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Dr. Michael A. Minovitch
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1901 Avenue of the Stars, Suite 277
Los Angeles, California 90067

Dear Dr. Minovitch:

I have had two exceptionally well-qualified people not mentioned in your list of references review your proposed article on "The Development of Gravity Thrust Space Trajectories." They both recognize the special problems of claims of originality in this particular area of astrodynamics, and recommend against publishing your paper. It is not that you didn't do interesting work and that you don't write well, but rather that the article promises to divert the attention of the reader from a history of ideas to a somewhat murky quest for precedents. One of the reviewers has set this down for me in a very clear way on the attached sheet. I might add that we prefer to run articles that show the advancing state of the art and new challenges.

Your paper, it seems to me, would be better directed to the AIAA History Committee and its yearly competition. This competition places no limits on length. Concerning this competition, you can write: Mr. George S. James, Program Coordinator, National Air and Space Museum, Smithsonian Institution, Washington, D.C. 20561.

I do appreciate your bringing your paper to my attention and hope you will see it as a candidate in the history arena of the Institute's activities.

Sincerely,

John Newbauer

John Newbauer
Editor-in-Chief, A/A

JN:EG

Enclosures

First Class

Review of

"The Development of Gravity Thrust Space Trajectories"

by Michael A. Minovitch

This is an interesting personal history of the development of swingby trajectories by an important contributor to this field. It is clearly written and contains an excellent bibliography. However, it is somewhat too detailed and is too much of a personal history for publication in Astronautics and Aeronautics. While the author goes into great detail as to his own thoughts on the significance of swingby trajectories he surmises the thoughts of others from their publications and is not always generous in doing this. As a result the entire history appears to be somewhat biased. I believe this bias is unintentional and is of a type that is common in contributors to a new and rapidly growing field.

Purely on the basis of publications, the principle of swingby trajectories was clearly understood by Lawden and Battin and unboubtedly others. The appreciation of the true significance of swingbys had to await the advent of better launch vehicles and for more extensive mission studies. When detailed studies were well underway on planetary round trips and outer planet missions the subject of swingbys became popular. The author was one of the more important popularizers. His article is interesting as a personal record of the development of swingby trajectories. However I do not think it is suited for publication.

Comments on the Review

This is an unfair and technically incorrect review. The principle of swingby trajectories was not "clearly understood" by Lawden or Battin or "undoubtedly"by others. On page 566 in Battin's paper,"The Determination of Round-Trip Planetary Reconnaissance Trajectories", he makes the statement: "The variations in the return velocity are much greater and, indeed, we observe the curious fact that the spaceship can return to Earth with a velocity smaller than the one with which it left". Battin makes no observation that this fact can be utilized to accomplish interplanetary missions that would otherwise require very large rocket propulsion. Indeed, in summation, Battin merely states: "The primary effect of the Martian gravitational field is approximately to double the component of the spaceship velocity normal to the planet's orbital plane. The result, as can be seen from the diagrams, is a rotation of the line of nodes of the spaceship orbit by some 60°." These remarks and omissions clearly show that Battin did not foresee how planetary perturbations could be utilized to reduce energy requirements of interplanetary missions.

In the case of Lawden we notice that in his paper, "Dynamic Problems of Interplanetary Flight", The Aeronautical Quarterly, Vol. 6, August 1955, pages 167-170, he reaffirms the classical results of Hohmann concerning minimum energy interplanetary journeys between two essentially co-planer planets. The classical trajectory between two planets requiring least expenditure of rocket propulsion is an elliptical path tangent to the orbit of the departing planet and tangent to the orbit of the arrival planet. This minimum energy trajectory is known in astronautics as the famous "Hohmann Trajectory". Prior to the development of gravity assist swingby trajectories, the use of these Hohmann "minimum energy" trajectories were considered axiomatic in the planning of all interplanetary missions. Lawden makes no effort to show that the use of large planetary perturbations can completely overthrow this previously assumed axiom of space travel. This paper (Dynamic Problems of Interplanetary Flight) was written after his paper entitled "Perturbation Maneuvers", Journal of the British Interplanetary Society, Vol. 13, No. 6, November 1954, where he does show that relatively small lunar perturbations can be used to reduce energy requirements for interplanetary journeys between Earth and Mars. Although Lawden did recognize that perturbations could be utilized to reduce rocket propulsion requirements for interplanetary flights, he did not recognize or understand how really large planetary perturbations could be utilized to reduce propulsion requirements nor did he formulate any fundamental concept for their general utilization. Indeed, on page 170 of the former paper he states: "When a rocket is perturbed by a planetary body, a transfer of energy takes place between it and the body which may be to the advantage of the rocket. Thus, by passing close to the Moon, a space ship outward bound from an orbit about the Earth to Mars can acquire a considerable amount of energy without any expenditure of fuel. The best way of utilizing such perturbation effects is not known, although there exist a few purely numerical studies, some of which will be found in Ref. 11." (Reference 11 is the latter reference.)

Several years later when Lawden published his book on trajectories entitled Optimal Trajectories for Space Navigation, Butterworth and Company Ltd., London, 1963, he again reaffirms the standard ideas regarding the use of Hohmann minimum energy trajectories for interplanetary missions. Nowhere in the book does he reference the possibility of using perturbations to reduce energy requirements. It is inconceivable that Lawden could have written this book if he really understood the principle of swingby trajectories.

Finally, the reviewer fails to acknowledge the fact that prior to 1961 all published papers on astronautics dealing with the possibility of missions to the outermost planets or to regions above or below the ecliptic plane or to regions close to the sun, concluded that the required energies were beyond the capabilities of ordinary chemical rocket engines and/or required flight times of many decades - and that all interplanetary missions were designed on the basis of Hohmann trajectories which were not questioned.

The concept and development of gravity assisted space travel or swingby trajectories was a major advance in astronautics as it overthrew previous ideas that assumed all interplanetary journeys were based on the application of rocket propulsion which necessitated the use of Hohmann minimum energy trajectories - that changes in interplanetary trajectories could only be the result of the application of rocket propulsion. I maintain that I invented this concept of swingby, gravity assisted space travel in 1961 (which was initially rejected by JPL) and developed it during the years 1961 through 1964 by my own large scale computer analysis research project that was supported primarily by UCLA. I offer numerious documentary evidence to prove my claims.