

Skype Session Questions St. Clements School

Q - Are we alone in the universe?

- We just don't know. We are still searching.

Q - When did people first think about this?

- I believe when the first human looked up on a clear night and wondered.

Q - What do things need to live on another planet?

- A living thing would need the right chemicals; a source of energy (usually its star); a medium to transport the chemicals (like water); and, protection from the harmful radiation of space.

Q - Is the universe infinite?

- The universe is not infinite.

Q - How do you know if the universe is infinite or not?

- Science needs evidence, and the evidence consists of the Hubble-discovered expansion of the universe; the cosmic microwave background radiation; and, the abundance of chemical elements through time.

Q - How can we understand something infinite?

- Georg Cantor in the early 20th century developed a mathematics of the infinite sets.

Q - What is your opinion of the panspermia theory?

- Sorry, I am not a fan of the panspermia. It begs the question of where life first began, if it used meteors to spread through the Solar System.

Q - What are scientists doing to prepare for 2022 space visit? Clipper to Europa?
Or, any space visit?

- There are many aspects to any space mission. There is mission inception; experiments; spacecraft classification; telecommunications; onboard systems; science instruments; and, navigation. All of these aspects have their own teams studying the issues and planning for the mission itself.

Q - What is on the horizon/planned?

- Many missions are on the horizon including: James Web Space Telescope; InSight mission to Mars; Mars 2020 rover; Parker Solar Probe; OSIRIS-X to an asteroid; Transiting Exoplanet Survey Satellite (TESS); Europa mission (possibly named Clipper); Space Launch System; Orion spacecraft; ICESat-2 and Grace Follow-on.

Q - When do you think we will know the answer if life exists beyond Earth?

- Only when we discover life elsewhere.

Q - What is the furthest a machine/technology has traveled into space?

- The Voyager 1 spacecraft is the furthest any has gone. It is now about 9.5 billion miles from the Sun; that is about 102 times the distance that the Earth is from the Sun.

Q - What would NASA do if there was life on other planets? Ethical considerations?

- There is an international treaty at the United Nations that spells out what any country should do, if they discover signs of life elsewhere. The ethical considerations have been debated for many years.

Q - Have they found life on Mars?

- No, we have yet to discover life on Mars; at least at any of the sites where craft have landed.

Q - How could life survive terrible conditions without a star's energy?

- The only way life could survive without a star's energy is to obtain energy from the interior of the celestial object itself. On Earth we call it geothermal energy.

Q - Is life in space different than life on Earth, if so, how?

- We don't know. We have yet to discover any life in space.

Q - How big are tardigrades?

- The average size is 0.5 millimeters.

Q - What is the structure of tardigrade's brains? Are they similar to ours?

- A tardigrade's brain is not like a human brain. It is little more than a group of cells, like nerve cells, that come together in the region called the brain, and share the information from other parts of the tardigrade.

Q - How do you find the tardigrades you release into space?

- Because of their size, it would be very difficult to find tardigrades in space.

Q - Why are tardigrades called water bears?

- Tardigrades are called water bears because they are always surrounded by a film of water, which they use for a process of gas exchange, like a fish in water or a human in air.

Q - Where do tardigrades live?

- Tardigrades can be found on every continent on Earth.

Q - What is the tardigrade related to, and why/how can it survive in space?

- They can be viewed as relatives of arthropods and nematodes.

Q - Can any other animals live in space?

- In a dormant stage, tardigrades are believed to be able to survive space.

Q - What living things are in space?

- We still don't know if there is any other living things in the Solar System outside of the life on Earth.

Q - What is the climate on Europa?

- There is no climate on Europa, it has no atmosphere. It has a surface that is totally frozen solid. Much of the surface is made of frozen water ice.

Q - Is it livable on Europa?

- It certainly isn't livable for human beings.

Q - What is the estimated temperature of the water at surface and in the depths on Europa?

- Surface temperature at Europa is 260 degrees Fahrenheit below zero.

Q - Is Europa the only planet/moon with water?

- No, Europa is not the only planet or moon with water, in our Solar System.

Q - Do you think there is life on Europa?

- There is no evidence for life on Europa.

Q - Who discovered Europa?

- Europa was discovered by Galileo in 1609.

Q - How was an ocean in space formed?

- Water condensed out of the gas cloud that formed the Sun and its planets.

Q - What formed Europa?

- Europa was formed within the protoplanetary gas cloud that formed Jupiter.

Q - Would it be safe to swim in Europa's ocean?

- No, because you could never come up for air. The surface of Europa is totally covered by ice.

Q - Could Europa's ice shell melt?

- Yes, some outside heat source could melt Europa's ice. At a time in the distant future, astronomers believe that our Sun's surface will expand to nearly reach the orbit of Jupiter.

Q - How do scientists know there is water on Europa? Is there proof? Is the magnet-like stuff with Jupiter and Europa like Earth and our moon? Tide pull causing mechanical energy?

-We have a number of different pieces of evidence regarding the possibility of water existing beneath the surface of Europa. First, we have known for many years that the surface of Europa is covered with lots of water ice. We use spectroscopy to tell us the chemical composition of a surface without ever having been to the surface. Here on Earth we know water freezes from the top to the bottom; that if there is frozen water on the surface, there will be liquid water below if you drill a hole through the solid ice. Another piece of evidence about liquid water beneath the surface of Europa comes to us from images taken by spacecraft of the surface; and, the changes that have taken place on the surface over a period of time. A third piece of evidence was obtained in 2016 when the Hubble Space Telescope was taking pictures of Europa. In those pictures there is evidence of eruptions of material coming from beneath the surface. It is most likely water from beneath the surface that is causing geyser like eruptions. Nonetheless, the interactions between Jupiter and Europa are quite different from that between the Earth and the Moon. The magnetic field of Jupiter is much larger than Earth's magnetic field. The tidal effect of Jupiter on Europa is much

different than that of Earth's effect on the Moon. Europa is almost twice the distance from Jupiter than that of the Moon from the Earth.

Q - What is your favorite part of astrobiology?

- Solving a mystery.

Q - Why did you become a scientist?

- To comprehend the universe around me.

Q - How long have you wanted to be an astrobiologist?

- Since I was 5 years old and my parents took me to the Hayden Planetarium in New York City.

Q - What would your reaction be if you found out there is life in outer-space?

- In general I would be ecstatic if we ever found life in outer space. How elated I would be would depend on the type of life we discover.

Q - What's your favorite thing about your job?

- I love to explore and my job allows me to explore all the secrets of the universe; and share my exploration with others and have them share theirs with me.