Radiation and the Space Environment

Overview, Basics and Measurement Challenges

ASTROWRIGHT radiation dosimetry

INTRODUCTION

The presence of radiation is common in the natural world. Igneous rocks, plants, and even human bodies regularly produce it, which in most cases does not pose a health threat. In fact, naturally-occurring sources of radiation are regularly and safely mined as a natural resource.

As a by-product of the processes that cause stars to shine, the presence of radiation is even more common in space. However, beyond the protection normally provided by the Earth's atmosphere, spaceflight participants will be at risk of increased radiation exposure.

IS SPACE RADIATION SAFE?

Because spacesuits, spacecraft walls, and even human skin serves as an effective barrier for many types of radiation, of primary concern to spaceflight participants are only the more penetrating, high-energy forms of radiation.

Like continued sunburns or prolonged exposure to gasoline fumes, increased exposure to high-energy space radiation can increase a person's risk of negative health side-effects later on in life. However, the human body's natural repair mechanisms are perfectly capable of repairing the effects of small doses and should be no cause for alarm.

It is only the event of an unexpected larger dose, (like that possible from a solar storm,) that may lead to more immediate or more severe undesirable health effects. For these reasons, any spaceflight participant would be wise to know his or her radiation exposure during flight.

WHAT IS RADIATION?

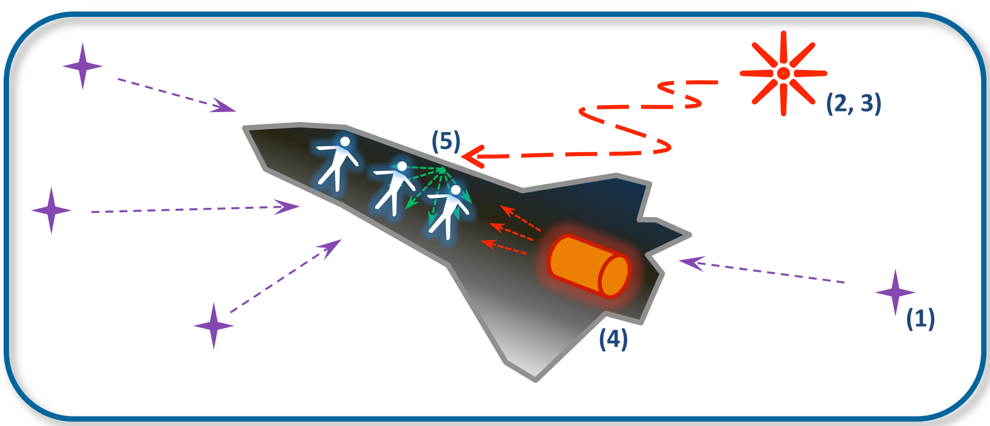
Radioactive elements are elements that are **structurally unstable**, and they emit particles and energy in order to return to a more stable state. Together, these particles and rays of energy represent what we collectively call, "radiation."

RADIATION TYPES

The types of energy and particles "radiated" away from unstable elements come in six primary types: **x-rays** and **gamma rays**, which are invisible forms of light; **alpha particles**, which are identical to the nucleus of a helium atom; **beta particles**, which is another name for electrons; **neutrons** and **protons**, which are nuclear particles, and **heavy charged particles** (HCPs), which are larger "chunks" of atoms or whole atoms themselves commonly found and produced in space environments.

WHERE DOES SPACE RADIATION COME FROM?

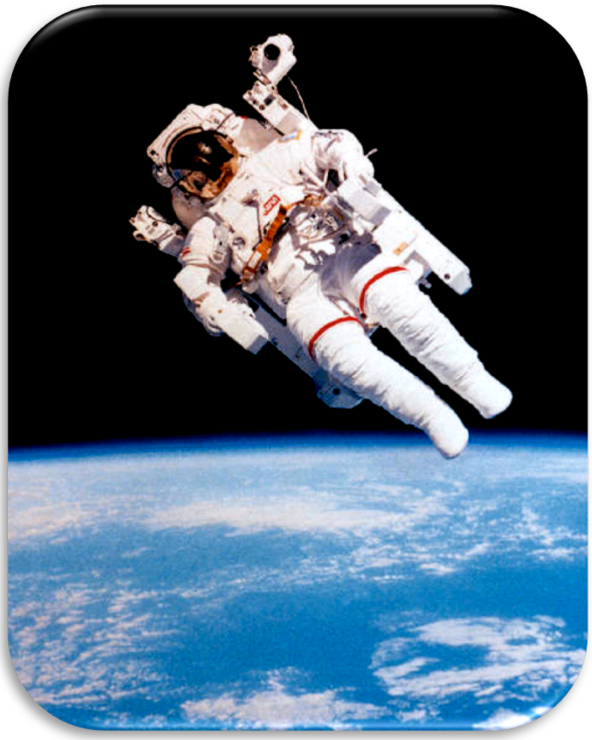
The radiation encountered in space comes from five primary sources: 1) **Galactic Cosmic Rays** (GCRs), which comes from other stars in the galaxy; 2) **solar protons** from nuclear fusion powering our own star, the Sun; 3) particles from **solar storms**; 4) radiation from man-made **space power or propulsion systems**; and 5) **secondary radiation** from a spacecraft's own materials responding to radiation.



SPACE RADIATION AND ASTRONAUTS

Spaceflight is still relatively new to human experience. In truth, fewer than 600 people have traveled to space, and only a fraction of them were there for more than a week at a time. However, several observations made during these pioneering trips hint at the possible effects of exposure to space radiation on the human body.

LIGHT "FLASHES"



During space travel, you may experience what many astronauts have described as flashes of light or "stars." These flashes are not real.

In truth, these flashes are generated as a result of radiation striking your retina and producing a false signal, which your brain interprets as light. As one might imagine, this is not necessarily good for your eyes. (Knowing this, it is worth considering that of the 39 astronauts who have developed cataracts after flying in space, 36 of them flew on higher-radiation missions.)

BIOLOGICAL EFFECTS

Quantitatively, the effects of GCRs and other high-energy radiation on space participants is poorly known. However, the damage to DNA that high-energy radiation is known to cause may increase the risk of developing cancer, cataracts, or neurological disorders later on in life.

Consequently, knowledge of how much radiation you receive during your flight can help to determine what your increased risk of negative health effects may be.

THE PROBLEM OF SPACECRAFT ORIENTATION

One of the difficulties in establishing radiation exposure "norms" for a given spacecraft relates to so-called "secondary" radiation. **Secondary radiation** is generated as a result of interaction with external radiation [solar, GCRs] and is beamed into the spacecraft's interior by the craft's walls, (shown in the below diagrams in green.) This radiation is not constant, however, and **changes as the spacecraft changes angle** with respect to the radiation source.

The complexity of the situation increases dramatically when more than one external radiation source is involved, which is typically the case.

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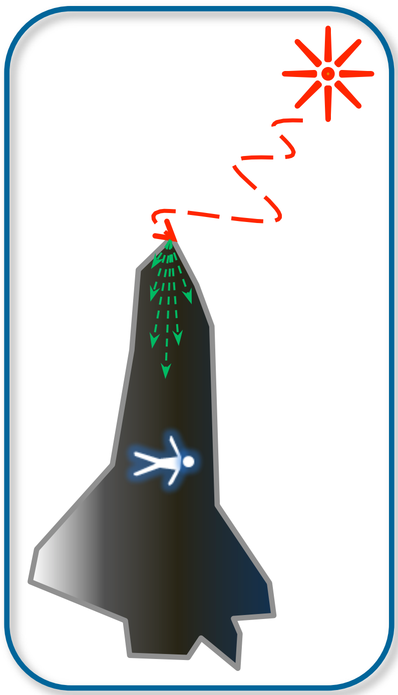

DETERMINING EXPOSURE

Because of the problem of secondary radiation, it is not economical or reliable for spacecraft providers to record the radiation dose in every area of a spacecraft for every flight. Doing so requires extensive instrumentation and simultaneous tracking of all passengers' locations within the craft, followed by intensive calculations to estimate the total radiation exposure for each individual.

Instead, wearable dose-measurement instruments, called **dosimeters**, are a much more space, weight, cost, and labor-efficient solution. Because they go wherever you go, **wearable dosimeters automatically record changes in the radiation you receive as conditions change,** from solar storms to spacecraft orientation.

GOVERNMENT DOSIMETRY

Government space agencies typically determines astronauts' radiation dose using large, centralized, power-hungry dosimeters that are linked to the spacecraft systems. These devices measure a *representative* ambient radiation environment for all aboard.

However, these determinations involve copious processing and can be uncertain or unreliable as passengers move about or in a craft that frequently changes orientation, such as on a sub-orbital flight. Further, dosimetry aboard government-funded flights is a service provided on a per-spaceflight basis, not per-passenger basis, which is a cost not typically borne by private spaceflight providers.

ASTROWRIGHT SPACEFLIGHT DOSIMETRY

Because wearable, individual spaceflight dosimetry is an extraordinarily new venture for non-governmental entities, we are in a unique position to leverage the latest in nuclear worker technology for private spaceflight, including state-of-the-art advances in solid state electronic and thermo/opto-luminescent dosimeters that are designed to be worn comfortably and inconspicuously by individuals.

While there are limitations with respect to the range of energy these wearable, low-power dosimeters may detect, a portable, wearable solution is a must-have for those who wish to obtain a truly personalized indication of the radiation you experienced during your spaceflight experience.

All Astrowright dosimeter solutions include a personalized dose estimate report. This report, in addition to breaking down your dosimeter results in an easy-to-understand format that relates your spaceflight dose to "normal," day-to-day exposures, also includes an analysis detailing the solar and geomagnetic activity during your flight.

WHAT TYPE OF DOSIMETER DO I WANT?

Astrowright offers two primary types of dosimeters, which each measure a different type of radiation and carry different advantages and disadvantages. **Active dosimeters** are sensitive to electromagetic radiation and display readings in real-time via an LCD display. While they do not detect heavier particles of radiation, **an active dosimeter will let you know immediately** if you experience an unusual radiation event. **Passive dosimeters**, on the other hand, are sensitive to low and high-energy heavy particles, but they contain no electronics and must be processed on the ground before exposure data may be retrieved.

For the most complete, wearable radiation solution, **we recommend both types.**

PRICING AND QUOTES

For more information and to request a quote for Astrowright's in-flight radiation dosimetry solutions and analytical services, please see our website at www.astrowright.com, and/or email us at info@astrowright.com.