

The Source of the Interplanetary Magnetic Field (IMF) Measured by Pioneer V

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Abstract

Solar atmosphere expansion into interplanetary space was a dominant theoretical models when Pioneer-V was launched in March 1960, to determine among others the source of measured anomalous Interplanetary Magnetic Fields (IMF); lacking alternatives, the experimenters endorsed the solar-wind theory; this paper noticed loopholes in that endorsement; such as the probe's failure to detect any increase in IMF for fifty five minutes, and a maximum horizontal magnetic field was recorded at three Earth Magnetic Observatories two hours before Pioneer-V measured maximum IMF, indicating the existence of magnetic disturbance source nearer to the Earth, contrary to the theory; these observations are hoped to give the scientific community a different angle to review many unresolved issues, that will reflect positively on the determination of type of the alternative renewable energy.

Keywords: Pioneer V experiment; Solar wind; Solar magnetic field; Embedded magnetic field; Interplanetary magnetic field; Interplanetary external magnetic field

Introduction

The past human dependent on fossil fuels, had led to accumulation of excessive greenhouse gases resulted in current global warming [1], with general certainty that, green alternative energy is the only exit from current circumstances [2], although great efforts and resources were exerted [3-5], however disappointments force some to seek new basic in science [3], hence what is the essence of that science? What is the type of that energy? Why it took so long? With fruitless attempt to assimilate nature in energization process [5]; hence what is the mechanism behind such energization? And why it was so elusive?

The natural energization of charged particles in the sun [6], and in the heliosphere [7], including the bow shock [8], magnetosheath [9] and magnetopause boundaries [10] may hold an answer to the renewable energy quest [11], hence efforts were exerted in space explorations since early rockets and satellites era [12], and more than two hundred satellites were sent to probe the Solar System (planetary, solar, asteroids and comets) since end of fifties [13], without finding the clue.

The reason undermined these efforts could be traced to the developed concepts of the Interplanetary Magnetic Field (IMF), which was based on the extension and expansion of the solar atmosphere into interplanetary space [14], the heliosphere magnetic discrepancy was deduced from terrestrial observation [15], and realization that computed Solar magnetic field at one astronomical unit is $10^{-2}\gamma$, (sunspots fields are negligible); while at 10^6 km Earth's magnetic field is only $10^{-2}\gamma$, hence no appreciable magnetic field should be expected within the interplanetary space [16], but satellites measurements detected anomalous magnetic field 100 times greater and opposite in direction to geomagnetic field and continuously changing directions [12]; hence Pioneer V was sent on March 11, 1960, to study among others the detected anomalous Magnetic Fields [17], for that reason the probe was stationed far at 5.2×10^6 km (863RE) on the Sun-Earth line to be far from magnetosphere influence [18]; when a large solar

flare erupted on March 30, 1960 at 14:55 U.T., the plasma reached the probe and earth the following day, maximum IMF of 23.4γ was measured, another 50γ the following day [19]; influenced by prevailed solar theories [14] the experimenters endorsed the IMF [20] developed by Parker [21], and others [22], thereafter the Interplanetary Monitoring Platform (IMP-1) was sent to recheck measurements [15], and IMP-1 carried extensive measurements, without repeating the experiment; thus the IMF envisioned as emanated from the sun [23].

The endorsement meant an entrained corona magnetic field is carried by solar wind [24], along the nine planets to inflate the heliosphere [25], a concept concealed various ideas, and generated many others; with great impact on astrophysics; thus the IMF formed the bases for nearly all related theories with many interpretations, among which: The magnetosphere [26], envisioned as closed cavity [27], and the outer geomagnetic lines of force are thought to carry solar wind away [28], the solar wind was envisioned to flow around the cavity, and igniting aurora through reconnection mechanism [29], neutral points were introduced [30], changes in magnetic field intensity and direction is interpreted as neutral sheet [31], and geomagnetic lines of force are thought to connect with the IMF [32], the magnetic reconnection extended to activate solar flare eruption [33], and to explain the extremely high temperatures solar corona [34], it was also thought to play major role in energy release, hence it has been invoked to explain chromospheres eruptions and many solar phenomena [35]; thus the IMF interwoven in complicated explanations, such as the sector structure [36], which thought to reflect on solar coronal holes, as source of low and high solar winds speed [14].

However recent discovery that the impenetrable blunt magnetosphere body [37], is continually breached by solar wind in several places [38], then energization in Van Allan radiations belts is carried through magnetic waves [39], in addition to detected anomalous magnetic fields bellow 4RE [40], and with early suggestion of External Magnetic Field (ExMF) production in the interplanetary space [41], suggestive to detected and measured anomalous magnetic fields [42], lead to reviews of early space explorations, including Pioneer V experimenters, where loopholes were detected, the paper

highlight on these loopholes, as this may offer a different line of thought towards the long awaited alternative renewable energy.

Pioneer-V Loopholes

Pioneer V was positioned in remote and far from geomagnetic field influences [18], when magnetic storm occurred [22], thus endowed uniqueness to the experiment [43], hence it represents the only experiment that could have verify the IMF origin.

Figure 1, is a composition of both Figures 1a and 1b [19] depicting IMF measured at Pioneer V and variation of horizontal geomagnetic field intensity at Honolulu Magnetic Observatory, and Figures 2a and 2b [20] showing Telemetered data from Pioneer V depicting timing of solar flare eruption, plasma arrival at Pioneer V, and at Earth and magnetic fields measured at the probe on March 31/April 1, 1960. While Figure 2, is an enlarged imposition of events in the three red marked squares on Figure 1. From both figures, the following loopholes were detected as consequence of 31st March events.

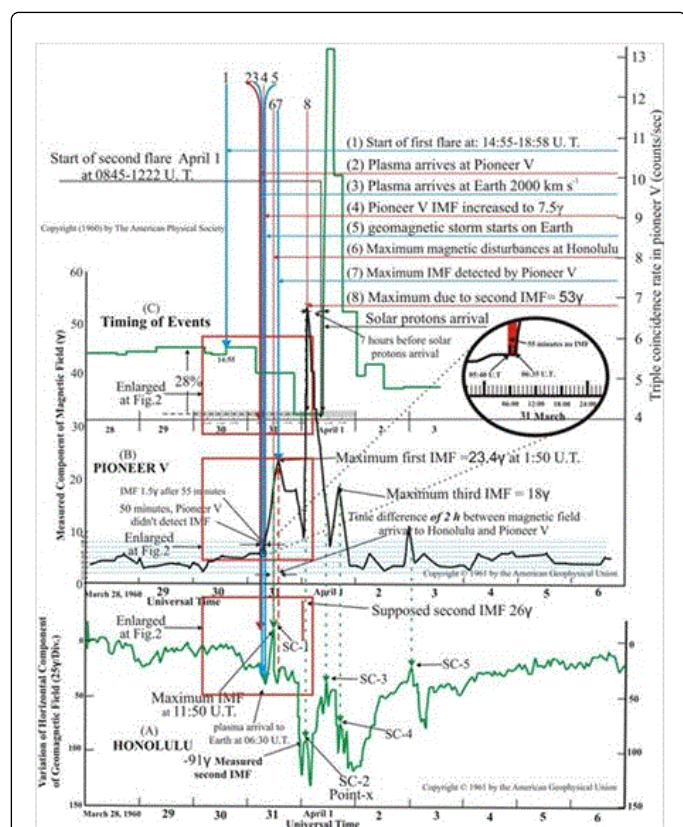


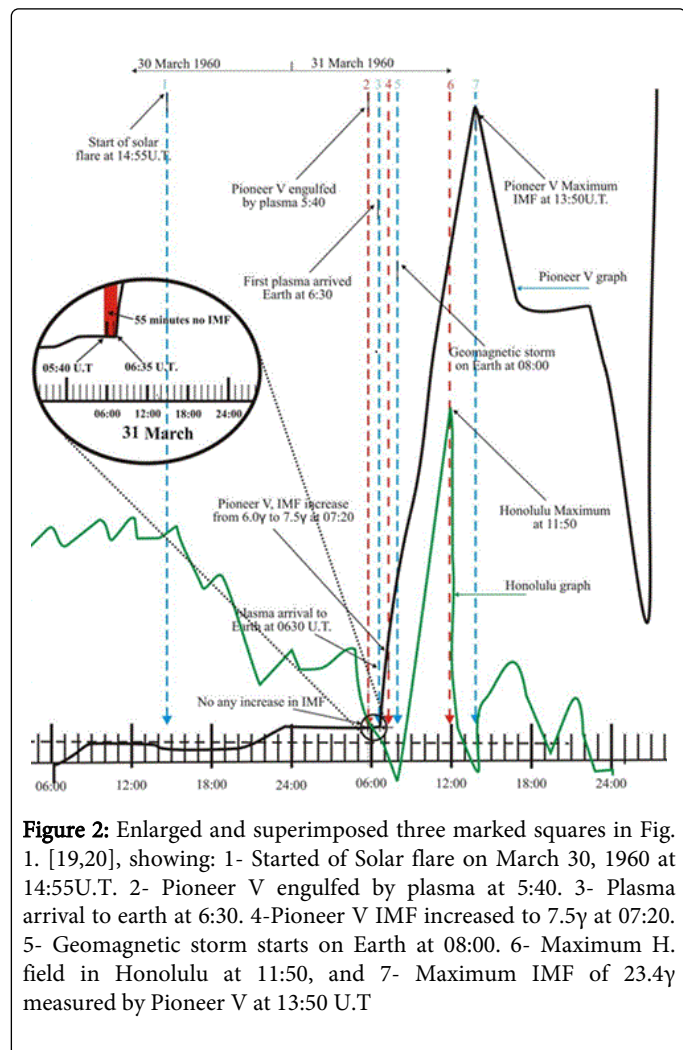
Figure 1: Re-analysis of March 30/31, geomagnetic storms, by combining Figures 1a & 1b [19], with Figures 2a & 2b [20]. The figure shows: 1-Solar flare Starts at 14:55 U.T. March 30, 1960. 2-Plasma arrival at Pioneer V at 5:40 (no increase in IMF). 3-Plasma arrive earth at 06:30. 4-Pioneer V IMF increased, 1.5γ to 7.5γ at 07:20. 5-Geomagnetic storm starts on Earth at 08:00. 6-Maximum H. field in Honolulu at 11:50. 7-Maximum IMF 23.4γ at Pioneer V 30 March at 13:50U.T., and 8- Second maximum IMF 53γ 7 hours on 1st April.

- When Pioneer V first engulfed with the solar plasma at 05:40 U.T., as shown by line 2 in Figures 1 and 2, no initial increase in IMF, hence no embedded IMF detected.
- For more than fifty five minutes, between first plasma arrivals at Pioneer V at 05:40 U.T. till plasma arrival to Earth at 06:30 U.T., no any increase in IMF was measured, shown by line 3 and the red strip in the expanded zoom Figures 1 and 2.
- After 55 minutes from Pioneer V first engulfed with plasma at 05:40 U.T., IMF start increases at 06:35 U.T., from 6.0γ till it reached 7.5γ at 07:20 U.T.; an increase of only 1.5γ after 1:40 hours from first engulfed with plasma.
- The IMF at Pioneer V steadily increased after 07:20 U.T., till it reached maximum 23.4γ at 1:50 U.T., after 8 h 10 m from first engulfed with plasma.
- Pioneer V measured maximum IMF of 23.4γ, two hours after a maximum magnitude of horizontal geomagnetic field recorded at Honolulu Magnetic Observatory, at 11:50 U.T.
- Maximum horizontal geomagnetic field components were measured at San Juan [44], Fort Belvoir [45], and Honolulu Magnetic Observatory [19], two hours before Pioneer V.
- Measurement of maximum horizontal magnetic fields at Honolulu, San Juan, and Fort Belvoir two hours before Pioneer V, suggested the existence of IMF disturbance source nearer Earth than Pioneer V [42].
- Two magnitudes of 23.4γ on 31st and 50γ on 1st April [19] measured by Pioneer V, showed periodic pulse characteristic [46], or periodic fluctuations [44], or one big pulse per flare, not related to supposed embedded solar field which supposed to varied with solar wind density and velocity, as given in Figure seven by Russell [47].
- The experimenters [20] stated that “our results describe large-scale transient magnetic fields over great distances from Pioneer V; the magnetometer in Pioneer V registers field changes at the position of the vehicle perpendicular to its spin axis.” This transition magnetic field at great distance implied recognition of delayed IMF.
- Evidence of IMF locally produced was strong from Pioneer V data as suggested by the experimenter’s conclusion [20]: “Both kinds of observations show that magnetic fields are being moved or generated in interplanetary space as a consequence of the solar flare on March 30.”
- With confusions, and lack of alternatives, the experimenters [20] clearly stated why they made their decision: “The only known way by which these transient fields could be established, or existing fields manipulated, is by moving, conducting plasma of solar flare origin.”

Spatial Magnetic Production

The early proposed shapes, nature and characteristics of IMF as an extension and expansion of solar atmosphere [14], had led to the embedded concept due to lack of alternative theory [20], and Pioneer V experiment was conducted merely as “an opportunity to observe magnetic field of the plasma cloud” [22]; however results from the experiment contradicts the solar expansion theory, while justification of measured 50γ IMF as due to “The accidental occurrence of solar cosmic rays during the time” [44], was disputed by solar protons arrival before and after the experiment [19,48], even if the 50γ resulted from cosmic rays, it should have been detected concurrently with the IMF.

However these loopholes were overlooked due to three suggestions [23], first of which emphasized on 1- the “absence of identifiable individual (source of) disturbances,” responsible for producing the IMF, then 2- the graphs of low level interplanetary field for 48 days were compared with solar activity graph, then 3- a conclusion is reached that “the background field level might itself have varied in response to varying background solar condition.”



Five decades had elapsed, so far several astrophysical phenomena still not been resolved [49,50], implying either they are outside science realm, or required theoretical breakthrough, but from these loopholes it is deduced that, the truth had been concealed by Pioneer V interpretation. After that experiment, several discoveries had given clues, but were overlooked or misinterpreted by Parker’ solar model [43], where satellites discovered that, energetic particles concurrently exists with anomalous magnetic fields [51]; and spatial increase in electrons density, lead to an increase in magnetic field magnitude, hence leading to an increase in electron’s energy [52], and that ions heating, occur behind the (anomalous) magnetic structure [53], and particles are accelerated in Van Allen radiation belts, through an intense electromagnetic waves region [39], and such regions with large magnetic field fluctuations were detected by Pioneer 1 and measured by Pioneer V between 9.4RE and 15.7RE [54], such magnetic field structures later named “the magnetic clouds,” they are characterized

by relatively strong magnetic fields with large smooth rotation in the magnetic field direction [14], but the source of such strong field was detected in magnetosheath at 12.46RE with magnitude three times greater than Honolulu record [55], however Honolulu was among the three geomagnetic stations, where horizontal magnetic fields were recorded two hours before maximum IMF measured at Pioneer V [19] implying the existence of source of such magnetic field near Earth [42], and since magnetosheath is a region dominated by great turbulence and local acceleration [28], in which flow of energetic protons is prominent feature [56], with field greater than that of the interplanetary region [22] and magnitude as high as ~56γ was measured [57], therefore the continual link between anomalous magnetic fields (sometimes rotating) with particles concentration and acceleration should be inferred as a local spatial production of these IMF, which been named the Interplanetary External Magnetic Field (I-ExMF) [42]; an I-ExMF source at magnetosheath is at around 12.46RE [55], and that is where both the 23.4γ and 50γ were suggested to be produced; but such anomalous magnetic field with magnitudes of 150γ, 300γ, and 700γ has been produced in ionosphere [58,59] during the High-altitude Nuclear Detonation (HND) [60] experiments and measured worldwide [61], its spatial location and magnetic moment was estimated [62], therefore the production of anomalous magnetic field similar to IMF in ionosphere during HND experiment, is a good proof that the ExMF is spatially produced in ionosphere and within the interplanetary space, hence IMF production is related to solar wind, thus to the solar activity [42], in line with above Pioneer V analysis, and as partially stated by Greenstadt [43], that “Disturbance in interplanetary conditions influenced the measured field component by statistically increasing its amplitude.”

Conclusion

Several loopholes were detected in the 30 March/1 April 1960 Pioneer V experiment, which endorsed the solar origin of Interplanetary Magnetic Field (IMF), it is showed that, horizontal magnetic fields were measured in three Earth Magnetic Observatories two hours before IMF was measured by Pioneer V, this with many factors lead to the suggestion that, the IMF was produced nearer Earth in Magnetosheath at around 12.46RE, and it is been named the Interplanetary-External Magnetic Field Moment (I-ExMFM), and such I-ExMFM was produced in ionosphere many times during the High-altitude Nuclear Detonation (HND), thus if External Magnetic Field-Moment (ExMFM) was produced in ionosphere then it could be produced in the interplanetary space and anywhere, supporting the non-solar origin of IMF and the possible production of I-ExMFM.

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