Neural Network Emulator for SPHEREx Observables

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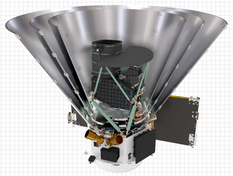

Background

- SPHEREx is an upcoming space telescope exploring the very early universe during inflation.
- Inflation can be studied through galaxy power spectra which describes the clustering behavior of galaxies.
- To prepare, we create galaxy power spectra for varying cosmologies and systematics. This will help us study their impacts and mitigate systematics.

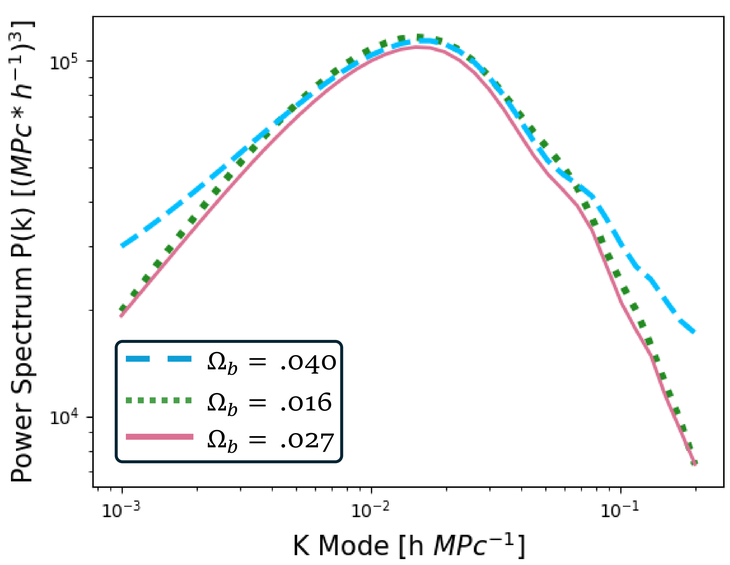

Figure 1. Varying cosmological parameters affects power spectra. Each line above is a different galaxy power spectra created from only varying the overall matter density parameter of the universe. Galaxy power spectra describe the amount of clustering of galaxies in the universe as a function of physical scale in Fourier space. The x-axis is k mode, which is proportional to inverse distance. The y-axis shows the amount of structure at a given scale.

Goals

- Run simulated likelihood analysis to study impact of systematics in SPHEREx.
- Study synergies between other upcoming surveys such as Rubin Observatory's LSST, the Roman Space Telescope, and the Dark Energy Spectroscopic Instrument.
- Analyze future SPHEREx data to constrain model parameters.

Methods

- Input: Cosmological and systematic parameters
- Output: Galaxy power spectrum
- Currently, we have a Markov Chain Monte Carlo simulation that calculates the most likely values for cosmological and systematic parameters given previous data.
- Integrating the neural network into the MCMC will drastically decrease run time, allowing many simulated analyses to optimize science return.

References

Boruah et al. (2022), MNRAS 4.4818
Doré et al. (2014), arXiv1412.4872
McEwen et al. (2017), JCAP 09.1475
Taruya et al. (2010), Phys. Rev. D 6.063522

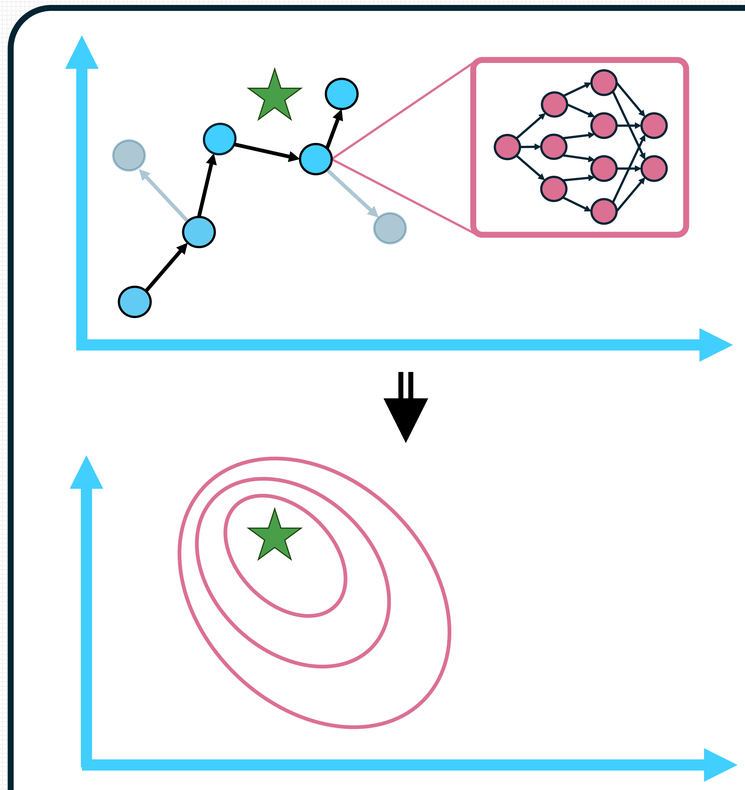

Figure 2. A diagram of a neural network integrated into an MCMC. The green star on both plots is the true value we are looking for. The top plot shows the emulator in the box at the right. At each point in the chain, the emulator develops a power spectrum from the parameters associated with its location. It then takes a step and repeats the process to find if the data we have is what we observe, accepting the step if it is and rejecting the step and repeating the process if not. The bottom plot shows the contours gained from this analysis. The smallest contour shows the most likely value of the parameters within one standard deviation, the next two, and finally three.

Steps & The Future

1. I have already developed code that inputs parameters and outputs galaxy power spectra.
2. Currently, I am creating the training data set.
3. Finally, I will develop and train the neural network.