Fiscal Year:	FY 2008	**Task Last Updated:**	FY 12/03/2009
PI Name:	Cucinotta, Francis A Ph.D.		
Project Title:	Quantum Multiple Scattering Model of Heavy Ion Fragmentation (QMSFRG)		
Division Name:	Human Research		
Program/Discipline:	HUMAN RESEARCH		
Program/Discipline--Element/Subdiscipline:	HUMAN RESEARCH--Radiation health		
Joint Agency Name:		**TechPort:**	Yes
Human Research Program Elements:	(1) **SR**:Space Radiation		
Human Research Program Risks:	(1) **ARS**:Risk of Acute Radiation Syndromes Due to Solar Particle Events (SPEs) (2) **Cancer**:Risk of Radiation Carcinogenesis (3) **CNS**:Risk of Acute (In-flight) and Late Central Nervous System Effects from Radiation Exposure (4) **Degen**:Risk of Cardiovascular Disease and Other Degenerative Tissue Effects From Radiation Exposure and Secondary Spaceflight Stressors		
Space Biology Element:	None		
Space Biology Cross-Element Discipline:	None		
Space Biology Special Category:	None		
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Zip Code:	89154-3037	**Congressional District:**	1
Comments:	Formerly at NASA Johnson Space Center, until summer 2013 (Ed., Oct 2013)		
Project Type:	GROUND	**Solicitation / Funding Source:**	Directed Research
Start Date:	09/01/2008	**End Date:**	08/31/2010
No. of Post Docs:		**No. of PhD Degrees:**	
No. of PhD Candidates:		**No. of Master' Degrees:**	
No. of Master's Candidates:		**No. of Bachelor's Degrees:**	
No. of Bachelor's Candidates:		**Monitoring Center:**	NASA JSC
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Flight Program:			
Flight Assignment:			
Key Personnel Changes/Previous PI:			
COI Name (Institution):	Saganti, Prem (Prairie View A&M) Kim, Myung-Hee (Wyle Laboratories)		
Grant/Contract No.:	NNX07AT25A		
Performance Goal No.:			
Performance Goal Text:			

Task Description:	The quantum multiple scattering model of heavy ion fragmentation (QMSFRG) is an important input to risk evaluation and radiation shielding calculations. Several areas of development in nuclear data base development and output deliverables with the QMSFRG model will be the focus of this directed research as guided by previous results. Applications include biophysical models of biological damage as ions passed through complex tissue structures (Ponomarev and Cucinotta, 2006), radiation transport code applications (Wilson et al, 1991) including shielding evaluations (Cucinotta et al., 2006), and in comparisons of models to flight experiments (Badhwar and Cucinotta, 2000; Cucinotta et al., 2000), and space radiation risk assessments (Cucinotta et al., 2001). It is important to note that although measurements of nuclear fragmentation cross sections are a step in code development for biophysical, shielding, and risk analysis, only theoretical models can provide a complete data base for such studies. Past nuclear fragmentation models have relied on parameterizations of experiments or semi-classical physics models. These approaches have been shown to fail badly in heavy ion radiation transport code comparisons to experiments (Wilson et al., 1986). Typical fragmentation measurements do not measure all secondary products and are usually restricted to fragments from ZP-1 to ZP/2 where ZP is the projectile charge. Lower charged fragments make important contributions to the galactic cosmic ray (GCR) transport. Parametric models include no underlying physical description and thus fail outside the range of measurements. This failure is amplified when one considers the large number of projectiles, target, and energies of interest and the lack of measurements for most of these reaction partners. Important aspects of nuclear reactions are not reproduced in Monte-Carlo models of heavy ion reactions and indicate the need for a quantum description that is capable of being implemented for GCR data bases. This features include the role of the nuclear surface, and nuclear structure effects such as shell structure and clustering. Our proposal will develop the quantum mechanical models of nuclear fragmentation based in multiple scattering theory (QMSFRG) that will substantially advance the nuclear data bases for space radiation transport applications and the ability to extrapolate away from existing experimental data sets. The QMSFRG theory has been shown to be a robust and accurate approach to multiple types of galactic cosmic ray (GCR) computational evaluations. For the two-year period of performance we have the following Specific Aims: Specific Aim 1: To develop Computer Subroutines from the QMSFRG model that will generate require cross section data for application within the high-charge-and energy (HZE) transport computer program (HZETRN) code in collaboration with Dr. John Wilson, NASA Langley Research Center (LaRC). A 190-ion grid for 9 projectile energies on arbitrary target materials (Hydrogen to Lead) applicable GCR shielding problems will be generated with appropriate interpolation schemes for other materials and energies. Furthermore, to prepare a data base generator for Monte-Carlo transport code applications (Dr. M.Y. Kim, Lead) and tested in the Geant4 code in collaboration with Dr. Maria Grazia Pia, INFN (Italian National Institute of Nuclear and Particle Physics), Genoa, Italy. Specific Aim 2: To report on the extension of the light ion production cross sections in the QMSFRG model for nuclear coalescence formation of light particles (d, t, h, a), and the resulting losses to n and p production (Dr. F.A. Cucinotta, Lead). Also, data bases of light-particle production multiplicities will be generated. Comparisons to experimental data will be reported. Specific Aim 3: To improve the model energy density formalisms used in the nuclear de-excitation process in QMSFRG Master decay-solutions (Dr. P. Saganti, Lead). Cross-comparisons of different models and to experimental data will be reported. Specific Aim 4: To implement the NASA Johnson Space Center (JSC) Selected Core formalism for the description of pre-fragment excitation functions in nuclear abrasion for selected GCR nuclei (12C, 16O, 20Ne, and 28Si) and to extend the formalism for alpha-clusters (Dr. P. Saganti, Lead). Fragmentation cross section calculations will be compared to experimental data. Future work will extend the quantum multiple scattering theory to explicit pion channels, to consider other light particle clusters, and to produce data bases of light and heavy particle energy spectra.
Rationale for HRP Directed Research:	
Research Impact/Earth Benefits:	
Task Progress:	New project for FY2008.
Bibliography Type:	Description: (Last Updated: 02/11/2021)