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Nuclear Physics and Radiobiology - Issues for Humans in Space and on Earth

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Nuclear physics is playing a vital role in human biological applications, specifically in planned space missions, in hadron radiotherapy, and in low dose radiobiology. While seemingly disparate, these and other areas share a common need for the understanding of nuclear interactions in biological systems. Radiobiology continues to provide valuable information that will help develop better methods for using radiation in the treatment of disease as well as provide a scientific basis for radiation protection standards. NASA is now focused on the agency's vision for space exploration encompassing a broad range of human and robotic missions including missions to the Moon, Mars and beyond. As a result, there is a focus on long duration space missions. Protection from hazards of space radiation has been identified as one of the five NASA critical areas for human space flight. The cost effective design of spacecraft demands a very stringent requirement on the optimization process. Exposures from the hazards of severe space radiation in deep space and/or long duration missions are very different from that of low earth orbit, and much needs to be done about their effects. However, it is clear that revolutionary technologies will need to be developed. Here on earth, particulate radiation treatment for cancer, such as proton radiotherapy, is playing an increasing important role, while the biological effectiveness remains less well understood than for x-rays and other forms of medical radiation treatments. Advanced imaging, dosimetric, Monte Carlo, and other techniques from nuclear physics are utilized to study the molecular basis of fractionation dependency and other tumor and normal tissue radiation responses, such as radiosensitivity. Moreover, advances developed by biological research efforts, such as the sequencing of the human genome, have opened new horizons for radiobiology. New techniques have made it possible to determine at the cellular / molecular level how living systems respond even to low doses of radiation. I will discuss the interplay between nuclear physics and human biological applications; Starting with high dose exposure in space applications, to controlled exposure in radiotherapy, and finally, low dose radiobiology. I will project how cellular level living system activities may provide the much needed impact of radiation exposure on living tissues in these applications.