



# Host Galaxy Properties of PTA Detectable SMBHBs Using Illustris

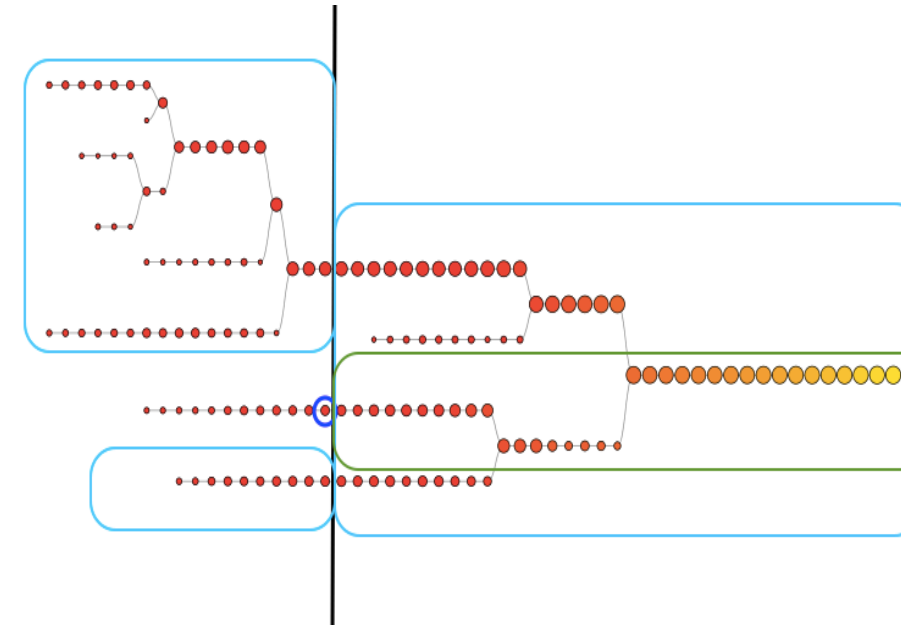
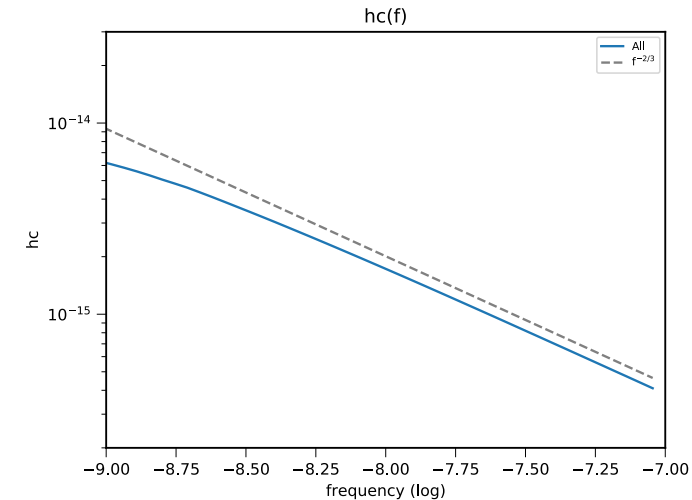
Katie Cella, Vanderbilt University  
Dr. Stephen Taylor and Dr. Luke Kelley  
International Pulsar Timing Array Meeting 2020

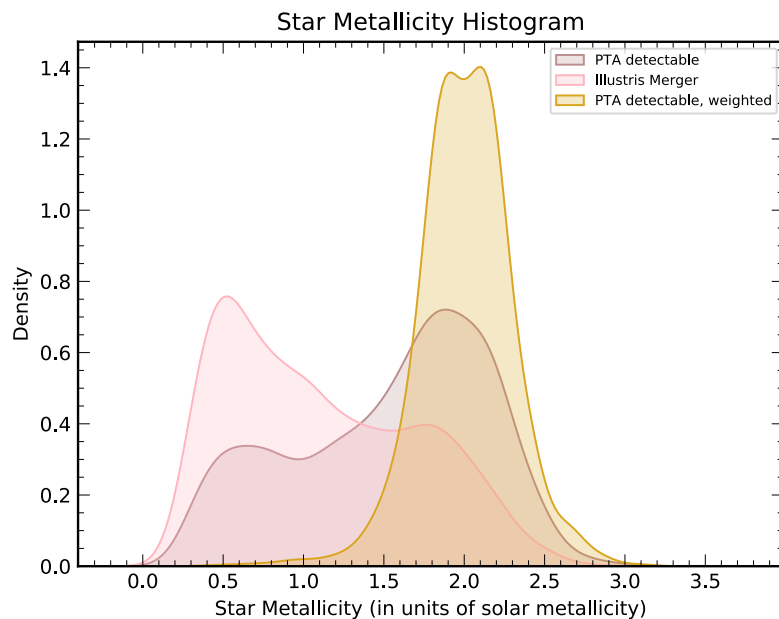
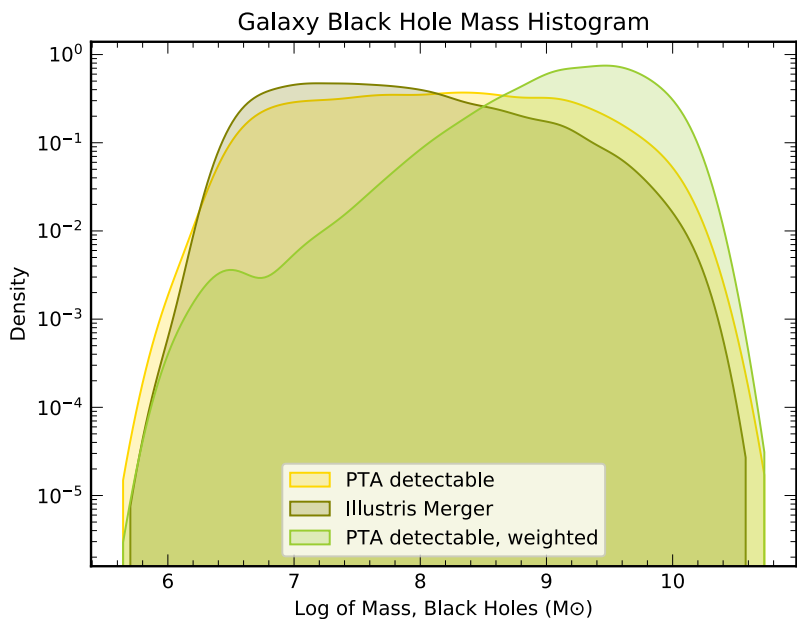
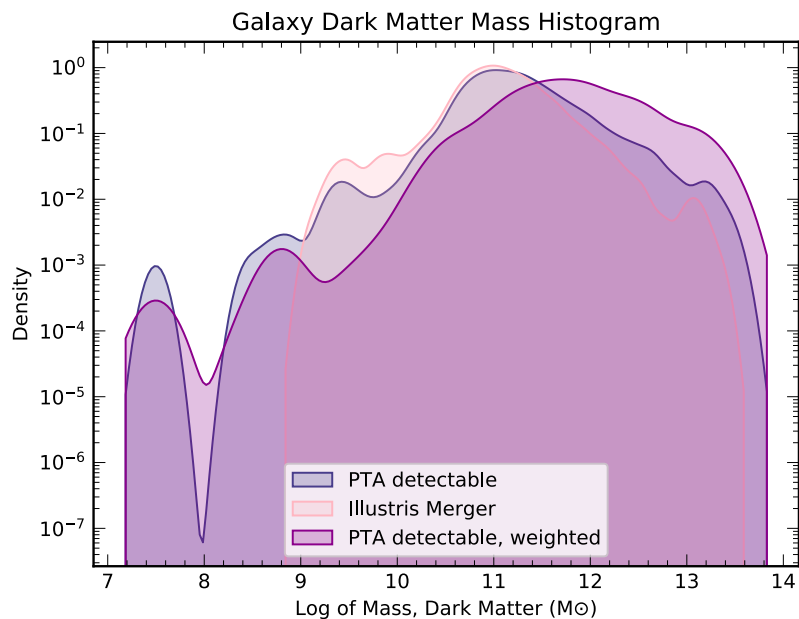
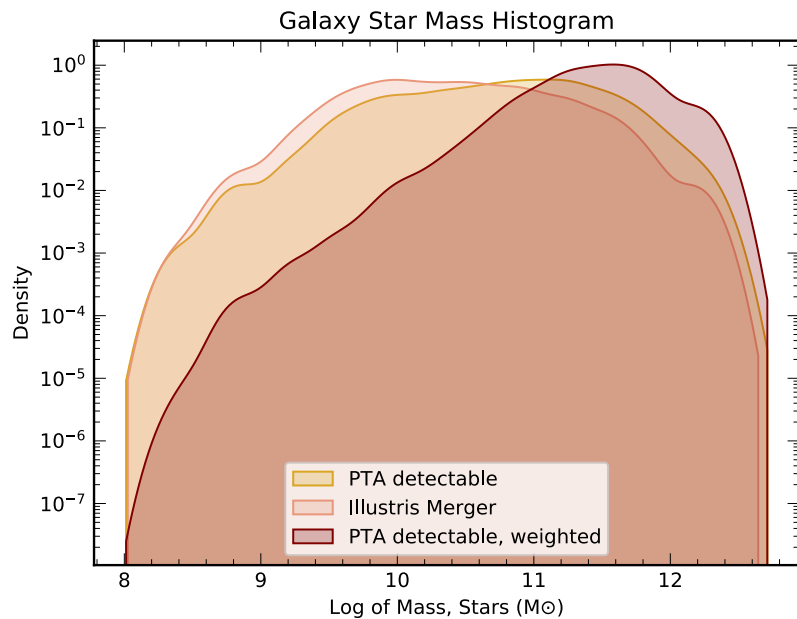
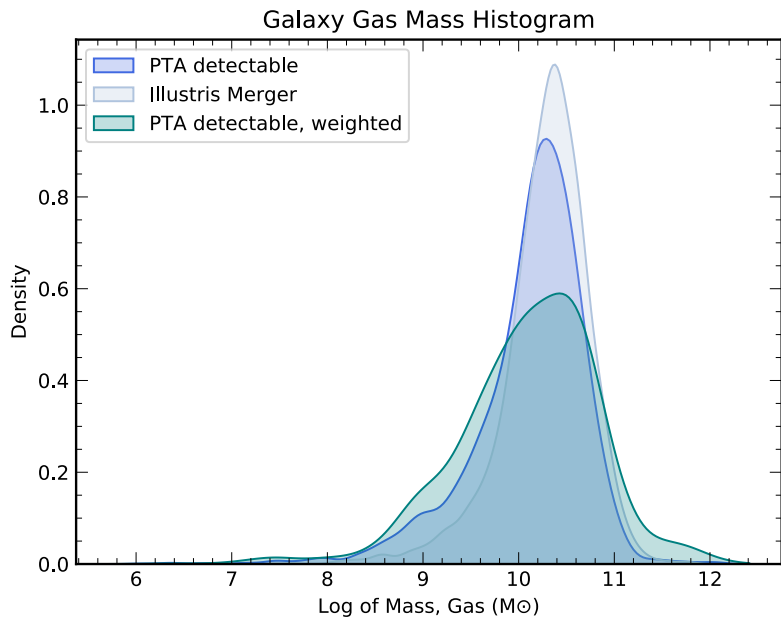
# Problem and Motivation

- **Intro:** Super Massive Black Hole Binary Systems
- **Problem:** to determine the characteristics of galaxies that produce gravitational waves that are detectable by Pulsar Timing Array (PTA)
- No gravitational waves have been detected yet using the PTA method so we can only rely on simulations to have a large population of galaxies and their binaries that we can evolve into the PTA band self-consistently (Kelley+2017)
- **Motivation:** Multi-Messenger detection (Goldstein+2017, Charisi+2016, Liu+2016, Comerford+2009)
  - Primary concern with single source detection (Arzoumanian+2014)

# Procedure

- Illustris Simulation  
(Vogelsberger+2014, Genel+2014)
- Dr. Luke Kelley provided identification of systems that would evolve to produce Gravitational Waves at frequency detectable by PTA (Kelley+2018)
- API
  - Merger trees used to find ID of system at the time they are in the PTA band



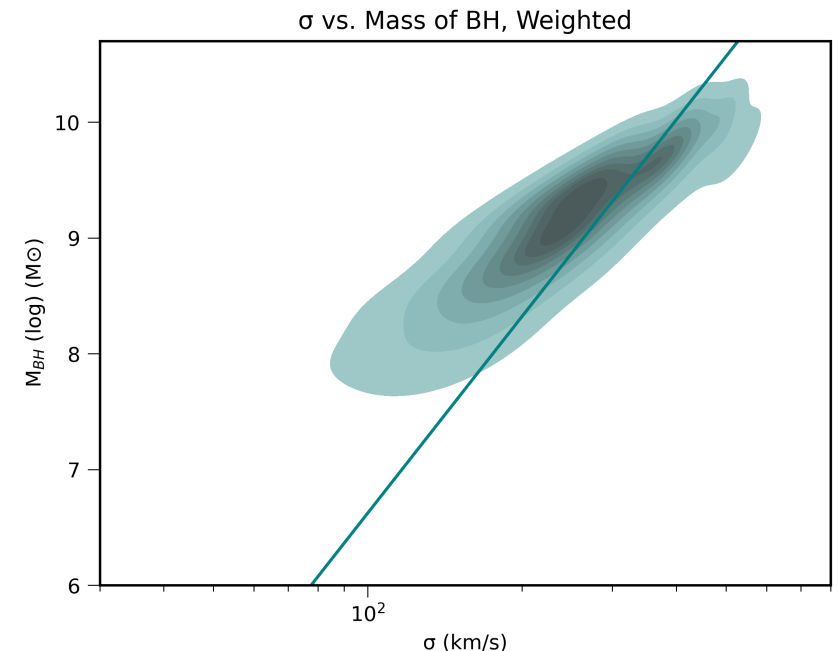
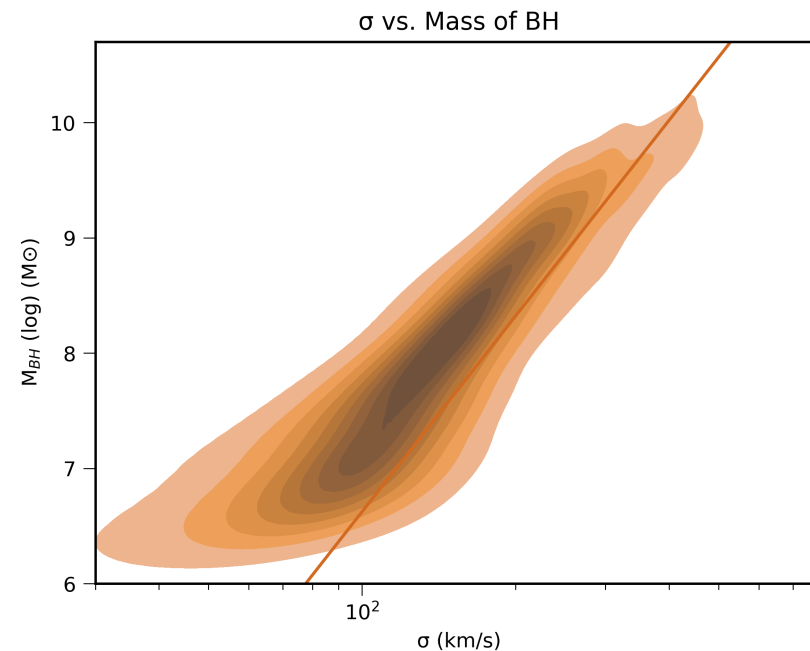
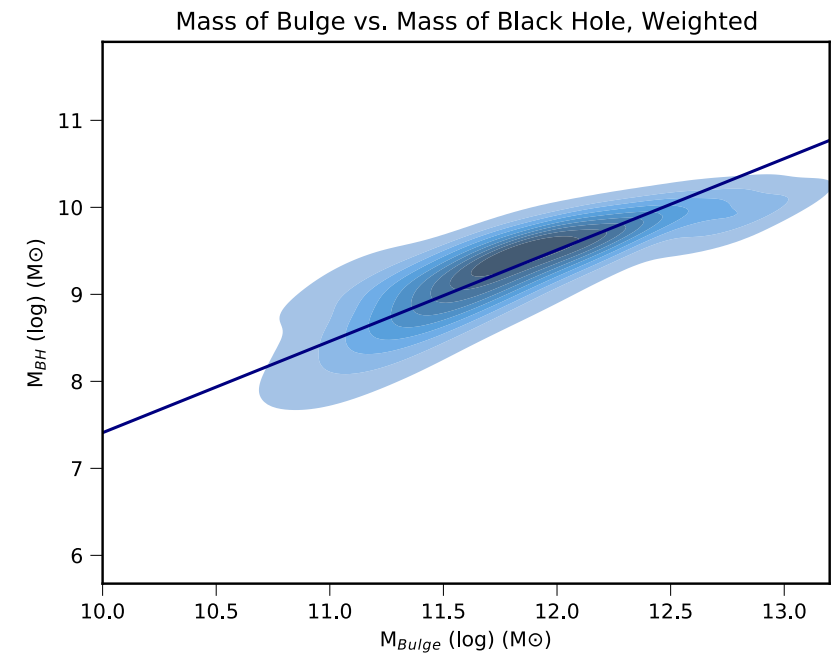
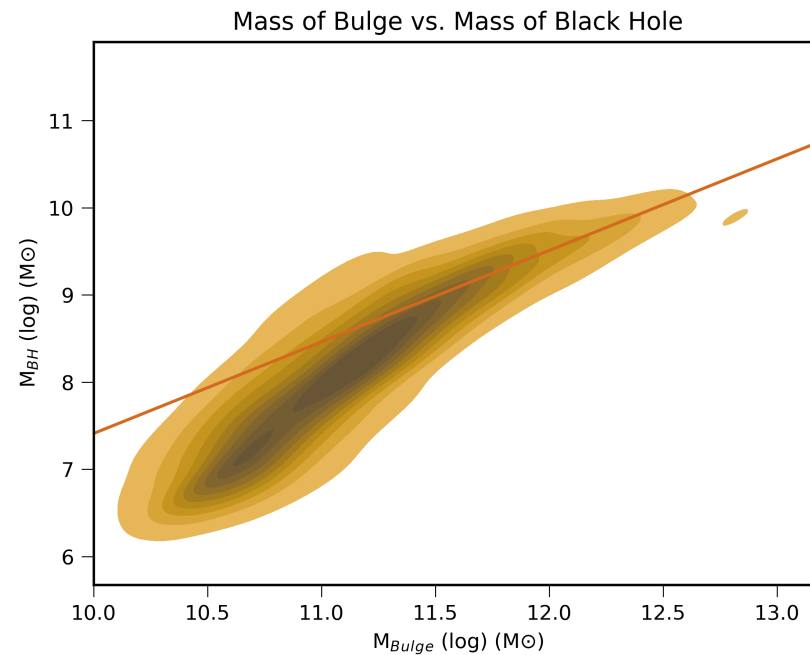


# Results

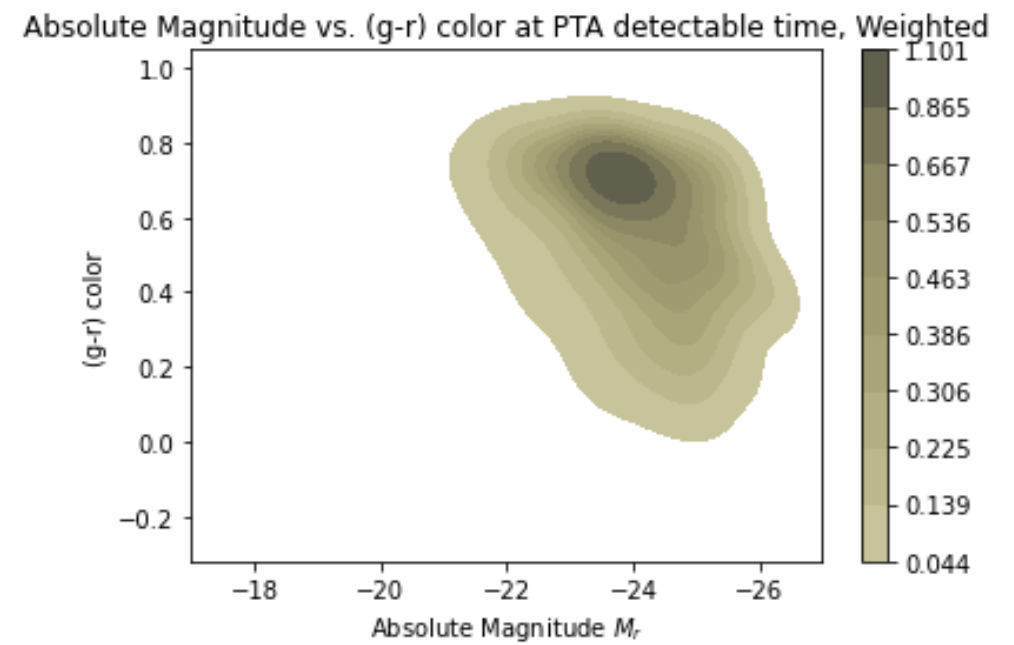
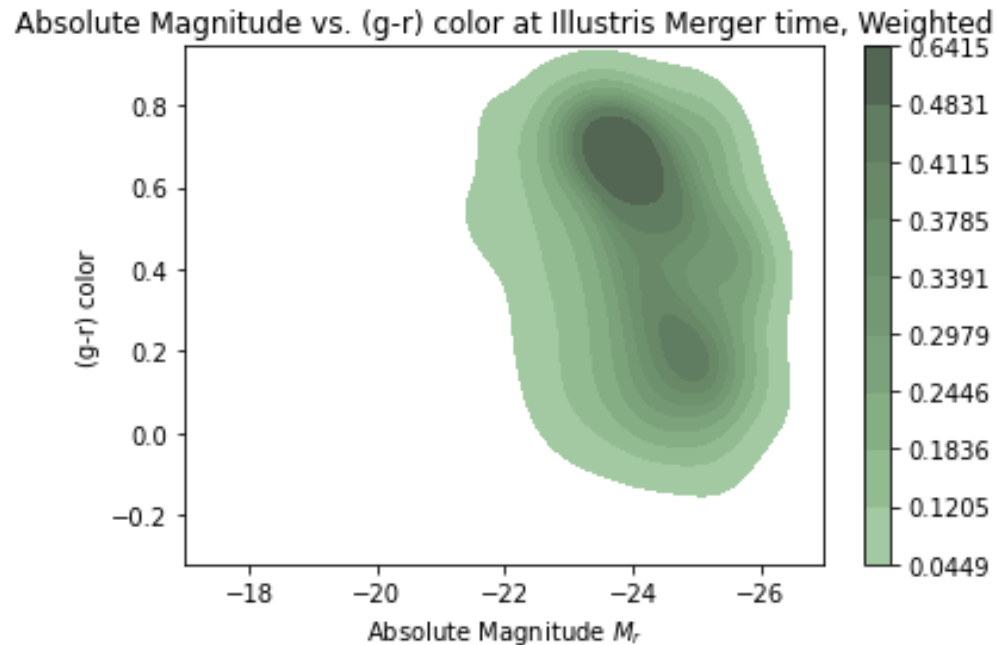
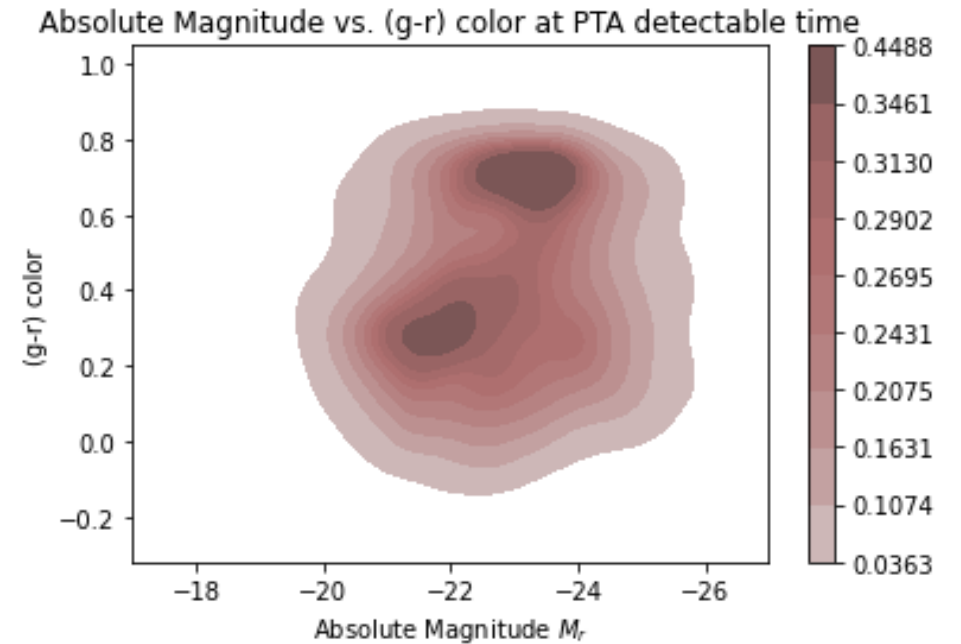
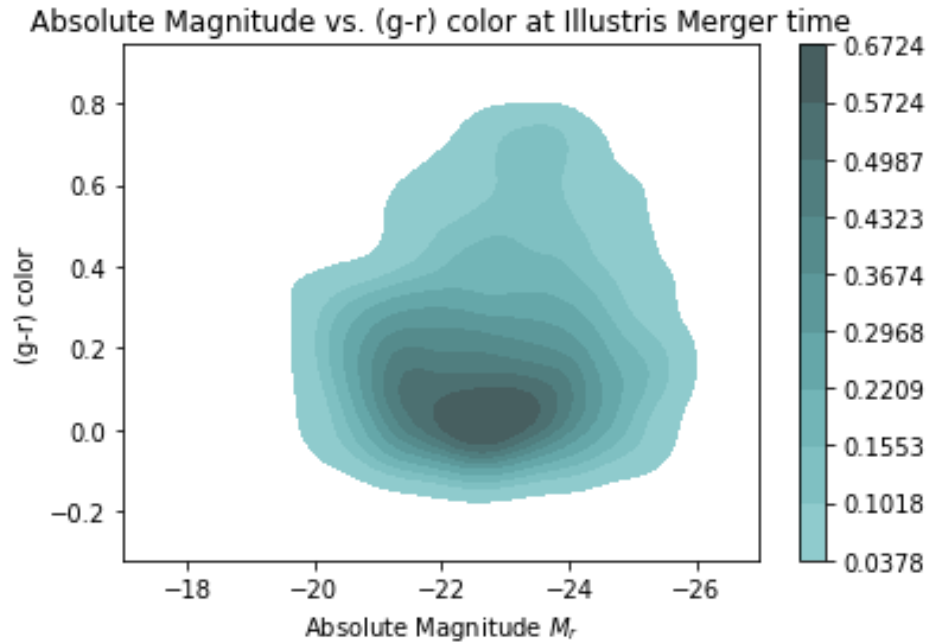
- Mass distributions split out by type
- Comparison between Illustris merger time and PTA detectable time

# Results

- Scaling relation between Mass of Black Hole and Mass of Bulge
- Scaling relation between Mass of Black Hole and Velocity Dispersion (McConnell+Ma-2013, Sijacki+2015, Gültekin+2009)
- Line represents the accepted relationship

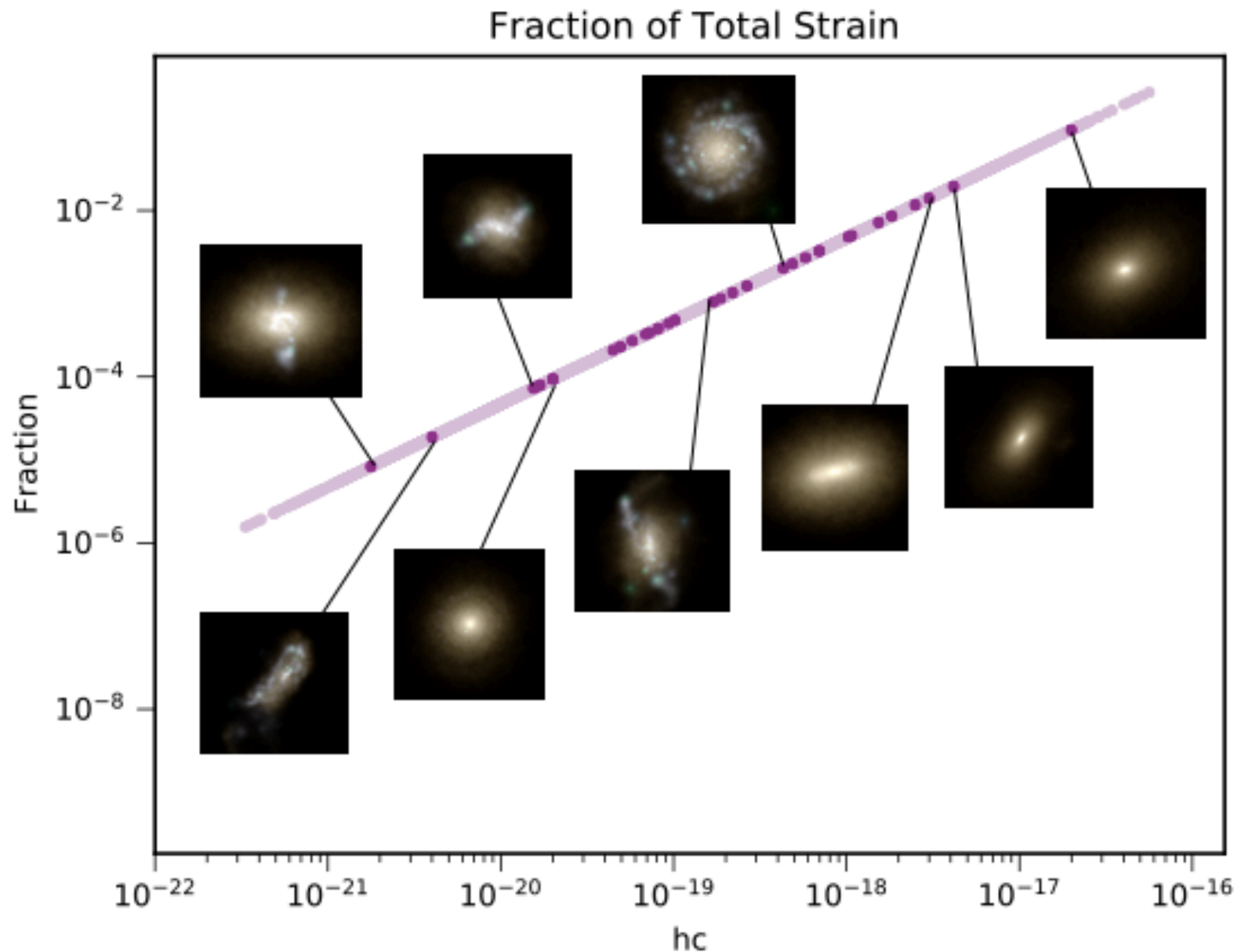


# Results



# Results

- Data available as an addition to Illustris (Rodriguez-Gomez+2019)



# Thank You!

**Conclusion: We self-consistently evolved Black Hole Binary Systems from Illustris, tracking their host demographics until they were detectable by the PTA**

Special thanks to Dr. Stephen Taylor and Dr. Luke Kelley