SigmaCamp Next 2025 Lectures

August 10 - 17, 2025

Lecture dates are subject to change

SigmaCamp Next 2025 Lecture Overview

Sunday, August 10

The Problem of Time
by *Alex Frenkel*

The steady passage of time is one of the few observable facts that every one of us can independently verify, one inextricably tied to human experience and the human condition. However, general relativity makes time weird, especially when one considers a black hole. Also, quantum mechanics makes time even weirder, especially when one considers a black hole. The problem of the subjective experience of time may sometimes seem like a matter of philosophy, but recently more and more leading experts in quantum gravity have found themselves forced to grapple with it when studying the fundamental degrees of freedom that make up our world. In this lecture, I will articulate why a reckoning with the problem of time seems inescapable. Also, we will consider black holes.

About the lecturer: *I have just received my Ph.D. in physics from Stanford University, specializing in quantum gravity, string theory, and black holes. This fall, I will be joining the Simons Center for Geometry and Physics as a postdoctoral scholar. My research interests primarily include (a) understanding any sort of plausible answer as to what happens to matter and quantum information at the black hole singularity, and (b) understanding how general relativity can emerge at low energies from the chaotic interactions and entanglement patterns of complicated quantum systems.*

Monday, August 11

From a Single Cell to an Organism: How Cells "Talk" to Each Other in Embryonic Development
by *Evguenia (Jenya) Alexandrova*

All living organisms have a diverse array of cells in their bodies, e.g., nerves, skin cells, muscle fibers, etc. But how do they appear from a single cell, the fertalized egg (aka zygote)? This is in part facilitated by what's called cell signaling pathways. In this lecture, we will talk about the main cell signaling pathways and how they affect embryonic development. Interestingly, these pathways are reused for different purposes in both, the embryos and adults. Conversely, gene mutations trigger embryonic abnormalities, e.g., cleft palate and spina bifida in the embryos or various diseases in the adults. We will also touch upon other biological mechanisms that impact proper formation of multicellular organisms.

About the lecturer: *Evguenia is an Assistant Professor in the department of Pathology, Stony Brook University. She got her Bachelor's degree at Moscow State University (Physiology, concentration Embryology) and Ph.D. at Stony Brook University (Molecular and Cell Biology). Evguenia currently works on breast cancer mechanisms and treatments, as well as skin diseases. In her free time, Evguenia enjoys traveling, camping, and spending time with her family.*

Electoral Math: The Mathematics of Voting
by *Mira Bernstein*

Say you're running an election with 5 candidates and 100 voters. The exact preferences of the voters are as follows:

31 voters rank the candidates $A > D > C > E > B$ (A is better than D, who is better than C, etc.)

20 voters rank the candidates $B > D > C > E > A$

19 voters rank the candidates $D > C > E > B > A$

16 voters rank the candidates $E > C > B > A > D$

14 voters rank the candidates $C > E > D > B > A$

It turns out that you can come up with five different reasonable-sounding voting systems, each of which would elect a different candidate in this situation. (All five of these voting systems are actually in use somewhere in the world.)

Welcome to the weird (and rather depressing) world of voting theory, where most results are of the form: "Wouldn't it be nice if you could find a voting system that had both of the following totally intuitive properties? Well, tough luck: unless you want a dictatorship, you can have one property or the other, but not both." In this lecture, we'll discuss some of the mathematics behind voting theory and also look at some real-world examples of voting systems producing counterintuitive election outcomes.

About the lecturer: *Mira Bernstein divides her time between math education and statistics. She has been one of the key organizers of Canada/USA Mathcamp since 1997, was a founding faculty member and admissions director at Proof School in 2015, and co-founded the Cambridge Math Circle in 2018. In data science and statistics, her focus has been on applying mathematics to issues of social importance, such as voting rights and the effects of extending health insurance to the uninsured.*

Electricity: A Practical Understanding of Magic
by *Luke Allen*

Electricity is the invisible magic that powers the modern world. In this lecture, we'll embark on a journey to uncover the hidden world of current and voltage: what they truly are, how they flow through circuits, and how engineers harness them to create light, motion, and even fire. By the end, you'll come away with a clear and intuitive grasp of how electricity works—an essential foundation before diving into the hands-on workshop, where you'll build your own circuits.

About the lecturer: *Luke is an engineer and entrepreneur who loves building things that combine robotics and artificial intelligence. He is the CTO and co-founder of Allen Control Systems, a defense tech company developing robotic systems to counter drones. He previously co-founded Bbot, a restaurant robotics startup acquired by DoorDash. Before that, he worked as a Navy engineer on control systems for nuclear reactors in aircraft carriers. Luke holds a Master's degree in Computer Science from Stanford, where he focused on AI and robotics, and in his spare time has built several mobile games with custom 3D physics engines—just for fun.*

Tuesday, August 12

Molecular Mechanisms and Treatments of Cancer
by ***Evguenia (Jenya) Alexandrova***

Cancer, "the emperor of all maladies", is caused — primarily — by gene mutations. Oncogenic mutations highjack normal cell signaling pathways and force the cells to divide noncontrollably (= form the tumor), spread to other organs (= metastasize), and evade recognition and elimination by the immune system. We will discuss some major cell signaling pathways that — when mutated — can cause cancer. We will also touch upon the major cancer treatment modalities and the roadblocks that doctors encounter.

About the lecturer: *Evguenia is an Assistant Professor in the department of Pathology, Stony Brook University. She got her Bachelor's degree at Moscow State University (Physiology, concentration Embryology) and Ph.D. at Stony Brook University (Molecular and Cell Biology). Evguenia currently works on breast cancer mechanisms and treatments, as well as skin diseases. In her free time, Evguenia enjoys traveling, camping, and spending time with her family.*

Electoral Math: The Politics of Rounding Fractions
by *Mira Bernstein*

> God help the state of Maine when Mathematicks reach for her and undertake to strike her down!
>
> — Representative Littlefield (R, ME), 1901

The US Constitution mandates that "representatives ... shall be apportioned among the several states ... according to their respective numbers". This is usually taken to mean that the number of representatives in each state should be proportional to its population.

But exact proportionality is not possible: for example, California cannot have 54.37 representatives. This is the *problem of apportionment*, and it's a lot trickier and more interesting than might appear at first glance. Over the course of US history, Congress went through five different apportionment methods, always accompanied by fierce political debates. The method that we currently use was proposed in 1921 by a Harvard mathematician, and it was adopted by Congress on the recommendation of the US Academy of Sciences. As far as I know, the US is the only country in the world that uses a method of apportionment that was derived by a mathematician from first principles! Come find out how it works.

About the lecturer: *Mira Bernstein divides her time between math education and statistics. She has been one of the key organizers of Canada/USA Mathcamp since 1997, was a founding faculty member and admissions director at Proof School in 2015, and co-founded the Cambridge Math Circle in 2018. In data science and statistics, her focus has been on applying mathematics to issues of social importance, such as voting rights and the effects of extending health insurance to the uninsured.*

Physics of Domino Tilings
by ***Sasha Abanov***

In how many ways can you tile a chessboard using dominoes of size 2×1? Starting with this simple and classic puzzle, we'll explore how randomness and order emerge in physical and mathematical systems. Along the way, we'll discover the surprising phenomenon of the "limit shape" — a typical large-scale pattern that emerges from random behavior. We will see how regions of order and disorder coexist, separated by a sharp boundary, as described by the beautiful Arctic Circle Theorem. Finally, we'll glimpse a deep connection between these tilings and the motion of quantum fluids.

About the lecturer: *Sasha is a Professor in Department of Physics and Astronomy at Stony Brook University, NY. Sasha's research is in theoretical condensed matter physics and in mathematical physics. He is mainly interested in systems whose properties are defined by the laws of quantum physics. Some examples of such systems are superfluids, superconductors and Quantum Hall effect systems. Sasha enjoys teaching physics and mathematics at different levels. He has a lot of experience in teaching school students in various summer camps and math circles.*

How Online Games Deal With Lag
by ***Anatoly Zavyalov***

How do most online games feel so smooth and responsive, even though the servers hosting them can be half a continent away? In this lecture, we will explore the surprisingly intricate networking techniques currently being used behind the scenes in online games such as Fortnite, Valorant, and Counter Strike 2 to combat latency and synchronization issues, prevent cheating, and make the gameplay experience as smooth as possible. You will also learn the necessary terms to blame your missed headshots on the game's developers, rather than on your poor aim, in an informed manner.

About the lecturer: *Anatoly is a Ph.D. student in computer science at Boston University. His research interests include differential privacy, sublinear algorithms, and theoretical computer science in general. In the past, he wrote software currently being used by several large radio telescopes, and contributed to open-source theorem provers. In his free time, Anatoly plays the piano and continues his childhood dream of being a game developer, currently working on the multiplayer browser game SUPREM.IO which has amassed a fanbase of 1,000+ players since 2020.*

Wednesday, August 13

Breast Cancer: Subtypes, Treatments, Therapeutic Resistance
by ***Evguenia (Jenya) Alexandrova***

Breast cancer is the most common female cancer and the leading cause of cancer-related death in women. Like many other cancers, it is not one disease but rather, has several molecular subtypes. We will discuss how molecular subtypes affect the choice of treatment. Furthermore, cancer cells have an ability to evade therapy, i.e., develop therapeutic resistance. Using HER2-positive breast cancer as an example, we will discuss how we study therapeutic resistance in the lab to find ways to overcome it and make cancer therapies more efficient.

About the lecturer: *Evguenia is an Assistant Professor in the department of Pathology, Stony Brook University. She got her Bachelor's degree at Moscow State University (Physiology, concentration Embryology) and Ph.D. at Stony Brook University (Molecular and Cell Biology). Evguenia currently works on breast cancer mechanisms and treatments, as well as skin diseases. In her free time, Evguenia enjoys traveling, camping, and spending time with her family.*

Electoral Math: The Politics of Geometry
by *Mira Bernstein*

The State of Connecticut has five representative in Congress. They are elected by dividing the state into five electoral districts with equal population. The voters of each district then elect one Congressional representative.

But there are many possible ways to divide a state into districts, and some of these might produce counterintuitive results. For instance, a political party supported by fewer than half the voters in a state might end up winning a large majority of the state's Congressional seats. When politicians design districts on purpose to create such unfair outcomes, it's called *gerrymandering*. (The term dates from 1812, when Massachusetts governor Elbridge Gerry tried to gain advantage for his party by drawing such a convoluted-looking district that local newspapers dubbed it "Gerry's salamander" — hence, "gerrymander".)

In this lecture, I will give an overview of how gerrymandering works and briefly summarize its legal and political history. I will then introduce you to the different mathematical tools that have been developed to combat gerrymandering. A big part of the challenge lies in articulating a quantitative standard of fairness, which turns out to be much trickier than you might think: many of the key properties that people expect from a "fair" districting plan turn out to be inherently contradictory. One way to sidestep these contradictions would be to ditch electoral districts and switch to an entirely different voting system — something that other countries have done, and that is increasingly being discussed in the US as well.

About the lecturer: *Mira Bernstein divides her time between math education and statistics. She has been one of the key organizers of Canada/USA Mathcamp since 1997, was a founding faculty member and admissions director at Proof School in 2015, and co-founded the Cambridge Math Circle in 2018. In data science and statistics, her focus has been on applying mathematics to issues of social importance, such as voting rights and the effects of extending health insurance to the uninsured.*

Are We Alone in the Universe?
by *Mark Lukin*

We still don't know how likely it is for life to emerge on planets similar to Earth. One of the greatest mysteries in science is how non-living organic materials made the leap to self-replicating life. This is the ultimate "chicken and egg" problem: complex systems need Darwinian evolution to arise, but evolution requires a system that is already complex. In this lecture, I will present a new theory that resolves this paradox.

About the lecturer: *Mark Lukin is a researcher at Stony Brook University, NY. The focus of Mark Lukin's scientific interests is nucleic acids (DNA and RNA), the molecules responsible for the storage and transfer of hereditary information in living organisms. How does DNA get copied? What happens when DNA molecules break? To answer these, as well as many other questions, Mark needs to prepare artificial (modified) nucleic acids and their building blocks, the crazy compounds that normally do not exist in nature. The only way to obtain them is to do a chemical synthesis, the thing Mark likes the most. Besides that, Mark loves music, history, Greek philosophy, and science fiction. When he was young, he loved to do simple but spectacular chemical experiments. Recently, he realized he still loves to do that.*

Thursday, August 14

How to Cure Cancer – From Scalpels to Immunotherapy
by ***Sanjana Rao***

In 1971, President Nixon signed the Cancer Care Act and declared a "War on Cancer". Since then, federal agencies have invested over $100 billion into cancer research, yet in 2022, nearly 9.7 million people worldwide died from cancer.

So is there no hope? Are we losing this war of attrition against this deadly disease?

From Galen to Farber, scientists have used a range of approaches to cure cancer, some more successful than others. This lecture will go over the mechanisms of these diseases, the history of cancer research, and the strategies we have used to attempt to eradicate one of the most pernicious maladies of our time.

About the lecturer: *Sanjana Rao works at the Kousteni Lab at Columbia University Medical Center studying the origin and progression of myelodysplasia and acute myeloid leukemia (AML). She received her Bachelor's Degree from the University of Chicago in Biology and Neuroscience. Her specific research focus is on the role of the bone marrow microenvironment in the clonality and heterogeneity of blood cancers. At SigmaCamp, she can often be found dissecting animals in the Chemistry Circle wearing severely impractical footwear.*

Microbial Ecology of Oxygen Minimum Zones
by *Natasha Butkevich*

While humans need oxygen to survive, some microorganisms can thrive without it. Marine oxygen minimum zones (OMZs) are expanding areas of the ocean with low or no dissolved oxygen, and are largely inhabited by such microorganisms. But how do scientists study marine microorganisms when they often won't grow in a lab? This lecture will touch on the fundamentals of microbial metabolism and examine available niches as well as the associated metabolic pathways that predominate in oxygen minimum zones. Understanding these processes is critical for advancing our knowledge of marine ecosystems and their role in global biogeochemical cycles. We will also explore the methods used by oceanographers to study marine microorganisms, both during expeditions at sea and on land.

About the lecturer: *Natasha earned her bachelor's degree from Cornell University in 2020, focusing on microbiology. Now, she is a Ph.D. candidate at the School of Marine and Atmospheric Sciences at Stony Brook University. Her research integrates stable isotope probing, Raman microspectroscopy and fluorescence in-situ hybridization to investigate the link between microbial identity and function in the Eastern Tropical North Pacific (ETNP) OMZ. She's been part of two scientific research expeditions during her Ph.D. In 2023, she visited the ETNP OMZ to gather the samples that are the backbone of her research. She's recently returned from the Bay of Bengal, just in time for SigmaCamp Next! Beyond her academic endeavors, Natasha has a long-standing passion for ballroom dancing, a pursuit she began as an undergraduate and has continued alongside her Ph.D. studies. In her free time, Natasha enjoys creating artwork, with plans to share her projects on Instagram in the future.*

From Structure to Properties: Why Are Beets Red?
by *Luiz Felipe Velasco Viegas*

This lecture explores the physical, chemical, and evolutionary origins of color in molecules. We will examine how molecular structure influences color properties, with particular emphasis on a naturally occurring class of pigments: Betalains.

Representing a relatively new and understudied class of pigments, betalains are notable for their vivid hues but also for their extreme instability. Despite of that, they're present in something as simple as a red beetroot (Beta vulgaris). Their sensitivity to light, temperature, oxygen, and water activity poses unique challenges for their study and application. The lecture aims to form substrate to answering fundamental chemistry inquiries on structure and its effects on physical properties of organic molecules: once they are basic components of life as we know, how do we know them?

About the lecturer: *Luiz Felipe Velasco Viegas is an undergraduate student at the Institute of Chemistry at the University of São Paulo (IQUSP), where he was part of the photochemistry and natural pigment synthesis group. His work was focused on the kinetic monitoring of reactions involving betalains and on techniques for encapsulating these highly labile pigments in lipophilic vesicles. He is currently transitioning his academic focus toward biochemistry. At SigmaNext this year, he will serve as a counselor, contribute to the Chemistry Workspace on sulfur polymers, and act as a TA for Mark Lukin's semi-lab "Molecular Structure, Spectra, and Spectroscopy".*

Who Gets to Breathe Clean Air?
by ***Anna Rosner***

Air is a necessity for human life. Whether or not you are breathing clean air can have major impacts on your long-term health. So why does where you live have such a large impact on whether or not you can expect to breathe clean air? Why do poorer and historically redlined neighborhoods have worse air quality?

We will discuss the science behind air quality and air pollutants, how we model them, and the regulations surrounding them. Then, we will dive into social determinants of air quality, and how the urban heat island effect can exacerbate poor air quality. Finally, we will look at how this impacts public health, and what we can do about it. You might have seen "environmental justice" in the news — now, let's dive into the science and data.

About the lecturer: *Anna Rosner is a junior at the Georgia Institute of Technology studying Environmental Engineering, with minors in Public Policy and Sustainable Cities. Their recent research as an NSF Research Experience for Undergraduates (REU) Intern at the Ohio State University focused on the intersection of urban heat and air pollution and its applications to environmental justice. This is Anna's fourth year as part of the SigmaStaff, and when they're not staring at a spreadsheet, you can probably find them in a thrift store, a kitchen, or generally frolicking in nature. Ask them about their tape measure collection.*

Friday, August 15

Neuroblox: A New Computational Platform for Mechanistic Brain Circuit Modeling / Precision Neurotherapeutics
by *Lilianne R. Mujica-Parodi*

Most brain imaging studies today are like looking at traffic patterns from a helicopter—you can see correlations between busy roads, but you can't predict what happens when you close a bridge or change a traffic light. We built Neuroblox to solve this problem by creating computational models that actually capture how brain circuits work, not just how they correlate. To illustrate this in practice, we examined brain aging. Combining data from nearly 20,000 people, we discovered that brains don't just gradually decline—they hit critical tipping points around midlife. The culprit? Insulin resistance in neurons, which starves brain cells of energy. Here's the exciting part: ketones can bypass this metabolic roadblock and restore brain function. Neuroblox lets us trace this story from individual brain cells all the way up to cognitive performance. The key breakthrough is what we call biomimetic computational primitives—functional building blocks that connect what's happening at the cellular level to what patients and their families actually care about: memory, decision-making, and thinking clearly. Instead of just saying "this brain region is less active," we can predict which interventions will improve cognitive function and when to use them. This opens up applications from drug development to brain stimulation therapies. Neuroblox transforms how we approach brain disorders—moving from describing problems to solving them with precision treatments tailored to each patient's brain circuits.

About the lecturer: *Lilianne R. Mujica-Parodi is Director of the Laboratory for Computational Neurodiagnostics, Baszucki Endowed Chair of Metabolic Neuroscience, and Professor at Stony Brook University in Biomedical Engineering. Additionally, she is Neuroscientist at the Athinoula A. Martinos Center for Biomedical Imaging. Dr. Mujica-Parodi received her B.A. from Georgetown University and Ph.D. from Columbia University in mathematical logic and foundations of physics. After her Ph.D., she continued as faculty at Columbia's College of Physicians and Surgeons until being recruited to Stony Brook. She is a recipient of the NSF Career Award, the White House's Presidential Early Career Award in Science and Engineering, and the Fulbright Distinguished Scholar Award. Dr. Mujica-Parodi has made fundamental contributions to clinical neuroscience through the application of control systems engineering and dynamical systems to human neuroimaging data, and is a co-inventor of commercialized MR hardware for clinical neuroimaging. Neurodiagnostic applications of this work have ranged from neurological and psychiatric disorders, to screening protocols for U.S. Navy SEALs. In 2023, Mujica-Parodi became CEO of the Stony Brook/MIT/Dartmouth spin-off, Neuroblox Inc. (www.neuroblox.ai).*

Decimal Expansion of Numbers: The Normal Case
by ***Krerley Oliveira***

The Babylonians estimated π as $25/8 = 3.125$. Today, we know π to more than 3×10^{14} decimal places. We also know that the decimal expansion of π is non-periodic. However, humanity still does not know whether the distribution of digits in π is "balanced". In other words, we do not know if the proportion of 5's in the first n digits of π approaches $1/10$ as n grows. Numbers that satisfy this property are called normal numbers.

Although we know very little about the properties of individual numbers, we know quite a lot about randomly chosen numbers. In fact, almost all of them are normal. This insight stems from a series of fascinating discoveries that began in the late 19th and early 20th centuries. A new theory emerged through seminal work by Poincaré and Birkhoff, giving rise to what we now call Ergodic Theory.

Although it was originally motivated by the study of celestial mechanics, we will see how this theory can also be used to extract information about numbers.

About the lecturer: *Krerley Oliveira is a Brazilian mathematician. He got his Ph.D. at 22 years old on ergodic theory from IMPA, one of the best math institutes in the world. He is now a Full Professor at the Federal University of Alagoas (UFAL), where he started programs to train students in mathematics and support scientific research in mathematics. He is passionate about helping talented students and runs a center called NES, which prepares high schoolers with advanced courses in math and computer science. Krerley has taught and given lectures around the world and has written books and papers on advanced topics like dynamical systems and applied math. He likes triathlons and works on the expansion of SigmaCamp in Brazil.*

The Multi-Billion-Dollar Race to Understand Why the Universe Exists
by *Lee Hagaman*

Neutrinos are very light, weakly interacting, ghostly particles. Trillions of neutrinos from the sun pass through your body every second, day or night. The particle physics community around the world has been building up its understanding of neutrinos for decades, with improved neutrino beams from particle accelerators and improved detector technologies. This effort is finally culminating in two enormous experiments under construction right now: DUNE in the US, and Hyper-Kamiokande in Japan. These experiments are in a race to be the first to definitively measure whether neutrinos and antineutrinos behave the same or differently, which could be key to understanding matter-antimatter asymmetry after the big bang, and therefore understanding why the matter in the universe exists. In this lecture, I will describe neutrinos and the key differences between these two experiments.

About the lecturer: *Lee Hagaman is postdoctoral research scientist studying neutrinos at Nevis Laboratories at Columbia University. He is currently focusing on searches for anomalous neutrino interactions in liquid argon time projection chambers like MicroBooNE and DUNE. He studied at UC Berkeley for his undergraduate degree in physics, and Yale and the University of Chicago for his PhD. Alex Frenkel roped Lee into Sigma after many years of persuasion.*

Violence-Driven Innovation
by *Anar Amgalan*

The world's militaries are traditionally conservative institutions, yet they have repeatedly driven transformative innovations. This talk will explore the complex relationship between warfare and technological progress.

We will examine two interconnected processes: how the urgent demands of warfare drive rapid innovation, and how these innovations transform the nature of conflict itself.

Beginning with World Wars I and II, we will trace developments forward through the 20th century and beyond. We will discover how military research has influenced the seemingly civilian technology of our everyday gadgets and the advanced medicine that we take for granted. If we have time, we will also go back in time and discuss even earlier innovations.

About the lecturer: *Anar studied math and physics as an undergraduate, and received his PhD in physics studying human brain networks. His primary interest, then and now, is to disentangle the age-related pathological processes from normal aging. He uses mathematical modeling and deep learning techniques for this purpose. As such, most of his time is spent writing and debugging software. His current side interests include development of software tools for geographic and geometric computations more broadly. Anar aspires to eventually become the person who has taught the broadest array of semilabs at Sigma.*

Saturday, August 16

Decimal Expansion of Numbers: The Abnormal Case
by *Krerley Oliveira*

In the previous talk, we learned about normal numbers — numbers where all digits (like 0 through 9) appear with equal frequency in their decimal expansion. Although almost all real numbers are normal in a mathematical sense, today we'll talk about the numbers that are not normal.

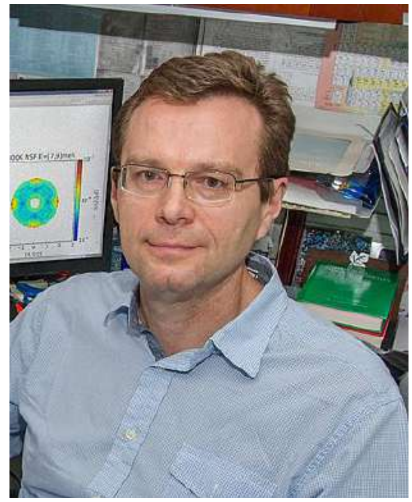
These unusual numbers may seem rare, but they form a very interesting and complex set. To study them, we'll use ideas from fractal geometry, which helps us understand shapes and sets that are too "irregular" for regular geometry.

One of the key ideas we'll explore is the Hausdorff dimension, which is a special way of measuring the size of sets — even if they are extremely small or broken up. For example, we'll see a famous result called Eggleston's Theorem, which says that the set of numbers that never use a certain digit (like 7) in their decimal expansion has Hausdorff dimension 1. That means that even though these numbers are extremely rare (they make up zero percent of all real numbers), their structure is still as rich as the whole interval from 0 to 1.

This talk shows how something that looks small or strange at first can hide a lot of beauty and complexity.

About the lecturer: *Krerley Oliveira is a Brazilian mathematician. He got his Ph.D. at 22 years old on ergodic theory from IMPA, one of the best math institutes in the world. He is now a Full Professor at the Federal University of Alagoas (UFAL), where he started programs to train students in mathematics and support scientific research in mathematics. He is passionate about helping talented students and runs a center called NES, which prepares high schoolers with advanced courses in math and computer science. Krerley has taught and given lectures around the world and has written books and papers on advanced topics like dynamical systems and applied math. He likes triathlons and works on the expansion of SigmaCamp in Brazil.*

How a Nuclear Reactor Works
by *Igor Zaliznyak*



Have you ever wondered how we turn tiny atoms into enormous amounts of energy? In this lecture, we will explore the fascinating world of nuclear reactors — the powerful machines that harness atomic energy to generate electricity. Starting with the basic structure of the atom, we'll dive into the process of nuclear fission, where atoms are split apart to release vast amounts of energy. You'll learn how this energy is captured in a reactor core, how it's safely controlled, and how it ultimately powers our homes and cities.

We'll examine different types of reactors and look at the key components that make them work, including fuel rods, control rods, and cooling systems, and understand how they all work together to maintain a delicate balance between energy production and safety. Along the way, we'll touch on real-world applications, environmental impacts, and reflect on the role of nuclear energy in building a sustainable future.

About the lecturer: *Dr. I. Zaliznyak is a physicist at Brookhaven National Laboratory, where he studies microscopic quantum properties of matter using neutron particles. Among others, these include exotic quantum states of electrons in metals such as superconductivity and magnetism, quantum liquids, superfluidity, as well as microscopic properties of functional materials. Dr. Zaliznyak obtained his Ph. D. degree at CEA-Grenoble and P. Kapitza Institute for Physical Problems, Moscow, in 1993. He also teaches math at SchoolNova.*

Chemical Electrostatics: What Does "Being Charged" Really Mean?
by *Victor Paiva*

In Physics textbooks, electrostatic phenomena are usually related generically to "space charges". Chemically, this definition is rather poor and boring. In this lecture we are going to explore the techniques that enable us to actually identify the nature of these charges, challenge well-known concepts such as the electroneutrality principle, discuss the main electrification mechanisms, look at how the atmosphere and earth itself can influence these processes and discuss their implications from manipulate chemical reactions to generate energy.

About the lecturer: *Victor has a Ms.C. in physical chemistry and is an enthusiast of academic competitions, in which he competed at international level as a student. Currently, he is a chemistry teacher at Colegio Etapa, in Brazil, and an academic advisor for Chemistry Olympiads. He was the Brazilian team leader in five International Junior Science Olympiads and two Iberoamerican Chemistry Olympiads, and personally trained students that collectively won 40 international medals. Besides chemistry and teaching, Victor is also a cat aficionado. Don't hesitate to ask him about his cats.*

An Overview of Cloud Computing
by *Marcus Fontoura*

In this talk, we will explore the fundamentals of how cloud computing powers modern digital infrastructure, enabling scalable, on-demand access to computing resources over the internet. We'll begin with a high-level overview of cloud architecture. Then, I'll focus on resource allocation, particularly Virtual Machines (VMs), which are the building blocks of cloud services. We'll explain how cloud providers use hypervisors to abstract physical hardware, allowing multiple VMs to run on the same physical server. This enables multi-tenancy, elasticity, and cost efficiency.

About the lecturer: *Marcus Fontoura is a Technical Fellow at Microsoft, where he works as CTO for Azure Core. Most recently, he was the CTO at Stone (2022-2025), where he led the engineering organization, focused on building highly efficient financial platforms and an amazing engineering culture. Marcus continues to serve as an advisor to the company. Marcus also had posts at Google, Yahoo Research, and IBM Research, where he worked on search engine infrastructure. Marcus holds a Ph.D. in Computer Science from the Pontifical Catholic University of Rio de Janeiro, Brazil.*