Debris dynamics under evection and inclination resonances

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The human activity in exploring the space has generated undesirable artificial debris. Unfortunately, the number of them is increasing so fast that a tremendous problem is arising. The natural and artificial debris are distributed in a very large range of altitude and according to the semi major axis of the orbit, the particle, may survive for very long time. For low altitude, less than 200 km, the life time of the particles is mostly dominated by the atmospheric drag, while for more distant debris, different disturbing forces should be considered, and the dynamics is slight more complicated. Although the maximum concentration of the debris is not at high altitude, the problem at high altitudes is important since the mitigation mechanism to clean these regions is very slow. Usually Poynting Robertson (P-R) effect and similar other forces are not efficient to remove rapidly the particles at high altitudes, in opposition to human activities which are always feeding more rapidly, almost any region of the space. Therefore, since the debris survive for very long time, it is important to increase our theoretical knowledge on the dynamics of these regions. In this work we show the existence of some important resonances which may give significant variations in the inclination and eccentricity of the particle. In the case of the Earth, they occur at about 10128.5 km and 12309.8 km and are related to a commensurability involving the mean longitude of the sun and the longitude of the node or the longitude of the perigee of the particle. In the case of capture in these resonances, the final effect is much more significant. We also show the role played by an interesting resonance due to solar evection. We obtained an analytical expression which predicts the location of this resonance in terms of the semi major axis of the particle: $a \approx 0.5 R_{Hill}$, where R_{Hill} is the usual Hill's distance. This time, in the libration regime, the eccentricity is strongly excited such the particle can be ejected from the system. However, in some cases the P-R effect wins the resonance: the particle escapes from the libration and the eccentricity ceases to increase. Then P-R effect dominates, driving the particle toward the planet. In other words we can say that P-R effect works in the sense to capture particles, preventing them to escape driving them to be debris of the planet. For other altitudes, in order to study the chaotic behaviour of the particles we are also studying the diffusion through the Hurst exponent.