NICOLAUS COPERNICUS UNIVERSITY IN TORUŃ
Faculty of Physics, Astronomy and Informatics

NATIONAL SCIENCE CENTRE
Opus

What are long duration gamma-ray bursts...

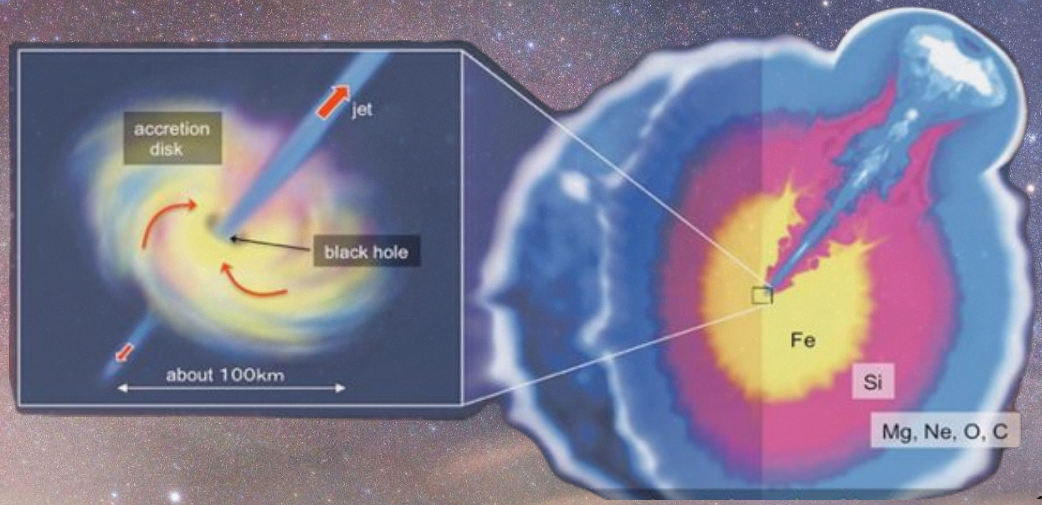


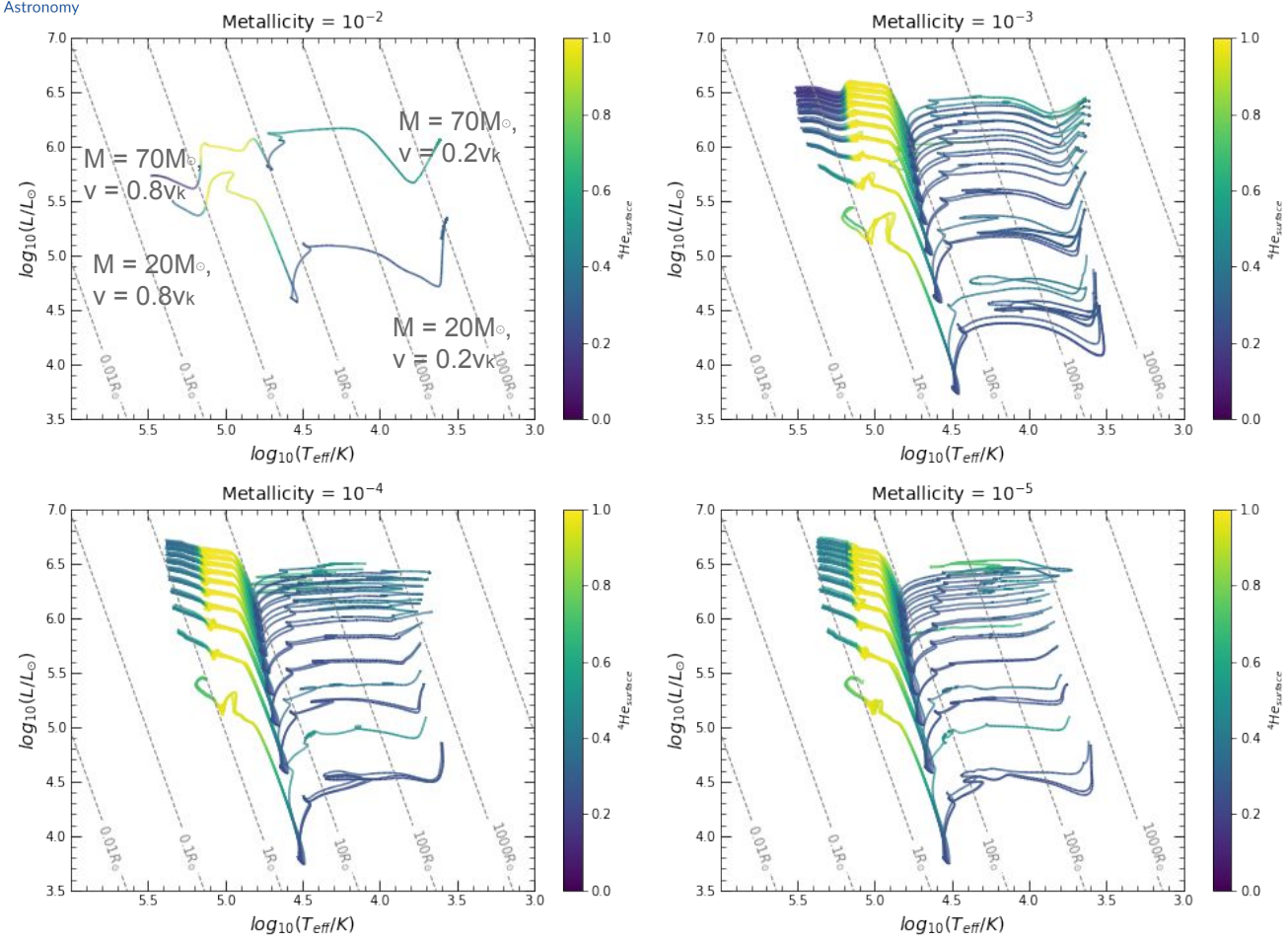
Figure Credit: NASA

Rafia Sarwar
27 February 2024

NICOLAUS COPERNICUS UNIVERSITY IN TORUŃ
Faculty of Physics, Astronomy and Informatics

Evolution of massive stars

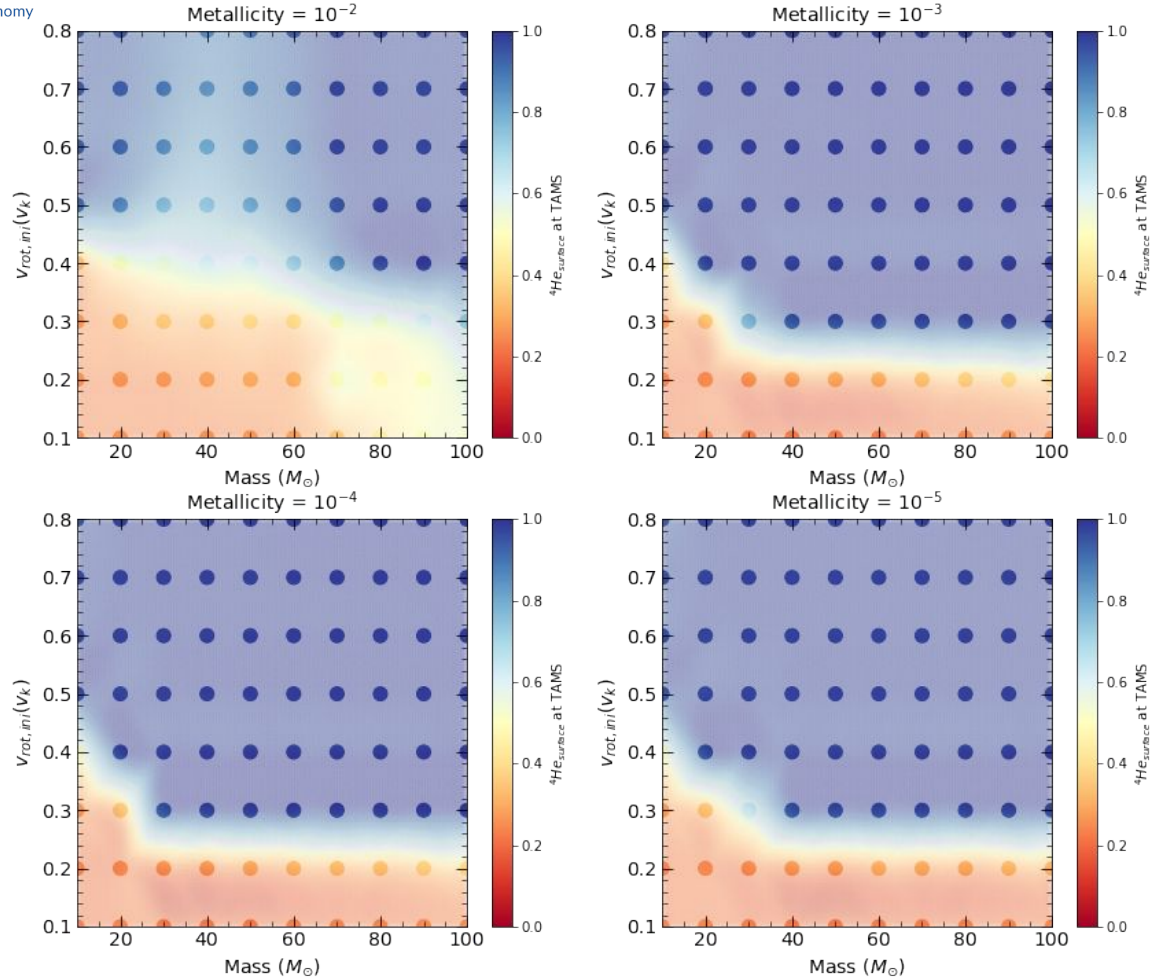
NATIONAL SCIENCE CENTRE
Opus



NICOLAUS COPERNICUS UNIVERSITY IN TORUŃ
Faculty of Physics, Astronomy and Informatics

MESA stellar grid

NATIONAL SCIENCE CENTRE
Opus

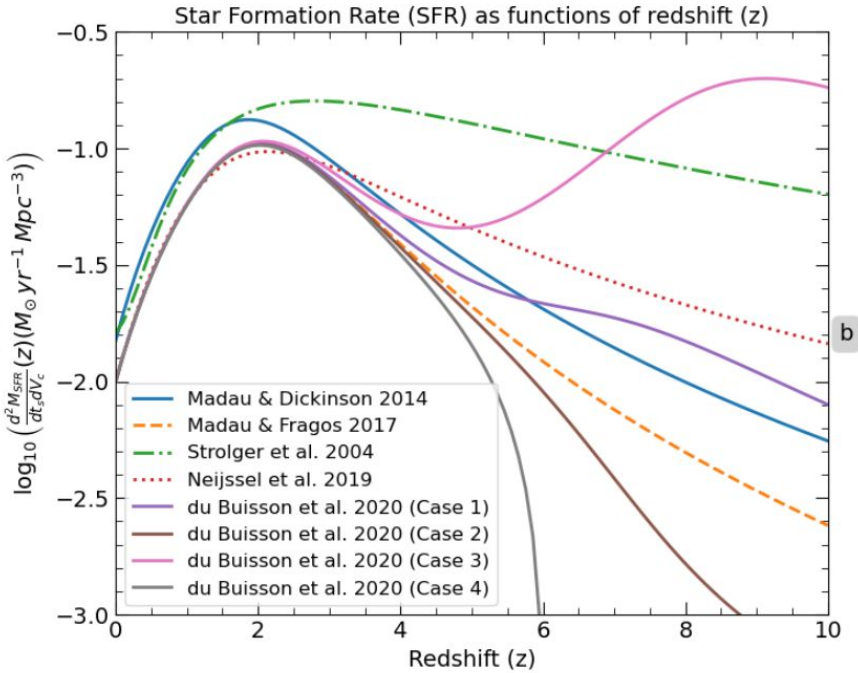


NICOLAUS COPERNICUS UNIVERSITY IN TORUŃ
Faculty of Physics, Astronomy and Informatics

NATIONAL SCIENCE CENTRE
Opus

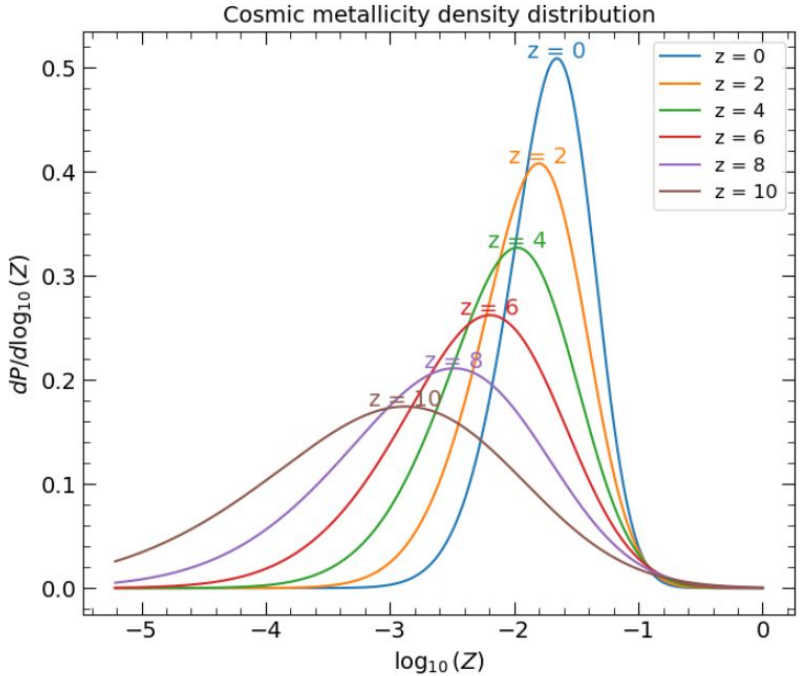
Cosmic star formation rate and metallicity distribution

a



$$\mathrm{SFRD}(z) = \frac{d^2M_{\mathrm{SFR}}}{dtdV_c}(z) = a\frac{(1+z)^b}{1+[(1+z)/c]^d}$$

b

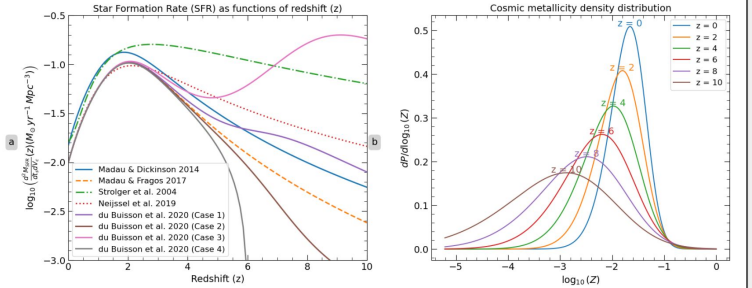


$$\frac{dP}{dZ}(Z,z) = \frac{2}{\omega(z)Z} \times \phi\left(\frac{\ln Z - \xi(z)}{\omega(z)}\right)\Phi\left(\alpha\frac{\ln Z - \xi(z)}{\omega(z)}\right)$$

NICOLAUS COPERNICUS UNIVERSITY IN TORUŃ
Faculty of Physics, Astronomy and Informatics

NATIONAL SCIENCE CENTRE
Opus

Metallicity-dependent cosmic star formation

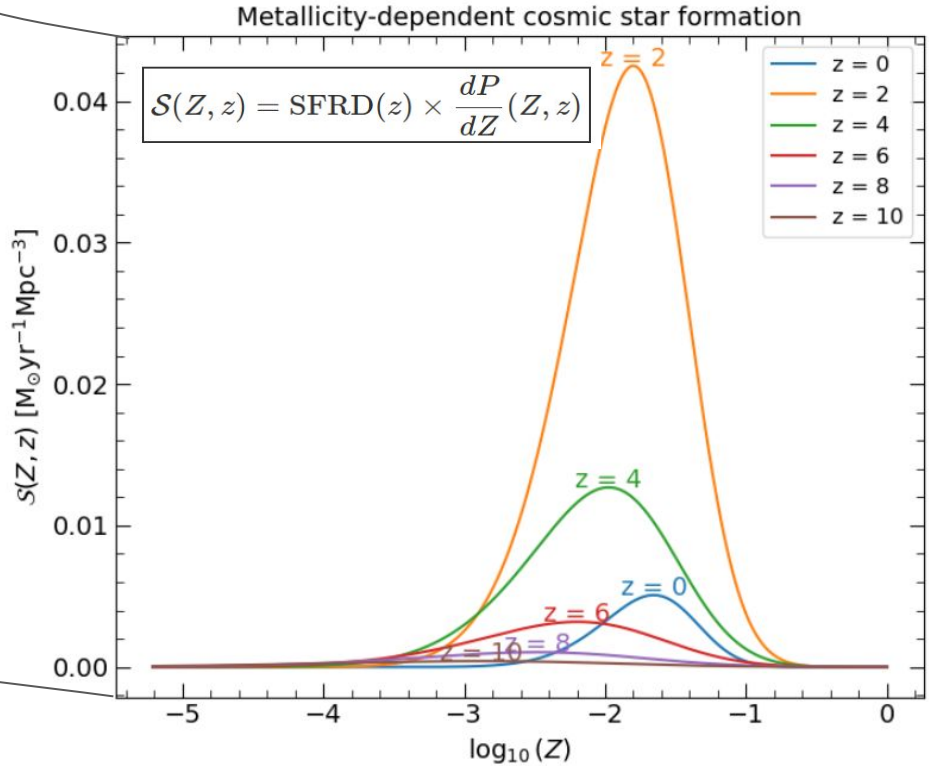


$$\mathrm{SFRD}(z) = \frac{d^2 M_{\mathrm{SFR}}}{dt dV_c}(z) = a\frac{(1+z)^b}{1+[(1+z)/c]^d}$$

$$\times$$

$$\frac{dP}{dZ}(Z,z) = \frac{2}{\omega(z)Z} \times \phi\left(\frac{\ln Z - \xi(z)}{\omega(z)}\right)\Phi\left(\alpha\frac{\ln Z - \xi(z)}{\omega(z)}\right),$$

C



NATIONAL SCIENCE CENTRE
Opus

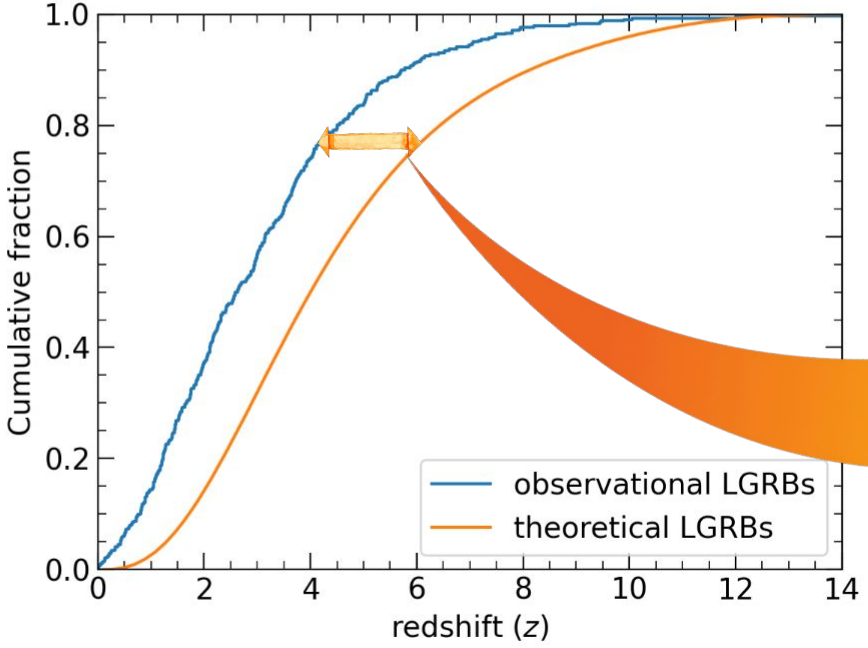
Single star models vs observation

Observational LGRBs Data:

475 GRBs

447 LGRBs

28 SGRBs



https://sites.astro.caltech.edu/grbox/grbox.php?starttime=700101&endtime=181231

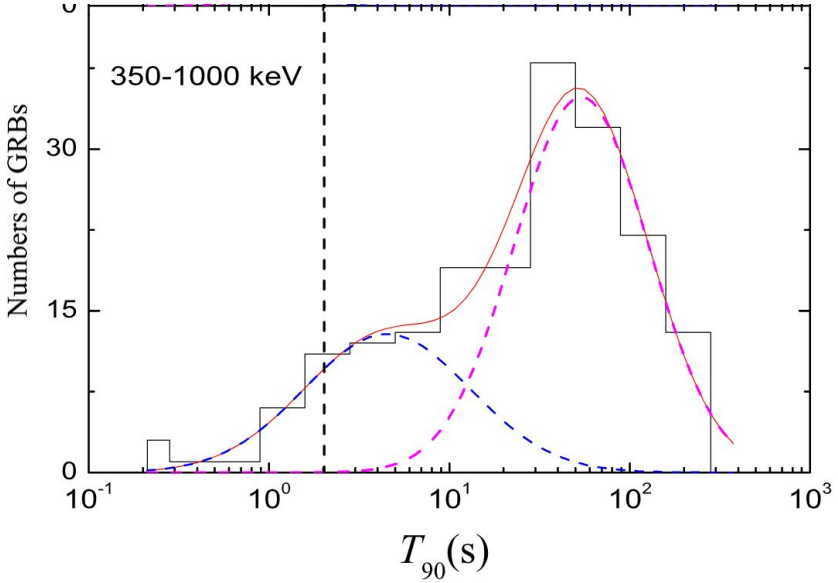
I Horvath et al., (2020)

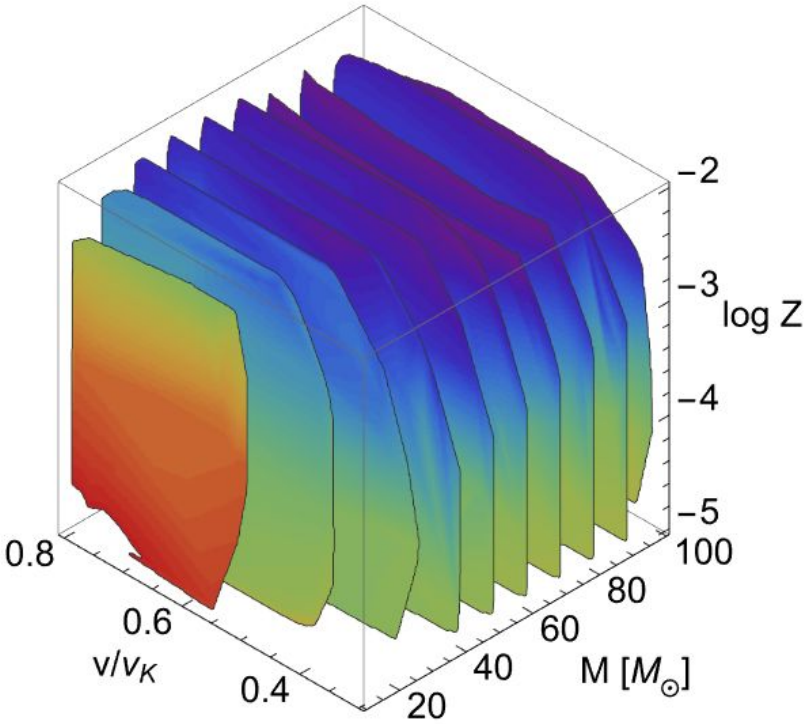
NICOLAUS COPERNICUS UNIVERSITY IN TORUŃ
Faculty of Physics, Astronomy and Informatics

4D convex hull

NATIONAL SCIENCE CENTRE
Opus

$\log t_{ff}\,(M, v/v_K, \log Z) \propto \mathrm{T90}$?



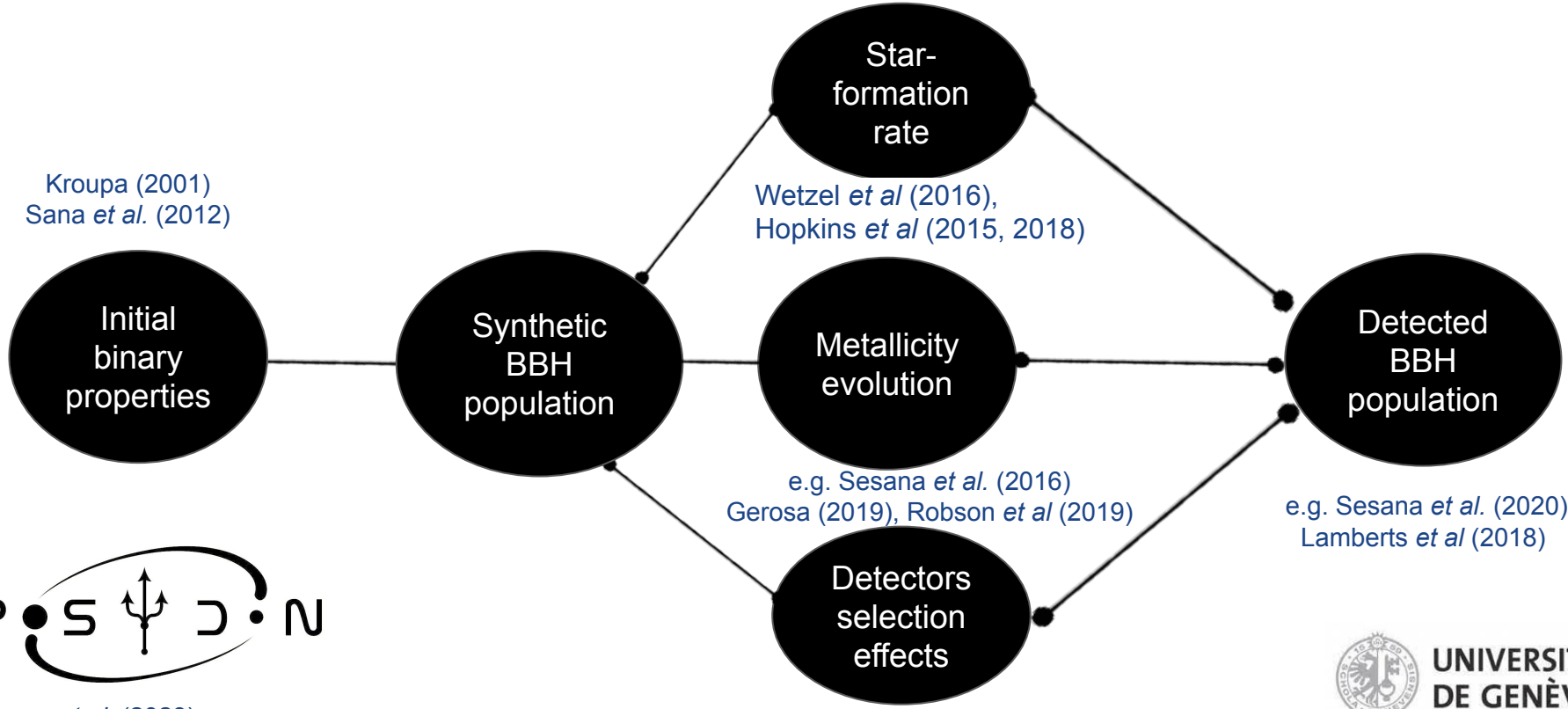


Y. Qin et al. (2013)

NICOLAUS COPERNICUS UNIVERSITY IN TORUŃ
Faculty of Physics, Astronomy and Informatics

BBHs in Milky Way galaxy with LISA

NATIONAL SCIENCE CENTRE
Opus



POSYDON

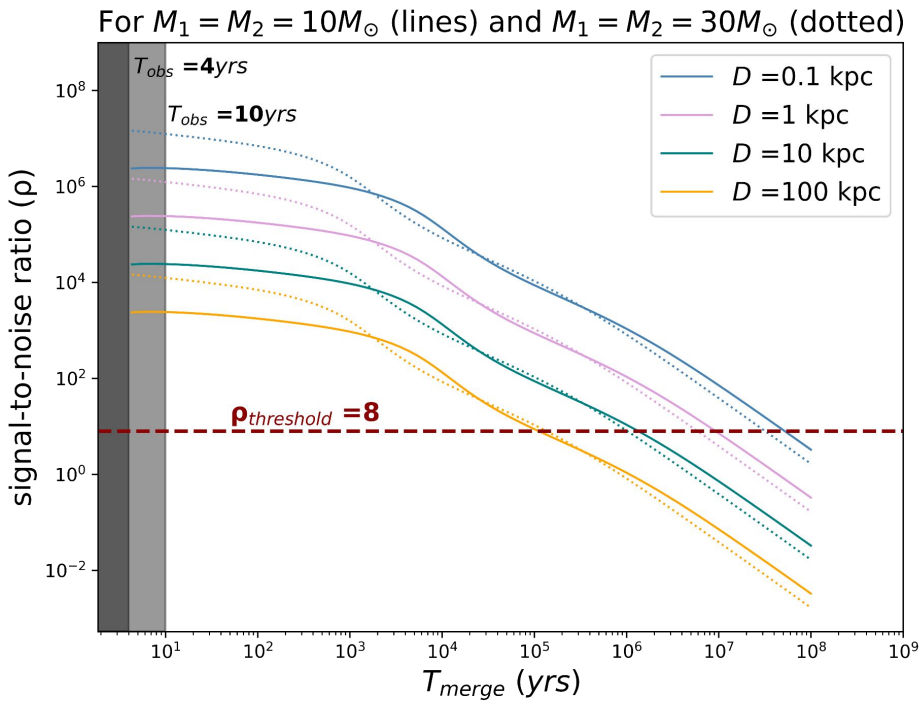
Fragos *et al.* (2023)
https://posydon.org/

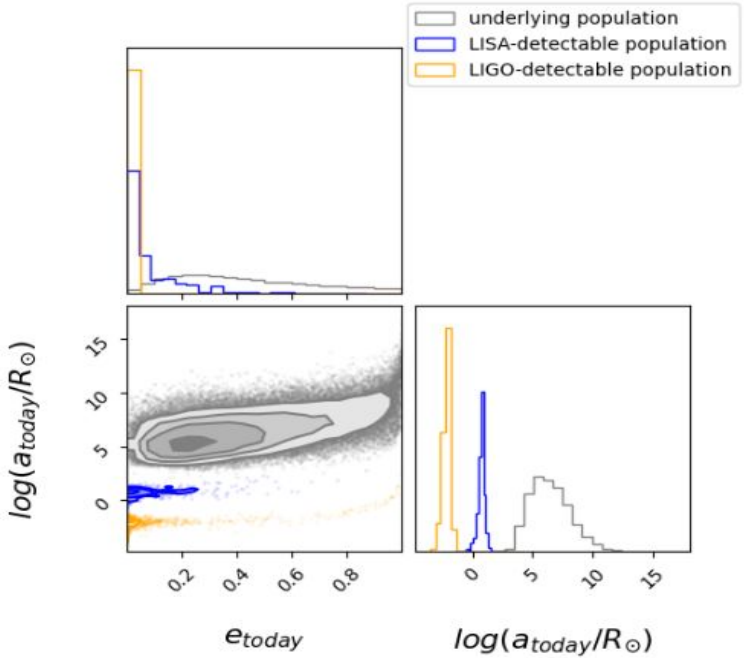
UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département d'astronomie

NICOLAUS COPERNICUS UNIVERSITY IN TORUŃ
Faculty of Physics, Astronomy and Informatics

BBHs in Milky Way galaxy with LISA

NATIONAL SCIENCE CENTRE
Opus





UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département d'astronomie