Compact binary coalescence rates and their evolution

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Rates

The expected coalescence rates are uncertain. Typically we hope to know them with the accuracy of plus minus one order of magnitude, or even worse.

We can say a little more about ratios of the rates than about the rates themselves.

I will specifically talk about the rate density as a function of redshift.

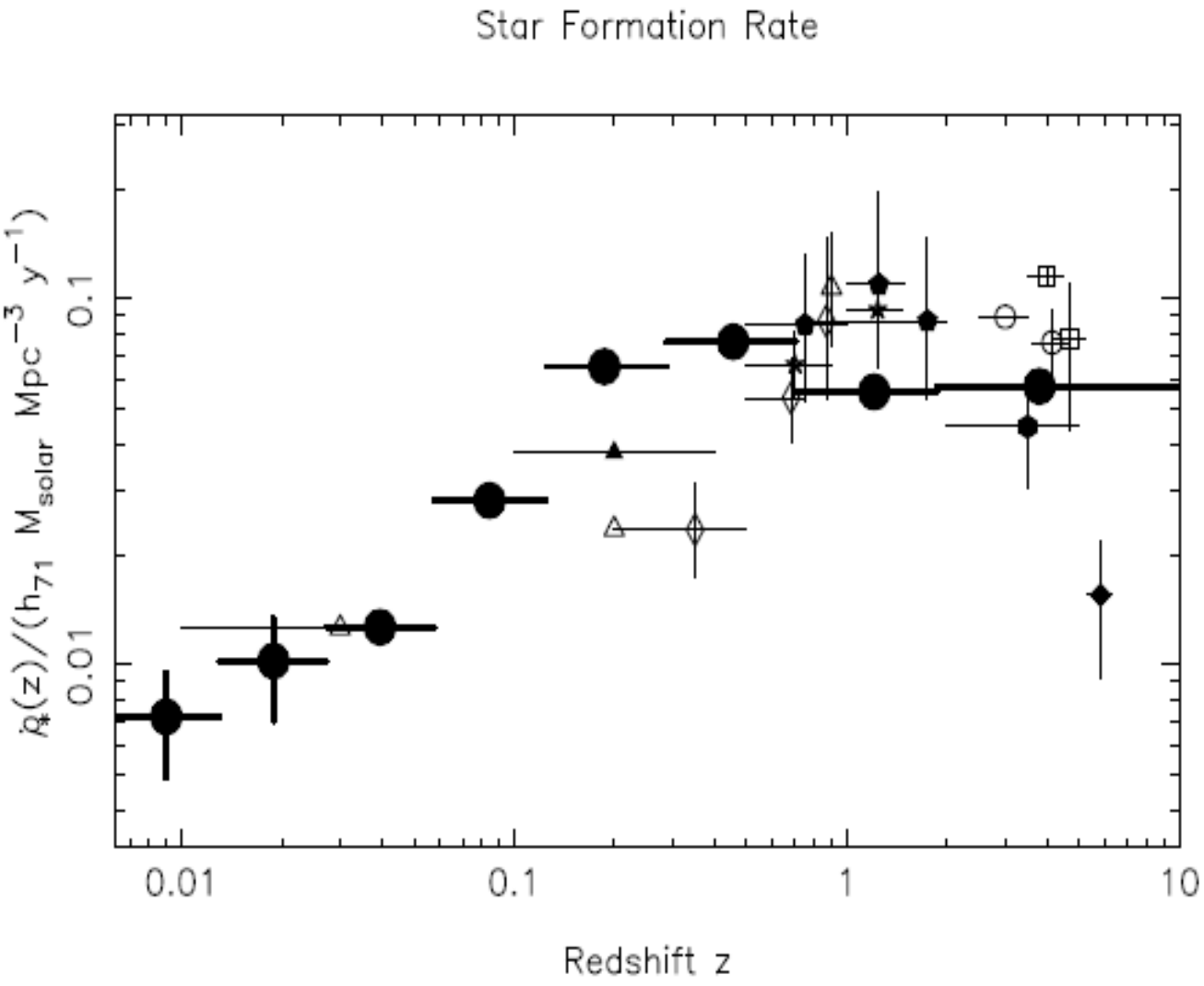
How to get the rates

- Star formation rate history
- Cosmology
- Stellar initial mass function
- Binary evolution:
  - Compact object formation rate
  - Delays between formation and coalescence
- Melatallicity evolution

What we have

- SFR – pretty well determined up to z=2
- IMF – needed for massive stars, Scalo exponent, but probablyt metallicity dependent, what is the upper mass limit?
- Binary evolution: good models exist but
  - CE evolution
  - NS/BH masses
  - Dependence on metallicity Z
  - Winds, etc..

Star formation history

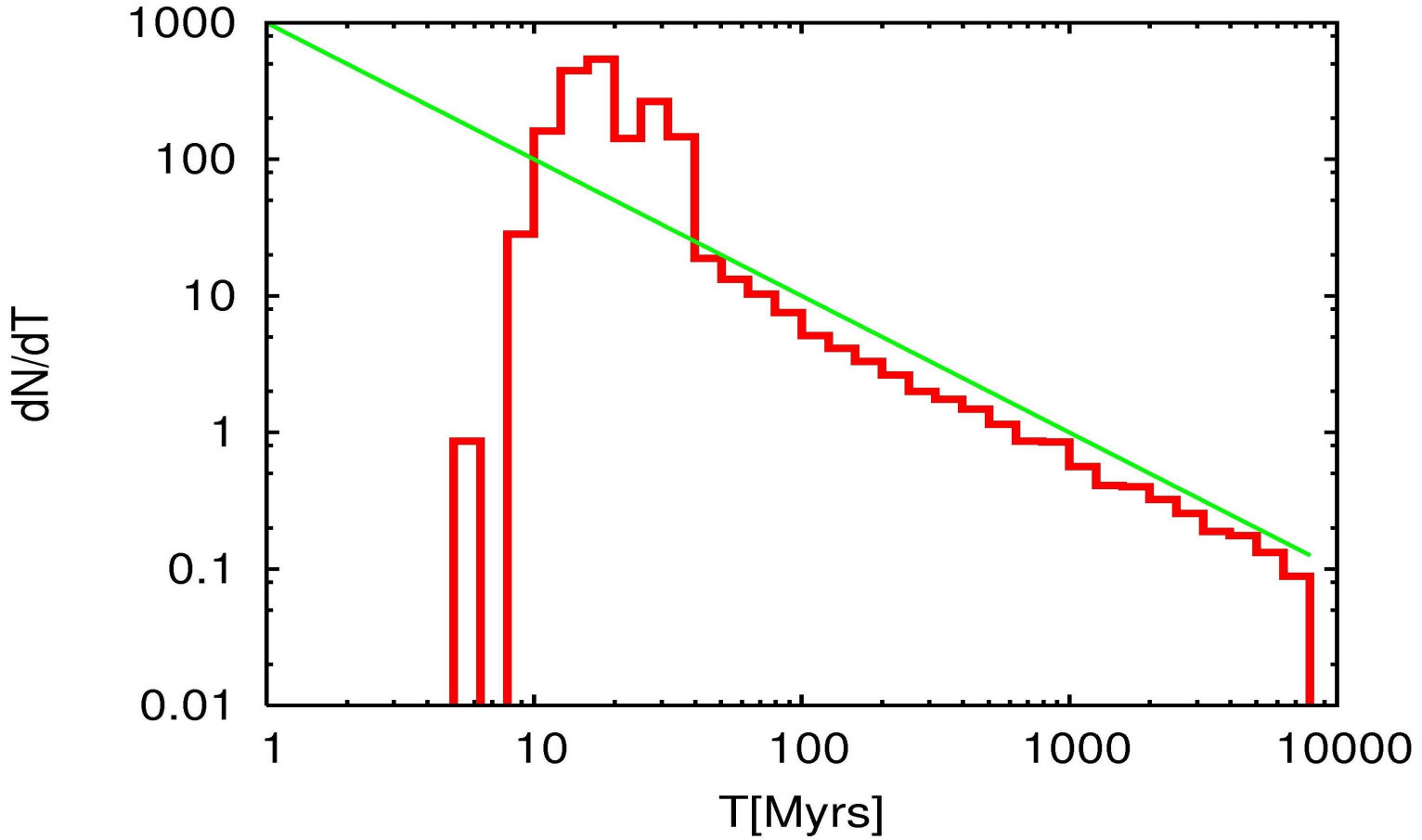


Heavens et al. 2004

Delay distribution

- DNS systems:
  - Observations
  - Modelling with population synthesis codes
- Consistent with 1/t
- Tmin around 10 Myr

Population synthesis - DNS

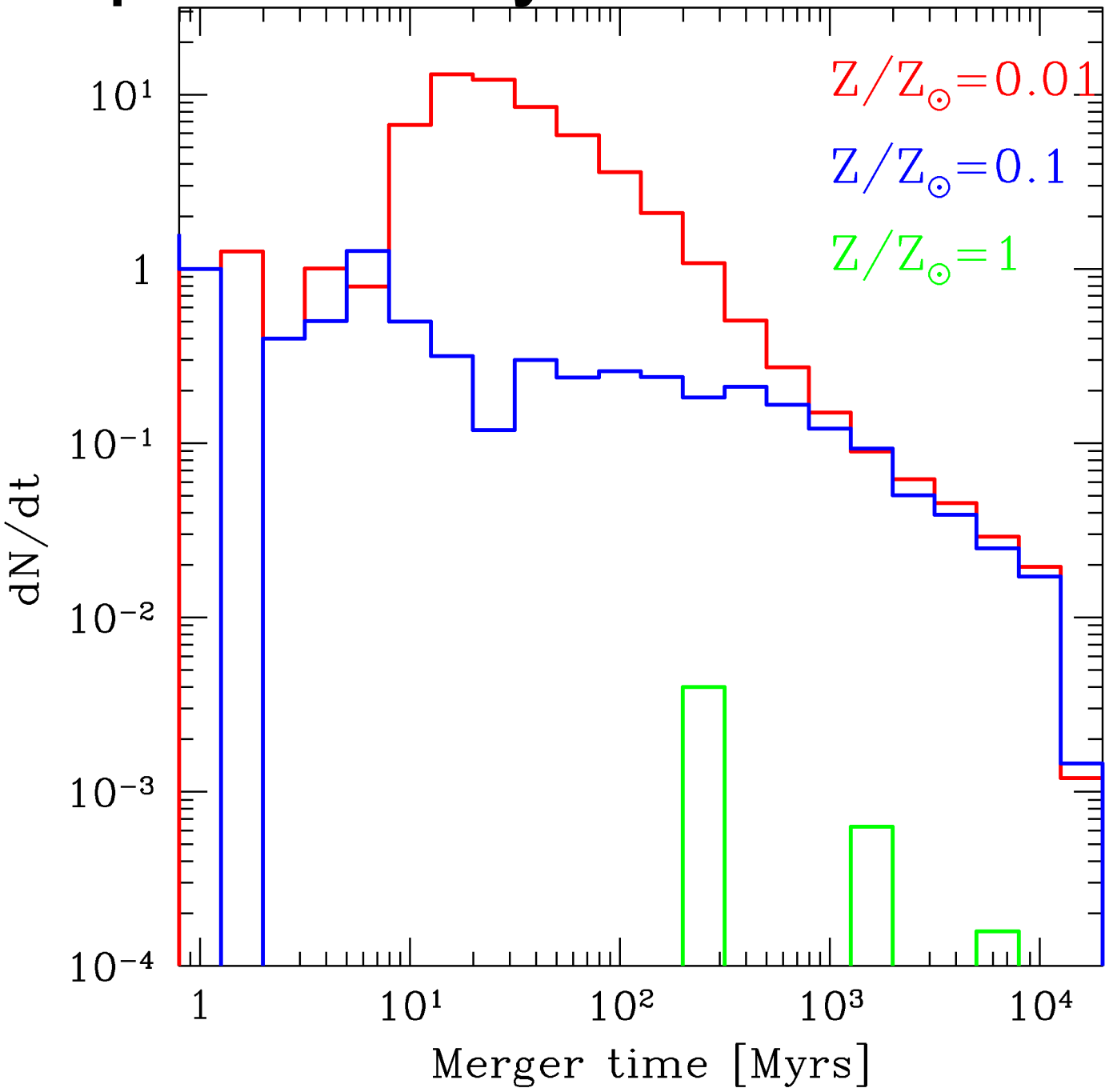


Delay between formation and coalescence

Delay distribution

- BHNS – probably similar to DNS with longer delay
- BBH – formation rate strongly depends on metallicity:
  - longer delays
  - may be flat, or like 1/t
  - metallicity very important

Population synthesis - BBH



Scalings

- Star formation rate – increases as t or even t^2
- Compact object binary formation rate – proportional to SFR, small evolution of metallicity up to z~2
- Delays – 1/t or flatter in case of BBH

- Current rate density has contributions from all redshifts
- What is the history of the rate density

Rate density

- DNS: Increse with z similar to the SFR evolution
- BHNS: probably similar trend to DNS
- BBH: increase dur to two factors:
  - SFR increase with z
  - Evolution of metallicity Z with z

Summary

Rate density will increase at least like the SFR, up to z=1~2.

This means about 10 times higher merger rate at these redshifts than locally.

Rate density as a function of redshoft and masses – to be observed

Science goals: formation of compact objects – core collapse calculations, evolution of massive stars