

LIST OF AWARD RECIPIENTS
UB2020 RESEARCH AND DEVELOPMENT ACTIVITIES FUND (IRDF)

**Corresponding Investigators
and Co-Investigators
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“Improving the driving of teens with ADHD through parenting”

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Project Description

American drivers between 16-20 years old have the greatest injury and fatality rate compared to other age groups. Outcomes are even worse when one considers the driving records of adolescents diagnosed with attention-deficit/hyperactivity disorder (ADHD). Across a number of studies, adolescents with ADHD fare significantly worse on measures of car accidents, moving violations, injuries and fatalities, and other driving-related negative behaviors such as “road rage” relative to other teenagers. Unfortunately, few effective, non-medication treatment programs for adolescents with ADHD exist, and those that work are not widely available. We propose a feasibility and proof of concept pilot study that uses an evidence-based treatment for ADHD, behavioral parent training, as a means of improving ADHD teen driving outcomes. The present study will: (a) develop the materials, program manuals, driving simulation computer programs and activities, and parent and teenager intervention components for the Supporting a Teen’s Effective

Entry to the Roadway (STEER) program; (b) gather information on the implementation of the STEER program, as well as parent and teen report on the acceptance, engagement, and follow-through; and (c) gather measures of treatment outcome and demonstrate the feasibility of proposed data collection methods (e.g., Global Positional System tracking, driving performance engine monitors). The explicit goal of this project is to demonstrate the STEER program is a feasible and promising program for promoting effective parental monitoring of at-risk teen drivers. The pilot data will be used in an NIH grant to investigate the STEER program in a randomized, clinical trial.

“Tailoring Superconductivity in MgB₂ Nanostructures for Technological Applications”

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Program Description

The recently discovered superconductor MgB₂ has great potential for technological applications due to its high critical temperature ($T_c \sim 39\text{K}$), low cost of raw materials, chemical simplicity and excellent grain boundary connectivity. MgB₂ holds the record for the highest T_c among the conventional superconductors. Though several groups have achieved improvements of the transport properties of this material in thin film form, increasing the upper critical field (H_{c2}) still remains a formidable challenge. In this project, we plan to tune, guided by sound theoretical ideas, the superconductivity in MgB₂ nanostructures by fabricating well-defined interfaces with other planar systems. Electronic properties of nanostructured materials, due to their reduced dimensionality, are extremely sensitive to small changes in structure, composition, and chemical environment. We propose to fabricate and evaluate novel structures, consisting of alternating layers of MgB₂ and graphene, for realizing *hole-doped* MgB₂ systems without chemical substitution, as potential candidates for improving both T_c and H_{c2} . The proposed work has three major parts: (1) Chemical synthesis of MgB₂ layers and nanowires/rods on graphene templates and spectroscopic characterization of charge transfer (Banerjee group) (2) Nanodevice fabrication and low-temperature (T)/high-magnetic-field (B) transport measurements of nanocomposite MgB₂/graphene interfaces (Ganapathy group) (3) Electronic structure calculations and rational design of novel structural motifs for improving T_c and H_{c2} (Zhang group). Research at this interface will provide fundamental insight into methods for tuning superconductivity, while simultaneously enabling the development of fabrication methods for the practical realization of MgB₂ superconducting device components.

“Exercise Treatment for Post Concussion Syndrome”

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Program Description

Traumatic brain injury (TBI) is a leading public health problem, with an estimated 1.5 million TBIs per year in the US, and it is an important source of injury in the Iraq and Afghanistan wars. Most individuals recover completely within the first three months; however, a significant minority experience continued symptoms. This is called post concussion syndrome (PCS). The primary forms of PCS treatment are rest, education and antidepressants, with only limited effectiveness. Prolonged rest, however, especially in athletes and soldiers, can lead to secondary symptoms such as fatigue and depression in addition to physical deconditioning. We have proposed that PCS occurs because the disturbances in brain and whole body physiology do not return to a state of equilibrium after TBI in some persons and that controlled exercise could treat the underlying problem. Our pilot research has shown that individuals with PCS for the most part benefited greatly from a controlled sub-symptom threshold exercise program. Our approach aims to treat the cause rather than the symptoms of PCS. Previous research on PCS has been limited by a lack of objective criteria to define the presence of the syndrome and the response to time and treatment. Physiological assessment holds great promise for objectively diagnosing the presence of and the recovery from TBI and PCS. We plan to use functional MRI (fMRI) to demonstrate cerebral blood flow and brain function abnormalities after TBI and hope to show that our exercise program improves these abnormalities.

“Chemical Biology of Ion Channels”

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Project Description

Transient receptor potential (TRP) channels play critical roles in the sensory nerve functions including the sensation of pain. Many TRP channels also exhibit significant sensitivity toward other stimuli such as temperature and pH. How a single channel achieves this functional multiplicity remains poorly understood at the molecular level. To address this question, one of the major hurdles is the lack of suitable tools that can be employed to probe channel dynamics with high spatial and temporal resolution. In this collaborative project, Prof. Qing Lin's lab in the Department of Chemistry and Prof. Feng's lab in the Department of Physiology and Biophysics team up and aim to elucidate the mechanism of multimodal activations in TRP channels, in particular, TRPV1. A key aspect of their joint effort involves further development of an exquisite technique called alkene co-translational incorporation-functionalization (AIF) discovered in Prof. Lin's lab. Using this technique, specific sites in the selectivity filter loop region in the extra cellular domain of the TRPV1 channel will be encoded with reactive alkene moieties. Depending on its location in the channel relative to the pore region, these alkene moieties will then serve as chemical reporters during the dynamic and multiplexed interrogations of channel function. This interdisciplinary project is expected to provide a time-resolved chemical biology tool in the study of multimodal channel gating dynamics, and thus shed light to the understanding of pain sensation in the peripheral cells.

“Enhancement of Breast Cancer Radiotherapy by Image-Guided Tracking of Tumor Motion”

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Project Description

Breast cancer is the most prevalent cancer among women in the world (~25%) and a large proportion of breast cancer cases are treated by radiation therapy. The success of radiation treatment (RT) is dependent on a combination of good target coverage and low radiation dosage to the normal tissue surrounding the target. The size of the necessary margins, and hence the risk of complication, can be reduced if the set-up margin uncertainties and the internal organ motion, such as those caused by breathing motion, are minimized. Generally, breathing-adapted RT is used

as a way of reducing toxicity by margin reduction or by increasing the distance to organs at risk. It can be facilitated either as gating, where the beam is turned on only in a pre-defined discrete phase of the breathing cycle, or as tracking, where the beam is moving synchronously with the movements of the target. If breathing-adapted RT is to be used in conjunction with more advanced treatment techniques, such as intensity-modulated RT, then a reliable tracking algorithm is required.

In this study, we propose to develop algorithms for accurate estimation of tumor motion enabling real-time adaptive conformal radiation therapy. Accurate real-time localization of tumor from this proposed technology reduces the volume of heart and lungs irradiated and will facilitate rational design of even more potent radiation treatment while minimizing: 1) exposure of healthy tissues to lethal radiations, 2) exposure to x-ray imaging doses and most importantly, 3) probability of relapse of tumor.

“Reconstructing CT Images from a Limited Number of Projections”

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Project Description

Computed tomography (CT) images are routinely used in clinic. Such images are obtained by first exposing patients to a beam of x-rays from a number (about 1000) of different angles and then using these projections to reconstruct the 3D images. Recent developments in CT have yielded relatively high resolution (about 0.5 mm), achieved mainly through an increased the number of projections and x-ray dose to patients which can lead to an increased incidence of cancer.

This project intends to develop a new CT reconstruction method for achieving three main objectives: (a) significantly reducing the radiation dose consumption, (b) speeding up the reconstruction time, (c) improving the quality of 3D images.

To reach the three objectives, this project proposes to develop (1) a mathematical/probabilistic shape model to take advantage of a priori knowledge (i.e., anatomic and shape information) of specific biological structures, (2) efficient computational geometry techniques to speed up the reconstruction, (3) new algorithmic techniques (based on information theory) to identify structures using fewer projections. Thus the obtained new method can determine the number of projections required on a patient specific basis, and reconstruct the objects optimally using these projections.