Prediction of imminent impactors: Manifold Of Variations methods

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The asteroid impact risk has recently been demonstrated by the Celyabinsk and 2014AA events. In cases, like the two mentioned before, it is important to know, even with very few observations, whether or not there is the possibility of an immediate impact with the Earth.

When such small asteroids are discovered, the confidence region resulting from preliminary orbit determination is not elongated in one direction, thus the Line Of Variations (LOV) is not representative of the entire region.

If we use for a short arc of observations the attributable elements $(A, \rho, \dot{\rho})$, where A is the attributable, the confidence region is a thin shell surrounding a subset of the Admissible Region (AR).

The **Manifold Of Variations** (MOV) is the set of the points S where the target function has a local minimum with respect to changes of A, for each fixed $(\rho, \dot{\rho})$, with minimum RMS of the residuals below some control Σ. When there is little information beyond A, S is parameterized by $(A(\rho, \dot{\rho}), \rho, \dot{\rho})$, defined on a subset B of the $(\rho, \dot{\rho})$ plane: B is an open set, not necessarily connected. Then the surface S can be computed point by point using a cobweb sampling (or a grid); then, each point could be used as Virtual Asteroid (VA) and propagated for some months in the future in order to have the trace of the cobweb (or grid) on the Target Plane (TP) of the immediate impact.

In this presentation we are going to

- define the MOV tool showing how it is used to predict imminent impactors;
- discuss how to assign a Probability Density Function (PDF) to the MOV: this is not a simple problem because we want to take into account the PDF for observations, but also some constraints deriving from population and physical models.

Moreover, we will address some examples using data from the NEOCP list of the Minor Planet Center (MPC).