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Short Communication

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Earth-Mars Fly by Trajectory (Earth-Planets Solar System)

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Abstract
Delivery of scientific equipment, robots to Mars is carried out today along the Goman trajectory. Conditions for realisation of such a flight appear every 26 months. This limits the possibilities of studying the planet and, in the future, the flight and return of people from Mars. The article considers the variant of flight to Mars, and to other planets of the solar system and beyond it, not on the Gomanov trajectory.

Keywords: Mars, Flyby Trajectory, Goman Trajectory, Annual Earth-Mars Flights

Earth-Mars Fly by Trajectory

The planets of the solar system follow the Sun along a spiral trajectory. The spiral motion is formed by the progressive motion of the planets in the direction of the Sun's motion (following the Sun) and the rotation of the planets around the Sun. Theoretical study and performed mathematical calculations have shown that the Earth's motion following the Sun (in the direction of the Sun's motion) occurs with intermittent speed. In the form of cyclic oscillations. The Earth is periodically ahead of the Sun (overtaking), or behind the Sun (lagging behind). A detailed calculation showed that the speed of the Earth's motion in the direction of planetary system motion (in the direction of the Sun's motion) is Figure 1.

- at the position of the winter solstice - 21.12 - 220 km/sec
- at the position of the vernal equinox - 21.03 - 208.149 km/sec
- at the position of the summer solstice - 22.06 - 220 km/sec
- at the position of the autumnal equinox -23.09 - 231, 835 km/sec.

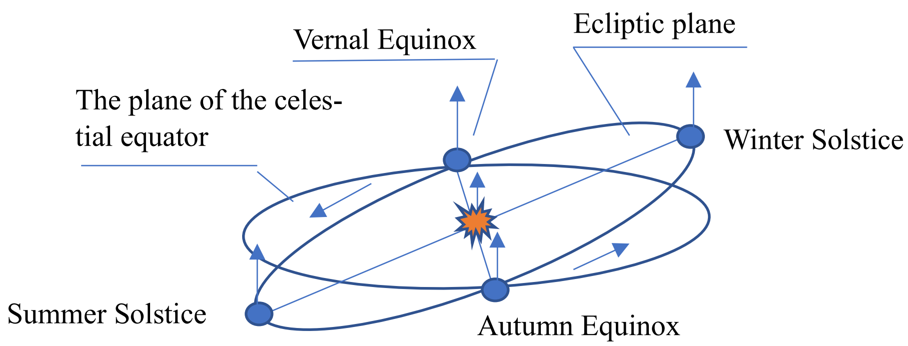

Figure 1

The Earth's velocity in the direction of planetary system motion (in the direction of the Sun's motion) decreases from the position of the winter solstice and increases from the position of the summer solstice. The plane of the celestial equator for an observer located at some distance from the solar system and stationary relative to the centre of the galaxy is placed passing through the centre of the Sun, parallel to the Earth's equator.

At the position of the autumn equinox, the speed of the Earth in the direction of motion of the planetary system, exceeds the speed of motion of the Sun by 11.835 km/sec. - equals 231.835 km/sec (The Sun's speed is 220 kilometres per second).

The rocket on the launching table during the autumn equinox moves together with the Earth relative to the Sun, in the direction of the Sun's motion (in the direction perpendicular to the plane of the celestial equator), with a speed of 11.835 km/sec.

Consequently, after switching on the engines, having accelerated to a speed of 11.183 km/s, relative to the Earth, the rocket will overcome the Earth's gravity and will move relative to the Sun (in perpendicular direction relative to the plane of the celestial equator) at a speed of about 23.018 km/s.

At the same time, the rocket (spacecraft) moves parallel to the Earth's orbit with a velocity of 30.0 km/s, Figure 2.

The calculation showed that the resulting speed of the rocket (spaceship) in orbit around the Sun will be 44.5 km/s. This is at a set speed relative to the launch table of 11.183 km/s. (It is still necessary to take into account the speed of rotation of the Earth around its axis).

Calculation of the speed of the spacecraft launched on the days of the autumn equinox, in the direction of motion of the planetary system. The calculation scheme is very simplified.

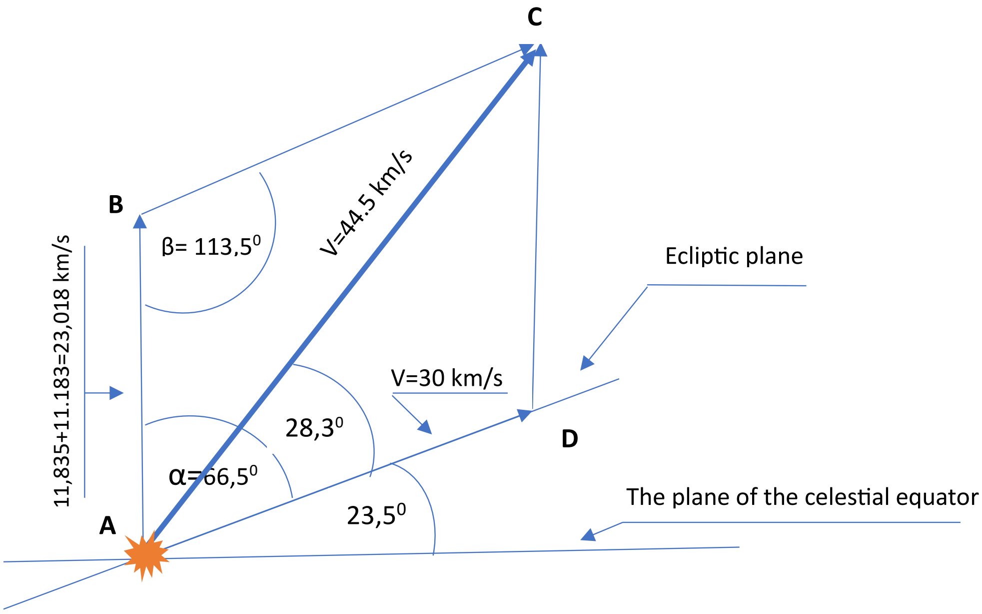

Figure 2

Calculation of the resulting velocity and direction of motion of the rocket (space probe) relative to the Sun is per-formed by the cosine theorem $(AC)_2$ =$(AB)_2$ + $(BC)_2$ – 2(AB+BC) *Cos β или =$(AB)_2$ + $(BC)_2$ + 2(AB+BC) *Cos α.

$$AC = \sqrt{a^2 + b^2 - 2ab * \cos\beta} = \sqrt{23{,}018^2 + 30^2 - 2 * 23.018 * 30 * \cos 113.5^0} = 44.503 \text{ km/s}$$

After a small correction, a rocket (spacecraft, probe, etc.) can be directed in any direction to any planet in the solar system and beyond in planes perpendicular (± N degrees) to the plane of the celestial equator (to the ecliptic plane), Figure 3.

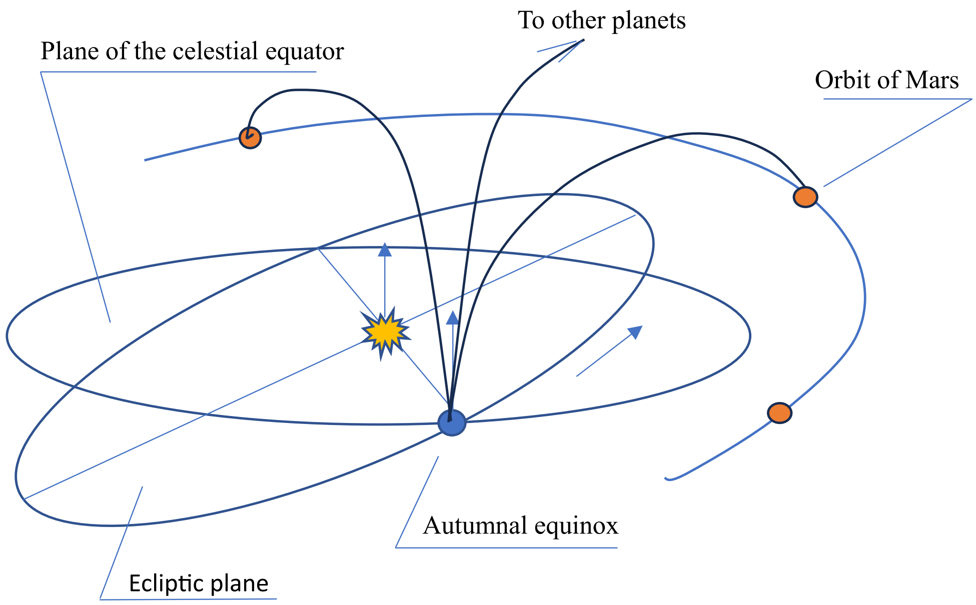

Figure 3

After a small correction, a rocket (spacecraft, probe, etc.) can be directed in the chosen direction to any planet in the solar system and beyond in planes perpendicular (± N degrees) to the plane of the celestial equator (to the ecliptic plane).

P.S.

1. A detailed calculation of the motion of the planets in the direction of motion of the planetary system (in the direction of motion of the Sun) is described in the article "Laws of Astronomy after I Kepler and I. Newton" - DOI 10.6084/m9.figshare.25218464 https://doi.org/10.6084/m9.figshare.25218464.v1

2. 2 The window for launching a spacecraft to Mars, to other planets (when the speed of the Earth's motion relative to the Sun in the perpendicular direction relative to the celestial equator is 10.0 km s and more) is open from 21 August to 25 October. After that, the Earth's speed relative to the Sun becomes less than 10.0 kilometers per second. The launch window may be extended.

3. The Earth's velocity in the direction of the Sun's motion (relative to the Sun) can be calculated through the Sun's (Earth's) ephemeris from published sources.

For example, for the autumn equinox (approx.)

Declination

23.09. ...d. δ= -0:02:50 Sinδ=0,0008241831646
B1=R*Sinδ=121,154.92519 km

24.09. ...d δ= -0:26:11 Sinδ=0.007616349293
B2=R*Sinδ=1,119,603.346071 km

B2 - B1 = 998,448.420881 km is the distance travelled by the Earth between the dates.

The distance travelled by the Earth is divided by the daily time 998,448.420881km : 86,400s = 11.556 km s

This is the speed of the Earth relative to the Sun in the perpendicular direction relative to the plane of the celestial equator.

Similarly, it is possible to calculate the speed of the Earth in the direction of planetary system motion (relative to the Sun) for the positions of the autumn equinox, winter and summer solstices.

To calculate the parameter "B", the distance R between the Earth and the Sun is assumed to be 147.0 million kilometers.