Formation of High Eccentricity GW Mergers

Johan Samsing
Princeton
What is the origin of BBH mergers?

* Spin
* Mass
* Eccentricity
GW Mergers and Inspiral

\[ \sigma_I \approx 0.025 \text{AU}^2 \left( \frac{v_\infty}{10 \text{ km/s}} \right)^{-2} \left( \frac{m}{M_\odot} \right)^{12/7} \left( \frac{a_0}{\text{AU}} \right)^{2/7} \]

- [BH, BH] binary
- [BH, BH] binary, \( t_M < 10^{10} \) years
- [BH, BH] GW inspiral
- Analytical sol., \( \sigma_I \propto a_0^{2/7} \)
- Analytical sol., \( \sigma_M \propto a_0^{-1/7} \)
Analytical Solution

\[
\frac{\sigma_I}{\sigma_M^{\langle \tau \rangle}} \gtrsim 0.01 \left( \frac{m}{10 M_{\odot}} \right)^{5/28} \left( \frac{\tau}{t_H} \right)^{-5/28}
\]

\[
\frac{\Gamma_I}{\Gamma_M} \gtrsim 0.01 \left( \frac{m}{10 M_{\odot}} \right)^{5/28}
\]

\[
\frac{\Gamma_{f_{GW}}}{\Gamma_I} \approx 0.2 \left( \frac{m}{20 M_{\odot}} \right)^{-8/21} \left( \frac{f_{GW}}{10 \text{Hz}} \right)^{-2/3} \left( \frac{a_0}{0.1 \text{AU}} \right)^{-2/7}
\]

No `N-body groups' incl. these corrections yet.
BBH eccentricity distribution

- Thick black line: Two-body GW mergers
- Thin black line: Post-interaction GW mergers

Histogram on the left:
- y-axis: histogram
- x-axis: log e [10 Hz]

Cumulative histogram on the right:
- y-axis: cumulative probability
- x-axis: e [10 Hz]
Current work.

- Improve analytical models (higher fractions?)
- Analyze full globular cluster simulations.
- Eccentricity distribution: compare different models.
Not all interactions are equally likely

Initial conditions

AGN example
BH-BH GW Inspiral

1: BH (10M\(_{\odot}\))
2: BH (20M\(_{\odot}\))
3: BH (20M\(_{\odot}\))

GW inspiral
art of science
THANK YOU