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Quasi-critical and quasi-heliosinchronous orbits

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Space missions exploring planetary satellites have been of great scientific interest. Currently scientific missions, especially reconnaissance, can benefit greatly from the use of certain natural orbits, including frozen and heliosynchronous ones. The main objective of this work is to revisit the concept of frozen orbits from a variational perspective, proposing an alternative method based on variational calculus, dynamic programming and optimal control to search for them. And, for a specific objective, apply the proposed method to find frozen orbits around natural satellites. In the present work the following hypotheses are considered: 1) perturbations due to the Sun and third bodies are not considered; 2) the distribution of the mass of the natural satellite is not uniform; 3) the orbit of the natural satellite around its primary is circular and uniform; 4) the equatorial plane is coincident with that of the ecliptic; 5) the natural satellite is gravitationally locked by tidal forces. The equations are put into Hamiltonian form and the Hamiltonian is put into normal form using Lie-Deprit transformations

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