SPACE DEBRIS SYMPOSIUM (A6)
Poster Session (P)

Author: Dr. Li Yiyong
Academy of Equipment, China, lyygod@163.com

Prof. Shen Huairong
China, shenhuair@tom.com
Prof. Li Zhi
China, lyygod@163.com
Dr. Wang Weijie
China, wwxljie@163.com

ERROR ANALYSIS AND REVISION OF SATELLITE COLLISION BREAKUP MODELS

Abstract

Satellite collision breakup model is the important foundation for studying satellite collision breakup problems. NASA collision breakup model is the most fashionable and important satellite collision breakup model today. Content and data-flow of the NASA model are described. Unfortunately, it is found that the model can not meet mass conservation law well. In lots of analysis and calculation, the calculated mass sum is often more than theory value. In the Case, calculation value is more 88.7% than theory value. The error sources are analyzed carefully, and they lie on size distribution and area-to-mass distribution of NASA collision breakup model. Model errors of large debris and small debris are studied based on respective data sources and modeling process, and reasons are discussed. For observable large orbit debris (commonly more than 10 cm), the effective cross-sectional area should be usually less than its average cross-sectional area. For small fragments (commonly less than centimeters), the calculated area-to-mass in NASA model is less than their practical values. Aiming at this problem, a revision method of NASA collision breakup model is presented based on the mass distribution of Battelle collision breakup model. The relations between mass and characteristic size of debris from collision breakup model are studied and discussed. The size distribution function, effective cross-section area function and area-to-mass distribution function of NASA collision breakup model are revised. The new **S**atellite **C**ollision **B**reakup **M**odel (SCBM) is derived by analyzing and comparing NASA model and Battelle model. The introduced coefficients, A and B, make size distribution function of SCBM is more applicable broadly. The size distribution of NASA model is only a special case of the SCBM function as $B = 0.75$. The coefficients, $k1$ and $k2$, are applied to calculate the effective cross-section area and area-to-mass ratio respectively. The verification case shows that the mean cumulative mass is 863.2 kg for ten times of seriate independent calculations, and only less 0.3% than the pre-event total mass (866 kg). So the new SCBM model obeys mass conservation law well. The new SCBM breakup model does not represent the final word on breakup models, but it is an important evolutionary step towards increasing the fidelity and accuracy of breakup models. Research continues on improving those sections of the model by various methods.