Probing Physics Beyond the Standard Model with Low-Background Liquid Argon Experiments

Speaker: Dr. Pietro Giampa (TRIUMF and SNOLAB)
Time: April 6, 2018 - 3:00 PM
Location: Atrium 101

The discovery of the higgs boson completed the standard model of particle physics (SM), a set of fundamental sub-atomical particles and force carriers that describe the nature of all known matter. However, there are many remaining questions that hint at physics beyond the assembled SM. In particular, supported by multiple cosmological and astrophysical evidence, is the resistance of Dark Matter (DM) which comprises up to 27% of the entire universe. DM is expected to be made of non-relativistic particles which do not interact with light. At the present time, Weakly Interacting Massive Particles (WIMPs) are the most theoretically motivated among DM candidates. High-energy collider experiments have mostly excluded WIMPs with masses below 80 GeV/c2, in minimal models, pushing direct detection experiment to search for high-mass WIMPs (>100 GeV/c2). In this talk, we will review how low-background liquid argon experiments are currently being used to perform a precision measurement of beyond the SM physics, by directly searching for WIMP-nuclei coherent elastic scattering. Particular emphasis will be given to the DEAP-3600 experiment, currently operating 2 km underground at the SNOLAB facility in Sudbury, Ontario, Canada.

PHD THESIS DEFENCE TALK: Massive Passive Galaxies at z~1.6

Speaker: Liz Arcila-Osejo (Saint Mary's University)
Time: March 29, 2018 - 9:00 AM
Location: Loyola 273

We present a K-selected catalog of z ~ 1.6 gzKs galaxies in the Deep and Wide fields of the Canada-France-Hawaii Legacy Survey, with a final effective area of 27.6 deg2 allowing us to recover a representative sample of rare massive passive galaxies (log (M*/M) > 11.14) and very rare ultra-massive passive galaxies (log (M*/M) > 11.49). The latter is an important population of galaxies, with significant build-up of stellar mass when the universe was only ~ 4 Gyr old.

This catalog allows us to constrain the bright end of the stellar mass function. Once corrected for Eddington bias, we find the number density of passive galaxies at z~1.6 to be well described by a Schechter function. Next, we find an absence of massive companions around ultra-massive passive galaxies (UMPEGs) and only a handful of lower mass companions. Based on a simple dynamical friction estimate, we calculate these UMPEGs to grow ~25% between z~1.6 and z~1. Finally, we recover regions with an over-density of massive passive galaxies as sample environments for proto-clusters with an evolved population.

Galaxy Evolution in the Group Environment

Speaker: Laura Parker (McMaster University)
Time: March 29, 2018 - 3:00 PM
Location: Sobey 255

Over time star-forming galaxies, like our Milky Way, transform into passively-evolving red galaxies. These transformations are due to a combination of internal processes and environmental processes, with the galaxy group environment playing a particularly important role. I will review some of our recent work in the local universe where we try to constrain the environmental processes driving galaxy evolution. We find that low mass galaxies living in X-ray rich environments have suppressed star formation and fewer disc-dominated galaxies, at fixed galaxy stellar mass and host halo mass, compared to those with weaker extended X-ray emission. We also find that the fractions of both star-forming and disc galaxies are sensitive to the dynamical state of their host group. I will discuss how these results can help constrain the mechanisms at play in environmentally-driven galaxy evolution. I will finish by presenting work on a recent high resolution hydrodynamic simulation of one interesting low mass galaxy group.

The Search for Life in the Universe

Speaker: 2018 CAP Lecture Dr. Jan Cami (Associate Professor, Dept. of Physics & Astronomy and Centre for Planetary Science & Exploration, the University of Western Ontario)
Time: March 23, 2018 - 10:00 AM
Location: Room 260 Sobey building

Abstract

Piecing together recent results from physics, astronomy, geology, chemistry and biology, we can start formulating a scientific answer to perhaps the most important unanswered scientific question: “Are We Alone?” – is life an accidental rarity, or is the Universe teeming with an abundance and wild variety of [intelligent] life forms, separated from each other by the vast space between their home planets?

Carbon isotope evidence points to an early start for life on Earth, and our genes still contain the blueprint of what that early life looked like and what environments it thrived in. The mineralogy of Mars reveals the surprisingly Earth-like past of the red planet, and spectacular observations of water geysers on some of the moons of Jupiter and Saturn show that their interiors may represent very similar environments as well. Chemical analyses of carbonaceous chondrites and laboratory experiments on cosmic ice analogues furthermore show tantalizing connections between life on Earth and complex organics in space, and astronomical infrared observations indicate that the molecular building blocks for life are widespread and abundant in the Universe.

The development of sensitive astrophysical techniques to detect and study planets around other stars has revolutionized our understanding of exoplanets. Using transit, Doppler and spectroscopic observations, we can measure planet sizes, determine their composition, see their atmospheres, and search for biomarker signatures. We now know that there are billions of planets that have a decent chance to harbor life. Increased odds for life implies better chances to also find intelligent life. Several

independent initiatives are currently transforming the Search for Extra-Terrestrial Intelligence (SETI) from a small-scale radio search to a multi-faceted enterprise that will provide firm quantitative limits to the number of communicating civilizations in the galaxy in less than two decades.

Short Bio

Prof. Jan Cami obtained his BSc and MSc in Physics at the University of Leuven (Belgium). A European MSc program in Astronomy and Astrophysics brought him to the University of Porto (Portugal) and Leiden University (the Netherlands). In 2002, he obtained his PhD in Astronomy and Astrophysics ("Molecular Gas and Dust around Evolved Stars") at the University of Amsterdam (the Netherlands). As a fellow of the National Research Council, he became an astrophysicist in the Astrochemistry Group at the NASA Ames Research Center in California. In 2005, he joined the SETI Institute. Since December 2006, he is a faculty member at Western University where he is currently Associate Professor in the Department of Physics and Astronomy, and also serves as Director of the Hume Cronyn Memorial Observatory and Associate Director of the Centre for Planetary Science and Exploration (CPSX). His research focuses on the physics and chemistry of large molecules in space, including fullerenes ("buckyballs") that he and his team discovered in space in 2010.

A study of Lyman Alpha Emitters in high-redshift protoclusters

Speaker: Dr. Nicola Malavasi (Purdue University)
Time: March 16, 2018 - 3:00 PM
Location: Atrium 101

Lyman Alpha Emitters (LAEs) are a class of galaxies that show a particularly bright Lyman Alpha emission line in their spectrum with respect to the UV continuum. This feature makes it possible to easily identify them at high-redshift, by means of matched narrow- and broad-band surveys. The study of the number of LAEs as a function of redshift, their luminosity, mass, star-formation rate, and other properties offers the possibility to gather information on the galaxy population at z ~ 3-4.

As LAEs are relatively easy to identify at high-redshift, the discovery of overdensities of such objects often leads to the identification of protocluster structures in the young Universe, at a time when structure formation was in full development. The study of the properties of LAEs in relation to their environment can therefore help to characterize the progenitors of nowadays galaxy clusters and allows us to understand at what redshift the environmental effects on galaxy evolution observed today began to appear.

In this talk I present results obtained investigating the characteristics of LAEs in two high-redshift protoclusters at redshifts z ~ 3.790 and z ~ 2.698. From the study of the Lyman Alpha luminosity and Equivalent Width functions, to their spatial distribution with respect to known overdensities and other galaxy types, to the case study of a particularly large and bright LAE in our sample, investigating these peculiar sources can provide us with a unique way of obtaining a picture of the typical properties of low-mass star-forming galaxies in the distant Universe.

Galaxy Cluster Evolution over the Past 10 Billion Years

Speaker: Michael McDonald (MIT Kavli Institute for Astrophysics and Space Research)
Time: February 16, 2018 - 3:00 PM
Location: Sobey 255

In recent years, the number of known galaxy clusters at has grown dramatically thanks in large part to the success of surveys utilizing the Sunyaev Zel'dovich effect. In particular, surveys such as the South Pole Telescope 2500 deg^2 survey have discovered hundreds of new distant clusters, allowing us to trace, for the first time, the evolution of clusters from shortly after their collapse (z~2) to present day (z~0). In this talk, I will highlight recent efforts to understand the observed evolution in the most massive clusters, in terms of the large-scale hot intracluster gas, the cooling gas in the very center of the cluster, the most massive central galaxy, and the supermassive black hole at the very center. In addition, I will attempt summarize the current state of galaxy cluster surveys and briefly discuss the potential of next-generation surveys.

CANCELLED: Going wide and deep with the Hypersuprime Camera Survey

Speaker: Dr. Jenny Greene (Princeton University)
Time: February 9, 2018 - 3:00 PM
Location: Atrium 101

Our ongoing imaging survey with the Hypersuprime Camera (HSC) on the Subaru Telescope provides a rich data set for studying galaxy evolution, from the most massive elliptical galaxies to ultra low surface-brightness dwarfs. I will discuss ongoing projects that utilize the deep and wide HSC imaging to address the role of merging in the growth of black holes and galaxies, as well as our search for some of the most extreme low surface-brightness galaxies.

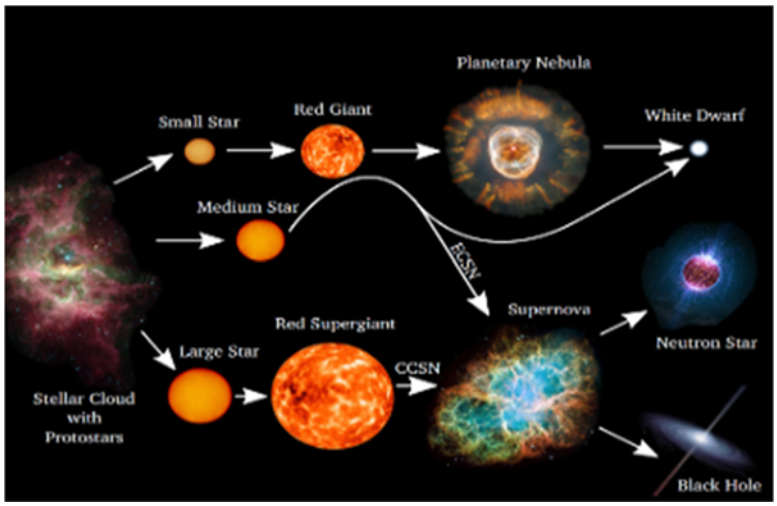
Electron capture on Ne-20 and the ultimate fate of medium-mass stars

Speaker: Dr. Oliver Kirsebom (Aarhus University)
Time: January 12, 2018 - 3:00 PM
Location: Atrium 101

Medium-mass stars develop an electron-degenerate core consisting mainly of oxygen and neon, which can become so heavy that it collapses under its own weight. While such a collapse is all but certain to trigger a thermonuclear runaway, the impact on the star is highly uncertain and depends critically on the density at which oxygen ignites, with lower densities favouring disruption of the stellar core and higher densities favouring collapse into a neutron star.

Understanding the final evolution of medium-mass stars is an interesting problem in itself, but it is also necessary if we want to understand how these stars contribute to galactic chemical evolution.

In my talk, I will review what we known about the final evolution of medium-mass stars, explain why electron-capture reactions on Ne-20 nuclei are important in this connection, and discuss ongoing efforts to improve our understanding of these reactions in laboratory experiments.



Probing the galaxy-mass connection in TeraByte-scale imaging surveys

Speaker: Dr. Jean Coupon (University of Geneva)
Time: November 24, 2017 - 3:00 PM
Location: Atrium 101

The past decade has seen the emergence of new techniques and exciting discoveries powered by wide-field imaging surveys from the UV to the near-IR domain. Owing to gravitational lensing, galaxy clustering and abundance matching (to name but a few), coupled with advanced statistical interpretation, the informative power of astronomical imaging surveys has significantly increased. In particular, the connection between galaxies and dark matter, a keystone in cosmology and the study of galaxy evolution, has widely gained from this "scale revolution" and the future is bright, as the next experiments such as HSC, LSST, Euclid or WFIRST are dedicated "survey" machines that will further increase imaging data by orders of magnitude (without mentioning the tremendous gain in image resolution, time domain and deep near-IR imaging). I will focus my talk on reviewing the main techniques to connect galaxies and dark matter in the context of wide-field surveys and I will show some concrete examples of applied data analysis in the CFHTLenS and COSMOS projects, showing that these techniques are now well proven, although the challenges in reducing some critical systematic uncertainties are ahead of us.

Stellar activity in exoplanet observations

Speaker: Dr. Giovanni Bruno (STScI)
Time: November 3, 2017 - 3:00 PM
Location: Atrium 101

While being a treasure of information for stellar physicists, stellar activity is a major source of headaches for exoplaneteers. Transit photometry and radial velocities, the main techniques to measure the radius and mass of exoplanets, are affected by the noise and systematic errors introduced by phenomena related to stellar activity, such as starspots. This is a serious limitation because the mass and radius of a planet are necessary parameters to model its internal structure. Starspots also affect the atmospheric characterization of exoplanets, as they can mimic particular spectral features which can erroneously be interpreted as aerosol signatures in otherwise clear atmospheres.

I will review the main challenges due to stellar activity and present different ways it can be dealt with, with their advantages and disadvantages, discussing real cases. We are far from the solution to this problem, but recent improvements in survey precision, analytic modeling and computational techniques give some reasons to be optimistic.

Dark Matter Substructure: Cosmological Treasure Trove or a Pandora's Box

Speaker: Dr. Frank van den Bosch (Yale)
Time: October 27, 2017 - 3:00 PM
Location: Atrium 101

Hierarchical structure formation in a LCDM cosmology gives rise to virialized dark matter halos that contain a wealth of subtructure. Being able to accurately predict the abundance and demographics of dark matter subhaloes is of paramount importance for many fields of astrophysics: gravitational lensing, galaxy evolution, and even constraining the nature of dark matter. Dark matter substructure is subject to tidal stripping and tidal heating, which are highly non-linear processes and therefore best studied using numerical N-body simulations. Unfortunately, as I will demonstrate, state-of-the-art cosmological simulations are unable to adequately resolve the dynamical evolution of dark matter substructure. They suffer from a dramatic amount of artificial subhalo disruption as a consequence of both inadequate force softening and discreteness noise amplification in the presence of a tidal field. I discuss implications for a variety of astrophysical applications, and briefly discuss potential ways forward.

MacLennan Memorial Lecture in Astronomy (public lecture) presents: Exoplanets and the Search for Habitable Worlds

Speaker: Dr. Sara Seager (MIT)
Time: October 20, 2017 - 7:00 PM
Location: McNally Theatre Auditorium

Thousands of exoplanets are known to orbit nearby stars with compelling evidence that all stars in our Milky Way Galaxy likely have planets. Beyond their discovery, a new era of “exoplanet characterization” is underway with an astonishing diversity of exoplanets driving the fields of planetary science and engineering to new frontiers. The push to find smaller and smaller planets down to Earth size is succeeding and motivating the next generation of space telescopes to have the capability to find and identify habitable worlds. The ultimate goal is to discover planets that may have suitable conditions for life or even signs of life by way of atmospheric biosignature gases.

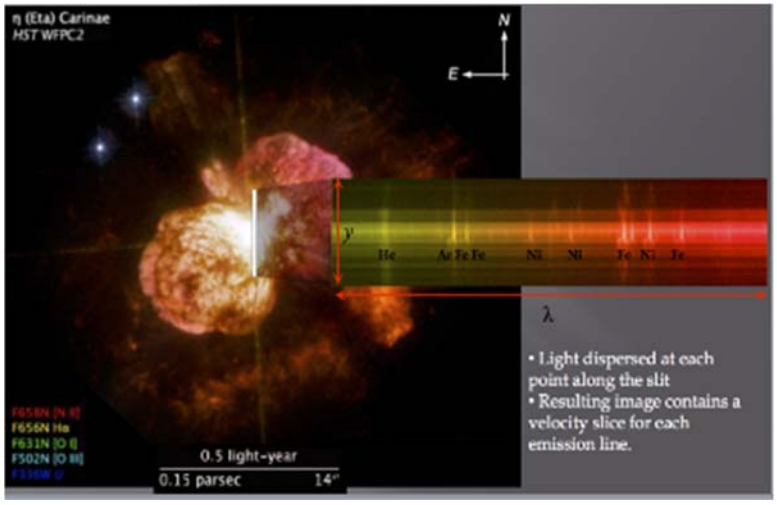
What drives the growth of supermassive black holes? -- Galaxy interactions versus secular evolution

Speaker: Dr. Andy Goulding (Princeton)
Time: September 29, 2017 - 3:00 PM
Location: Atrium 101

Collisions and interactions between galaxies are thought to be pivotal stages in their formation and evolution, causing the rapid production of new stars, and possibly serving as a mechanism for fueling the most rapid growth of supermassive black holes (BH). However, the majority of more moderate luminosity growing BHs, so called active galactic nuclei, appear to be hosted in isolated disk-like systems. These spiral galaxies do not appear to have undergone a significant merger in the last 2-3 billion years, and are evolving along a more secular route.
I will discuss our recent efforts to harness the enormous statistical power of wide-field surveys, such as the Hyper Suprime Camera Survey and the Sloan Digital Sky Survey, to perform a multi-wavelength analysis of BHs and their galaxies, and to investigate AGN triggering in the context of galaxy evolution.

Eta Carinae: a Rosetta Stone or an anomaly

Speaker: Dr. Ted Gull (NASA/GSFC)
Time: September 22, 2017 - 3:00 PM
Location: Atrium 101



The first metals that enriched the interstellar medium came from very massive stars that evolved quickly. We can gain understanding of the physical processes by studying nearby massive stars in the present epoch, especially those that have undergone rapid evolutionary changes leading to huge ejections. However their estimated frequency is about one per galaxy per century.

Fortunately the massive star with historical ejection in our Milky Way, Eta Carina, is sufficiently nearby that we are able to study the ejected material and even monitor its current behavior with modern observatories.

I will describe observations and models of the Eta Carina binary system, its fossil wind structures and its nineteenth century ejecta: the Homunculus and the Little Homunculus. 3D models of the Homunculus and the current interacting winds will be presented. Questions still persist on how Eta Carina might explain the distant supernova imposters, some of which precede actual supernovae.

Eclipse Chasing in Nebraska

Speaker: Dave Lane (SMU) and Dave Chapman
Time: September 15, 2017 - 3:00 PM
Location: Atrium 101

Several Nova Scotians and many other Canadians headed to Nebraska (and other western states) last month to view the Great American Total Solar Eclipse. This "light" colloquium will chronicle our journey, experiences and some of the images and video collected by us and other Canadians.