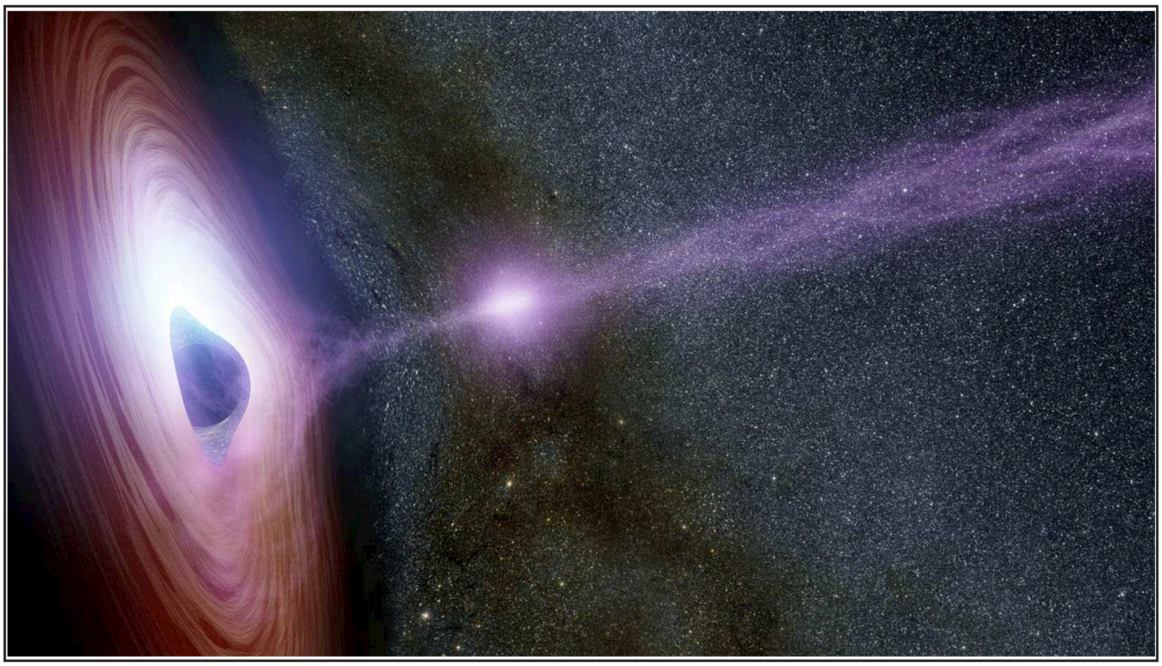
Thirteenth Annual Undergraduate Mini-Symposium

Department of Astronomy and Physics
Saint Mary's University
12:00–4:00 pm, Friday September 9, 2016
Atrium 305 (lunch); Sobey 265 (presentations)



An artist's concept of Markarian 335 with its jet interacting with its corona. (Image courtesy NASA/JPL-Caltech; see abstracts by Hellmich, Blue, and Gallant.)

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The Department of Astronomy and Physics

The Office of the Dean of Science

Thirteenth Annual Undergraduate Mini-Symposium

Friday September 9, 2016, 12:00 pm – 4:00 pm
Lunch in AT 305; presentations in SB 265

Programme

Lunch, AT 305 (courtesy the dean of science)			12:00 – 12:50
Opening remarks, SB 265 (Clarke)			12:50 – 1:00
1	M. Hellmich (Gallo)	*The UV–X-ray spectral energy distribution of Active Galactic Nuclei, I*	1:00 – 1:20
2	D. Blue (Gallo)	*The UV–X-ray spectral energy distribution of Active Galactic Nuclei, II*	1:20 – 1:40
3	D. Gallant (Gallo)	*The UV–X-ray spectral energy distribution of Active Galactic Nuclei, III*	1:40 – 2:00
4	T. Fields (Thacker)	*Looking for a link between disk galaxy stability and the level of chaos in galactic dynamics*	2:00 – 2:20
5	O. Workman (Kanungo)	*Measuring production yields of rare isotopes*	2:20 – 2:40
6	P. Reid (Sarty)	*The Hall A Coordinate Detector at Jefferson Lab: adventures in construction, assembly and testing*	2:40 – 3:00
7	H. Ehler (Gallo)	*A Rigorous Flux-Flux Analysis of Markarian 335*	3:00 – 3:20
8	A. Salyzyn (Sarty)	*Cosmic ray signal identification and signal gate testing in the Super BigBite Spectrometer's Coordinate Detector*	3:20 – 3:40
Award presentations (Kaur, Sawicki, Clarke)			3:40 – 4:00

Abstracts

1. *The UV–X-ray spectral energy distribution of Active Galactic Nuclei, I*

Martin Hellmich (Gallo)

Active Galactic Nuclei (AGN) are extremely luminous objects at the centre of many galaxies, thought to consist of rapidly accreting supermassive black holes. In this project, the spectral energy distribution (SED) of several AGN were analyzed in a search for potential correlations between the ultraviolet, low-energy ($E < 10\,\mathrm{keV}$), and high-energy ($E > 10\,\mathrm{keV}$) wavelengths of the SED that correspond to different emission mechanisms. Analysis of these spectra lead to the hypothesis that high-luminosity objects tend to emit relatively less X-rays at higher energies.

This presentation is split into three parts. This first part will introduce AGN and the field of x-ray astronomy, and will explain how we selected and obtained our data.

2. *The UV–X-ray spectral energy distribution of Active Galactic Nuclei, II*

Derek Blue (Gallo)

Active Galactic Nuclei (AGN) are extremely luminous objects at the centre of many galaxies, thought to consist of rapidly accreting supermassive black holes. In this project, the spectral energy distribution (SED) of several AGN were analyzed in a search for potential correlations between the ultraviolet, low-energy ($E < 10\,\mathrm{keV}$), and high-energy ($E > 10\,\mathrm{keV}$) wavelengths of the SED that correspond to different emission mechanisms. Analysis of these spectra lead to the hypothesis that high-luminosity objects tend to emit relatively less X-rays at higher energies.

This presentation follows directly from the previous and will go into detail on how the data were analyzed and the testing of our hypotheses using a model independent investigation.

3. *The UV–X-ray spectral energy distribution of Active Galactic Nuclei, III*

Dennis Gallant (Gallo)

Active Galactic Nuclei (AGN) are extremely luminous objects at the centre of many galaxies, thought to consist of rapidly accreting supermassive black holes. In this project, the spectral energy distribution (SED) of several AGN were analyzed in a search for potential correlations between the ultraviolet, low-energy ($E < 10\,\mathrm{keV}$), and high-energy ($E > 10\,\mathrm{keV}$) wavelengths of the SED that correspond to different emission mechanisms. Analysis of these spectra lead to the hypothesis that high-luminosity objects tend to emit relatively less X-rays at higher energies.

This presentation follows directly from the previous and will describe how we tested our findings using simulated data and full modelling of X-ray spectra as well as a summary of our results.

4. *Looking for a link between disk galaxy stability and the level of chaos in galactic dynamics*

Tiffany Fields (Thacker)

The possible relationship between disk galaxy stability and the level of chaos in galactic dynamics was explored. First, a method of choosing a contour of gas particles in a simulated galaxy was created and implemented in galactic simulations. Developing code to choose the appropriate contour proved non-trivial. Once this was complete, a method to add test particles when spacing between existing particles in the contour became too great was created. Next, simulations were run, tracking particle positions over time. The positions of the particles over time allowed us to track the total length of the contour as the galaxy evolved. From the increase in the length of the contour, the finite time Lyapunov exponent was evaluated, which gives us an approximate measure of the chaos in the system. The stability of the model disk galaxies in the simulation is known, so future honours thesis work will involve generating galaxies with different levels of instability and applying the contour-following code to measure the amount of chaos, in search of a (possible) relationship between stability and chaos.

5. *Measuring production yields of rare isotopes*

Orry Workman (Kanungo)

Proton-rich and neutron-rich nuclei are of great scientific interest. These nuclei are important in nucleosynthesis pathways such as the r-process and rp-process and understanding these pathways will increase our understanding of elemental abundances in the universe. Additionally, these nuclei have differences in nuclear structure from stable nuclei, such as neutron skins and halos, that are of great interest for study. However, studying these nuclei is incredibly difficult as they are very short lived and must be produced by nuclear reactions in order to be available for study. Understanding the production yield of these nuclei is necessary to determine the feasibility of studying them as well as to determine their various reaction probabilities. TRIUMF, Canada's national laboratory for nuclear physics is one of the few facilities in the world capable of producing these nuclei. In this presentation I will discuss how these nuclei are produced at TRIUMF as well as how their production yields are measured using radioactive decay.

6. *The Hall A Coordinate Detector at Jefferson Lab: adventures in construction, assembly and testing*

Parker Reid (Sarty)

During the summer of 2016, the final construction and assembly was required for a high-energy charged-particle Coordinate Detector (CDET) as part of the SuperBigBite Spectrometer (SBS) project located in Hall A at Jefferson Lab. This detector was designed to be capable of determining the vertical out-of-plane emission angle of scattered electrons in an electron-proton collision with very high resolution by using two 3m-tall vertical walls of very thin scintillating bar strips. The CDET construction process required implementation of various components associated with the scintillation bars and signal, including installation of previously used photo multiplier tubes (PMT) and use of untested CAEN SY527 high voltage crates. Using data from a previous SMU summer student, an optimal PMT selection analysis method was developed based on the range of previously-measured maximum gain for each PMT pixel. This was then used to select the best PMT for installation, and establish a desired current output spread for the PMT. In order to then ensure a matched and consistent gain for all of the chosen PMT, a high voltage system using the CAEN SY527 crates was constructed and tested using cosmic rays via a remote java GUI. An overview of all these aspects of the CDET construction and assembly will be given during this presentation.

7. *A Rigorous Flux-Flux Analysis of Markarian 335*

Hannah Ehler (Gallo)

Markarian 335, a Narrow-Line Seyfert 1 Galaxy, has been one of the brightest x-ray sources in the sky until 2007 when its flux dropped to 10% of its previous value. Despite this dramatic decrease, M335 still remains one of the brighter AGN in the x-ray, and is a highly variable source. "Flux-flux plots", a model-independent technique, were utilized to determine the mode of spectral variability in this AGN. This technique compares fluxes in two different energy bands, and the shape of the relationship between the two bands indicates the mode of spectral variability. Flux-flux plots were created using x-ray data from XMM-Newton to examine spectral variability on short timescales (*e.g.*, ≤ 1 day). The distinction between binning the data in the flux-domain *vs.* the time-domain was examined and found to be significant. Simple one-component models to the flux-flux plots were poor and nearly indistinguishable, indicating that the spectral variability in M335 is more complex than can be described by only one variable component. It seems that the spectral variability is likely the result of the variation of multiple components simultaneously.

8. *Cosmic ray signal identification and signal gate testing in the Super BigBite Spectrometer's Coordinate Detector.*

Abbie Salyzyn (Sarty)

This talk presents the research conducted at The Thomas Jefferson National Accelerator Facility (Jefferson Lab) using the segmented scintillator "Coordinate Detector" (CDet), which was under construction during the summer of 2016. The specific research conducted was on the process for identifying cosmic ray signals as part of the overall detector testing protocol, as well as the process of examining/adjusting/testing the timing of the photomultiplier signal gates for the ADC data acquisition modules. A brief introduction to the schematic of the detector will be given. The tests performed to ensure accurate cabling and timing for data acquisition will follow. The focus will then shift to the overall detectors data acquisition assembly and the exact process of identification/detection of a cosmic ray in any of the detector's scintillator bars.

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