# Ultracompact NS/BH Binaries in the Galactic Field

**Chris Belczynski**
Northwestern University

The Physics of Ultracompact Binaries
Feb 1- 2, 2003, KITP, Santa Barbara

## StarTrack: Population Synthesis Code

- wind mass loss (standard, LBV, WR type)
- tidal synchronization/circularization
- magnetic breaking, gravitational radiation
- conservative/non-conservative MT
- CE evolution
- rejuvenation of accretor
- hyper-critical accretion onto NS/BH in CE's
- detailed SN treatment (kicks, eccentric orbits)
- fall back and direct BH formation

# Initial Conditions:

*Primary mass: 5-100 Msun, IMF~ - 2.7*

*Secondary mass: 0.5-100 Msun, flat q distr.*

*Separation: distr. flat in logarithm*

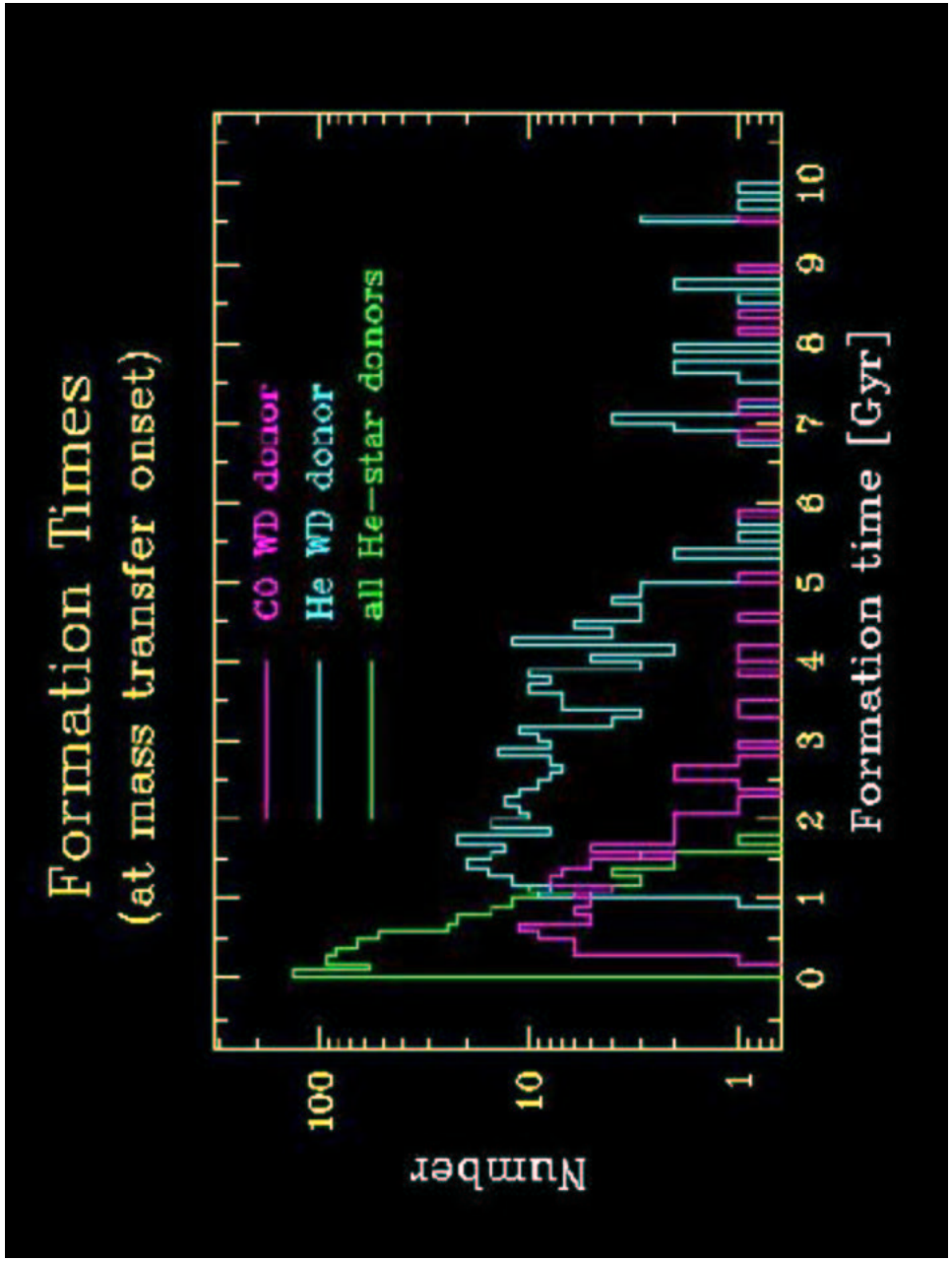
*Eccentricity: thermal distr.*

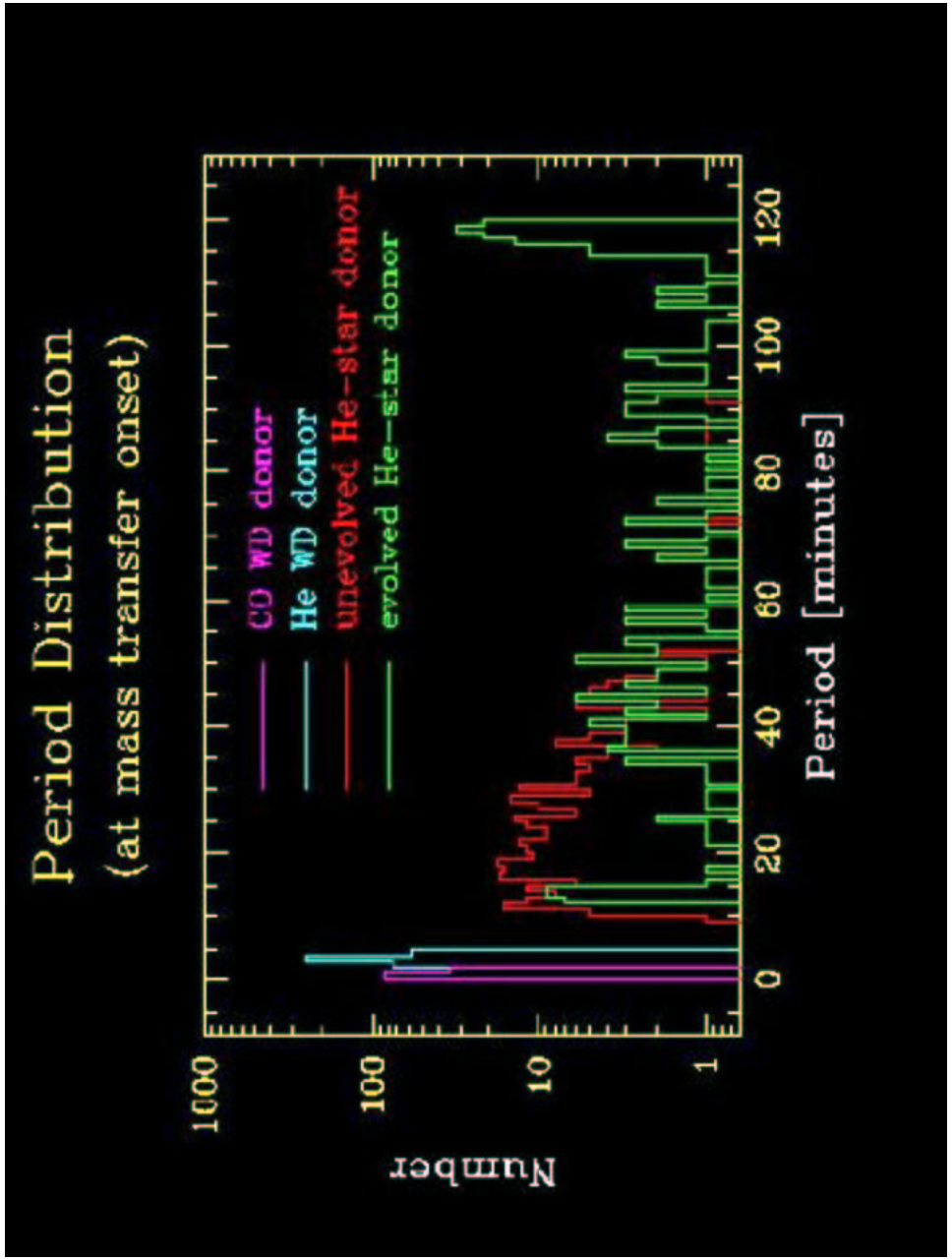
*Standard evolution: Arzoumanian et al. 2002 kicks, Webbink 1984 CE: $\alpha\lambda$=1, Hurley et al. 2000 single star evolution, Fryer 1999 core collapse BH masses, Hut 1982 tidal evolution, Rappaport et al. 1983 magnetic breaking, .....*

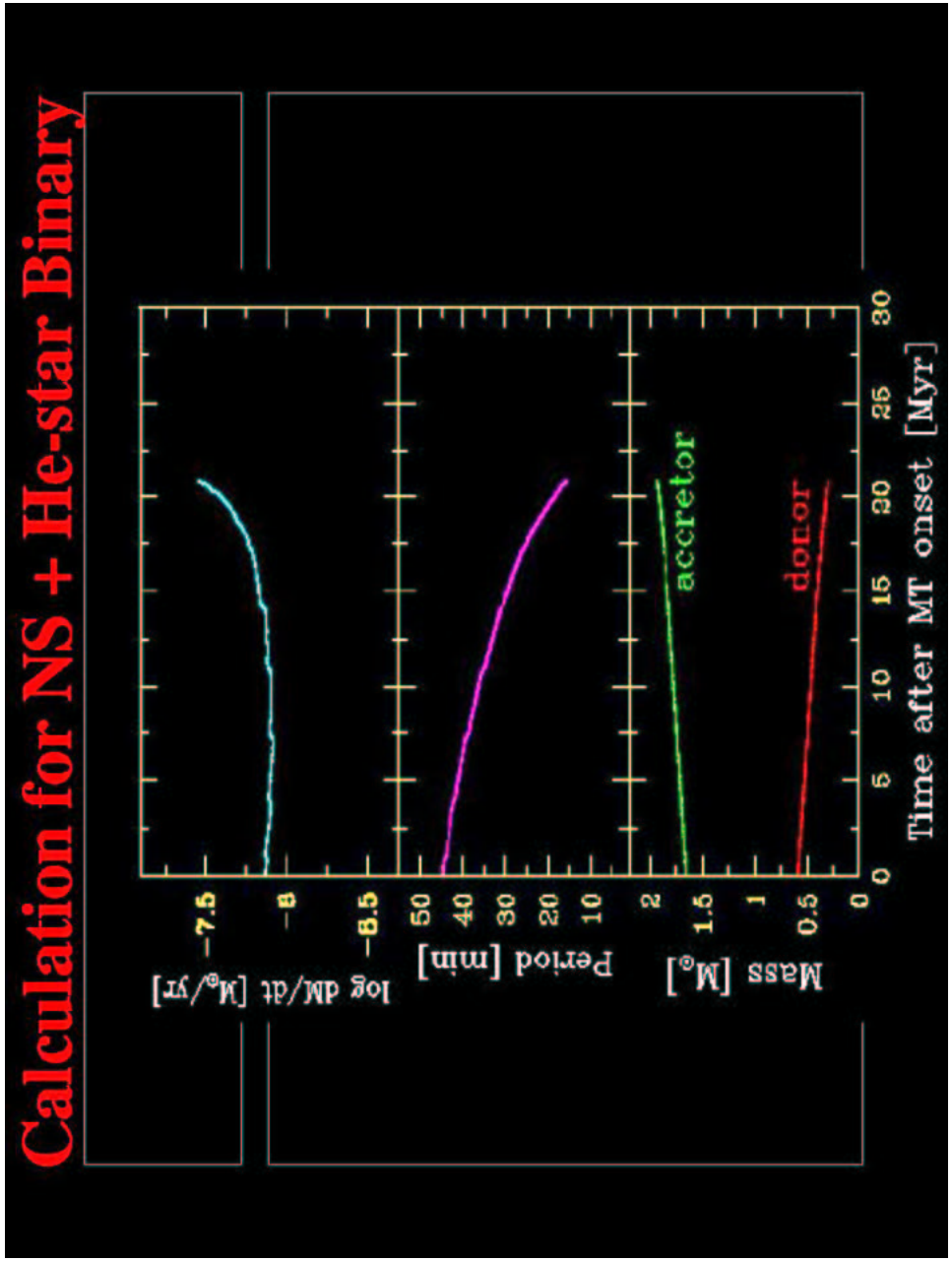
# Formation Rates

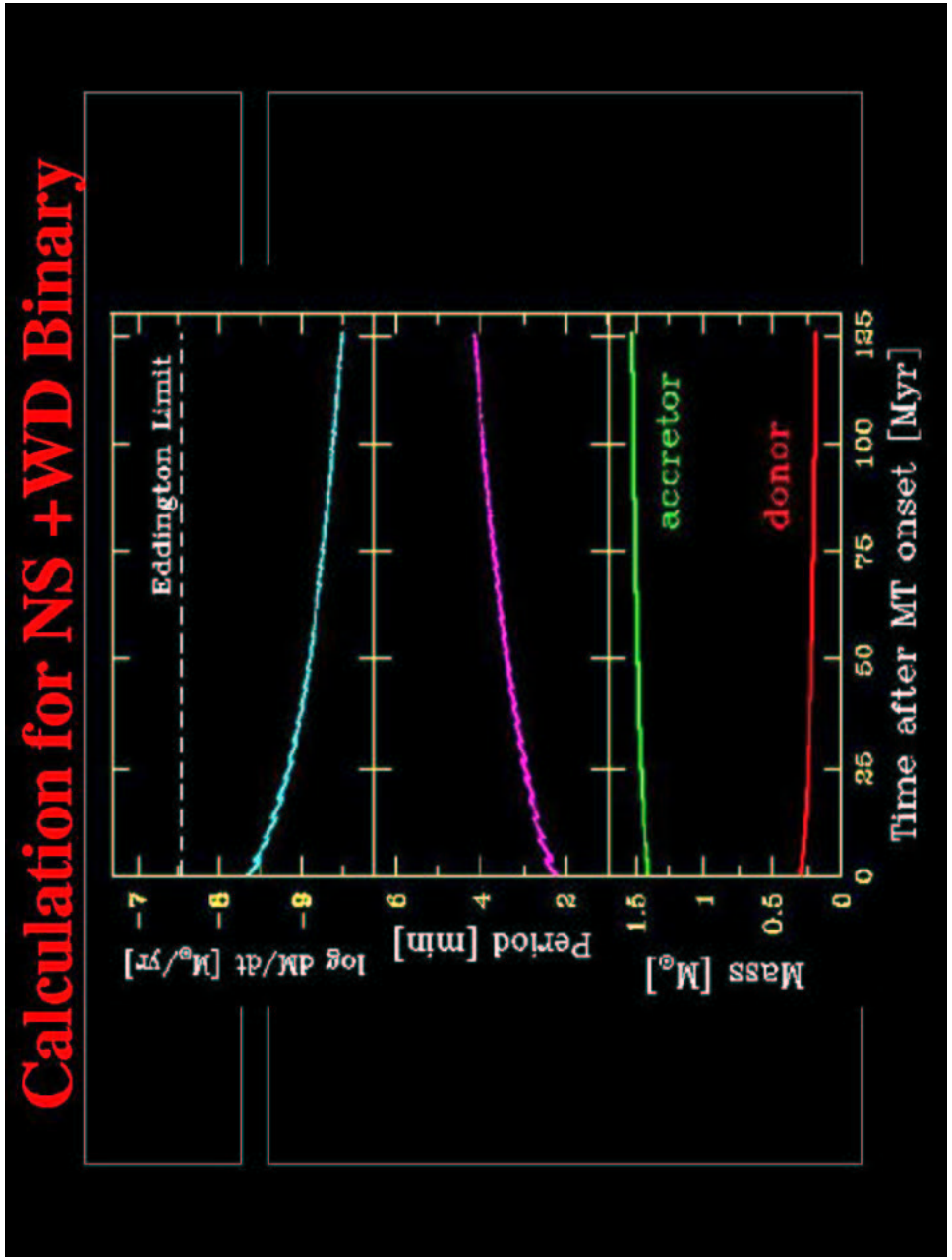
**number of binaries evolved:** $1.6 \times 10^6$
**binary fraction: 50%**
**metallicity: 0.02 (solar)**
**SFR: outburst**
**SN II rate: 0.86 per 100 yrs per** $10^{10} L_{\odot}^{blue}$
**(Cappellaro et al. 1999)**

| Binary Type | Number | % | Galactic Rate [$Myr^{-1}$] |
|---|---|---|---|
| All systems | 1088 | 100% | 26.4 |
| NS accretor | 1069 | 98 % | 26.0 |
| BH accretor | 19 | 2 % | 0.4 |
| He-star donor | 586 | 54 % | 14.2 |
| WD donor | 502 | 46 % | 12.2 |


Formation Times
(at mass transfer onset)
CO WD donor
He WD donor
all He-star donors
Number
100
10
1
0
1
2
3
4
5
6
7
8
9
10
Formation time [Gyr]


Period Distribution
(at mass transfer onset)
CO WD donor
He WD donor
unevolved He-star donor
evolved He-star donor
Number
1000
100
10
1
0
20
40
60
80
100
120
Period [minutes]


Calculation for NS + He-star Binary
log dM/dt [M⊙/yr]
−7.5
−8
−8.5
Period [min]
50
40
30
20
10
Mass [M⊙]
2
1.5
1
0.5
0
accretor
donor
0
5
10
15
20
25
30
Time after MT onset [Myr]


Calculation for NS +WD Binary
Eddington Limit
log dM/dt [M⊙/yr]
−7
−8
−9
Period [min]
6
4
2
Mass [M⊙]
1.5
1
0.5
0
accretor
donor
0
25
50
75
100
125
Time after MT onset [Myr]

## Summary: ultracompacts with NS/BH accretors

- Work in progress
- Few tens of systems formed in Galaxy per Myr
- Subpopulation dominated by NS-WD systems

i) initial population consists of 50% WD donors

ii) many He-donors will evolve to become WDs

## Initial Donor Masses