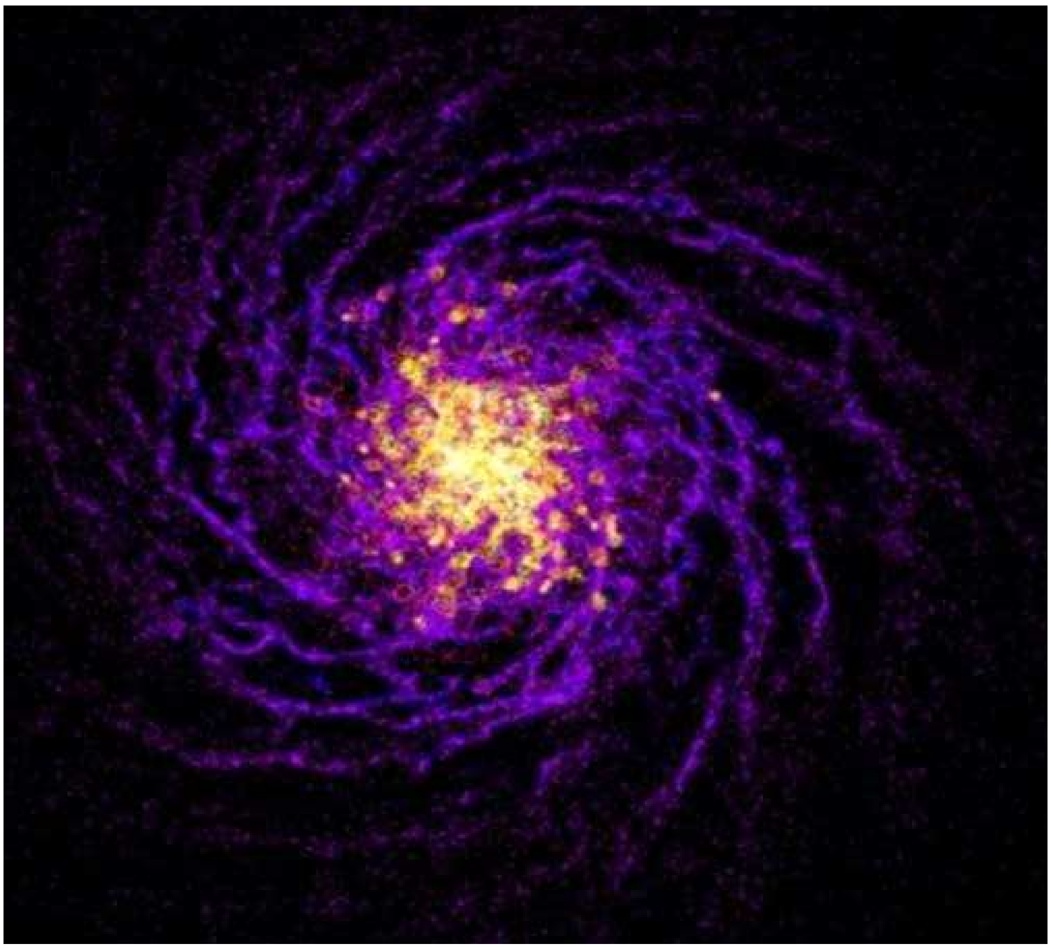
Ninth Annual Undergraduate Mini-Symposium

Department of Astronomy and Physics
Saint Mary's University
Friday September 7, 2012, Atrium 101



An N-body simulation using 280,000 particles showing a temperature plot of an isolated galactic disc after 0.26 Gyrs using the the SPH HYDRA code (Hani, Thacker).

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The Department of Astronomy and Physics

The Office of the Dean of Science

Ninth Annual Undergraduate Mini-Symposium

Friday September 7, 2012, 10:00 am – 2:30 pm

Atrium 101

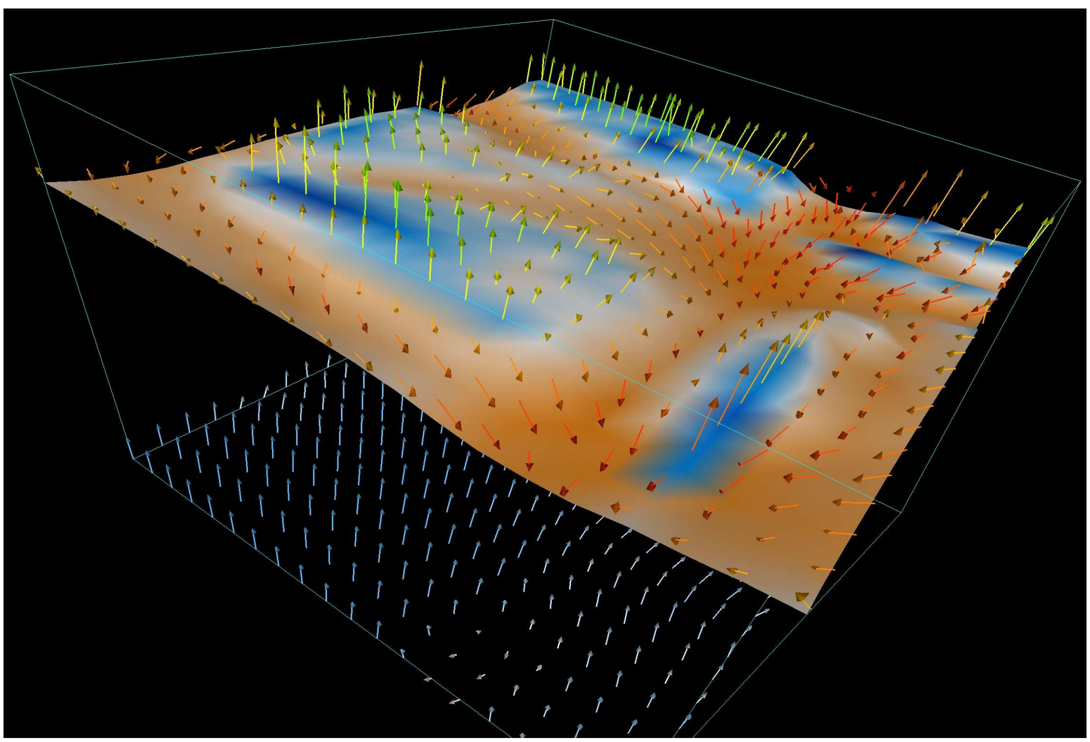
Programme

Opening remarks (Clarke)			10:00 – 10:10
1	W. Beslin (Geroux, Deupree)	*3D Visualization of the interaction stars between turbulent convection and radial pulsation in RR Lyrae*	10:10 – 10:30
2	J. Campbell & N. Murtha (Sarty)	*Performance assessment tests of multi-anode photomultiplier tube at Jefferson Lab*	10:30 – 11:00
3	S. Campbell (Gallo)	*Multi-wavelength analysis of NLS1 AGN using XMM-Newton and Suzaku*	11:00 – 11:20
4	C. MacMackin (Gallo)	*AGN 1ES 1927+654: Where does it fit in?*	11:20 – 11:40
5	P. McLeod (Kanungo)	*Development of a new facility IRIS for the study of rare isotopes*	11:40 – 12:00
Lunch (courtesy of the dean of science)			12:00 – 12:40
6	K. MacLeod (Guenther)	*Asteroseismology and Procyon*	12:40 – 1:00
7	R. Campbell (Sarty)	*Testing and rebuilding the Tagger Microscope at the Mainz Microtron*	1:00 – 1:20
8	M. Hani (Thacker)	*The impact of star formation algorithms on the morphology and evolution of isolated galactic disc models*	1:20 – 1:40
9	C. Wilson (Bennett)	*Epsilon Aurigae: deriving a Baade-Wesselink distance*	1:40 – 2:00
Award presentations (Young, Gruberbauer)			2:00 – 2:30

1. *3-D Visualization of the interaction between turbulent convection and radial pulsation in RR Lyrae stars*

Wilfried Beslin (Geroux, Deupree)

Variable stars, located in the instability strip on the H-R diagram, pulsate radially at high amplitude because the ionization zones within them act as a driving force. Traditionally it has been thought that stars to the right (red) side of the instability strip do not pulsate because their ionization zones are too deep, and therefore incapable of lifting the upper zones. However this is not the case, and a better explanation may be that significant convection in these ionization zones quickly remove the energy stored in them to drive pulsation. We have performed hydrodynamic simulations of the pulsation and convection in RR Lyrae stars to better understand the interaction between these two phenomena, and support the latter explanation. In this talk I will be showing a three-dimensional visualization of these simulations, designed to be viewed in the ACEnet data cave. Since convection is very turbulent, there is significant motion in three dimensions, and therefore the data are best interpreted graphically in 3D. It can be seen from this visualization that convection interacts with the pulsation in such a way as to at least decrease the pulsational growth.



3D visualization of a hydrodynamics simulation of a pulsating star. Presented is a $T = 10^4$ K isosurface with an overlayed vector slice of convection speeds showing pockets of hot gas rising (blue) and cooler gas sinking (orange). (Beslin, Deupree)

2. *Performance assessment tests of multi-anode photomultiplier tube at Jefferson Lab*

Jessica Campbell and Nathan Murtha (Sarty)

In nuclear physics, photomultiplier tubes (PMTs) are used to detect high-energy photons (gamma rays) produced by collision events. The Thomas Jefferson National Accelerator Facility (Jefferson Lab) in Newport News, VA received 602 16-channel, Multi-Anode PMTs from Fermilab's decommissioned CDF experiment. These PMTs are being incorporated into the design and construction of a new Coordinate Detector to be located in Hall A. Of the PMTs received, 186 were HAMAMATSU H8711 tubes and 416 were HAMAMATSU R5900-00-M16 tubes. To identify the best-performing PMTs for use in Hall A, each tube was tested using a LED light source to analyze the (ADC) spectrum signal response of each of its sixteen pixels. The ADC spectrum in the absence of light (noise or dark current) was also characterized for each pixel from each PMT. A statistical analysis algorithm was used to fit single and double Gaussian distributions to each ADC spectrum, with the double Gaussians needed to account for cases in which the LED spectra exhibited both signal and noise responses superimposed. The fits determined the mean and standard deviation for all of the dark current (noise) and LED (signal) measurements. With this information, the actual signal response of each pixel, and the average and relative responses for the 16 pixels within all 602 PMTs were evaluated. These results were used to classify the performance of the tubes and their associated pixels.

3. *Multi-wavelength analysis of NLS1 AGN using XMM-Newton and Suzaku*

Stephen Campbell (Gallo)

The field of X-ray astronomy has long been interwoven with the study of Active Galactic Nuclei (AGN). One of the major challenges intrinsic to the study of AGN in the x-ray band is that Earth's atmosphere is optically thick at such wavelengths. To overcome this, much of x-ray astronomy is performed using space-based telescopes, such as XMM-Newton. Using data from the XMM-Newton Science Archive (XSA), as well as previously collected data from other sources such as the Suzaku space telescope, two x-ray projects were investigated. First, a sample of 30 objects were compared in the x-ray, uv and infrared wavebands. Using simple graphical analysis intrinsic properties, such as black hole mass and full-width-half-maximum (FWHM) of the Hβ line, were compared to hypothetical power law slopes of the given objects. No apparent correlations were observed. Secondly, an in-depth analysis of the object Zw 229.015 was performed using concurrent observation data from both XMM-Newton and Suzaku. X-ray spectra were analysed with the HEAsoft package xspec. Light curves from the two observations show consistency. Spectral analysis remains in progress.

4. *AGN 1ES 1927+654: Where does it fit in?*

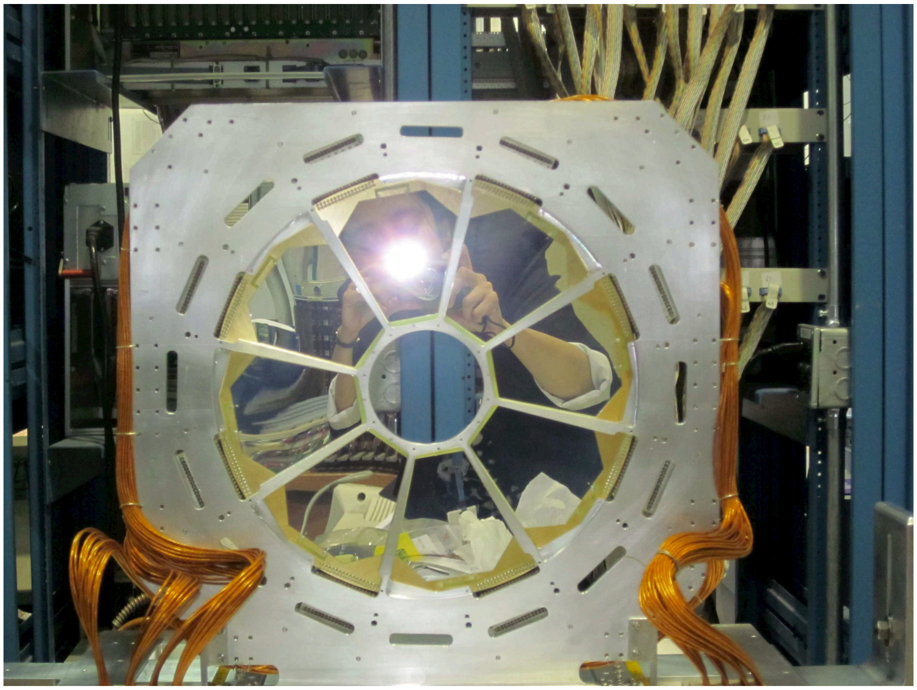
Chris MacMackin (Gallo)

The AGN designated 1ES 1927+654 has proved difficult to classify according to the traditional Unification Model. Optically it appears to be an obscured galaxy, while in the X-rays it appears to be unobscured. It thus has the potential to refine the model, potentially revealing something about the evolution of AGN. Observations with the XMM Newton and Suzaku telescopes were analyzed in an attempt to learn more about the nature of this object. Spectral and timing analysis was performed on the data from both telescopes. The spectrum could be described by non-physical models, partial covering models, and blurred reflection models. The light curves revealed rapid, large amplitude variability. Based on critical analysis of the fit parameters, it appears that the absorption models of 1ES 1927+654 are less plausible than a reflection model for providing a physical description, although neither can be ruled out. The results did not agree well with suggestions for the nature of this object found in the literature, although might still be consistent with a suggestion for an evolutionary model of AGN. Further observations and analysis will be required in order to come to any firm conclusions.

5. *Development of a new facility IRIS for the study of rare isotopes*

Pauline McLeod (Kanungo)

Most of the elements present on Earth are believed to have been created through intense nuclear reactions at the centre of neutron-rich environments like neutron stars and supernovæ. These reactions involve short-lived unstable nuclei with large asymmetry of neutrons, deemed rare isotopes, whose properties are thought to be the key in understanding the origins of matter around us.



The YY1 silicon detector used for the study of rare isotopes at the IRIS facility at TRIUMF. (McLeod, Kanungo)

Located at TRIUMF, Canada's national laboratory for nuclear and particle physics, is the new Saint Mary's Univeristy facility IRIS that was recently commissioned in July–August, 2012. Through the use of a pioneering application of a solid hydrogen target and a low pressure ionization chamber, IRIS is at the forefront of nuclear research activity aimed at revealing the secrets of these rare isotopes. Using large silicon strip and cesium-iodide detector arrays, the innovative IRIS facility will be able to investigate the fundamental changes in nuclear structure in regions far from stability to gain valuable information on their role in nucleosynthesis. Two neutron transfer reactions will be used to study the pairing correlation between neutrons in neutron-rich nuclei.

I will describe our commissioning experiment using an ^{18}O beam. Following this, I will give an overview of the detectors and apparatus involved in this experiment, with a focus on the solid hydrogen target. Lastly, I will present a few preliminary observations from online monitoring.

6. *Asteroseismology and Procyon*

Kieran MacLeod (Guenther)

Asteroseismology is the study of the oscillations of stars. Asteroseismology has the potential to teach us much about some of the physical processes in stars, but until recently, there has not been sufficient observational data to study stellar oscillations. The first stellar oscillation observations were made by Leighton, Noyes, & Simon (1962) of the Sun. They measured Doppler velocity shifts and saw relatively short period (five minutes) oscillations distinct from granular motion. The first helioseismic observations eventually lead to asteroseismic observations using satellite-based telescopes above the earth's atmosphere, such as Canada's pioneering MOST telescope.

In this project, Procyon was modeled with an assumed helium abundance, heavy metal abundance, and mass to find the corresponding mixing length and age to give the proper luminosity and effective temperature. Procyon has an extremely shallow convective envelope and a developing convective core, both of which are difficult to model numerically. I changed the input helium abundance and mixing length trying to come within given uncertainties of the observed luminosity and effective temperature (or, equivalently, radius). Animations were made comparing modeled and observed oscillation frequencies as the mixing length parameter, which controls the basic behaviour of the convective zones, was varied. The amount of convective overshoot was also varied and studied using animations. The latter revealed significant unstable behaviour in the modelling physics.

7. *Testing and rebuilding the Tagger Microscope at the Mainz Microtron*

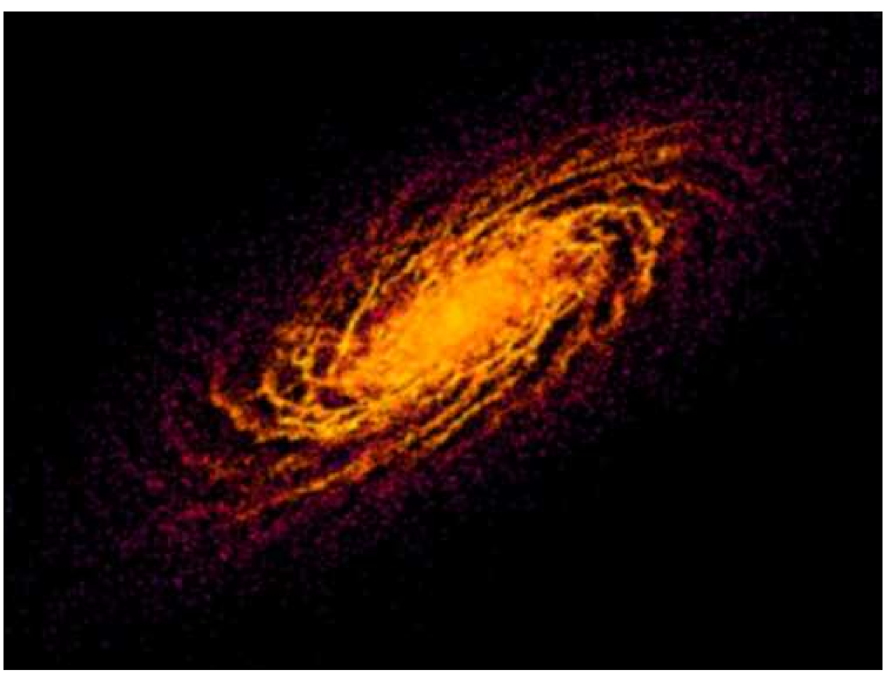
Rebecca Campbell (Sarty)

This presentation reports on summer research activities in Mainz, Germany, at the Nuclear Physics Institute of the Johannes-Gutenberg University. The Institute houses a race-track microtron known as the Mainz Microtron (MAMI). The microtron accelerates electrons, producing a beam with energies up to 1.5 GeV. This research project was with the A2 Collaboration, focusing on investigations of high-energy gamma-ray interactions with protons, specifically meson production and Compton scattering. In order to determine the energies of the photons, they must first be tagged by the Glasgow Photon Tagging Spectrometer. This determines the energies of the bremsstrahlung photon's counterpart electron. The Tagger Microscope is a small scale version of the spectrometer which focuses on a smaller energy range but has a much higher resolution which is extremely useful in threshold experiments. The specific summer research project reported here involved testing the constituents of the Tagger Microscope as it had not been used in many years. It was then rebuilt and tested with both cosmic rays and a ^{90}Sr source to determine whether the Tagger Microscope could be used in future experiments in the A2 hall at the Mainz Microtron.

8. *The impact of star formation algorithms on the morphology and evolution of isolated galactic disc models*

Maan Hani (Thacker)

The association of star formation with collapsing regions ($\nabla \cdot \vec{v} < 0$) is controversial in large scale models of galactic star formation. Two simulations of isolated galactic discs (280,000 particles each) differing in the star formation conditions were performed to help understand the effect star formation has on the morphology of star forming regions and, as a result, the evolution of model galaxies. This first analysis considered isolated evolved galaxies. It is possible that the two different approaches applied to simulations of galaxy formation could produce results far more different than those we present.



An N-body simulation using 280,000 particles showing the density distribution of gas in an isolated galactic disc after 0.26 Gyrs using the SPH HYDRA code. (Hani, Thacker)

9. *Epsilon Aurigae: Deriving a Baade-Wesselink distance*

Christine Wilson (Bennett)

Epsilon Aurigae is a 3rd magnitude long-period binary that eclipses every 27.1 years and has been continuously observed for more than 160 years. The observed spectrum is that of an apparently normal F supergiant. The duration and magnitude of the eclipse and the amplitude of the derived radial velocity orbit imply the presence of a massive companion; however, this eclipsing companion is dark. Here we focus on the nature of the F supergiant by determining the distance to the system using a variation of the Baade-Wesselink method. In combination with existing analyses, this distance estimate suffices to establish the masses of both the F star and its unseen companion, and thus its evolutionary state.

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