INDIA'S MANGALYAAN MISSION TO MARS: A BEAUTIFUL EXAMPLE OF LEAST ACTION

By Pierre Beaudry, 9/15/2017

FOREWORD

The Mars Orbiter Mission (**MOM**), informally called **Mangalyaan** (Sanskrit: मङ्गलयान: Marscraft) was successfully launched on November 5th 2013 by the Indian Space Research Organization (**ISRO**) and attained its Mars objective 10 months later in the most efficient way of traveling across the Solar System. The secret to their method was as simple as it was brilliant; it was a beautiful example of a matter of mind. The Indian scientists used the Sun's gravity of the Earth's orbit to propel their satellite to Mars. How was this done, and what was the universal physical principle involved?

INTRODUCTION

On November 5, 2013, the Indian Space Research Organization (**ISRO**) launched its Mars Orbiter Mission (**MOM**) called **Mangalyaan** (Marscraft), which reached the orbit of Mars after 299 days, on September 24, 2014. Two weeks after the Indian launch, on November 18, 2013, the United States launched a similar mission to Mars with its MAVEN orbiter, which reached the orbit of Mars on September 22, 2014, two days before the India mission arrived at its destination. What does that demonstrate? That Americans are better than Indians? No. This proves that least action is better than mere force.

The Indian Space Research Organization (**ISRO**) "sent a satellite to Mars using an old rocket and a lot of gravity!" The Indian mission was less powerful than the American one, but more least-action-efficient; the American mission was six times more powerful and consumed much more fuel. The total cost of the **ISRO** mission was about 4.5 billion rupees ($70 million current US dollars), while the total NASA mission cost nine and a half times more; that is, about $671 million dollars.

Why was that Indian project more efficient than the American one? The Indian mission placed the satellite in a low orbit and raised its speed out from the Earth's gravitational field through six orbital motions during a period of 25 days and reached Mars 10 months later. As for the Americans, the launch of the MAVEN was 13 days after the Indian launch, and their arrival to Mars orbit was 2 days before the Indians. What is the difference between the two? What is the irony of that difference and what is its significance for space travel? The answer is: The Americans launched the MAVEN spacecraft into its heliocentric transit orbit to Mars with the aid of a second booster rocket in order to counter Earth's gravity after an orbit of only 27 minutes, while the Indians used Earth's gravity during 25 days and did not require a second booster rocket.

Why was the Indian mission more efficient? The idea the Indian scientists used was the Nicholas of Cusa and Kepler Minimum-Maximum principle. The Indian mission used the least action principle of the Solar System itself; that is, the force of least action between the minimum (perigee) and the maximum (apogee) distances of an elliptical orbit. The effective use of that force enabled the Indian scientists to increase the speed of their satellite without requiring much additional fuel and without boosting rocketry. With this mission, India became the fourth country to reach Mars, after Russia, the United States, and the European Union. However, India was the first nation to have done it in its first attempt for the following reason.

When the Indian satellite was at the perigee of the Earth, its speed was at its maximum along that low orbit; so they gave the satellite a little push in order to increase the distance of the next apogee. The reason they did this was because

when the satellite is at the closest to the Earth, pushing it into a longer orbit will increase its speed significantly the next time it comes around to the perigee. Between November 5th and November 16th, the scientists increased the satellite speed at perigee 8 times more than the speed which was required to put **Mangalyaan** into orbit in the first place; and this was done with very little boosting expenditure.

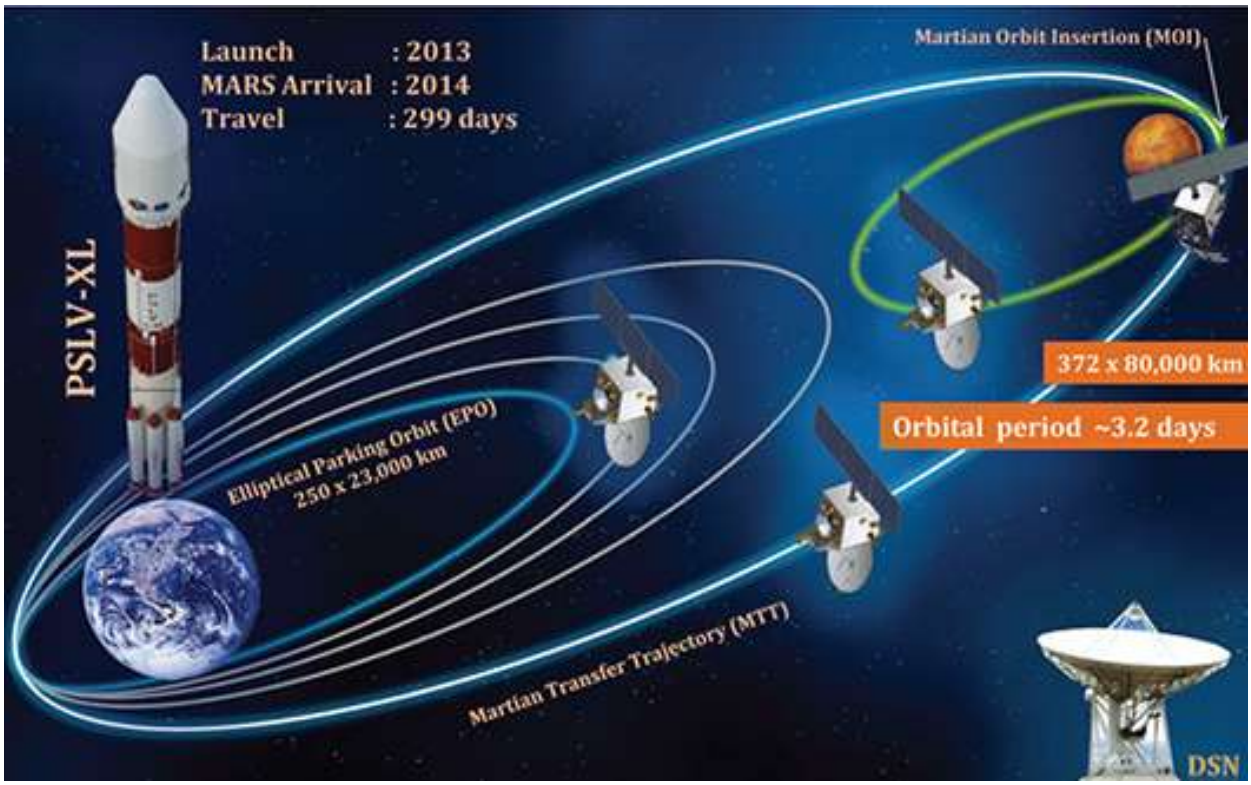

Figure 1 How **Mangalyaan** left Earth's orbit on December 1, 2013 to enter into Mars Orbit on its first attempt, on November 9, 2014. **ISRO**

When the **ISRO** pushed the satellite to the velocity needed to escape the orbit of the Earth, on December 1, and move it into the Sun's orbit, they knew that if they applied the same principle in reverse when the spacecraft was to reach the orbital space of Mars, they would get the same result, except in reverse. All they had to know was how to control those least action extraction and insertion processes.

As the **ISRO** reported on December 1, the motor was ignited one more time from base control in order to move the satellite away from the Earth's gravity after six orbits, and that pushed it into the Sun's gravity field. At the seventh orbit, the **Mangalyaan** spacecraft escaped the Earth's gravity slightly faster than the speed of the Earth orbiting around the Sun at that time. The spacecraft went smoothly from the dimensionality of the Earth orbit to the dimensionality of the Sun's orbit without indicating any discontinuity. It was as if it had made an axiomatic jump between two different manifolds in total continuity.

By using the least action force of the Solar System as a whole, the launching of a geocentric looping around the Earth was made according to the energy-efficient Hohmann transfer orbit[1] by going from the Earth's orbiting power to the Sun's orbiting power. Thus, the Mangalyaan spacecraft was able to take the least action pathway and make the trip to Mars more economically.

Thus, the most outstanding achievement of this project was the demonstration of the feasibility of the least action transfer of any satellite spacecraft from Earth-centered orbit to a heliocentric trajectory and the capture into another Solar System planetary orbit by the inversion of the same principle. If you understand this, then you understand why the **ISRO** video commentator concluded that traveling to Mars doesn't take any more fuel that it takes for going to the Moon, although it may be a 100 times further away. As he said: "Most of the fuel we need is just to launch the satellite, the rest of the journey is mostly courtesy of gravity."

The beauty of this success is that the Indian scientists knew, even before they started, that they were going to succeed, because they knew how to get there in accordance with the Cusa-Kepler universal physical principle. The Indian satellite may have taken more time than the American satellite to extract itself from the Earth's gravity (13 days vs 27 minutes), but it went to Mars more economically than the American one did. Chapeau India!

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[1] A Hohmann transfer orbit is an orbital maneuver which brings a spacecraft from a lower circular orbit to a higher one in the same plane. The idea was invented by the German scientist, Walter Hohmann, and published in his 1925 book, *The Attainability of Heavenly Bodies*.