Tennessee Section of the American Association of Physics Teachers (TAAPT) Annual Meeting

March 24-25, 2023

University of Tennessee
Ken and Blaire Mossman Building

Friday, March 24

5:30-6:00 PM	**Registration and Check-in**
6:00-7:00 PM	**Dinner - Mossman Bldg Lobby**
7:00-8:00 PM **Keynote Speaker**	**Dr. Hanno Weitering** Chancellor's Professor of Physics and Astronomy University of Tennessee *Engineering Chiral Superconductivity on a Silicon Template*
8:30-9:30 PM	**Planetarium Show in Nielsen Physics Bldg Rm 108**

Saturday, March 25

Morning Session

8:00-8:45 **Registration and Breakfast – Mossman Bldg Lobby**

8:45-9:00 **Welcome and Announcements – Mossman Bldg Rm 212**

9:00-9:15 **Ling Jun Wang, University of Tennessee at Chattanooga**
Theoretical Derivation of Biot-Savart Law and Lorentz Force

The empirical Biot-Savart Law and Lorentz force have been derived theoretically based on Ether Dynamics. All mysteries with Biot-Savart law and Lorentz force, including the sinusoidal factor in these two laws, the fact that the magnetic field being perpendicular to the plane of the velocity and the displacement vector, and the Lorentz force perpendicular to the plane of the velocity and the magnetic field, and that these vectors obey the right-hand-rule, have been solved and derived in detail. The reason that the magnetic field is perpendicular to the velocity and the displacement vector as stipulated in Biot-Savart Law is because the magnetic field is nothing but the local vorticity of ether, which is perpendicular to the velocity of the charged particle. The mysterious sinusoidal factor naturally appears in the cross product of these vectors. Because the vorticity is also inversely proportional to the distance, the inverse square law in Biot-Savart law is naturally produced from the ether dynamics. Likewise, the Lorentz force is nothing more than the force experienced by a charge moving in a turbulent ether, it is proportional to the cross product of the velocity of the charge and the vorticity of ether (essentially the magnetic field). Ether Dynamics explains first time ever the propagation of magnetic interaction (the magnetic field and the magnetic force).

The only properties of ether so far known to physics community are the permittivity and permeability of free space (which should correctly be ether). Ether dynamics reveals two more properties of ether not known to physics community thus far: Ether is a highly viscous and in-compressible fluid up to the accuracy of Biot-Savart law and Lorentz force.

9:15-9:30 **Sean Lindsay, University of Tennessee at Knoxville**
Teaching Astronomy Through Immersive Scenario-based Learning

In this presentation, I will share the student-centered pedagogy and teaching philosophy behind the development and implementation of an in-depth scenario-based learning experience for an intermediate-level astronomy course. The “Salvation of the Yggdrasil” (SotY) scenario is a three-chapter science fiction adventure where the students must apply course materials to solve a series of multi-step problems. Working in small groups, students must integrate the fundamentals of Newtonian motion, stellar parallax, observable properties of stars, energy production in stars, and interstellar extinction and reddening to solve “realistic” problems. An emphasis is put on collaboration, critical thinking, and multi-step problem solving, while also giving students immersion (“buy in”) and agency, while also exploring alternatives to examination-style assessment. Through setting class-relevant problems into a rich science fiction world, I create a unique experience that gets the students invested in solving the problems set to them while also providing course work that closely simulates real-world scientific problem solving. Here, I will present the “Salvation of the Yggdrasil” scenario, initial student reactions and results, and the future of SotY in classroom settings.

9:30-9:45 **John Varriano, Christian Brothers University**
Construction and Operation of a Microparticle Electrodynamic Ion Trap

Electrodynamic ion traps, also known as Paul traps, are used in research laboratories to trap and study charged particles ranging in size from small ionized atoms to microparticles upwards of 100 microns in diameter. Simple demonstration models that can be built in an undergraduate laboratory are described in the literature and on-line. Such a trap was constructed and tested to see how straightforward the task really is. The results of the venture to date will be discussed.

9:45-10:00 **Hanna Terletska, Middle Tennessee State University**
New "Quantum computing for all" course at MTSU: from non-STEM to STEM majors

Recently, we have piloted a new "Quantum computing for all "course for al STEM majors at MTSU. The course does not require any previous knowledge of physics, or advance mathematics. The course uses visual representation of quantum qubits and gates, before mathematical analysis is involved. This course will be also piloted for high school students summer camp and high school teachers workshops.

10:00-10:15 **Break**

10:15-10:30 **Geoffrey Burks, Tennessee State University**
Student Centered Teaching for Students on the Autism Spectrum: Summer Experiments at the Frist Center for Autism and Innovation

Being on the Autism Spectrum can be a plus for those studying physics. The level of focus seen in many of the brain architectures associated with Autism helps with problem solving. Taking into account that the unemployment rate for people who are noticeably on the spectrum in over 50%, the Frist Center for Autism and Innovation at Vanderbilt has a set of summer REUs to help students broaden their experience base with both science and communication. A summer experiment with students on sustainable battery design was used a laboratory for better understanding student centered teaching for those on the spectrum.

10:30-10:45 **Blake Laing, Southern Adventist University**
Quantifying measurement errors using digital blood glucose meters

An introductory physics laboratory exploring experimental uncertainty using a blood glucose meter measurement of a dextrose solution provides a startling example of both random and systematic error, using a context that demonstrates that quantifying measurement uncertainty actually is highly relevant in the life sciences. In addition, the use of a digital instrument to explore experimental uncertainty avoids inadvertently reinforcing the common beliefthat that digital instruments eliminate "human error" and therefore any digital measurement must be accepted uncritically.

10:45-11:00 **Abdorreza (Abdi) SamarBakhsh, Middle Tennesse State University**
Designing hands-on activities for QIS courses:
dice and "superposition state" in a quantum system

In this work we present hands-on activity on how to visualize different superposition states in a 2-state quantum system with designing different dices in shape and color/number. Later we expand the method in order to be able to represent a 3-state, 4-state quantum system. This approach can be used in high-school as well as undergraduate level hands on activities in QIS courses.

11:00-11:15 **Anjali Filinovich, Southern Adventist University**
Encouraging social learning in conceptual physics through co-teaching with a student

We will share our experiences developing a sense of social belonging in our conceptual physics classroom. We chose to co-teach the class to help me, a student, prepare for a career in teaching and found that this choice also enabled us to set an open, conversational tone with one another and with students. Students engaged in peer instruction discussions, which encouraged them to meet and talk with many different classmates. Group discussions and presentations emboldened students to learn together, develop their reasoning abilities, and gain confidence doing so.

11:15-11:45 **Poster Session – Mossman Building Second Floor**

Daniel Davis, Malliyah Helms, Ariel Winston, and Dr. Nicholas Wolff, Lane College
Determining The Refractive Index: The Michelson Interferometer

In these experiments, we used a Michelson interferometer to find the index of refraction of plexiglass with different thicknesses and a microscope slide. The Michelson interferometer is used to measure small changes in the optical pathlength. We began by assembling the Michelson interferometer in order to get an interference pattern to study. Once we all had a good understanding of how to illustrate an interference pattern, we developed our own separate project to conduct.

The procedure of my experiment consisted of finding the refractive index of different materials such as a plexiglass slab of known index of refraction and a microscope slide of unknown index of refraction. After finding the average percentage error and calculated index of refraction, we had a conclusive number to compare to the values supplied by the manufacturer for the plexiglass and possible candidates for the microscope slide. We were able to identify an unknown material based on the index of refraction.

In future work, I plan to use larger angles for fitting the wavelength or plate thickness to the data along with different materials to analyze and discovering how the wavelength of these materials react under different temperatures and pressures.

Suja Kochat, Christian Brothers University
Speed of Sound-Resonance Tube

A physical science course has been developed for Elementary Education majors at CBU. Several simple experiments were incorporated into this course. The resonance tube is one of these simple inexpensive experiments related to sound. The speed of sound is calculated using the measured wavelength and known frequency of a tuning fork.

Ariel Winston, Daniel Davis, Malliyah Helms, and Dr. Nicholas Wolff, Lane College
Determining the Wavelength and the Spectral Width of a Laser using a Michelson Interferometer

In this presentation we highlighted different aspects of physics using the Michelson Interferometer. The Michelson Interferometer is an apparatus that measures small displacements. We demonstrated how the interferometer can serve as a spectrometer. We measured the wavelength and the coherent length of a type II laser. We measured the wavelength by counting the light to dark transitions while using a micrometer drive to translate a moveable mirror. We also measure the distance between two spectral peaks from the laser by measuring the coherence length. Observing an interference pattern transition from high contrast to low contrast allows us to measure the coherence length. Our measured laser wavelength and spectral distance were close to the nominal values from the manufacturer.

Malliyah Helms, Daniel Davis, Ariel Winston, and Dr. Nicholas Wolff, Lane College

Using a Michelson Interferometer with Two Applications: Determining the Coherence Length of two LEDs and Coefficient of Thermal Expansion of an Aluminum Rod

A Michelson Interferometer was used in two applications: coherence length of LEDs and coefficient of thermal expansion.
The objective for the interference of LEDs experiment was to determine the coherence length of a red and white LED, by using the interferometer as a spectrometer. Coherence length is the length over which two waves stay coherent. The moveable mirror should be shifted to a position of low contrast twice. The measured coherence length is the difference between the mirror positions. The measured coherence length agreed with the theoretical coherence length.
In the coefficient of thermal expansion experiment, the interferometer was used to determine the coefficient of expansion for aluminum. Thermal expansion describes how much materials expand when their temperature changes. The moveable mirror was replaced with an aluminum rod with a mirror and heater attached. When the rod was heated, it expanded and caused the mirror to move. We compared the data to a linear model. This concluded that the measured coefficient of thermal expansion agreed with the reference value.

Joshua Rye, Dr. Eugene Donev, and Dr. Nicholas Kirby, Austin Peay State University

Dynamics of a Chaotic Pendulum

Many events in nature such as the weather can naively be classified as unpredictable behavior. The unpredictability can be simultaneously deterministic and chaotic. Chaotic behavior can happen when the system surpasses two degrees of freedom, the equations associated are nonlinear, and there are vastly different outcomes that arise from slight changes to the initial conditions. To show this behavior in a controlled environment, we observed the motion of a damped and driven pendulum. We held the damping coefficient and amplitude constant while we varied the driving frequency to map out the phase plane of angular velocity and angular displacement. Starting with single- and double-period oscillations, we increased the driving frequency and decreased the dampening to arrive at chaos. Sampling the phase plane of the chaotic behavior once per driving cycle, we constructed a chaotic attractor of the motion. Our work demonstrates that we can characterize seemingly random unpredictable behavior within short time intervals to reveal complex deterministic patterns.

Neda Naseri and Hanna Terletska, Middle Tennessee State University

Broadening participation in quantum at Middle TN State University

Broadening participation in Quantum Information Science (QIS) is a persistent challenge in both industry and academia, particularly for women and minorities. This lack of diversity may be rooted in the university majors that lead to the QIS workforce, such as physics, computer science, and engineering, which have traditionally had a lower proportion of women and other underrepresented groups. At MTSU, we have a demonstrated record of a strong commitment to the broadening participation efforts via faculty-led mentoring and outreach events, including "Women in Quantum" hands-on workshops, "Quantum for All" workshop in partnership at Fisk University, and "Physics Phun" workshop for middle school girls.

Meleah Lanier, Dr. Andriy Kovalskiy, and Dr. Eugene Donev, Austin Peay State University

Showcasing Raman Spectroscopy of Carbon Allotropes and Other Bulk and Thin-Film Samples

Raman spectroscopy is a nondestructive optical technique for identifying and characterizing samples by their unique spectral 'fingerprints'. In Stokes Raman scattering, the incident light scatters inelastically from molecules of solid, liquid or gas substances, with the outgoing photons red-shifted to lower energies relative to the incoming photons because of the simultaneous excitation of molecular or lattice vibrations. One area of current research where (micro-) Raman spectroscopy especially shines is the study of graphene films and microscopic flakes, which consist of single or few layers of carbon atoms in a hexagonal lattice and hold great technological promise. The Raman spectra we present here demonstrate the power and versatility of this technique to distinguish diamond from graphite from graphene and determine the number of layers in graphene samples, as well as to identify various liquid, solid, and powder substances, such as colorless organic solvents, precious vs. faux gemstones, and branded vs. generic pharmaceutical tablets. Furthermore, we show how Raman spectroscopy can be used to quantify the contributions from different short-range chemical bonds in a thin film of amorphous arsenic trisulfide glass, an important material for infrared optics. The relative ease of implementation makes Raman spectroscopy an attractive teaching tool in advanced laboratory settings.

Neda Naseri, Middle Tennessee State University

Re-Designing Online Astronomy Course at Middle Tennessee State University: Strategies for Enhancing Student Engagement and Learning

The redesign of the online astronomy course at MTSU offers an opportunity to improve the quality of education and enhance student engagement. The key ideas to consider when redesigning such a course, including the incorporation of interactive content, real-world applications, assessments, and accessibility. By implementing these elements, an online astronomy course can be transformed into a more engaging, interactive, and personalized learning experience for students, fostering critical thinking, and promoting inclusivity and equity in education.

11:45-12:00	**Business Meeting**

Afternoon Session

12:00-1:00	**Lunch**
1:00-3:00 **Worshop**	**The Cavendish Experiment** **Nielsen Physics Bldg Room 304**