CSAAPT Spring 2024 Semi-Virtual Meeting

Saturday, March 16, 2024 - Saturday, March 16, 2024

Delaware State University

Chesapeake Section of the
American Association of Physics Teachers
Spring 2024 Semi-Virtual Meeting
March 16, 2024 @ DelawareStateUniversity

Book of Abstracts

Contents

2

Demystifying the use of complex numbers with driven-damped harmonic oscillators

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In 1930, Born and Jordan wrote a quantum mechanics textbook. In that work, they used a curious map to convert the harmonic oscillator equations of motion into two linear (uncoupled) first-order equations. When used in classical mechanics, this mapping clearly shows how one should introduce complex numbers into the motion of a harmonic oscillator and how to solve for the position and momentum observables. In this talk, I will explain how this mapping works and show how to demystify complex numbers usage in damped-driven harmonic oscillators.

3

DOD STEM RESOURCES

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DOD STEM Resources

4

Sticking point: The Role of Quantum Mechanics in Gecko Wall Climbing, and How to Create Synthetic Gecko Tape.

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This presentation would delve into the fascinating world of gecko locomotion, a topic that captivates both biologists and physicists alike. The remarkable ability of geckos to scale vertical surfaces and even traverse ceilings has long intrigued scientists, leading to groundbreaking insights at the intersection of biology and physics. Central to this ability are the billions of nano-sized hairs, known as setae, found on the feet of geckos. These setae adhere to surfaces not through conventional means like glue, suction, or mechanical grip, but via Van der Waals forces. These forces, though weak individually, collectively enable a gecko's remarkable adhesive capability.

Our presentation will explore the quantum mechanical nature of the Van der Waals force, a phenomenon emerging from the subtle interplay of interatomic forces between the minuscule tips of gecko setae and the molecules of the wall surface. Additionally, we will introduce a simple yet innovative experiment designed for high school and undergraduate laboratories. This experiment

aims to synthesize a ‘gecko tape’, replicating the gecko’s natural adhesive properties using synthetic materials.

5

Learning Differences and Physics Teaching

Author: Sean Lally[1]

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You have likely come into contact with many students who have learning differences - some slight, some moderate, and some severe. I currently teach at a school that focuses on the teaching of students with dyslexia and related language-based learning differences and I see all sorts of issues among college-bound high school students. In this talk, I wish to address some of the things you may see exhibited by your students. There is no solution that helps everyone, but there are strategies for teaching physics (and indeed all sciences) that I have found useful. I will chat about executive function, note-taking, lab preparation, classroom practices, and other possible ways to help address learning differences.

6

The Physics of NASCAR

Author: Diandra Leslie-Pelecky[None]

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Most people watching a NASCAR race see racecars. Dr. Diandra Leslie-Pelecky sees a science experiment on wheels —and a way to interest more people in physics. She’s gotten behind-the-scenes access to race shops and personnel, driven the 24-degree banking of Texas Motor Speedway, and embedded with a race team. She shows fans how a team cannot win a NASCAR race without mastering math, science and engineering, and how their understand of the sport will be enhanced if they learn a little more about the science behind the speed.

In 75 years, NASCAR has evolved from moonshine and dirt tracks to computational fluid dynamics and finite element analysis. Dirt tracks are still part of the picture, but so are sweeping superspeedways and sprawling road courses. NASCAR has changed profoundly in the 16 years she’s been reporting on the sport. This will be the third year of racing with the seventh-generation Next Gen racecar, which looks more like a production car and has cutting edge safety features.

NASCAR has even built their first electric racecar.

Dr. Diandra will explain how racing isn’t as simple as mv2/r, how you can use cars to increase student interest. She’ll also explain how motorsports have the potential to help lead the change to more sustainable vehicles. Whether you’re a race fan curious to know why your driver is (or isn’t) winning, or a scientist wondering why people get so excited about cars driving in circles, you will enjoy learning about the science of speed.

Dr. Diandra Leslie-Pelecky is the author of “The Physics of NASCAR” and the “Building Speed” blog. She is a contributor to NBC Sports and SiriusXM Speedway. Outlets from the New York Times to Sporting News to Physics World have covered her work and drawn on her expertise.

7

The Total Solar Eclipse on April 8, 2024

Author: Matthew Bobrowsky[1]

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This CSAAPT meeting is occurring less than a month before the total solar eclipse that will occur on April 8, 2024. In this presentation, we will describe the fascinating circumstances that will create April's spectacular event. Topics include:

- What is an eclipse?
- Why will the eclipse be so spectacular?
- From where can the eclipse be seen?
- How often do eclipses occur? When is the next one after April 8? (Spoiler alert: If you're in the U.S., you'll have to wait decades [!] to see another total solar eclipse.)
- How to safely view the eclipse. (Eclipse-viewing glasses will be available.)
- Fun facts and common misconceptions about the sun, moon, and eclipses.

There will also be a Q & A session. Come and hear about the eclipse – and then plan to see it!

8

Virginia Science Standards of Learning Revision - Seeking Input!

Author: Gregory MacDougall[1]

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The Virginia Science Standards of Learning Revision and Implementation timeline is being revised. This session will provide an update on the revision process. In addition, the VDOE is seeking input from the community on the standards and seeking nominations for individuals who are qualified and available to serve on the Science Standards Revision Committee to review the K-12 Science Standards of Learning during the summer of 2024. Courses of interest include Physical Science, Physics, and Physics II,

10

Empowering Students through Open Access Publishing

Author: Stefano Colafranceschi[1]

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This talk explores the role of open access journals in science and physics education, focusing on the importance of publishing for students. Through practical insights and discussions, we will discuss the highlight and benefits of writing for students and the broader scientific community.

11

THROW THINGS DOWN THE STAIRS AND CALL IT SCIENCE - A DESIGN/BUILD CONCUSSION PROJECT

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In a given physics classroom, the odds are good that at least one student has had a concussion or has a friend who did. Many students participate in sports or activities with a risk of head injury. This problem-based lesson tackles concussion prevention in football and bridges the disciplines of physics and engineering.
Students are challenged to design their own helmet padding using upcycled packing materials. The test rig is currently a foam head-form with an embedded accelerometer. Students must complete a set of blueprints, construct the designs, and then test for efficiency.
I will walk you through the phases of the project, providing insight from missteps and successes, and share adjustments I will try in the next iteration. We will step through a dry run of the data collection with old designs.

12

Using hand-held visual accelerometers and the CER Framework in student-centered classrooms to talk through FCI misconceptions.

Author: Judson Wagner[1]

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In establishing student-centered learning environments, educators look for ways to prompt student-directed exploration, rich and authentic discourse, and collaborative peer instruction, while eliciting evidence of student learning. The Claim-Evidence-Reasoning (CER) writing framework can help classrooms normalize effective student-centered science activities. This presentation offers educators a strategy in a student-centered environment that uses Force Concept Inventory (FCI) misconceptions to quickly guide students to make a claim, puts visual accelerometers into students'hands to help them to quickly explore and present evidence, and consequently, give students more time to craft their scientific reasoning that ties the claim and evidence together and contributes to their enduring conceptual understanding.

13

Experimental Projects for a Capstone Engineering Physics Course at Delaware State University

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The presentation discusses capstone experimental projects designed for senior students majoring in Engineering Physics at Delaware State University. In this capstone experience, students complete a

total of ten short experimental projects in two semesters from a repository of twenty laboratories, which include experiments in electrical circuitry, spectroscopy, modern physics, thermodynamics, acoustics, optics, and renewable energy technology. Students are expected to conceive and design the experimental protocol to test the hypothesis or verify a known theory. Students prepare a technical report upon completion of each experiment. They also make an oral or a poster presentation for one experiment of their choice as a culminating assessment. Students are guided to prepare reports and presentations following the structure/format similar to a regular scientific communication. To enhance the creativity of the experience, students also perform additional mini-projects based on Arduino microcontroller kits.

15

Exploring ChatGPT for Creating Curricular and Instructional Material

Author: Muge Karagoz[None]

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Every STEM teacher has likely already considered using Generative AI tools in their courses, if not already applied. In this talk, I will examine two separate uses of ChatGPT for physics: One to create course material, and another to perform case studies for promoting critical thinking skills. I will share my experiences on testing ChatGPT for re-generating some figures I previously created using TikZ (a LaTeX package for graphics) for a UMD upper division physics course on waves and oscillations. I will then finish with illustrating how ChatGPT's responses can be used as part of in-class peer-led and teacher-led discussions.

16

Building Student Interest in Quantum Careers: Quantum Pathways Programs

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We will discuss two programs that we have been running to introduce students to quantum concepts and the pathways into quantum careers. The Pathways to Quantum Summer Immersion Program introduces high school students to key quantum concepts and the jobs in quantum. The program is an immersive experience that includes a virtual program to build an understanding of key concepts and an in-person program that focuses on learning about quantum careers through site visits. The Quantum Pathways program was a one-day workshop pilot aimed at community college and early college students to introduce them to quantum key concepts and to help them understand how they could pursue a career in quantum. We will discuss the key elements of these programs and what we have learned about students'thinking about quantum concepts and careers through these experiences.

17

Learn about the Heliophysics Big Year events such as the eclipse through NASA's Community Coordinated Modeling Center's (CCMC) tools

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The Heliophysics Science Division at NASA Goddard Space Flight Center (GSFC) is calling October 2023 through December 2024 the Heliophysics Big Year (HBY). Learn about heliophysics, and how you can use the Community Coordinated Modeling Center's (CCMC's) tools to engage with the events from the annular eclipse from last October, this upcoming total solar eclipse on April 8th, and Parker Solar Probe's closest approach to the sun on December 24th. The CCMC has hands-on space weather modeling tools for formal and informal educators. The CCMC supports educational activities, such as heliophysics and space weather summer schools, contests, research visits and exchanges. We create and maintain a wide variety of tools for space weather simulations, analysis, forecasting, and visualization. This includes tools such as the iNtegrated Space Weather Analysis System (iSWA), Database Of Notifications, Knowledge, Information (DONKI), and OpenSpace 3D visualization project.

18

Highlights from Two-Year College Programs

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The Organization for Physics at Two-Year Colleges (OPTYCs) is an NSF-funded project to bring two-year college physics and astronomy faculty together through professional development and networking opportunities. In this presentation, I highlight two of our cohort-based programs: the New Faculty Development Series, and the DEI Capacity-Building Program. OPTYCs is supported by NSF grant #2212807, and activities are open to everyone. For more information, visit: https://optycs.aapt.org.

19

Mechanical Oscillations With and Without Damping - An Analog Computer Physics-Themed Simulation

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A breadboard analog computer was constructed to approximate a solution to the second-order linear differential equations for a sliding block attached to a massless spring, which is attached to a rigid vertical frame. Two cases are considered: (1) with damping and (2) without damping. In both cases, the sliding friction is assumed to be 0. Units were omitted in each equation for clarity. The solutions to both cases are displayed on an oscilloscope upon initialization. An analytical solution is provided for each case as comparison. This demonstration provides a model of instruction which allows students to visualize classical physics and differential equations through hands-on analog circuit design.

20

Social Dynamics around a Black Woman's Equipment Handling in a Physics Lab

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In undergraduate physics laboratory courses, there is new emphasis on engaging students in authentic science learning experiences centering on knowledge-building. Limited research, however, has sufficiently explored the ranges of positioning dynamics around equipment handling roles, particularly in gender and racially diverse groups. This is especially true for the experiences of women of color. We seek to identify and describe the dynamics of students'positioning around equipment handling in multiple diverse groups that included a Black Woman who indicated preference towards handling lab equipment. We draw on literature on positioning theory, discourse analysis, roles, small groups, and physics labs to analyze episodes of video on the groups. We characterize each group's dynamics, identified participants'roles around equipment handling, and wrote memos on the positioning dynamics. We find that students enacted three positioning dynamics in the groups: explicit assignment, implicit assignment, and explicit negotiation. Also, different positioning dynamics and distinct types of interactions across groups shaped the Black woman's participation around the equipment handling role. The complexities in interactions and positioning dynamics across groups increase the weight of evidence that suggests explicit role assignment in small groups does not guarantee group work equity.

21

Examining the Role of Family in Women's Engagement and Success in Physics

Author: Laura Akesson[1]

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Although some progress has been made over the last 50 years, physics still has one of the largest gender gaps of the sciences. The gap has been attributed to a variety of causes, including aspects of culture, early exposure to STEM, and gender-based psychologies, but few studies approach this issue centering the perspectives and experiences of women in physics. We focus on the role of family to understand the engagement and success of undergraduate women in physics. In this presentation, we will discuss our qualitative analysis of 120 surveys and 31 interviews of undergraduate physics students (92% identifying as female). We relate our findings to recent established STEM- and physics identity frameworks (including Carlone & Johnson and Hazari), and present new aspects emerging from our data.

22

Enhancing STEM Graduate Student Teaching: The cultivation of teaching skills and identity among graduate students.

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We examine the evolution of the teaching identity of graduate teaching assistants (GTAs) during their first year as they engage in teaching professional development and gain experience in the classroom. This study is part of a larger project that aims to increase active and collaborative learning in Math, Physics, and Computer Science at George Mason University. To prepare and support GTAs, the project has established pre-semester and academic-year professional development initiatives. The pre-semester workshop spans two days and aims to ready new GTAs for their classroom responsibilities. It covers practical teaching skills, emphasizing active learning, making a positive first day impression, available resources, and fostering a welcoming and inclusive classroom atmosphere. Academic-year professional development varies among departments but typically involves weekly meetings of GTAs, serving as a platform for discussing teaching methods and strategies. Following the two-day workshop in August 2023, we conducted seven focus groups, each comprising 3-4 GTAs. Currently, we are conducting one-on-one interviews to gain a deeper understanding of how GTA teaching identities evolve over time and to examine potential differences in experiences for international GTAs. The data collected from these focus groups and interviews provide preliminary insights into the development of teaching identity for new GTAs.

23

Let it go!

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In this demo, we roll cylindrical objects down a ramp to see which one reaches the bottom first. The speed is determined by how the initial gravitational potential energy is shared between the translational and rotational kinetic energies of the rolling object. The highlight of the demo is the race between Frozen and Thawed cans of orange juice.

24

Brachistochrone and Tautochrone

Author: Tatsu Takeuchi[1]

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We will show how to construct tracks you can rolls marbles along simply and cheaply. These tracks can be used to demonstrate the brachistochrone and tautochrone.

25

Physics of an Accelerating Unicycle

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The free-body diagram of a unicycle pedaled across level ground is analyzed, showing that riders must tilt their bodies into the direction of the acceleration. A comparison is made with an unpowered round object rolling without slipping up or down an inclined plane. A Newtonian analysis predicts an acceleration of the unicycle as a function of the tilt angle that is in good agreement with measurements of an actual unicycle using the accelerometer on a smartphone. This work has been performed in collaboration with Heiko Kabutz, Ph.D. student of mechanical engineering at the University of Colorado in Boulder.