

Short Commentary

Apollo Flights and the Hazards of Radiation

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Abstract

This correspondence inspired by recent NASA plans for two astronauts to spend 6.5 days on the moon-reviews the radiation effects upon the Apollo astronauts who traveled to the moon and back from 1969 to 1972. In its 2001 report, "Safe Passage/Astronaut Care for Exploration Missions", the Institute of Medicine described the Van Allen radiation belt and solar storms as crucial sources of radiation.

The available biological data indicates that aluminum alloy structures may generate inherently unhealthy internal spacecraft environments in the thickness range for space applications and aluminum cannot provide effective shielding against Gamma or neutron rays. In essence scientific observations suggest deep space is radioactive and incompatible with normal health without effective protection against radiation and the Apollo astronauts did not have sufficient protection. The radiation readings for the Apollo 11 astronauts' skin of 0.18 rad, significantly, did not differ from radiation readings from missions restricted to low earth orbit and none of the Apollo astronauts developed cancer, died prematurely or showed ill effects from radiation.

Furthermore, these medical inconsistencies seem to highlight the surprising observations that the Apollo 11 astronauts did not show any signs of space sickness from microgravity upon their return to earth on July 24th 1969. It would be most helpful, ethical and medically necessary for NASA to provide scientifically valid explanations about the medical inconsistencies regarding the Apollo flights before future manned missions into deep space.

Introduction

Recent NASA plans for two astronauts to spend 6.5 days on the moon highlight the challenges regarding health hazards in space

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Citation: Salerian AJ (2021) Apollo Flights and the Hazards of Radiation. J Phys Med Rehabil Disabil 7: 061.

Received: January 29, 2021; Accepted: February 05, 2021; Published: February 12, 2021

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identified by the Institute of Medicine's report, (2001): In its 2001 report, "Safe Passage/Astronaut Care for Exploration Missions", the Institute of Medicine described the Van Allen radiation belt and solar storms as crucial sources of radiation and reconfirmed that health hazards remained unsolved for manned flights to deep space [1]. To date only the Apollo astronauts have traveled into deep space and walked on the moon [1]. It is true that deep space radiation and radiation safety have been crucial topics of interest for any future manned flights to the moon and beyond. This essay attempts to answer the following questions: what have we learned about radiation hazards during the historic flights to the moon in? How can future astronauts traveling to the moon be better protected from the hazards of radiation?

Is deep space radioactive?

In 1959, Van Allen wrote in Scientific American: So far, the most interesting and least expected result of the men's exploration of the immediate vicinity of the earth is the discovery that there are regions of high energy radiation extending many thousands of miles into space. The discovery is of course troubling to astronauts; somehow the human body will have to be shielded from this radiation even on a rapid transit through the region. In its 2001 report, "Safe Passage/Astronaut Care for Exploration Missions", the Institute of Medicine described the Van Allen radiation belt and Solar storms as crucial sources of radiation and reconfirmed that health hazards remained unsolved for manned flights to deep space [2]. Radiation exposure is perhaps an even greater risk from travel beyond Earth's orbit. Little is presently known about the interaction with this none ionizing form of radiation and DNA, cells and tissues of astronauts. There is no data on the effects of terrestrial exposure to such protons and high atomic number high energy particles that flood space beyond Earth orbit.

How were the Apollo Astronauts Protected Against Radiation?

Prior to the manned missions to the moon in 1969, there had been no previous travels to deep space of using animal subjects as experiments to scientifically evaluate radiation dangers [3]. The Apollo 11 capsule's aluminum shielding amounted to a wall of lead about 7 mm thick [4]. These space suits did not contain lead, the standard material used to protect patients receiving X-rays. Instead of lead, which is very dense and therefore resistant to motion, different materials--Aluminum, Titanium and Teflon, specifically--were the primary materials used in space suits to protect astronauts against radiation .But Aluminum cannot provide effective shielding against Gamma or neutron rays [5]. The available biological data indicates that aluminum alloy structures may generate inherently unhealthy internal spacecraft environments in the thickness range for space applications [6]. In summary, scientific evidence suggests that health related challenges of travel into deep space remain unsolved and render manned flights to the moon and beyond impossible.

How much exposure to radiation did the Apollo 11 crew receive?

The Apollo 11 crews were exposed to 1.67 mSv per second as they crossed the Van Allen radiation belt (Figure 1) [7]. This amounts to a total exposure of 1.8 Sv in 3 hours of travel through the radiation belt during the mission. Any exposure to 1 Sv or more, however, brings about fatal injuries [8]. The radiation readings for the Apollo 11 astronauts' skin of 0.18 rad, significantly, did not differ from radiation readings from missions restricted to low earth orbit [4].

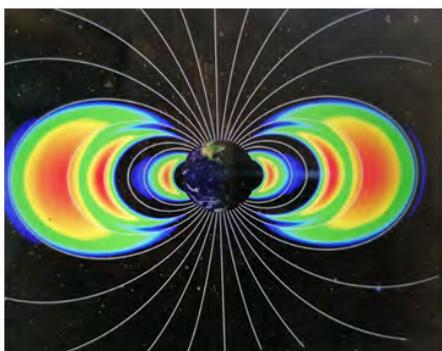


Figure 1: Van Allen Belt.

Did the Apollo crew experience radiation-related ill effects?

None of the three astronauts developed cancer, died prematurely or showed ill effects from radiation.

Discussion

Flights into deep space present serious hazards to astronaut health from exposure to radiation. Scientific data suggests that the Apollo 11 astronauts were not sufficiently protected against radiation: Neither the spaceship nor the spacesuits contained lead.

Aluminum is ineffective against gamma and neutron rays. The calculated exposure to of the Apollo crew was 1.8 Sv, an amount of associated with nausea, vomiting, bone marrow changes and 20% mortality. Surprisingly no Apollo astronaut showed any ill effects from radiation exposure. These inconsistencies seem to reflect either possible over-estimation or under-reporting of the health hazards summarized in *Safe Passage*. Furthermore, these medical inconsistencies seem to highlight the surprising observations that the Apollo 11 astronauts did not show any signs of space sickness from microgravity upon their return to earth on July 24th 1969 [9].

It would be most helpful, ethical and medically necessary for NASA to provide scientifically valid explanations about the medical inconsistencies regarding the Apollo flights before future manned missions into deep space.

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