rates. The Division has not repeated the monochord comparisons and reproduces them as recorded.

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