2018 Red River Valley Physics and Astrophysics Undergraduate Research Symposium

Program

Saturday, April 21, 3rd floor of Hagen Hall, MSUM (Department of Physics and Astronomy)

- **12:30-1pm**
  - Check in.
    - Posters may be set up on easels and cardboard backing provided
    - Oral presentations may be put on HA325 computer (if needed), or AV may be tested for compatibility with individual laptops
- **1pm in Hagen 325**
  - Official welcome
    - SPS president Jane Glanzer
    - College of Science, Health, and the Environment Dean Jeff Bodwin
    - Chair, Department of Physics and Astronomy Steve Lindaas
- **1:10-2:30 poster presentations/refreshments in Hagen 3rd Floor Hallway**
- **2:30-3pm Refreshments, lab tours, department tours**
  - Lower division lab space, upper division lab space
  - Labs
    - Astro analysis lab
    - Tide pool (Physics/Biosciences collaboration)
    - NMR lab (Physics/Chemistry collaboration)
    - Fish ECG lab (Physics/Biosciences collaboration)
  - Equipment for teaching and research
    - 3D printer, Earth's field MRI, LabVIEW and ELVIS boards,
- **3-4 pm Oral presentations**
- **4-4:30 pm Planetarium presentation (Bridges Hall)**

Posters (1:10-2:30 pm, Hagen Hallway)

1) Jane Glanzer, MSUM, *Calculating Galactic Distances Through Supernova Light Curve Analysis,* The purpose of this project was to experimentally determine the distance to the galaxy M101 by using data that was taken on the type Ia supernova SN 2011fe. Type Ia supernovae are useful for determining distances in astronomy because of their ability to be standardized. The absolute magnitudes of the supernova could be used to determine a distance measurement and were estimated in two ways: using an empirical relationship from the literature between the rate of decline and the absolute magnitude, and using sncosmo, a python package used for supernova light curve analysis that fits model light curves to the photometric data.

2) Erin Aadland, MSUM, *Variable Stars in the Field of TrES-3b,* The star field around the exoplanet TrES-3b has potential for finding unknown variable stars (stars whose brightness changes over some period of time). The field was observed over several nights using Minnesota State University Moorhead's Feder Observatory. A light curve for each star was created and is being evaluated for variability and periodicity. A python program is in development to help complete the analysis by automating some of the process. Several stars in the field appear to be variable and are being further analyzed to determine a period and to classify the type of variable.

3) Paige Meyer, MSUM, *Zebrafish ECG Signal Amplification,* The long-term research goal is to understand behavioral patterns of zebrafish by using the heart rate to probe fish anxiety. This research works to improve the previous Ag-AgCl sensor's signal-to-noise ratio. The sensor tested in this research is an electric potential integrated circuit (EPIC) sensor, a newly developed electric potential sensor used to monitor the electrocardiogram (ECG) of zebrafish embryos. Two configurations for the EPIC sensor were tested. In the first configurations, a single sensor was placed below the zebrafish tank. The first configuration was not significantly different from the background noise. In the second configuration, two sensors were used. Although the double sensor model has not been tested on zebrafish yet, it looks promising as a human ECG was detected. The average, and deviation was calculated for each configuration. The results will be presented.

4) Joe Kitzman, UND, *Deposition of Ir on HOPG,* The formation of iridium (Ir) clusters on highly ordered pyrolytic graphite (HOPG) has been studied. This has been done using different deposition techniques to deposit Ir as well as different software and experimental methods to view and analyze the sample. Throughout the course of this project, we have observed the formation of different shapes of Ir islands form on the surface of HOPG in different sizes. To view the islands after deposition, both scanning tunneling microscopy (STM) and atomic force microscopy (AFM) were used to study the sample. The expected equilibrium crystal structure of Ir is face-centered cubic (fcc). HOPG was chosen as the substrate for this experiment because it is easily accessible and is relatively inert, so the expected crystal structure for the formation of HOPG on Ir is fcc, which would form a hexagonal shape on the surface of our sample. However, while varying both the deposition time and current, in addition to the expected hexagonal islands, square islands were also observed. This suggests that the equilibrium crystal structure is not fcc in these special cases. It has been noted that the formation of square islands corresponds to a crystal structure of simple cubic. We find why the shape transition for Ir island occurs and what causes this transition.

5) Andrew Louwagie Gordon, MSUM, *Examining the 2017 Solar Eclipse*, On August 21, 2017 there was a total solar eclipse, the first to cross the continental United States since 1991. From Ravenna Lake State Recreation Area in Nebraska, we observed the total solar eclipse, both photographically, and using a Sky Quality Meter and Spectrometer to make sky brightness and sky color measurements. Data was taken on sky brightness and color and the eclipse was photographed throughout the event. The motivation for this collection of data was to examine how the sky color changes as the sun became more obscured. In principle, examination of the changes in the sky brightness and sky color can be used to model the scattering of sunlight off gas molecules in the atmosphere. This presentation examines the design of the apparatus, and its major components and functions and the resulting data obtained and the processes by which it was analyzed. The results will be discussed.

6) Andrew Block, MSUM, *Source Detection and Photometry in Python*, Source detection in images is an important part of analyzing astronomical data. This project discusses an implementation of image detection in Python, as well as a processes for performing photometry in Python.

7) Sakurako Tani, Melissa Foley, MSUM, *Sodium Jump Distance* Most rechargeable batteries today are made with lithium as the mobile ion. However, because of lower cost and greater abundance of sodium, sodium shows promise for use in stationary batteries. Applications include solar and wind energy. In this research experiment the sodium ion

mobility (activation energy) was determined for 6 different glass compositions using sodium NMR data. The glasses we are studying are promising candidates for sodium batteries. They have relatively good ionic conductivity. The glass composition with the largest ionic mobility was determined, and the ionic jump distance was estimated. The results will be presented.

8) Salim Abdou Thomas, MSUM, ***Determining the best sodium conductor in a series of glasses using 23Na nuclear magnetic resonance****,* Most rechargeable batteries today are made with lithium as the mobile ion. However, because of lower cost and greater abundance of sodium, sodium shows promise for use in stationary batteries. Applications include solar and wind energy. In this research experiment the sodium ion mobility (activation energy) was determined for 5 different glass compositions using sodium NMR data. The glass composition with the largest ionic mobility was determined.

9) Elias Holte, MSUM, ***BinCat: a Catalog of Nearby Binary Stars with Tools for Calculating Light-Leakage for Direct Imaging Missions,*** Binary stars have been largely left out of direct imaging surveys for exoplanets, specifically for earth-sized planets in their star's habitable zone. Utilizing new direct imaging techniques brings us closer to being able to detect earth-like exoplanets around binary stars. In preparation for the upcoming WFIRST mission and other direct imaging-capable missions (HabEx, LUVIOR) it is important to understand the expected science yield resulting from the implementation of these imaging techniques. BinCat is a catalog of binary systems within 30 parsecs to be used as a target list for future direct imaging missions. There is a non-static component along with BinCat that allows researchers to predict the expected light-leakage between a binary component and its off-axis companion (a value critical to the aforementioned techniques) at any epoch. This is accomplished by using orbital elements from the Sixth Orbital Catalog to model the orbits of the binaries. The software was validated against the historical data used to generate the orbital parameters. When orbital information is unknown or the binaries are purely optical the proper motion of the pair taken from the Washington Double Star catalog is integrated in time to estimate expected light-leakage.

Oral Presentations (3-4pm, Hagen 325)

Each speaker will be given 20 minutes, with 10 minutes for questions

3-3:30pm: Nathan Carlson, UND, ***Object Orientated Novel Monte Carlo Algorithm Development for Physical Systems,*** This work describes both the Replica Exchange Cluster Algorithm (RECA) and an object oriented framework written in C++ for Monte Carlo Markov Chain sampling algorithm development relating to physical systems. The framework is oriented around lattice based systems. The goal is to provide flexibility, modularity and the ability to impart physical meaning directly into the code. RECA is a cluster algorithm that can be applied more widely than other specially tailored Monte Carlo Markov Chain cluster algorithms. Its development is motivated by the desire to study systems in presence of symmetry breaking fields. RECA itself is not capable of reaching all configurations of the overall system. Strategies for working with this shortcoming are described.

3:30-4pm: Christian Peterson, UND, ***Euler's Rotation Equations for a Freely Rotating Object and the Dzhanibekov Effect,*** Euler's rotation equations, a set of non-linear coupled ODE's, are solved analytically in the non-inertial or body frame of reference in terms of Jacobi's Elliptic functions. The solution constructs a transformation between the stationary and rotating frames by giving the time dependence of the Euler angles, Ï•, Î¸, and Ïˆ that define three factors of the rotation matrix. A computer animation of the elliptic function solution is applied to explain the flipping motion of a spinning T-handle in zero gravity, known as the Dzhanibekov effect, seen in several famous videos on the internet. A video of the Dzhanibekov effect at: https://www.youtube.com/watch?v=1n-HMSCDYtM