

Humans in a Vast Universe: Astronomy and Cosmic Significance - Science for Seminaries Resources

How big is the universe? What is our place within it? As astronomers and astrophysicists study the vast expanse of the universe, they encounter new ideas about the origins of this expanse and the significance of humans within it. In this film, Drs. Guy Consolmagno, Jennifer Wiseman, and David Charbonneau explore humanity's connection with the universe, the expanding nature of the universe, and the existence of exoplanets. They explain how looking outward at our galaxy and the estimated 400 billion galaxies around us should evoke a sense of awe and stimulate inquisitive minds to ask bigger philosophical questions.

Featured Scholars:

Dr. David Charbonneau is a professor of astronomy at Harvard University and an astronomer at the Harvard-Smithsonian Center for Astrophysics. His research focuses on the development of novel techniques for the detection and characterization of planets orbiting nearby Sun-like stars. He led the first studies of the compositions of exoplanets and of their atmospheres, and he is a member of the NASA Kepler Mission to find Earth-like planets.

Dr. Guy Consolmagno is director of the Vatican Observatory and curator of the Vatican's meteorite collection. His research explores the connections between meteorites and asteroids, and the origin and evolution of small bodies in the solar system. His work in asteroid and meteorite studies prompted the International Astronomical Union to name an asteroid, 4597 Consolmagno, after him in 2000. He is author of *The Heavens Proclaim: Astronomy and the Vatican* (2009) and *Would You Baptize an Extraterrestrial?* (2014)

Dr. Jennifer Wiseman is a senior astrophysicist at the NASA Goddard Space Flight Center, where she studies the formation of stars and planetary systems using radio, optical, and infrared telescopes. As an undergraduate at MIT in 1987, she discovered comet Wiseman-Skiff. Dr. Wiseman is also Director of the AAAS Dialogue on Science, Ethics, and Religion (DoSER) program.

Transcript:

Dr. Jennifer Wiseman: We now have evidence from many directions that the universe is about 13.8 billion years old, beginning with an enormously spectacular burst of energy. And that energy transforming over time into a mix of matter and energy, and that matter becoming

atoms, gas, stars, and galaxies. And then within these galaxies, generations of stars producing heavier elements, those heavier elements enabled the formation of planets around stars. And then on at least one planet, we have life. We are very intimately connected with the rest of the universe in a very practical way. Our bodies actually do contain atoms that were forged in stars. In fact, most of the elements that we are familiar with, we don't know how to create them originally other than in stars. So, it's not us here and the universe out there. We are all part of the same wonderful physical entity.

Dr. David Charbonneau: Astronomy is an entirely observational science. What we do is we can listen to the universe, basically through our telescopes. We can gather light from distant objects. And through studying light, we're able to puzzle out the properties of objects that we can never go to directly. There are many astronomers who study light from 10 billion years ago, and basically we are allowed to look back in time through using our telescopes. So, telescopes are sort of like a time machine.

Dr. Jennifer Wiseman: Everything we look at we are looking at it as it was when the light began its journey to us. Astronomers use this wonderful time machine tool to help us understand how the universe has matured from a burst of energy to a place teeming with galaxies, stars, and planets.

Br. Guy Consolmagno: The early solar system was a very violent place where planets were being formed and broken up constantly. We know that the planets form from a cloud of gas and dust.

Dr. Jennifer Wiseman: Where does this dust and gas come from? So, stars themselves are little factories that start with mostly hydrogen collapsed into a dense clump of gas. And then that pressure creates a fusion reaction in the core of stars that can result in the production of heavier elements. Then when stars die, they actually release all of that material they've created into the interstellar medium, and the next generation of stars incorporates some of that richer material. So you have generations of stars that create heavier and heavier elements. All of this has served over the 13.8 billion-year history of the universe to enrich galaxies with more and more varieties of elements that we now enjoy on places like planet Earth.

Dr. David Charbonneau: The distances between things in our own solar system is tiny compared to the distances between different solar systems.

Br. Guy Consolmagno: If you go to a football field and you have a beach ball at the goal line, at about the 30 yard line, there will be a pebble. That's the earth. At the other goal line is maybe a golf ball, that's Jupiter. If you travel from there to the other side of the earth, from America to Russia, that distance would be one light year. And the nearest star is four and a half light years away. And that's our nearest star.

Dr. Jennifer Wiseman: We also see that the universe is still expanding.

Br. Guy Consolmagno: Space between galaxy clusters is growing. It's not that these galaxies are going out into empty space, but the space itself is actually expanding.

Dr. Jennifer Wiseman: So, we don't really know a crisp answer to how big the universe is. We know its age, and we know it's enormous. And we know the content of the universe is

enormous. In the visible universe, there are something like 400 billion galaxies, and each galaxy can have hundreds of billions of stars. So, it's mindboggling.

Dr. Jennifer Wiseman: As we are realizing more and more the enormous size and scale of the universe and its enormously rich content, it begs the question of whether there could be life outside our own solar system.

Dr. David Charbonneau: If you had asked me 10 years ago how common are small, rocky planets like the Earth, I would have said we really had no idea. Humans have been asking that question for hundreds, arguably thousands of years. What's so exciting is that we are the first generation in human history that actually can answer that question. An exoplanet is a planet that orbits another star, and we really didn't know anything about exoplanets about 20 years ago and that situation has changed dramatically.

Br. Guy Consolmagno: In the last ten years, we had something called the Kepler Space Telescope which allowed us to focus on one particular part of the Milky Way. Very, very narrow field, but study it very intently.

Dr. David Charbonneau: At this point, astronomers have found about 5,000 planets orbiting many different stars throughout the galaxy.

Dr. Jennifer Wiseman: Because of all these planets, there's a lot of speculation that life might be common. Why should Earth be the only place where there's life? So, it certainly seems in some sense just by the statistics that life could be very common, at least simple life.

Dr. David Charbonneau: An active, current question is what is the minimum set of things you need to measure to really conclude that the only explanation is life? And it may be that there's other molecules, such as methane, directly seeing that there are liquid oceans, maybe seeing the green, the photosynthetic color. But is that enough? Will we ever be able to make a conclusive statement that we really know that there's life on another planet? I do think in the next even 10 years, it's possible we're going to answer that question.

Dr. Jennifer Wiseman: And of course, these are just the scientific questions. There are the bigger philosophical questions of why capital W, why is life existing and is there purpose in it? Those are the kinds of questions beyond the tools of our microscopes and telescopes, but this type of science does beg all these interesting types of questions.

Astronauts have commented on looking back at Earth from space. It gives them an entirely new perspective when they see all of humanity in one unified space. I think you can have a similar reorienting experience looking the other direction. Looking out in the larger cosmos and realizing that we are a tiny part of an extraordinary system.

Br. Guy Consolmagno: I had a little telescope I'd take up country and everybody in the village would come out and they'd look through the telescope and see the craters on the moon, or the rings of Saturn, and they'd go, "Ooh and ahh," just like my family and friends back in Michigan do. And it finally hit me – this is what makes us human, this ability to look at the sky with wonder.