True and False Unicorns: Simulated Rates of Dark Massive Companions to Bright Stars

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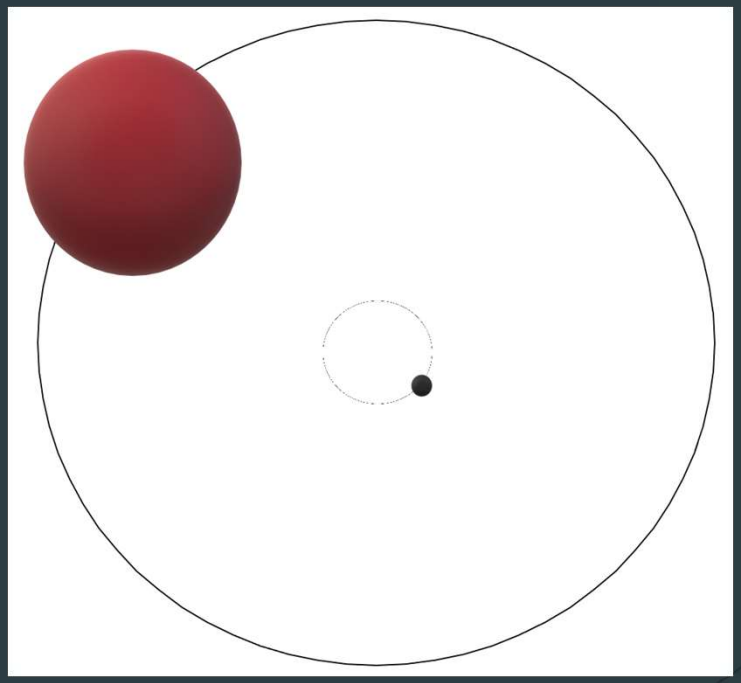
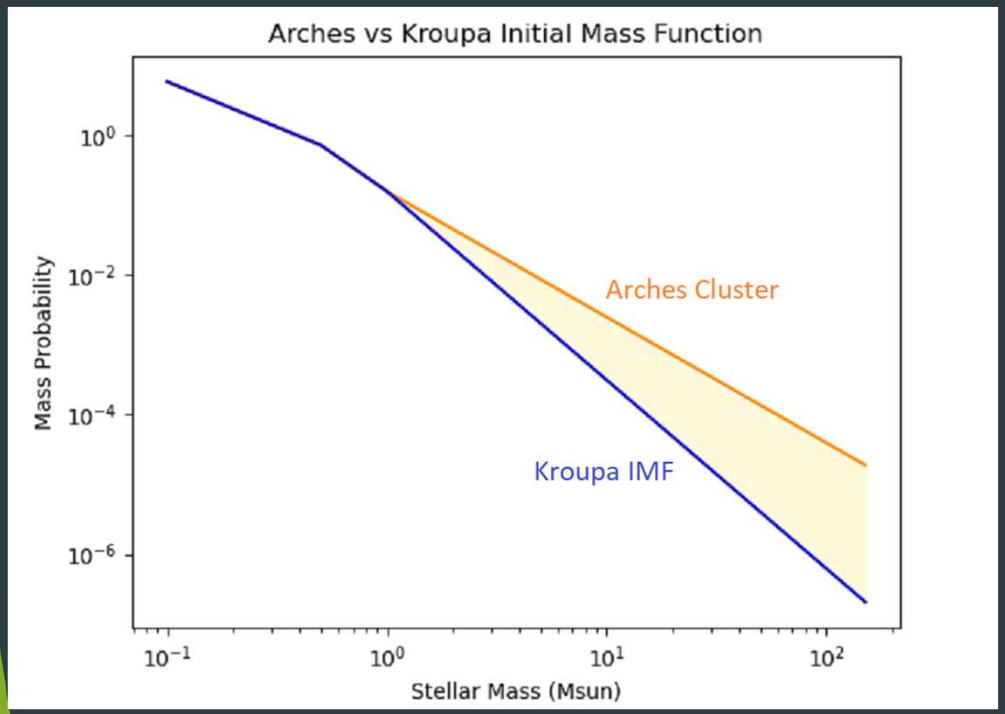
What do we mean by a “unicorn?”

- V723 Monocerotis
- Black hole discovered: Jayasinghe et al. (2021)
- Black hole disproven: El-Badry et al. (2022)



Building the Model



Kroupa et al. (1993)

Hosek et al. (2019)

COSMIC: Breivik et al. (2020)

Image: NASA/ESA HST

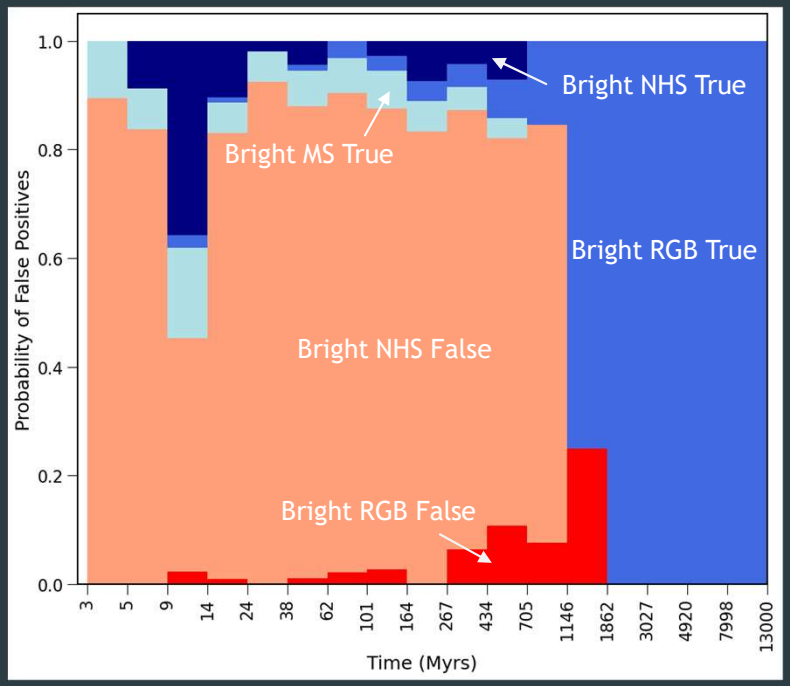
Limiting Criteria

- Dark companion
  > 1.45 M_{sun}
- Bright star
  < 10.0 M_{sun}
- Period:
  5 < p < 100 days

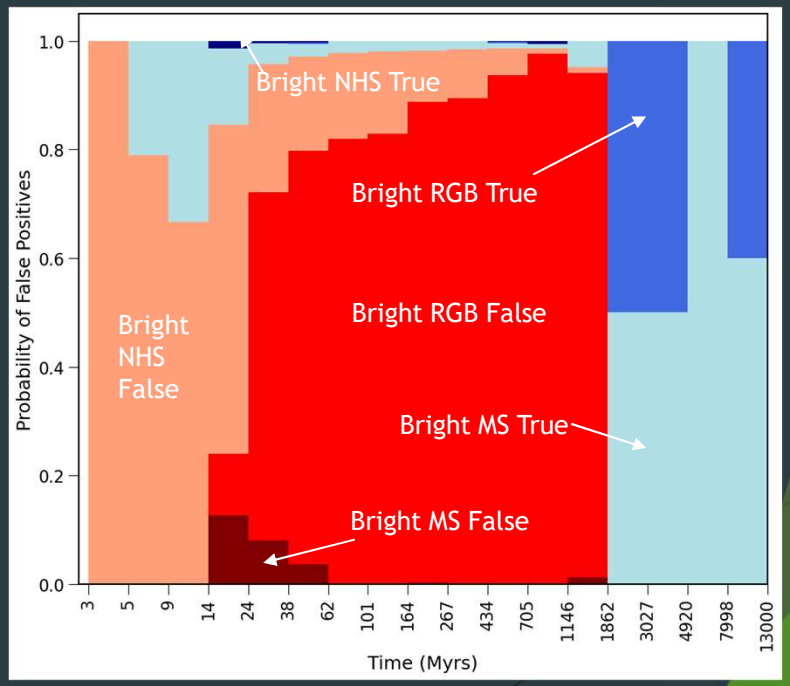
True Unicorns	False Positives
Neutron Star/Main Sequence	Red Giant/Main Sequence
Neutron Star/Red Giant	Red Giant/Red Giant
Neutron Star/Naked Helium Star	Naked Helium Star/Main Sequence
Black Hole/Main Sequence	Naked Helium Star/Red Giant
Black Hole/Red Giant	
Black Hole/Naked Helium Star	

Results: Kroupa IMF (Kroupa et al. 1993)

Criteria #1 (Dark object more massive)



Criteria #2 (Dark object more or less massive)



Conclusions:

- Our models help show the likelihood that the dark object in a binary pair is a black hole or neutron star
- Compact objects are more likely if:
  - Bright star is older than 2 billion years (Gyrs)
  - Bright star is on the main sequence
  - Stars are formed under a top-heavy IMF (metallicity may affect this)