Time and Energy analysis for the gravitational capture

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Gravitational capture is a phenomenon that happens when a particle coming from far away gets close to a planet, and due to the gravitational attraction, its trajectory is changed from hyperbolic to elliptic. Many authors demonstrated that this phenomenon is temporary, however in astrodynamics jets can be used to stabilize the trajectory and turn it into a permanent capture. This is benefic due to the low relative velocity which results in a low cost to change the elliptic trajectory to a circular one. In solar system dynamics the gravitational capture is studied to explain the existence of the irregular satellites of the gaseous planets. In this case some kind of perturbation is needed to change the temporality of the trajectory. In astrodynamics there are two relevant parameters, the orbital energy of the particle when it is in the position of the stabilization of the trajectory and the time needed to be in this position. The first parameter is a measure of the fuel saved when the trajectory is circularized, therefore the interesting value is the most negative one. The time need to be the lowest possible. This study covers the semi-major axis versus eccentricity space, with initial conditions chosen in the line of conjunction, measuring the time for the capture. The lowest values of the semi-major axis gives the most negatives values of the orbital energy, and this study shows that, in general, the region near the planet the time for the capture is long. But for the different values of the eccentricity the capture time suffers large variations. Therefore this results show that is possible to have a better time for the capture, depending on the eccentricity, with low energy, depending on the semi-major axis.