航空学报 » 2011, Vol. 32 » Issue (3) :390-399 DOI: CNKI:11-1929/V.20101229.1628.004

空间碎片再入烧蚀预测与地面安全评估软件系统

胡锐锋[1], 吴子牛[1], 曲溪[2], 王翔[2]
1. 清华大学 航天航空学院, 北京 100084
2. 中国空间技术研究院, 北京 100094

Debris Reentry and Ablation Prediction and Ground Risk Assessment Software System

HU Ruifeng[1], WU Ziniu[1], QU Xi[2], WANG Xiang[2]
1. School of Aerospace, Tsinghua University, Beijing 100084, China;
2. China Academy of Space Technology, Beijing 100094, China

摘要 参考文献 相关文章

Download: PDF (1703KB) HTML 1KB Export: BibTeX or EndNote (RIS) Supporting Info

摘要 再入航天器解体产生的空间碎片在高速气体加热作用下发生烧蚀,残存碎片对地面造成很大威胁。开发空间碎片再入烧蚀预测与地面安全评估软件系统(DRAPS),建立碎片三自由度(3DOF)弹道模型,在连续流、自由分子流和过渡区流分别采用牛顿流模型、无碰撞分子动理论和桥函数方法进行碎片气动力/气动热预测,利用零维或一维热传导模型模拟材料烧蚀过程,在高度准则基础上建立考虑烧蚀效应的多种解体模型,形成航天器/碎片再入烧蚀预测与仿真分析界面化软件。研究结果表明:软件预测能力和预测结果与国外类似软件基本相同,该软件能用于更多复杂的碎片外形,并提供更具物理意义的解体模型。

关键词: 空间碎片 再入 烧蚀 风险评估 评估软件系统

Abstract: Debris generated by spacecraft breakup enters the atmosphere with ablation due to hypersonic aerodynamic heating. The survived fragments would pose great risks to the ground and people. This study aims at developing a debris reentry and ablation prediction system (DRAPS) for rapid prediction of spacecraft and debris reentry and ablation. A three degree of freedom (3DOF) ballistic model is used for predicting the spacecraft and debris trajectories. The Newtonian flow theory, collisionless molecular kinetic theory and bridging method are adopted respectively for aerodynamic and aerothermodynamic prediction in the hypersonic continuum flow region, the free molecular flow region and the transitional flow region. A zero or one dimensional heat conduction model is established for ablation analysis, and several breakup models are built concerning the ablation effect. The capability and accuracy of the current software are similar to other existing debris reentry prediction tools. However, the present tool integrates more physical breakup models and can be used for debris with more complex shapes.

Keywords: space debris reentry ablation risk assessment assessment software system

Received 2010-06-11;

About author: 胡锐锋(1984-) 男,博士研究生。主要研究方向:空气动力学。 Tel: 010-62773794 E-mail: hudf03@mails.thu.edu.cn 吴子牛(1963-) 男,博士,教授,博士生导师。主要研究方向:空气动力学。 Tel: 010-62784116 E-mail: ziniuwu@tsinghua.edu.cn 曲溪(1982-) 女,硕士,工程师。主要研究方向:飞行器总体设计。 Tel: 010-68744810 E-mail: zhaikun@tsinghua.edu.cn 王翔(1973-) 男,博士,高级工程师。主要研究方向:飞行器总体设计。 Tel: 010-68747316 E-mail: wangxiang0223@gmail.com

Service
把本文推荐给朋友
加入我的书架
加入引用管理器
Email Alert
RSS
作者相关文章

引用本文:
胡锐锋, 吴子牛, 曲溪, 王翔. 空间碎片再入烧蚀预测与地面安全评估软件系统[J]. 航空学报, 2011, 32(3): 390-399.

HU Ruifeng, WU Ziniu, QU Xi, WANG Xiang. Debris Reentry and Ablation Prediction and Ground Risk Assessment Software System[J]. Acta Aeronautica et Astronautica Sinica, 2011, 32(3): 390-399.