AST425 Final Talk

4-Body Formalism for Interactions Within Star Clusters

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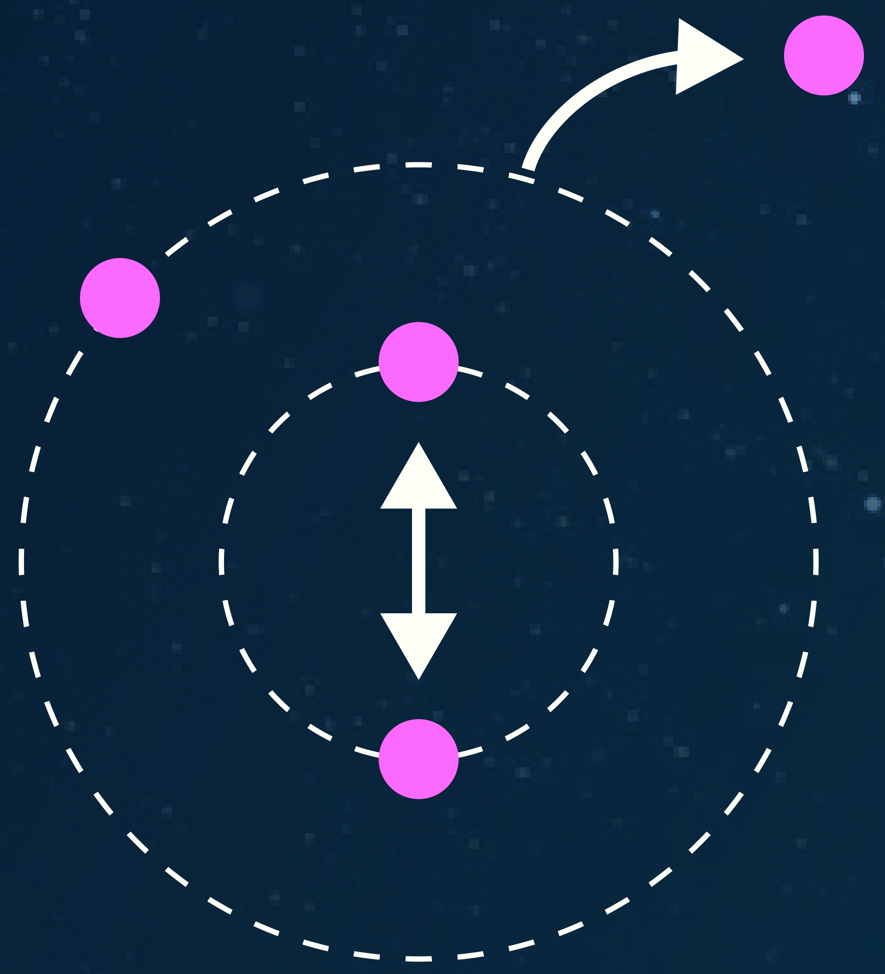
Brief Recap

Motivations:

- 4-body interactions provide insights on the physical characteristics of a GC.
- Current corespray code does not support this, new code must be written to implement a 4-body formalism.

Accomplished Goals:

1. Succeeded in modifying corespray for 4-bodies.
2. Tested various different GCs and simulated 3+1 interactions.
3. Compared four-body results with 3-body results.
4. Made conclusions based on trends and differences seen.



Tackling the 4-Body Problem

Outline of corespray's procedure:

- **Step 1:** Defines 3-D position and velocity in the GC for single stars and binaries.
- **Step 2:** Star and binary masses are sampled to create a probability distribution that finds if the star will escape the system; finds *total energy of the system* if so.
- **Step 3:** corespray computes escape velocity distributions for random three-body encounters; this is repeated until ***N*** extra-tidal escaper stars are generated.
  - 4 body corespray computes orbital distributions of escapers and recoil triples.

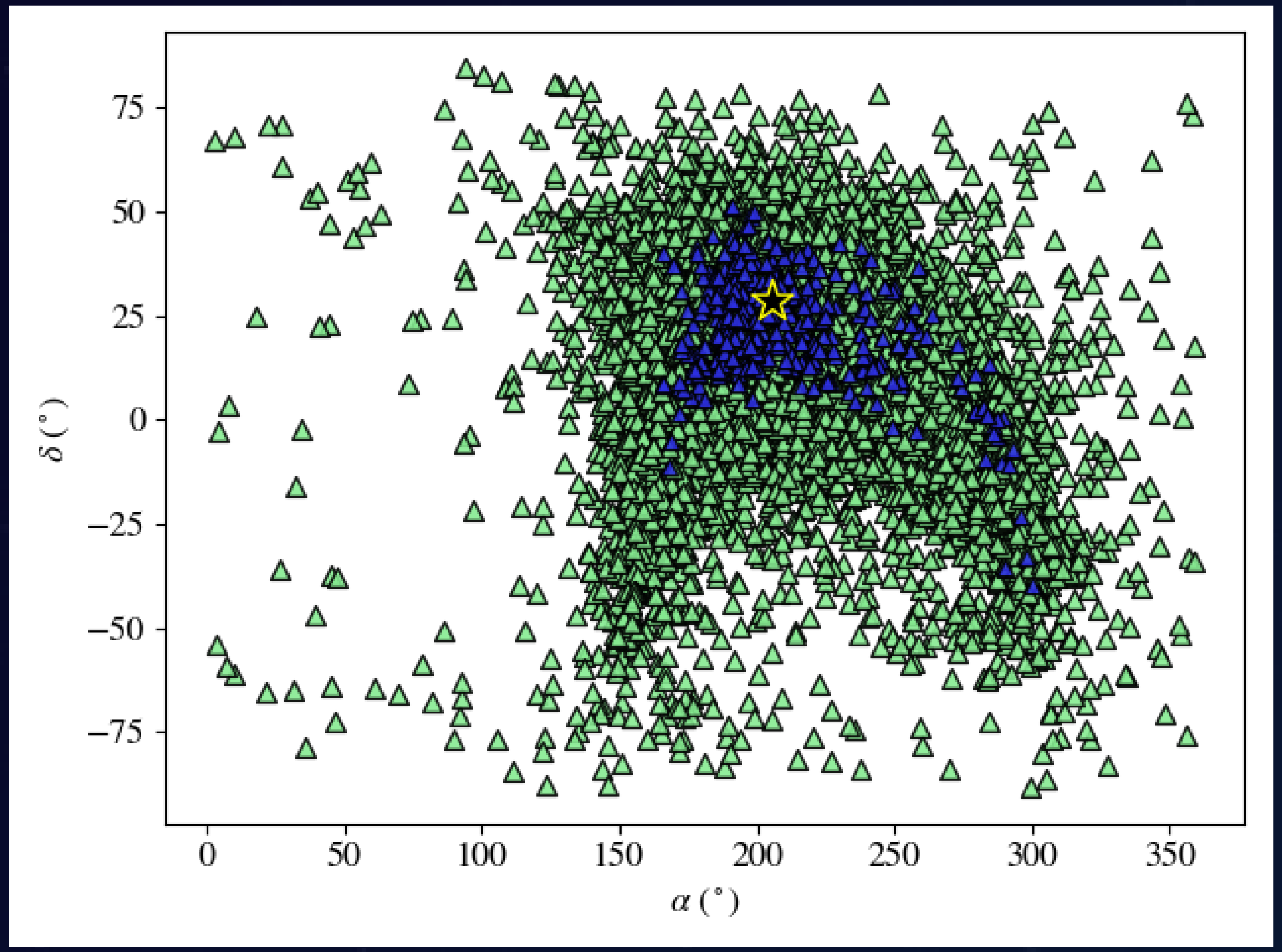
n = power law index

$$\boxed{f(v_\mathrm{e})dv_\mathrm{e} = \frac{(n|E_0|^{n-1}(m_\mathrm{e}M/m_\mathrm{b}))v_\mathrm{e}dv_\mathrm{e}}{(|E_0| + \frac{1}{2}(m_\mathrm{e}M/m_\mathrm{b})v_\mathrm{e}^2)^n}.}$$

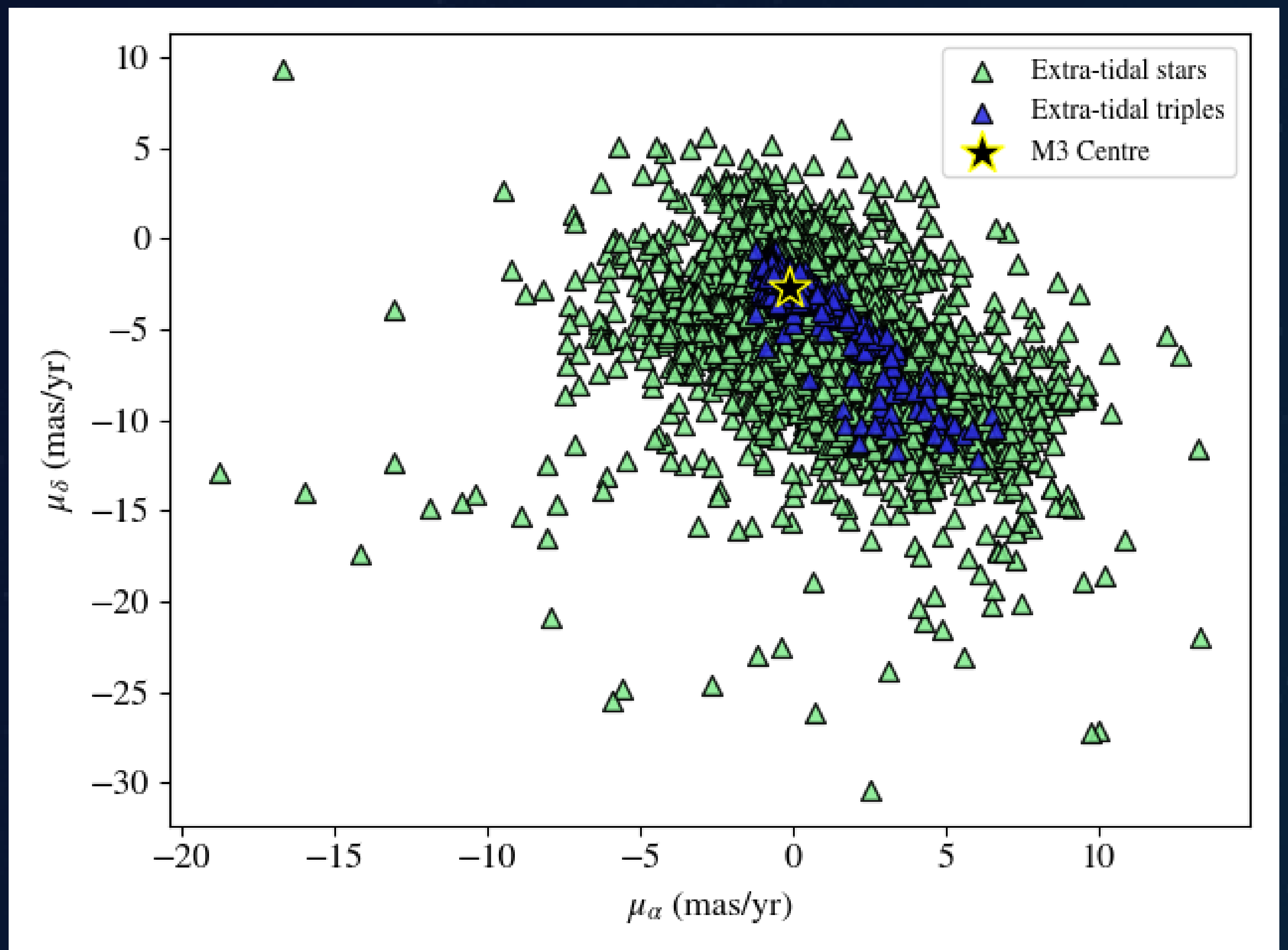
Leigh et al., 2016

Results from 3+1 Interaction

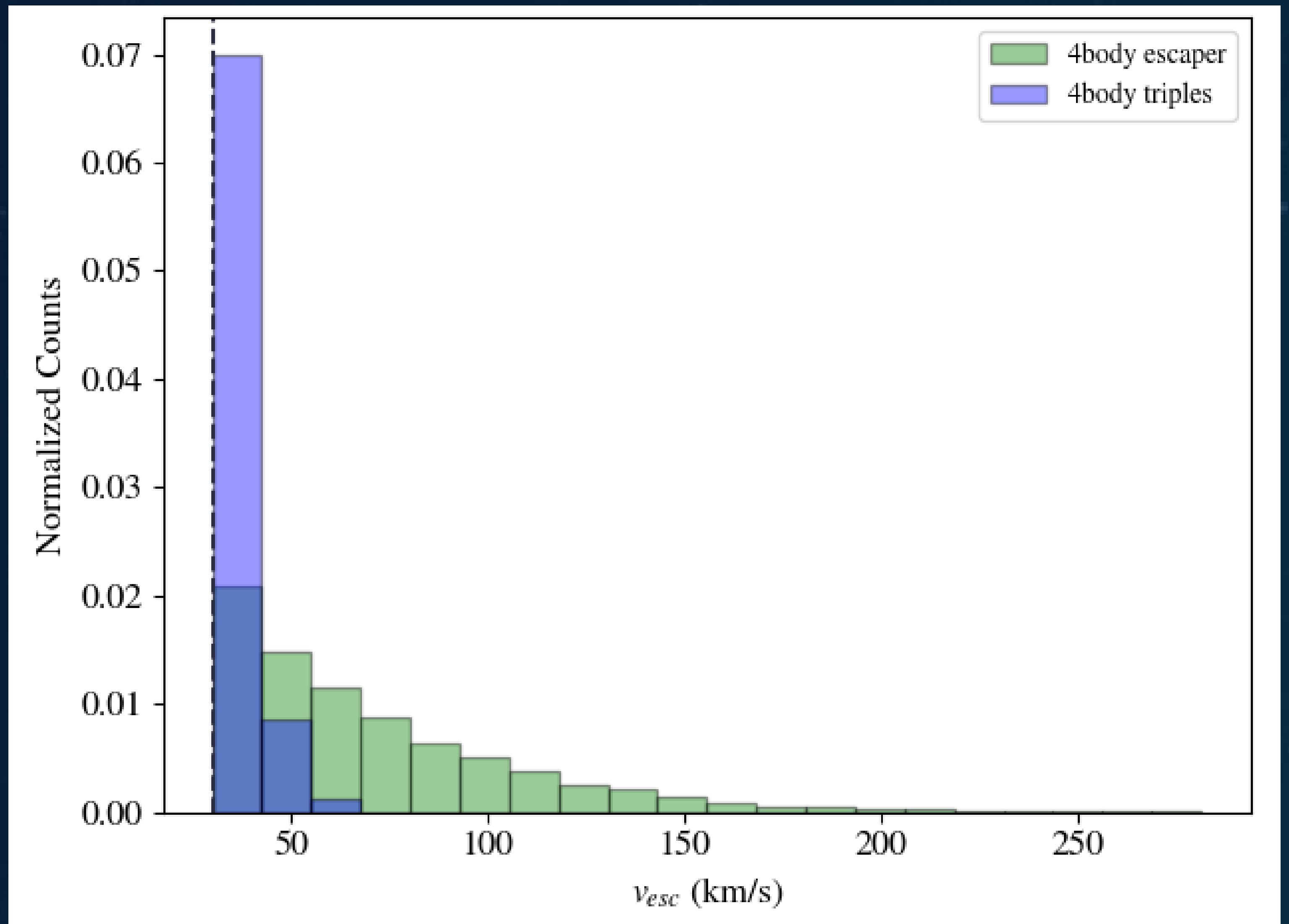
Four-Body Parameter Spaces for 10,000 Stars in M3's Core



RA vs. Dec



Proper Motions

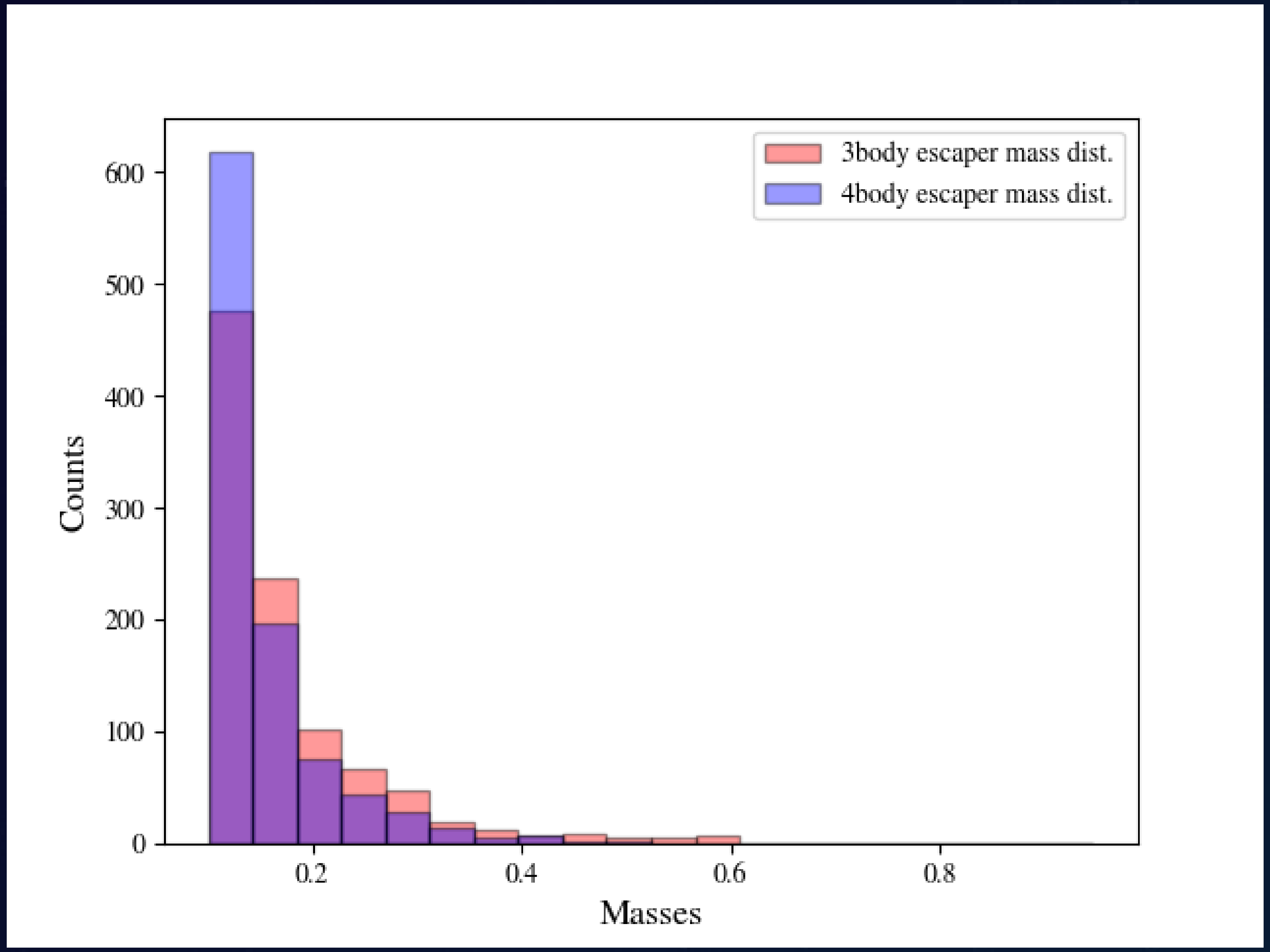


Escape Velocity Distribution

Binary/Triple Mass Fraction: (On average) 10% of binaries escaped M3, and <5% of triples escaped.

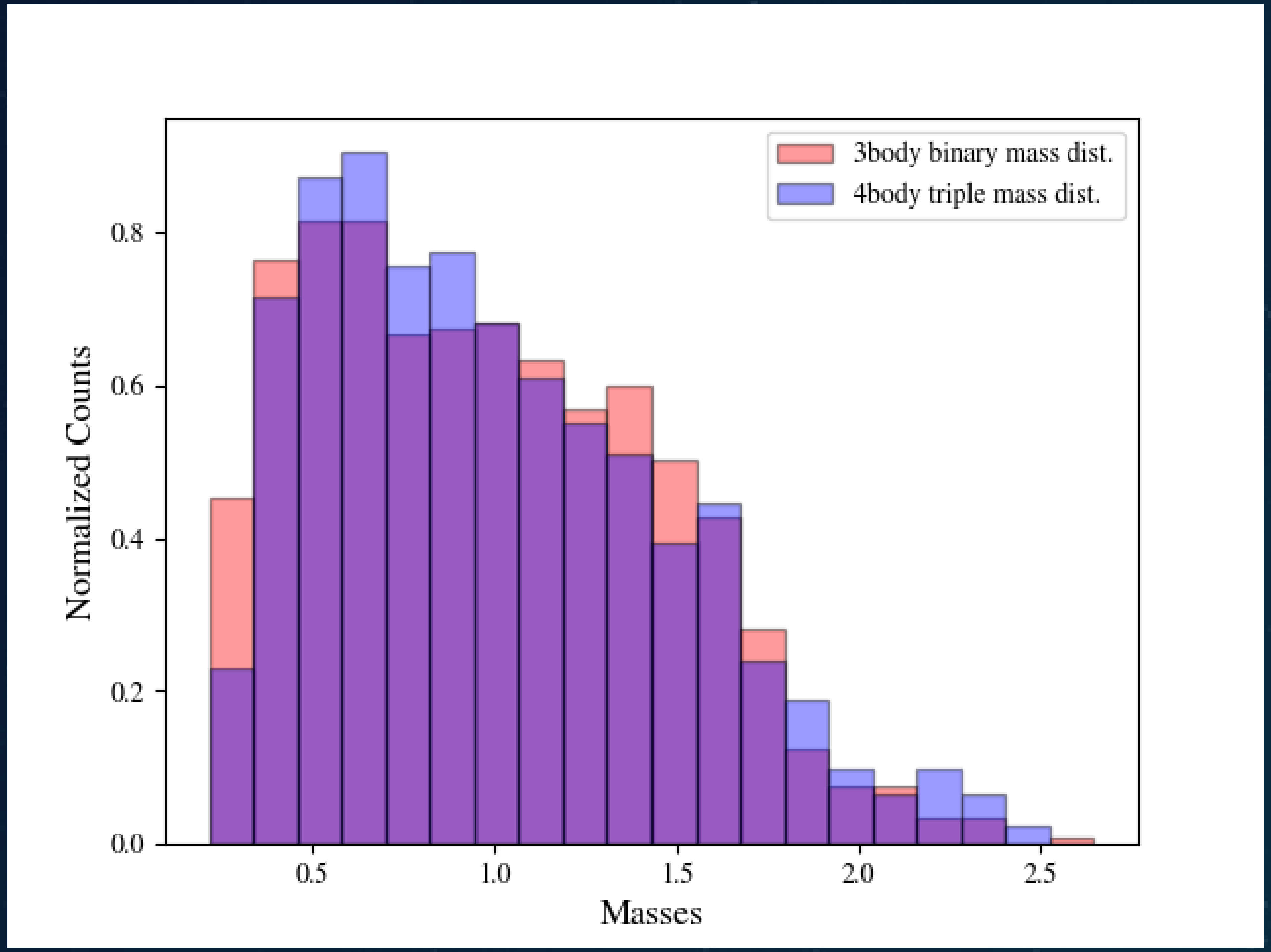
Comparing 3 and 4 Body Results for M3

Escaper mass distribution



- 3 body interactions can more easily produce high mass escapers.

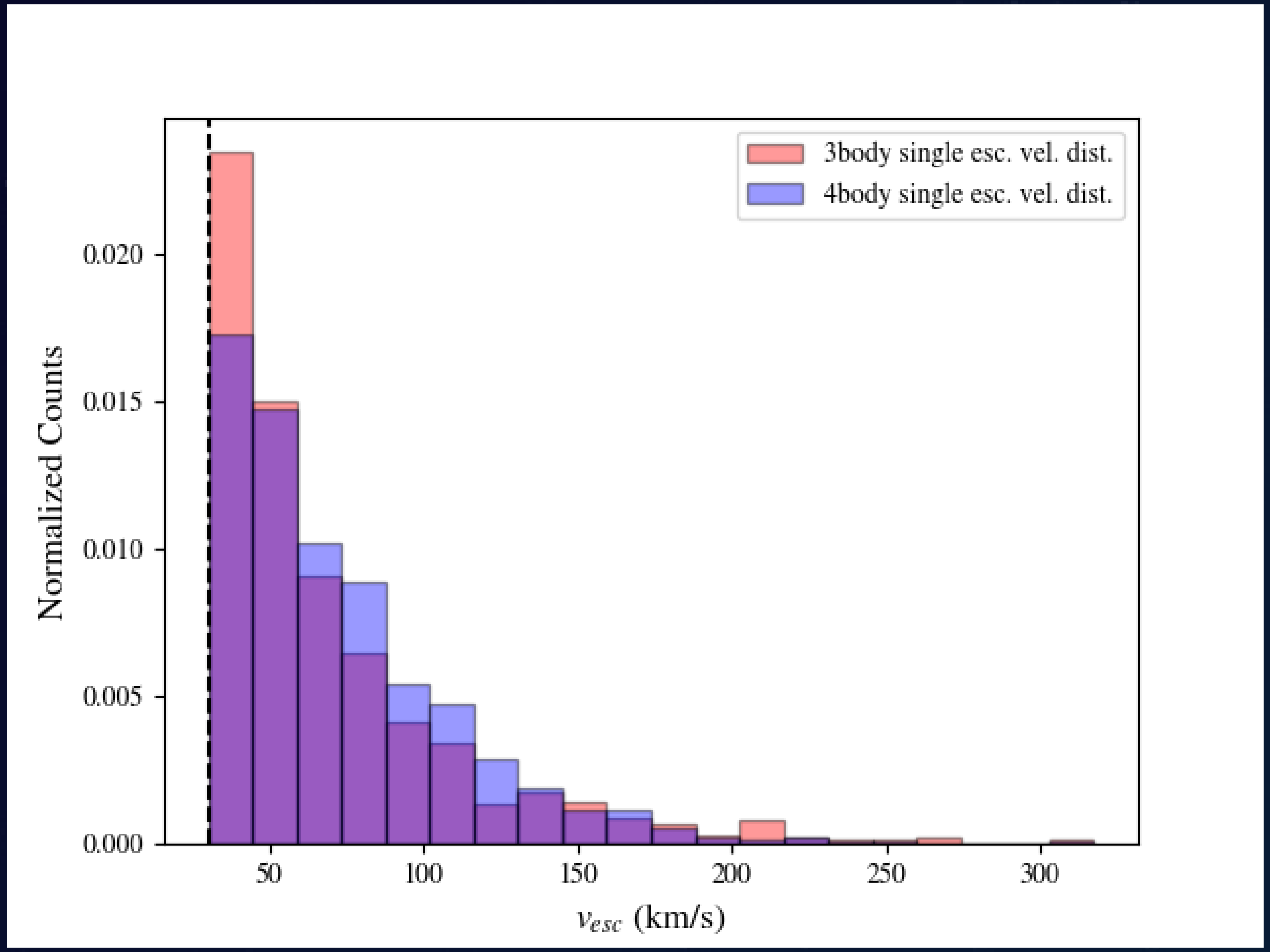
Binaries and triples mass distribution



- Both interactions had similar trends in binary and triple mass distributions.

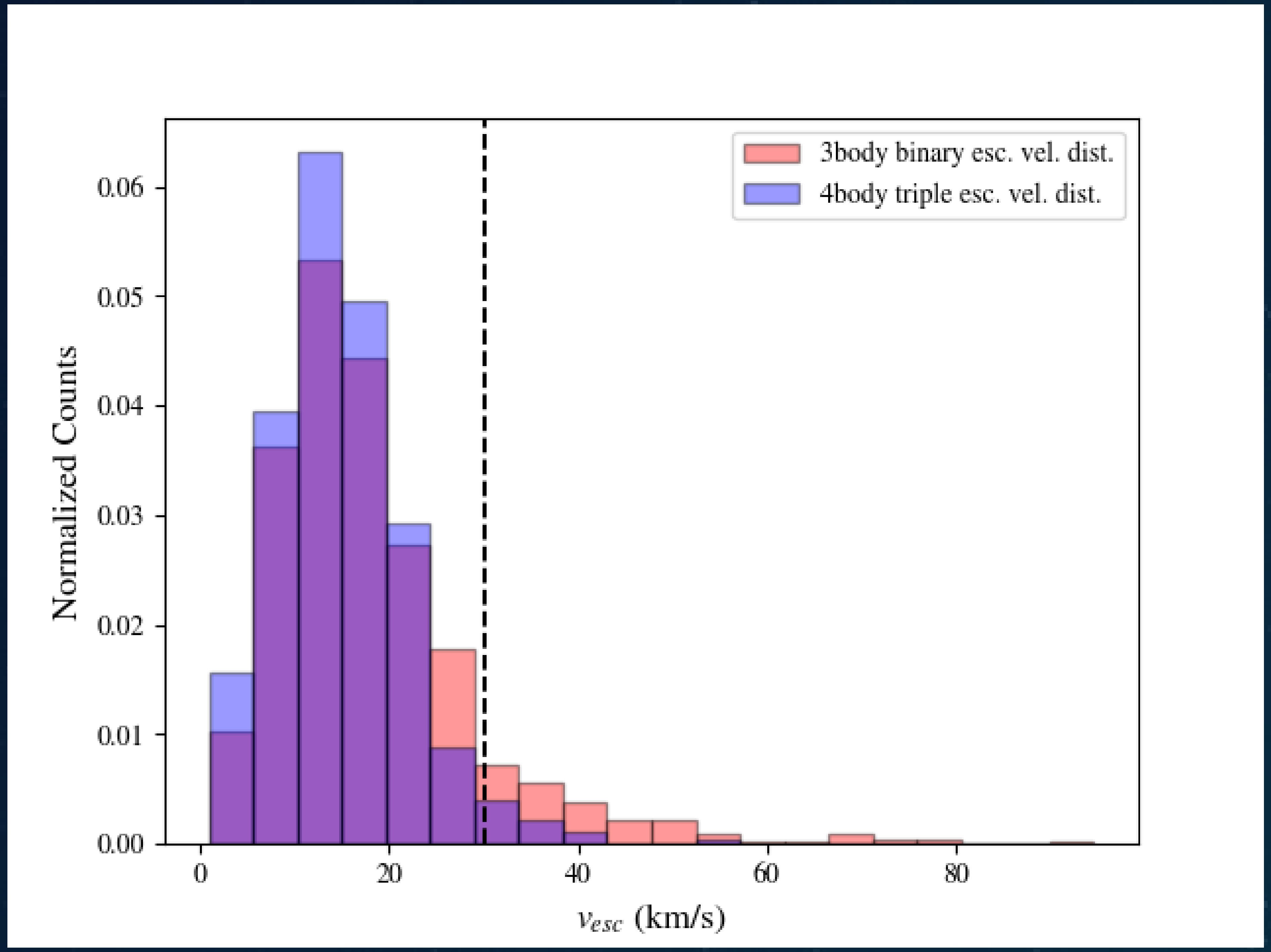
Comparing 3 and 4 body Results for M3 (con't)

Escaper star escape velocities



- 4-body escapers had faster escape velocities.
- Some 3-body escapers can achieve higher velocity kicks.

Binary and triple escape velocities



- 3-body binaries had faster escape velocities.