Low Mass X-ray Binaries: Population at Roche Lobe Overflow

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Abstract: We present an alternative method in constraining the mass transfer evolution of low and intermediate-mass X-ray binaries by using a reverse population synthesis technique. We constrain the possible results obtained by population synthesis using the detailed 1D stellar evolution code MESA. This is done by using the properties observed in persistent binaries to constrain possible population of binaries at the onset of Roche lobe overflow and mass transfer. In addition to constraining progenitor systems of observed systems, this study also allows us to further constrain magnetic braking prescriptions.

Method

Mass transfer is one of the main ways we can probe binary systems, however the number of persistent, well observed binaries is limited[2,6,11].

Using MESA[8,9,10], we run binary simulation models using a variety of initial conditions to test possible donor masses and initial periods that may reproduce observations. The models were done using the default prescription for magnetic braking[12].

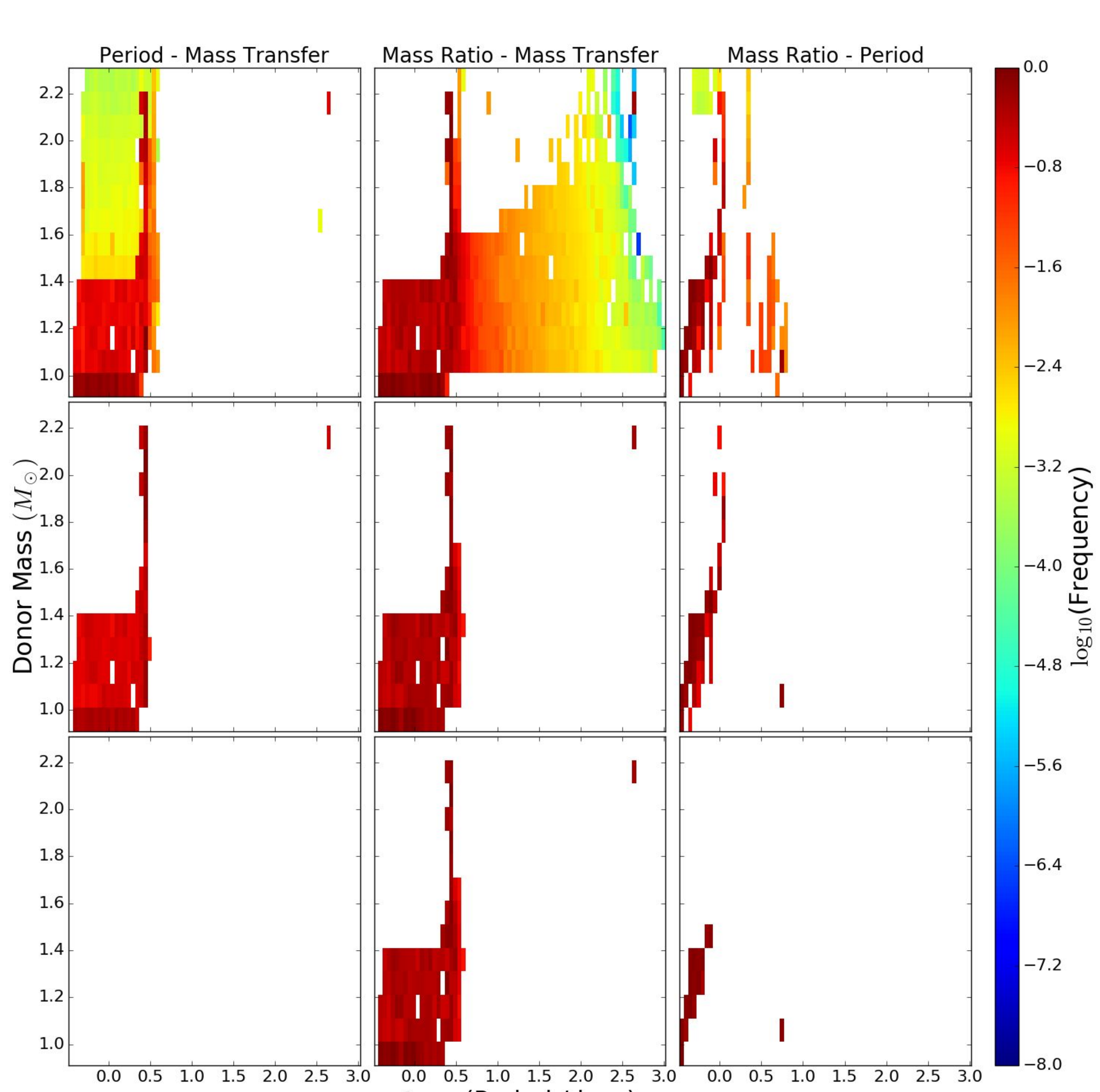
Different magnetic braking schemes are tailored for different systems[3,4,7] and it is uncertain if the default magnetic braking is appropriate for the systems being modelled.

The simulated models can be combined together to produce a density plot allowing for comparisons between simulations and observed models.

Models that come within a certain range of observed values can be traced back to their initial conditions giving insight to what possible configurations may have formed observations.

Possible Progenitors

By comparing the observed systems to the simulated results we can produce a set of possible progenitors to the persistent systems.

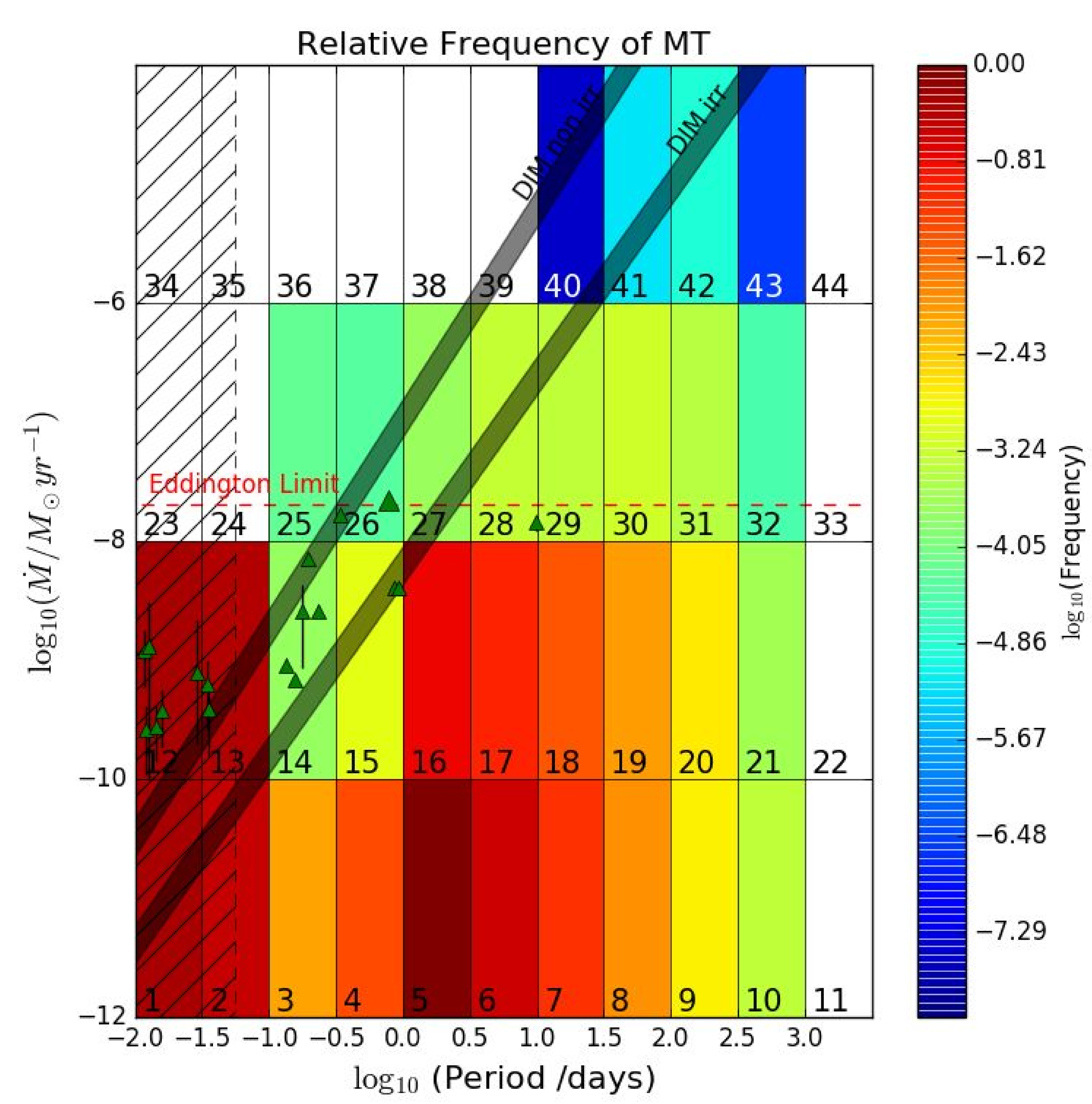


The three columns show what two variables we compared between observation and simulation.

The three rows are amount of time we require a simulation to appear similar to an observed system. From top to bottom, 0 years, 10^6 years, and 10^7 years.

Normalized Frequency Plot

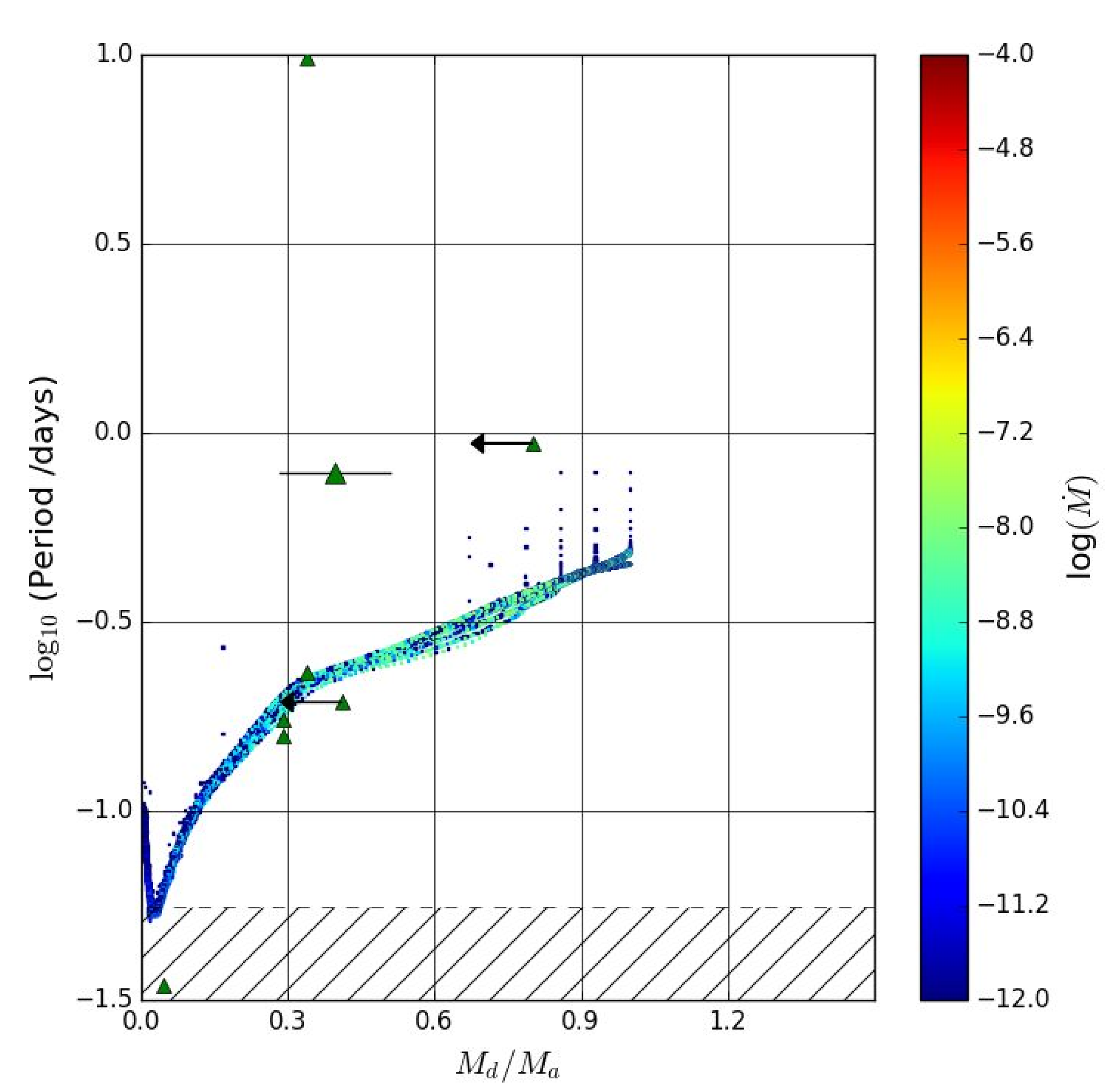
Binning the total amount of time spent in each grid square, and normalizing to number of models that pass through, we can produce a normalized frequency plot.



The hashed area shows the systems that are considered "ultra compact" with periods shorter than 80 minutes[2].

The two grey lines show two disc instability models that theoretically split persistent systems and transient systems[1,5].

Possible Persistent Systems



While in principle, the simulated results can produce persistent systems, if we require that the lifetime of the simulation the be greater than 10^6 years the simulations can no longer match observations.

At 10^6 years there are only a small subset of initial configurations that may produce persistent systems and the observed systems possible are all relatively short period.

Changes to Magnetic Braking are Required to Produce Observed Results

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