Shaun presenting evidence for life on Earth before 3.8 Gyr (Mojzsis et al, 1996).

The earliest evidence of life is about 3.5 Gyr, and it is of complex structures, so there is probably earlier simple life.
The researchers are looking for evidence of life in Greenland apatite grains in banded iron formations, because they're some of the few areas that are older than 3.5 Gyr left on Earth. Banded iron formations are sedimentary, archaean, where the iron is produced by bacteria, marine in origin. Apatite is less than 1% of the material. The phosphates in the apatite is are about 10 microns in diameter. Metamorphic effects are not responsible for the light carbon inclusions. The delta C-13/C-12 shows it was likely that organic in nature. There’s -26%, -30%, and -37% delta C-13/C-12 values, where 0 to -10% would be considered inorganic. All of these are evidence for life. Later review by coauthors did not reach same conclusion.

Japanese-Indian mission JAXA missed Venus because of an engine failure, but was able to make a second attempt at an orbital insertion. Just successfully inserted today!

Astrobiology journal was formed 15 years ago today. Astrobiology was not a significant field until ALH84001 piqued interest in alien life.

Europa may or may not have been tidally heated consistently depending on its orbit around Jupiter. Moving to a distance orbit could kill off life during formation/evolution.

Colin presents life on exoplanets (looking for biomarker spectral fingerprints).

The habitable zone is different depending on the type of star. Lives of stars vary depending on their size (F class stars live for 5 Gyr, G class live for 10 Gyr, and M class live for 100 Gyr, which is much older than the age of the universe). Anything brighter/hotter/bigger than F class stars live and die too quickly to form planets and have life evolve.

This paper uses reflectance and emission spectra. Planets reflect star light, and emit in the infrared. O2, O3, CH4, N2O, CO2 are good biomarkers.

In low spectral resolution, spectral features can blur together. To see the emission spectrum of the Earth, we look to the moon. Earthshine on the moon is solely emission from the Earth that is not spectrally resolved. Being able to disentangle the spectra of the Earth emission spectra when not spectrally resolved is an important tool when it's difficult to resolve an exoplanet.
They also needed to model the spectral signature of the host star, based on its spectral class. O3 is easier to detect in K stars because it’s a more clear spectral signature.

It’s hard to see the exoplanet with a star nearby. Exoplanets are fainter by $10^{10}$ in the visual spectrum, and $10^7$ in the infrared. Jupiters are easier to see because they’re larger.

When an exoplanet is in front of the star, you see a dip in flux. When it is behind the star (not perfectly aligned), we see a blip (bump) in the flux, since it’s also reflecting light from the star. In the infrared, you can see different infrared emission on the dayside and the nightside.

The biggest problem in the this search is the unknown variable of inclination. Inclination affects the amplitude of the dip and blip in the flux, with a maximum when the system is nearly edge-on.

If you observe spectra of exoplanets, you can see where in its evolution it is. This is the most important part of this paper. If O2 or O3 is present, or the emission signature is similar to plants on land, one can compare where the exoplanet is in its evolution relative to when Earth went through similar stages of evolution.

O2 is very reactive, and disappears very quickly from an environment if not continuously added back into the system.

Spectra changes for surface cover. Grass has a high reflectance in the infrared. Snow has a very high reflectance, while water is very low.

Cryptobiotic life is life under the surface. This study determined that it could not be detected in the spectra.