ICS 49.140
CCS V06

NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

GB/T 42214-2022

Space environment - Model of high energy radiation at low altitudes (300 km - 600 km)

空间环境 低高度（300km～600 km）高能辐射模型

Issued on: December 30, 2022 **Implemented on: July 1, 2023**

**Issued by: State Administration for Market Regulation;
Standardization Administration of the PRC**

Table of Contents

Foreword

This document was issued on 30 December 2022 by the State Administration for Market Regulation; Standardization Administration of the PRC and takes effect on 1 July 2023.

It is a GB/T standard: recommended rather than compulsory, but it is the text a Chinese reviewer applies when assessing a submission.

It is classified under ICS 49.140, Chinese classification V06.

This document is in accordance with the provisions of GB/T 1.1-2020 "Guidelines for Standardization Work Part 1.Structure and Drafting Rules for Standardization Documents"

drafting.

This document is modified to adopt ISO 17761.2015 "Space Environment (Natural and Artificial) Low Altitude (300km~600km) High Energy Radiation

Model".

Compared with ISO 17761.2015, this document has made the following structural adjustments.

--- Added the chapter "Normative References";

---Chapter 3 corresponds to Chapter 2 in ISO 17761.2015, where 3.1~3.5 corresponds to 2.1~2.5 of ISO 17761.2015, add

Added 3.6, 3.7.

The technical differences between this document and ISO 17761.2015 and their reasons are as follows.

--- Increase the expression of positrons and electrons and their energy ranges (see Chapter 1) to improve the accuracy of the use of this document;

--- Changed the term "cut-off stiffness" to "geomagnetic cut-off stiffness" (see 3.3);

--- Changed the definition of "geomagnetic coordinate system L and B" (see 3.4);

--- The terms "positron" (see 3.6) and "flux" (see 3.7) have been added to facilitate the understanding and use of this document;

--- Increased the provisions of the energy range of positrons and electrons (see Chapter 4).

The following editorial changes have been made to this document.

--- In order to coordinate with existing standards, change the name of the standard to "Space Environment Low Altitude (300km~600km) High Energy Radiation Model";

--- Changed the flux symbol (see Chapter 4 and Appendix A) to make the context consistent;

--- Replaced ISO 15390 with the informative referenced GB/T 37834 (see Chapter 4);

--- Changed the unit representation of differential flux (see Appendix A) to comply with industry practice;

--- Changed some error values in the headers in Table A.1 and Table A.2.

Please note that some contents of this document may refer to patents. The issuing agency of this document assumes no responsibility for identifying patents.

This document was proposed by the Chinese Academy of Sciences.

This document is under the jurisdiction of the National Aerospace Technology and Its Application Standardization Technical Committee (SAC/TC425).

This document is drafted by. Beijing Institute of Satellite Environmental Engineering, Shenzhen Xingdi Twin Technology Co., Ltd., Harbin Institute of Technology (Shenzhen),

Beijing Aircraft Overall Design Department, National Space Science Center of Chinese Academy of Sciences, Harbin Institute of Technology, Tianjin Binhai New Area Microelectronics Research

Institute, China Aerospace Standardization Institute.

The main drafters of this document. Shen Zicai, Hu Yanqi, Yu Lantao, Wang Shijin, Ji Qizheng, Li Xingji, Liu Xiaoning, Zhao Yu, Feng Xueshang,

Li Changhong, Wang Xinyue, Zhong Qiuzhen, Bi Jinshun, Chen Dong, Xu Dongyan, Zuo Pingbing, Yang Jianqun, Ge Lili, Peng Yuchuan, Liu Wei.

Introduction

This document is used to estimate the flux of energetic charged particles at low altitudes (300km~600km) in the Earth's magnetosphere.

The high-energy galactic cosmic rays[2] incident on the earth interact with the atmosphere to produce various secondary components, mainly including electrons, protons, neutrons and gamma.

Horse rays, in which charged particles will move along a certain trajectory under the action of the geomagnetic field [4]. A large number of secondary charged particles have a stiffness less than

The geomagnetic cut-off rigidity can only move toward the outer space along the earth's magnetic force line[3], reaching the height of the satellite orbit and forming high-energy particle radiation around the earth

bring. Some of the secondary protons are directly captured by the geomagnetic field to form the inner radiation belt, and these protons with energies greater than tens of MeV mainly come from

The beta decay of albedo neutrons is the so-called "cosmic ray albedo neutron decay" (CRAND) mechanism. Based on the above mechanism, there is space in the Earth's equator

In a ring-shaped high-energy particle radiation belt, that is, the Earth's radiation belt. Due to the offset of the geomagnetic dipole axis relative to the center of the earth, the

Trapped particles can be observed at a low altitude of about 300km in the Western Anomaly Area (SAA).

Based on observational data from the mid-1960s to the early 1970s, the AP-8 model of the United States gives the Earth-captured proton

Radiation model [5]. Later, based on the Combined Release and Radiation Effects Satellite (CRRES), the Solar Anomaly and the Magnetosphere Particle Explorer/(Proton/Electron

Sub) Telescope (SAMPEX/PET) and the NOAA/T IROS series

The radiation environment model of low earth orbit (LEO) has been improved[6]~[8], which can be used to estimate the energies below about 100MeV.

Some of these models take into account the long-term variation of the geomagnetic field and the drift of the South Atlantic Anomaly (SAA) [9].

The European Payload for Matter/Antimatter Exploration and Light Nuclear Astrophysics Research (PAMELA) mission to LEO high energy (energy approx.

100 MeV and above) cosmic rays have been measured more accurately[10], the model described in this paper is based on the measurement data of PAMELA (including

Contains trapped particles and reflective particles).

Space environment Low altitude (300km~600km)

high energy radiation model

1 Scope

GB/T 42214-2022 gives a model of the energetic charged particle environment in near-Earth space at low altitudes, between 300 km and 600 km, built on in-orbit measurements from the PAMELA instrument. It covers protons with energy above 100 MeV up to the geomagnetic cut-off rigidity, and electrons and positrons at 70 MeV and above up to that same cut-off. The clauses settle the terms, among them the IGRF geomagnetic field model the geometry depends on, and the general concepts and conventions in which the model is stated; an informative annex carries the tables of differential proton and electron flux. It is a modified adoption of ISO 17761:2015. A model for this band exists on its own because the flux there is not the trapped radiation belts alone: cosmic rays striking the atmosphere produce secondary charged particles that travel along the geomagnetic field, so what a spacecraft meets depends on where it is over the Earth as much as on how high it is. Designers use figures of this kind to size shielding, estimate upset rates in electronics, and work out dose to onboard detectors. Written for spacecraft and payload designers and for the space environment analysts supporting them.

This document describes the charged particle flux in near-Earth space based on PAMELA in-orbit measurements.

This document applies to protons with energy greater than 100 MeV to the geomagnetic cut-off stiffness at low altitudes (300km~600km), as well as energy

Flux calculations of electrons and positrons greater than or equal to 70 MeV to the geomagnetic cutoff stiffness and used to determine the impact of energetic charged particles on spacecraft

Effects on equipment or astronauts.

2 Normative references

This document has no normative references.

3 Terms and Definitions

The following terms and definitions apply to this document.

3.1

IGRF modelIGRFmodel

The geomagnetic reference field represented by a series of spherical harmonics.

Note. The International Association for Geomagnetism and Aerophysics (IAGA) is responsible for the development and revision of the IGRF model, and releases the coefficients every five years.