A proposal for an Astronomy seminar

The Universe: It's full of stars!

Who are we?

- Dr. Véronique Petit and Dr. John Gizis are both astrophysicists in the Department of Physics and Astronomy at UD, specializing in the structure and evolution of stars.
- Dr. Petit's research focuses on massive stars that will end their lives as neutron stars and black holes. These hot, massive stars are the powerhouses of our galaxy: they shape their environment by their powerful stellar winds and drive the chemistry of galaxies with the products of their nucleosynthesis.
- Dr. Gizis's research focuses on stars smaller than the Sun and "failed stars" known as brown dwarfs. Brown dwarfs evolve in a similar way to giant planets and serve as a stepping stone to the study of "exoplanets" -- planets in other solar systems.

Why us?

- The astronomy research group at UD does world-renowned research in the field of stellar physics. It has close ties with the Mount Cuba observatory (located in Greenville, DE), which hosts a planetarium. Both Dr. Petit and Dr. Gizis are frequent users of NASA facilities, such as the Hubble Space Telescope and the Chandra X-ray Observatory.
- Dr. Petit has experience teaching introductory astronomy in a planetarium.
- Dr. Gizis has been teaching introductory physics and astronomy at UD since 2001.

Why astronomy?

- Astronomy is an excellent gateway into STEM. It makes us dream of space travel and exploration, and at the same time pleases our esthetic sense with colorful, mind-boggling images of planets, nebulae, and galaxies far away.
- Astronomy problems are exciting and draw our curiosity, but most of the time they can be understood with very simple, down-to-Earth physics concepts and everyday experiences.

What will we learn?

- **Stars in the sky**: How did the stars in the sky tell us about our place in the Universe? This part can make good use of access to a planetarium, to, for example:
    - Better visualize the night's sky, and understand the motion of our Sun in the sky.
    - Understand the phases of the moon.
    - Explore the historical discovery of the structure of our solar system through the relative motion of stars, of our sun, and of the 'wanderers' that are now known as planets.

- **The life cycle of stars, and nucleosynthesis**: We will use open-source computer tools (such as the MESA star evolution calculator and Jupyter Python notebooks) to calculate and visualize the structure and evolution of stars. With these tools, we can for example:
    - Learn why stars in the sky have different brightness and colors.
    - Compare and contrast the life of our Sun with the lives of stars that are much more massive and much less massive.
    - Understand the origin of elements heavier than hydrogen and helium.

- **The new frontiers in astronomy**: We will discuss the two "hot topics" of this decade, in which technological advances will revolutionize our view of the universe:
    - The launch of the James Webb Space Telescope (JWST) in the spring of 2019 will mark the beginning of the next era in space based observations. JWST will be one of the premier observatory of the next decade, serving thousands of astronomers worldwide. It will study many phases in the history of our Universe, ranging from the first luminous glows after the Big Bang, to **the formation of solar systems capable of supporting life on planets like Earth**, to the evolution of our own Solar System. Of particular relevance are the capabilities of JWST to explore the birthplaces of planetary systems by seeing into the natal massive dust clouds, to characterize **extrasolar planet atmospheres**, and to explore the nature of the smallest, coolest stars.

    - Thanks to the efforts of the recipients of the 2017 Nobel prize of Physics, the **direct detection of gravitational waves** is finally possible. Gravitational waves were predicted by Einstein's theory of general relativity, and are produced when two very compact objects, such as **black holes** and neutron stars are in orbit around each other. Because of this technological advance, we can now learn the properties of binary black holes and neutron stars located billions of light-years away, and see their catastrophic merger events. For example, it has been recently discovered through such an event that most of the gold and platinum in the universe is produced by the merger of neutron stars.