Physics Department Summer Lectures 2021

Report of Contributions

https://indico.bnl.gov/e/11947

Contribution ID: **1** Type: **not specified**

The Standard Model and Beyond (Block 1)

Tuesday, 15 June 2021 12:00 (1h 15m)

Abstract: Although the Standard Model of particle physics, in conjunction with General Relativity, explains a wide range of physical phenomena, there are good reasons to believe that it does not represent a complete description of Nature. In this lecture, we will introduce the Standard Model and discuss some of its empirical and conceptual shortcomings.
Some of the ideas that have been proposed to address these open questions will also be briefly discussed.

Presenter: DAVOUDIASL, Hooman (Brookhaven National Laboratory)

Contribution ID: **2** Type: **not specified**

A precision measurement of the anomalous magnetic moment of the muon (Block 2)

Wednesday, 23 June 2021 12:00 (1h 15m)

Abstract: In this talk you will learn what a muon is, what a magnetic moment is, why it is anomalous, and what this has to do with the energy of the vacuum.

Presenter: MORSE, Bill (BNL)

Contribution ID: **3** Type: **not specified**

The Elusive Neutrino (Block 2)

Tuesday, 22 June 2021 12:00 (1h 15m)

Abstract: Neutrinos are the least understood of the currently known elementary particles.
In this lecture we will discuss the history of the neutrino including the astonishing phenomenon of neutrino flavor oscillations. We will then review the current knowledge of neutrino properties and the remaining open questions in neutrino physics.

Presenter: GEHRLEIN, Julia

Contribution ID: **4** Type: **not specified**

A Golden Age in Physics: nuclear collisions at ultra-relativistic energies (Block 3)

Tuesday, 29 June 2021 12:00 (1h 15m)

Abstract: I give a pedagogical introduction to gauge theories, and how they appear in the theory of strong
interactions, where quarks and gluons form neutrons, protons, and other particles. I make several historical detours, to emphasize how the lore of "As everyone who is anyone knows…" has failed in physics. A brief overview of results from the Relativistic Heavy Ion Collider will be outlined, but the emphasis is on why a Quark-Gluon Plasma, created at about a trillion degrees, is a subject of fundamental interest.

Presenter: PISARSKI, Rob (Brookhaven National Laboratory)

Contribution ID: **5** Type: **not specified**

Introduction to high energy spin physics (Block 3)

Friday, 2 July 2021 12:00 (1h 15m)

Abstract: After a general introduction to hadrons, quarks and QCD, I will focus on spin physics.
I give a brief overview of spin in quantum mechanics and in particle physics.
I then introduce the physics of the proton spin. I explain the puzzle concerning the origin of proton spin and our past, present and future efforts to solve this puzzle.

Presenter: HATTA, Yoshitaka (BNL)

Contribution ID: **6** Type: **not specified**

The Really Big Picture: Cosmology in the 21st Century (Block 4)

Starting from a very basic level we review how to describe the standard Big Bang model of an expanding universe. We discuss the connection between expansion dynamics and different types of matter and energy densities, and focus on the evidence for the accelerated expansion of our Universe driven by dark energy. Different schools of observation and measurement will be mentioned and we conclude with possible projections for our (very) long-term future.

Recording available at https://bluejeans.com/s/ohla9n4@Kx7/

Presenter: STANKUS, Paul

Contribution ID: **7** Type: **not specified**

Basic statistics of charge and time measurements from photo-sensors (Block 5)

Friday, 23 July 2021 12:00 (1h 15m)

Abstract: In this lecture, we will take a detailed look at the functioning and analysis of a common detector used in particle and nuclear physics. We will go through a detailed calculation of what we expect from a sensitive photo-multiplier tube used to detect photons.
We will perform a statistical analysis of the charge spectrum, gain fluctuations, the measurement of time, and statistics of counters. We will learn to use methods from probability and statistics that are applicable for many other circumstances.

Presenter: DIWAN, Milind (BNL)

Contribution ID: **8** Type: **not specified**

Demystifying Radio Astronomy (Block 5)

Tuesday, 27 July 2021 12:00 (1h 15m)

Abstract: If you have ever wondered what radio astronomy is, this lecture will attempt to demystify the topic. What is radio astronomy? Is it about listening to or watching the sky? Why is the universe transmitting radio waves anyway? This talk will explain techniques for doing radio astronomy and provide insights into the nature of light and radio. As well, Brookhaven's role in the exciting new field of 21cm dark energy cosmology will be introduced.

Presenter: HAUPT, Justine

Contribution ID: **9** Type: **not specified**

Charge and Light Detection for Noble Liquid Time Projection Chambers (Block 5)

Friday, 30 July 2021 12:00 (1h 15m)

Abstract: Time projection chambers, which take 3D pictures of elementary particles as they interact with matter, have been used in experimental particle physics since the 1970s. Measuring how neutrinos, which are very light, very weakly interacting particles, interact with matter can help solve some key mysteries of physics, such as why the universe is matter instead of anti-matter. Huge time projection chambers filled with tons of noble liquid, such as argon or xenon, are the next generation of particle detectors designed to measure properties of neutrinos. These detectors need to make accurate measurements of the electric charge and light generated by neutrinos in the noble liquid mass. This talk will describe some of the instrumentation critical to accurate measurement of the electric charge and light in noble liquid time projection chambers.

Presenter: WORCESTER, Matthew (BNL)

Contribution ID: **10** Type: **not specified**

Latest in Higgs and new physics searches with the ATLAS Detector (Block 2)

Friday, 25 June 2021 12:00 (1h 15m)

Abstract: In this talk, we will review a few salient ATLAS results in the searches for new physics at the LHC. This will include searches for exotic states, super symmetry, extended Higgs sectors, long-lived particles and dark sector states.

Presenter: Dr ASSAMAGAN, Kétévi Adiklè (BNL)

Contribution ID: **11** Type: **not specified**

Flavorful ways to new physics (Block 6)

Tuesday, 20 July 2021 12:00 (1h 15m)

Abstract: This lecture will give a brief overview heavy-flavor physics, i.e., the study of weakly decaying b and c quarks. It will discuss why heavy flavors are an excellent laboratory for new physics searches, what is the current experimental status, focusing the attention on recent measurements ("b anomalies") that form coherent set of deviations from the standard model and could represent a first hint of new physics.

Presenter: DI CANTO, Angelo (BNL)

Contribution ID: **12** Type: **not specified**

(Maybe)Review of Linear Algebra Applications in Some Recent Neutrino Experiments (Block 7)

Abstract: Linear algebra has been widely used in physics analysis of experiments. In this talk, I am going to review some of its recent usage in detector signal processing, noise filtering, event reconstruction, and data unfolding. In particular, its connections to various numerical and analytical techniques including the Fast Fourier Transformation, the Compressed Sensing, and the biconjugate gradients stabilized method, will be discussed. Through many real world applications, we show the power of linear algebra in high-energy experiments.

Presenter: QIAN, Xin (BNL)

Contribution ID: **13** Type: **not specified**

Computing challenges in nuclear and particle physics (Block 7)

Tuesday, 3 August 2021 12:00 (1h 15m)

Abstract: Big physics experiments, like the Electron Ion Collider, DUNE and the Large Hadron Collider experiments at CERN, present many technical challenges, one of which is computing. This talk will use the ATLAS experiment at the LHC as an example to explain why computing is so important in our physics experiments, and how we use computing resources around the world to get from the raw detector data to physics results. We will also see that, while things may look challenging now, they will become even more challenging in the future!

Presenter: LAYCOCK, Paul (Brookhaven National Laboratory)

Contribution ID: **14** Type: **not specified**

Quantum Computation for Nuclear Physics and beyond (Block 7)

Tuesday, 6 July 2021 12:00 (1h 15m)

Abstract:
I will give an introduction into the exciting field of quantum computation and quantum simulation from the perspective of a nuclear theorists.
My goal is to convince you that this potentially is the very beginning of a new era, where theorists may be able to compute things that had been impossible before.
I will highlight the many connections between high energy and nuclear, condensed matter and atomic, molecular and optical physics that are inspired by advances
in controlling matter at the single quantum level. These connections force us to think about old (and new) problems in very different and exciting ways.

Presenter: MUELLER, Niklas (University of Maryland)

Contribution ID: **15** Type: **not specified**

The electron-ion collider: A collider to unravel the mysteries of visible matter. (Block 3)

Tuesday, 13 July 2021 12:30 (1h 15m)

Abstract:Understanding the properties of nuclear matter and its emergence through the underlying partonic structure and dynamics of quarks and gluons requires a new experimental facility in hadronic physics known as the Electron-Ion Collider (EIC). The EIC will address some of the most profound questions concerning the emergence of nuclear properties by precisely imaging gluons and quarks inside protons and nuclei such as the distribution of gluons and quarks in space and momentum, their role in building the nucleon spin and the properties of gluons in nuclei at high energies. In January 2020 EIC received CD-0 and Brookhaven National Laboratory was chosen as site. This presentation will highlight the capabilities of an EIC and discuss its status, accelerator design and the concepts for the experimental equipment.

Presenter: Dr ASCHENAUER, E. C. (BNL)

Contribution ID: **16** Type: **not specified**

Introduction to deep learning methods and their scientific applications (Block 7)

Friday, 6 August 2021 12:00 (2 hours)

Abstract: Deep learning is the backbone technology of the current wave of AI revolution that has changed people's daily lives from smart assistants, autonomous driving, to computational photography. In this talk, I will introduce some deep learning methods, their milestone breakthroughs, popular tools, and AI projects for science at BNL.

Presenter: REN, Yihui

Contribution ID: **17** Type: **not specified**

The journey to seek symmetry in Quark-Gluon Plasma (Block 6)

Friday, 9 July 2021 12:00 (1h 15m)

Abstract: Di-leptons and photons are a crucial probe of the strongly interacting matter created in ultra-relativistic heavy-ion collisions. Leptons and photons are produced during the whole evolution of the created matter and can traverse the medium with minimal interactions. Different kinematics of dilepton pairs (mass and transverse momentum ranges) can selectively probe the properties of the formed matter throughout its entire evolution. In the low invariant mass range (Mll < 1.1 GeV/c2), vector meson in-medium properties may be studied via dilepton decays and may exhibit modifications related to possible chiral symmetry restoration. The di-lepton spectra in the intermediate mass range (1.1 < Mll < 3.0 GeV/c2) are expected to be directly related to the thermal radiation of the Quark-Gluon Plasma. In this lecture, I will talk about my journey to seek symmetry in Quark-Gluon Plasma using di-leptons.

Presenter: RUAN, Lijuan (Brookhaven National Laboratory)

Contribution ID: **18** Type: **not specified**

First steps in cosmology (Block 4)

Friday, 16 July 2021 12:00 (1h 15m)

Abstract: In the lecture, I will outline the basic assumptions of cosmology. We'll derive the Friedman equation in the Newtonian approximation and discuss its standard solutions as well as complications arising from general relativity. Then we will discuss some observational milestones the support the standard cosmological model.

Presenter: SLOSAR, Anze (BNL)