ORAL presentation

Dose-Effects Models for Space Radiobiology: An Overview on Central Nervous System Dose-Effect Relationship

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Abstract

Space radiobiology is an interdisciplinary science that examines the biological effects of ionizing radiation on humans involved in aerospace missions. The dose-effect models are one of the relevant topics of space radiobiology. Their knowledge is crucial for optimizing radioprotection strategies, the risk assessment of the health hazard related to human space exploration, and reducing damages induced to astronauts from galactic cosmic radiation. Dose-effect relationships describe the observed damages to normal tissues or cancer induction during and after space flights. They are developed for the various dose ranges and radiation qualities characterizing the actual and the forecast space missions.

Based on a Pubmed search including 53 papers reporting the collected dose-effect relationships after space missions or in ground simulations, 7 significant dose-effect relationships (e.g., eye flashes, cataract, central nervous systems, cardiovascular disease, cancer, chromosomal aberrations, and biomarkers) have been identified.

For each considered effect, the absorbed dose thresholds and the uncertainties/limitations of the developed relationships are summarized and discussed. The current knowledge on this topic can benefit from further in vitro and in vivo radiobiological studies, an accurate characterization of the quality of space radiation, and the numerous experimental dose-effects data derived from the experience in the clinical use of ionizing radiation for diagnostic or treatments with doses like those foreseen for the future space missions.

The growing number of pooled studies could improve the prediction ability of dose-effect relationships for space exposure and reduce their uncertainty level. Novel research in the field is of paramount importance to reduce damages to astronauts from cosmic radiation before Beyond Low Earth Orbit exploration in the next future. The study aims at providing an overview of the published dose-effect relationships with a particular emphasis on the central nervous systems effects and illustrates novel perspectives to inspire future research.

Keywords: Central Nervous System, Space Radiobiology, Space Radiation, Cosmic Ray, Human Space Exploration

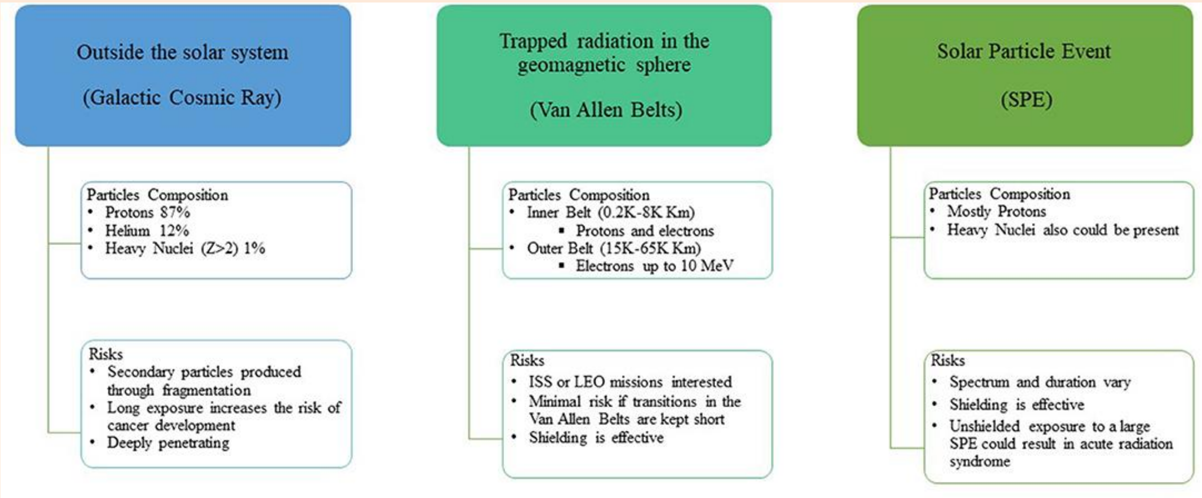

Figure 1. Scheme of the origin of space radiation particles and consequent risk.

Model	Study type	Dose range/threshold or LET	Reference	Reliability	Priority
Eye flashes	Spaceflight	LET> 5–10 keV/μm	(7–10)	****	*
Cataract	Spaceflight	8 mSv	(11–15)	***	***
CNS	Ground/Simulation	100–200 mGy	(16–27)	**	*****
CVD	Spaceflight	1000 mGy	(28–31)	*	***
	Ground/Simulation	(0.1–4,500) mSv	(32–39)		
Cancer	Spaceflight	<100 mGy	(40, 41)	***	*****
	Ground/Simulation	<100 mGy	(42–50)		
Biomarkers or	Spaceflight	5–150 mGy	(51–61)	***	*****
Chromosomal aberrations	Ground/Simulation	<10,000 mGy	(62–65)		
Other Risks	Ground/Simulation	~2,000 mGy	(66, 67)	*	***

** = Very Low, ** = Low, *** = Medium, **** = High, ***** = Very High.*

Table 1. Dose-effect relationship for space radiation risk assessment.

Recent Publications:

- Strigari L, Strolin S, Morganti A G, Bartoloni A. (2021) Dose-Effects Models for Space Radiobiology: An Overview on Dose-Effect Relationships. Front Public Health. 2021 Nov 8;9:733337. doi: 10.3389/fpubh.2021.733337. PMID: 34820349; PMCID: PMC8606590.

- Aguilar M. et al. (2021) The Alpha Magnetic Spectrometer (AMS) on the international space station: Part II Results from the first seven years, Phys.Rept. 894, 1-116, DOI: 10.1016/j.physrep.2020.09.003

- Aguilar M, et al. (2021) Properties of Iron Primary Cosmic Rays: Results from Alpha Magnetic Spectrometer, Jan 29, 2021, Published in: Phys.Rev.Lett. 126 8, 081102, DOI:10.1103/PhysRevLett.126.041104

- Aguilar M, et al. (2021) Properties of heavy Secondary Fluorine Cosmic Rays: Results from Alpha Magnetic Spectrometer, Jan 29, 2021, Published in: Phys.Rev.Lett. 126 (2021 4, 041104, DOI:10.1103/PhysRevLett.126.081102

Biography

After the MD in Electronics Engineering, I joined the **Italian Institute of Nuclear Physics** (INFN) in 1992, working in the Rome division on developing supercomputers for theoretical physics numerical simulations.

Later as a User Associate at the European Organization for Nuclear Research (CERN), I took part in the construction of the Compact Muon Solenoid (CMS) detector at the Large Hadron Collider (LHC). In 2012 CMS was one of the experiments that observed a new particle consistent with the predicted Higgs boson.

For several years (1999-2011), I was a Lecturer at the Faculty of Engineering at the Sapienza University of Rome, responsible for courses on a computer science subject.

Since 2000 I have been in the Alpha Magnetic Spectrometer collaboration (AMS) (http://ams02.space). AMS02 is a state-of-the-art particle physics detector operating on the International Space Station.

My actual principal fields of interest are Cosmic Rays' Physics, Space Radiation Science, and Space Radiobiology.

Presenting Author Details and Photo

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