American Physical Society
1 Physics Ellipse
College Park, MD 20740

March Meeting 2023 Featured Presentations
Master Tip Sheet

A Key Statistical Method, Its 'Hidden Figure' Origins and Its Possible Connections to the Hydrogen Bomb

March 6, 8:48 a.m. PST, Room 225

The Metropolis Monte Carlo method, an algorithm that allows a user to draw random samples from a probability distribution, is used in many fields that rely on statistics. In this talk, Adam Iaizzi will describe some of the historical context for the creation of this algorithm. Key to the Metropolis method's origin story is the contribution of physicist Arianna Wright Rosenbluth, one of the co-authors on the 1953 paper proposing the algorithm, who wrote its first complete computer implementation. The talk will also highlight the algorithm's possible connections to the development of the hydrogen bomb in the mid-20th century.

Study Quantifies How People Perceive the Structure of Bach's Music

March 6, 9:24 a.m. PST, Room 125

A celebrated pioneer of Baroque-style music, Johann Sebastian Bach wrote music that varied in structure, composition and medium. In this talk, Suman Kulkarni and colleagues will share a framework to better understand complicated patterns found within many of the artist's pieces. Based on principles of information theory, this study provides a comprehensive quantitative analysis of how networks formed by the notes (nodes) and transitions (edges) present in Bach's compositions are structured. Through sequences of notes, these compositions — represented as music networks — convey information to listeners. Using a model for human perception, the framework examines how that information is then perceived by listeners. Among the results is the finding that different compositional forms are distinguishable through their inherent and perceived information content. Furthermore, the musical networks communicate large amounts of information efficiently through motifs that are easier to infer accurately. The work provides a fresh look at how people interact with and experience this historic composer's creativity.

System Models Dynamics of Arctic Ice Mélange, Helping Improve Forecasting of Sea Level Rise

March 6, 9:24 a.m. PST, Room 208

Famed for driving iceberg formation, the geophysical process known as glacial caving also creates a unique, soft material called ice mélange. Studying this granular mixture's physical dynamics is important for accurately predicting sea level rise. But because ice mélange is composed of various forms of icebergs and sea ice with different properties, it is hard to model its behavior. Here, Justin Burton and colleagues will share an experimental system that can simulate ice mélange from tidewater glaciers, like those in Greenland. The group used polypropylene as an ice mélange-like substitute and placed it in a narrow tank emulating a fjord, describing the material's fluid flow, velocity and friction under different conditions. The team's insights could inform and enhance geoscientists' efforts to characterize climate change's impact on sea level rise.

Talk Reveals Counterintuitive Investor Behaviors in Prediction Markets

March 6, 10 a.m. PST, Room 125

Investor behavior changes based on events like geopolitical conflicts and pandemics. This is especially pronounced in "prediction markets" — in which people bet on the outcome of different real-world events, like who will win a political race. But these markets' accuracy in predicting outcomes — and how they reach their correct or incorrect predictions — remain poorly understood. Now, K. Mason Rock and colleagues introduce a new method for analyzing investor behaviors in prediction markets. Their approach proactively evaluates whether prices are at an appropriate value before any event happens and investors react to market conclusions. The team's findings include the counterintuitive discovery that investors consistently overvalue the likelihood of high-profile events like the U.S. presidential race. These insights help contextualize the interplay between human behavior and price dynamics, with implications for other financial markets.

Static Electricity Helps Jumping Nematodes Reach Prey

March 6, 11:30 a.m. PST, Room 131

Jumping nematodes launch their millimeter-sized bodies into the air to attack insect prey. But they don't accomplish this distinct hunting tactic solely because of their athletic ability. Instead, the jumping parasites reach their electrically charged prey by harnessing electrostatic forces and wind-assisted dispersal, as Victor Ortega-Jimenez and colleagues will explain. By manipulating flow current and other variables in a lab setup, the researchers explored how the nematode species Steinernema carpocapsae uses electrostatic forces to gain a mid-air assist. The work has implications for conceptualizing the physical forces acting on ecological interaction dynamics at the milli-scale.

Researchers Contextualize the Varying Properties of Layers in an Important Oceanic Arctic Staircase
March 6, 12:06 p.m. PST, Room 414

Arctic staircases are sets of oceanic layers that differ in temperature and salinity and that transport heat towards sea ice. These phenomena can be used to track ocean heat in the Arctic Basin, including the Beaufort Gyre. But it is not clear exactly how Arctic staircases develop or what influences their layers' thickness. Here, Nicole Shibley and colleagues will explain that the Beaufort Gyre's Arctic staircase and its layers' thickness — or thinness — likely depends on the way that warmer water crosses the cooler Gyre, dissipating heat and salt. Based on their findings, the team hypothesizes that this staircase's properties may be applied to better understand changing water properties in the Arctic Basin.

Findings Describe How Cell Wall Development and Shape Impact Antibiotic Efficacy in Gram-Positive Bacteria like MRSA Superbug
March 6, 12:54 p.m. PST, Room 202

Gram-positive bacteria include harmful germs like those in the Staphylococcus family, which can cause strep or pneumonia. This taxonomic category is also home to Methicillin-resistant Staphylococcus aureus (MRSA) — the pathogen behind antibiotic resistant staph infections. It is thought that exploring how cell walls develop in the related rod-shaped bacterium, Bacillus subtilis, could yield useful information for optimizing therapeutics that fight MRSA. This talk by Felix Barber and colleagues will answer a 20-year-old question concerning Gram-positive bacteria's cell walls: how does one step of development, cell wall teichoic acid (WTA) synthesis, regulate cell shape? The group says their work may help explain why antibiotics that target WTA synthesis restore MRSA's susceptibility to more common treatments. They add that the results, which will also be viewable during a poster session, could also help in the creation of novel antibiotics that deliberately cause this outcome.

Model Reveals Atmospheric CO_2-Driven Tipping Point With Potential for Global Warming of Six Degrees Celsius
March 6, 1:18 p.m. PST, Room 414

Due to human-caused climate change, the world is rapidly approaching several tipping points where Earth's climate will be damaged irreversibly. To implement successful policies that slow global warming and avoid tipping points, policymakers and scientists need as much information as possible about the geophysical and atmospheric dynamics that propel global warming forward. This talk by Alex Mendez and colleagues delves into the role that atmospheric carbon dioxide (CO_2) concentration has in driving global temperatures to various tipping points. Using an energy balance model and mathematical analyses to simulate how atmospheric CO_2 will change under various carbon emission and capture rates, the researchers discovered a previously unidentified way in which atmospheric CO_2 levels could impermanently rise. Because of the greenhouse effect, this transient rise would still catalyze a drastic global surface temperature increase — regardless of whether CO_2 levels then declined. The [model describes this interaction and its severe consequences], as well as suggesting more rigorous strategies that could avert the CO2 concentration-dependent tipping point.

Wirelessly Controlling a Venus Flytrap to Grab Objects

March 6, 3:12 p.m. PST, Room 206

Actuators — components responsible for moving parts of machines — are a key element of robotics. Actuators that are soft can perform delicate tasks that rigid actuators cannot, but conventional soft actuators require high power input or are slow to respond. In this talk, Wenlong Li will show how they turned a living Venus flytrap into a soft actuator and developed a new way to operate it, using electrical signals that can be controlled wirelessly with a smartphone. The electrically controlled Venus flytrap actuator is energy efficient and responsive. Li used it to grasp thin wires and even moving objects, showing how plants could be used as sustainable components for robotics.

Scientists Develop a Way to Disentangle Energy of Enormous Ocean Currents

March 6, 3:36 p.m. PST, Room 414

Much like atmospheric circulation and weather systems, ocean currents are silos of kinetic energy that massively influence Earth's climate. Typically, scientists study ocean currents' kinetic energy by examining box-shaped regions in the sea less than 1,000 kilometers in extent. However, regional analyses are difficult to extrapolate to a global picture. Here, Hussein Aluie and colleagues will share a new coarse-graining technique that can finally evaluate the energy of ocean currents of all sizes, both smaller and larger than 1,000 kilometers. During their analyses, the researchers discovered that the Antarctic Circumpolar

Current — which is 9,000 kilometers in diameter — is the most energetic current. The group says that their methodology will enable better contextualization of the impact that the ocean's circulation has on the planet's climate system.

A Way to Harvest Solar Energy and Sea Salt Simultaneously
March 6, 5:12 p.m. PST, Room 315

In this talk, Peixin Dong will propose a system that can simultaneously harvest solar energy with solar panels and salt from sea water. With a 3D numerical model, Dong investigated how factors like the installation height and coverage area of solar panels would affect the evaporation rate of open-air seawater evaporation ponds underneath. The findings could inform designs of joint solar energy and salt generation plants.

Analog Robots Can Help Scientists Predict the Micro-Interactions Behind Macroeconomic Downturn
March 7, 9:12 a.m. PST, Room 124

Macroeconomic field theory struggles to adequately describe why sudden economic crashes happen. Microeconomics is better able to do so, because it better accounts for the role of "agents," like workers and institutions, in economic systems. Here, Trung Phan and colleagues will present how they used analog, autonomous robots as agents to model sudden economic collapses. In this analog economic system, the group had robots that represented workers and firm owners traverse a dynamic 2D landscape and make individual decisions about their microeconomic interests. From this, the group observed macro-patterns emerging from small-scale, agent-level interactions. They say the system could be applied to better anticipate macroeconomic responses to real world events, potentially like the default of the debt ceiling.

Tracking Memes to Understand How Information — and Misinformation — Travels Through Social Networks
March 7, 9:48 a.m. PST, Room 124

Past studies have investigated the spread of misinformation using hashtags and metadata, but the complex behavior of social information networks is difficult to characterize. Internet memes provide a natural source of data that traces the shapes of these networks. In this talk, Jedediah Kistner-Morris and Nathaniel Gabor will describe how they analyzed the way image-based internet memes spread and evolve through social networks, using machine learning image recognition techniques and analysis approaches inspired by condensed matter physics. Understanding how memes spread through social networks could offer insights into how other types of information, and misinformation, spread and evolve through various networks.

Social Outcomes of In-Person and Virtual Conferences
March 7, 10:12 a.m. PST, Room 124

The COVID-19 pandemic led to widespread adoption of virtual conferences, but differences in the social effects of virtual and in-person conferences have not been rigorously studied yet. In this talk, Emma Zajdela and colleagues will describe a model they created to investigate how scientific collaborations arise at conferences. They tested their model with data of participant interactions from several in-person and virtual meetings. The researchers found that the interactions that participants had in organized events, like scientific sessions, predicted who formed teams at virtual meetings better than they predicted team formation at in-person meetings, possibly because informal interactions played a larger role at in-person meetings. However, their analysis also implied that in-person conferences boost attendees' overall awareness of other attendees better than virtual meetings do. The findings suggest that conference organizers may want to choose the meeting format that best suits the participants' goals.

How a Longhorn Beetle Gets Its Color
March 7, 1:06 p.m. PST, Room 129

Many species of longhorn beetles sport vivid colors in complex patterns made up of colored scales. These colors come from both pigments and the ordered or disordered arrangements within photonic crystals — nanostructures with certain light-refracting properties — contained in the scales. In this talk, Viola Bauernfeind and colleagues will present how they identified the specific structures of photonic crystals in the green stripes and blue feet of a longhorn beetle species known as Sternotomis virescens. They will also explain how these structures lead to the beetle's non-iridescence — colors that don't change no matter the viewing angle.

Developing the World's First Undergraduate Quantum Engineering Degree
March 7, 4:24 p.m. PST, Room 226/227

Quantum technology is a fast-growing industry, with job creation outpacing the numbers of new engineers with training in the field. In this talk, Andrea Morello and colleagues will describe the design and implementation of a new undergraduate quantum engineering degree at the University of New South Wales in Australia. This program is distinct from existing quantum engineering programs in that it was born out of an engineering curriculum rather than a physics curriculum and includes elements of engineering programs like design courses and engineering accreditation, the speakers say. The team says they hope that this new program and the lessons learned from it will inform what a standard quantum engineering curriculum could look like in the future.

Spacing Matters More Than Density For B Cells in Aggressive Breast Cancer Tumors
March 7, 4:48 p.m. PST, Room 420

Tumors with more killer T cells that are closer together tend to respond better to immunotherapy treatment. This is because immunotherapy boosts T cells' ability to destroy tumor cells. But B cells, which also lurk in cancer tumors, do not kill tumor cells. Instead, they generate antibodies that train other immune cells to fight tumor cells. Until recently, whether the spatial distribution and density of B cells within tumors similarly correlates to immunotherapeutic prognosis has come under question. New work on the possible relationships between B cells' distribution, density and responsiveness to immunotherapeutics by Juliana Wortman and colleagues addresses this topic. By tracking immune cell densities and distributions in patients' tumors of particularly aggressive type of cancer called triple negative breast cancer (TNBC), the team found that TNBC tumors actually responded better to treatments when B cells are spread farther apart. During the team's talk, this result and other findings will be contextualized, adding insights about how the spatial dynamics between intratumoral immune cells could be used to evaluate the likelihood of success for treatments like chemotherapy, radiation or even immunotherapy.

Investigating a New Way to Sort Plastics for Recycling
March 7, 4:48 p.m. PST, Room 132

Before plastics can be recycled, recycling facilities need to separate the different types from one another. Currently, recycling facilities use properties like density or spectral signature for sorting, but it is difficult to quickly separate large volumes of plastic waste based on these properties. In this talk, Kalman Migler and colleagues will describe their measurements of how the kinetic friction of several kinds of plastics depends on temperature. Investigating how this property differs from one type of plastic to another could potentially let researchers develop new ways for recycling facilities to sort plastics in the future.

Research Explains Why Cancer Cells Can Develop Resistance to Chemotherapy After Exiting a Polyploid State
March 8, 8:12 a.m. PST, Room 308

Cancer cells that resist and survive chemotherapy do so by entering a recently described phase called the polyaneuploid cancer cell (PACC) state. But the PACC state as it relates to mechanisms that promote cancer cell survival and affect patient outcomes has not been thoroughly characterized. In this talk, Robert Austin and colleagues will discuss their new research on the elusive characteristics of the PACC state and link those characteristics to cancer cells' ability to rebound post-chemotherapy. Their analysis suggests that being in the PACC state enables surviving cancer cells to better repair DNA damaged by genotoxic chemotherapy. The group also found that the presence of additional chromosomes during PACC state facilitates the evolution of treatment-resistant mutations. They say that these results reveal two potential avenues for cancer treatment research: preventing the PACC state from emerging in cancer cells and/or stopping the PACC state from ending at which point newly resistant cancer cells begin duplicating.

The Mixing of Water and Rock Layers During Water World Planet Formation
March 8, 8:48 a.m. PST, Room 212

Researchers believe that water worlds — exoplanets about Earth's size or larger with lots of water — have rocky mantles beneath their watery surfaces. In smaller planets, the rock and water layers should be distinct. But in larger planets, the higher temperatures and pressures at the rock-water interface could lead to interaction between these layers. In this talk, Tanja Kovacevic and colleagues will explain how they simulated a rocky silicate interacting with water at extreme temperature and pressure conditions. They found that when the rock and water get hot enough, like when the rock melts, the two materials fully mix together. Through further simulations, the team showed that these high temperatures are reached during the collisional growth of these water worlds, which are thought to be part of the planet formation process. The findings suggest that water worlds have mixed rock-water layers during their initial formation, furthering researchers' understanding of the structure, formation and evolution of water worlds.

[Study Explains Why Some PFAS Pollutants Are Resistant To Foaming Separation]

March 8, 9:12 a.m. PST, Room 127

Health-threatening chemical pollutants that last forever and accumulate in the body called per- and polyfluoroalkyl substances (PFAS) can still be found in a variety of items and resources like non-stick cookware and drinking water. Foam separation has emerged as a promising strategy to remove PFAS from water because it doesn't create additional waste products as these carcinogenic compounds migrate to the air-water interface. Yet, much is not understood about how foam fractionation works on the molecular level when it removes PFAS. More specifically, it is unclear why foam fractionation is less effective on short-chain PFAS, which have less carbon molecules. This talk by Muchu Zhou and colleagues will explore why foam fractionation success changes depending on varied-chain length PFAS. The findings, which they will also share at a poster session, could help improve short-chain PFAS removal and have implications for improving the safety of global water resources.

[Simulation Unravels the Mechanical Properties of Knit Fabrics]

March 8, 10:48 a.m. PST, Room 130

Different knit fabrics have distinct mechanical properties depending on the stitch patterns and textiles that crafters use to make them. One example of these properties is the ability to store potential energy in materials with diverse fabric structures and geometries when experiencing mechanical strain, such as being stretched. Here, Xiaoxiao Ding and colleagues present a new, physically-validated yarn-level simulation which is able to yield more accurate insights about the strain energy and force responses in knit fabrics. Their talk will delve into how exploring the properties of knit materials is exploitable for designing wearable soft robotics.

[Energy-Saving Smart Windows Made With 2D Materials]

March 8, 11 a.m. PST, Exhibit Hall (Forum Ballroom)

Materials that can sense and adapt to their environments may be crucial to smart, sustainable architectural designs. During this poster session, Qian Wang and colleagues will present a new method of making 2D materials like graphene sense and respond to environmental triggers. They demonstrated this method by constructing windows that can open and close automatically in response to small changes in room climate throughout the day, which could be used in energy-saving smart housing. More generally, the work provides insight into the mechanisms behind bending in 2D materials and could also be useful for soft robotics, tissue engineering and other applications.

Magnetic Stimulation Study Shows That Brainwave Synchronization Correlates To Better Outcomes When Treating Resistant Depression

March 8, 11 a.m. PST, Exhibit Hall (Forum Ballroom)

The psychiatric field needs new ways to tackle treatment-resistant major depressive disorder (MDD), which does not respond to existing drug therapy or psychotherapy. Repetitive transcranial magnetic stimulation (rTMS) has shown some potential as a treatment for this persistent type of MDD. During this poster session, Xiaoxiao Sun and colleagues connect findings from their six week long rTMS clinical study — which used an electroencephalography (EEG)-triggered phase-locking rTMS delivery system and was active from 2018 to 2022 — to newer data regarding neuroplastic changes in participants' brainwaves. Their novel results indicate that EEG-informed rTMS neural stimulation can lead to brainwave synchronization, or entrainment. Since patients with better entrainment had greater treatment improvement, the presenters say their work spotlights the potential for EEG-informed rTMS therapy in cases of resistant MDD.

Ultrafiltration Membranes With Tunable Pores Could Improve Wastewater Reclamation

March 8, 11 a.m. PST, Exhibit Hall (Forum Ballroom)

Water scarcity is a global health concern. Experts consider wastewater reclamation one solution for addressing this issue. But which methods are best for wastewater treatment is still up for debate. In this poster session, Kshitij Sharma and colleagues unveil a methodology for better membrane filtration of wastewater, demonstrating how tuning membranes' pore sizes improves standardized filtration of nonorganic and organic waste. The technique for creating these ultrafiltration membranes could be applied in industrial and municipal settings where waste water disposal is necessary, the team says.

New Machine Learning Approach Makes Modeling Extreme Matter, Like in Planet Cores, More Feasible

March 8, 12:42 p.m. PST, Room 301

Researchers have had great success using machine learning approaches to model properties of matter in various situations. But since these models are usually trained on cases where electrons are in their ground state, they cannot effectively simulate matter under extreme, high-temperature conditions, like those in the cores of giant planets where electrons tend to be in excited states. In this talk, Federico Grasselli and colleagues will present a new machine learning-based method for predicting the behavior of excited electrons based on their ground-state counterparts. The researchers showed that their method lets them simulate the properties of matter in extreme conditions much more cost-effectively than conventional approaches and demonstrated this by modeling metallic hydrogen within a young Jupiter-like planet.

Together, Wearable Sensors and AI Can Detect Early Biomarkers of Heart Disease
March 8, 4:24 p.m. PST, Room 308

Early detection is important in many disorders including cardiovascular disease. Recently scientists have been exploring how artificial intelligence (AI) can be harnessed to detect heart disease and predict associated risks. Here, Anand Babu and colleagues will introduce their novel experimental approach, which synthesized wearable piezoelectric sensors with AI machine learning systems to predict the risk of cardiovascular disease in humans. Tested on 20 subjects with differing body mass indexes (BMIs) and histories of existing heart disease, the device analyzed patterns of arterial pulse to detect biomarkers of heart disease with a prediction accuracy of over 94%. The authors stress that their design could facilitate proactive diagnosis of conditions before they progress beyond the point of recovery.

Non-Invasively Studying Infant Ants and Other Insects Underground
March 9, 9:24 a.m. PST, Room 206

Researchers are interested in understanding the collective behaviors of social insects like ants and termites. But these insects spend much of their lives underground, making it challenging to monitor their behaviors. In this talk, Hosain Bagheri and colleagues will describe how a laser spectroscopy technique previously used for studying the behavior of granular media could be used to non-invasively study the movements of underground insects. They demonstrated the technique in detecting ants in multiple developmental stages, showing that they could study the frequency, length and intensity of the insects' movements.

A Physics-Based Approach for Analyzing the Quality of Basketball Player Positions
March 9, 9:36 a.m. PST, Room 206

Density functional theory (DFT), a modeling method for studying structures made up of many interacting particles, has recently been used to model a variety of social systems and situations. In this talk, Boris Barron and colleagues will explain how they used a DFT-inspired approach to analyze data of basketball player positions throughout games. The new method lets the researchers predict where a player is likely to be based on the positions of other players and the ball. It also lets researchers judge the quality of a player's position based on the probability of it leading to a good shot, providing a new data-driven method for quantifying a player's contributions to the team. The new approach could also be generalized to apply to a variety of other sports.

Nanoparticle-Based Technique Could Improve Treatment of Late-Stage Cancer
March 9, 11:30 a.m. PST, Room 316

Undiagnosed and untreated cancer tumors tend to metastasize — an occurrence correlated with poor treatment outcomes and high mortality rates. To target metastatic, late-stage cancers, radiation therapy applies a controlled administration of near infrared (NIR) light to tumorous tissues. This new method is called photo-immunotherapy (PIT). But this approach's efficacy depends on how well administered photons can penetrate bodily tissue. In this talk, David Beke will discuss a technique for improving radiotherapy, building upon research published from 2021 and a study from 2022. Beke and colleagues will share how nanoparticles made from chromium-doped zinc gallate spinel oxides can give off their own light emissions when exposed to X-ray or UV radiation, amplifying the number of photons that reach tumor cells during treatment. The researchers say the work, also highlighted in a poster session, demonstrates the nanoparticles' potential for in vivo bioimaging and radioactivity detection.

Scientists Present a Path for Modeling Microbes' Immune Memory
March 9, 12:06 p.m. PST, Room 238

Vaccines seek to build "immune memory" by training the immune system to mount better, faster responses upon reexposure to past pathogens. But this type of adaptive immune memory doesn't only exist in animals. Microbes also possess similar elements of immune memory. This talk, by Sidhartha Goyal and colleagues, will provide a framework for modeling the dynamics of immune memory on a microbial-scale. Using theoretical simulations and experimental CRISPR models of adaptive immunity, the team made a counterintuitive discovery: high levels of microbial diversity correlate to low overall immune memory. In addition to this finding, other results related to the evolution of coexisting bacteria and phage diversity could enhance knowledge about microbial communities and how manipulating their immunity can advance public health.

[Fluid Dynamics Can Explain Why Dogs Are Constantly Sniffing the Ground and Air]
March 9, 12:30 p.m. PST, Room 203

As many dog owners know, canines love to sniff the ground and occasionally pause to sniff the air. Intriguingly, researchers have also observed that behavior in rats. In this talk, Nicola Rigolli and colleagues will display a [fluid dynamics-based strategy] for understanding why both dogs and rodents exhibit these alternating sniffing patterns. The group created [simulations] of agents interacting with irregular odor transport plumes. To minimize time spent looking for the odor source (target, food …), the modeled agents evolved an optimized searching strategy that led them to alternate between sampling airborne and ground odor flows. Moving forward, the researchers hope to see studies in animals to test whether this explanation of alternation-based olfactory search holds true in the real world.

[Experiment Shares More Results on New Device that Monitors the Heart's Electrical Activity Without Temperature Constraints]
March 9, 1 p.m. PST, Exhibit Hall (Forum Ballroom)

According to 2022 data from the Centers for Disease Control and Prevention, someone in the United States experiences a heart attack every 40 seconds. One way to monitor heart health is through magnetocardiography, in which superconductive quantum interference devices (SQUIDs) detect and measure magnetic fields produced by the heart's electrical activity. Currently, SQUIDs best operate at -269 degrees Celsius — a temperature which is difficult to reach outside of a high caliber, state-of-the-art laboratory. During this poster session, Alexander Khitun will share new experimental data on a magnetic sensor that was [recently published in 2020] and which may have the same sensitivity as SQUIDs and easily functions at room temperature. Based on spin wave interferometer technology [described in 2017], the compact device goes on a patient's chest to obtain data and can upload that data to the patient's doctor or their healthcare center's electronic records. The technique could also be used to proactively warn patients about upcoming heart attacks.

[Study Explains How Two Individual Nostrils Work With Neurons to Perceive One Smell]
March 9, 11:54 a.m. PST, Room 203

Each human nose has two nostrils that independently sense and compile data from external cues. But despite their independence, those nostrils somehow interact with the brain in a way that ultimately results in one unified smelling experience. Here, Bo Liu and colleagues will show how olfactory cortical neurons that operate separately to process cues from each nostril ultimately align through crosstalk by projection fibers that connect brain hemispheres. The insights, derived from experiments in mice and modeling, reveal an inverse scaling relationship which shows that the inter-hemispheric projections can be sparser apart if there are more cortical neurons. According to the team, the inverse scaling relation adds new information about bilateral alignment in olfactory neural processing.

Harvesting Energy From Turbulent Fluids

March 9, 5:24 p.m. PST, Room 307

Birds and fish take advantage of the energy naturally found in the turbulent motions of air and water to ease their flying and swimming. In this talk, Yagmur Kati and colleagues will describe how they investigated whether humans might also be able to take advantage of turbulent flows by teaching an object to react to the erratic motions of turbulent fluids in certain ways to generate energy. Through numerical simulations and analytical calculations, they showed that rotational motions of a neutrally buoyant body — an object with the same average density as the fluid it is in — could allow energy to be harvested from turbulent fluid motion efficiently. They suggest that further investigating this question using machine learning techniques could help find an optimal way for the buoyant object to harvest energy.

New Results on a 'One-Way' Superconducting Device and Outlook for Advancing Computing Technologies

March 10, 8:36 a.m. PST, Room 233

In this talk, Mazhar Ali will give an update on a big result from last year — the demonstration of a Josephson diode, a device with nonreciprocal, or "one-way," superconductivity behavior. Such devices could potentially lead to applications like higher speeds for next-generation computing technologies. Ali will outline challenges to address before these devices can be used for commercial applications, including one that appears to have been overcome already — to raise the operating temperature of the device from only a few Kelvin to above 77 Kelvin, making it cheaper and more environmentally friendly to operate. They suggest that other challenges should be solvable within this decade, implying that a big advance in computing technology may be around the corner.

Analysis of Yellowstone Bacteria Genomes Shows How Bacterial Populations Evolve

March 10, 8:48 a.m. PST, Room 131

Because bacteria reproduce asexually and exchange little genetic material, conventional thought was that bacteria would tend to evolve into increasingly specialized strains over time. However, new evidence from a bacterial population in Yellowstone may challenge this assumption. In this talk, Gabriel Birzu and colleagues will describe how they analyzed the genomes of cyanobacteria from Yellowstone hot springs to study the genomic evolution of a bacterial population over a long time period. They found that even if subpopulations of bacteria had different ecological traits, the genetic differences between them tended to decrease over time. Despite the traditional idea of increasing specialization, it seems that when subpopulations of bacteria from distinct genomic clusters coevolve for a long time period, they can result in populations that are a genetic mix of their ancestors.

Chloroplasts in Plant Cells Show Glass-Like Behavior in Dim Light

March 10, 9 a.m. PST, Room 129

The chloroplasts in plant cells can move toward or away from light depending on the light intensity, organizing themselves into various configurations. In this talk, Maziyar Jalaal and colleagues will describe a study of the re-arrangements of chloroplasts in cells of a water plant often used in home aquariums. They found that when chloroplasts in a plant cell arrange themselves into a single layer to increase their light exposure in dim lighting conditions, their collective motions bear similarities to the behavior of glassy materials near the glass transition — the point where glass shifts between solid and fluid states between solid and fluid states. The researchers suggest that being in a state close to this glass transition may let the chloroplasts quickly ball up into a clump to avoid damage when suddenly exposed to intense light.

The Story of Bruno Touschek and the Quest to Build the World's First Matter-Antimatter Collider

March 21, 9:24 a.m. PDT, Virtual Room 10

Physicist Bruno Touschek led a remarkable life. He survived the Holocaust and went on to propose and oversee the building of the world's first matter-antimatter collider, the Anello di Accumulazione in Italy. In a new biography, Giulia Pancheri-Srivastava describes Touschek's life journey and includes previously unpublished family letters, new archival research and records of correspondence with several famous physicists of the time. This talk will discuss Touschek's story, including new findings from Pancheri-Srivastava's research.

Study Uses Marine Microbes to Challenge Keystone Species Concept

March 21, 10:24 a.m. PDT, Virtual Room 8

Keystone species are organisms that perform vital roles in ecosystems. But it is hard to evaluate the number of any given keystone species in a habitat because these species' value is usually not well-understood until after they disappear. In this talk, Akshit Goyal and colleagues suggest keystone species may be much rarer than previously thought by ecologists. Their lab-based experiments, involving marine microbial communities, indicate that there are very few keystone species whose removal can dramatically affect a biodiverse environment. Instead, additional analyses through machine learning and mathematical modeling underscore the value of structured interspecies interactions in habitats. The team argues that interactions among communities are structured and that it is the structure of those interactions that challenges the incidence of keystone species as understood by classical literature.

Analysis of Energy Usage Reveals New York City's New Normal in the COVID-19 Pandemic

March 21, 1:30 p.m. PDT, Virtual Room 1

The emerging "new normal" brought about by the COVID-19 pandemic has sparked countless predictions about the future of work-from-home policies. Now, scientists have begun collecting information that can be used to identify tangible, long-term changes in the dynamic COVID-19 work-scape. In this virtual poster session, Christoph Meinrenken and colleagues will discuss insights that they derived by sampling average energy usages at specific times in 390 inhabited Manhattan apartments from April 1 to April 28 over the last four years. By doing so, they could tell which apartments were vacant during work hours for the past four years. Most notably, the team found that average electric loads at 12 p.m. from 2020 to 2022 went up to 26%, 24% and 12% respectively when compared to 2019 data at the same time. This result indicates that New Yorkers are still working from home more than they did prior to the pandemic. Other observations — like the finding that New Yorkers are back to waking up as early as they did prepandemic — will also be shared, spotlighting the many nuances that lurk within data used to track work-from-home trends.

Early Results From a Study on Identity Development of Neurodivergent Nonacademic Physicists

March 21, 1:30 p.m. PDT, Virtual Room 1

Recent data indicates that increasing numbers of neurodivergent students are entering college, but these students tend to drop out or leave their fields at much higher rates than their neurotypical peers. Research in disability studies suggests that certain factors, including encouraging the development of disability identity in students, can mitigate students leaving the field. During this virtual poster session, Liam McDermott will discuss a study that examined identity development in neurodivergent physicists and present preliminary data on the perspectives of neurodivergent physicists who have left the field.

Propelling Maglev Graphene Vehicles With Lasers

March 22, 6 a.m. PDT, Virtual Room 8

In this talk, Feng Lin and colleagues will present a method of propelling graphene-based materials by illuminating sails attached to them with a laser. They demonstrated their technique with a maglev graphene “boat” suspended in a glass tube of rarefied air, showing that they could make the boat rotate and control the direction of its rotation. They also showed that they could smoothly and rapidly accelerate a maglev graphene “train” along a track of magnets. The propulsion method could potentially be used for laser-launched rockets or laser-driven vacuum tube trains in the future, the researchers say.

A Tangram-like Puzzle Game for Introducing a Quantum Computing Model

March 22, 1:42 p.m. PDT, Virtual Room 1

In this talk, Ashlesha Patil and colleagues will describe a game they designed to teach the player how to map a model of quantum computation that is easier to understand, known as the quantum circuit model, onto another, more complex model called measurement-based quantum computation (MBQC). The game takes the form of a tangram-like puzzle, where players arrange puzzle blocks on the game board, though they must follow specific rules that are dictated by the MBQC model. The researchers hope the project will help introduce MBQC, which is not widely known even in the quantum computing community, to everyone from students to quantum computing researchers.