Physics Colloquium Fall 2023

Physics Colloquium with Richard Taylor – UO (Department Head)
Date: September 28, 2023
Time: 4:00pm
Location: Willamette 100

State of the Department

Physics Colloquium with John Toner, UO Physics
Date: October 5, 2023
Time: 4:00pm
Location: Willamette 100
Title: Birth, Death, and Flocking: The Hydrodynamics of Dry Active matter
Abstract:
In creatures ranging from birds to fish to wildebeest, we observe the collective and coherent motion of large numbers of organisms, known as ‘flocking’. In this talk, I’ll use the hydrodynamic theory of flocking to explain why a crowd of people can all walk, but not point, in the same direction. Along the way I’ll illustrate how one goes about formulating a hydrodynamic theory for heretofore unconsidered states and systems. This involves powerful techniques from theoretical condensed matter physics such as hydrodynamic theories, the gradient expansion, and the renormalization group, as well as using concepts from fluid mechanics.

Host: TBA

Physics Colloquium with Spencer Chang – UO (Candidate for Promotion)
Date: October 12, 2023
Time: 4:00pm
Location: Willamette 100
Title: General New Physics Observables at Colliders

Abstract: Given the ongoing data taking at the LHC and at its planned upgrade, the High Luminosity LHC, it is crucial to continue the search for new physics in the most general way. In this talk, I will describe how to determine the most generally allowed scattering interactions involving Standard Model particles. This can be achieved by writing down the most general Lagrangian, but suffers from redundancies, since there is no physical effect if when one changes variables or adds total derivative terms. I will relate these redundancies to similar issues in classical and quantum mechanics and explain how to interpret why they occur, e.g. energy conservation. By overcoming these issues, we have determined the structure of allowed interactions for the Higgs boson, the top quark and W/Z bosons. One can then use this classification of the interactions to perform a systematic search for new physics at colliders.

Host: Graham Kribs

Physics Colloquium with Rob Phillips – California Institute of Technology Physics

Date: October 19, 2023

Time: 4:00pm

Location: Willamette 100

Title: A Language Whose Characters are Triangles

Abstract: One of the most intriguing outcomes of casting our thinking about the world around us in mathematical terms is that phenomena that were thought to be quite distinct are instead revealed as being the “same.” Thinkers as long ago as Pliny the Elder made observations on active matter noting: “It is a peculiarity of the starling to fly in troops, as it were, and then to wheel round in a globular mass like a ball, the central troop acting as a pivot for the rest.” In this talk I will introduce field theory and the emergence of the modern theory of active matter as formulated by Toner and Tu to describe the collective motions of animals such as the giant herds of wildebeest on the plains of the Serengeti. We will then use active matter theory at a billion fold smaller scale to describe the motion of “flocks” of actin that power the movement of the single-celled parasites that cause malaria and toxoplasmosis. Our theoretical analysis will be used as a tool to interpret single-cell/single-molecule experiments on the dynamics of these fascinating parasitic organisms.

Host: John Toner
Physics Colloquium with Carol Paty – UO Earth Sciences

Date: October 26, 2023

Time: 4:00pm

Location: Willamette 100

Title: Exploring the Magnetosphere of an Ice Giant: Probing Uranus is No Laughing Matter

Abstract: The National Academies Decadal Survey for Planetary Science and Astrobiology ranked the Uranus Orbiter and Probe as the highest priority new flagship mission to initiate in the 2023-32 decade. From the perspective of magnetospheric scientists, Uranus provides one of the most interesting natural laboratories for studying the influence of large obliquities, rapid rotation, highly asymmetric magnetic fields, and large Alfvénic and sonic Mach numbers on magnetospheric processes. Uranus is subjected to extreme seasonal variations resulting from the nearly 98° tilt of its rotation axis. The solar wind-magnetosphere interaction varies dramatically on diurnal timescales as well due to the apparent offset and tilt of the dipole field. With in situ observations at Uranus limited to a single encounter by the Voyager 2 spacecraft in 1986, a growing number of analytical and numerical models have been put forward to characterize its magnetosphere and test hypothesis related to magnetospheric boundary layers, the solar wind interaction, the formation of the intense radiation belts, dynamo processes and interior structure, understanding charged particle precipitation, aurora, and energy deposition to the atmosphere, and quantifying potential plasma sources and the distribution of plasma observed. Despite these recent studies, many questions regarding the observations of Uranus' unique magnetosphere remain unanswered. Here I'll discuss some key science objectives relevant for the upcoming flagship mission to Uranus. These objectives are centered in magnetospheric science, but cross key disciplines in planetary science, geophysics, and heliophysics. I'll also give a brief update on NASA's current Flagship mission to a moon of Jupiter; at T-1 year to launch the Europa Clipper mission is cruising through the last stages of preparation before shipping off to Cape Canaveral!

Host: Katelin Donaldson

Physics Colloquium with Leif Karlstrom – UO Earth Sciences

Date: November 2, 2023

Time: 4:00pm

Location: Willamette 100

Title: The intrinsic and extrinsic geometry of Earth surface topography
Abstract: Earth surface topography evolves over time due to a competition between differential surface uplift relative to the geoid and a variety of erosive processes. The resulting patterns have a long history of study amongst geomorphologists, who seek to associate characteristic patterns of topographic slope, curvature, and drainage area with mechanisms (and geologic time evolution) of uplift and erosion. I'll talk about an active project in my group that seeks to use tools of classical differential geometry to find new patterns in Earth surface topography. I'll outline how invariant metrics of surface curvature appear to encode geomorphic process regimes that have thus far defied unified description, and some preliminary thoughts about why this may be the case.

Host: John Toner

Physics Colloquium with Marianna Safranova- University of Delaware [AMP/HEP]

Date: November 9, 2023

Time: 4:00pm

Location: Willamette 100

Title: Discovering new physics with quantum technologies in the lab and in space

Abstract: The extraordinary advances in quantum control of matter and light have been transformative for atomic and molecular precision measurements enabling probes of the most basic laws of Nature to gain a fundamental understanding of the physical Universe. Exceptional versatility, inventiveness, and rapid development of precision experiments supported by continuous technological advances and improved atomic and molecular theory led to rapid development of many avenues to explore new physics. I will give a broad overview of atomic physics searches for physics beyond the standard model of elementary particles. Several examples will be highlighted, including dark matter searches with atomic and nuclear clocks and new ideas for searches of physics beyond the standard model with quantum sensors in space.

Host: David Wineland

also on November 9th, Professor Safranova will give a talk from 10am to 11am in the OMQ conference room (Wil 240D)

Title: Atomic theory in the 21st century: breakthrough advances, new applications, and challenges

Abstract: I will tell a story of amazing advances in atomic theory in the past two decades and numerous applications that grew from improved computational abilities, including atomic clock development, fundamental physics, ultracold atoms and quantum simulations, and astrophysics. This story intervenes with experimental advances in quantum control and resulting advances in measurement accuracy. I will focus on recent developments, including
large-scale high-performance computing, turning research codes into software everyone can use, making all data available to the community via the data portal, and machine learning. The talk will include a brief description of new methodology developments and remaining challenges.

**Physics Colloquium with Sid Nagel [CMX] – University of Chicago**

Date: November 16, 2023

Time: 4:00pm

Location: Willamette 100

**Title: Disorder is different**

Abstract: In a perfect crystal, every atom has its place in a unit cell that is repeated interminably throughout space. Amorphous solids have no such regularity or obvious long-range order. Yet, we customarily start our study of disorder by considering perturbations about a crystalline structure. This approach becomes increasingly untenable as the degree of disorder increases; it is abysmal for understanding the rigidity or excitations in a completely amorphous solid such as a piece of glass. However, if one takes the fully disordered solid as the starting point, it is possible that new and different laws emerge. Jamming is an alternate, far-from-equilibrium way of creating amorphous rigid solids that are qualitatively different from crystals. In jammed solids we find that a new principle emerges: independence of bond-level response. By fully embracing the aging of disordered and far-from-equilibrium materials, one can drive the overall system into different regimes of behavior and achieve unique, varied, and tunable response. We are left with the question: How far can this vision be pushed to generate broad classes of materials with desired functionality?

**Host: Eric Corwin**

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**Physics Colloquium with Mark Raizen – University of Texas -CANCELLED-**

Date: November 30, 2023- CANCELLED