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RESONANT ORBIT FOR THE EXPANSION OF ACHIEVABLE LANDING AREAS ON THE VENUS SURFACE IN FRAMEWORK OF VENERA-D PROJECT

Abstract

The Venera-D project has the objective of studying the surface and atmosphere of Venus. The mission is planned to be launched in 2029. The spacecraft will include a lander and an orbital module. The descent vehicle will also include a long-lived (about 1 month) and short-lived (a few hours) science stations.

A noticeable part of the Venera-D mission is to identify areas on the Venus surface that would be reachable for landing. At first, we limited by the possibility of landing to only that points that would be accessible by the orbital position of Venus relative to the Earth. The dense atmosphere of Venus is also high-priority constraint. Due to the listed above factors ensuring landing accessibility of every point on the surface of Venus proves to be very difficult. Due to all these factors, the total area accessible for landing will be very small.

The easiest way to expand the accessible landing areas may simply consist of increasing the launch Δv budget required for flight to Venus. However, such possibilities are strongly restricted, primarily by the value of ΔV. The current study proposes a different way of choosing and reaching any point on the Venus surface. The launch of a spacecraft to Venus during the launch windows in 2029-2034 is considered for this purpose. The constraints for the method are the re-entry angle (or the maximum possible overload). The key-point of the proposed method is to use the Venus gravity field itself for transferring the spacecraft to

a resonant orbit to planet with return through one Venusian year. The direction of the spacecraft relative velocity would be changed during the gravity assist, due to that landing would occur into the different point on the Venus surface in the next close encounter the spacecraft with Venus. The total landing sites would increase, because Venus gravity field can provide a bunch of the different relative trajectories that would transfer the spacecraft onto resonant orbits. This method allows one to provide an access to any point on the surface of Venus, but the time of flight will be increased on the one Venusian year. Results of the research showed that the new strategy provides an essential extension of accessible landing areas and makes any point on Venus surface accessible with a small increasing ΔV for launch from the Earth and duration of the flight.