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# Stability Analysis for Cellinoid Shape Model in Inverse Process from Lightcurves

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Based on the special shape first introduced by Alberto Cellino, which consists of eight ellipsoidal octants with the constraint that adjacent octants must have two identical semi-axes, an efficient algorithm to derive the physical parameters, such as the rotational period, spin axis, and overall shape from either lightcurves or sparse photometric data of asteroids, is developed by Lu et al.[1]. They call this model 'Cellinoid' shape model. Numerical applications confirm that the cellinoid shape model could derive the best-fit rotational period for the asteroid from several lightcurves observed in one apparition. Furthermore by exploiting more lightcurves observed in various viewing circumstances, the derived spin axis could be refined [2]. Additionally the cellinoid shape model is applied to the sparse Hipparcos data with the average number of measurements being of the order of 70 per object, similar to the future catalog of the ongoing space project, Gaia [3]. The derived rotational periods from 70 sparse measurements are accurate and the spin axes are close to the known results, derived from lightcurves by other methods. With only 3 more parameters than the traditional triaxial ellipsoid, the cellinoid shape model of having the asymmetric morphology could perform efficiently and simulate the real asteroids better. That could be employed for the huge number of photometric sparse data observed by Gaia in the coming future.

For thoroughly investigating the relationship between the morphology of the synthetic lightcurves generated by the cellinoid shape model and its six semi-axes, the numerical tests are implemented to compare the synthetic lightcurves generated by various cellinoid models. Furthermore, the sensitivity of the stable spin axis of cellinoid shape model with respect to its semi-axes is analyzed, too. These numerical tests provide important information for optimizing the aforementioned algorithm to search the physical parameters for asteroids based on the cellinoid shape model. Then the regularization tools and constraints could be added in the inverse algorithm to limit the parameter space for saving the computational cost and enhancing the stability of the algorithm.

References:
[1] Lu X.-P. et al.(2014) Earth,Moon and Planet. 112, 73-87
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[3] Lu X.-P. et al.(2016) Icarus. 267, 24-33