# 2025 Meeting of the TAAPT

## The University of Tennessee at Martin

Friday, April 4th and Saturday, April 5th

## Schedule at a Glance

Note that all events are on the ground floor, north side of building, directly accessible from the Quad

**Friday, April 4th – Latimer-Smith Building, rooms 102/103**

5:30 pm to 6:00 pm – Check-in and registration, just outside room 102

6:00 pm to 7:00 pm – Dinner, Latimer-Smith building

7:00 pm to 8:00 pm – Keynote Speaker, Dr. Peggy Hill, Professor of Physics Emerita, Southeast Missouri State University

**Saturday, April 5th Latimer-Smith Building, 102/103**

8:00 am to 8:55 am – Registration/ light breakfast (pastries, tea, coffee)/poster setup

8:55 am to 9:00 am – Welcoming Remarks

9:00 am to 10:30 am – Oral presentations

10:30 am to 10:45 am – break/poster setup (atrium Latimer-Smith building)

10:45 am to 11:15 pm – Business meeting/poster setup

11:15 pm to 12:00 pm – poster session, atrium Latimer-Smith building

12:00 pm to 12:10 pm – poster prizes

12:10 pm to 1:00 pm – boxed lunch

1:00 pm-2:00 pm – Tour of Latimer-Smith building

# Program for Saturday, April 5th – Latimer-Smith Building, Rooms 102/103

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| **8:00 – 8:55** | **Registration/light breakfast (first floor atrium,** Latimer-Smith Building**)** |
| **8:55 – 9:00** | **Welcome Remarks**: Jason Alexander, UT Martin (102/103) |
| **9:00 – 10:30** | **Oral Presentations (102/103)** |
| **9:00 – 9:15** | **Geoffrey Burks, Tennessee State University**<br>*A Prototype Setup for Teaching Physics, Astronomy, and Math*<br><br>A prototype set up for teaching physics, math, and astronomy from middle-school through college is presented. A solar panel on a cradle that allows changing the angle of orientation on one axis is used. The set up allows measurement of the solar panel output set to different vector altitudes. The output varies depending on the angle between the vector direction of the panel and the changing apparent position of the sun. The best orientation on a monthly basis is determined by using a spreadsheet available to students. Experiments can compare panel output at different orientations on time scales varying from minutes to days. Multiple topics in physics, astronomy and math are addressed. |
| **9:15 – 9:30** | **Nat Smith, Middle Tennessee State University**<br>*Dense Astronomy - A Simple but Powerful Concept for an Introductory Astronomy Lab*<br><br>Density is a unifying concept in astronomy that is utilized at all astronomical scales, from planets up to the entire universe. It is also an easy concept to understand, and mathematically simple enough that it does not "frighten" non-major, general education students in an introductory astronomy course. In this presentation I will describe a lab I developed for our Astr 1031 lab course in which students measure the density of various metal and rock samples and use that information to gain an insight into what planets are made of. Using a simple model of the structure of the terrestrial planets, students are able estimate the size of the metallic core of Mars. We also look briefly at more exotic objects – Earth sized, but with masses typical of small stars. Based on the density of these objects, students infer that they can't be ordinary planets. The lab incorporates hands-on activities, simple calculations, graphing, and computational modeling. It could easily be extended in many ways to make it more challenging or to investigate different astronomical topics. |
| **9:30 – 9:45** | **John Varriano, Christian Brothers University**<br>*Desmos: Some More Physics Examples of This Quick, Easy, and Free Graphing Tool*<br><br>Desmos offers an advanced graphing calculator that is available as a free web application (www.desmos.com). I presented some examples of this is easy-to-use tool in the teaching of various physics topics at the 2022 TAAPT meeting. More examples are presented in this presentation including some graphs that have replaced Java applets that I routinely use in my teaching. |

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| **9:45 – 10:00** | **Pei Xiong-Skiba, Austin Peay State University**<br>*Using D2L to Create Tests for both Online and Face-to-Face Courses*<br><br>Online courses have grown increasingly popular in recent years. At Austin Peay State University, approximately 50% of our introductory physics courses have been offered online over the past four years. This highlights the need for consistent standards across both in-person and online modalities. A key aspect of maintaining the standards is designing comparable online tests, used in both modalities. Austin Peay State University uses Desire2Learn (D2L) as its learning management system. In this presentation, we will discuss how we utilize D2L features—such as Sections, Multiple-Selection, Double Submission, and Honorlock— to help create more effective assessments that better align grades with students' understanding of the subject. |
| **10:00 – 10:15** | |
| **10:15 – 10:30** | |

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| **10:30 – 10:45** | **Break/Poster setup** (atrium) |
| **10:45 – 11:15** | **Business Meeting** (102/103)/Continued Poster setup |
| **11:15 – 12:00** | **Poster Session** (atrium) |
| | **Thomas Bouchard, Austin Peay State University**<br>*Applying Transfer Learning to Graph Neural Networks for Predicting Defect Formation Energies*<br><br>Defect formation energy is a critical metric describing a defect's thermodynamic stability and is fundamental to applications ranging from semiconductors to quantum technologies. However, calculating these energies using density functional theory (DFT) is computationally expensive at scale, leading to datasets typically on the order of 100 to 1000 entries. This limited data size hinders the full exploitation of data-hungry deep learning models. To address the data scarcity for defects, we propose using transfer learning to leverage larger datasets (over 10,000 entries) available for pristine crystal formation energies, which are less costly to compute. We pretrained a graph neural network on pristine crystal formation energies and then fine-tuned it for defect formation energies, with a focus on metal and oxygen vacancies in oxide materials. This method not only improves predictive performance but also accelerates convergence and stabilizes training, significantly reducing the number of epochs required to achieve optimal results. Compared with models trained from scratch, the transfer learning model demonstrated superior accuracy approaching that of DFT calculations, offering broad implications for materials discovery. |

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| | **Amaya Caudel, Austin Peay State University**<br>*Numerical Study of Geometric Effects on Structural Color in Morpho-Inspired Nanostructures*<br><br>Morpho butterflies are one of the most vivid examples of structural color found in nature. They have blue wings not due to pigments, but rather an optical phenomenon called structural color. The wings are built of tiny nanostructures in which the incident light can bounce around, interfere with itself, and cancel out every reflected spectral component except for a dominant band of blue wavelengths. The brilliance and durability of this blue color motivates an investigation into how the geometry of Morpho-inspired structures would influence their spectral response and coloration. To this end, we have modeled various 2D geometries with parametric sweeps of their features in COMSOL Multiphysics and converted the reflectance spectra obtained by each simulation into RBG values. To verify our color space conversion method, we experimentally measured spectra from standard color patches, used the conversion routine, and compared the resultant colors to the physical colors. Our results show that the branch thickness and/or gap between branches have the greatest effect on the color hue, which confirms that constructive interference is the dominant cause of structural color in this system, and that those parameters can be used to tune the hue of the perceived color. |
| | **Jeremy Gordon and Tiffany Decker, The University of Tennessee at Martin**<br>*Autonomous Robotics*<br>The purpose of this project is to demonstrate an understanding of Computer Science and physics by designing, building, programming, and testing a modified Radio-controlled car robot. We are building modular software that the device will utilize to navigate the University of Tennessee at Martin's main campus, specifically between the Holt Humanities and Latimer-Smith Engineering and Sciences building. We have partnered with a faculty mentor from the university, a physics professor by the name of Dr. Cahit Erkal, to procure hardware and solidify the goals of the project. |
| | **Deja Graves, The University of Tennessee at Martin**<br>*Design and Construction of a Single-Channel Fiber-Coupled Laser Source*<br><br>We describe the design and construction of a single-channel, fiber-coupled laser source with temperature control. The benchtop source operating near 30 mW output at 685 nm is designed for ease of use in a biochemistry laboratory. The current through and temperature of the laser diode junction is fed to the LED front panel displays on the up-cycled enclosure via an open-source embedded microcontroller (Arduino Uno clone) and custom code. We also present initial characterization of the laser system performance. |

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| | **Li Loy, Austin Peay State University**<br>*Examining KR Aur and Surrounding Field*<br><br>The cataclysmic, nova-like, antidwarf, variable KR Auriga was observed to examine the period of the nova-like variable to compare with past observations to independently confirm the period of the system. The field surrounding the object was also observed and the magnitudes of the surrounding stars were plotted against time to find evidence of more, possibly undiscovered, variable stars. During observations, the magnitude of KR Aur was seen fluctuating in an irregular manner, known as "flickering", caused by the accretion disk surrounding the object. Further examination of the data gathered from the observations will be conducted to compare past known magnitudes to magnitudes that were recently observed. |
| | **Jair Martinez and Keira Scott, Austin Peay State University**<br>*Comparing Four Methods for Determining the Refractive Index of a Glass Prism Using a Multi-Wavelength Laser and a Versatile Optical Setup*<br><br>We present an update on the progress of our work to include measurements and fits of the Fresnel reflectance curves for s- and p-polarization, using mixtures of s- and p- polarization. Previously, we measured the dispersion of the refractive index of a glass prism using the angle of minimum deviation, fitting to the minimum deviation curve, and Brewster's angle. The angle of minimum deviation yielded the results closest to the Sellmeier values (maximum percent error: 0.03%), while the Fresnel method showed the overall largest inconsistency (percent errors between 0.05% and 1.54%). The minimum deviation fitting results are consistently lower due to a yet unknown systematic error, while the Brewster's angle results can be made to match by mixing in small fractions of s-polarization. The next steps include implementing the total internal reflection and rotating analyzer ellipsometry methods. These experiments and computations can be adapted to various undergraduate projects ranging from a few advanced laboratory sessions to semester/summer-long student research experiences, teaching the importance of precise alignment, calibration, careful measurements, and fitting. |
| | **Kylene Monaghan, University of the South**<br>*Photolithography for Graphene Electrical Contacts*<br><br>Photolithography is a technique used widely in the semiconductor industry and is vital to digital electronics. A modified version of this method can be used in the undergraduate setting to create electrical contacts to microscopic materials. The material of interest for this research is graphene, a one-atom thick layer of graphite which possesses conducting electrons that are one hundred times faster than those found in standard semiconductors. Since its discovery in 2004, graphene has been of immense interest for research purposes and has been shown to be significantly conductive for both heat and electricity. In this research, we have developed our own photolithographic system and exfoliated graphite into graphene to be able to produce electrical contacts for the study of conductivity. |

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| | **Leonardo Wang, University of the South**<br>*Fabrication of a Schottky Diode*<br><br>According to a physics teacher's article, Volume 58, Issue 1, Schottky diode properties can be replicated with a silicon wafer, a hot lamp, gold leaf foil, and aluminum foil. However, the Schottky barrier diodes created by this process failed to match the rectifying behavior of the commercial 1N4001 rectifying diode in both forward and reverse biases. Throughout my research, I will refine the experimental procedures to create a Schottky barrier diode with enhanced rectifying behavior under both forward and reverse bias conditions. |
| **12:00 – 12:10** | **Poster Prize Presentation** (102/103) |
| **12:10 – 1:00** | **Boxed Lunch** (atrium) |
| **1:00 – 2:00** | **Tour of Latimer-Smith Building (start in 102/103)** |