Simulated Space Radiation Studies for The Assessment of Chromosomal Damage: An Integrated Experimental and Theoretical Approach

Aloke Chatterjee, Ph.D.
Lawrence Berkeley National Laboratory

Abstract:

Risks to astronauts from exposure to protons and HZE particles have always been of great concern to NASA. This concern was highlighted by a recent published report based on measurements of chromosome exchanges in the blood lymphocytes of eight crew members after their respective space missions. Significant increases in aberrations were observed in the six crew members of the Mir mission and two crew members of a 10-day shuttle mission. Measurement of chromosome aberrations has a special significance with respect to risks. They can lead to cell killing, intergenic mutations and cancer. The research proposal presented here involves measurement of chromosomal aberrations, including lethal, non-lethal and potentially carcinogenic, and a class known as complex aberrations following irradiation of human cells with protons and HZE particles under different shielding conditions. Some fraction of the incident beam of high-Z particles undergoes nuclear fragmentation as they penetrate a thick shielding material. This creates a mixed beam of different radiation qualities. It is important to identify each of the components of the mixed beam for a better understanding of the overall chromosomal aberration yields. The experimental component of the proposal is complemented by research in developing a suitable theoretical model for interphase chromosomes in human nucleus to predict the radiation-induced aberration yields. These breaks are determined on the basis of biophysical and biochemical mechanisms of damage to DNA sites. In order to evaluate the chromosome aberrations an algorithm will be used which is based on a hypothesis that the probability of joining between any end of a double strand break with another is dependent upon the distance between them. At the end of the three year duration of the research, we will have a user-friendly software for NASA to be able to use to assess shielding parameters for designing spacecrafts to lower risks to crew members of long-duration space flights.