Creativity in Physics: SGER

Goal: Goal of this project is to explore the process behind creativity in physics.

Objective: Objectives are to build a toy creativity tool, and to test the hypothesis that the laws in physics can be represented as formal constraint-knowledge base that can help explore the new ideas.

Relevance to the CreativeIT Initiative: The initiative *CreativeIT* appears at a cross road of computer science and creativity. The latter has been scantily addressed in the literature within psychology because of the lack of any verifiable model. It is conjectured that computation can provide such a model. Understanding scientific creativity can be at the forefront of this initiative. In this project we will attempt to achieve such a understanding by developing a knowledge representation scheme for Physics. Past works on invention was more qualitative in scope compared to what we are proposing here. Also, the previous works on scientific creativity addressed primarily the historical angles – trying to understand how an older discovery took place. In contrast, our objective is primarily to build creativity tools for scientists/students.

Intellectual merits: We have identified three areas of creative activities in Physics to be addressed in the project: (1) *Deriving a new law from the existing theory*; (2) *Asking what-if questions within the scope of a theory*; and (3) *Given a theory, deriving a falsifiable hypothesis that can be experimented upon*. Targeting the area of classical mechanics we will build a constraint-based knowledge representation of physical laws. Our toy knowledge-base will be enhanced with heuristics to address the three creative activities mentioned above. We will evaluate this exploratory model in a class room set up. The PI has terminal degrees in Physics and in Computer Science, and has been involved in research on reasoning with spatio-temporal constraints for over a decade (initiated by a NSF Career award). We will be supported by a physicist and a psychologist in our project (letters attached).

Broader Impact: Our primary purpose is to develop a constraint-oriented model of scientific knowledge base that can help understand and enhance creativity in science. The proposed model may impact areas other than physics, like chemistry or biology. Constraint-based model has already been popularized in architectural design activities [Gross, 1991]. Research in creative activity at FIT is likely to impact numerous students coming from the local high-tech industries at Florida's Space Coast. We will aim to hire and interact with minority and female students in which the PI has particular experience.

Why SGER? This is a high risk high pay off research that may be able to influence the *CreativIT* initiative at NSF. Success of this exploratory effort could lead to a novel project in developing creativity tools for science and to a better understanding of the process of creativity there. Even if we have a relative failure in modeling creativity this project will lead to an educational tool in physics. Lack of any prior results makes it particularly vulnerable to the regular research project evaluation methods. Without an exploratory grant, the PI will not be able to successfully initiate the project.