

The background of the slide is a 3D visualization of a gravitational well, represented by a blue grid that curves downwards to form a series of concentric, overlapping wells. Two bright, glowing blue spheres, representing white dwarf stars, are positioned in the deepest part of the well, slightly offset from each other. The overall color scheme is a gradient of blues, from dark to light, with a grid pattern overlaid on the surface.

# Detecting Eccentric White Dwarf Binaries with LISA

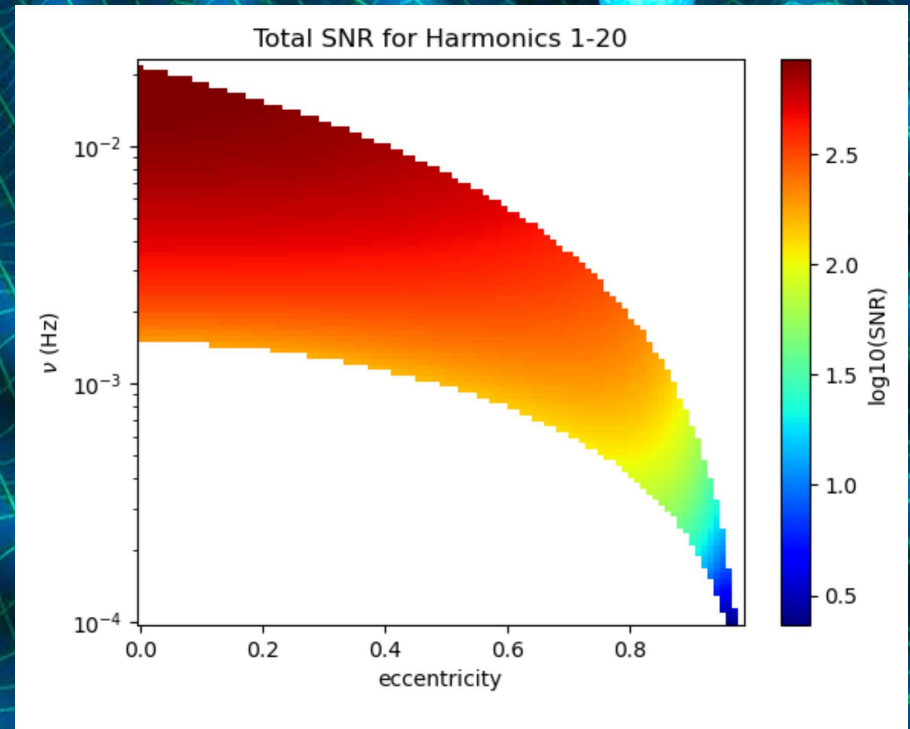
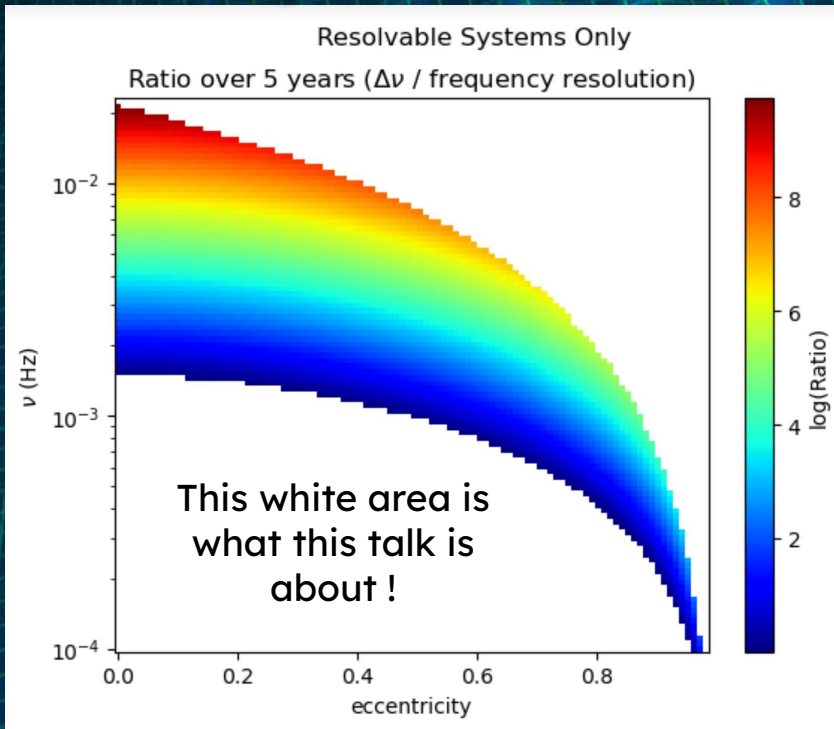
## Part 2: Modeling the WD Foreground Noise

By Lane Scheel and Dr. Hang Yu

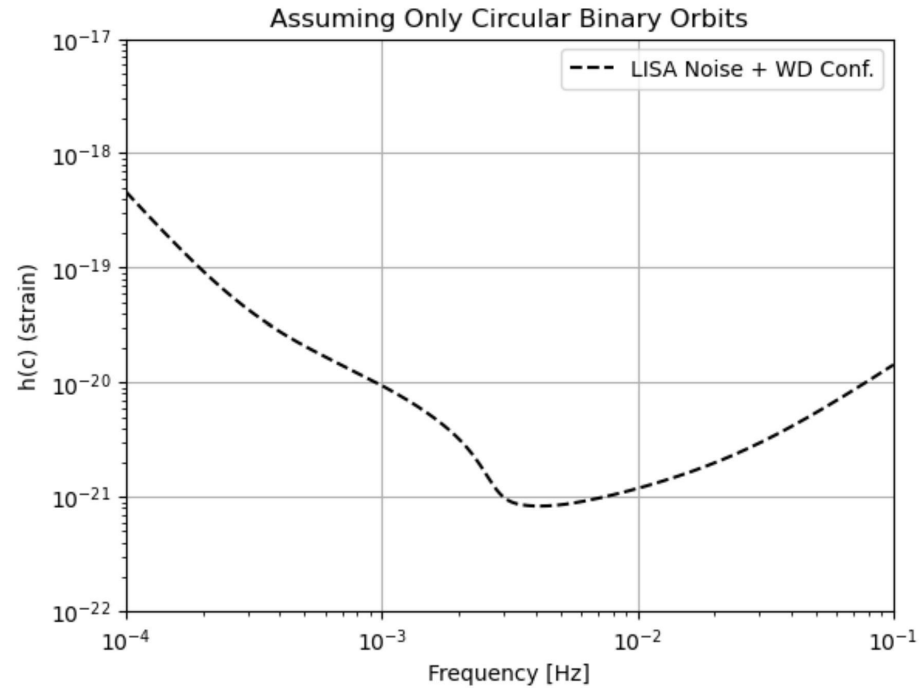
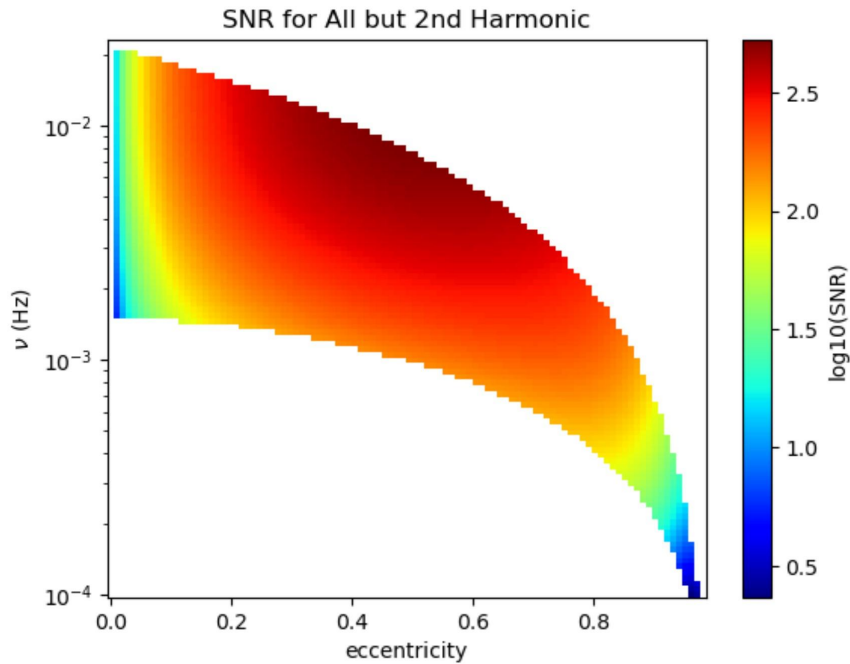
# Recap

- **LISA is the next generation GW observatory**
- **Previously, we investigated individually resolvable WD binary systems and their detectability**
- **However, most systems will not be individually resolvable and will thus create foreground noise**

# Recap



# Recap



# Our Motivation

The background of the slide is a 3D visualization of a gravitational well, represented by a blue grid that curves downwards to form a central depression. Two bright blue spheres, representing stars, are positioned within this well, illustrating a binary system. The overall aesthetic is scientific and futuristic.

- **Eccentricity is a natural result due to perturbation**
- **Little literature considering binary WD eccentricity**
- **More physical models can help us better prepare**
- **Help Lane develop the skills necessary to do contemporary astrophysics research**

# Objectives

The background of the slide is a 3D visualization of a gravitational well, represented by a blue grid that curves downwards to form a deep central well. Two bright blue spheres are positioned within the well, representing a binary system. The overall color scheme is dark blue with lighter blue highlights.

- **Part 1 - Investigate the SNR of eccentric WD binaries over a large parameter space to quantify the detectability of such systems**
- **Part 2 - Model the WD foreground noise coming from a galactic population of binary WDs assuming different eccentricity distributions**

**(This Talk)**

# Methods



- **All coding done in Python**
- **Libraries include Numpy, Scipy, and Matplotlib**
- **Grounded in previously established literature**
- **Write some codes and do a lot of math**

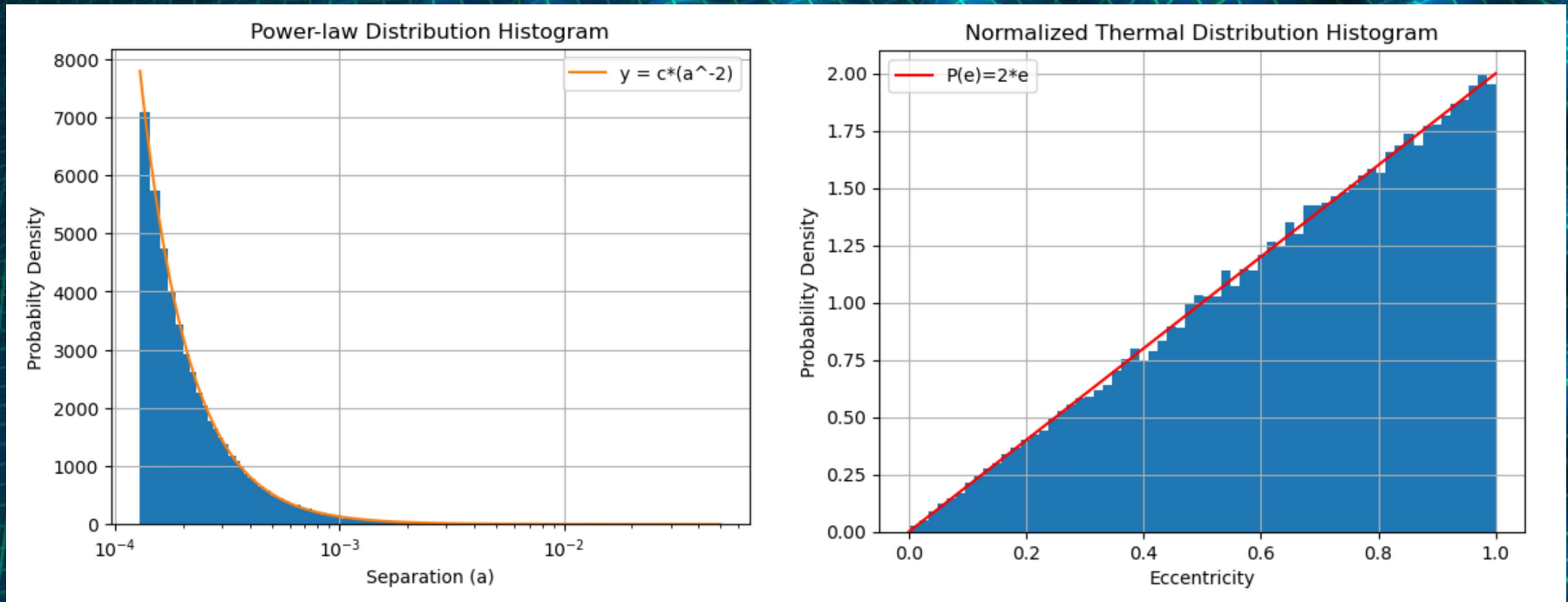
# Road-map

The background of the slide is a blue grid representing spacetime curvature. The grid is distorted into concentric, elliptical shapes, suggesting the presence of a massive object. In the upper right quadrant, two glowing blue spheres are positioned close together, representing a binary system of white dwarfs.

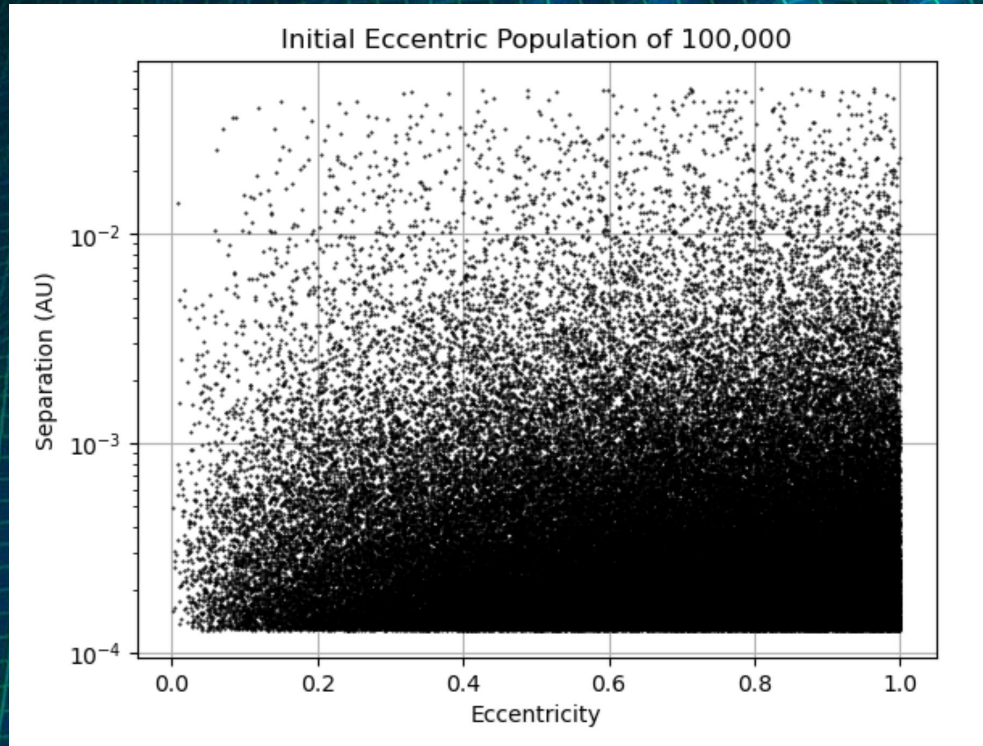
- **End Goal: Calculate the foreground noise from galactic population of eccentric white-dwarf binaries**
- **We chose to use a Monte Carlo simulation**
- **In order to get to the end goal, we first need to try to accurately represent today's population of galactic WD binaries**



# Making of the Monte Carlo

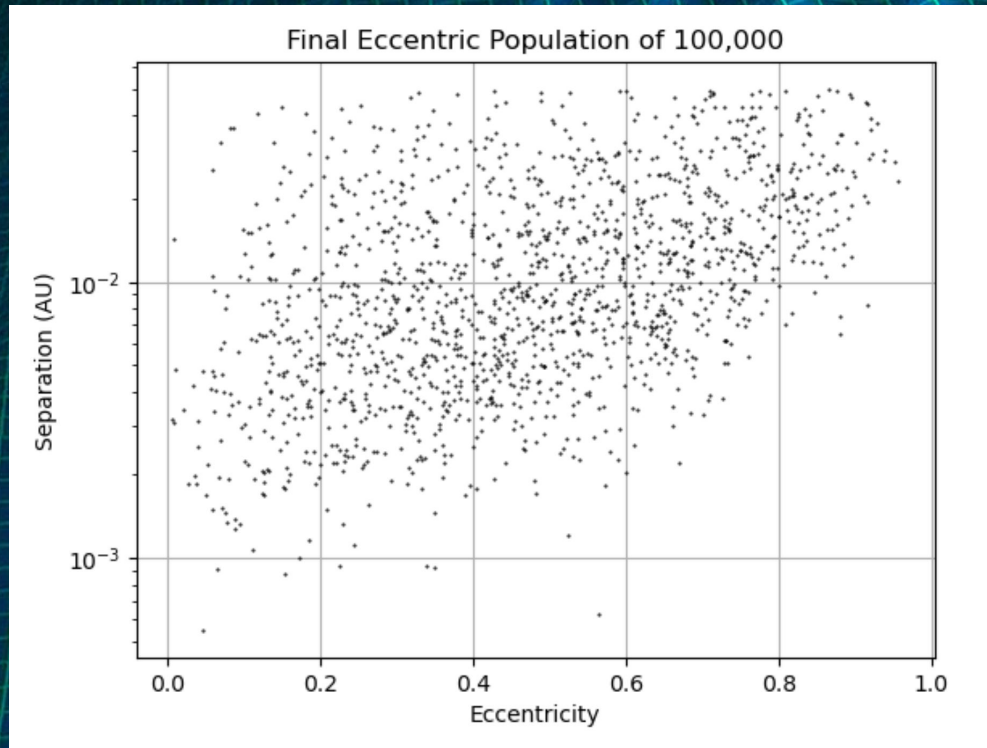


# Initial Populations



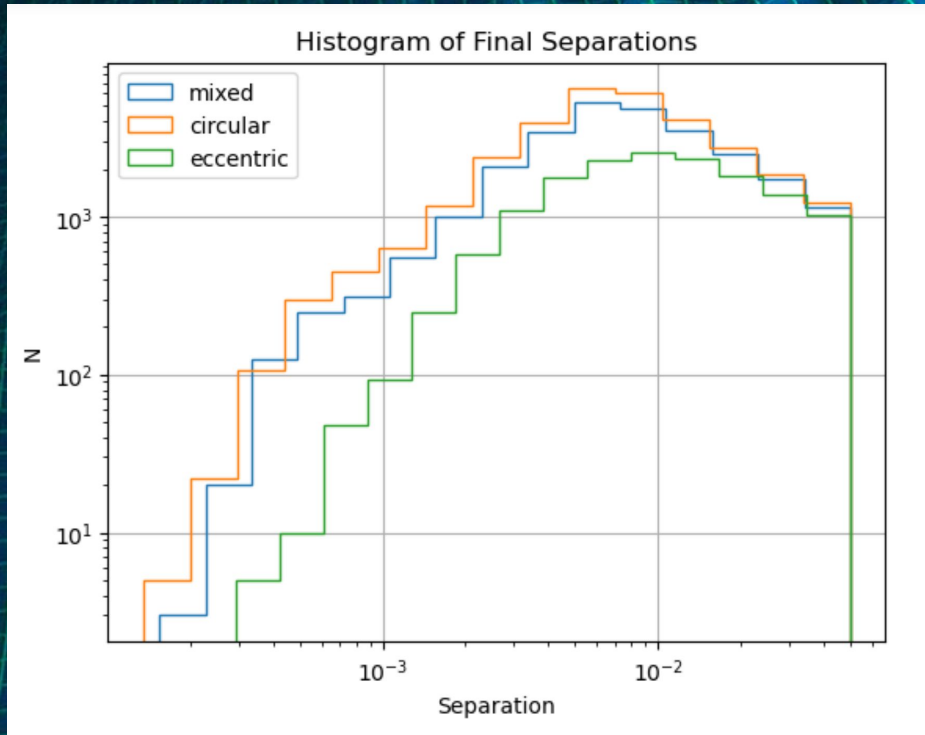
- Each point is a binary system
- Each has its own age to be evolved by
- Imagine compressed to vertical line for circular distribution

# Final Populations



- **Much fewer points**
- **About 1.5% survive the evolution**
- **Imagine compressed to vertical line for circular distribution**

# Separation Distributions



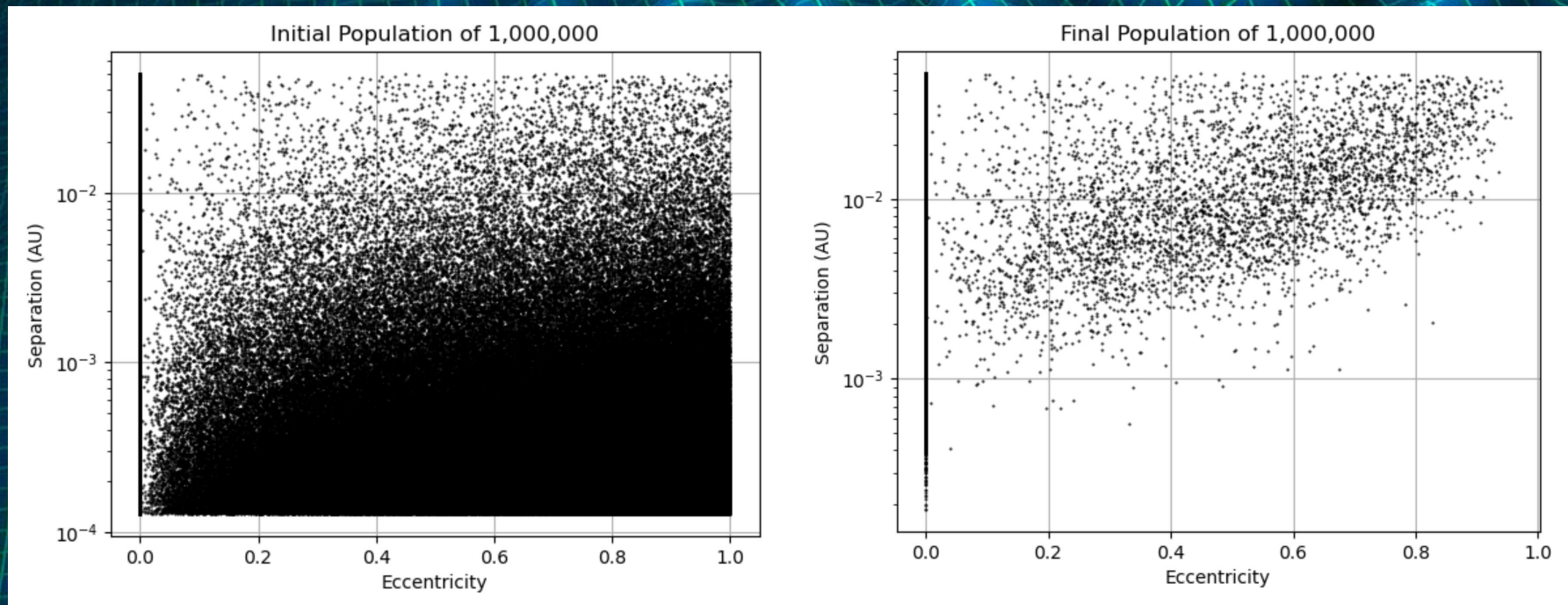
- **Post Evolution**
- **Elliptical histogram is shifted to slightly larger separations due to more efficient decay**
- **Mixed?**

# Concatenation

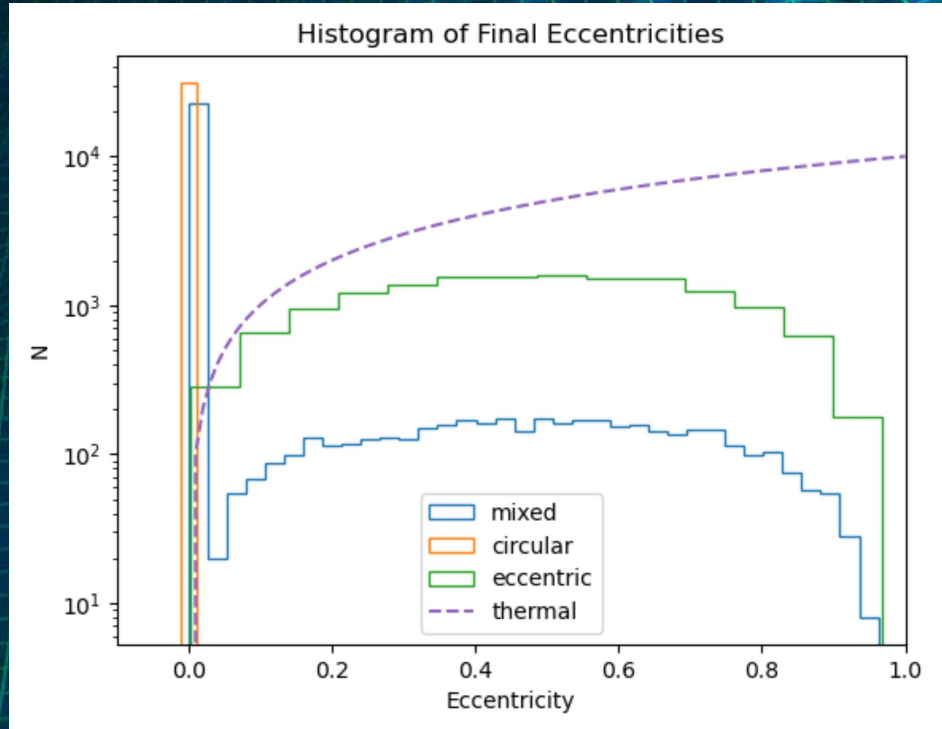


- Up until now, the circular population and eccentric populations were exclusive from one another
- Must concatenate the initial populations in some ratio to better represent today's population
- This will allow us to determine how different initial ratios affect today's WD foreground noise

# Initial and Final Populations

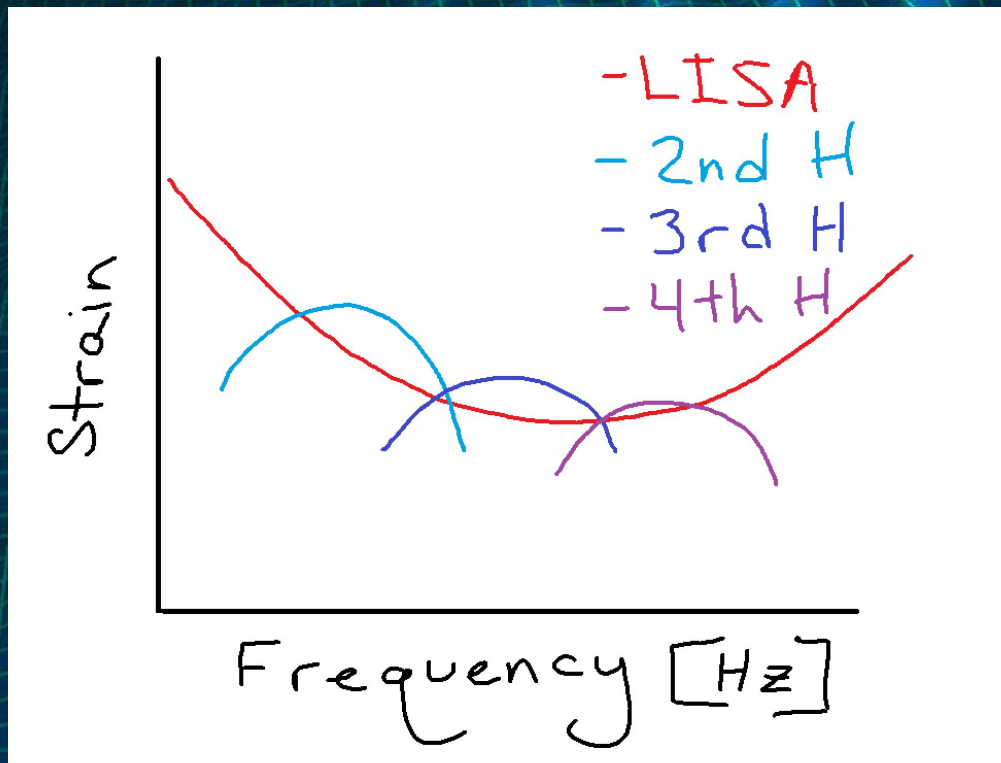


# Final Eccentricity



- **Post Evolution**
- **Fewer highly eccentric systems**
- **Any system w/ eccentricity will shift the foreground**

# GW Foreground Noise



mined...



# References

A 3D visualization of a gravitational well, represented by a blue grid that curves downwards to form a deep well. Two bright blue spheres are positioned within the well, representing objects in orbit. The background is a dark blue gradient.

Barack and Cutler. “LISA Capture Sources: Approximate Waveforms, Signal-to-Noise Ratios, and Parameter Estimation Accuracy.” *Phys.Rev.D* 69

<https://doi.org/10.48550/arXiv.gr-qc/0310125>

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Moaz et al. “Characterizing the Galactic White Dwarf Binary Population with Sparsely Sampled Radial Velocity Data.” *The Astrophysical Journal* 751

<https://doi.org/10.48550/arXiv.1202.5467>

**A Big Thank You to MSU !**

