**UND Dept of Atmospheric Sciences**
PI Name: Matthew Gilmore Building Name and Office Room #: Clifford Hall, Room 460
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**PROJECT TITLE:** Toward Understanding Environmental Parameters Controlling Tornado Intensity and Longevity

**Project Objectives:**

The objective of this project is to identify whether the rotational characteristics of a large set of tornadic and non-tornadic supercell storms in nature can be reproduced using a cloud model. Cloud models use environmental weather conditions representative of actual storm events to initialize and support the simulated storms. A weather conditions database of 897 events was provided by the Storm Prediction Center consisting of three different intensity categories (weather conditions associated with non-tornadic, weakly tornadic, and significantly tornadic storms in nature). These have already been simulated by the PI at storm-resolving grid spacing. Now those preliminary simulations need to be data-mined and analyzed. To address the project objective, simulated mean rotation strength will be compared between the three groups of weather conditions to address statistical significance (i.e., whether the signal in the model is consistent with nature). A follow-on proposal has also been recently submitted to NSF, funding from which would be used to simulate and analyze some of the exemplar cases from the present study at tornado-resolving grid spacing to better understand how these weather conditions lead to tornadoes.

**Student Role in Project:**

The student will assist in automated “data mining” of the 897 storm resolving simulations and determine the storm type, amount of low-level rotation, and storm longevity. The student will then organize the necessary data for calculating statistical differences between the different group means using hypothesis testing (statistics application) using pre-existing software written by the PI and his collaborators. The student will also learn how to properly draft figures and tables for presentation of the results within a poster, conference preprint, and formal publication. The PI will also train and encourage the student to present this research on behalf of the research group at the upcoming American Meteorological Society’s Annual Meeting in Jan 2010. This training in the scientific method and presentation skills should prove to be very beneficial to jumpstart the student’s scientific career no matter what area of Atmospheric Science that they eventually choose.

**UND Dept of Atmospheric Sciences**
PI Name: Gretchen Mullendore Building Name and Office Room #: Clifford Hall, Rm 452
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**PROJECT TITLE:** Resolving climate variability in atmospheric models of the Northern Great Plains

**Project Objectives:**

Climate variability has significant economic and environmental effects on the Northern Great Plains (NGP; North Dakota, South Dakota and Minnesota), impacting agriculture, water resources, wildlife, and energy production. In order to assess the effects of both natural and human-induced climate variability at regional scales, we need to first make sure that the regional atmospheric models are simulating current variability correctly. Although much work has been done to improve the numerical weather models, verification statistics for NGP at regional scales is lacking. This project tackles the very important problem of assessing model ability to reproduce NGP climate at spatial resolutions of 50 km and higher. Features such as land-cover, water features, and terrain will be important to resolve in certain weather regimes. We need to quantify what climate variability is "missed" by the simulations.

**Student Role in Project:**

The AURA student will help this research effort by organizing the observational and model data and calculating basic statistics. Observations have been collected from surface stations as well as from satellite retrievals. The 50-km model data for years 1970-2000 has been completed as part of the North American Regional Climate Change Assessment Program. The student will also assist the research group, and get hands-on modeling experience on a high performance computing cluster, by running the Weather Research and Forecasting (WRF) model, the same model used by the National Weather Service to forecast United States weather. The WRF model will be used to run 15- and 5-km resolution simulations.

**UND Dept. of Biology**
PI Name: Brett Goodwin Building Name and Office Room #: Starcher Hall, 207
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**PROJECT TITLE:** Insect movement behavior in heterogeneous prairie landscapes

**Project Objectives:**

Habitat loss and fragmentation has become ubiquitous and is considered a driving force behind current extinction rates. To understand how species are to survive in such fragmented landscapes it is necessary to understand how individuals move between isolated habitat patches. The ability to move between patches of habitat is a function of both the spatial structure of the landscape and the movement behavior of the organism moving. I am currently investigating a suite of phytophagous insects associated with two native, patchily distributed prairie plants (goldenrod and stiff sunflower) and using these as a model system to address how movement behavior and landscape structure interact to determine interpatch movements. Specifically, I am focusing on katydid (*Orchelimum gladiator*) movement behavior and using computer simulations and harmonic-radar to explore how fine scale movement behavior scales up to the distribution of individuals in a heterogeneous landscape.

**Student Role in Project:**

This summer the AURA student investigator will: (1) measure katydid movement behavior in response to landscape elements (e.g., patches of different vegetation and the edges between them); (2) assess the impact of weather conditions on katydid movement behaviors; (3) use the observed movement behavior to parameterize an individual-based, spatially explicit computer simulation model to assess the impact of movement behavior and landscape structure on displacement and redistribution of katydid individuals in landscapes; (4) field test the model predictions using mark-release-resight experiments employing harmonic radar tags that allow for relatively long term (1-2 weeks) tracking of individual katydids.

**UND Dept of Biology**
PI Name: Robert Newman Building Name and Office Room #: Starcher Hall Room 211
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**PROJECT TITLE:** Ecology of amphibians on the Sheyenne National Grassland and Prairie Pothole Region of eastern North Dakota

**Project Objectives:**
The overall goal of my research program is to learn how environmental variation influences critical ecological and evolutionary processes. The project described here focuses on the impacts of habitat quality and landscape patterns on amphibians in eastern North Dakota. The Prairie Pothole Region is an important region, both ecologically and economically. It contains among the highest density of wetlands in the world, yet at the same time is intensively used for large-scale food (and now bio-fuel) production. Perhaps nowhere else are unique ecological systems so interlocked with vital human activities. The Sheyenne National Grassland, which is found within the Prairie Pothole Region, provides another situation with intensive management (cattle-grazing) intertwined with the now rare tall grass prairie ecosystem. Amphibians, with their small body size, permeable skins, limited mobility and high sensitivity to environmental conditions, provide a valuable model to examine the mechanisms linking landscape patterns and habitat characteristics to ecological and evolutionary processes. Individual health and population persistence depend on the quality, distribution, and dynamics of wetlands and the surrounding terrestrial habitat. There is substantial geographic variation in these factors, even within eastern North Dakota, offering an opportunity to investigate how differences in key habitat factors influences amphibian health, diversity, distribution, and breeding success. The primary objectives of this project are to learn how these environmental factors influence levels of parasitic infection in individuals, the probability of wetland utilization by populations, and reproductive success in those wetlands of several species of amphibians.

**Student Role in Project:**
The student will assist in all aspects of field work, including wetland surveys, characterization of habitat, and capture of frogs. In the lab, after appropriate training, the student will assist with data entry, updating of our geographic information system (GIS), photographic-based identification of recaptured frogs, and quantification of parasitic infection. As time and the student's interests permit, the student may contribute to other facets of research ongoing in the lab, or develop additional lines of inquiry. The student will experience firsthand all stages of ecological research, learn the fundamentals of field sampling, use tools such as GPS and GIS technology that have become central to many ecological research programs, and develop an understanding of an ecologically important ecosystem and group of animals. Through readings and regular meetings with my lab group, the student will learn how these methods are applied to answer fundamental questions in population ecology and conservation biology.

**UND Dept of Biology**
PI Name: Steven Ralph Building Name and Office Room #: Starcher Hall, room 217
Phone #: 777-4673 Fax #: 777-2623 Email address: steven.ralph@und.nodak.edu

**PROJECT TITLE:** Identification of Insect Resistance Genes in Poplar Trees Using Forward Genetics

**Project Objectives:**

In the United States, forestry is a $200 billion dollar per year industry employing more than one million workers. Concurrent with an increasing demand for forest products, there is also a strong public desire to conserve forest ecosystems for both their ecological and aesthetic values. However, the health of our forest resources is at risk due to the increasing threat posed by insect pest epidemics. The overarching objective of our research program is to identify genes that contribute to the defense of forest trees against feeding insects and to functionally characterize these genes using genomics technologies. In the summer of 2008, we screened a population of 600 genetically modified (i.e., activation tagged) poplar trees to identify mutants that displayed resistance to insect larvae feeding. Our bioassay screen identified at least three insect resistant (insect resistant or resistance = IR) mutants for further molecular characterization in the current study. For the summer 2009 AURA project we have two specific aims: 1) map the location of T-DNA inserts in the genomes of the three IR mutants using genome walking polymerase chain reaction (PCR); and 2) identify the activated gene in proximity to the T-DNA that confers IR using real-time PCR. This research will identify critical IR genes that can be incorporated into traditional tree breeding programs to produce superior trees for reforestation that are tolerant to feeding insects.

**Student Role in Project:**

This summer the AURA student investigator will contribute to this study by: (1) assisting in the UND Biology greenhouse to grow and maintain poplar trees; (2) isolating genomic DNA and RNA from each of the three IR mutant trees; (3) determining the number of T-DNA copies and their location in the genomes of each IR mutant; (4) using computational analyses to identify genes upstream and downstream of each T-DNA insert in the poplar genome; and (5) identifying the activated gene in proximity to each T-DNA that confers IR using real-time PCR.

**UND Dept. of Biology**
PI Name: William F. Sheridan Building Name and Office Room #: Starcher, Room 317
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**PROJECT TITLE:** Chromosome Segmental Dosage Analysis of Maize Plant Morphogenesis

**Project Objectives:**

1. To assess the dosage-sensitive interactions of two nonhomologous chromosome segments in affecting maize plant development.
2. To sort out whether the effects of an extra copy of these two segments are additive effects of their extra dosage or are a result of gene interaction between them.
3. To further develop quantitative polymerase chain reaction (PCR) protocols using simple sequence repeat (SSR) molecularly marked DNA sites to relate the relevant chromosome segments to the maize molecular genetic map.
4. To further subdivide the maize genome for dosage analysis by producing additional B-A-A chromosomes.

**Student Role in Project:**

The student will work together with the P.I. in the laboratory and the field:

* identifying the chromosome segments for analysis;
* selecting the DNA primers flanking the SSR marked regions to be used in the PCR analyses;
* performing the quantitative PCR protocols, fine-tuning them to distinguish one, two, and three doses of the amplified sequence;
* analyzing trait measurements by conducting t-tests for significant differences;
* performing genetic experiments by cross pollinating B-A-A stocks onto appropriate tester stocks;
* measuring and recording plant traits of plants containing one, two and three doses of the two chromosome segments borne on the B-A-A chromosomes;
* harvesting, tagging and evaluation of test crossed ears to confirm the genetic identity of the plants measured in the field.

The student will prepare a poster describing progress on the project and will present the poster on campus and at a national scientific meeting.

**UND Dept of Biology**
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**PROJECT TITLE:** Birds, mosquitoes, and parasites: the impact of parasitism on birds of the northern Great Plains

**Project Objectives:**

This project continues the original goal of the EPSCoR RNEST project awarded to the UND Biology Department back in 2002; that is; to develop collaborative research that focuses on a common theme – *i.e*., ***parasitism***. Within that thematic focus, there are three investigator-led projects. One examines the potential of certain nematode parasites (=microfilariae) in songbirds to enhance the transmission of arboviruses by mosquitoes. This could have direct applicability to the local transmission of West Nile virus within our region. Another project examines the potential of migratory songbirds that breed in North Dakota to transport deleterious parasites (such as bird malaria) from the breeding grounds into ecologically sensitive areas (*e.g*., Galapagos Islands), thus threatening endangered bird species that live there. Since nothing is known about the malaria parasites of North Dakota songbirds, this project could have important implications for global wildlife conservation. A third project compares the morphology of helminth parasites with their DNA sequences as a way to elucidate their general evolution. Because the parasitic life style often leads to a uniformity of body form, the evolutionary relationships among many similar-looking parasite species remain in doubt. This project will examine whether similarities and/or differences in DNA sequences can resolve the phylogenetic relationships between certain parasite groups. All three projects contain their own unique scientific objectives, but a commonality exists in the projects' blending of classical and molecular techniques. This combination, together with a vibrant team approach, will provide a stimulating and highly educational experience for advanced undergraduate research.

**Student Role in Project:**

This project is a team effort composed of three faculty researchers and four graduate students. The project seeks to recruit two AURA students. Students will participate in a wide range of research activities including; field research (e.g., collecting of birds and mosquitoes), parasitological techniques (recovery and slide-mounting of parasites), bench work (e.g., DNA based identification of parasites) and bioinformatics (e.g., use of computerized data bases to compare DNA sequences). AURA students will be an integral part of the research team and as such, will be expected to attend and actively participate in weekly laboratory meetings. At these weekly meetings, specific duties for each student will be assigned according to the specific target goals that have been defined and the progress made towards accomplishing those goals has been discussed. Students will receive training in research techniques, data management, and the analysis & interpretation of results.

**UND Dept. of Computer Science**
PI Name: Ronald Marsh Building Name and Office Room #: Streibel Hall Room 201
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**PROJECT TITLE:** Optimization of Airspace Risk Mitigation Model

**Project Objectives:**

Research is under way to develop a Risk Mitigation System (RMS) that analyzes air traffic trajectories and performs risk assessment on airspace of interest. This RMS will permit a high-degree of situational awareness, collaboration between a broad array of users, and a method to link information systems and users together in an efficient and effective manner. Such a system will provide for effective decision-making regarding safe UAS operations.

The RMS employs a Monte Carlo –based gas model to determine a probability of an interaction of a randomly traveling aircraft with a target in a three dimensional space of 50 square miles and height up to 4 miles. The moving aircraft is constrained by parameters that govern the maneuverability of a set of aircraft to be determined. During the random walk an angle of deviation from a straight line motion of the aircraft is limited to 10 degrees from the last direction of motion. A cross sectional area of the moving aircraft with a scaled distance based on the aircraft velocity is calculated as an impact parameter. The second aircraft is set as a stationary object with an effect volume of 500 cu. ft. An interaction of the moving aircraft and the stationary aircraft is determined by the overlap of the cross sectional areas. The probability of interaction is determined by the ratio of the number of interactions with the number of total number of random paths through the cube.

**Student Role in Project:**

The current model must be ported to C/C++ and verified for correctness. Once ported, the model must be optimized to the target architecture. Optimization requires an analysis of the target architecture, application of compiler and code optimizations and repeated testing for performance and correctness. We must also explore the possibility of parallelizing the model, which will require another round of optimizations and testing. The student may also have to contribute to the development of the target parallel architecture as it has not yet been identified. The student research component falls under the classification of “experimental computer science.”

**UND Dept of Electrical Engineering**
PI Name: Reza Fazel Building Name and Office Room #: Upson II, 160
Phone #: 777-3368 Fax #: 777-5253 Email address: reza@mail.und.edu

**PROJECT TITLE:** Controlling Brain Wandering using a Neurofeedback System

**Project Objectives:**

In the proposed research, a neurofeedback system will be developed. This system will be used in several projects that the PI is involved in with collaboration with faculty members of the School of Aerospace Sciences at UND. The main target will be to develop a neurofeedback system to enhance the performance of the subjects in flight simulators and air traffic control. Using the hardware (EEG amplifiers) available at the Biomedical Signal Processing Laboratory in the Department of Electrical Engineering, a software package in MATLAB environment will be developed to monitor different frequency bands of brain activities. Simple paradigms will be designed to train subjects to produce specific brain rhythms.

**Student Role in Project:**

An undergraduate student considered for this research proposal will work at the Biomedical Signal Processing Laboratory and will be responsible for developing the computer program interface and paradigms for the neurofeedback system. He/She will use MATLAB and Simulink to develop an interface and display paradigms for the neurofeedback system in a monitor. In addition, he/she will help in collecting data from different subjects in flight and air traffic control simulators. Although he/she will be working in a team, responsibilities will be clear and work will be done under direct supervision of Dr. Fazel.

**UND Dept of Electrical Engineering**
PI Name: Sima Noghanian Building Name and Office Room #: Upson II, 160M
Phone #: 777-4433 Fax #: 777-5253 Email address: sima@mail.und.edu

**PROJECT TITLE:** Parallel Programming for Microwave Imaging

**Project Objectives:**

Microwave imaging is one of the most powerful non-destructive imaging methods. However the efficiency of the method is limited by the computation time needed for image reconstruction. To improve the computation time parallel computing can be employed. The objective is to improve the parallel fast solver, developed in our research group based on the Finite Difference Time Domain (FDTD) numerical method, to be used in the microwave imaging system. The program is written using C language and Message Passing Interface (MPI). The MPI is a widely embraced standard that allows a user to run programs across multiple computers or on a parallel computer.

**Student Role in Project:**

A one dimensional parallel FDTD program (in C language using MPI) has been written and tested on cluster high performance computers (in the University of Manitoba and on WestGrid). The student's role is to:

1- Test the one dimensional program on Shale cluster (University of North Dakota High Performance Computer).
2- Extend the one dimensional parallel FDTD to two dimensional parallel FDTD.
3- Test the developed parallel FDTD within the microwave image reconstruction program.

In these tasks the student will be supervised by Dr. Noghanian and receive help from one of her Ph.D. students who is developing the image reconstruction program.

**UND Dept. of Mathematics**
PI Name: Ryan Zerr Building Name and Office Room #: Witmer 313
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**PROJECT TITLE:** Generalized Ducci Sequences

**Project Objectives:**

A classical problem dating to the 1930s asks for a characterization of the behavior of strings of integers (a,b,c,d) under iteration by the so-called Ducci mapping T(a,b,c,d)=(|a-b|,|b-c|,|c-d|,|d-a|). It has been shown that in this case the sequence of iterates (a,b,c,d), T(a,b,c,d), T(T(a,b,c,d)),… obtained through repeated application of the Ducci map will always reach the zero tuple (0,0,0,0) in a finite number of steps. In addition, some natural generalizations to this problem have been considered, such as expanding the domain to include tuples of real numbers, studying the effect of string length on the long-term behavior, or introducing a weighting and analyzing the possible changes in the behavior of the iterates. A number of these more general questions have been considered and solved; however, a surprising number still remain open. This project will involve a consideration of some of these open problems, with a particular emphasis on studying the effects of generalizing the function T by using permutations.

**Student Role in Project:**

The student working on this project will investigate the behavior of Ducci sequences for a variety of different input vectors and a variety of different generalizations of the Ducci map. These investigations will initially be carried out by running computer simulations as part of a conjecture-building process. These conjectures will then be investigated with a view toward their confirmation through rigorous proof. Throughout this process the student will be reading and searching the relevant mathematical literature for known results and established techniques. The goal of this project will be to more fully understand the behavior of Ducci sequences and generalized Ducci sequences, and to prove a number of new mathematical facts related to this.

**UND Dept. of Mechanical Engineering**
PI Name: Matthew Cavalli Building Name and Office Room #: 274 Upson II
Phone #: 777-4389 Fax #: 777-2271 Email address: matthewcavalli@mail.und.edu

**PROJECT TITLE:** Diffusion Bonding of High Temperature Alloys

**Project Objectives:**

The efficiency of turbine engines and coal-fired power plants is directly related to the temperature of their process gases. The higher the process gas temperature, the more energy that can be extracted from them and the higher the process efficiency. A limiting factor for process gas temperature is the melting temperature of the design components. But thermal degradation of materials can be significant well below the melting temperature. Creep, continuous deformation under constant applied load, can be considerable in metal alloys at any temperature above about $0.5T_M$ (melting temperature). An example of creep deformation would be a turbine blade elongating due to the centrifugal forces of rotation until it contacts the shroud, leading to catastrophic failure.

Traditional joining methods such as arc welding involve melting the base metal which destroys the creep-resistant structure and leads to premature failure under elevated temperature service. More recently, diffusion bonding has garnered interest for bonding high temperature alloys. This process typically involves placing a lower melting temperature foil between the pieces to be bonded. Upon heating, the foil melts and diffuses away from the bondline, forming a continuous joint. Diffusion bonding has been used to successfully bond iron- and nickel-based alloys while maintaining the microstructure needed for high temperature strength and creep resistance. This project will focus on fabrication and analysis of diffusion bonded joints of iron, nickel and their alloys to better understand the process and the resulting joint properties.

**Student Role in Project:**

The AURA student will work closely with the PI on all stages of specimen preparation and analysis. Tasks will include sectioning samples from metal stock and polishing them flat, bonding samples under vacuum in the tube furnace and performing microstructural and chemical analyses using metallurgical and scanning electron microscopes. In some cases, desired stock metal compositions may not be available commercially and will need to be fabricated using a vacuum induction furnace currently under construction in the department. The student will be introduced to the concept of Design of Experiments (DOE) as a means of increasing experimental efficiency and identifying the relative importance of process variables like temperature, pressure, time and chemistry. Depending on the student's aptitude and interest, as well as the progress of the experimental program, the PI may introduce the student to numerical modeling tools that can be used to predict the diffusion of materials.

**UND Dept. of Mechanical Engineering**
PI Name: Matthew Cavalli Building Name and Office Room #: 274 Upson II
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**PROJECT TITLE:** Corrosion-Fatigue of Aluminum Alloys

**Project Objectives:**

The General Accounting Office estimates at least 25% of the Navy's maintenance budget is spent to combat corrosion. Future systems will only exacerbate the problem. Each new design requires novel materials and innovative fabrication techniques, which can lead to unique fatigue and corrosion problems. Improving the understanding of fatigue and corrosion will lead to better methods of control, better designs, and less money spent on repairs.

This project will focus on corrosion-fatigue testing of aluminum alloys and welded joints. The specific type of welded joints that are of interest are friction stir welded joints. Friction stir welding, a relatively new joining method that has various advantages over traditional arc or resistance welding, is somewhat unique in that the corrosion behavior of the joint is not the same on both sides of the weld. This arises from fundamental changes in material microstructure during the welding process, which does not melt the material but forms a bond by a combination of heating and severe plastic deformation. During the process, material on one side of the weld is 'pulled' and material on the other side is 'pushed', leading to very different microstructures and very different fatigue and corrosion behaviors. Maximizing fatigue life and minimizing corrosion of friction stir welded joints is essential for the next generation of naval designs.

**Student Role in Project:**

The AURA student will work closely with the PI on all stages of specimen preparation and analysis. Tasks will include sectioning samples from the metal stock or welded plates, preparation of the samples for testing, operating the electromagnetic fatigue testing machine, and performing microstructural and chemical analyses using metallurgical and scanning electron microscopes. The student will be introduced to the concept of Design of Experiments (DOE) as a means of increasing experimental efficiency and identifying the relative importance of process variables like electrolyte molarity, loading range and loading frequency. During the course of the project the student will conduct a guided review of the scientific literature which will inform the design of a series of fatigue corrosion experiments. Results will be presented internally to the PI's research group and externally in a conference proceeding or journal submission.

**UND Dept. of Mechanical Engineering**
PI Name: Jeremiah Neubert Building Name and Office Room #: Upson II, Room 272
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**PROJECT TITLE:** Qualitative Robotic Task Specification

**Project Objectives:**

Powerful methods for the visual control of robots have existed for some time, but yet the applications of these methods seem to be limited to manufacturing and the laboratory. Furthermore, the use of tele-operated robots is a growing area with applications in bomb disposal, nuclear reactor maintenance, medicine, and assisting humans despite the fact that such robots are difficult to use and require a trained expert. One must ask, “Why do these systems not utilize the various vision systems to aid the user?" A major inhibiting factor to the expanded use of visually controlled robotics is the failure of existing systems to fully exploit the strengths of the human operator and computer. There is a desperate need to increase the usability of visual robot control algorithms without limiting their flexibility. This can be accomplished by combining the user's ability to segment and understand images with technologies from computer vision, graphics, and robot control. The availability of an intuitive human-robot interface will facilitate wide spread adoption of visually controlled robots. In order to construct this interface it is necessary to develop more robust methods for extracting 3D information from images and use this information to control a robot. Specifically, the PI proposes to improve stereo matching (matching items of interest between two images) by producing small motions with one of the cameras similar to those used by human to obtain an initial position estimate. The improved method will yield the location of the object in the world which is imperative to the success of the interface.

**Student Role in Project:**

The project has a wide variety of opportunities for students at all levels. This year’s student will build on the accomplishments of the AURA student that worked on this project during the summer of 2008. During this time a system was developed for calibrating and modeling the vision system and robot. The incoming student will conduct experiments using a single camera mounted on a pan tilt using to estimate the position of an object. The 3D location of an object is found by moving the camera to several positions and analyzing how its position changes in the images. The problem is that when the camera’s motion is small, as is the case here, the signal to noise ratio becomes small. The student will investigate how Bayesian statistics can be used to maximize the information obtained from the data to get the best possible estimate of the object’s position.

**UND Dept. of Nursing**
PI Name: Cindy M. Anderson Building Name and Office Room #: College of Nursing, 340D
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**PROJECT TITLE:** Maternal Vitamin D Status and Risk for Preeclampsia

**Project Objectives:**
The **objective of this project** is to identify the role of vitamin D status as a determinant of vascular dysfunction underlying the development of preeclampsia and cardiovascular disease. The rationale for these studies is that rural women in the northern plains are at significant risk for vitamin D deficiency, a condition linked with preeclampsia and cardiovascular disease. We propose to test the *central hypothesis* that maternal vitamin D deficiency during pregnancy impairs vitamin D placental transport and availability, leading to placental insufficiency and development of preeclampsia. *Rationale*: Reduced vitamin D availability due to altered placental transport leads to inadequate placental angiogenesis and the subsequent development of preeclampsia.

**Student Role in Project:**
The AURA student's role in this project will be to assist in the determination of vitamin D status during pregnancy and pregnancy outcome. The following specific aims will be carried out:
Specific Aim 1: Elucidate the association between alterations in maternal vitamin D status and vitamin D transport across the placenta. *Our working hypothesis* is that marginal vitamin D deficiency during the first trimester of pregnancy leads to altered placental vitamin D transport in late gestation.
Specific Aim 2: Determine the relationship between placental vitamin D transport and maternal preeclampsia. *Our working hypothesis* is that reduced vitamin D transport during pregnancy induces altered placental angiogenesis leading to placental insufficiency and preeclampsia.
Specific Aim 3: Determine the relationship between placental vitamin D transport and fetal growth. *Our working hypothesis* is that impaired vitamin D transport during pregnancy induces altered placental angiogenesis leading to placental insufficiency and impaired fetal growth.

**UND Dept of Pharmacology, Physiology & Therapeutics**
PI Name: Van A. Doze Building Name and Office Room #: Medical School, Rm. 5700
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**PROJECT TITLE:** Adrenergic Regulation of Neurogenesis & Cognition

**Project Objectives:**
Neurogenesis is the production of new nerve cells in the brain. Norepinephrine (NE), an endogenous neurotransmitter, may be involved in promoting neurogenesis through the activation of alpha$_{1A}$ adrenergic receptors (ARs). The goal of this project is to obtain additional evidence for a possible role of alpha$_{1A}$ARs in adult neurogenesis. Recently, our research group found that mice genetically engineered to overexpress alpha$_{1A}$ARs which appear to be less prone to hyperexcitability (seizures), have enhanced learning and memory processes, and perhaps even live longer. These animals also appear to possess more inhibitory nerve cells called interneurons, particularly in their hippocampus, an area of the brain critical for learning and memory, highly susceptible to seizures, and often involved in temporal lobe epilepsies. Based on this preliminary evidence, we have hypothesized that NE, through activation of alpha$_{1A}$ARs *stimulates the production of new neurons, leading to improved cognitive function.* To test this hypothesis, this project will use transgenic mice engineered to overexpress a constitutively active $\alpha_{1A}$AR to determine the effects of alpha$_{1A}$AR activation on hippocampal cell populations and plasticity. Fluorescent microscopy, transgenic animal technology, immunohistochemical, electrophysiological and stereological techniques will be used to achieve these aims. The results of this project will not only yield information about the role of norepinephrine in hippocampal neurogenesis and cognition, but should increase our understanding of the development, regeneration, and aging of the nervous system, as well as possibly leading to development of new strategies for treating neurodegenerative disorders.

**Student Role in Project:**
The AURA student will be a contributing member of this PI's research group which currently consists of a part-time lab technician, two graduate students and several undergraduate students. In addition to basic lab procedures, the student will learn immunohistochemical and stereological methods, fluorescent microscopy, mouse transgenics, and electrophysiology recordings. These procedures are in routine use in the PI's lab. The AURA student will be taught how to execute the experiments, analyze data, interpret the findings, and make short presentations. In addition to daily interactions with the PI and his lab personnel, the AURA student will attend lab meetings at which data will be presented and the entire lab will discuss the significance of the findings and future research directions. The AURA student may also be provided the opportunity to stay in the lab beyond the term of this award.

**UND Dept of Pharmacology, Physiology & Therapeutics**
PI Name: Van A. Doze Building Name and Office Room #: Medical School, Rm. 5700
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**PROJECT TITLE:** RGS Proteins in $\alpha$2A Adrenergic Receptor-Mediated Antiepileptic Actions

**Project Objectives:**

The long-term goal of our research is to identify new epileptic therapies by characterizing the effects of norepinephrine (NE) on epileptiform activity in the hippocampus, a cortical structure important for learning and memory and often involved in seizures. We have shown that NE, through activation of an alpha-2A adrenergic receptor ($\alpha_{2A}$AR) in the hippocampal CA3 region, reduces epileptiform bursts, which could have significant implications in the treatment of epilepsy. The understanding of this action is currently limited only to ligand-receptor interactions, as the underlying molecular mechanism is unclear. The $\alpha_{2A}$AR mediates its actions via G proteins, predominately $G_o$ and $G_i$. It is thought that $G\alpha_o$ modulates calcium channels and inhibits presynaptic neurotransmitter release, whereas $G\alpha_i$ is believed to primarily regulate potassium currents which occur both pre- and post-synaptically. These G proteins are, in turn, regulated by GTPase-accelerating RGS proteins. This project will examine the role of RGS proteins in mediating the $\alpha_{2A}$AR-mediated antiepileptic effects of NE. Field potential electrophysiological recordings, transgenic mice, and pharmacological methods will be used to determine which RGS protein(s) modulate the antiepileptic effects of NE in vitro, and if the enhancement of $\alpha_{2A}$AR-mediated antiepileptic effects occurs in vivo. The results of this project will not only yield information about the role of NE in attenuating epileptic activity, but may reveal novel targets for potential antiepileptic drug development research, as manipulations of RGS proteins could represent a new therapeutic strategy for treating seizures.

**Student Role in Project:**

The AURA student will be a contributing member of this PI's research group which currently consists of a part-time lab technician, two graduate students and several undergraduate students. In addition to basic lab procedures, the student will learn electrophysiological recordings, mouse transgenics, and pharmacological methods. These procedures are in routine use in the PI's lab. The AURA student will be taught how to execute the experiments, analyze data, interpret the findings, and make short presentations. In addition to daily interactions with the PI and his lab personnel, the AURA student will attend lab meetings at which data will be presented and the entire lab will discuss the significance of the findings and future research directions. The AURA student may also be provided the opportunity to stay in the lab beyond the term of this award.

**UND Dept. of Pharmacology, Physiology & Therapeutics**
PI Name: Eric Murphy Building Name and Office Room #: 3700 Edwin James
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**PROJECT TITLE:** Role of alpha-synuclein in astrocyte cholesterol metabolism

**Project Objectives:**

The **Objective** is to elucidate the impact of alpha-synuclein on astrocyte cholesterol metabolism. We have previously demonstrated, using an alpha-synuclein gene-ablation model, that in the absence of alpha-synuclein brain cholesterol mass is elevated (J. Neurochem. 101:132-141) and that astrocyte cholesterol mass is elevated (J. Neurochem. 94:839-849). This increase was not the result of altered expression of key proteins involved in brain cholesterol synthesis, suggesting that alpha-synuclein has a direct role in modulating brain cholesterol metabolism. Because astrocytes synthesize cholesterol in the adult brain, our **Central Hypothesis** is that the presence of alpha-synuclein modulates astrocyte cholesterol synthesis and metabolism. This hypothesis will be tested by incubating astrocytes cultured from alpha-synuclein +/+ and -/- mouse brain with [$^{14}$-C]acetate to measure cholesterol synthesis. In a parallel set of experiments, astrocyte HMG-CoA reductase activity will be assayed. Because cholesteryl esters are increased in these model systems, cells labeled with [$^{3}$H]cholesterol and subsequently treated with sphingomyelinase will be used to determine alterations in cholesteryl ester synthesis, which will be confirmed by measuring acyl-CoA cholesterol acyl transferase activity. It is our expectation that alpha-synuclein influences cholesterol metabolism via an influence on enzymes involved in cholesterol synthesis, however an alternative hypothesis is that alpha-synuclein modulates astrocyte cholesterol export via a potential interaction with cholesterol export proteins. This alternative hypothesis will be tested by measuring the export of preformed radioactive cholesterol into the medium. This alternative strategy could also account for the observed elevated cholesteryl ester levels, which will be confirmed by this experiment.

**Student Role in Project:**

The student will be responsible for all aspects of this project, including learning to genotype the mice, techniques essential in mouse husbandry, and culturing of astrocytes from neonatal mouse brains. In addition, the student will learn techniques used to assay enzyme kinetics as well as learning radioactive tracer techniques. The latter will require the student to become well versed in the handling of radioactive materials. More importantly, the student will be guided in the analysis and interpretation of acquired data, including statistical analysis of the results. During and following completion of this study, the student will be taught how to write a scientific manuscript for submission to a peer-reviewed journal, e.g. J. Neurochemistry or Biochemistry. This is an important aspect of the overall research experience and will afford the student a true culmination of their summer research efforts and give them a lasting tangible result.

**UND Dept. of Pharmacology, Physiology & Therapeutics**
PI Name: James Porter Building Name and Office Room #: School of Medicine, Room 3700
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**PROJECT TITLE:** Hormone-Initiated Intracellular Scaffolding Complexes that Protect Against Cell Death

**Project Objectives:**

Programmed cell death is a tightly regulated biological process important for tissue development and immune responses. Heat shock proteins (HSPs) represent an emerging model for regulating apoptotic signaling events because of their protective properties. We have recently established in human cells following pre-incubation with a selective β adrenergic receptor (AR) agonist, an association of the small heat shock protein (HSP) 27 with both β-arrestin isoforms that was sufficient and necessary to protect against a subsequent challenge with an inducer of apoptosis. However, no information is described in the literature regarding any biochemical mechanisms that may be associated with our observations.

To better understand the intracellular signaling processes occurring, DNA microarray technology was used to characterize genomic expression pattern changes brought about by βAR stimulation prior to incubation with staurosporine. Analysis and grouping of altered gene targets suggested consequential relationships between other signaling molecules and the β-arrestin/HSP27 complex. Our ***premise*** is that formation of βAR-initiated multicomponent signaling complexes (*i.e.*, signalosomes) are mechanisms by which modulatory effects on programmed cell death are mediated using β-arrestin and HSP27 to traffic proteins for specific cellular locations.

Two specific β-arrestin/HSP27 trafficking mechanisms based upon grouping of these identified gene products into functional categories can be hypothesized. Validation of these mechanisms will be confirmed using molecular as well as *in vitro* and *in situ* immunologic analysis. Results from these studies will further our understanding of signaling cascades associated with β-arrestin cytosolic protein complexes along with providing clarity concerning the regulation of HSPs and programmed cell death.

**Student Role in Project:**

The AURA student will be a contributing member of this research team, which includes a third year graduate student, both of whom will be directly supervised by the principal investigator. In addition to understanding basic laboratory operations, the student will become knowledgeable in nucleic acid isolation, microarray technology, real-time RT-PCR protocols, immunoblotting methodologies and cell culture techniques. The student will be taught how to consistently execute these experiments, analyze raw data, interpret results and ultimately will be expected to make short written and oral presentations of their findings. These anticipated communications specifically performed by the AURA student will include daily interactions with the research team, informal presentations at weekly laboratory meetings, abstract submissions to local, regional or national symposia, formal poster presentations at scientific meetings and finally co-authorship of peer-reviewed manuscripts. All of these activities serve to disseminate the student's scholarly works and increase their success for future scholarship applications.

**UND Dept. of Physics**
PI Name: Dr. Wayne Barkhouse Building Name and Office Room #: Witmer Hall, Room 219
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**PROJECT TITLE:** Unveiling the Optical Counterparts to X-ray Galaxy Clusters

**Project Objectives:**

Clusters of galaxies are one of the most massive, gravitationally relaxed, concentrations of matter in the Universe. As such, they play a key role in our endeavor to understand how galaxies evolve in high-density environments. In order to sample galaxy clusters over a wide range in distance, and hence look-back time, a statistically significant compilation of clusters must be assembled. The detection of galaxy clusters has mainly been done by utilizing X-ray and optical methods. Multi-wavelength cluster detection schemes generally overlap in their ability to distinguish clusters from the background galaxy field population, but they sample different regions of parameter space that fully characterize the properties of clusters. Understanding how galaxy clusters are detected by various techniques, with their associated bias and selection functions, is a fundamental avenue of astronomical research.

In order to compare X-ray and optical cluster detection methods, we have assembled a sample of 210 extended X-ray sources (*i.e.* galaxy cluster candidates) detected serendipitously using data from the *Chandra X-ray Observatory* archive. In addition, we have obtained optical and near-infrared imaging data for 24 clusters in order to study their properties at multiple wavelengths. These datasets will permit us to search for interesting X-ray/optical clusters that span a large range in distance, allowing us to develop an understanding of how galaxies evolve in the high-density cluster region.

**Student Role in Project:**

The role of the student for this research project is to; 1) learn the methods and procedures involved in reducing astronomical image data into a format that is suitable for scientific analyses, 2) look for optical galaxy counterparts to the extended X-ray sources detected previously, 3) employ the luminosity and color characteristics of cluster galaxies to learn about the physical properties of each cluster, and 4) contrast and compare X-ray and optical cluster detection schemes to map the bias that plague both methods. In addition, the student will help with preparing their conclusions for publication in a peer-reviewed scientific journal, with the possibility of attending a major national astronomical meeting to present their research results.

**UND Dept. of Physics**
PI Name: Graeme Dewar Building Name and Office Room #: 213 Witmer Hall
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**PROJECT TITLE:** Negative Index of Refraction Metamaterial

**Project Objectives:**

The fabrication of so-called ``smart'' metamaterials which have indices of refraction unavailable in naturally occurring or easily synthesized materials has opened up new possibilities for devices and optical systems. For example, it is possible to create metamaterials which allow one to create images which have detail significantly smaller than the wavelength of the light involved and one can create cloaking materials which operate on different principles than the current stealth technology used by the military to hide aircraft from enemy radar.

The proposed research is unique in that a normal magnetic material is used to create a negative permeability. The other essential ingredient for a negative index of refraction is a negative permittivity which is provided by a wire array photonic crystal. The thrust of this project is to fabricate and measure the index of refraction (in the 12 - 18~GHz microwave regime) of such a metamaterial. My calculations regarding the expected behavior of this metamaterial have been tested by experiment. The next step is to tune the relevant parameters so that the most interesting behavior occurs in the frequency range available with our apparatus. This involves design of the wire array, fabrication of the metamaterials(s), characterization of the electromagnetic response of the metamaterials by performing microwave reflection and transmission measurements on samples, and analyzing the results. I expect these results to be presented at a national conference and published in a refereed journal.

**Student Role in Project:**

The AURA student's role in this research will be to learn the relevant physics, learn to use the computer programs used to predict the index of refraction of the structures of interest and design these structures, to fabricate these metamaterials, to perform microwave transmission and reflection measurements on the metamaterials, and to help organize the results of these measurements into an oral presentation and a research paper.

**UND Dept. of Physics**
PI Name: Glenn I. Lykken Building Name and Office Room #: 101 Witmer Hall
Phone #: 777-3519Fax #: 777-3523 Email address: glenn_lykken@und.nodak.edu

**PROJECT TITLE:** Alpha Radiation in Secondhand Smoke

**Project Objectives:**

Currently there is concern about health hazards of secondhand cigarette smoke (SHS). We propose to capture SHS and determine the alpha particle activity in secondhand smoke. We propose to establish that SHS contains polonium-210, the highly radioactive alpha particle emitting carcinogen that was used to murder former Russian spy Alexander V. Litvinenko in 2006. Identification of polonium-210 in SHS will give credence to efforts to prohibit smoking in public establishments especially when children less than 18 years of age are present. In conjunction with sampling SHS we will also measure the environmental radon concentrations in regions with SHS.

**Student Role in Project:**

The student will help collect samples from private dwellings and public establishments where minors are allowed to be present. The student will learn how to operate the alpha spectrometer and collect data on polonium-210 alpha particle emissions. Furthermore, the student will also learn how to operate the scintillation counter to determine radon concentration in air collected in the Lucas cells. The student will learn about sampling statistics and data analysis as well as the physics of radioactive decay of environmental radon of which polonium-210 is a daughter. The student will be encouraged to present his/her findings at a scientific meeting such as the annual meeting of the North Dakota Academy of Science or The Health Physics Society or possibly Experimental Biology-20??.

**UND Dept of Physics**
PI Name: Tim Young Building Name and Office Room #: 226 Witmer Hall
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**PROJECT TITLE:** Coordinated Telescope Observations of Extra-solar Transiting Planets and Gamma-ray Burst Optical Afterglows

**Project Objectives:**

1) We have received funding for a new camera to observe extra-solar transiting planets. The goal is to identify 10 of these objects by the end of 2009.

2) In addition, 10 follow-up observations of GRBs from NASA-SWIFT satellite detections will be monitored, including one independent GRB discovery at UND by Jan 2010.

3) Develop new techniques in low signal to noise photometric observations.

4) Make used of the UND – University of Minnesota-Crookston collaboration of telescopes. UND – TOAST and UMC – CRUST.

5) Develop techniques in simultaneous observations of candidate extra-solar transiting stars.

6) Create an online database for images taken by TOAST and CRUST.

**Student Role in Project:**

1) Learning state of the art observing techniques using small telescopes. (telescopes with diameters around 0.25 meters at UND and UMN-C). Work with automated roof apartaus.

2) Learning photometric software packages such as MaximDL, ACP, TheSky, & Pinpoint.

3) Creating an astronomical image online database.

4) Develop a spiral telescope search and cloud detection indicators.

5) Bringing two telescopes online and automate observations.

6) Develop ACP programs to simultaneously observe objects and prioritize observations.

**UND Dept. of Psychology**

PI Name: F. R. Ferraro Building Name and Office Room #: Corwin-Larimore 303

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**PROJECT TITLE:** Risk, Decision Making, & Information Processing: Application to Unmanned Aerial Vehicles (UAVs)

**Project Objectives:**

The use of Unmanned Aerial Vehicles (UAVs) has dramatically increased over the past 5-10 years and many of the applications involve non-military uses. The pilots of UAVs, unlike more traditional aircraft, are not physically in the air but pilot the UAV from the ground, and thus from a secure location. Piloting from the ground dramatically reduces any sort of risk to the pilot, for if the UAV crashes the pilot is still safe and sound on the ground (and often hundreds and/or thousands of miles away from where the UAV is flying. Because of this lower risk of loss of life, it may be the case that the decision making and risk perception of the UAV pilot is lowered, thereby resulting in possible increases in risky piloting behavior. Unfortunately, there is little empirical evidence of whether such increases in risky behavior actually occur. To this end the present proposal will examine whether lowered risk perception (by adopting the role of a UAV pilot) increases risky behavior and what, if any, psychological and information processing attributes are related to these increases. This proposal will also develop a lab-based protocol that can then be used with actual UAV pilots. One goal of this protocol is to aid in the selection of individuals able to pilot UAVs but not be bogged down by increases in risky behavior.

**Student Role in Project:**

Since the initial components of this proposal involve the use of human sucbjects, the AURA student will call young adult subjects to schedule apppointments in the PIs lab on the UND campus. AURA student will also test participants, help with data entry, help with data analysis, and assist in poster/publication presenattions. The PI has worked with many AURA students before and ensures that all aspects of the research topic (from reading papers to writing up results) is covered. Weekly meetings will take place as well as assisatnce in designing posters, writing for publication, and getting the hands-on aspects of all components of the research endeavor accomplished. The AURA student is seen as a colleague, learning the ways of successful research as well as how to present the research findings.

**UND Dept. of Psychology**

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**PROJECT TITLE:** Advancing the Science of Suicide Prevention: Identifying the Inter-Relationship between Non-Suicidal Self-Injury and Suicide in Young Adults

**Project Objectives:**

Suicide is the second leading cause of death among college students and the 3rd leading causes of death in youth aged 15 to 25 years. Additionally, up to 30% of college students report a history of engaging in non-suicidal self-injurious behaviors (NSSI), which has been identified as a potentially significant risk factor for suicidal behavior. Despite the apparent connection between NSSI and suicide attempts, there remains a notable lack of research identifying factors that increase the likelihood a person will engage in NSSI. An even larger deficit exists in the research examining what factors increase suicide risk among those with a history of NSSI. Being able to identify the factors that increase, as well as those that decrease risk for NSSI and suicide can inform critical prevention and intervention efforts geared towards saving young lives.

The primary study objectives are to produce two research manuscripts by analyzing an existing epidemiological-based sample of college students (n = 14,329) drawn from 8 colleges around the U.S. including UND to: 1) identify critical demographic and psychosocial factors associated with engaging in NSSI, 2) examine the incremental level of risk (odds ratio) for suicidal behavior contributed by frequency and history of NSSI, and 3) identify factors associated with having attempted suicide among a subsample of participants reporting a history of NSSI. This study will enhance current understandings of risk for suicide among young adults and evaluate the potential accuracy of a current theory of suicidal behavior that postulates NSSI as being critical to understanding long-term risk for death by suicide.

**Student Role in Project:**

The AURA student will be trained in various aspects of the research process including study conceptualization and conducting research on sensitive topics (IRB training), data entry and analysis, interpretation of results, and the dissemination of findings. The student will attend regular research group meetings to discuss the study progress, address concerns with data analysis/writing, learn how to consume research, and identify how research is essential to advancing the scientific background of professions. He/She will be closely mentored by the PI and graduate student RAs to conduct basic and advanced statistical analyses using SPSS, to prepare the research findings for regional and national conference presentations (ND EPSCoR, Northern Lights Psychology Conference, American Psychological Association), and coauthor publications in peer-reviewed journals. The student will also be provided with a PI mentored opportunity in writing nationally competitive research grants for the study of suicidal behavior, which will use data from the proposed study to inform the research goals of the grant submission.

**UND Dept. of Psychology**

PI Name: Jeffrey N. Weatherly Building Name and Office Room #: Corwin-Larimore, 205

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**PROJECT TITLE:** Studying Gambling Experimentally

**Project Objectives:**

Pathological and problem gambling afflict over 5% of the population, sparking a great deal of research. Unfortunately, very little of that research has employed experimental methodology. That fact is problematic because experimentation is the best and most straightforward method of determining cause-and-effect relationships, which is important if we intend to successfully understand, prevent, and treat problem gambling. My research program focuses on determining what environmental or personal history variables might influence if and how people gamble. I am especially interested at this point in time in determining the relationship between gambling and how people might discount events that may occur to them in the future. If discounting predicts actual gambling behavior, then addressing how people frame future events may serve as a successful treatment for problem gambling. Fortunately, we are in an excellent position to answer such questions. The state laws of North Dakota allow for experiments on gambling behavior to be designed so as to mimic actual gambling as closely as possible (e.g., using modern machinery, having participants risk money). Such designs are illegal in every other state in the union.

**Student Role in Project:**

The student would be asked to be involved in every aspect of this research, beginning with the formation of the research question and designing the procedure to test it. The student would then get IRB approval for the project, recruit participants, collect data with those participants, analyze the data, present the data at a conference, and write a paper to be submitted for publication. I have worked with four AURA students in the past. All four have appeared as authors on peer-reviewed research articles as a result.