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A Fast and Accurate Power Series Expansion Method to Compute the Probability of Collision for Short-term Space Encounters

We present a new method for computing the probability of collision between two spherical space objects involved in a short-term encounter under Gaussian-distributed uncertainty. In this model of conjunction, classical assumptions reduce the probability of collision to the integral of a two-dimensional Gaussian probability density function over a disk. We derive an analytic expression for the integral, in the form of a product between an exponential term and a convergent power series with positive coefficients. For this we use Laplace transform and algorithmic properties of D-finite functions (which are solutions of linear differential equations with polynomial coefficients). Moreover, rigorous analytic bounds on the truncation errors are also derived. This results in a reliable, accurate and efficient algorithm for the risk evaluation. This is a joint work with R. Serra, D. Arzelier, J.-B. Lasserre, A. Rondepierre and B. Salvy.