# Enhancing College Astronomy and Physics Courses through Research-Based Teaching Methods and Assessments

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## Project Overview

- This project will develop a set of instructional resources using heliophysics content as the context that can be used in typical college astronomy and physics courses, both at the introductory and advanced level, as well as courses for preservice teachers.
- The materials will be small-scale and modular, designed to fit into and enhance existing physics and astronomy courses.

## Timeline (under development)

- Each year, we will pick a topic or context based on the focus of the HEC activities.
- The team will engage in the following activities on a cyclic, annual basis:
  - Team face-to-face gathering (1-2 days)
  - Resource development
  - Beta testing over the course of academic year
  - Resource revision
  - Dissemination at AAPT Winter and Summer Meetings, section gatherings, publications, etc. (among other venues)
- Items will be field-tested as they are developed, then disseminated at the AAPT national meetings and other appropriate venues.

## Team

- Team Organizations
  - Temple University
  - American Association of Physics Teachers
- Members
  - Ramon E. Lopez, University of Texas-Arlington, lead
  - Janelle M. Bailey, Temple University PI
  - Rebecca Vieyra, American Association of Physics Teachers PI
  - Ximena Cid, California State University-Dominguez Hills
  - Brad Ambrose, Grand Valley State University
  - Shannon Willoughby, Montana State University

This team has expertise in astronomy and physics education research, heliophysics content, and access to post-secondary classrooms to field test all materials.

## AER and PER Foundations

The physics and astronomy education research communities bring a wealth of expertise that have significantly improved teaching and learning over the past few decades.

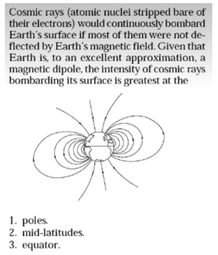
**We will supplement research-based teaching methods employed by faculty across the nation.**

### Astronomy and Astrophysics Education


#### Peer Instruction

developed by: Eric Mazur, Catherine H. Crouch, and colleagues

We will develop concept test questions for Peer Instruction, a method that engages students in large lecture courses. The approach uses peer-peer discussion about thought-provoking questions, and effectively employs the use of clickers as a formative assessment tool.


Cosmic rays (atomic nuclei stripped bare of their electrons) would continuously bombard Earth's surface if most of them were not deflected by Earth's magnetic field. Given that Earth is, to an excellent approximation, a magnetic dipole, the intensity of cosmic rays bombarding its surface is greatest at the

1. poles.
2. mid-latitudes.
3. equator.

#### Ranking Tasks for Introductory Astronomy

developed by: David Hudgins, Kevin Lee, and Edward Prather

Based on *Tasks Inspired by Physics Education Research (TIPERs)* by Maloney, Heiggelke, & Kanim, we will develop similar tools specific to astronomy education. TIPERs challenge students' thinking by asking them to answer questions in multiple formats, including ranking, comparing, troubleshooting, etc.

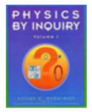

#### Lecture-Tutorials for Introductory Astronomy

We will develop tutorials (Socratic dialogue-driven activities), including structured discussions and hands-on mini-lab experiences for large classroom audiences.

### Pre-Service Teacher Education

#### Modeling Instruction

developed by: David Hestenes and Malcolm Wells




#### Physics by Inquiry

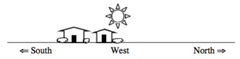
developed by: Lillian C. McDermott, Peter S. Shaffer and the Physics Education Group at UW

We will develop integrated paradigm labs and experiences that can extend two frequently-used science methods course approaches, which are primarily "physics-based" approaches, to include astronomy education.

**We will create opportunities for teachers to address identified common student difficulties in learning astronomy topics.**

We will use the outcomes of diagnostic tools used on our own students to determine which types of activities are most necessary and effective to enhancing astronomy education.

On about September 22, the Sun sets directly to the west as shown on the diagram below. Where would the Sun appear to set two weeks later?
A. Farther south B. In the same place C. Farther north




## Thematic Work

We intend to support the holistic work of the NASA HEC through identified themes, topics, and relevant astronomical events.

### Total Solar Eclipse 2017

- Our work, beginning this fall, will focus for one year on the 2017 total solar eclipse.
- Topics of development might include:
  - Size and Scale
  - Gravity
  - Orbital Motion
  - Electromagnetic Radiation and Fields
  - Geometric Optics and Telescopes

## Dissemination Venues

- American Association of Physics Teachers
  - Winter and Summer Meetings (2x per year)
  - New Physics and Astronomy Faculty Workshop (2x per year)
  - *The Physics Teacher* (publication)
  - AAPT.org and its subsites, including PhysPort.org
- American Astronomical Society
- National Society of Hispanic Physicists
- National Science Teachers Association
  - National conference
  - *Journal of College Science Teaching* (publication)

## Collaborative Efforts

- We welcome any interested collaborators. Please contact:

  Ramon E. Lopez relopez@uta.edu

  and

  Rebecca E. Vieyra rvieyra@aapt.org

- To learn more about PER and AER and how it can support your own efforts, please visit PhysPort.org

PhysPort
Supporting physics teaching