Astrobiology for Education and Outreach: Three Immersive Projects

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Abstract

The search for life in the universe can inspire students and members of the public alike. Three projects are described which provide an immersive experience with astrobiology. The first is teaching astrobiology to non-science majors in the virtual world Second Life. Second Life can support authentic learning and foster cross-cultural competencies. In the next iteration of the course, students will create simulations of exoplanet landscapes and architectures of exoplanetary systems. The second project is a virtual reality exhibit for education and outreach. It has models of major facilities in astronomy and space science in a virtual space. Users wear Oculus Quest headsets and use game controllers to navigate. Next additions to the VR space will be examples of exoplanet science and fully animated exoplanet systems. The third project is a new version of a multimedia performance piece called StellarScape, combining original electronic music, dance and simulations of star birth. A live dancer interacts with simulations via sensors. The next version is PlanetScape, where back-projected video is a series of realistically rendered exoplanet surfaces. The dancer undertakes a "hero's journey," experiencing the altered gravity and physical conditions of alien planets as they try to find their way home.

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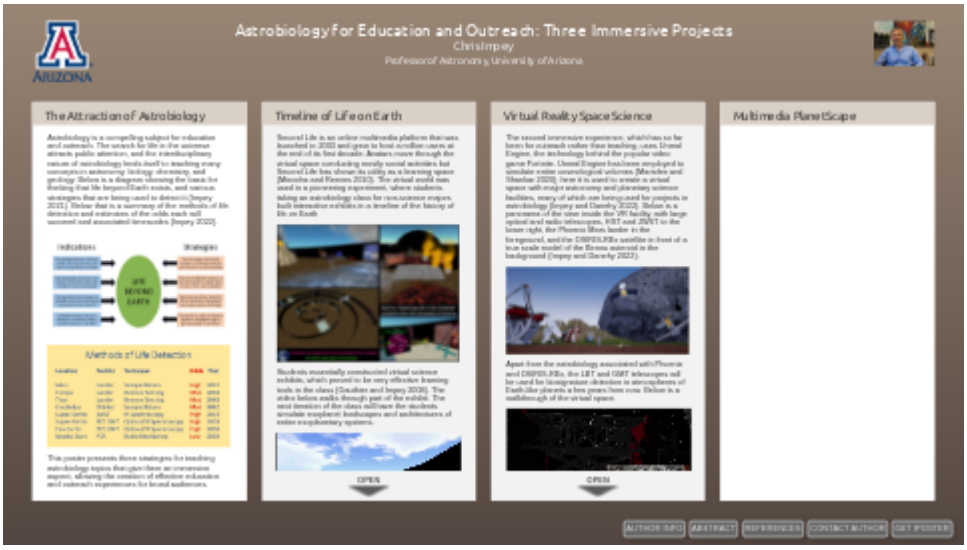

Chris Impey

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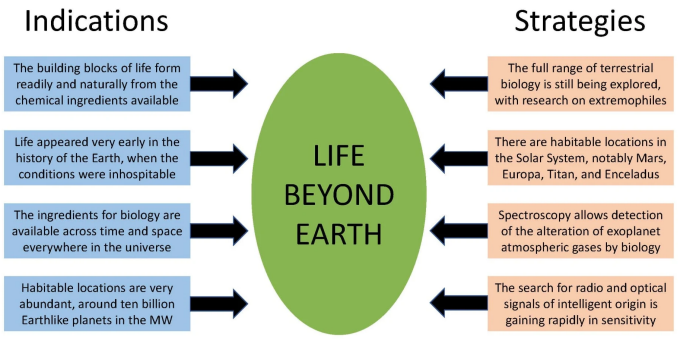
PRESENTED AT:

THE ATTRACTION OF ASTROBIOLOGY

Astrobiology is a compelling subject for education and outreach. The search for life in the universe attracts public attention, and the interdisciplinary nature of astrobiology lends itself to teaching many concepts in astronomy, biology, chemistry, and geology. Below is a diagram showing the basis for thinking that life beyond Earth exists, and various strategies that are being used to detect it (Impey 2021). Below that is a summary of the methods of life detection and estimates of the odds each will succeed and associated timescales (Impey 2022).



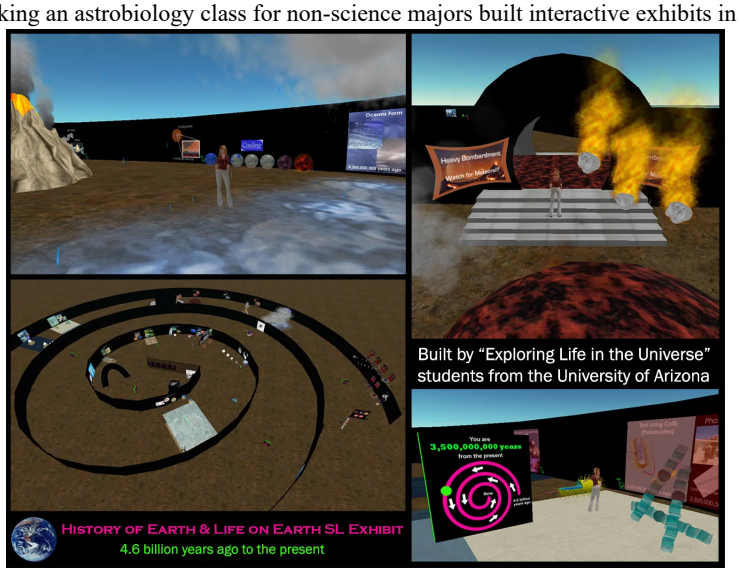
Methods of Life Detection

Location	Facility	Technique	Odds	Year
Mars	Lander	Sample Return	High	2032
Europa	Lander	Remote Sensing	Mod	2038
Titan	Lander	Remote Sensing	Mod	2040
Enceladus	Orbiter	Sample Return	Mod	2042
Super-Earths	JWST	IR Spectroscopy	High	2024
Super-Earths	ELT, GMT	Optical/IR Spectroscopy	High	2028
Exo-Earths	ELT, GMT	Optical/IR Spectroscopy	High	2030
Nearby Stars	ATA	Radio Monitoring	Low	2050

This poster presents three strategies for teaching astrobiology topics that give them an immersive aspect, allowing the creation of effective education and outreach experiences for broad audiences.

TIMELINE OF LIFE ON EARTH

Second Life is an online multimedia platform that was launched in 2003 and grew to host a million users at the end of its first decade. Avatars move through the virtual space conducting mostly social activities but Second Life has shown its utility as a learning space (Minocha and Reeves 2010). The virtual world was used in a pioneering experiment, where students taking an astrobiology class for non-science majors built interactive exhibits in a timeline of the history of life on Earth

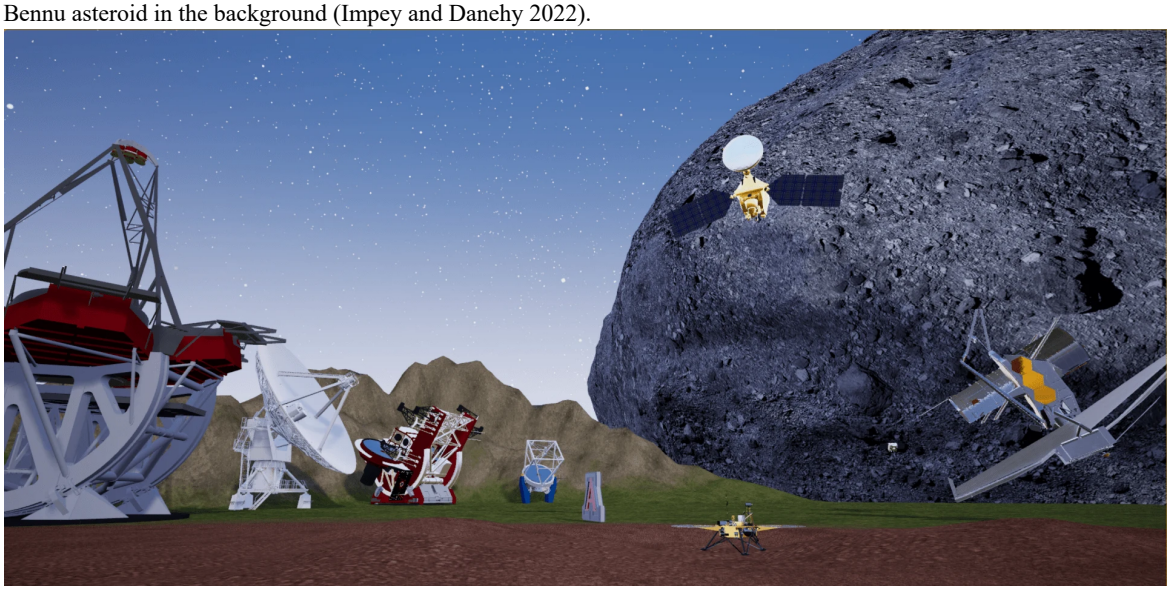


Students essentially constructed virtual science exhibits, which proved to be very effective learning tools in the class (Gauthier and Impey 2008). The video below walks through part of the exhibit. The next iteration of the class will enable the students to simulate exoplanet landscapes and create a set of plausible biological scenarios for each planet.

[VIDEO] https://res.cloudinary.com/amuze-interactive/video/upload/vc_auto/v1649806322/agu/A7-F1-DC-0A-2B-40-1C-3D-51-53-28-91-0B-E8-07-31/Video/SL_Timeline_p12azg.mp4

VIRTUAL REALITY SPACE SCIENCE

The second immersive experience, which has so far been for outreach rather than teaching, uses Unreal Engine, the technology behind the popular video game Fortnite. Unreal Engine has been employed to simulate entire cosmological volumes (Marsden and Shankar 2020); here it is used to create a virtual space with major astronomy and planetary science facilities, many of which are being used for projects in astrobiology (Impey and Danehy 2022). Below is a panorama of the view inside the VR facility, with large optical and radio telescopes, HST and JWST to the lower right, the Phoenix Mars lander in the foreground, and the OSIRIS-REx satellite in front of a true scale model of the Bennu asteroid in the background (Impey and Danehy 2022).

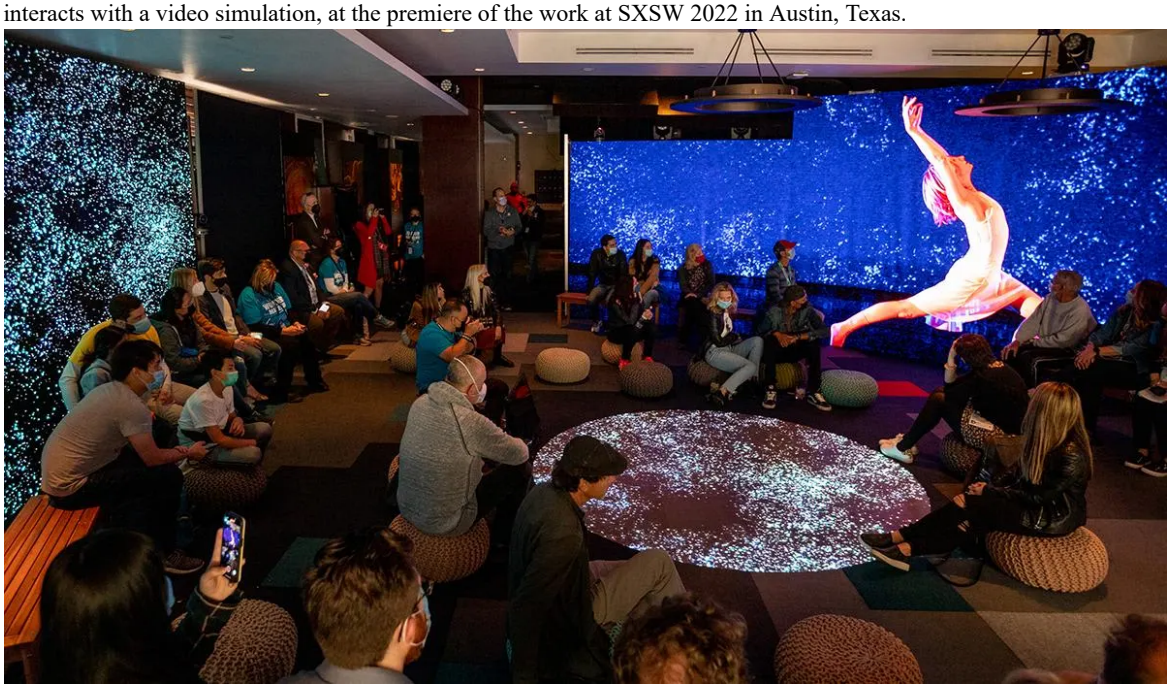


Apart from astrobiology associated with Phoenix and OSIRIS-REx, the LBT and GMT telescopes will be used for spectral biosignature detection in atmospheres of Earth-like planets a few years from now. Below is a walkthrough of the virtual space. Additions to the VR build will enhance the astrobiology content: exoplanets landscapes that avatars can explore, and animated 3D models of exoplanet systems orbiting their parent stars. The capabilities will be used in the non-science major classes on the search for life in the universe.

[VIDEO] https://res.cloudinary.com/amuze-interactive/video/upload/vc_auto/v1649808836/agu/A7-F1-DC-0A-2B-40-1C-3D-51-53-28-91-0B-E8-07-31/Video/VR_Walkthrough_Small_ss8zpw.mp4

MULTIMEDIA PLANETSCAPE

A final immersive astrobiology project is the spin-off of a multimedia collaboration at the University of Arizona that has music, dance, astronomy, and sensor technology applied to video projections of astronomical scenes. StellarScape is the life story of a star, told as a metaphor for human birth and death, with music and dance evoking the human elements. Designed for live performance with a dancer, five musicians, and sensors to manipulate the video, a filmed version has been produced to be deployed at planetaria around the country. The image below shows the dancer who interacts with a video simulation, at the premiere of the work at SXSW 2022 in Austin, Texas.



Stellarscape is an unusual, fruitful collaboration between a musician and an astronomer, aided by a multimedia specialist, a dancer, and the sensors that let the dancer interact with particles in back-projected video (He, Impey, and Burleson 2022). The next iteration of the piece is PlanetScape and it will tell the story of visiting a variety of habitable exoplanets in a hero's journey. Set to an original score, the dancer encounters different planetary environments, and contemplates life, loneliness, survival, and death. A video showing an artistic rendering of the exoplanet scenes is below.

[VIDEO] https://res.cloudinary.com/amuze-interactive/video/upload/vc_auto/v1649882993/agu/A7-F1-DC-0A-2B-40-1C-3D-51-53-28-91-0B-E8-07-31/Video/Alien_Worlds_txhgnb.mp4

AUTHOR INFORMATION

Chris Impey is a University Distinguished Professor. For 17 years he was Deputy Head of the Astronomy Department at the University of Arizona, and he is currently Associate Dean of the College of Science. He has over 210 refereed publications and 70 conference proceedings in astronomy, and 80 publications on educational topics. His work has been supported by $20 million in grants from NASA and the NSF. As a professor, he has won eleven teaching awards, and has been heavily involved in curriculum and instructional technology development. He has mentored 30 graduate students and 240 undergraduates. Chris Impey is a past Vice President of the American Astronomical Society. He has also been an NSF Distinguished Teaching Scholar, a Phi Beta Kappa Visiting Scholar, and Carnegie Council on Teaching's Arizona Professor of the Year. He was a co-chair of the Education and Public Outreach Study Group for the 2010 Decadal Survey of the National Academy of Sciences. In 2009 he was elected Fellow of the American Association for the Advancement of Science, and in 2014 he was the first astronomer named a Howard Hughes Medical Institute Professor.

Chris Impey aims to convey the excitement of astronomy in as many ways as possible to a large public audience. He gives 20 public talks a year, to audiences as large as 5000 and as varied as NASA engineers, first graders, and judges of the Ninth Circuit Court. For a decade, he has traveled to India to teach Buddhist monks in a program started by the Dalai Lama. He designed and led four tours for donors and alumni exploring landmarks of science and culture: "Visiting Galileo's Italy," "Exploring Chile: Earth and Sky," "Britain in a Golden Age of Science," and "Origins of Humankind and Astronomy." He has written over forty popular articles on cosmology and astrobiology and co-authored two introductory textbooks. He has published eight trade science books: The Living Cosmos (2007, Random House), How It Ends (2010, W.W. Norton), How It Began (2012, W.W. Norton), Talking About Life (2010, Cambridge), Dreams of Other Worlds (2013, Princeton), Humble Before the Void (2014, Templeton), Beyond (2015, W.W. Norton), and Einstein's Monsters (2018, W.W. Norton). His first novel, Shadow World, was published in 2013. His "Teach Astronomy" web site has had over three million unique visitors, and his YouTube lectures and videos have over two million views. He has surveyed 25,000 college students and members of the general public on their science literacy and attitudes towards science. About 320,000 adults from over 170 countries have enrolled in his 4 Massive Open Online Classes (MOOCs), watching over four million minutes of video lectures since 2013.

ABSTRACT

The search for life in the universe can inspire students and members of the public alike. Three projects are described which provide an immersive experience with astrobiology. The first is teaching astrobiology to non-science majors in the virtual world Second Life. Second Life can support authentic learning and foster cross-cultural competencies. In the next iteration of the course, students will create simulations of exoplanet landscapes and architectures of exoplanetary systems. The second project is a virtual reality exhibit for education and outreach. It has models of major facilities in astronomy and space science in a virtual space. Users wear Oculus Quest headsets and use game controllers to navigate. Next additions to the VR space will be examples of exoplanet science and fully animated exoplanet systems. The third project is a new version of a multimedia performance piece called StellarScape, combining original electronic music, dance and simulations of star birth. A live dancer interacts with simulations via sensors. The next version is PlanetScape, where back-projected video is a series of realistically rendered exoplanet surfaces. The dancer undertakes a “hero’s journey,” experiencing the altered gravity and physical conditions of alien planets as they try to find their way home.

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