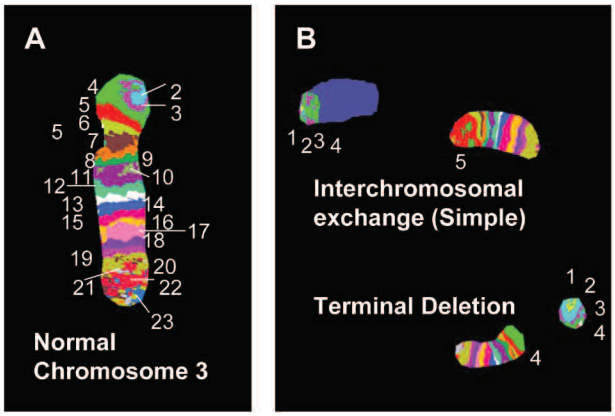
Chromosomal Damage Induced by Space-Like Radiation in Human Cells

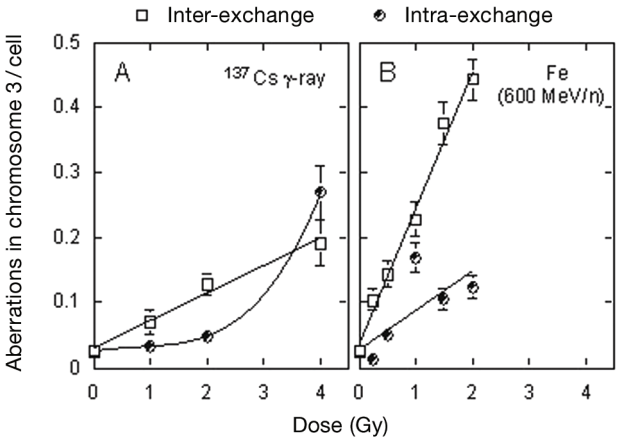
Megumi Hada, *Universities Space Research Association*
Steve Gonda, *Johnson Space Center*
Francis Cucinotta, *Johnson Space Center*
Honglu Wu, *Johnson Space Center*

The overall goal of this project is to provide a mechanistic understanding of the detrimental effects of space radiation on human cells, which can lead to reductions in the uncertainties in risk projections. We aim to analyze low- and high-linear energy transfer (LET)-induced chromosomal aberrations in human lymphocytes and human epithelial cells using varying state-of-the-art techniques, including two novel tools, multicolor fluorescent in situ hybridization (mFISH) and multicolor banding in situ hybridization (mBAND), known to provide advantageous benefits over other cytogenetic techniques. These two techniques are capable of identifying complex chromosomal aberrations and stable intrachromosomal aberrations, respectively. mFISH analysis will provide the true complexity of chromosomal damage in all human chromosomes, while the use of mBAND may allow us to identify longer-lived biomarkers for high-LET exposure.

We exposed human epithelial cells in vitro to ^{137}Cs γ rays or Fe ions (600 MeV/nucleon) at the NASA Space Radiation Laboratory, and collected chromosomes using a premature chromosome condensation technique. Aberrations in chromosome 3 were analyzed using mBAND probes. Results of our study confirmed the observation of higher incidence of inversions for high-LET irradiation. However, detailed analysis of the inversion type revealed that both Fe ion and γ ray exposures induced a low incidence of simple inversions. Half of the inversions observed in the low-LET irradiated samples were accompanied by other types of intrachromosome aberrations, but few inversions were accompanied by interchromosome aberrations. In contrast, Fe ions induced a significant fraction of inversions that involved complex rearrangements of both inter- and intrachromosome exchanges.



Example of chromosome 3 painted with mBAND. A chromosome 3 is shown with 23 pseudocolor bands. All other chromosomes are stained with DAPI only and shown in blue. Panel A: Normal chromosome 3. Panel B: Aberrations observed after radiation exposure.



Dose response of chromosome aberrations.