空间物理学★大气物理学

# 太阳风在地球激波前兆区减速的统计研究

符慧山[1,2],曹晋滨[1],张铁龙[1,3],H. Reme[4],E. Lucek[5]

1 中国科学院空间天气学国家重点实验室, 北京  100080
2 中国科学院研究生院, 北京  100049
3 Space Research Institute, Austrian Academy of Sciences, 8042 Graz, Austria
4 Centre d'Etude Spatiale des Rayonnements, 31028, Toulouse, France
5 The Blackett Laboratory, Imperial College, London, SW7 2BZ, United Kingdom

摘要　本文首次利用完全相同两颗卫星（CLUSTER C1和C3）的数据对地球激波前兆区太阳风的减速和偏转特性进行了统计研究.结果表明, 在激波前兆坐标系中, 太阳风减小的速度随观测点到激波的距离$D_{BS}$增大而减小, 随行星际磁场与激波法向夹角$\theta_{BN}$增大也减小, 在ULF波动区深度$D_{WS}$小于$6R_e$($R_e$为地球半径)的范围内最为显著; 伴随着太阳风减速的另外一个现象——太阳风的偏转, 也存在相似的规律.其最大减速和最大偏转角度分别为10 km/s和3°.太阳风减速和偏转, 以及随之变化的太阳风动压, 可能会引起地球磁层顶位置和形状发生改变, 同时也为激波前兆区弥散（diffuse）离子的起源及加热提供了一种可能的机制.

关键词　相同卫星　太阳风减速　太阳风偏转　激波前兆坐标系
分类号　P353

DOI:  10.3969/j.issn.0001-5733.2009.04.005

## Statistical study of the solar wind deceleration in the Earth's foreshock region

FU Hui-Shan[1,2], CAO Jin-Bin[1], ZHANG Tie-Long[1,3], H. Reme[4], E. Lucek[5]

1 State Key Laboratory of Space Weather, Chinese Academy of Sciences, Beijing 100080, China
2 Graduate University of the Chinese Academy of Sciences, Beijing 100049, China
3 Space Research Institute, Austrian Academy of Sciences, 8042 Graz, Austria
4 Centre d'Etude Spatiale des Rayonnements, 31028, Toulouse, France
5 The Blackett Laboratory, Imperial College, London, SW7 2BZ, United Kingdom

**Abstract** The data from two same satellites (CLUSTER C1 and C3) were used to make a statistical study of the solar wind deceleration and deflection in the Earth's foreshock region for the first time. In the foreshock coordinates, the magnitude of deceleration is inversely proportional to $D_{BS}$ measuring the distance between the satellite and the bow shock along the interplanet magnetic field (IMF), and also inversely proportional to $\theta_{BN}$ （the angle between the IMF and the bow shock normal）. The decelerations mainly occur when $D_{WS}$ (the distance from satellite to the ULF wave boundary along $X$ direction) is less than $6R_e$. On the other hand, the solar wind deflection, displays a similar feature. The largest values of deceleration and deflection are, respectively, estimated as 10 km/s and 3°. These decelerations and deflections not only lead to a variation of the magnetopause's position and shape, but also supplies a possible generation mechanism of the diffuse ions in the foreshock region.

**Key words**  Same satellites; Solar wind deceleration; Solar wind deflection; Foreshock coordinates

通讯作者:
符慧山 hsfu@spaceweather.ac.cn
作者个人主页: 符慧山[1;2];曹晋滨[1];张铁龙[1;3];H. Reme[4];E. Lucek[5]