Harvard-MIT Undergraduate Research Conference

A Collaboration Between Harvard and MIT SPS

September 26, 2015

10:00 AM

32-141

Building a Quantum Computer is as Simple as Tying a Knot! Braiding of Majorana Modes

Samuel Moore

Topological quantum computation has opened up a new avenue for protecting qubits from decoherence. While there are multiple methods for achieving such topological protection, in this talk I will present the experimental realization of so-called Majorana Bound States (MBSs). MBSs require topological superconductivity, where a superconductor is placed in contact with a 1D semiconductor. Topological superconductivity is achieved in this system when a special arrangement of gate voltages and magnetic fields effectively break electrons into pairs of MBSs. I will discuss the bizarre exchange statistics of these MBSs and their prospects for quantum computation.

32-155

Towards Increased Carrier Densities in Graphene Intercalated Devices

Cyndia Yu

Graphene-intercalated devices have recently received special attention due to their unusual electrical properties, including superconductivity and paramagnetism, at sufficiently high carrier densities. This work attempts to maximize carrier density of Li+ ions intercalated in few-layer graphene devices. Graphene and hexagonal boron nitride layers are stacked in van der Waals heterostructures and nanofabricated into Hall bar devices. A lithium electrolyte is applied and a four point measurement is used to measure Hall voltages as a function of B field, temperature, and applied voltage. We find that 2D carrier density is a function of number of layers for few-layered devices and seek to continue to improve carrier densities for the mono- and bilayer cases.

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In Pursuit of Metallic Hydrogen: A New Design for Diamond Anvil Cells

Roman Berens

One of the most difficult challenges of experimental condensed matter physics in the past 80 years has been the production of metallic hydrogen. It is predicted that around 400 gigapascals (about 4 million times atmospheric pressure), solid diatomic molecular hydrogen would disassociate into an atomic metallic solid, able to conduct electricity like any other metal. Metallic hydrogen is thought to have many interesting properties, not the least of which is high-temperature superconductivity (maybe even at room temperature). Additionally, it is thought to be possibly metastable, enabling hydrogen to stay in its metallic state after pressure has been reduced, much like the metastability of diamond relative to graphite. Lastly, it is estimated that 60-70% of the planetary mass in our solar system is fluid metallic hydrogen in the interior of Jupiter and Saturn. Understanding the details of their composition and origin requires a thorough knowledge of the properties of metallic hydrogen. The most commonly used device in static high-pressure experiments is the diamond anvil cell (DAC). This device consists of two opposing diamonds a few millimeters wide with a sample contained in a gasket compressed between their tips. An advantage of DACs is that diamonds are transparent to both visible light and X-rays, which can be used to measure various optical properties of the sample or to change its temperature. My project consisted of designing a new two-chambered gasket that would theoretically enable much higher pressures for the same experimental setup.

32-155

Comparing Simulations of Galaxy Halos

Paco Holguin

There is still no complete theory of galaxy formation and evolution. One way of making progress is the use of hydrodynamical simulations, but there still remain many uncertainties in their use, particularly on scales not resolved. The goal is to compare the results from five different hydrodynamical simulations of section of a universe at z=3. We characterize these simulations by analyzing the relationship between total halo, star, and gas mass in dark matter halos. We also compare these relationships with observational data.

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Preheating in Multifield Inflation

Anirudh Prabhu

The theory of cosmic inflation was proposed to address problems with Standard Big Bang cosmology. The theory suggests the existence of an epoch during which the universe underwent an exponential expansion, following by an epoch of slower expansion. Most current theories of inflation are based on the evolution of a quantum scalar field (called the "inflaton") in a curved space-time. Many quantum field theories predict the existence of many scalar fields in the early universe. Part of the inflationary hypothesis explains a period at the end of inflation called "reheating" during which the energy of the inflaton field gets transferred to Standard Model particles. A precursor to this, a phase called "preheating", explains how the energy of the inflaton field gets transferred to the other scalar fields through a process called "parametric resonance". I describe models of preheating in multifield models of inflation.

32-155

I'm Not Paranoid, But They're Out To Get Me!

Yihui Quek

Many quantum cryptographic and quantum computing tasks require the ability to distinguish between quantum states. If only + and - z states were available, a Stern-Gerlach apparatus would accomplish the task, but alas – nonorthogonal quantum states cannot be discriminated perfectly. It has been suggested that postselection - the ability to discard data from the outcome of statistical trials - may help in this task when the cost of discriminating states wrongly is prohibitively high. I analyze the optimal decision rules and quantum measurements in a decision theoretic setting where postselection is allowed but incurs a cost. Lastly, I will present an original result in which a minimax analysis is used to determine the best decision rule in the presence of an adversary, when the prior probabilities of each hypothesis are not known.

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Measuring the Temperature of Superheated Water Using Laser Diffraction Patterns in a Solid-State Nanopore

Kaan Alp Yay

Superheating occurs when a liquid is heated up to a temperature above its boiling point but does not boil. Until now, superheated water had not been achieved under atmospheric pressure; therefore, it was not possible to determine the physical properties of water in this particular state. In July 2014, the Harvard Nanopore Group has achieved superheating near the critical temperature of water and homogeneous nucleation in an electrolyte solution within a nanopore in a thin silicon nitride membrane. This is an ideal environment for superheating because silicon nitride is smooth, wettable by water and at a lower temperature than the water surrounding it. This result has paved the way to use solid-state nanopores in order to investigate the physical properties of superheated water. One of the most interesting physical properties to be investigated is the refractive index, the ratio of the speed of light in vacuum to that in a medium, because the refractive index changes over time with the temperature of the superheated water. My research involves fabricating nanoscale slits in a silicon nitride membrane and using a laser to create diffraction patterns due to the wave property of light. Then, the intensity of the diffracted laser beam will be measured via a silicon photodetector. The dimensions of these diffraction patterns will lead to measuring the refractive index and therefore the temperature of the superheated water. An application of the experiment would be to use the nanopore with superheated water as an adjustable lens whose refractive index changes as one changes the temperature.

32-155

Physics of Ultra Cold Atoms in Optical Superlattice

Sean Burchesky

When a gas of bosonic Sodium atoms is cooled to a sufficiently low temperature a new quantum state of matter described by a macroscopic wave function forms. Since the realization of Bose-Einstein condensation in 1995, physicists have implemented an amazing assortment of diverse Hamiltonians. One such Hamiltonian, the optical superlattice provides a system rich with interesting physics. The superlattice is a periodic array of double wells, with a distinct condensate associated with the upper and lower well. The two superfluids behave as if they are orthogonal states, which may be coupled to produce interference. The superlattice has a band structure, featuring an inverted second band with the ground state at edge of the

Brillouin zone. This separation in quasi-momentum space allows for much longer lifetimes. The superlattice Hamiltonian, when factored into Pauli matrices follows similar quantum mechanics to a spin system in magnetic field. This suggests that such a system may be used to implement spin orbit physics using the double well states as a pseudo-spin basis. Spin orbit coupling has the potential to give new insight on novel quantum phases.

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Collapse of the Selection Rules in 2D Plasmons

Nicholas H. Rivera

Plasmons are electromagnetic waves confined to the surface of a conductor. Plasmons in graphene and other 2D materials are unique in that their wavelengths are far shorter than those of photons at the same wavelength (by factors of up to 200). In this work, we demonstrate some of the consequences of this drastic confinement. Precisely, by computing the spontaneous emission rates associated with Hydrogenic transitions, we show that these plasmons can be used to observe highly forbidden multipole transitions, making radiative decays even such as E5 potentially observable. We then show that these enhancements carry over to two-plasmon spontaneous emission processes, where large wavelength squeezing can lead to fourteen orders of magnitude rate enhancements. In some cases, the two-plasmon spontaneous emission rate exceeds the one-plasmon rate. These large enhancements motivate us to estimate the coupling constant of plasmonic quantum electrodynamics. From these estimates, we show that graphene can serve as a platform to access the ultrastrong and deep-strong coupling regimes of QED, where new phenomena arise, such as: atom-light binding, Rabi oscillations without a cavity, and Lamb shifts comparable to the ground state energy.

32-155

Analysis of the Quantum and Semiclassical Horseshoe Maps

Shreya Vardhan

The horseshoe map is a non-area-preserving map on a unit square in phase space which is found to be approximately embedded in many chaotic systems with hyperbolic dynamics. We studied the properties of the quantized version of the horseshoe map, and also defined a semiclassical horseshoe map, along the lines of the semiclassical Van Vleck propagators for Hamiltonian systems, which express the probability of going from an initial state to a final one in terms of classical expressions. We found good agreement between the semiclassical and quantum propagators for the initial steps, to approximately the same extent as the agreement between the quantum and semiclassical propagators for the bakers map (an area-preserving chaotic map nearly analogous to the horseshoe). We also analytically found an expression for the density of states of the semiclassical propagator in terms of a sum over the classical periodic orbits, in analogy to Gutzwillers trace formula, a well-known similar result for Hamiltonian systems, and compared the density of states predicted by this expression with the density of states from the exact quantum propagator. We also compared difference in the loss of area in the classical and quantum versions of the map. As expected from quantum mechanical interference effects, the area retained quantum mechanically at each step was larger. We found that, independent of the stretching parameter of the horseshoe map, after a large number of steps (on the order of 10^2), the fractional quantum mechanical area retained was the square root of the fractional classical retained area, and are in the process of trying to analytically understand what causes this.

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Lattice Polytopes and Orbifolds in Quiver Gauge Theories

Matthew DeCross

Superstring theory predicts a (9+1)-dimensional background spacetime and thus requires the orbifold compactification of six spatial dimensions, achieved by taking the quotient by a finite isometry group. Recent work in the context of quiver gauge theories has focused on enumeration of Abelian orbifolds of $\mathbb{C}^n$, whose toric diagrams are lattice simplices in $\mathbb{R}^{n-1}$. We will review crystallographic methods for enumerating inequivalent orbifolds via such toric diagrams and for obtaining analytic expressions for the resulting sequences by means of generating functions. We will then apply these methods to Abelian orbifolds of more general spaces with geometrically interesting toric diagrams, namely, the Platonic solids. Motivation for studying the Platonic solids comes from the study of quiver gauge theories; in the ADE classification of discrete subgroups of SU(2), the symmetry groups of the Platonic solids correspond to particularly simple quivers.

32-155

The Euler Disk

Michael Landry

The dynamics of spinning disks on a flat table in the presence of a uniform gravitational field have been the subject of repeated analysis over the last century but a satisfactory understanding of the mechanics has remained elusive. We identify a novel two-stage mechanism for energy loss based on rolling resistance and slippage at the point of contact. Predictions based on this mechanism are currently being experimentally tested. The data as of now supports this model.

KEYNOTE SPEAKERS

12:15 PM

32-141

Universality of Physics and Mathematics

Cumrun Vafa

Physical ideas often have a wider domain of applicability than the area they first arise in. This universality of physical ideas often unify mathematical areas as well.

-LUNCH BREAK-

2:15 PM

32-155

The Internal Structure of Spinning Black Holes

Edmund Bertschinger

Spinning black holes have strange interiors, as viewers of Interstellar have seen. The simplest model of a spinning black hole is the Kerr solution, which describes an eternal, unchanging black hole. The Kerr solution has long been thought to imply the possibility of time travel via closed timelike curves, and to permit travel to other universes via wormholes. I describe work showing that closed timelike curves are not necessary and arise from a misunderstanding about coordinate systems. Wormholes, on the other hand, are not coordinate artifacts, but whether they exist depends on whether they can form, which requires finding a metric beyond the Kerr solution.

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Conformational Relaxation of Large Molecules in Buffer Gas Cells

Kenneth Wang

Molecules can often exist in many different conformations, related by rotations, and separated by energies on the order of a hundred wavenumbers. Because microwave spectroscopy, which addresses the rotational energy states of a molecule, is sensitive to the mass distribution, each conformer has a unique microwave spectrum. We have successfully cooled 1,2-propanediol, and 1,4-butanediol in a buffer gas cell and observed all known conformers. We have been able to induce relaxation by increasing the density of the buffer gas in our cell. This relaxation could help us understand the potential energy surfaces involved, and help simplify the microwave spectra of mixtures.

32-155

Towards Single Phonon Fock State Generation in an Optomechanical Crystal

Hengyun (Harry) Zhou

Quantum information processing requires the generation and detection of non-classical quantum states and the ability to interface disparate quantum systems to utilize their respective advantages. Optomechanics provides a natural interfacing platform in which the generation of Fock states would be important progress. We analyze the experimental requirements for successful generation, heralding, and subsequent detection of a single phonon Fock state in an optomechanical crystal and describe ways to improve our system for optimal signal-to-noise ratio in a Hanbury-Brown Twiss measurement of phonon statistics. In particular, we highlight ways to engineer the mechanical thermalization rate by varying the period number of a phononic shield surrounding our device, so that pulsed experiments can be performed at higher repetition rates, significantly reducing the acquisition time required for single phonon Fock state generation.

3:20 PM

32-141

Plasmon Mediated Thermal Radiation Transfer in Graphene

Mahmoud Ghulman

Plasmon polaritons are coupled excited states between plasmons and photons. Theoretical calculations suggest that energy transfer mediated by such electromagnetic surface waves is not limited by Planks blackbody radiation law. Therefore, heat transfer between bodies can be greatly enhanced in the near-field. Our study aims to measure the near-field heat transfer between two closely separated graphene surfaces. The tunability of near-field thermal radiative transfer is studied within the framework of fluctuational electrodynamics. Experimentally, the apparatus is set-up to measure the near field transfer between a graphene-coated microsphere and flat substrate using an atomic-force microscope cantilever. Tunable near-field transfer between graphene sheets offers a novel and promising mechanism for efficient energy conversion applications.

32-155

Synchronization of the Pixel and Strip Telescopes at the Fermilab Test Beam Facility

David Gonzalez-Dysinger

A tracker telescope consisting of silicon pixel and strip detectors is in place at the Fermilab Test Beam Facility in order to test new detectors for the High Luminosity and Phase II upgrades of the CMS experiment at CERN. The pixel telescope is to be removed, leaving only the strip telescope, which has a larger coverage area and better resolution. The goal of my project was to improve the merger code to allow the two telescopes to reconstruct the same particle tracks. Analyzing four test beam runs conducted using both the pixel and strip telescopes, I noticed that some trigger numbers were out of order with respect to the Beam Crossing Number (BCO) which is used to correlate in time hits from different detectors. I managed to improve the efficiency computed using only strip telescope by adapting an algorithm used by collaborator Matthew Jones to calculate the Event BCO. However, the efficiencies computed using just the strip telescope are still lower than those computed using just the pixel telescope. A detailed analysis of the inefficient events points to synchronization problems between the different Data Acquisition (DAQ) firmware for strip and pixel detectors as the cause of the remaining inefficiency. Future study of the inefficient events is needed to develop improvements to the existing firmware.

<u>3:40 PM</u>

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The Electron Spectrum and Magnetic Field of the Fermi Bubbles

Sruthi Narayanan

The Fermi Bubbles are giant Galactic structures observed in both gamma-rays and microwaves. There is support for the hypothesis that the gamma-ray and microwave emission arise from a cosmic-ray electron population within the Bubbles, via inverse Compton scattering and synchrotron radiation respectively. Using data from the Fermi Gamma Ray Telescope we estimate the variation of the electron spectrum in the bubbles and use this to obtain bounds on the magnetic field strength within the Bubbles as a function of distance from the Galactic plane.

32-155

Optics of Chirally Selective Reflectors in Scarabaeid Beetles

Mark Arildsen

The biosphere is filled with color, much of it visible to the human eye. Some of the more beautiful colors found in life forms arise not from pigments but from the physical structure of organisms through interference, diffraction, and even the presence of photonic crystals. The metallic golden markings of the scarabaeid beetle C. resplendens are one example of such phenomena, referred to as structural coloration. The markings of C. resplendens, however, have an additional interesting property first observed by Michelson in 1911, which is that they selectively reflect only one circular polarization of light at some wavelengths. Bouligand in 1967 noticed structural and optical similarities between scarabaeid elytra and cholesteric liquid crystals (CLCs), which also have the chirally selective reflection property. Extensive research has been done on the chirally selective reflection of CLCs, but many of the scarabaeids exhibit deviations from the regularity of an ordinary (bulk periodic) CLC model. We will examine some of these variations, and we will posit a relation between the CLC model of the chiral multilayers and the more straightforward case of alternating isotropic multilayers that allows us to use existing work on those structures to shed light on the chirally selective reflectors of scarabaeid beetles.

4:00 PM

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Exact Quantum Dynamics of Electron Transfer in Condensed Phases

Diptarka Hait

Condensed phase mediated electron transfer processes are extremely common in our daily existence, lying at the core of systems as diverse as photosynthetic light-harvesting complexes to electrochemical cells. It would therefore be useful to be able to predict the dynamics of electron transfer from first principles alone, although such attempts are often rendered difficult due to the presence of the condensed phase. Herein, we attempt to model such systems by representing the electron donor-acceptor region as a two level system, which is linearly coupled to a bath of harmonic oscillators that approximates the condensed phase. We show that it is possible to obtain an analytical solution for population dynamics for certain classes of system-bath interactions, and present ways to numerically improve this method to deal with general cases. We also discover non-exponential long time behavior in certain regimes, which had been previously observed experimentally but not explained by Marcus theory.

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Normal Modes of an Exponential Block-Spring System

Patrick T. Komiske

A system consisting of an infinite line of blocks of the same mass connected by springs with spring constant $k_0 * s^j$ between blocks j and $j+1$ is considered. For the familiar case of s=1, the normal modes are harmonic and spread throughout all of space. For $s \neq 1$, the modes are localized and can be found by deriving a recurrence relation and solving it using a generating function constructed out of the block amplitudes. The modes are constructed to be orthonormal, from which we obtain a family of transformations indexed by s that go between position space and mode space. For $s = 1$ this is simply a Fourier transformation but for $s \neq 1$ the mode space interpolates between position space and Fourier space. This suggests looking for applications of these mode transformations wherever Fourier decomposition is applied, such as in image/audio compression or signal processing.

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Photon time-bin qudit measurements using laser sources

Eric Metodiev

A photon time-bin qudit measurement based on the Hong-Ou-Mandel effect is presented. The idea is to use linear optics and local reference photons to perform an effective measurement in a mutually unbiased basis (MUB) to the canonical time-bin basis. From there, I analytically expand on a "decoy state" approach to implement such an MUB measurement using realistic laser input and reference sources rather than ideal single-photon sources. Basic detector and beamsplitter imperfections are modelled to demonstrate the robustness of the method. This new type of measurement has applications in quantum key distribution to monitor eavesdropping.

32-155

Computing Casimir Forces Between Arbitrary Shapes

Francisco Machado

Up until recently the Casimir effect had remained a theoretical curiosity, however recent developments in nano fabrication have allowed the its measurement, forcing an effort in understanding and computing the Casimir effect in real-world/arbitrary geometries. Although usually associated with the zero point energy of radiation in vacuum, the Casimir Effect has a sibling explanation corresponding to the coupling of current fluctuations between two objects, a framework more suitable for a computer to explore. In this talk I will start by presenting the principle of equivalence in electromagnetism. From there we will see how the coupling of the fluctuating currents, whose theory I will present, in the two bodies will give rise to the Casimir force. Based on the Green's function formalism and using an arbitrary complete basis for the surface currents, we will see how the final Casimir force and energy arises as a easily computable, basis independent quantity. From there we will investigate a simple and computationally easy basis for arbitrary geometry and see some calculation examples comparing them to theory.

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Discovery of Leggett-Garg Inequality Violation in Neutrino Oscillations

Talia Weiss

The Leggett-Garg inequality, a time-analogue of Bell's inequality, stands as one of the hallmark tests of quantum mechanics against classical predictions. Tests of violations of both the Leggett-Garg and Bell inequalities have been carried out in a number of systems, though those experiments are typically restricted by the coherence length over which the systems quantum behavior can be maintained. Neutrino oscillations should also adhere to quantum mechanical predictions and provide an observable violation of the Leggett-Garg inequality. Due to the extremely long coherence length observed in neutrino oscillations, violations of the Leggett-Garg inequality can be tested over longer distances than in past experiments. This research demonstrates how oscillation phenomena can be used to test for violations of the Leggett-Garg inequality. A study of oscillation data taken at the MINOS experiment in Soudan, MN shows a greater than 5 sigma violation over a distance of 735 km, representing the longest distance over which either the Leggett-Garg or Bell inequalities have been tested. Alternate tests of the Leggett-Garg inequality with neutrino oscillations are also discussed.

32-155

Investigating the Short Gamma-Ray Burst Detection Rate of the Swift Burst Alert Telescope via Trigger Simulations

Charles Law

The burst alert telescope (BAT) aboard the Swift spacecraft uses a complex two-stage trigger algorithm in which successful gamma-ray burst (GRB) detections must pass at least one rate trigger criterion as well as an image threshold. However, BAT detects short GRBs with a significantly lower frequency than other comparable instruments, such as Fermis Gamma-ray Burst Monitor (GBM). Due to their brief pulse duration, short GRBs may not be able to accumulate sufficient photon fluence to exceed the image threshold. Using a BAT trigger simulator code, which incorporates rate and image criteria, a sample of short GRBs lying in both BAT and GBMs field of views was tested to confirm that the code correctly reproduced BATs observations. Then, a set of bursts was simulated with varying parameters (e.g. spectral shape, incident angle) and correlations between burst characteristics and BATs response (triggered, missed as failed event, or undetectable) were identified. The trigger code generally reproduced BATs response for short GRBs, showing only minor deviations. However, the codes method of assigning an image threshold led to some incorrect predictions of BATs behavior; spurious triggering was prominent when the code was run on large sections of BAT observational data. This work provides a confirmation of the trigger codes efficacy for simulation studies of short GRBs and continues a systematic study of the causes of BAT non-detection of short GRBs. The eventual goal of this investigation is to increase BAT detections of short bursts, which will lead to better burst localizations and improved follow-up observations.

5:00 PM

32-141

A model for ds-DNA pairing based on two colliding, rigid rods

Amir Bitran

An astounding feature of living systems is their ability to spontaneously and reliably self-assemble into their functional configuration. For example, during meiosis, identical chromosomes from the mother and father find each other and pair up. This process, known as homologous pairing, faces two challenges that are universal to all self-assembly processes. First, chromosome 1 from the mother must discriminate its true partner– chromosome 1 from the father–from other chromosomes, such as chromosome 2 (even if 2 and 1 are similar in some regions by chance). Second, once the two chromosome 1 molecules meet, they must form a stable and durable complex. These two requirements often come at each others expense. For example, if chromosomes 1 and 1 form a stable complex, yet 1 is, by chance, similar to 2 in some regions, then 1 and 2 should also form a partially stable complex. But experiments have shown that matching DNA sequences are in fact able to form pairings that are both tight and selective, even without the help of proteins. How this happens is not understood. Using a mathematical model, we show that the conflict between speed and specificity can be resolved if DNA sequences test each other for similarity in a series of stages akin to dates. In the first date, two DNA molecules collide at an angle. This angle prevents the molecules from interacting too tightly during the initial test,so mismatching sequences easily come apart (even if they have regions of accidental similarity beyond the collision region). But if the pairing is correct, then the regions flanking the collision match, so these regions attract and zip up the rest of the molecule. Thus, only true matches stably pair. The simplicity of this argument makes it attractive as a model for self-assembly in DNA pairing as well as other systems, be they biological or artificial.

32-155

The Physics of 2D Conductive Metal-Organic Frameworks

Tomohiro Soejima

Metal-Organic Frameworks (MOF) consist of metal clusters connected by organic ligands. Due to their high porosity and cristallinity, MOFs have been studied extensively for gas storage and separation purposes. Lately, new types of 2D MOF with high electrical conductivity have been discovered. This can open a way to a wide range of applications such as chemiresistive sensing, or exotic quantum phases such as quantum spin liquid or topological insulator. In this talk I will introduce basic concepts of MOF and discuss theoretical and practical implications of conductive MOFs.

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A Statistical Model for Determining the Probability of Observing Exoplanetary Radio Emissions

Rudy Garcia

The idea that extrasolar planets should emit radiation in the low-frequency radio regime is a generalization of the observation of decametric and kilometric radio emissions from magnetic planets in our own solar system, yet none of these emissions have been observed. Such radio emissions are a result of the interactions between the host stars magnetized wind and the planets magnetosphere that accelerate electrons along the field lines to cyclotron frequencies. To understand why these emissions had not yet been observed, and to guide in target selection for future detection efforts, we took a statistical approach to determine what the ideal location in parameter space was for these hypothesized exoplanetary radio emissions to be detected. We derived probability distribution functions from current datasets for the observationally constrained parameters, and conducted a review of the literature to construct reasonable probability distribution functions to obtain the unconstrained parameters. We then used Monte Carlo sampling to develop a synthetic population of exoplanetary systems and determined whether the radio emissions from the systems were detectable. From millions of simulations we derived a probability distribution function that illustrated the optimal parameter values of an exoplanetary system that made the systems radio emissions detectable.

32-155

Modeling Tidal Effects on the Stellar Environment around Supermassive Black Holes

Brent Belland

Tides transfer angular momentum and energy between stellar bodies, dynamically changing many-body systems. While the effects of tidal evolution on stellar binary orbits can be inferred from observations of many different systems, the gravitational strength of a supermassive black hole and star system would also be conducive to measuring these tidal effects precisely. While telescopes cannot currently view many stars about the closest such supermassive black hole, Sagittarius A* at the center of the Milky Way, the next generation of telescopes should be able view many more, making modeling the environments in black hole-star systems a relevant, current topic. In my talk, I will discuss the theoretical framework for approaching the question of tidal dissipation in such a stellar neighborhood as well as briefly discuss software that simplifies the task of analyzing stellar tidal resonances.