IAF SYMPOSIUM ON ONGOING AND NEAR FUTURE SPACE ASTRONOMY AND SOLAR-SYSTEM SCIENCE MISSIONS (A7)
Science Goals and Drivers for Future Exoplanet, Space Astronomy and Space Physics (2)

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USING L2 LAGRANGE POINT ORBIT TO STUDY VENUS AS AN EXOPLANET

Abstract

Venus exploration by spacecraft started in 1960s and has included flybys and orbiting missions, landing probes as well as floating balloons. The past missions to Venus have provided valuable information about its atmosphere and surface, but many important questions remain for lack of systematic or continuous observations. Being the most Earth-like planet, Venus observations also help to understand the divergent evolution of terrestrial planets. Current surface temperatures on Venus preclude presence of liquid water but likely had large lakes or oceans in its past and may have been the first habitable planet. The resent reports of phosphine gas in the atmosphere of Venus, and re-examination of past data, might indicate the potential presence of biological activity in the Venus clouds. Much about Venus and its clouds remains a puzzle, and there is significant interest in the astrobiological community to investigate Venus to understand it and thereby Venus-like exoplanets and their habitability. Most of the exoplanets found to date have been detected by transit observations, but observation from Earth of Venus transiting the Sun is a rare event, which occurs in the pattern of 105.5, 121.5 and 8-years gaps within 243 years cycle. This work focuses on investigation of potential of observing Venus as an exoplanet in transit more often from specially designed orbits. Locating a spacecraft in the L2 Lagrange point region of the Sun-Venus system might provide more frequent observations of the transit of Venus. The collinear L2 point is constantly located on the Sun-Venus line in about 1 million km from Venus. A suitable orbit can be designed to exploit the shadow zone and observe Venus against the solar disk. In addition, L2 region is an excellent location to continuously monitor the night hemispheres. Another advantage of the Lagrange point orbits is a low station-keeping cost, estimated about 1 m/s per year and allowing a long-lived mission. The analysis in this work includes a trade-off study of different L2 point orbit options, performed in the frame of the Circular Restricted Three-Body Problem using SEMpy package.