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August 26, 1999

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Dr. Richard H. Battin
Department of Aeronautics and Astronautics
Massachusetts Institute of Technology
77 Massachusetts Avenue, Building 9, Room 470
Cambridge, Massachusetts 02139

Re: Unsubstantiated Claims of Inventorship of Gravity-Assist Trajectories
(Our Ref.: D-7621)

Dear Dr. Battin:

We received your letter dated August 8, 1999, in which you attempted to make two points and summarily concluded that should put an end to this matter. Needless to say, we vehemently disagree.

First of all, copies of entries alleged to come from your university's instrumentation library (of questionable authenticity) are not the kind of conclusive evidence that proves you discovered gravity-assist Earth-Venus-Mars-Earth trajectories and the principle behind these trajectories prior to Dr. Minovitch's August 23, 1961 JPL paper. Scientific inventions are documented by published papers and the like, not suspicious entries in library logs.

Secondly, addressing Arthur C. Clarke's 1997 letter, as you well know at issue here is not who first pointed out that it might be possible to utilize gravitational perturbations for space travel, which was very old and proposed many years before Lawden and which was shown to be impractical by Professor Samuel Herrick in 1959 (Exhibit 1). Rather it is the *particular method* of utilizing gravitational perturbations that was discovered by Dr. Minovitch that is at issue here.[1]

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[1] This method is represented by a free-fall multiplanetary trajectory $P_1 - P_2 - P_3 - \ldots - P_n$ ($n \geq 3$) where the gravitational influence of each successive planet is used to change the launch trajectory to achieve space travel throughout the entire solar system essentially without any rocket propulsion. It became known as gravity-assist trajectories. Although the possibility of multiplanetary trajectories was known prior to Dr. Minovitch's work, the design of these trajectories was based on the assumption that planetary perturbations destroyed the required synchronism and had to be canceled out in order to achieve the desired planetary interceptions. (Exhibits 2-6) As a consequence, multiplanetary trajectories required launch energies so high that they could not be achieved by chemical rocket propulsion and were regarded as "academic pastimes" before Dr. Minovitch's invention became known. (Exhibit 3, 4). Lawden did not anticipate the invention for

The fact that the invention was new can be established from the numerous peer-reviewed papers published in the professional aerospace journals stating this fact.

Thirdly, and most importantly, your response failed to address any of the points raised in our letter of July 20, 1999, which undermines the credibility of your claims, including:

1. Why did you allow your graduate student, Mr. Walter Hollister, to take credit for gravity-assist propulsion in his 1963 thesis?[2]

2. Why did your fellow faculty member Hollister in 1970 publish a paper giving Dr. Minovitch the credit for originating gravity-assist trajectories? How could you have failed to inform Hollister regarding your claim of discovering gravity-assist trajectories in January 1961, so that Hollister could properly give you the credit instead of Dr. Minovitch?

3. How do you explain the later dates for the other references in the *Air, Space and Instruments* book, if indeed it was submitted to the publisher prior to the August 23, 1961 date of Dr. Minovitch's JPL paper?[3]

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the simple reason that he never published a single paper dealing with multiplanetary trajectories. Dr. Minovitch's invention involved a particular method for using gravitational perturbations and not the fact that gravitational perturbations could be used which was shown to be an impractical idea prior to the invention.

[2] How can you claim that you discovered and designed the first gravity-assist trajectory in 1961 when you acknowledged a graduate student from your Department of Aeronautics and Astronautics at MIT named Walter Hollister for making this innovation in 1962? As you know, Hollister presented his claimed innovation to the Department of Aeronautics and Astronautics, and used it for satisfying the innovative requirement for a Ph.D. dissertation which was approved by your Department. Then you acknowledged Hollister's claimed innovation by actually helping him compute his claimed gravity-assist trajectories that he presented in his Ph.D. dissertation. The specific gravity-assist trajectory that you acknowledged Hollister as discovering was Earth-Venus-Mars where the gravitational field of Venus was used to propel a spacecraft to Mars. Hollister named his claimed innovation a "Bi-Elliptical Transfer" trajectory. Numerous peer reviewed papers were published in the professional journals identifying Hollister as the person who originated gravity-assist trajectories. The gravity-assist trajectory that you claimed to have discovered in 1961 had the form Earth-Venus-Mars-Earth. The gravity-assist portion of this trajectory was Earth-Venus-Mars, which you acknowledged Hollister as originating in 1962. The existence of Hollister's Ph.D. dissertation shows that you did not make the invention. Clearly, the authenticity of this dissertation far surpasses the authenticity of any log from the library of your Instrumentation Laboratory. How do you explain this? Why did you fail to mention Hollister's 1963 Ph.D. dissertation in your 1994 IAF paper?

[3] How could Draper's book *Air, Space and Instruments* published in 1963 by McGraw-Hill containing your paper which you claimed was delivered to the publisher in early 1961 also contain several other papers with references published in 1962? In particular, how could one of these papers published in that book described a conference in the past tense held during May 14-16, 1962 (that can be documented) where the author (Weiss) attended and presented a paper that he described and cited in that book?

4. In 1990 why did you tell William Kosmann in a documented interview regarding your role in the development of gravity-assist trajectories that you discovered Earth-Venus-Mars-Earth gravity-assist trajectories in 1956?

5. Despite the many related articles you have published over the years, why did you never publicly claim credit for this revolutionary and fundamentally important discovery until 1994?[4]

And additionally:

6. Why in June 1962 did you publish a paper (Exhibit 7) relying on conventional Earth-Mars-Earth trajectories that required flight times over three (3) years, if at least seventeen months earlier you had discovered Earth-*Venus*-Mars-Earth gravity-assist trajectories that only required flight times of about one (1) year as you claim?[5]

Absent a satisfactory response and explanation of all of the above, only upon three (3) conditions being met will this matter be resolved:

1. Withdrawal of your 1994 paper from further publication;

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[4] As you know, the discovery of gravity-assist trajectories broke the high-energy barriers of the classical theory of space travel based on reaction propulsion and direct transfer trajectories. It opened up the entire solar system to exploration with instrumented spacecraft by providing the technical basis for all of NASA's gravity-assist missions. The names of these missions were: Earth-Venus-Mercury (Mariner 10); Earth-Jupiter-Interstellar (Pioneer 10); Earth-Jupiter-Saturn-Interstellar (Pioneer 11); Earth-Jupiter-Saturn-Interstellar (Voyager 1); Earth-Jupiter-Saturn-Uranus-Neptune-Interstellar (Voyager 2); Earth-Jupiter-Out-Of-Ecliptic (Ulysses); Earth-Venus-Earth-Earth-Jupiter (Galileo); and Earth-Venus-Venus-Earth-Jupiter-Saturn (Cassini). The combined scientific information obtained from those missions filled many books on astrophysics, space science, and geology, and essentially provided the first detailed information on the structure of the solar system.

[5] In June 1962, 17 months after your alleged January 26, 1961 discovery of Earth-Venus-Mars-Earth gravity-assist trajectories, you submitted a lengthy paper on navigation for round-trip trajectories to Mars and Venus where flight time was a critical factor (Exhibit 7). However, you explicitly described these trajectories as the usual single planet Earth-Mars-Earth and Earth-Venus-Earth trajectories on the first page of this paper by referencing earlier papers from MIT (Exhibits 8, 9). The low launch energy Earth-Mars-Earth trajectories required flight times of about three years which was a serious disadvantage. Since the Earth-Venus-Mars-Earth gravity-assist trajectories which you claimed to have discovered in January 1961 and "anxious to publish" (see page 6, of your 1994 IAF paper) required flight times of a little over one year they represented a fundamentally new discovery in astrodynamics. However, as you can easily see by examining your own 1962 paper (Exhibit 7), you made no mention of these revolutionary trajectories. Since it is absurd to assume that you did not mention your claimed 1961 invention in your June 1962 paper because you did not consider them important, this represents documentary evidence that when you submitted this paper for publication you were not aware of the possibility of Earth-Venus-Mars-Earth gravity-assist trajectories.

2. Stopping of all claims of inventorship of gravity-assist trajectories; and

3. Issuance of a press release or other public statement crediting Dr. Minovitch.

We must hear from you again within twenty (20) days, this time with a much more detailed response. If you do not respond by then, we will assume you have no satisfactory explanation and that you have been less than truthful in your public claims since 1994 regarding your alleged January 1961 discovery of gravity-assist Earth-Venus-Mars-Earth trajectories. If we do not hear from you, you may be haled into court to resolve this controversy, before further damage is done by your unfounded claims of inventorship.

We await your detailed and timely response to this letter.

Very truly yours,

CISLO & THOMAS LLP

Robert J. Lauson

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Enclosures
Exhibits as defined above

cc: Dr. Donald C. Elder, Editor-in-Chief, AAS History Series
Mr. Cleude Gourdet, Executive Secretary, International Astronautical Federation
Dr. Wesley T. Huntress Jr., President, American Astronautical Society
Mr. Robert H. Jacobs, President, UNIVELT
Dr. Michael Minovitch
Mr. Frederick Ordway, IAA Committee Chairman on the History of Astronautics
Jeffrey Swope, Esq., Palmer & Dodge LLP (MIT Legal Representative)

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