

Knowing the Universe: History and Philosophy of Astronomy

Chris Impey, University Distinguished Professor, Department of Astronomy

Overview: This course will cover the history of the oldest field of science, from prehistory and the ancient Greeks to research on the earliest instants of our 14-billion-year-old universe. We will not only be looking at the history of ideas and discoveries, but also at the deeper questions of how knowledge is created. This class addresses fundamental issues of time, space, and our place in the universe.

Schedule: 5 weeks, 3 hours per week, 9-12am Tuesdays, starting Mar 15, 2022.

Meetings: The structure is a 45-minute lecture, a 10-minute break, 20 minutes for Q&A, another 45-minute lecture, a 10-minute break, then a final 45-minute lecture. Short descriptions of the topics covered in each class session follow.

- **Origins.** The extensive and sometimes ingenious use of astronomy by ancient cultures. The sky as a clock, a calendar, and a map. The birth of mathematics, logic, and the scientific method in ancient Greece. First speculations about the size and contents of the universe. Astronomical thought at a time when Europe was in decay and astronomy made little progress. The slow rebirth of science and humanism.
- **Revolution.** Profound change in world view of the Copernican Revolution, and the contributions of Tycho Brahe and Johannes Kepler. Galileo as the first modern experimental scientist, his revelations with the telescope, and his collision with the Catholic Church. Advances in philosophy, notably by Descartes, as the backdrop for Newton and his monumental contributions to astronomy and physics.
- **Evolution.** A broader view of the evolution of science across Europe, its role in the Industrial Revolution, and the beginnings of science as a true profession. Concepts of cyclic and linear time throughout history. Physics approaches to understanding time, in particular the concept of entropy. Early observations of the natural world leading to understanding of the timescales of geological and biological evolution.
- **Quantum.** Albert Einstein and transformation of ideas of space and time. Einstein as a cultural icon. General relativity, curved space, and the nature of the universe. The revolution in physics in the early 20th century. New concepts of mass, energy, particles, and waves. Heisenberg's uncertainty

principle and fundamental limits on measurement. The weirdness and philosophical issues raised by quantum theory.

- **Cosmos.** Hubble's discovery of the nature of the nebulae and the cosmic expansion. Large scale structure of galaxies. Evidence for dark matter and dark energy, the two dominant ingredients of the universe. A scale model of the universe, and the idea of distant light as old light. Evidence for the big bang and status of the model. Frontier topics, including inflation, the unification of fundamental forces, and the multiverse.

Background Reading List: The lecture slides will be made available as pdfs. One highly recommended book, with fine narrative and storytelling, for a reasonable price on [Amazon](#), is *Coming of Age in the Milky Way* by Tim Ferris (Anchor, 2003). Rather than readings, a set of YouTube videos are recommended for enrichment.

Instructor Bio: Chris Impey is a University Distinguished Professor of Astronomy at the University of Arizona. He has over 210 refereed publications on cosmology and his research has been supported by \$20 million from NASA and NSF. He has won twelve teaching awards and he teaches online classes (or MOOCs) with over 350,000 enrolled. Impey is a past Vice President of the American Astronomical Society, NSF Distinguished Teaching Scholar, Carnegie Council's Arizona Professor of the Year, and recently, a Howard Hughes Medical Institute Professor. He won the 2020 Education Prize of the American Astronomical Society. His research on science literacy, instructional technology, and online teaching has led to over 90 papers on those subjects. He has written 70 popular articles on cosmology and astrophysics, two astronomy textbooks, a novel called *Shadow World*, and eight popular science books: *The Living Cosmos*, *How It Ends*, *Talking About Life, How It Began*, *Dreams of Other Worlds*, *Humble Before the Void*, *Beyond: The Future of Space Travel*, and *Einstein's Monsters: The Life and Times of Black Holes*. His next book will be on the search for exoplanets, called *Worlds Without End*. You'll find them all on Amazon at <https://www.amazon.com/Chris-Impey/e/B001IZXGTS>

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