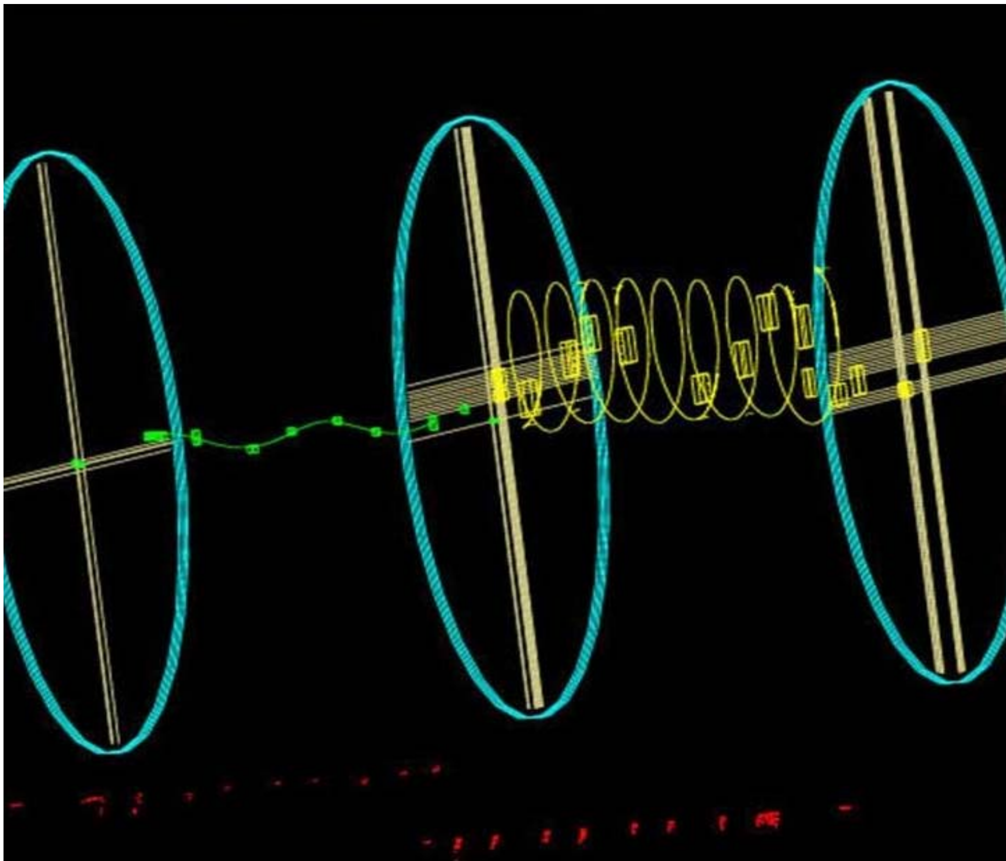
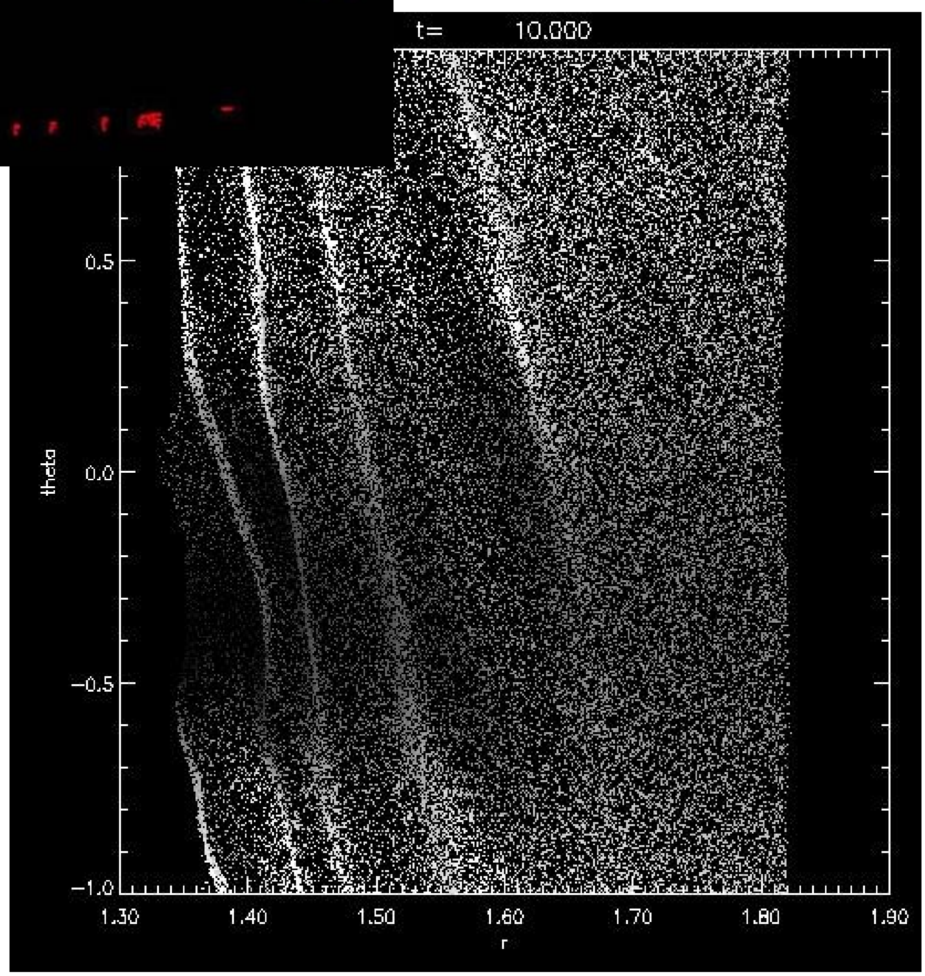
ASTRONOMY & PHYSICS
SUMMER UNDERGRADUATE RESEARCH CONFERENCE



SEPTEMBER 10, 2004



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SAINT MARY'S UNIVERSITY

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Upper figure on cover:
A screenshot from the main TWIST analysis software: MOFIA. Here a muon comes in (green) and decays in the target into a positron (yellow) downstream. The blue circles represent some wire chamber planes, where the fired wires are highlighted in gold.

Lower cover figure:
Results of an Nbody simulation of a dense particles ring that is perturbed by a nearby planet.

PROGRAM

Friday, September 10, 2004 in Sobey Room 265

Session 1: Planets, Stars, and Galaxies

10:00am	**(1.01)**	**Making waves with Sisyphus** **Simulating Spiral Waves with a modern n-body integrator** ***A. Chaffey, J. Hahn, P. Wiegert***
10:20am	**(1.02)**	**Determining Intrinsic Color Indexes Through Code** ***M. Chouinard, D. Turner***
10:40am	**(1.03)**	**Photometric Data Collection at the BGO** ***J. Derrah, D. Turner***
11:00am	**(1.04)**	**Bolometric Interpolator** ***C. Geroux, D. Guenther***
11:20am	**(1.05)**	**The Feasibility of the Yarkovsky Effect on Kuiper Belt Objects** ***D. Majaess, J. Hahn***
11:40am	**(1.06)**	**Physical Properties in the Molecular Gas of S0 Galaxies** ***J. Savoy, G. Welch***

12:00pm LUNCH

Session 2: Scintillation Counters, Dead Zones, and Circumstellar Emission

1:00pm	**(2.01)**	**Isolating the circumstellar emission of Sigma Orionis E** ***J. Tanner, I. Short***
1:20pm	**(2.02)**	**Detector Optimization: Novel Light Guide for Scintillation Counter** ***J. Glister, A. Sarty, B. Wojtsekhowski***
1:40pm	**(2.03)**	**Space Charges and Dead Zones in the TWIST Spectrometer** ***B. Barrett, A. Sarty***
2:00pm	**(2.04)**	**Forensics Using Cocoa and a Strobe Light** ***C. Tilley, A. Sarty, S. Mitchell, L. MacDonald, J. Williams***

2:20 COFFEE BREAK

Session 3: Computer Clusters and Cosmic Showers

2:50pm	**(3.01)**	**Parallel Processing on a Beowulf Cluster I** ***P. Rogers, N. MacDonald and R. Deupree***
3:10pm	**(3.02)**	**Parallel Processing on a Beowulf Cluster II** ***N. MacDonald, P. Rogers, R. Deupree***
3:30pm	**(3.03)**	**Simulations of Cosmic Ray Air Showers using Corsika 6020** ***A. Misner, J. Maclean, I. McLeod, M. Butler***
3:50pm	**(3.04)**	**Are EHECRs caused by Magnetic Monopoles** ***J. Maclean, M. Butler***

4:10pm CLOSE OF CONFERENCE

ABSTRACTS

SESSION 1: Planets, Stars, and Galaxies

(1.01) Making Waves with Sisyphus:
Simulating Spiral Waves with a modern n-body integrator
A. Chaffey, J. Hahn,(SMU), P. Wiegert (UWO)

Spiral wave phenomena have long been predicted to exist in discreet gravitating particle-disks. Observations of galactic disks confirm this prediction. The existence of these waves in planetary-ring systems has also been confirmed by direct observation: most prominently in the rings of Saturn by both the Voyager missions, and the more recent Cassini observations. In spite of the phenomena being apparently well-understood, to date no n-body simulations of a planet, satellite and particle-disk have been successful in producing spiral waves.

My research consists of utilizing a modern n-body integration scheme to resolve spiral waves in a planetary-ring system. The integrator utilizes a very fast momentum-conserving tree code to perform force calculations, and a Wisdom-Holman-type map to evolve the system based upon the forces calculated. In this talk I shall summarize spiral wave theory, include an overview of the observations of spiral waves, and report on progress to date in attempting to simulate them numerically.

(1.02) Determining Intrinsic Color Indexes Through Code
M. Chouinard, D. Turner, (SMU)

The use of dereddening techniques in the UBV system permits one to establish the intrinsic colors and reddenings of stars from their observed color indices, B-V and U-B. Others have coded such operations previously, but without the flexibility of user-specified reddening relations, proper conversions to stars of a common temperature type (essential for variable extinction studies), and the use of intrinsic relations for stars of all luminosity classes. Such software is essential for modern analyses of open cluster stars, in order to simplify the establishment of cluster distances and ages. The present study presents the results of coding new software for dereddening in the UBV system, with applications illustrated.

(1.03) Photometric Data Collection at the BGO
J. Derrah, D. Turner (SMU)

Observations with a moderate-sized reflecting telescope remain an effective method for collecting astronomical data of bright stars. At the Burke-Gaffney Observatory (BGO), the primary technique of data collection has been photometry, and for the past year and a half that has included solid state photometry using an Optec SSP-3 photometer. Since classical photometry has not been done at the BGO for several decades, one goal of the observations has been to collect raw data to establish relationships to correct for atmospheric extinction as well as to link the photometry to a standard system via transformation equations. To do that, readings have been obtained for various standard stars at different sky positions, and therefore at different air masses. Such calibrations are required to standardize the photometric data being collected for Polaris, the brightest and closest Cepheid variable star to us. The empirical correction of the observational measures for the effects of atmospheric extinction at the BGO is an essential first step in characterizing the pulsation of Polaris and other pulsating stars being observed with the telescope.

(1.04) Bolometric Interpolator
C. Geroux, D. Guenther (SMU)

The talk will start with a brief discussion of color indices. The Green et al. and Lejeune et al. color tables will be introduced with an explanation of how they are used to obtain color indices given certain stellar parameters. Finally how the reverse is done, obtaining the effective temperature and luminosity from the color indices, will be discussed.

(1.05) The Feasibility of the Yarkovsky Effect on Kuiper Belt Objects
D. Majaess, J.Hahn (SMU)

Recent studies have shown that the Yarkovsky Drift--a radiation force—plays an important role in delivering particles from the asteroid belt into the inner solar system. The force causes the asteroid's orbit to decay where it will eventually drift into chaotic resonances. In this talk I shall present evidence which suggests that the tiny force induced by the Yarkovsky effect is enough to deliver (~10-100m-sized) comets from Kuiper belt distances into resonances, whereupon they are either trapped or scattered into planet crossing orbits.

(1.06) Physical Properties in the Molecular Gas of S0 Galaxies
Jonathan Savoy and Gary A. Welch (SMU)

The goal of this study is to use CO line ratios to examine the physical conditions in the molecular gas of several S0 galaxies. These galaxies are disk galaxies that lack spiral structure and have an extremely small gaseous component. The paucity of gas makes S0s interesting because it implies that their evolution must be significantly different from that of normal spiral galaxies. The molecular gas is studied by determining the intensities of two or more collisional transitions of CO, a molecule that serves as a tracer for star-forming hydrogen. Intensity ratios are used in a model to establish the temperature and density of the gas. The results can then be compared to the well-studied gas in the Milky Way or other gas-rich spirals where star formation rates, densities, and temperatures have been established. The present study is unusual in that data has been collected from two different telescopes (the IRAM 30m and the JCMT 15m radio telescopes) that have nearly identical beamwidths for the 12CO(1-0) and 12CO(2-1) transitions, respectively. This allows the important 2-1/1-0 ratio to be determined without the common and quite uncertain corrections for differences in beam sizes, which would increase the uncertainty of the results. Intensity ratios for several galaxies are presented and their implications discussed.

SESSION 2: Scintillation Counters, Dead Zones, and Circumstellar Emission

(2.01) Isolating the circumstellar emission of Sigma Orionis E
J. Tanner, I. Short (SMU)

The flux level and spectrum of the Be star Sigma Orionis E (HD 37479) vary with its rotational phase. This is due largely to the existence of co-rotating circumstellar Hydrogen. The circumstellar clouds are observed with a series of high quality H-alpha and H-delta spectra. Modeling this material requires separating the underlying spectrum of the star from the spectrum of the circumstellar material. Using the PHOENIX model atmosphere and spectrum synthesis code, we have calculated new, more accurate models of the underlying stellar atmosphere and spectrum.

(2.02) Detector Optimization: Novel Light Guide for Scintillation Counter
J.Glister, A. Sarty (SMU) and B. Wojtsekhowski (Jefferson Lab)

Scintillation detectors are used in the high resolution spectrometers in Hall A of the Thomas Jefferson National Accelerator Facility. They are triggers for events (i.e. electron beam has collided with target) and help determine the speed of particles through time-of-flight measurements. Light guides are used to transport scintillation light from the scintillator to the photomultiplier tube by means of total internal reflection. There is a planned replacement of two of the scintillation planes and it is proposed that the 90 degree twisted light guides currently in use be replaced by a new adiabatic s-shape design (2 or 3 strips). Monte Carlo simulations were performed on different light guide geometries using CERN's Guide7. Collection efficiency and time resolution were used as criteria for guide efficiency. A 2-5x increase on collection efficiency and a 1.5-2x improvement on time resolution were found over simple light guides (i.e. rectangular and standard fishtail). An experimental test will also be performed on the s-shape guide to determine the angular acceptance of green laser light entering the guide that emerges from the other end.

(2.03) Space Charges and Dead Zones in the TWIST Spectrometer
B. Barrett and A. Sarty (SMU)

The TWIST experiment, currently in production at TRIUMF, uses a specially designed spectrometer to detect the helical tracks of positive muons and their decay positrons in a uniform magnetic field. In order to achieve high precision measurements of these tracks, dense stacks of wire chambers are used. Sometimes, after a muon causes a wire to fire in these chambers, that particular wire may remain "dead" for a period of time afterwards. This talk will describe what effects these "dead zones" have on the experiment and will give some results of my research on the topic. It will also briefly describe the TWIST experiment and the inner workings of wire chambers.

(2.04) Forensics Using Cocoa and a Strobe Light
C. Tilley, A. Sarty, S. Mitchell, L. MacDonald, J. Williams (SMU)

At St. Mary's University, a diploma in forensics is offered. Currently the first year forensics course is held on campus and is, therefore, not accessible to all who may like to expand their knowledge of the subject. To solve this problem, the first year course is being put online. This presents more problems which must be overcome. How would labs be put online in a way that would get the students to be involved in data collection? How would large blood spatter boards, larger than the size of a door, be put online without distortion? In this talk the techniques used in creating the online labs will be discussed.

SESSION 3: Computer Clusters and Cosmic Showers

(3.01) Parallel Processing on a Beowulf Cluster I

P. Rogers, N. MacDonald R. Deupree (SMU)

This project was to write a primer for Dr. Deupree on parallel processing using the 48-processor Beowulf cluster in the department. Parallel computing offers the ability to shorten the computational time spent on a problem by dividing that problem between a number of processors. We explored the specifics of what is involved in writing and running parallel codes, and what kind of gains in processor time (if any) were possible for different classes of problems.

To write a parallel code one must have a means by which to communicate information between different processors. The Message Passing Interface (MPI), a set of library calls that can be used in a FORTRAN code, is such a means. The use of MPI was a focus of our primer and an overview of its most important routines and their uses will be given.

(3.02) Parallel Processing on a Beowulf Cluster II

N. MacDonald, P. Rogers, R. Deupree (SMU)

This project was to write a primer for Dr. Deupree on parallel processing using the 48-processor Beowulf cluster in the department. Parallel computing offers the ability to shorten the computational time spent on a problem by dividing that problem between a number of processors. We explored the specifics of what is involved in writing and running parallel codes, and what kind of gains in processor time (if any) were possible for different classes of problems.

In our research we parallelized three problems of different classes –matrix multiplication, Monte Carlo simulation, and finite difference simulation—and explored whether parallel versions were any more efficient than their serial counterparts. We discovered that an efficient parallelization depends on the class of problem and whether the gain in having more processors work on a problem outweighs the cost of necessary communications. Detailed results of timing studies will be given.

(3.03) Simulations of Cosmic Ray Air Showers using Corsika 6020

A. Misner, J. Maclean, M. Butler, I. McLeo, (SMU)

The air shower code Corsika 6020 was dissected to better understand how cosmic rays showers occur in nature. Understanding of the code and decoding various binary files were done in order to create air shower graphs. Several runs were done at energy levels of 1 x10^5 to 1x10^7 GeV, and then graphed for comparison. Findings yielded the groups of low energy appeared to cluster, while at higher energies they stayed on the same increasing slope. Moreover, the area these showers covered were also analyzed, and found to range from 4 km^2 to 500 Km^2. Additionally, alternate binary files were decoded in the effort towards disc space conservation.

(3.04) Are EHECRs caused by Magnetic Monopoles?

J. Maclean, M. Butler (SMU)

This summers work objective was to make progress in understanding cosmic rays and to write a baby Monte Carlo simulation program to simulate possible monopolistic proton capture in the atmosphere. Utilization of an EAS (extended air shower) code, CORSIKA quantitatively supported the research. Results are inconclusive and will be discussed later along with future directions.