Abstracts for Plenaries at the October 12, 2019 Workshop

9:10 Plenary **Gravitational Wave Polarization: Did Einstein Get it Right and Why Should We Care?**

Bob Hilborn (American Association of Physics Teachers)

Gravitational wave (GW) detectors give us a new "telescope" to view astronomical objects and events never seen before (at least by humans). For example, GWs provide substantial evidence for black holes with masses 10-30 times the mass of the Sun, for their coalescence into yet more massive black holes, and for the merging of binary neutron stars. Critical to the interpretation of the properties of these GW sources is the polarization of the emitted gravitational waves. Just as the polarization of electromagnetic radiation (light) affects the response of many light detectors, the polarization of gravitational waves affects the response of GW detectors. Until recently, there has been no direct evidence for the character of GW polarization. Einstein's theory of gravity (general relativity) predicts that the polarization will have a "tensor" character. Other theories predict "vector" and "scalar" forms of polarization. However, with the detection of GWs by the LIGO-Virgo network of three observatories, it is now possible to draw definitive conclusions about the nature of GW polarization. To-date, the most interesting data come from the binary neutron star merger event GW170817. Surprisingly, the data seem to support "vector" polarization over Einstein's "tensor" polarization. In this talk, I will explain how the GW data can be used to determine the GW polarization and why we conclude that the GW170817 data strongly favor "vector" polarization. Why should we care? In the words of noted astrophysicist Clifford Will, such a conclusion "would be disastrous for general relativity."

This work has been carried out in collaboration with A. A Svidzinsky (Texas A&M University)

1:30 Plenary **Innovating Astronomy Education with Robotic Telescopes**

Kathryn Williamson (West Virginia University)

We are on the cusp on an astronomy education revolution. Robotic telescopes are now bringing the excitement of authentic astronomy practices and concepts to large numbers of students and educators far and wide. With internet access to a worldwide network of remotely controlled, research-quality telescopes, even the most novice student can obtain accurate position measurements of asteroids, collect and analyze images of planetary systems to test Kepler's Laws, and map the invisible universe through radio astronomy. In this talk, I will provide an overview of the Skynet Robotic Telescope Network, a collection of dozens of telescopes positioned around the world and operated out of the University of North Carolina at Chapel Hill. I will discuss how the Skynet Juniors Scholars project engages young students, including those with visual or hearing impairments, in astronomical discoveries. I also will discuss how I have used Skynet in my introductory college astronomy course, Astro 101, in both lecture and lab settings at West Virginia University. Student comments and independent project examples will show the amazing possibilities and profound impact of access to robotic telescopes and one's very own astronomical data.

Abstracts for Breakout Sessions at the October 12, 2019 Workshop

10:30 **Make & Take: Projection Microscopes**
Larry Browning (SDSU)

CAUTION: Not for the squeamish! By using a drop of water as a lens, a laser beam can be used to enlarge critters in the water so that a classroom can see them swimming. Participants will build and use these projection microscopes to see what's in the water they've been drinking along with other samples. This is a good project for classrooms as each microscope can be made for pennies. Also this can be used to motivate discussions on geometrical and physical optics as magnifications can reach 1000x and interference/diffraction patterns are apparent.

Resource: https://openprairie.sdstate.edu/physics_edu-resources/1

10:30 **The UNL Approach to IPLS**
Steve Ducharme (UNL), Keith Foreman (UNL)

Teaching introductory physics to life science students often presents certain unique challenges not found in other physics classrooms. In this session, participants will discuss the challenges of teaching IPLS courses and the UNL approach to these courses. We will examine both the in-class structure and activities of these courses as well as some of the behind-the-scenes decisions we can make to keep students engaged and motivated. By choosing appropriate pedagogies and active learning strategies, we can teach life science students to think like physicists!

10:30 **Phantastic Photon (Make & Take)**
Tom Brestel (Holdrege High School)

Attendees will set up a simple Schlieren photography system for use in the classroom using mirrors and light emitting diodes. Attendees will determine the track spacing of a CD or DVD using handheld lasers. This session will have a make and take component. These activities are a good way to bring quantum theory into your high school classroom.

10:30 **BLUE MARBLE MATCHES - Using Earth for Planetary Comparisons**
Michael Edmundson (Millard South High School)

This activity is designed to introduce students to geologic processes on Earth and how to identify geologic features in images. It will also introduce students to how scientists use Earth to gain a better understanding of other planetary bodies in the solar system.

11:00 **Interactive Use of Physics Demos**
Kevin Lee (UNL), Cliff Bettis (UNL)

This session will focus on using demonstrations in the introductory physics classroom. The educational literature on this topic will be quickly summarized illustrating the importance of interactive usage. Attendees will be experiencing these interactive materials in the role of student and talking about them in the role of instructor. Examples of peer instruction questions based upon physics demonstrations will be utilized. Examples of short worksheets will also be demonstrated. Some worksheets take a conceptual approach, while others have a more computational flavor. Electronic copies of all demonstration worksheets from UNL's Physics 151: Elements of Physics class will be available to participants.

11:00 **IoLab**
Jeff Skillman (Macmillan Publishing)

iOLab is a revolutionary new hardware and software solution for your physics lab. It combines all the measurement devices, and components needed for hundreds of physics labs in a single device and links them to a software solution for gathering data and recording results. iOLab can replace or augment your current lab set up and is perfect for online, hybrid, or traditional classes.

During this 30-minute breakout session, you will get a BRIEF introduction to the hardware & software. Afterwards, we will let you loose to play with the device & the software on your own. We will showcase, during your self-exploration of the iOLab device, the accelerometer, light sensor & how multiple sensors can be used simultaneously to record data.

This will be an interactive session, so we hope you'll join us to learn more about this exciting learning tool!

11:00 **NASA Space Grant Opportunities**
Tammy Blobaum (Nebraska City High School), Elizabeth Dunn (Nebraska City Middle School)

This session will provide a brief overview of NASA Educational Resources as well as Professional Development opportunities for educators. We will share resources for classroom lessons, summer camp ideas, and funding options for educators seeking PD or research ideas. A brief overview of the newest NASA missions will also be included.

11:00 **HTML5 Simulations on Lunar Phases**
Chris Siedell (UNL)

This session introduces three new HTML-based simulators recently developed by the UNL Astronomy Education Group. These simulators are intended to help develop an understanding of lunar phase geometry, and target grades K-12 and beyond. They have been designed to work on a multitude of devices, from smartphones to desktop PCs. This work builds off of the already extensive set of Flash-based simulators that have been available on the astro.unl.edu website for many years. This work was done in collaboration with PBS Learning Media, which is developing lesson plans for the simulators.

11:30 **Modeling Activities in Astronomy**
Ethan Van Winkle (Lincoln Southeast High School)

Modeling Instruction is a pedagogy that uses student-driven authentic laboratory investigations to help students construct, refine, and apply the fundamental conceptual models that form the content core of the sciences. In 2017, the American Modeling Teaching Association with collaboration with Hands on Universe developed new curriculum for astronomy. The attendees will get an overview of the types of activities that this new curriculum provides and experience two of them. These two activities presented build up to measuring parallax within images. Attendees will learn how to use free imaging software SalsaJ or Chromebook friendly JS9 to measure lengths in images and do a hands-on activity measuring Angular Size.

11:30 **The Living Physics Portal**
Bob Hilborn (AAPT)

The Living Physics Portal project aims to provide curricular and assessment resources for faculty teaching physics for life and health science students. In this session, I will provide a guided tour of the Portal (www.livingphysicsportal.org) to illustrate the kinds of resources available, their vetting and curation, and how faculty might both use and contribute to the resource collection.
This work is supported by NSF Grants 1624185, 1624478, 1624017, 1624374, 1624158, 1624007, 1624006, 1624549, 1624192.

11:30 **Teaching STEM/Nano: Quick, Cheap, & Easy**
Steve Wignall (UNL)

In this session the attendee will experience several activities and demonstrations that can be used in the Science classroom. They will be easy to set-up and relatively inexpensive to do. Examples such as Nanotechnology kits available from the University NCMN at moderate price, Piezo and Static electricity generation activities, aerodynamics, and whatever else I can show with the time permitting.

11:30 **Exploring Venus**
Mindi Searls (UNL)

Venus is an extremely difficult planet to study. Its dense cloud cover hides a surface rich in unique volcanic features, craters, heavily deformed tessera, and fracture systems resembling spider webs. In this session, we will use hands-on activities to discover how scientists learn about the surface of Venus using remote sensing tools such as a synthetic aperture radar and radar altimeter.

12:00 **Interactive Use of Astronomy Demos**
Dale Stille (U Iowa), Cliff Bettis (UNL)

We will show up to 10 astronomy demonstrations with brief discussion of each in the form of "clicker questions". The participants will have to predict, observe, and interpret, each demonstration just as students in their classes would be asked to do.

12:00 **Math Readiness Exams**
Brandon Harper (UNL), Allan Donsig (UNL)

Students may not have full command of prerequisite knowledge when starting a course. We discuss and display a "Math Readiness Exam" used at the start of an introductory Physics course at UNL to ensure students review and master prerequisite math knowledge. The first implementation of the exam has provided information on the best practices for using this type of exam. Similar exams have been used in UNL Mathematics courses and we compare the effects of such exams in the two types of courses.

12:00 **Funsize Physics**
Jocelyn Bosley (UNL), Shireen Adenwalla (UNL)
(DISCLAIMER: Funsize Physics is not responsible for any minds that are blown.)

Condensed-matter physics is the hustler of the physics world. It is the science that gave us silicon transistors, MRIs, and solar panels. It is the reason your smartphone fits in your pocket, and why you may soon be able to fold up your big-screen TV and keep that in your pocket, too. But condensed matter physics is not just useful—it is also beautiful and awe-inspiring. Funsize Physics is an NSF-funded website developed to communicate the excitement, wonder, and potential of condensed-matter physics to a broad audience. In this session, we will explore the resources available on Funsize Physics, and consider how connecting fundamental physics concepts to cutting-edge research can enhance student learning.

12:00 **Lunar Astronomy Demonstration Videos**
Emily Welch (UNL)

One of the big topics in beginning astronomy is helping students understand the relation geometric relations between Earth, the Moon, and the Sun. The relationship between these objects is the key to understanding eclipses, lunar phases, tides, etc. In this short breakout session, I will overview some of the resources that have been developed at UNL by the Astronomy Education Research group to help students develop this geometric intuition. I will focus on the Astronomy Demonstration Video project and highlight two vides (1) a capstone video about lunar phases and telling time with the moon and (2) an introductory video about eclipse geometry that focuses on types of shadow and the scale of the moon's shadow versus the Earth's. Educators will take the role of students in watching a demonstration video and working on a worksheet.

This work is supported by NSF grant #1245679.

Abstracts for Longer Focused Sessions at the October 12, 2019 Workshop

2:30 pm **Integrating Computation into Undergraduate Physics and Astronomy: Simple ways for you and your students to get started.**
Bob Hilborn (AAPT)

This session will provide motivation for integrating computational work throughout the undergraduate physics and astronomy programs. (Much of the session will be appropriate for high school teachers as well.) We will then have an introduction to spreadsheets, Vpython, Glowscript, and the computational exercises available for faculty and students on goPICUP.org. There will be ample time for discussion and for exploring computational exercises in a wide variety of physics and astronomy topics. Participants are asked to bring a laptop if at all possible.

This work is supported by NSF grant 1524963.

2:30 pm **The Pulsar Search Collaboratory**
Kathryn Williamson (WVU)

The Pulsar Search Collaboratory (PSC) engages high school students and teachers in analyzing real data from the Robert C. Byrd Green Bank Telescope for the purpose of discovering new pulsars and the hope of contributing more pulsars to the NANOGrav network. The PSC trains participants through an integrated online platform, complete with pulsar plot certification tests, training videos, and an online discussion forum. Students who analyze enough data are eligible to attend two in-person PSC events: a Capstone symposium at a host university where students present their work, and a Summer Institute at the Green Bank Observatory where they learn advanced pulsar data analysis and other STEM skills. Through working with each other, teachers, and scientists, students gain long-term confidence and interest in pursuing STEM careers.

2:30 pm **Broadening Participation in Science**
Elizabeth Lewis (UNL), Ashley Jadwin, & Emily Welch (UNL)

This 90-minute interactive session will focus on engaging participants for the purpose of: (1) increasing their understanding of common issues of equity (i.e., gender, culture/race, disability, socioeconomic status) in physics and STEM education; (2) evaluating their current teaching setting for equity issues, and (3) discussing productive ways to address recruiting and retaining underrepresented groups in middle, high school, and higher education. Participants will leave with an action plan to address one or more of their major concerns about broadening participation in physics, astronomy, and physical sciences education.