Retrieving ballistic parameters from the ray patterns of impact ejecta on the Moon; mainly that of the Tycho crater

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Introduction: Lunar ray patterns provide a test of our understanding of impact and ejecta mechanics.

Recent observations by LROC [1] has resulted in detailed normalized light (643 nm) reflectance maps of the entire Moon. These maps show that several of the impact craters anchor extensive ray fans which in some cases reaches across large distances (thousands of km). The prominence, in this respect, of the near side's Tycho crater triggered several earlier investigations including, two-body, ballistic simulations [2, 3]. The ejecta and reimpact dynamics are well understood in this approximation and may, if need arises, be supplemented by generalizations to those of "wandering" pole situations [4]; all such ballistics formulae can be conveniently manipulated [5].

Methods and Results: We use standard image analysis tools [6] in order to select sequences of locations within particular ray filaments. The resulting data set constitute one terminus of the, assumed, ballistic trajectory path. The other terminus, the initiation site, is allowed to attain a range of positions within the confines of the impact crater rim boundary. Fixing the value of the rotation rate of the Moon and the direction of its rotation axis will then determine a multidimensional parameter volume (i.e. intervals of time of flight, speed, and ranges of launching vector angles) for the Keplerian motion of the ejecta fragment. Proceeding in this fashion along a specific ray produces a family of distinct parameter volumes. We further process these parameter volumes by searching for maximum overlap between volumes associated with pairs of adjacent reimpact locations on the ray of interest. Various forms of likelyhood assignments can then be computed for the aggregated shape of the ejecta launching vectors. The Tycho crater ray setting is analyzed accordingly with an added emphasis on providing plausible scenarios for the discernment of launching parameter values allowing for antipodal reconnections.

The far side of the moon is repleat with craters anchoring distinct ray patches and among these we select some of the more clearly delineated for a launching parameter determination analogous to that performed on the Tycho ensemble. Common features are recognized and anisotrophies in ray pattern direction distributions are categorized.

References

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