White Dwarf Kicks

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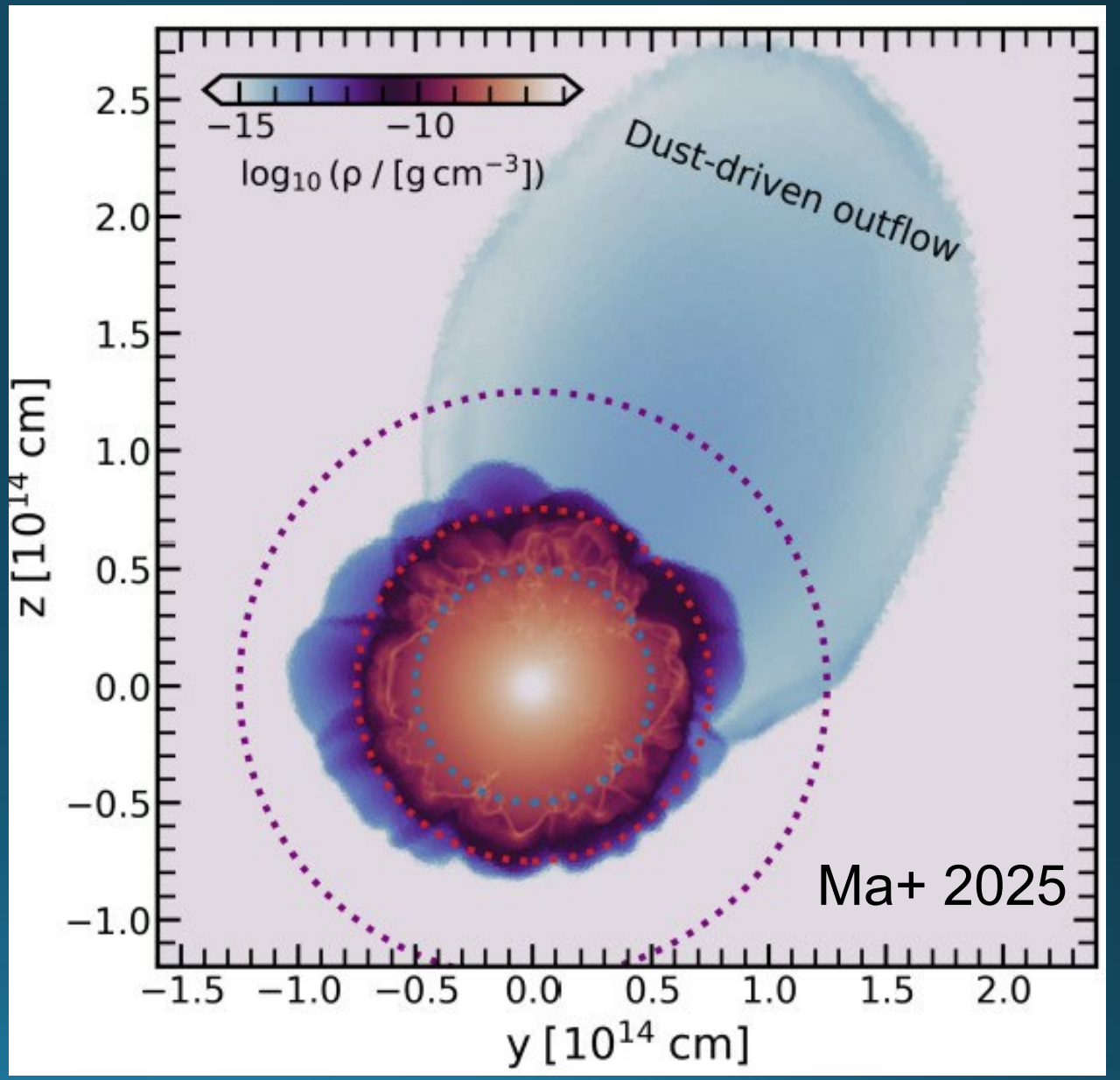
Our findings

- White dwarfs receive “kicks” of ~1 km/s as they are born from the cores of red giant stars
- The kick is actually a series of ~10,000 small, randomly oriented mini-kicks due to mass ejection events from red giants
- The kicks can cause red giant stars to run away from or collide with binary stellar companions

Simulations of Mass Loss

- Convection and pulsations drive shocks into atmosphere of star, causing mass ejection events



Individual Kicks

- Each mass ejection event expels a mass

$$M_{\rm ej} \sim 10^{-4}\, M_\odot$$

- The corresponding kick to the red giant star is

$$v_{\rm k} \sim \frac{M_{\rm ej}}{M_1} v_{\rm esc}$$

$$\sim 3.3\,{\rm m/s}$$

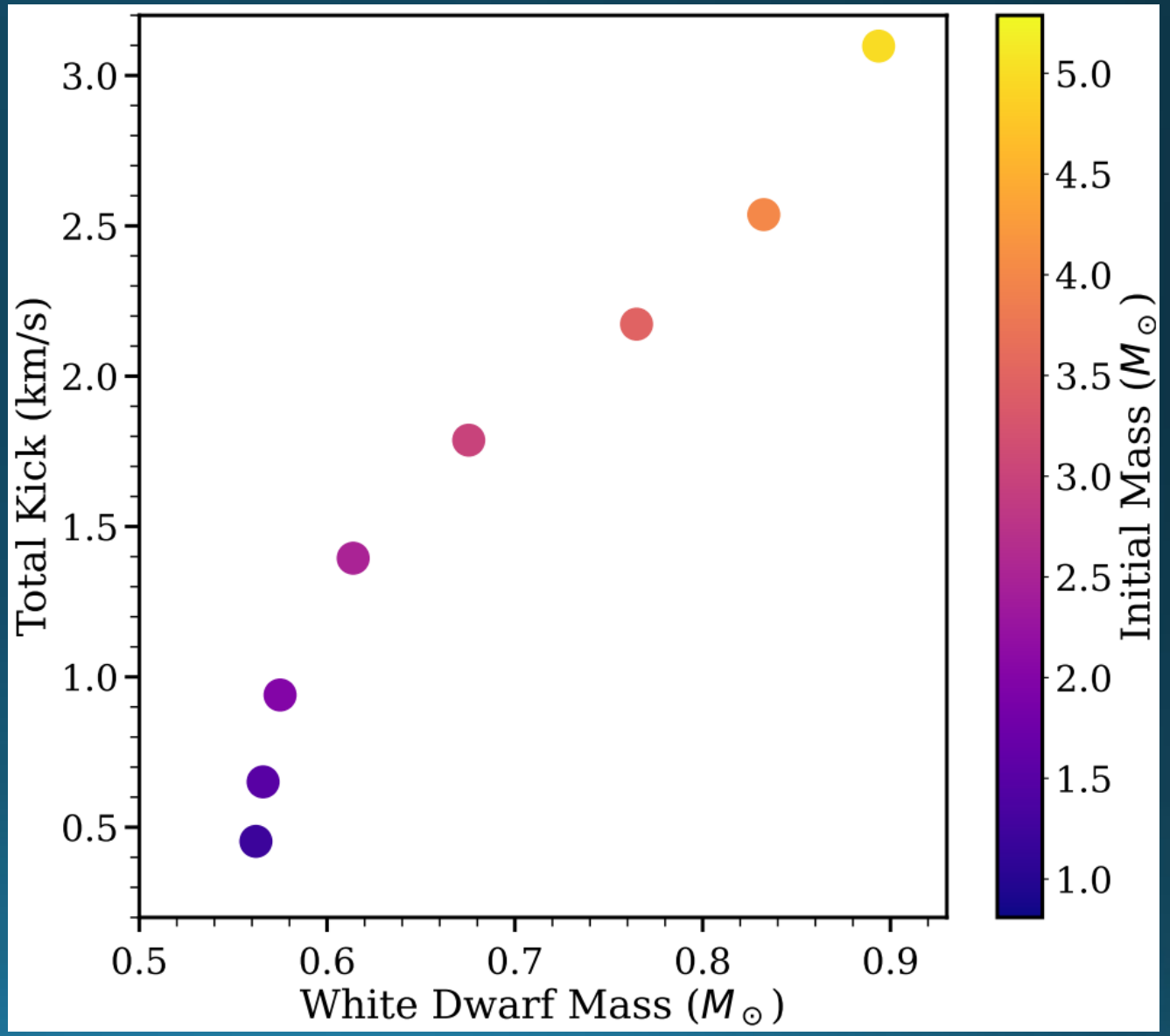
Total kick

- Total number of mass ejection events is

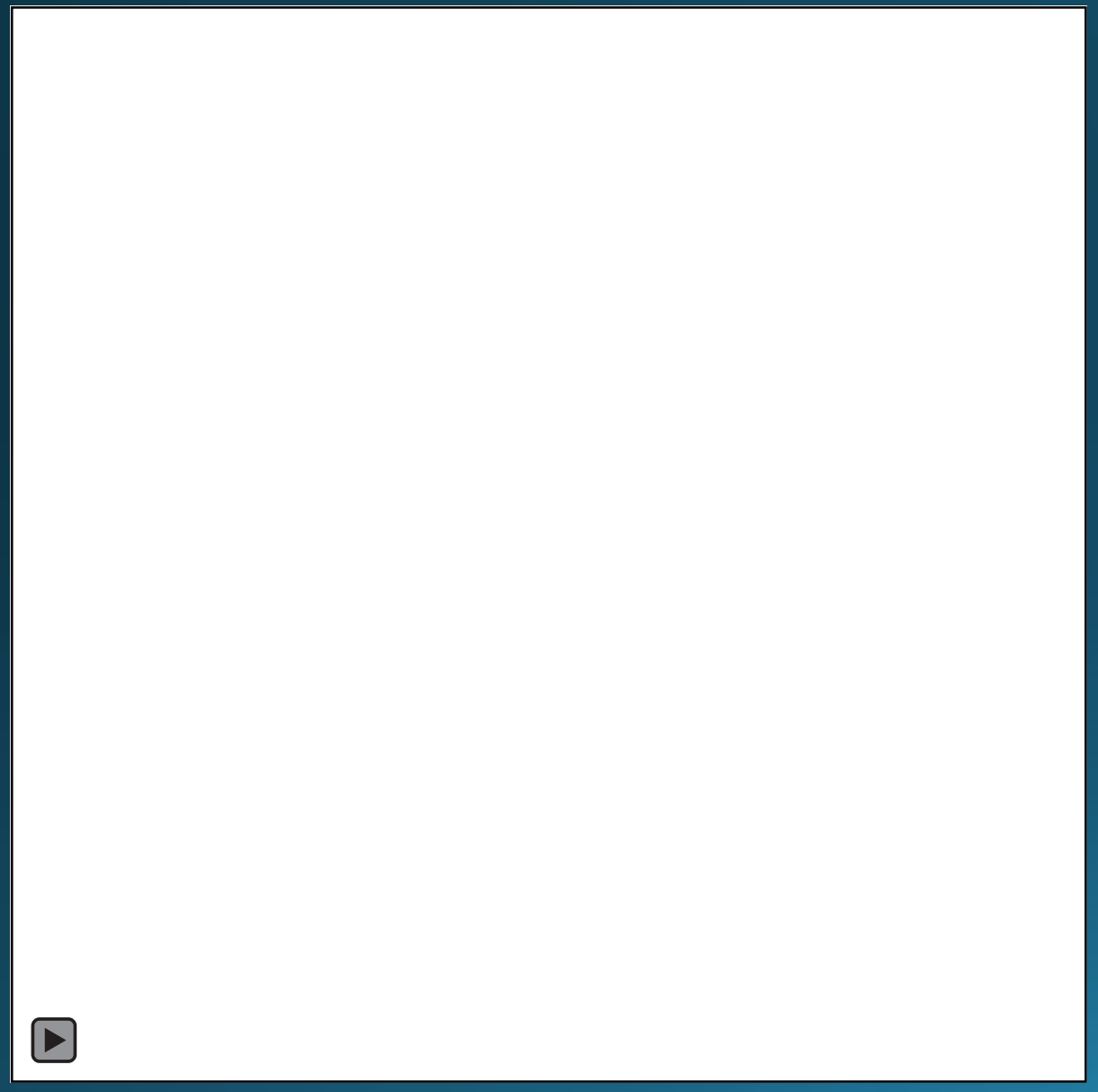
$$N = M_{\rm env}/M_{\rm ej} \sim 10^4$$

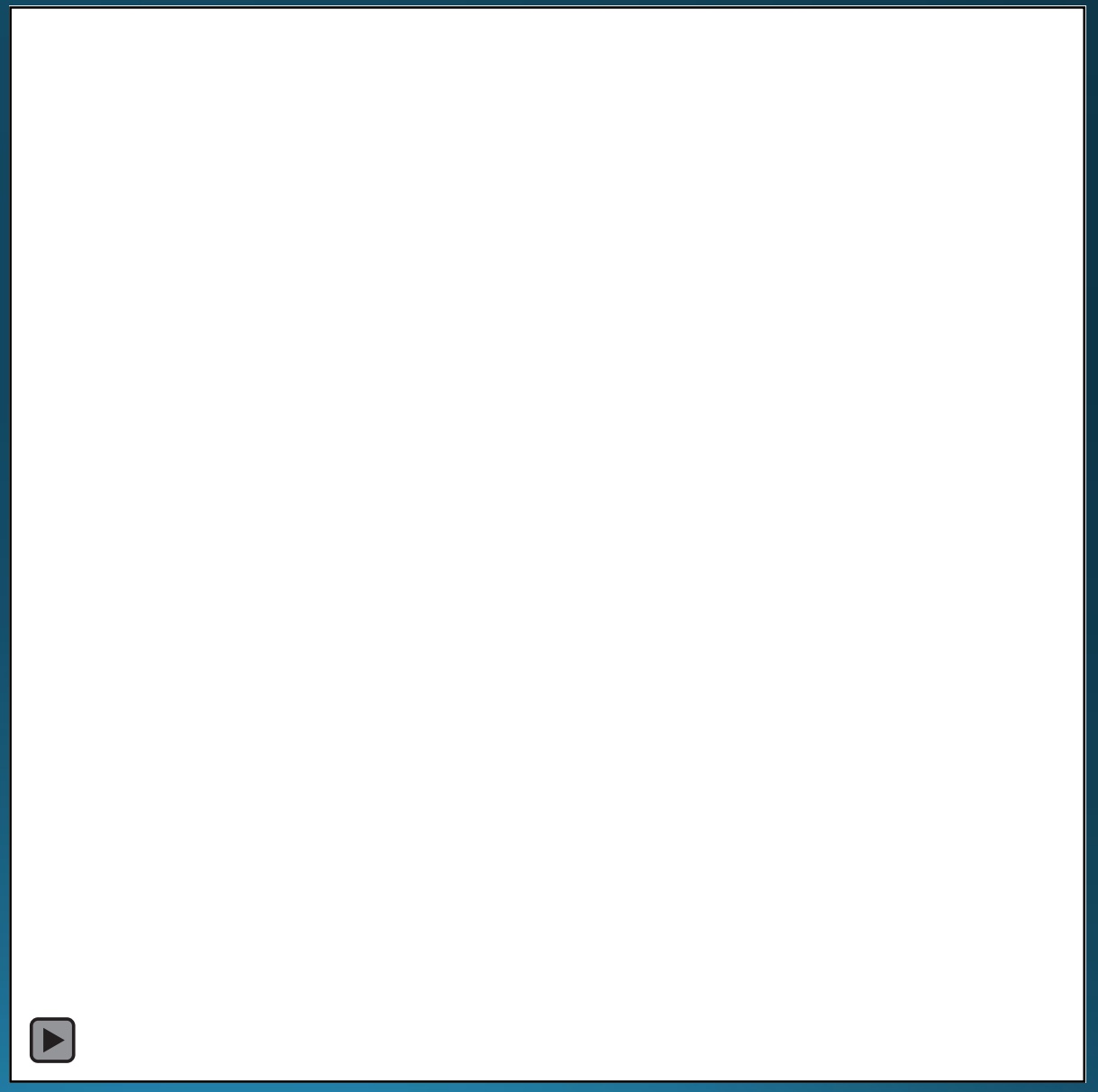
- If kicks are in random directions, the net kick is

$$v_{\rm k,tot} \sim \sqrt{N}\frac{M_{\rm ej}}{M_1}v_{\rm esc} \sim 0.4\,{\rm km/s}$$

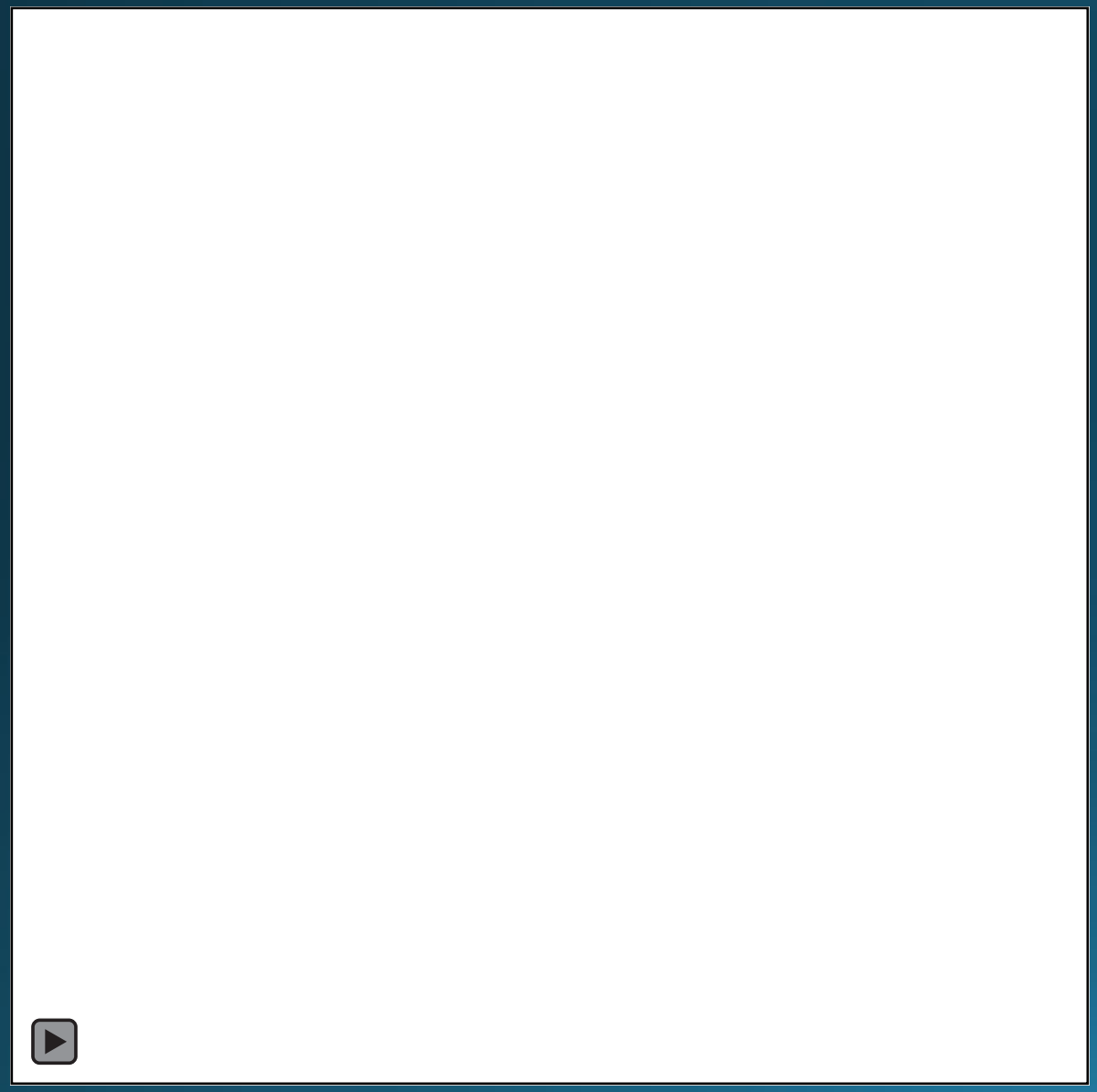


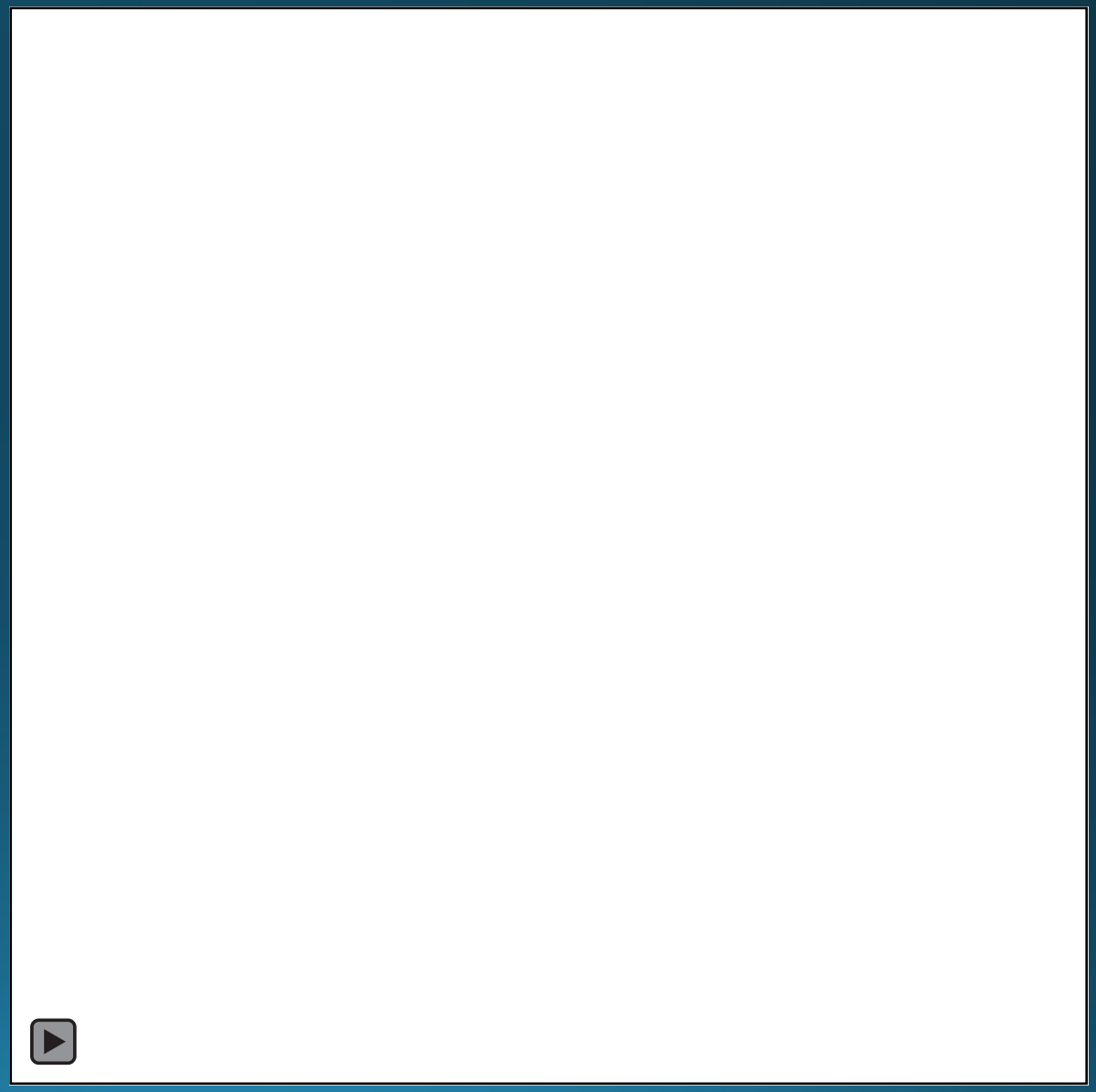
Single stars: random walks



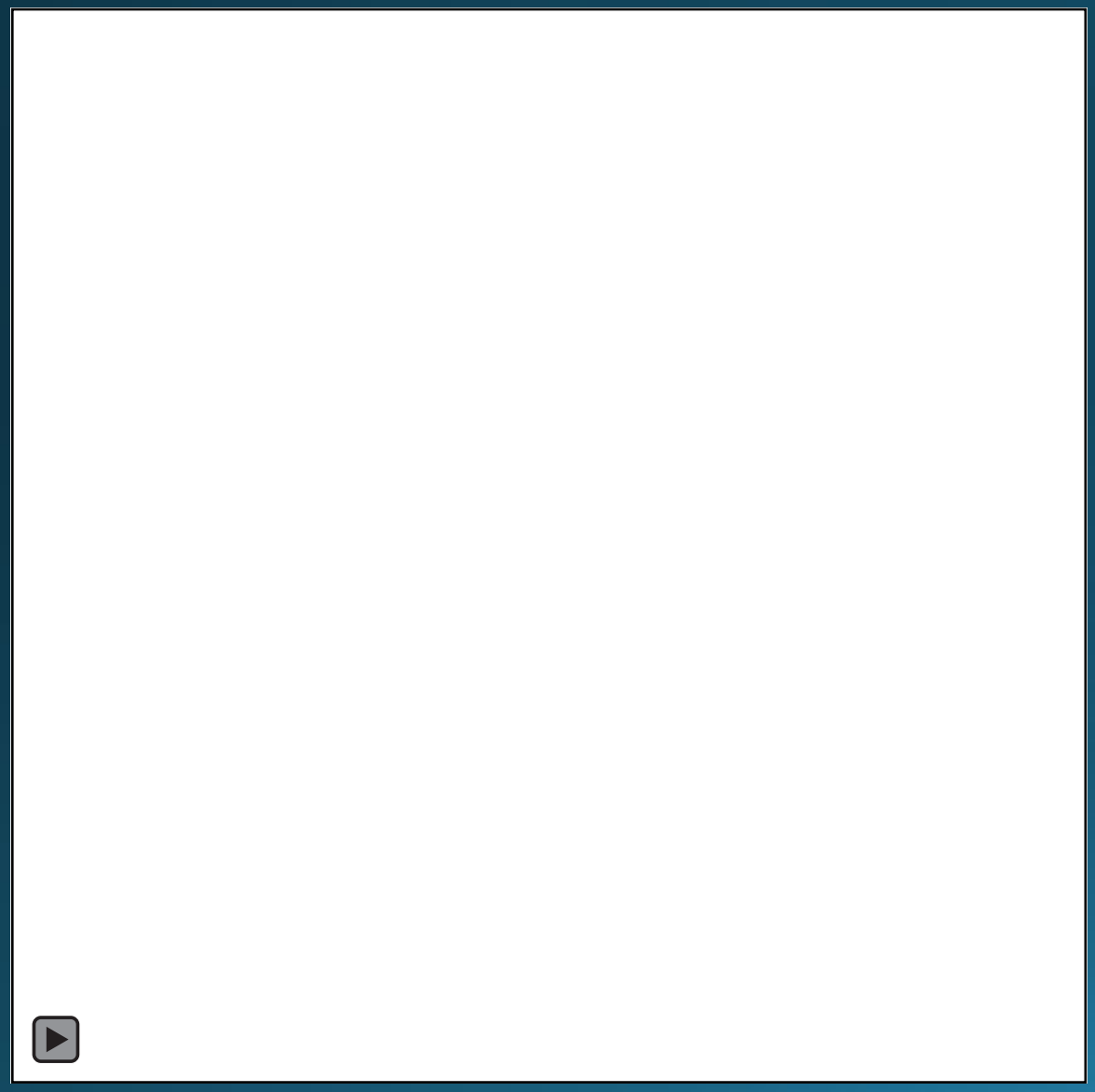


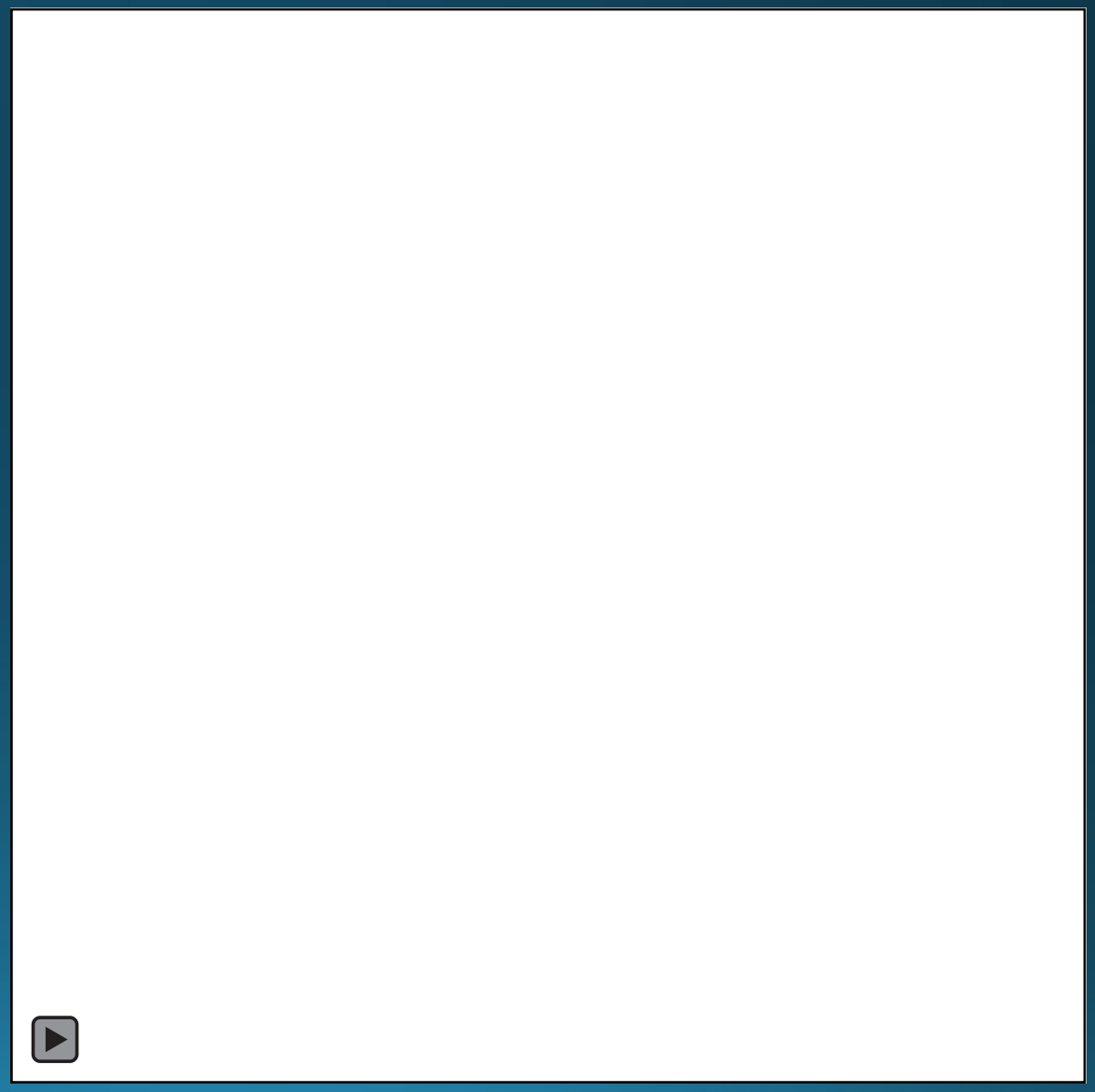
Binaries: random walks





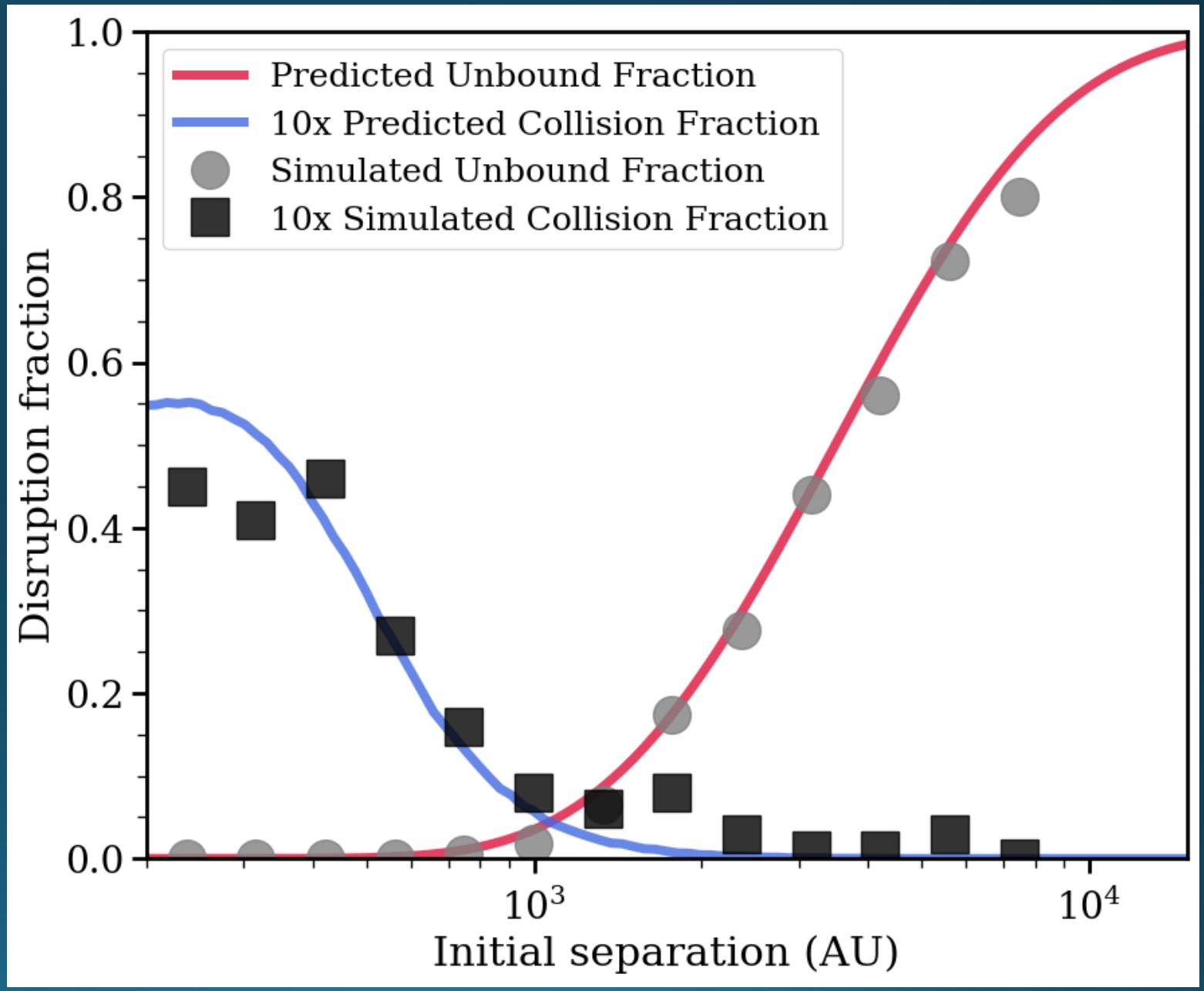
Binaries: ejections and collisions





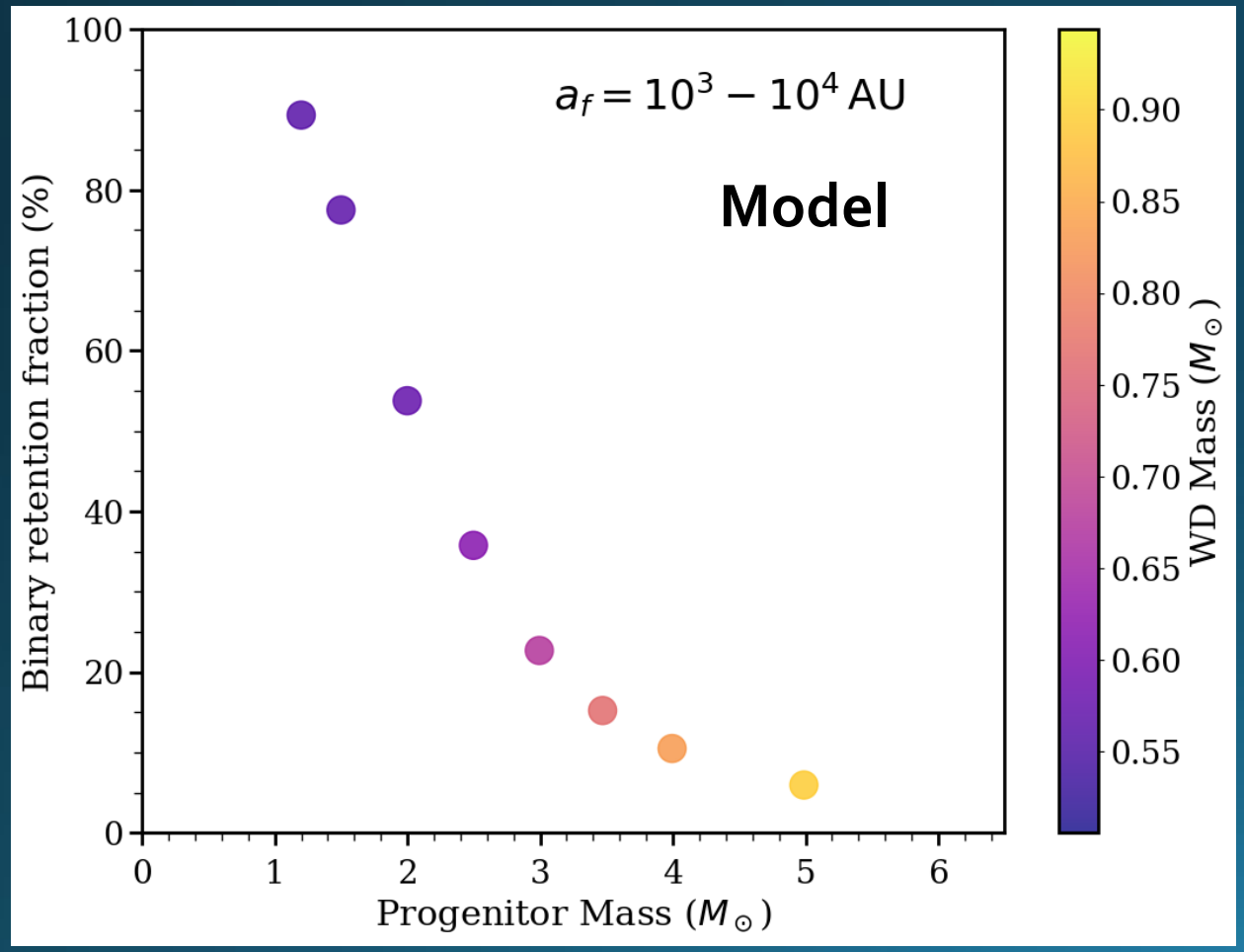
Binary Disruption

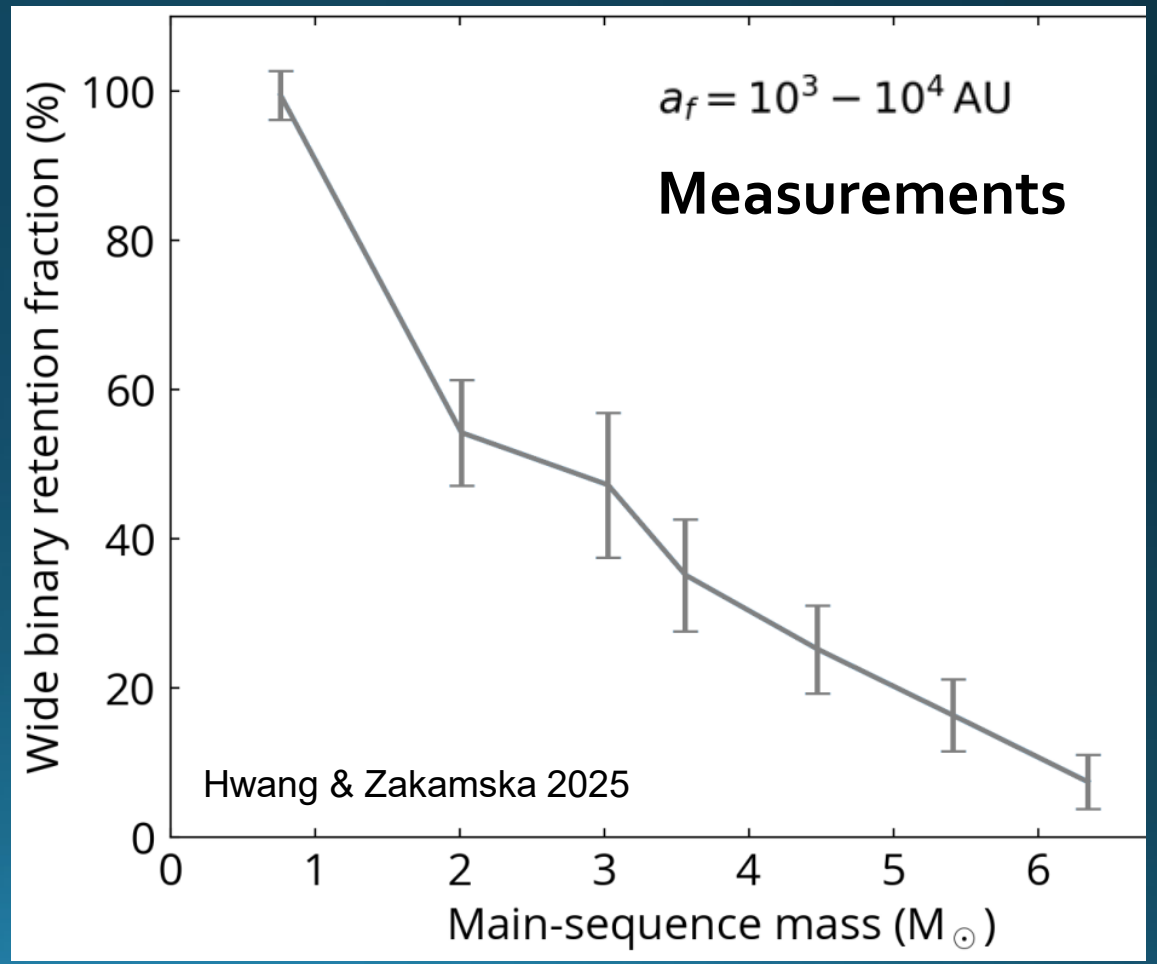
- Many widely separated binaries become unbound
- A small fraction of closely separated binaries collide



Binary Retention Fractions

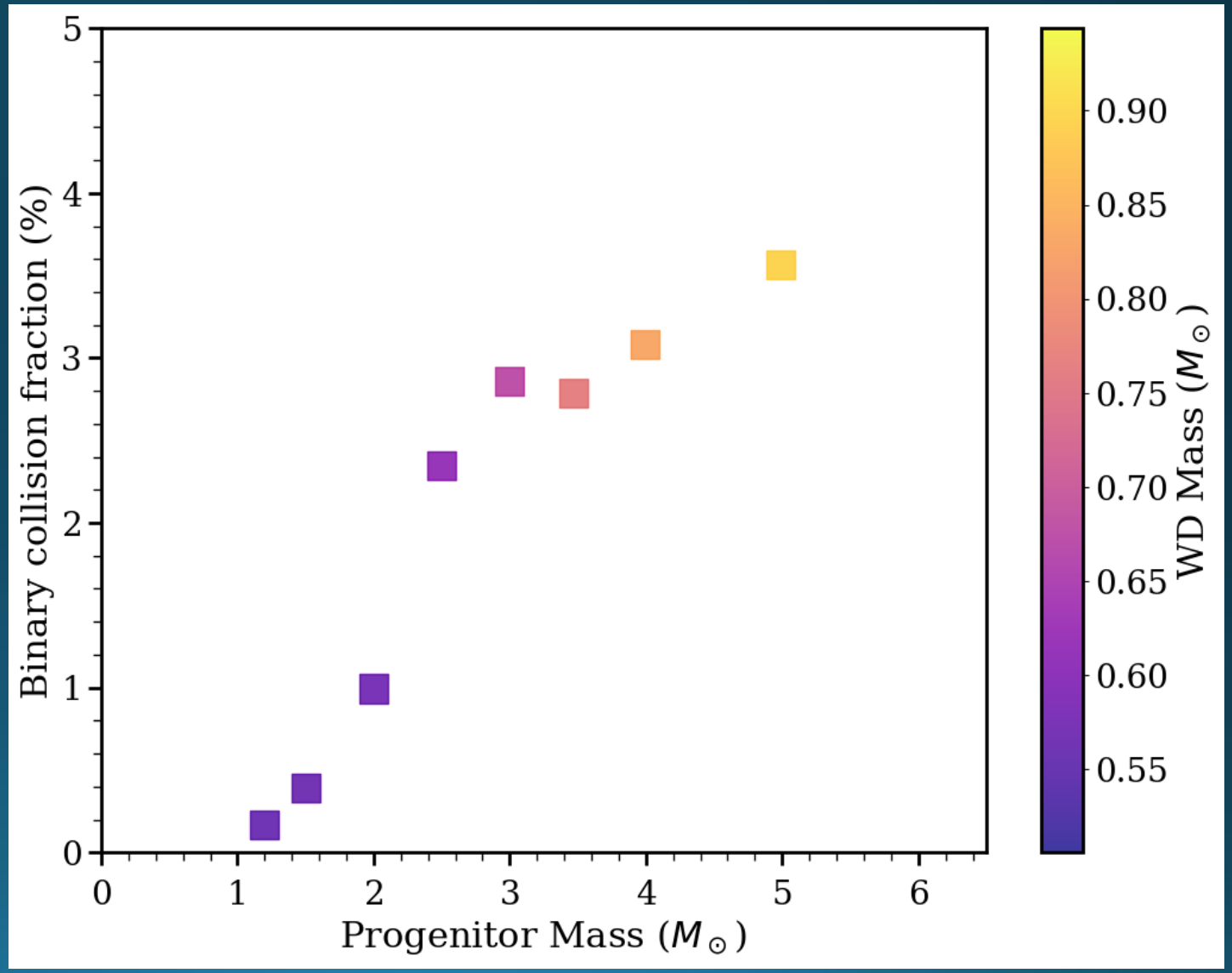
- High-mass white dwarf binaries preferentially disrupted





Binary collisions

- A few percent of binaries will collide
- The collision will produce a “common envelope” event resulting in a short-period binary star
- A luminous red nova will be produced during the collision



Thank You!