

# Oppenheimer, Groves, and the Atomic Bomb: How the Manhattan Project Came to Be

**Dr. Cameron Reed**

(Saint Mary's University)

Friday 15 September 2023

The Manhattan Project was the United States Army's program to develop and deploy fission weapons in World War II. After two and a half years of intense work and great expense, Project scientists succeeded in developing two very different designs for fission bombs, one of which used uranium and the other plutonium. One bomb of each type was dropped on Japan in August 1945 and helped to bring the war to an end. In this talk I will give an overview of the Manhattan Project, touching on its origins, organization, major personalities, facilities, accomplishments, challenges encountered, some of the physics of nuclear explosions, and why two different bomb designs were necessary. I will also describe the context of the war in the summer of 1945 and the effects of the bombs.

# What have we learned about Galaxy Formation from the First Year with JWST?

**Dr. Casey Papovich**

(Texas A&M University)

Friday 22 September 2023

In its first year, JWST has given us an amazing view of what galaxies looked like during the immediate period after the Big Bang. The JWST observations have led to a series of discoveries, many of which were wholly unexpected. In this talk, I will present some of this work using JWST imaging and spectroscopic from "deep fields". I will focus primarily on key results enabled by the CEERS (the Cosmic Evolution Early Release Science) Survey as well as data from JWST deep fields. These results include the discovery and characterization of the properties of galaxies at the earliest times, with redshifts of 7 and higher, during the cosmic period known as reionization. The properties of these galaxies imply they are dominated by very young, massive stars, with extremely high ionizing flux, accompanied by rapidly stochastic, variable star-formation rates. Other JWST observations have demonstrated that early galaxies host "hidden" active galactic nuclei (AGN), obscured by gas and dust, which implies we are seeing a rapid phase of supermassive blackhole growth in early galaxies. Understanding the relation between the star-formation and blackhole growth in these galaxies will be a challenge for future JWST observations, and I will discuss some ways to disentangle these effects. Lastly, I will use these discoveries to speculate about what we may learn in the coming years with JWST.

## BGO & Chroma+, A "Made at Saint Mary's" stellar lab

Dr. Ian Short  
(Saint Mary's University)  
Friday 6 October 2023

I will describe the low resolution spectrograph currently mounted at the Burke-Gaffney Observatory (BGO), the observing and data reduction procedure, and will present a selection of resulting stellar spectra. I will then describe the Chroma+ stellar spectrum synthesis code and its latest improvements, and will compare observed BGO and synthetic Chroma+ spectra. The BGO spectrograph and the Chroma+ modelling code are suitable for projects at the Honours level and for advanced class projects, and are both entirely supported by local staff and faculty expertise.

Much of the content of this talk can be found in these recent papers:

- "The Burke-Gaffney Observatory, a fully roboticized remote access observatory with a low resolution spectrograph", Short, C, Ian, Lane, David.J., & Fields, Tiffany, 2023, arXiv:2307.07022 [astro-ph.IM]
- "Chroma+GAS: An Expedited Solution for the Chemical Equilibrium for Cool Stellar Atmospheres", Short, C. Ian & Bennett, Philp.D., 2021, PASP, 133, 064501, arXiv:2206.01236 [astro-ph.SR]
- "The ChromaStar+ modelling suite and the VALD line list", 2023, Short, C. Ian, 10.48550/arXiv.2307.01279

## Indigenous Knowledges and Western Astronomy: Indigenizing the Drake Equation

Dr. Hilding Neilson  
(Memorial University of Newfoundland & Labrador)  
Friday 13 October 2023

The Drake Equation is a thought experiment whose purpose is to understand the ingredients necessary for life and advanced technological civilizations to exist on other worlds in our galaxy. However, beyond reflecting on life on Earth we have no knowledge of many of these ingredients, such as the number of planets that have life, the number with intelligent life, the number with advanced civilizations, and the lifetimes of these civilizations. In this talk I will review the Drake Equation and the biases that scientists have traditionally had in discussing this equation and how it has led to the current searches of biological and technological signatures. I will discuss how the Drake Equation looks different if we consider it through the lens of Indigenous methods and sciences and how these methods would lead to a dramatically different view of life in our Galaxy.

## Using indirect methods to map the central engine in NGC 6814

Dr. Adam Gonzalez  
(Saint Mary's University)  
Friday 20 October 2023

Active galactic nuclei (AGNs) are the most luminous continuous sources of emission in the Universe. Powered by the accretion of matter onto a central supermassive black hole (SMBH), the compactness of the so-called central engine in AGNs makes direct imaging of these systems impossible for all but a handful of targets. Indirect methodologies examining the flux variability and spectral energy distribution of AGNs in the X-ray band have allowed us to probe the region just outside of the SMBH event horizon, revealing the physical processes at work in this extreme environment. In this talk, I will highlight recent works by our group focused on the nearby AGN NGC 6814 in which we have measured the size of its X-ray emitting region using an exquisite X-ray eclipsing event as well as uncovered evidence of a possible non-standard accretion scenario using a 75-day multi-wavelength monitoring campaign.

## Stemless plastic scintillation detectors: a novel detector with a bright future

Dr. Alasdair Syme  
(Dalhousie)  
Friday 27 October 2023

Ionizing radiation plays a vital role in many areas of society, including the diagnosis and treatment of disease. In order to be used safely, accurate, quantitative measurements of radiation fields are an essential prerequisite. Many tools are available for this task, but all have some limitations. In this talk I will discuss our efforts to develop radiation detectors based on organic electronic devices and plastic scintillators that overcome most of these shortcomings.

## Machine Learning applications in Nuclear and Particle Physics

Dr. Michelle Kuchera  
(Davidson College)  
Friday 3 November 2023

Machine learning has become ubiquitous in data-rich applications. Fundamental physics research provides an exciting realm for machine learning research with applications ranging from experimental data acquisition through making theoretical predictions. This talk will introduce machine learning theory, highlighting applications from my group in nuclear and particle physics research. Specifically, I will focus on experimental applications for detector systems at the Facility for Rare Isotope Beams and CERN. I will highlight innovative approaches in machine learning that show promise in these physics applications and discuss how our research can assist in machine learning research.

## Milky Way's Stellar Streams as Cosmological Probes

Dr. Ting Li  
(University of Toronto)  
Friday 17 November 2023

Stellar streams are one of the most powerful tracers to determine the mass and profile of the Milky Way as well as constrain the properties of dark matter. In this talk, I will discuss two ongoing spectroscopic programs to study the stellar streams in our Milky Way and highlight a few latest scientific results from these two programs. The Southern Stellar Stream Spectroscopic Survey (S5), started in 2018, is the first systematic program pursuing a complete census of known streams in the Southern Hemisphere using the fiber-fed AAOmega spectrograph on the Anglo-Australian Telescope. The Milky Way Survey of the Dark Energy Spectroscopic Instrument (DESI), on the other hand, is a recently started 5-yr spectroscopic program in the Northern Hemisphere. We are entering an extremely data-rich era in the next decade, with full 6D+chemistry information on dozens of stellar streams, to shape our understanding on the chemo-dynamical evolution of the Milky Way, as well as the nature of the dark matter.

## A portable ambient light-compatible spectroscopic probe for disease detection

Dr. Kevin Hewitt  
(Dalhousie)  
Friday 24 November 2023

The Hewitt Bionanophotonics lab at Dalhousie explores the use of inelastic light scattering - enhanced using nanoscale surfaces in some instances - for disease detection. In this talk I will describe a patent (pending) portable ambient light-compatible spectroscopic probe to non-invasively assess global and macrovesicular steatosis in human liver specimens. Two-stage biochemical and histopathological validations highlight the potential of the examined system as a trustworthy, non-invasive modality for steatosis evaluation. Notably, the ambient light-compatible approach is a notable progression beyond prior spectroscopic

methods, effectively addressing associated limitations. The correlation between fat content results derived from the investigated Raman system and traditional triglyceride quantifications reinforces the reliability of this methodology. Moreover, introducing a dual-variable prediction for identifying significant ( $\geq 10\%$ ) discrepancies in global HS and MaS demonstrates the advanced precision and subtlety the system can deliver.

Beyond immediate outcomes, this study lays the foundation for the broader application of ambient light-compatible spectroscopic probes in clinical environments, potentially revolutionizing intraoperative liver assessments. Amidst the escalating demand for liver transplantation, tools of this nature hold substantial promise in ensuring optimal graft quality, consequently benefiting liver recipients. While the results are encouraging, further research is imperative to affirm the comprehensive potential and applicability of this system, especially in real-world operating room contexts.

## The art of measuring galaxy physical properties

Dr. Camilla Pacifici  
(Space Telescope Science Institute)  
Friday December 1st, 2023

One of the most common approaches to measure stellar masses and other physical parameters for galaxies is spectral energy distribution (SED) fitting. This consists of comparing the light from galaxies with templates for which we know the physical parameters and extract the best template match or probability distribution functions of the parameters associated with such templates. Many years ago, when we were looking predominately at local galaxies and the observations consisted of a few photometric bands, SED fitting was considered a relatively simple job. In recent years, ground-based and space telescopes have given us a whole new set of information, with both photometry and spectroscopy for a large number of galaxies at all redshifts. Such quantity and quality of data require more and more advanced tools to make the most of the observations. Here is when SED fitting becomes a complicated job, or an Art! I will present the various ingredients and complexities that go into state-of-the-art SED fitting tools, what parameters we can now measure, and how we can assess the uncertainties in the modeling approach.

## Careers after a degree in astro/physics: a panel discussion with SMU Astronomy & Physics alumni

Adam Chaffey & Dr. Shruti Tripathi  
Friday 19 January 2024

Adam is a licensed Professional Physicist (P.Phys). He holds an Honours B.Sc. in Astrophysics from Saint Mary's University, an M.Sc. in Physics from Dalhousie University,

and has been awarded two patents for LED optical systems design. He is currently Director, Smart Lighting Products at Liveable Cities. Adam has been involved in the development of industry leading technology for street and roadway lighting applications since 2008. He actively participates on the ANSI C136 Committee on Roadway and Area Lighting Equipment, and other technical committees. He is also involved in the IES Street and Area Lighting Conference (SALC), the premier outdoor lighting conference in North America, where he is currently serving as SALC Committee Vice-Chair. In 2019, Adam served as Conference Chair for the SALC in San Diego, which hosted over 1000 outdoor lighting professionals. He has hosted and delivered seminars on outdoor lighting and lighting controls technology to audiences in North America, the Caribbean, Asia, Australia, New Zealand, the United Kingdom and in Europe.

Shruti, who started her journey as an astrophysics researcher, is now working as a Data Engineer (AI/ML) with a multinational company, Kellton. She holds Masters in Physics, and a PhD in Astrophysics, which she obtained in India before coming to Canada in 2015. She worked as a part-time Research Associate working for Binary stars simulation at Bishop's University, in Sherbrooke, Quebec. She moved to Halifax in 2017 and then joined Prof. Luigi Gallo's research group at SMU as a full-time postdoc. She also worked in the department as a part-time faculty, teaching physics, astronomy and environmental sciences and concluded a short-term teaching faculty position in 2021. Throughout her career, she participated in several conferences and symposiums and was awarded prestigious fellowships. In her current work she uses AI tools and programming to build advanced automation solutions and products to help streamline repetitive tasks and make lives simpler. She was crowned first prize in the companywide AI hackathon. Outside of work, she plays musical instruments such as the harmonium and keyboards, and she loves long drives with family and friends!

## Deciphering Type I X-ray Bursts through Nuclear Physics Insights

Dr. Melina Avila (Argonne National Laboratory)

Date: Friday 8 March 2024

Type I X-ray bursts, the most prevalent stellar explosions in our Galaxy, result from explosive hydrogen-helium burning triggered by thermonuclear ignition in the envelopes of accreting neutron stars within low-mass binary systems. To comprehend the mechanism behind these bursts, astrophysical models must incorporate an understanding of key nuclear reactions occurring in this stellar environment. Replicating such stellar conditions in a laboratory poses significant challenges due to the typically small cross sections of these reactions and the experimental complexities associated with low-intensity radioactive beams required for their study. Consequently, most of these reaction rates remain unknown. However, recent developments in the capabilities of radioactive ion beam facilities and experimental techniques have presented new opportunities to measure these crucial astrophysical

reactions. This presentation will go into these recent advances, shedding light on how they enhance our insights into the nuclear physics measurements relevant for Type I X-ray bursts.

## Anticipating the (Impending) Avalanche of Astrophysical Transients

Dr. Daryl Haggard  
(McGill University)  
Friday 15 March 2024

I will discuss some of the exciting transient science enabled by new and upcoming astrophysical time domain surveys. I'll start by outlining the physics we can derive from the spectra of kilonovae, explosions resulting from the merger of two neutron stars, in the context of the first (and only) gravitational wave multi-messenger event, GW170817. I'll focus on a new tool, "Spectroscopic r-Process Abundance Retrieval for Kilonovae" (SPARK), which offers an engine for performing Bayesian inference on kilonova spectra to (1) retrieve elemental abundance patterns, and (2) identify individual absorption features in early-time, optically-thick spectra. I'll also discuss the ongoing LIGO-Virgo-KAGRA O4 campaign in which some 2-10 NS-NS and NSBH mergers are anticipated (median localization  $\sim 100$  sq.deg). If EM counterparts can be identified, these new multi-messenger discoveries will push beyond the single detection of a kilonova to help us identify a *population* of well characterized BH and NS encounters. I'll wrap up with a wider discussion of explosive transients and prospects for studying them with existing and upcoming facilities, including Chandra, CFHT, JWST, the current (and next generation) Event Horizon Telescope, LISA, and proposed X-ray and UV facilities.

## Pandora's Cluster IV: A New Hope

Dr. Bill Harris  
(McMaster University)  
Friday 22 March 2024

Abell 2744, also known as Pandora's Cluster, is an enormously rich and massive lensing cluster at a redshift of  $z=0.3$  and a lookback time of 3.5 Gyr. New JWST imaging with NIRCcam from several individual programs now gives us an exceptionally deep database to explore a wide range of phenomena of galaxy-based phenomena. Among these is an immense population of globular clusters concentrated around the five giant galaxies that dominate the gravitational potential, and also throughout the IntraCluster Medium. I will describe the results of our new study of this system, which for the first time gives us a deep, direct look at the evolutionary state of a GC system at a cosmologically significant lookback time. Part of this study includes direct comparisons with predictions from the new EMP-Pathfinder models.