Probing Electron Capture Supernovae

X-Ray Binary Observations

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Supernova - Death of a Star

- Violent explosion which creates a neutron star or black hole
- Asymmetries in the explosion give compact object significant velocity (natal kick)

Electron Capture Supernovae

- Proposed method of supernova collapse (Miyaji et al. 1980, Nomoto 1984, 1987)
- Heavy elements merge with electrons, decreasing electron degeneracy pressure
- Much less energetic (smaller natal kick) than iron core-collapse supernovae (Dessart et al. 2006, Kitaura et al. 2006)

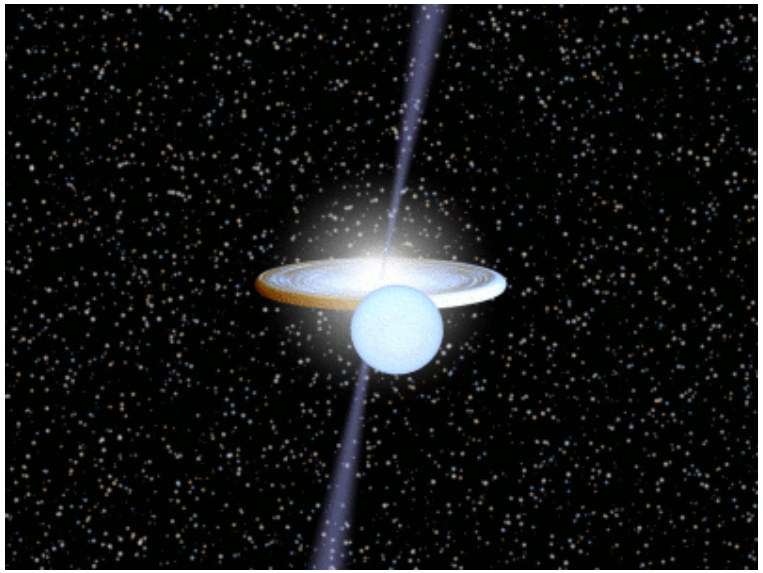
ECS Uncertainties

- Stellar core mass for ECS is highly uncertain
- May only produce a couple percent of total supernovae events (Poelarends et al. 2007)
- But could be much more important in binaries (Podsiadlowski et al. 2004)

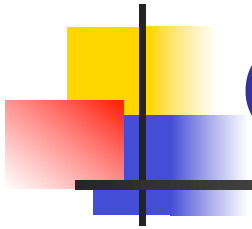
ECS in binaries

- Binary properties easy to observe
- Neutron Stars from ECS are smaller
- Smaller natal kick leads to higher survival rate, and different orbital separations and eccentricities

X-Ray Binaries (XRBs)



- Tightly orbiting compact object and nuclear-burning star
- Mass is transferred from the star into the deep potential well of the compact object
- Matter heats up as it falls, emitting X-Rays with a characteristic spectrum

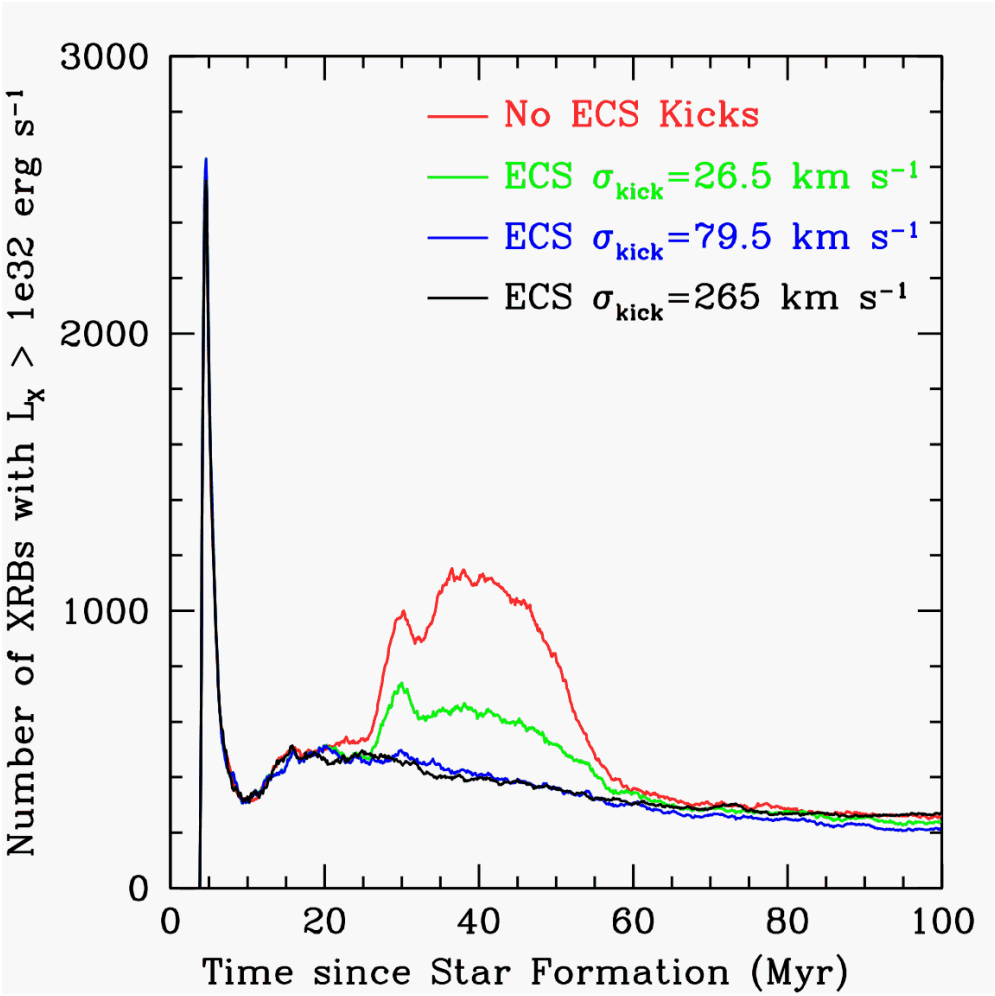


Our Models

- Use population synthesis method (Belczynski et al. 2005, 2008)
- Randomly generate initial binary parameters
- Use theoretical predictions for subsequent evolution and XRB production

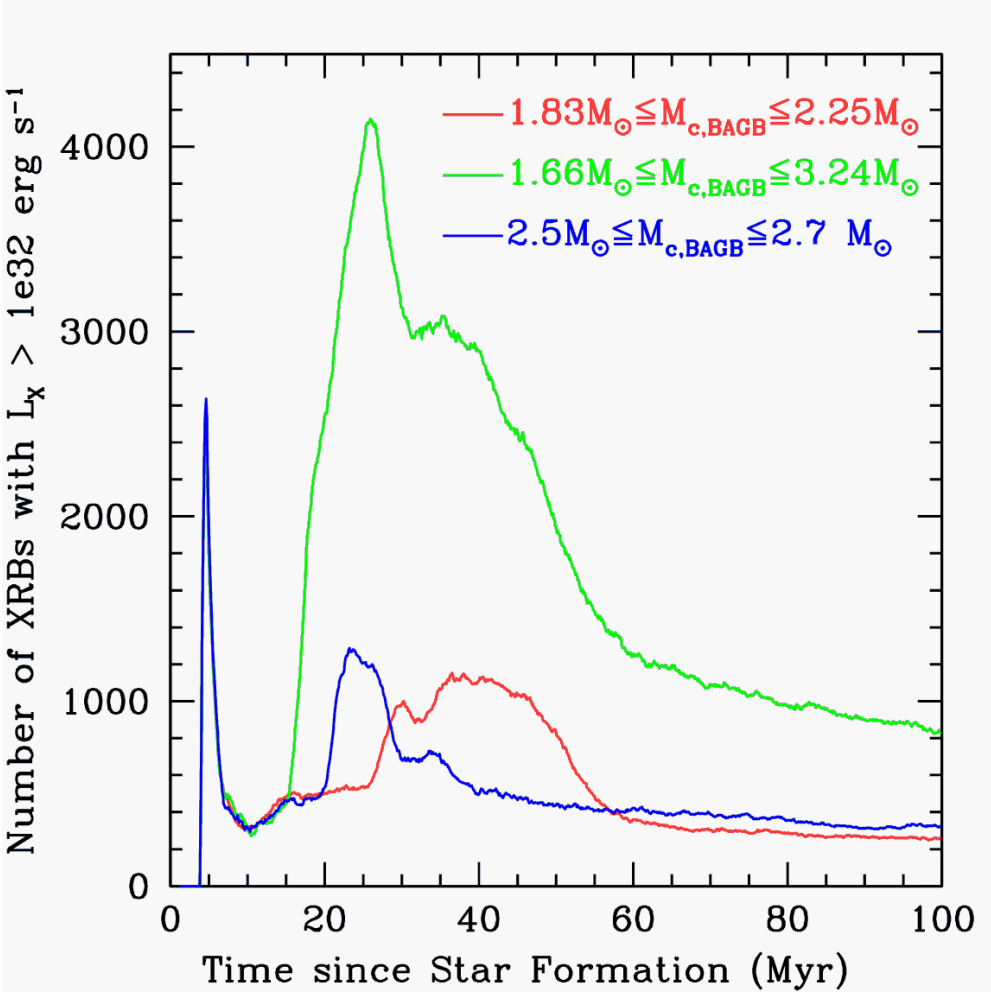
ECS natal kicks

- ECS systems create bulge between 25-60 Myr
- Bulge due to the small natal kicks of ECS



Analysis of ECS Mass Ranges

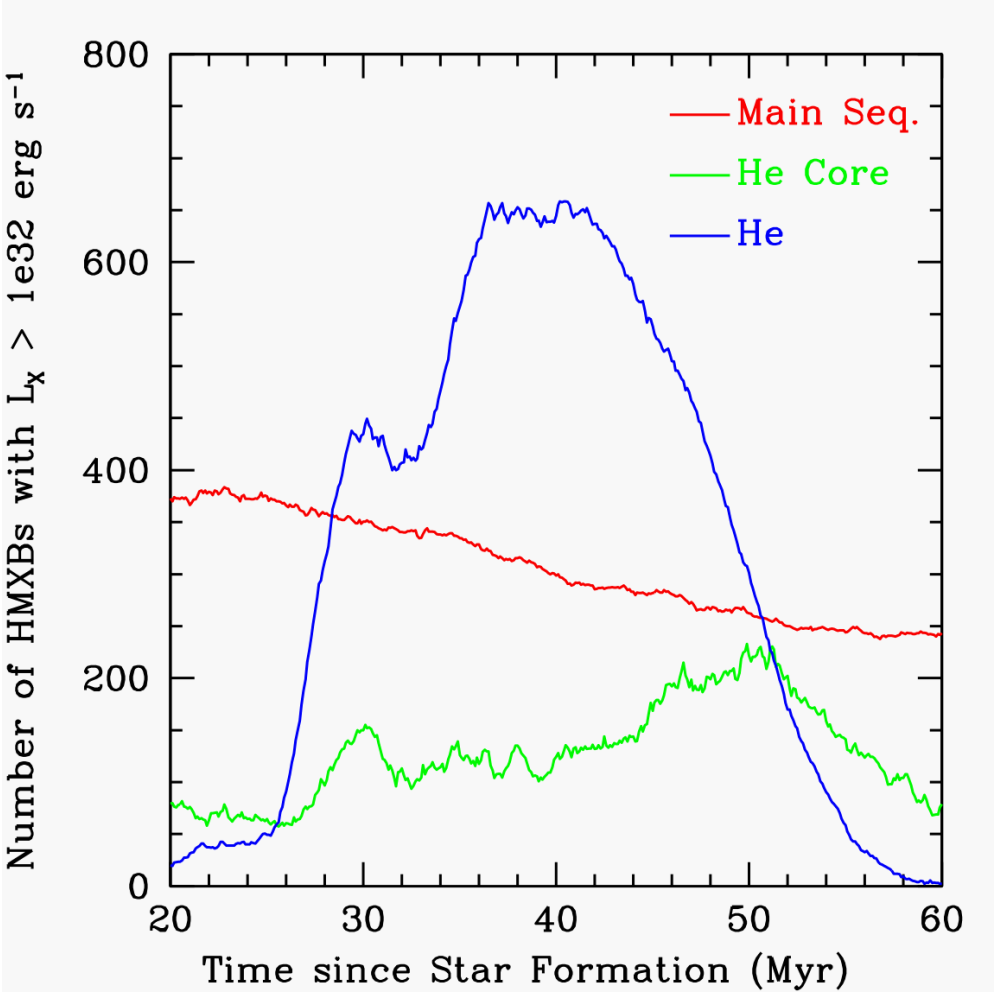
- Intensity and timing of peak highly dependent on mass range
- Size of peak <u>not</u> correlated to width of mass range



(Assuming no ECS natal kick)

Donor Types

- ECS systems are highly correlated with evolved donor stars
- Main sequence donors are almost entirely background stars



(Assuming no ECS natal kick)

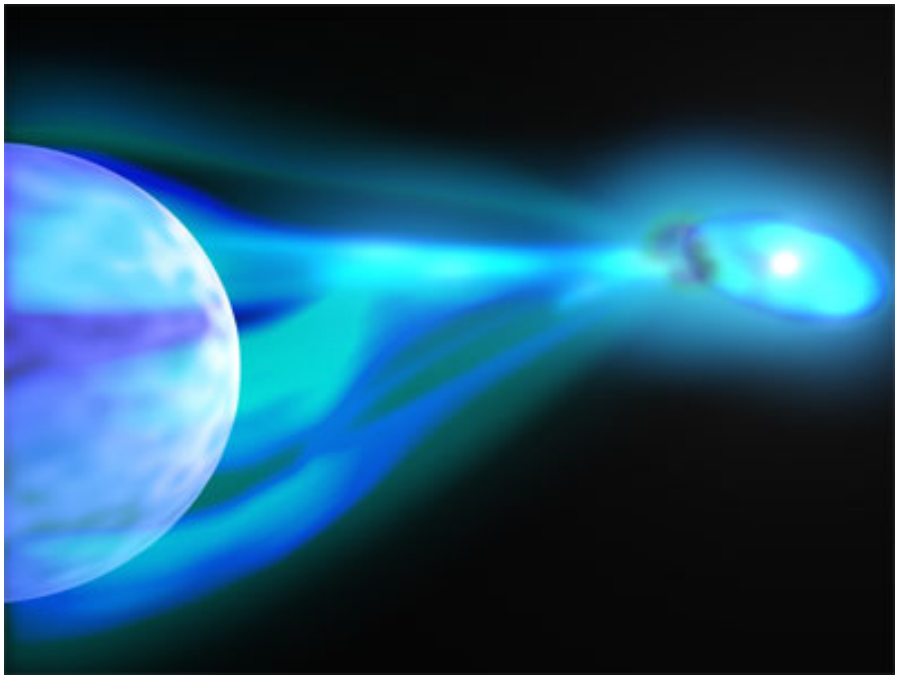
Observational Tests

- Small Magellanic Cloud is a galaxy approximately 60 kpc away
- Experienced intense star formation 30-60 Myr ago
- Found to be overabundant in XRBs with low velocities and eccentricities

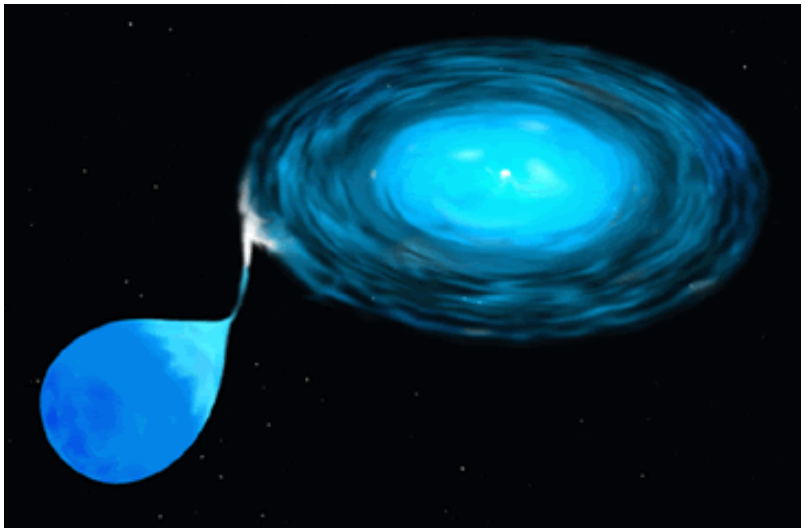
Conclusions

- XRBs allow us great insight into the formation of massive stars in distant galaxies
- ECS may produce a substantial number of XRBs, but the parameters are still uncertain
- The ECS mechanism provides the best explanation for explaining XRBs in the Small Magellanic Cloud

Types of X-Ray Binaries



Wind Accretion



Mass Transfer