Student questions: SESE Graduate Student colloquium:

Theresa Fisher: Network Theory as a Tool for Understanding Exoplanet Atmospheres

4/13/22

Is it possible to make predictive or retroactive CRN's to better understand how the atmospheres are changing over time?
Potentially! There's a lot of work on looking at dynamic networks through time, though I haven't yet applied it to planetary atmospheres. Some of my labmates, however, have expressed interest in examining the CRNs of Earth as it went through the Great Oxidation event.

Do you think using Earth's atmosphere to generalize and create a network leaves us vulnerable to missing signs of alien life that hasn't evolved yet?
The hope of using this type of approach is that network structure may be something intrinsic in all life, regardless of the biochemistry involved. If this turns out to be the case, it may allow us to detect different biospheres, and possibly biospheres that have not yet fully evolved.

What exactly happened to the atmosphere to make it achieve disequilibria, in terms of the hot Jupiters you're talking about?
Honestly, for the purposes of modeling, we didn't assume that any one thing was moving the planet away from disequilibrium, just that it was. In practice, however, solar flux and photochemistry would probably be the most likely driver away from equilibrium.

What does a flux of methanogenic bacteria in the atmosphere mean for the planet, is it a good/bad/neutral thing?
Neutral—methanogens are just another species of anaerobic bacteria. With that said, if you end up with too many of them, it can start to mess with your climate, since methane is a fairly potent greenhouse gas.

Are there any planets that have the same or similar chemical reaction networks, specifically with the atmospheres?
The gas giants have very similar networks in particular, which isn't surprising given that their atmospheres have somewhat similar compositions.

What planetary bodies are the biggest candidates for exoplanet exploration?
In the near-term, probably super-Earths—they're small enough to be potentially habitable, but larger (and therefore easier to resolve using telescopes) than Earth-sized planets.

What are your thoughts of using fixed-wing or balloons instead of drones for your research?
If it could get us more accurate information on the composition of planetary atmospheres, I'm all for it.

From an astrobiology perspective, what are the most exciting parts about the JWST, and what would finding a biosignature with it look like?
JWST is just powerful enough to potentially resolve the spectra of an atmosphere of an Earth-like world. In our case, if we modeled the atmosphere based off of that spectra and found that its network had a topology very similar to Earth's, it would be compelling evidence that the planet might have a biosphere.