Health risks from cosmic radiation

Mattias Karlsson, Claes Jolérus, Renjith Oomen Mathew Padicamannil,
Abishek Raina and Prantik Patnaik
TMAL02, Linköping University, 2017

1 What is cosmic radiation?

Cosmic radiation is a form of space radiation which consists primarily of ionizing radiation which exists in the form of high energy charged particles. Most of these energetic particles originate from outside the solar system, though the sun is an important source during solar storms. Cosmic radiation consist of protons, helium and ions. Showers of these high energy particles occur when energetic cosmic rays strike the top of the Earth's atmosphere and collide with molecules of nitrogen and oxygen and decay into different secondary particles which strike earth from all directions. Earth's magnetosphere, which acts as a giant magnetic shield, blocks most of the radiation from ever reaching the planet. However, cosmic rays have free access over the polar regions where the magnetic field lines are open to interplanetary space.
The high energy radiation which contains atomic nuclei and protons are cosmic rays. It also consist of galactic nuclei. They are of 2 types, Galactic cosmic rays, which are found outside the solar system and Solar energetic particles, which are directly from the sun. The rays which comes from outer space is cosmic ionizing radiation. Cosmic radiation consist of protons, helium and ions. They enter the earth's atmosphere and collides with the atoms present in the atmosphere and produces cosmic radiation. While compared to the ground level, the cosmic radiation is 100 times higher in altitude of 35,000 [ft]. At high altitude the air gets thinner, this thinner air deflects which produces cosmic rays. In galactic cosmic radiation, it contains 85 percent protons which is hydrogen, 14 percent helium and 1 percent of heavy ions HZE- high energy nuclei. The nuclei of atoms travel at the speed of light. Galactic cosmic radiation decreases at solar maximum and increases at solar minimum.

2 How does cosmic radiation affect humans?

Considering that we are always getting bombarded with cosmic radiation, is there any risk with it?
According to the World Health Organization (WHO) and International Agency for Research on Cancer (IARC) [1] state that these kind of radiation do cause cancer and other issues with the reproductive system. A single cosmic ray has enormous amounts of energy which if collides with the DNA ends up destroying a part of the DNA strand. This can cause cell change (mutation) that could eventually become cancer cells shown in fig. 1. If we consider a fetus which is already undergo changes during it's development, avoiding these mutations is important.

But when is the amount of exposed to much for the body?

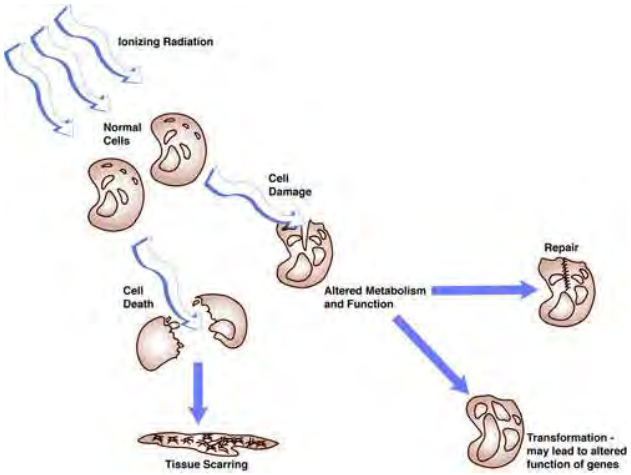

Fig. 1 . Illustrating how ionizing radiation affect the cells.

The International Commission on Radiological Protection (ICRP) [1] recommend that radiation workers should not get exposed to more then 20 mSv/year. That is a rather high value if you compare with the European Union members that state an limit of 6 mSv/year for aircrew. But both agree on pregnant women should not exceed 1 mSv during there pregnancy, and no month alone exceed 0.5 mSv.
How easy is it to gain these amounts?
Division of Radiation Safety [2] say if you fly at 39,000 feet for one hour the exposed is 0.005 mSv. With the 6 mSv/year for the aircrew they can fly at that altitude for 1200 hours, if you work 40 hours/week then you could only work for 30 week per year, also the recommended limit for pregnant women was only 1 mSv which is calculated to 200h

or just 5 weeks.
A study [3]was conducted of pilots to see if they got more cancer then the general population, it showed an increase risk to get cancer of a certain type, especially Malignant melanoma where it was 10 times more likely that a pilot get it then a regular person.

3 Prevention/Shielding

Now that you know more about what cosmic radiation is and how it affects aviation, I guess you are thinking, "Then how can we shield ourselves from radiation?". Is it even possible? Luckily the Earth has its own natural shield in the form of the magnetosphere and the atmosphere that shields Earth from most of the radiation. Though the amount of radiation exposure grows rapidly the higher you get in the atmosphere. The exposure is about 100 times higher at 10 km than at sea-level. In low-earth-orbit you are still protected by the magnetosphere, but the amount of radiation is about 1000 times higher than back on the surface of Earth. It is even worse when leaving the orbit of Earth and moving into interplanetary travel, then you don't really have any protection at all and you get completely exposed to solar winds and radiation from other parts of space. This is a huge issue for an eventual manned mission to Mars.

Studies has been made on different kind of shielding strategies against cosmic radiation. Material shielding can be used, but it requires a certain thickness or otherwise is may cause an increased amount of secondary radiation from high energy rays. Scientists has been experimenting with making spacecraft in hydrogen-rich plastics instead that have better shielding properties than aluminum. They have also tested using liquid hydrogen (fuel) and water placed around the vehicle to be used as shielding. One hypothetical alternative is also to use magnetic deflection which creates a shield similar to the magnetosphere but on a much smaller scale. Though this method requires a lot of energy compared to the other alternatives.
Research has also been made into developing drugs that can mimic or enhance the body's natural capacity to repair damage caused by radiation. Of course, one alternative is also to time the trip with the current state of the cosmic radiation. So you don't take off while a huge solar flare is happening. What you may have noticed is that most of these methods are developed for astronautical vehicles, because that is when radiation exposure can get severe consequences. As an occasional flyer you don't really get enough radiation exposure for it to be affecting your health. Therefore, there has not really been a huge investment in developing radiation shielding for aeronautical vehicles. To reduce cosmic radiation we can try to reduce the working time on longer flights. Some aircraft have some extra shielding in the form of some type of material shielding that can be helpful for aircraft flying at higher altitudes, like the U-2.

Authenticity and Plagiarism

By submitting this report, the author(s) listed above declare that this document is exclusively product of their own genuine work, and that they have not plagiarized or taken advantage from any other student's work. If any irregularity is detected, the case will be forwarded to the University Disciplinary Board.

REFERENCES

[1] NIOSH. *Cosmic Ionizing Radiation*. 2017th ed. The National Institute for Occupational Safety and Health (NIOSH).

[2] Division of Radiation Safety. *F. Typical Sources of Radiation Exposure*. 2013th ed. Office of Research Services.

[3] Rafnsson, V Hrafnkelsson, J Tulinius, H. *Incidence of cancer among commercial airline pilots*. 2000th ed. National Center for Biotechnology Information.