C. THE SCIENCE OF THE INVISIBLE: FROM THE BIOLOGICAL TO THE COSMIC
Multi-professor Course
Thursdays, 9:30 - 11:00 a.m. Norris University Center

How can science reveal invisible worlds beyond direct human perception? This lecture series brings together professors who are leaders in their fields of astronomy, chemistry, robotics, nanotechnology, physics, and biological engineering to unveil previously invisible new phenomena. What do these discoveries mean for humanity?

Oct. 1 **Simulating Black Hole Feasts and Burps**
Sasha Tchekhovskoy, *Associate Professor, Physics and Astronomy*
We think of black holes as voracious, invisible beasts that consume everything around them. However, it turns out that they are extremely picky eaters! I will discuss how the diet of black holes affects their ability to eat and burp away the surrounding gas and how cutting-edge numerical simulations on the largest supercomputers help us to figure this out. I will finish by discussing the future prospects of studying black holes using supercomputers, in particular how generative artificial intelligence can help us to achieve the breakthrough in the realism of our simulations.

Oct. 8 **Evolutionary Robotics**
Sam Kriegman, *Assistant Professor of Computer Science, Mechanical Engineering, and Chemical and Biological Engineering*
In this talk I will describe how robots can broaden our parochial understanding of life and its rules. “Endless forms most beautiful” await our discovery, along with the ever deeper, more wonderful mysteries they reveal. For centuries we have imagined the social utility of understanding life well enough to create technologies that are indistinguishable from it. But the most important uses of this knowledge remain as unrecognizable to us now as the strange and bizarre forms life may adopt, and has already adopted, elsewhere in the universe.

Oct. 15 **Real Images of Other Worlds**
Jason Wang, *Assistant Professor, Physics and Astronomy*
We have discovered over 6000 planets orbiting other stars. Most of these exoplanets are detected indirectly by measuring the effect each has on its star, so their true nature is invisible to us. Imaging exoplanets is difficult because the bright diffracted glare of the star hides the faint light of the planet. I will discuss how we have been able to take images of some of these worlds by using the largest telescopes in the world combined with specialized optics and signal-processing techniques. I will show the dozen or so planets we have imaged, including a new planet orbiting a binary star system that we discovered last year. I will discuss what we learn from studying these planets directly and the prospects of imaging an Earth-like planet around another star.

Oct. 22 **The Invisible Foundations of the Universe**
Alexander Edison, *Research Assistant Professor, Physics and Astronomy*
For more than a hundred years, particle physicists have been smashing things together in an attempt to understand the smallest bits of nature. We’ll explore the discoveries that led from an invisible “particle zoo” to the modern Standard Model of particles. We’ll discuss how this theory explains almost everything, and how thoroughly it has been tested. However, it has a few holes, both blatant and subtle, which modern physicists are attempting to understand.

Oct. 29 **Listening In On the Poetry of the Brain**

Indira M. Raman, *Bill and Gayle Cook Professor of Biological Sciences, Chair, Neurobiology*

Many people are aware that the brain uses electricity. But how did scientists figure out that neural information is transmitted electrically - and how neuronal electric signals are altered by medicinal, recreational, and illicit chemicals - when brain electricity is not only literally invisible to the eye but also figuratively invisible to all other human senses? Here we will discuss the remarkable story of how, over two centuries, scientists crept up on an understanding of "bioelectricity" and developed techniques to eavesdrop on neuronal signals, start deciphering the brain's elegant electrophysiological languages, and ultimately translate ongoing neuronal communication into the visible domain.

Nov. 5 **Engineering the Invisible: How Nanomaterials Are Transforming Modern Life**

Sarah H. Petrosko, *Research Professor, Chemistry (Mirkin Group); Associate Director, International Institute for Nanotechnology*

Over time, humans have progressed from using simple to more advanced materials that improve our safety and health. Today, nanotechnology allows us to prepare and study materials far too small to see with the naked eye. Using powerful methods and tools, scientists can design and synthesize tiny structures with unique properties that are driving innovation in medicine, energy, and manufacturing. By uncovering the invisible world at the nanoscale, we are accelerating scientific discovery and transforming modern life.

Nov. 12 **The Supermassive Black Hole and Magnetic Filaments at the Center of the Milky Way Galaxy**

Farhad Zadeh, *Professor, Physics and Astronomy*

The center of our Milky Way Galaxy hosts many fascinating objects, one of which is the supermassive black hole Sagittarius A* with a mass more than four million times than the mass of the Sun. The other is a population of filaments distributed throughout the inner few hundred light years of the Galaxy. There are a number of puzzles related to the origins of daily flaring activity of the black hole - and how nature produces the shape of the remarkable magnetized filaments in space, invisible up until now. I will present highlights of the results of our recent measurements taken with two major observatories using the James Webb Space Telescope (JWST) and the MeerKAT radio telescope in South Africa.

Nov. 19 **Engineered Biotechnologies Are Already Transforming Society**

Julius B. Lucks, *Margery Claire Carlson Professor of Chemical and Biological Engineering, Co-Director, Center for Synthetic Biology*

If you take a close look at the natural world, you will appreciate that biology can do things that no other human-made technology can. Plants can not only grow into beautiful structures, but can provide us materials to build with, fibers to weave with and food that we eat, all from a single seed. Similarly, microbes, invisible to our eyes but more numerous than the cells in our bodies, are able to synthesize compounds ranging from fuels to pharmaceuticals all from the same simple building blocks. Imagine if we could harness biology as a technology and use it to solve our greatest societal challenges? In this talk I will explain how we are already partnering with

biology to create engineered biological technologies. I will explain the basic principles behind this new science of synthetic biology, and forecast how engineered biotechnologies will soon transform society.

Nov. 26 THANKSGIVING – NO CLASS

Dec. 3 Invisible Light

Ryan Bethel, *Associate Professor of Instruction, Chemistry*

Visible light is a form of electromagnetic radiation, but it makes up a tiny band of the full electromagnetic spectrum. Spectroscopy is the field of science that studies how matter interacts with electromagnetic radiation from the weakest radio waves to the strongest X-rays. But how did scientists first discover these invisible rays of light? How do we utilize this ephemeral energy to discover, identify, and characterize new chemistry? And how can spectroscopy drive further advances in science and medicine?