Chesapeake Section of the American Association of Physics Teachers Fall 2021 Virtual Meeting

— Program —

Saturday, October 23, 2021

- 8:00AM – 8:55AM : Zoom Breakout Rooms where people can gather to socialize will be open from 8:00AM until the end of the Meeting (5:00PM).
- 8:55AM – 9:00AM : Welcome from CSAAPT President Jason Sterlace
- 9:00AM – 9:45AM : Morning Session 1 (Chair: Jason Sterlace)

  1) 9:00AM – 9:15AM : Leah Flax (Tidwater CC)
     "PHYSANIC: Physics Panic and How to Keep it Away!"
  2) 9:15AM – 9:30AM : Ananya Sitaram, Landry Horimbere (UMD, College Park)
     "High School Research Program for Underrepresented Minorities in Physics"
  3) 9:30AM – 9:45AM : Henry Snyder (Gallaudet U.)
     "A Semester-Long Project Laboratory"

- 9:45AM – 10:00AM : Break & Discussion
- 10:00AM – 10:45AM : Morning Session 2 (Chair: James Freericks)

  4) 10:00AM – 10:15AM : John Schiller (Broadneck HS), Peter Brereton (USNA)
     "QIS for the High School Student: An Exploration of 'Spin First' Methodologies"
  5) 10:15AM – 10:30AM : Phuc Tran (John Tyler CC)
     "Simple Harmonic Oscillator solution without calculus"
  6) 10:30AM – 10:45AM : John Ochab (Reynolds CC)
     "Interpreting Reality – Bell's Test"

- 10:45AM – 11:00AM : Break & Discussion
- 11:00AM – 12:00 noon : Featured Talk (Chair: James Freericks)

  7) Dr. Karen Jo Matsler (U. of Texas, Arlington) "Is Quantum in HS Crazy?"

- 12:00 noon – 1:00PM : Lunch Break and Zoom-Breakout-Room Social
- 1:00PM – 1:45PM : Afternoon Session 1 (Chair: Samantha Spytek)

  8) 1:00PM – 1:15PM : Carl Mungan (USNA) "Modified Atwood Machine"
  9) 1:15PM – 1:30PM : Ronald Freeman (AIAA)
     "STEM – Teaching Particle Physics in Space Weather Studies"

10) 1:30PM – 1:45PM : Ryan Fisher (Christopher Newport U.)
"Fun with Fourier Transforms, or, How I Learned to Stop Worrying and Love Convolutions"

- 1:45PM – 2:00PM : Break & Discussion
- 2:00PM – 3:00PM : Afternoon Session 2 (Chair: Muge Karagoz)

11) 2:00PM – 2:15PM : Donna Hammer, Angel Torres (UMD, College Park)
"Toolkit for Success: Physics is for Everyone"
12) 2:15PM – 2:30PM :
Ojo Akinwale, Fred Garcia, Joao Pereira, Norman Moon (UMD, College Park)
"Peer Research Mentorship for FIRE"
13) 2:30PM – 2:45PM : James Freericks (Georgetown U.)
"Strategies that work for performing research with undergraduates, high school students and private citizens"
14) 2:45PM – 3:00PM : David Wright (Tidewater CC)
"The WISE Stragey for Problem Solving"

- 3:00PM – 3:15PM : Break & Discussion
- 3:15PM – 4:00PM : Demo Share-a-thon (Chair: Deonna Woolard)

1⟩ Tatsu Takeuchi (Virginia Tech) "The Catenary"
2⟩ Kerlin Doss (North Stafford HS) "Finding the Speed of Light"
3⟩ Alex Barr (Howard CC) "Simple Invisibility Cloak"
4⟩ Tim Proudkii, Hana Mir, Hampton Smith, Grant Davis (Virginia Tech)
"A Real World Example of Invisibility"
5⟩ Daniela Topasna (VMI) "3D Glasses"
6⟩ Chris Martin (Shenandoah Valley Governor's School)
"Determining the Width of a Hair with a Laser"
7⟩ Ryan Fisher (Christopher Newport U.) "Surface Tension Speed Boats"
8⟩ Kevin Mitchell (Tidewater CC) "DC Motor"
9⟩ David Wright (Tidewater CC) "Chocolate Chip Motor"
10⟩ We welcome jump-in's!

- 4:00PM – 4:05PM : Closing remarks and announcements from CSAAPT President Jason Sterlace
- 4:05PM – 5:00PM : CSAAPT Business Meeting – Outbreak Rooms will be kept open for people who would like to socialize.

— Talk Abstracts —

Morning Session 1 (9:00AM–9:45AM)

1) **Leah Flax** (Tidwater CC)

   PHYSANIC: Physics Panic and How to Keep it Away!

   A physics course is often the most difficult class in a student's schedule. This can cause great stress, panic, and lead to a general dislike of the sciences. We will discuss causes of poor mental health due to anxiety induced by a physics course and how to avoid it. A good starting point is to have discussions with experienced instructors about key problems in the classroom and how they fix them. Students that are singled out, get terrible grades before the curve, work too quickly, don't have the equipment to succeed, and have stressed out instructors do poorly and dislike coming to class. Knowing your own boundaries and anticipating issues before they arise can make your physics course the favorite of their academic career and instill a love of learning science.

2) **Ananya Sitaram**, **Landry Horimbere** (UMD, College Park)

   High School Research Program for Underrepresented Minorities in Physics

   There is widespread acknowledgment that physics and astronomy must improve diversity, equity and inclusion overall. The University of Maryland is well suited to address this issue given the demographics of the surrounding area and the strength of its physics department. We present the design and implementation of a pilot high school summer research program aimed at students of underrepresented backgrounds (Physics Research Opportunity for Promoting Equity in Learning, or PROPEL). We will describe the process of recruiting students and mentors for the program, designing the curriculum, which included lectures and workshops from faculty and graduate students, and next steps in continuing the program next year. We will also discuss the benefits and challenges of running the program remotely, and plans for running the program in person in the future.

3) **Henry Snyder** (Gallaudet U.)

   A Semester-Long Project Laboratory

   In a first semester of a three-hour per week introductory physics lab, students completed traditional laboratories on mechanics and heat, where student reports recorded experimental methods, analysis, and results. The second semester lab was implemented as a semester-long student project. The project consisted of building the structure and electronic system for a functioning remotely operated vehicle (ROV). The purpose of the project was to provide practical experience with extended project work, electro-mechanical hardware/software systems, circuit fabrication, electrical measurements, and interactive control/testing. The ROV circuitry was designed for this project and assembled with parts from various commercial sources. At the end of the semester, all the student ROVs were tested in the university swimming pool.

Morning Session 2 (10:00AM–10:45AM)

4) **John Schiller** (Broadneck HS), **Peter Brereton** (USNA)

QIS for the High School Student: An Exploration of "Spin First" Methodologies

Quantum Information Science (QIS) and applied technologies such as quantum computing and quantum communication are emerging technologies deemed critical to the future technical workforce and economy [1] . Generally, the concepts of QIS are outside the contents of study in most high school physics classes, however, recent progress has been made in developing high school accessible curricula. High School Physics Teacher John J. Schiller, Jr., and US Naval Academy Associate Professor of Physics Dr. Peter G. Brereton will share their recent experience piloting a "spin first" style high school primer into QIS. Utilizing materials and texts available via open source [2], Mr. Schiller and Dr. Brereton, have implemented an introduction to QIS based on developing the concepts of qubits, entanglement and quantum communication.

[1] National Strategic Overview For Quantum Information Science, Office of the Science and Technical Advisor to the President, September 2018 (https://www.quantum.gov/wp-content/uploads/2020/10/2018_NSTC_National_Strategic_Overview_QIS.pdf)

[2] Anastasia Perry, et al. Quantum Computing as a High School Module, arXiv:1905.00282v2 (2020).

5) **Phuc Tran** (John Tyler CC)

Simple Harmonic Oscillator solution without calculus

The analytical solution to the simple harmonic oscillator requires a knowledge of calculus (even worse differential equation), so how does one teach it at the College Physics level where students only know algebra? In this talk I will present an iterative approach that is accessible to algebra-level students. This method can be implemented quickly in Excel. The iterative solution will be compared with exact solution for both undamped and damped simple harmonic oscillator.

6) **John Ochab** (Reynolds CC)

Interpreting Reality - Bell's Test

Albert Einstein and Neils Bohr held a friendly debate for years on the nature of physical reality. Bohr, true to quantum theory (QT), swore that reality only existed after one "observed" the latter. Einstein believed the QT to be incomplete and that reality existed independent of our observation, because of some "hidden variables", which, if discovered, could remove the probabilistic nature of QT and give reality a meaning.

This dispute climaxed in the Einstein-Podolsky-Rosen paradox that discusses the bizarre, action-at-distance correlation two distinct objects can have on one another despite their inability to communicate.

It was John Steward Bell who proved that if Einstein's hidden variables did exist, then in real correlation experiments, the measured QT probabilities should satisfy particular inequalities. A famous precision experiment by Alain Aspect, in 1982, confirmed that quantum entanglement for twinned photon (light) pairs is irreconcilable with Albert Einstein's world views. In this talk I will introduce a simulated "Bell" Test and compare its results to those obtained experimentally by Alain Aspect in 1982 in order to find closure to the Einstein-Bohr debate.

Featured Talk (11:00AM–12:00 noon)

7) **Dr. Karen Jo Matsler** (U. of Texas, Arlington)

   Is Quantum in HS Crazy?

   If someone were to tell you that technology is not important, you would think they were crazy, especially after all the technology that was used during COVID. The National Quantum Initiative was signed into law in 2019 with the intent of increasing awareness at the K-12 level as to the importance of quantum in technology, national security, and future jobs. The Quantum for All project is focusing on this initiative using an NSF grant to help get quantum information science in the HS curriculum. This talk will give an overview of the project and how the challenges are being addressed.

Afternoon Session 1 (1:00PM–1:45PM)

8) **Carl Mungan** (USNA)

   Modified Atwood Machine

   A standard textbook problem and lab experiment involves a cart moving along a horizontal track and connected by a string to a hanging weight around a pulley at the corner between the track and vertical drop.

   What happens if the pulley is raised vertically, so that the string connects the pulley to the cart at an angle relative to the track? Then one can no longer find an analytic solution because the tension and accelerations are no longer constant, but one can still write down the equations and solve them numerically.

   The theory has no way to know the track ends at the vertical drop. So consider what happens if the track overhangs beyond the edge of the table (and the pulley is slightly twisted so the hanging block doesn't run into the track).

   Can you predict what the interesting motion of the cart and hanging weight will be?

9) **Ronald Freeman** (American Institute of Aeronautics and Astronautics)

   STEM– Teaching Particle Physics in Space Weather Studies

   Whereas the Standard Model has typically been developed through experimentation within an artificially-produced electromagnetic environment, similar particles have been detected within space weather regions with solar probing imagers and detectors onboard satellites. To better understand coronal mass ejections, solar winds, galactic cosmic rays as they constitute space weather and penetrate the Earth's atmosphere to infrequently impact terrestrial as well as space telecommunications, the natural space environment has been observed to contain the same subatomic particles as those observed and analyzed from detectors housed in particle accelerators and colliders of US Department of Energy national labs and CERN.

   The purpose of this paper is to contextualize the study of particle physics, hence make the study relevant for learning, reframed within the environment of space weather. Subatomic and/or ionized particle absorption in Earth atmosphere infrequently impacts global commerce. The relevance of astrophysics has implications not only for disruptions to radio and other telecommunications, power of electrical grids, GPS localizations and navigations but to the less frequently mentioned global warming.

How relevant STEM students value these potential impacts on their lives correlate to the degree of personal engagement they see themselves in a career that addresses environmental challenges. In other words, STEM students envision their roles in the outcome expectations/contributions of their chosen vocations. And, their visions signify self-identification with their choices. By illustrating the progression timeline in developing astrophysics according to real-world events and knowledge-building milestones, student self-reflection becomes the instructional process for further STEM-based education and vocational planning.

10) **Ryan Fisher** (Christopher Newport U.)

Fun with Fourier Transforms, or, How I Learned to Stop Worrying and Love Convolutions

I will describe a few amazing applications of Fourier transforms and convolutions in the context of sound synthesis, astronomy and LIGO gravitational wave detection. The aim of this talk is to present some topics to motivate the power of transformations that can be introduced to students at a very early level, even before calculus or their first exposure to the formal Fourier transform. This can be useful in training students to conduct research as well as in the classroom.

Afternoon Session 2 (2:00PM–3:00PM)

11) **Donna Hammer**, **Angel Torres** (UMD, College Park)

Toolkit for Success: Physics is for Everyone

Toolkit for Success is a pre-college research and skill development immersion program for incoming underrepresented undergraduate minorities in physics at the University of Maryland, College Park. The six-week summer program is designed to foster inclusion, belonging, and self-confidence in research, academics, and community. Students train with mentors, code in Python, learn about diverse research areas, and internalize strategic career practices while developing relationships with peers, graduate students, faculty, and staff. Toolkit for Success is implemented in coordination with a series of recruiting and retention efforts carried out by the physics department. The program context, development, operation, and assessment will be discussed.

12) **Ojo Akinwale**, **Fred Garcia**, **Joao Pereira**, **Norman Moon** (UMD, College Park)

Peer Research Mentorship for FIRE

At the University of Maryland, the First-Year Innovation & Research Experience (FIRE) is one of the ways that first-year students can engage in impactful research. FIRE students go through a three semester sequence where they are introduced to a research group, select and become familiar with how research works in their selected stream and work with a team to produce meaningful results. Peer Research Mentors (PRM) are students that have previously undergone the FIRE program and completed the FIRE sequence, continuing their research as a part of the FIRE Research Leadership program. To ensure the success of FIRE, PRM are responsible for leading teams of undergraduate students in their assigned research group, tasked with the responsibility of helping students understand the material and complete assignments, providing an example of the structure of the course.

13) **James Freericks** (Georgetown U.)

Strategies that work for performing research with undergraduates, high school students and private citizens

Over my career, I have published about 30 refereed journal articles with undergraduates, high school students and citizen scientists; currently I publish 3-5 such articles per year. The same techniques work with all of these groups to enable you to lead students to a successful conclusion of their research with a refereed journal article. In this talk, I will describe techniques that can be used to publish work with these groups of researchers. The methods are quite simple and do not require a significant time commitment. We all know that students who engage in research often are more successful in physics and are less likely to drop out. Let's make the research experience successful for all! (The ides summarized in this talk are currently being written up for the American Journal of Physics.)

14) **David Wright** (Tidewater CC)

The WISE Stragey for Problem Solving

Physics students benefit from a structured problem solving strategy. In order to be successful, it should be explicitly taught, practiced on the board and in small groups, and required on homework and tests. The strategy involves the following four steps: What's Happening, Isolate the Unknown, Substitution, Evaluation. This problem solving approach increases accuracy, improves communication, and promotes organization.

— Demo Abstracts —

Demo Share-a-thon (3:15PM–4:00PM)

1⟩ **Tatsu Takeuchi** (Virginia Tech)

The Catenary

The catenary is the shape of a string of uniform linear mass density hung between two points. I will demonstrate that this shape is given by the graph of a hyperbolic cosine.

2⟩ **Kerlin Doss** (North Stafford HS)

Finding the Speed of Light

I will demonstrate how the speed of light can be estimated using a microwave. This is done by heating up some marshmallows for a short time, and measuring the distance between intensities between cooked and raw marshmallow. This gives us a wavelength that is multiplied by the manufactured specified frequency.

3⟩ **Alex Barr** (Howard CC)

Simple Invisibility Cloak

I will demonstrate how to use an arrangement of 8 triangular prisms to create a cloaked region of space (when viewed from an appropriate angle).

4⟩ **Tim Proudkii**, **Hana Mir**, **Hampton Smith**, **Grant Davis** (Virginia Tech)

A Real World Example of Invisibility

When we place Pyrex glass in a large container filled with water, we are able to observe the piece of Pyrex glass submerged within the container, as we would expect. However, when we repeat the process using vegetable oil, instead of water, the piece of Pyrex glass seems to disappear within the vegetable oil. This is because Pyrex glass and vegetable oil have the same index of refraction. By Snell's Law, the light incident upon the Pyrex glass leaves the medium at the same angle that it enters. In other words, the light is neither reflected nor refracted, thus we have no way of observing the Pyrex glass. This demonstration can be used to aid in students' understanding about certain concepts in optics, like refraction, Snell's Law, and the nature of light.

5⟩ **Daniela Topasna** (VMI)

3D Glasses

Will show how to make 3D glasses. Fun activity.

6⟩ **Chris Martin** (Shenandoah Valley Governor's School)

Determining the Width of a Hair with a Laser

The opportunity doesn't often arise for you to pluck out your students' hair without negative repercussions, but this demo is exciting enough for students to offer it freely! Because light acts as a wave, we see a diffraction pattern when it passes over a small slit or obstruction.

Using only a laser pointer, measuring tape, and a ruler, you can measure the width of a human hair by analyzing your laser's diffraction pattern on a viewing screen.

7⟩ **Ryan Fisher** (Christopher Newport U.)

Surface Tension Speed Boats

Demonstration of making a speed boat using the power of surface tension. (Credit to Mr. Wizard's Supermarket Science!)

8⟩ **Kevin Mitchell** (Tidewater CC)

DC Motor

I built a simple DC motor to show how direct current can be used to create an electromagnet that has the ability to alternate the direction of the magnetic field in order to continuously rotate. I will also show that this changing magnetic field can be picked up by a guitar. The demo will show how to change the rotational speed of the motor along with the direction of rotation.

9⟩ **David Wright** (Tidewater CC)

Chocolate Chip Motor

This demo will illustrate the principle of buoyancy in a very unusual way. Supplies: Chocolate chips, clear carbonated soda, glass container.