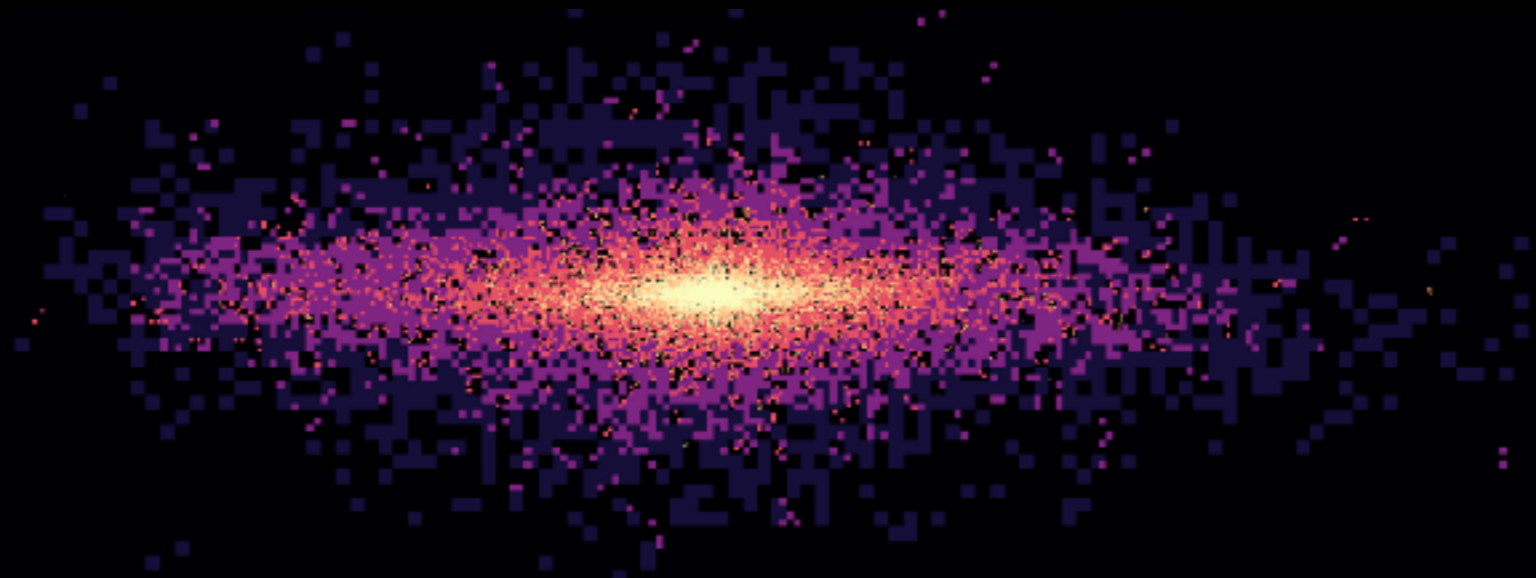


# WHITE DWARF BINAIRES IN THE MILKY WAY



**Astrid Lamberts (Observatoire de la Côte d'Azur)**

**Sarah Blunt, Thomas Kupfer, Tyson Littenberg, Shea Garrison-Kimmel, Robyn Sanderson**

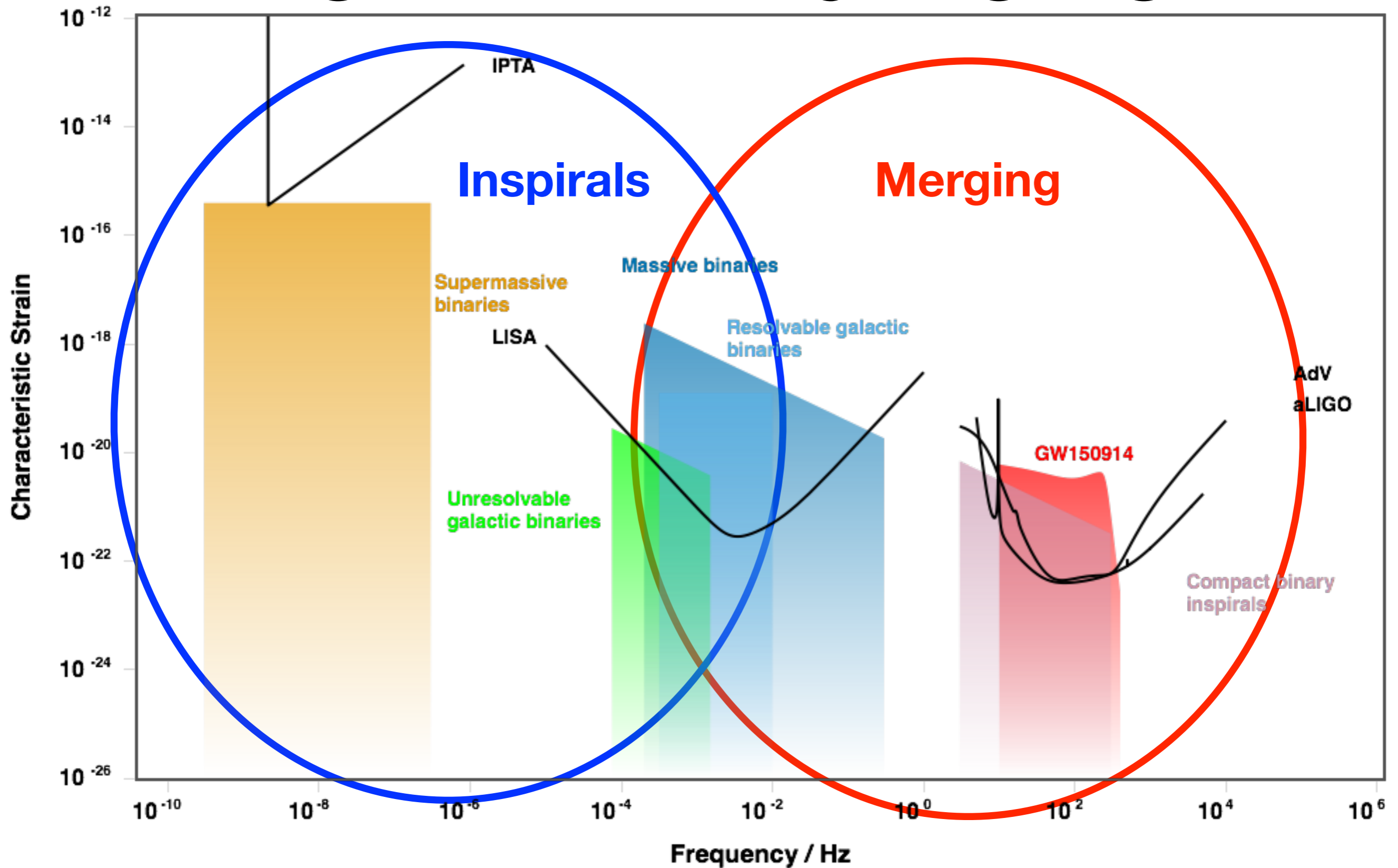
**arXiv.1907.00014**



**Observatoire**  
de la CÔTE d'AZUR

**June, 25, 2019, EWASS-SS22**

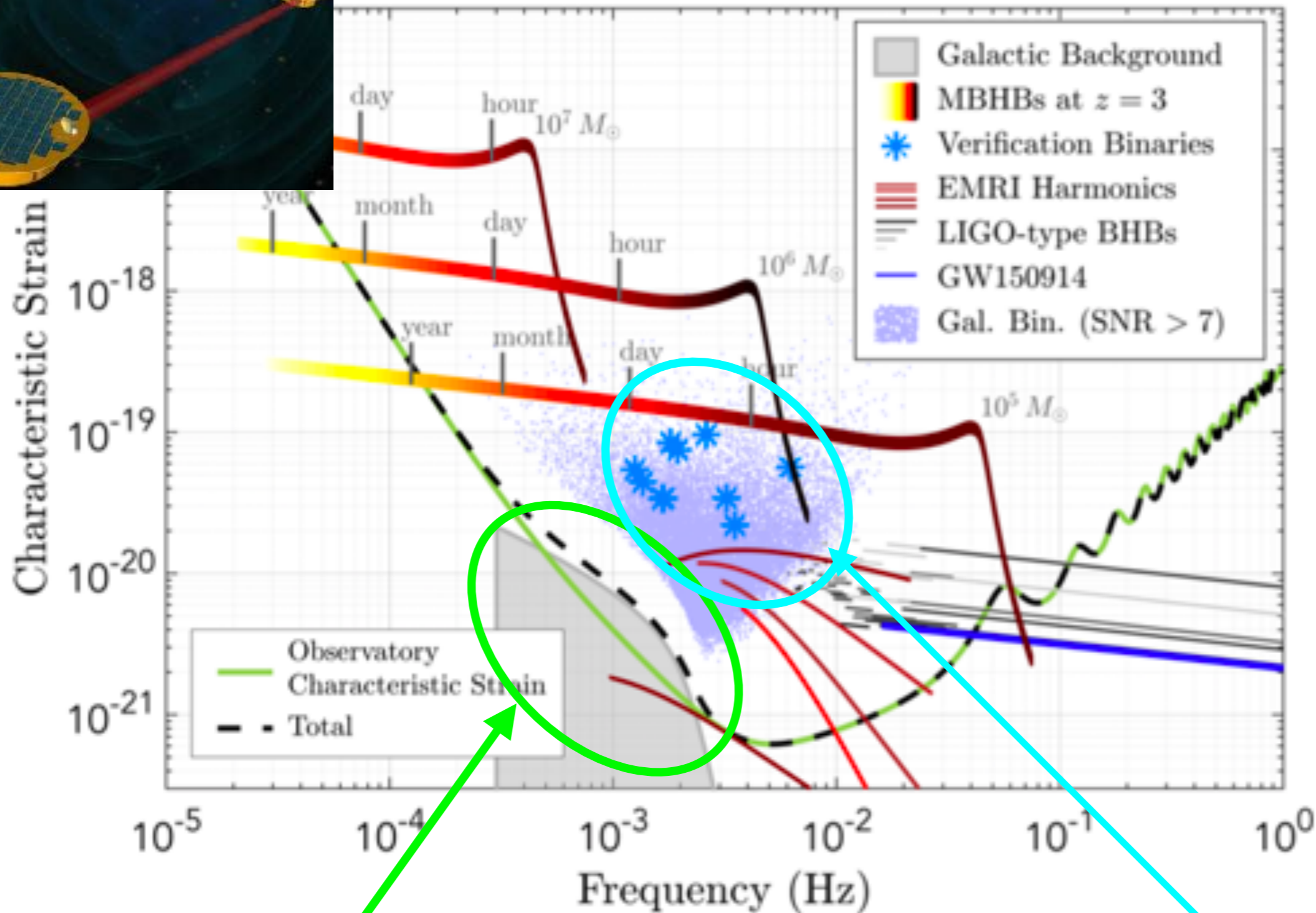
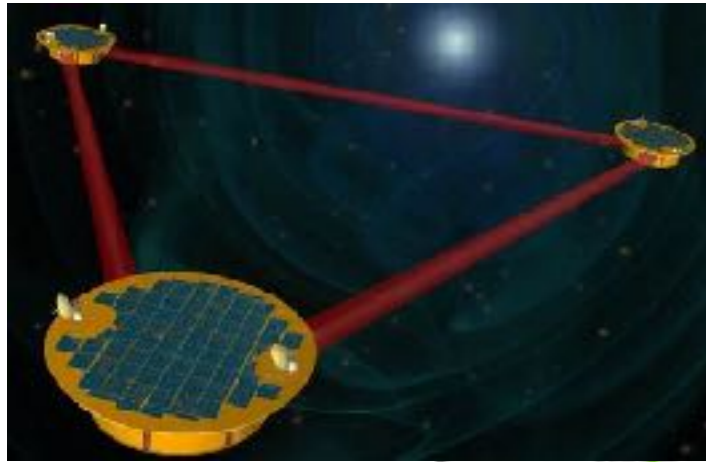
# A WHOLE NEW ASTRONOMY



Frequency gravitational wave = 2 x orbital frequency

# 2035 : ULTRACOMPACT WHITE DWARF BINARIES

WITH LISA



Unresolved sources:  
Confusion noise

Verification binaries  
Periods : few minutes - 45 minutes

# IMPORTANCE OF LISA

95% of stars end as white dwarfs

Very short orbits: Understand binary evolution:  
common envelope, mass transfer, tides,

Type Ia supernovae

(Nelemans+01, Ruiter+10, Nisanke+12, Tauris+18, Breivik+18, Kremer+17)

Flux( $r$ )  $\sim 1/r$ , no extinction, no crowding :

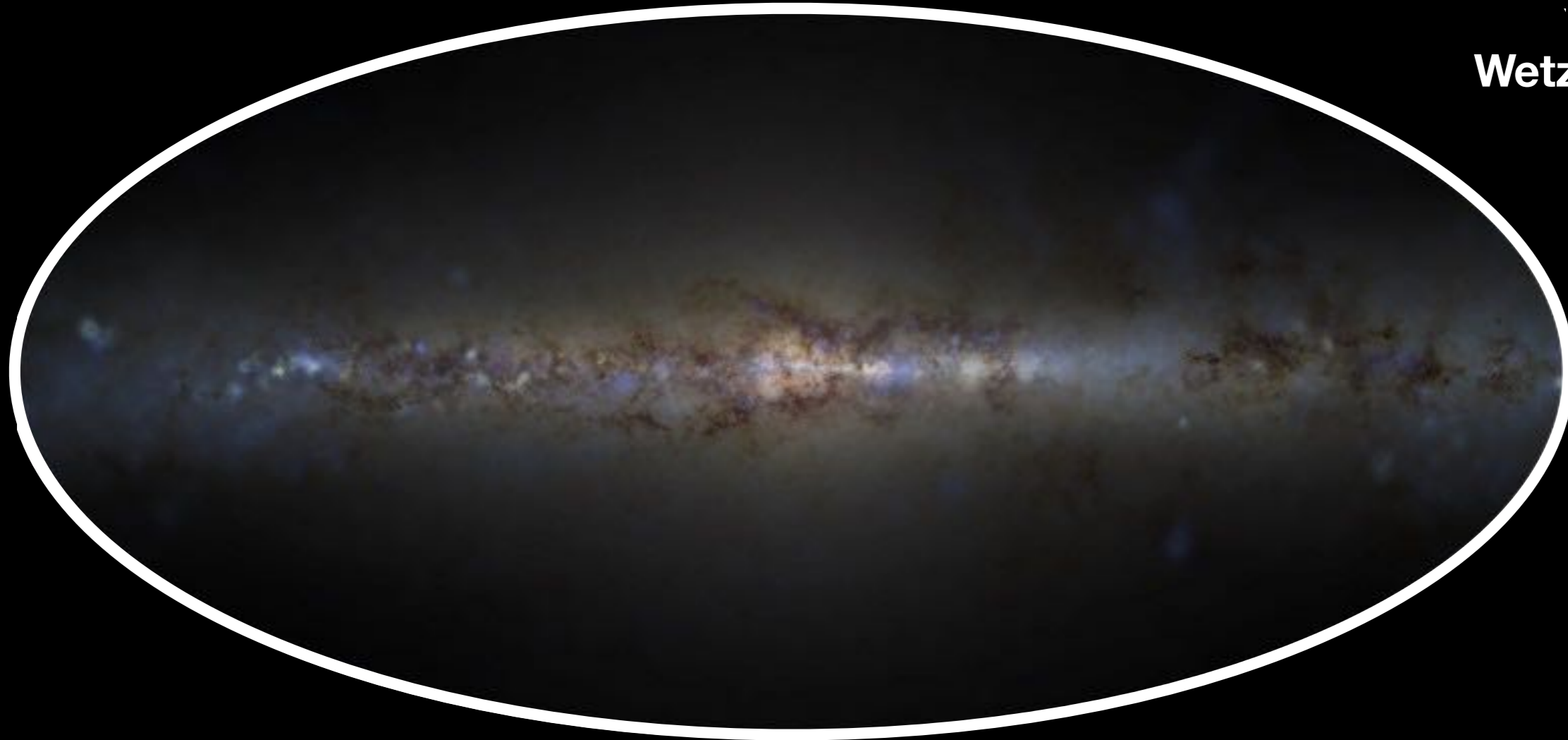
Map the Milky Way and its environment

(Benacquista+06, Korol+18, van Oirschot+18)

BUT : So far only simplified models of the MW



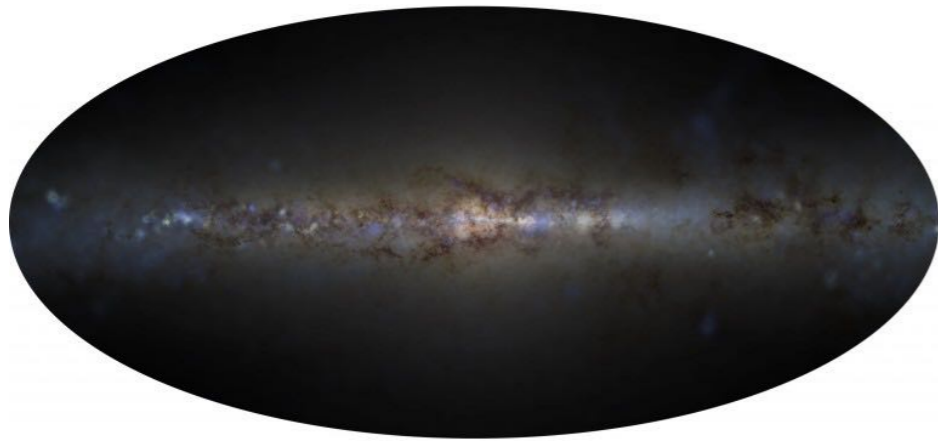
Wetzel+16



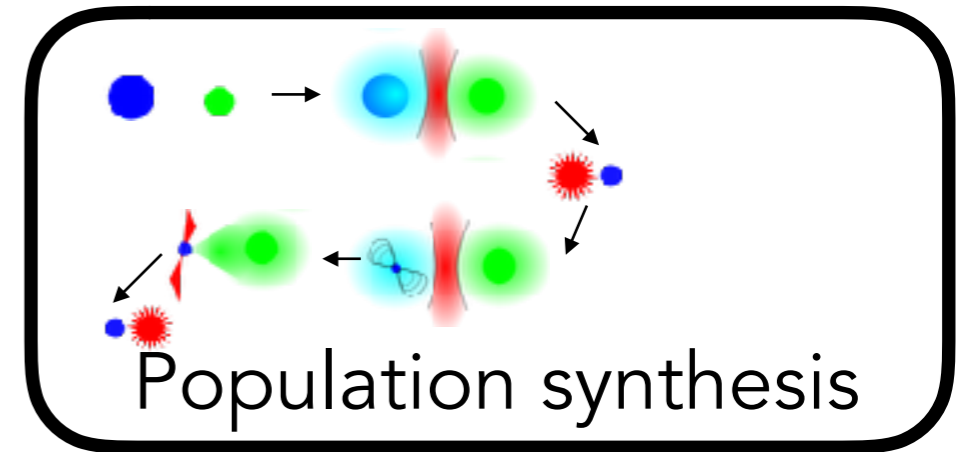
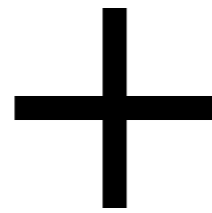
Gaia DR2



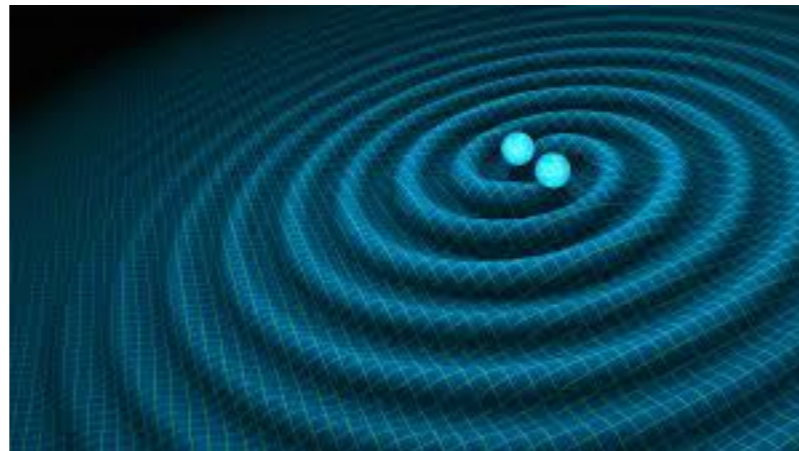
# GROWING COMPACT BINARIES IN THE MILKY WAY



Star formation history  
Metallicity  
Positions/Trajectory



13 bins :  $Z=0.005 - 1.3 Z_{\text{sun}}$   
 $M_1, M_2, t_{\text{form}}, \text{orbit}$

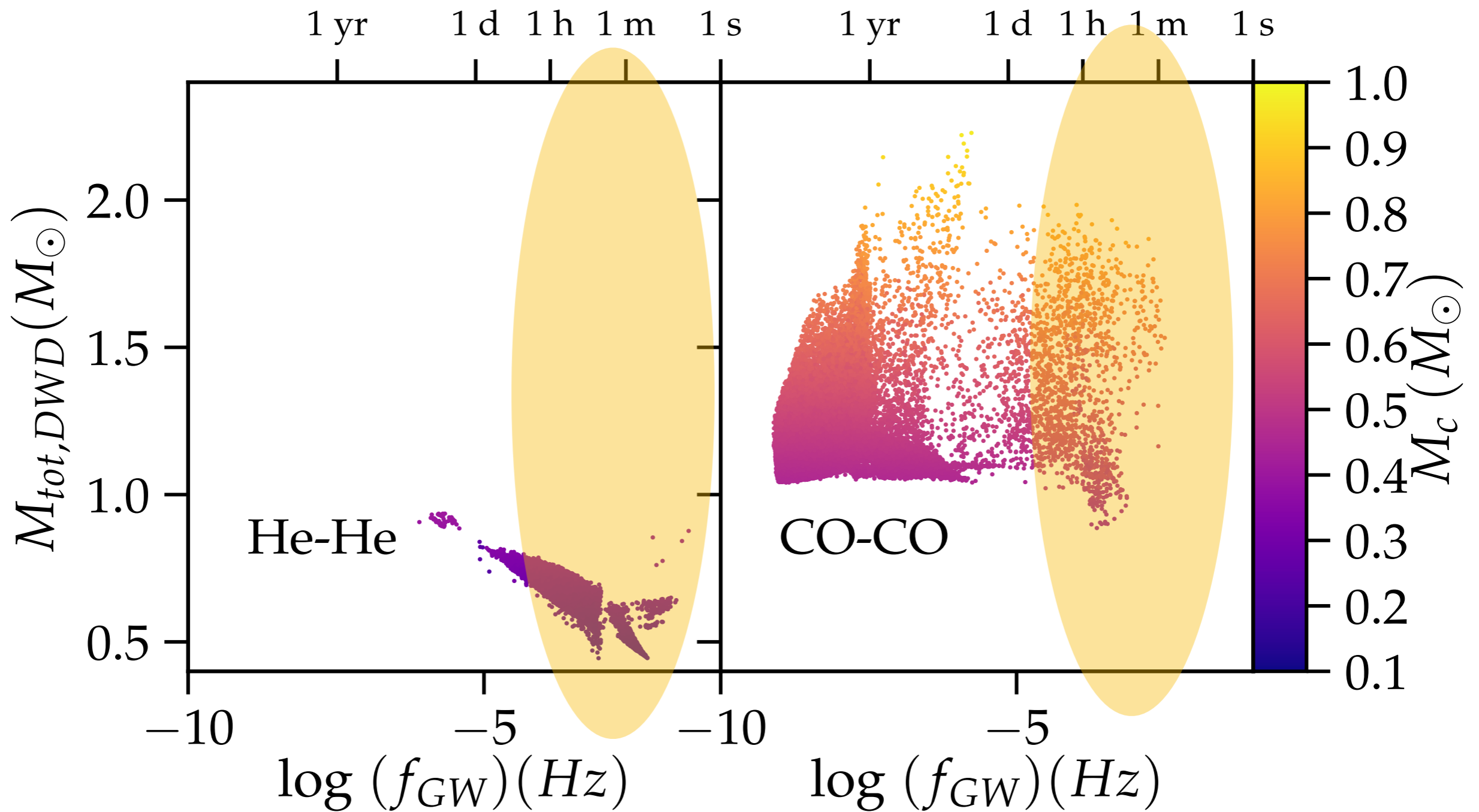


Keep track of binary compact objects

Final evolution through GW emission  
Model of GW detections

See Lamberts+18 for binary black hole models

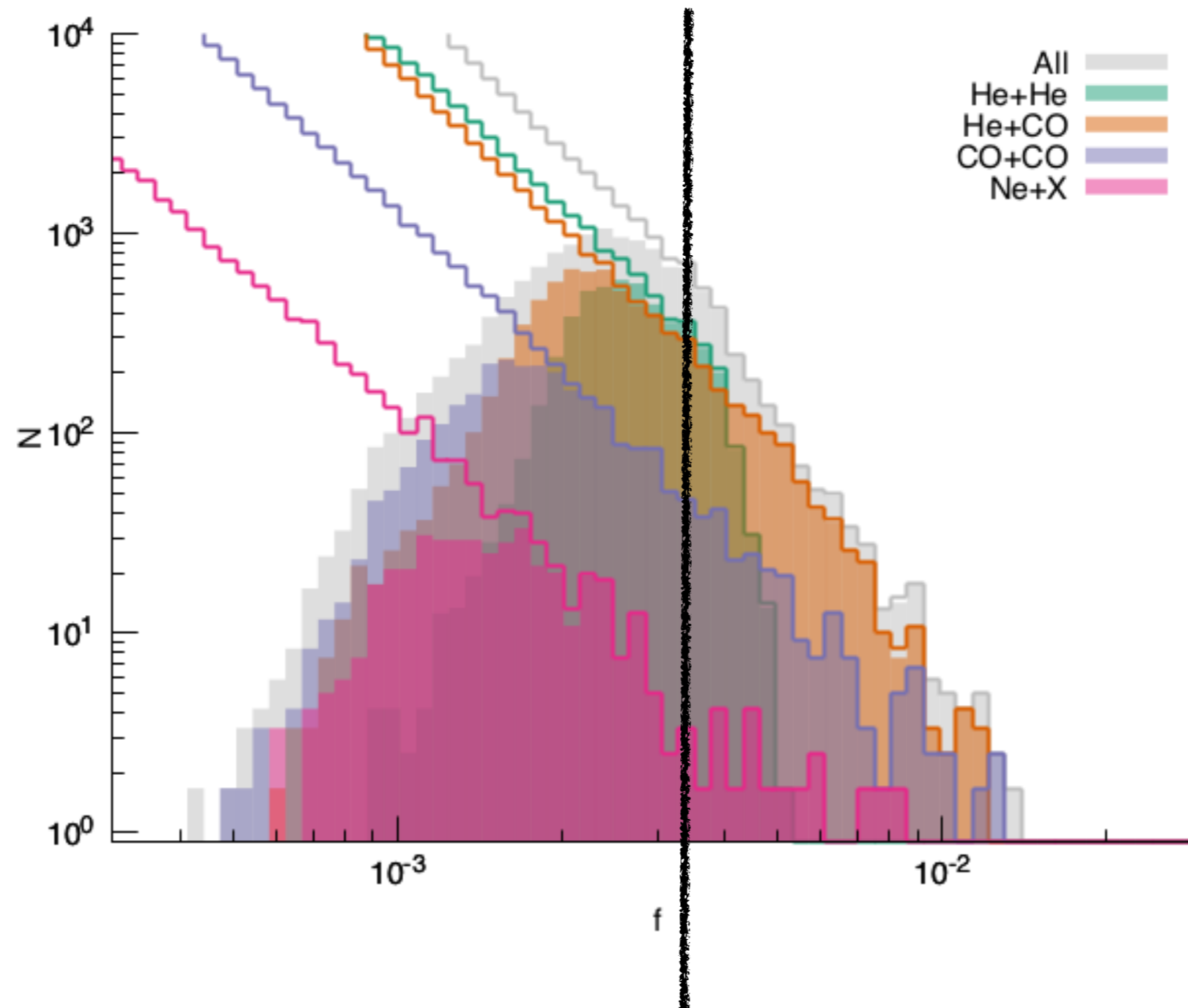
# DIFFERENT TYPES OF WHITE DWARF BINARIES



All LISA binaries are recently formed DWD or would have merged  
Formation time : 2-13 Gyrs <3 Gyrs



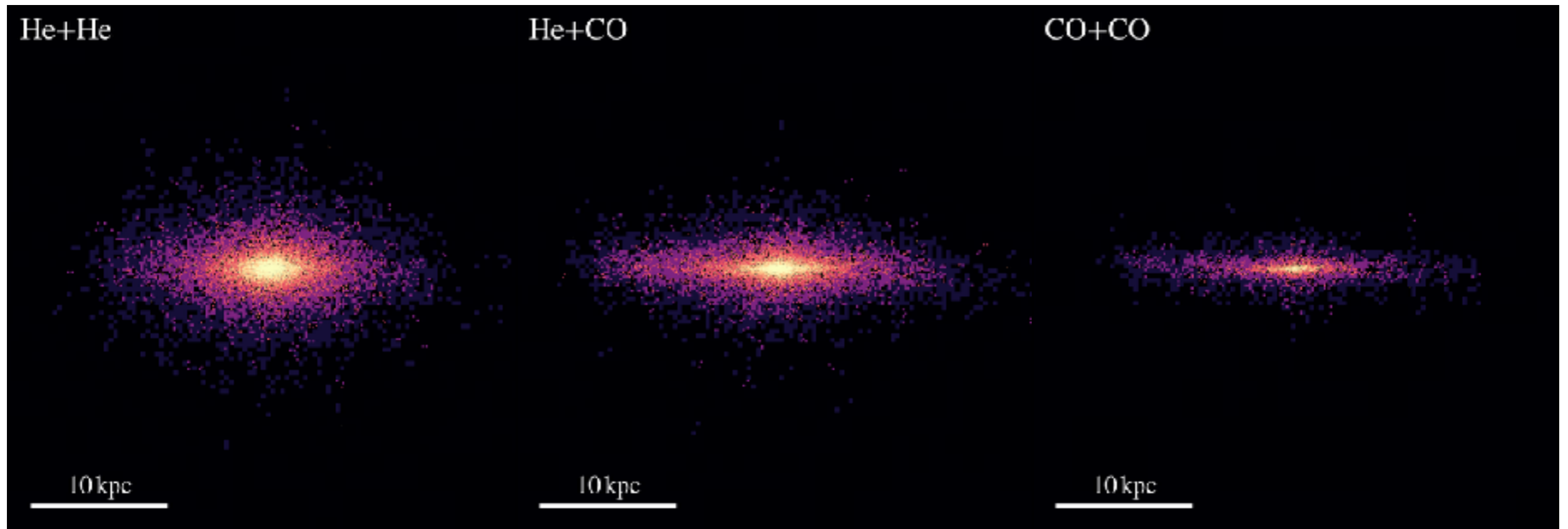
# A COMPLETE CATALOG



Complete down to  $f \sim 3$  mHz : all binaries below 11 minutes  
Includes binaries in whole galaxy, and beyond



# DIFFERENT BINARY POPULATIONS

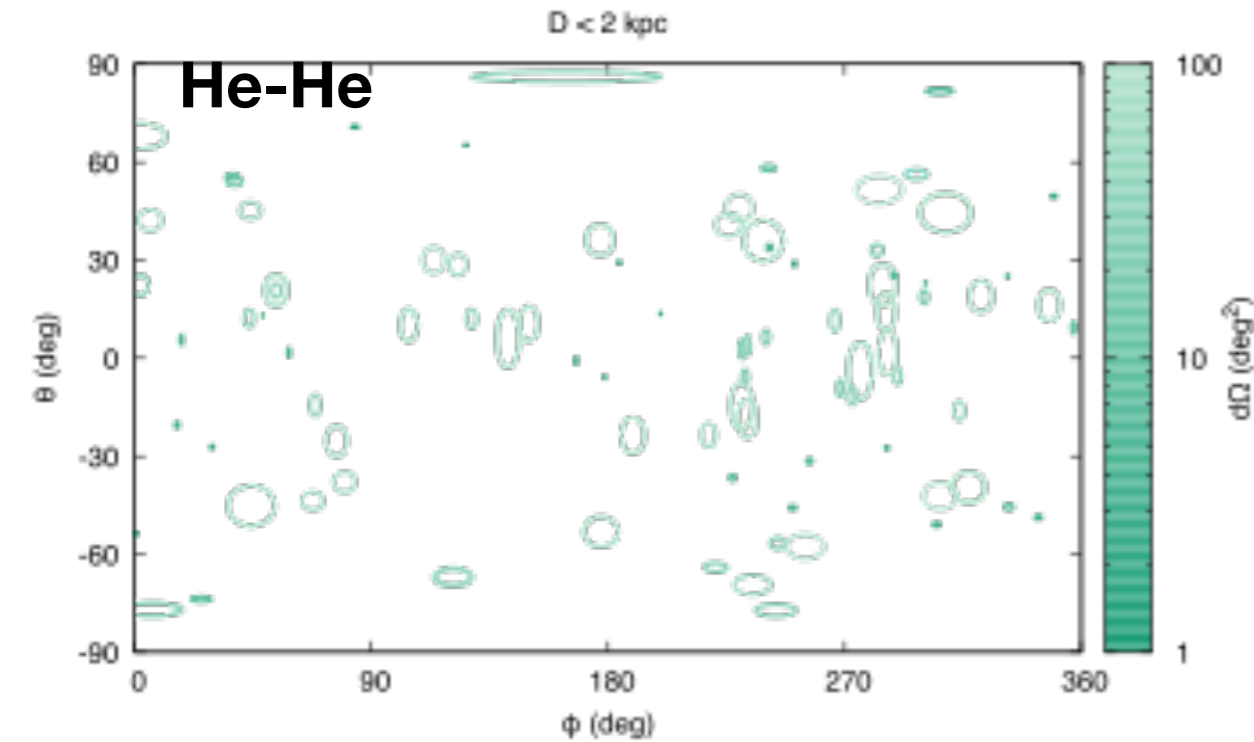


He-He : old progenitor stars : bulge, thick disk and stellar halo

He-CO : intermediate case

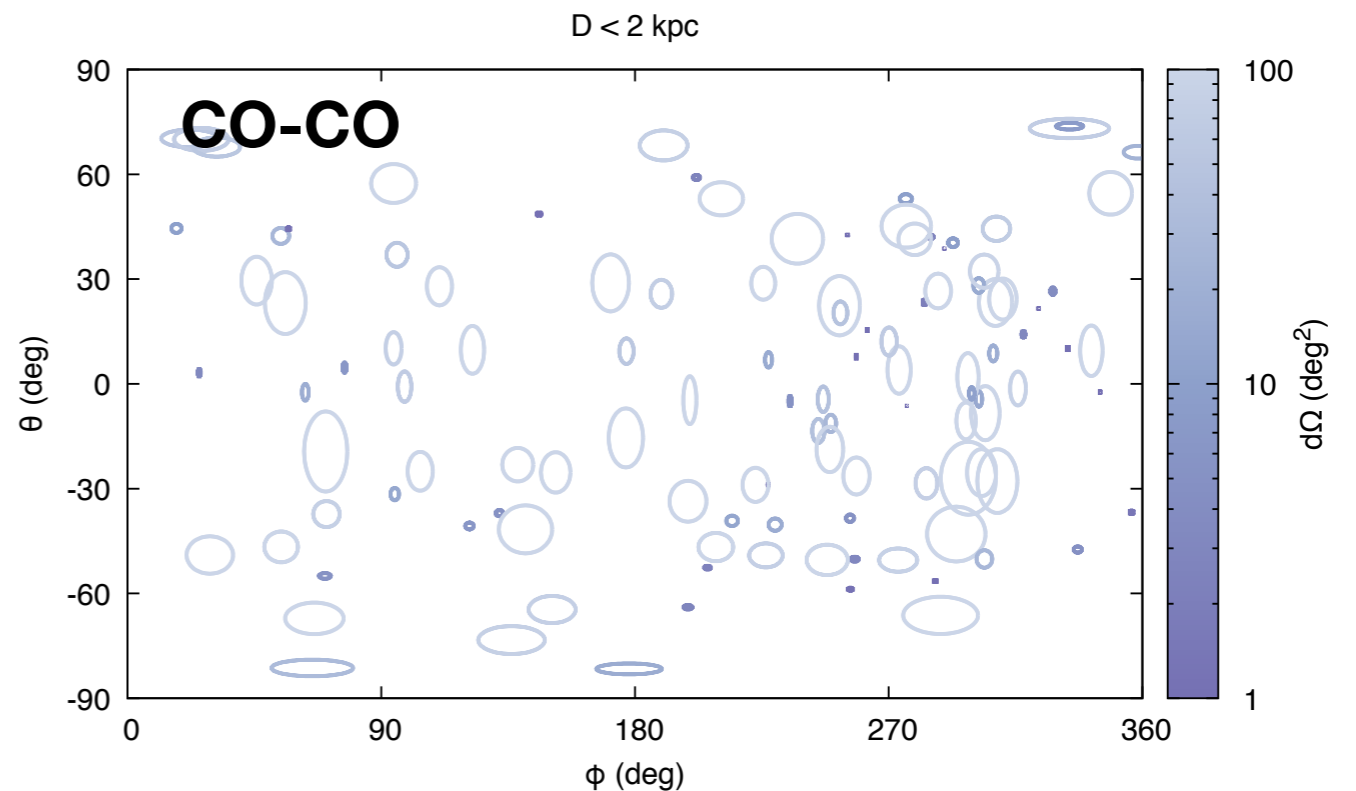
CO-CO : young progenitor stars : think disk

# POSSIBLE DETECTIONS WITH GAIA



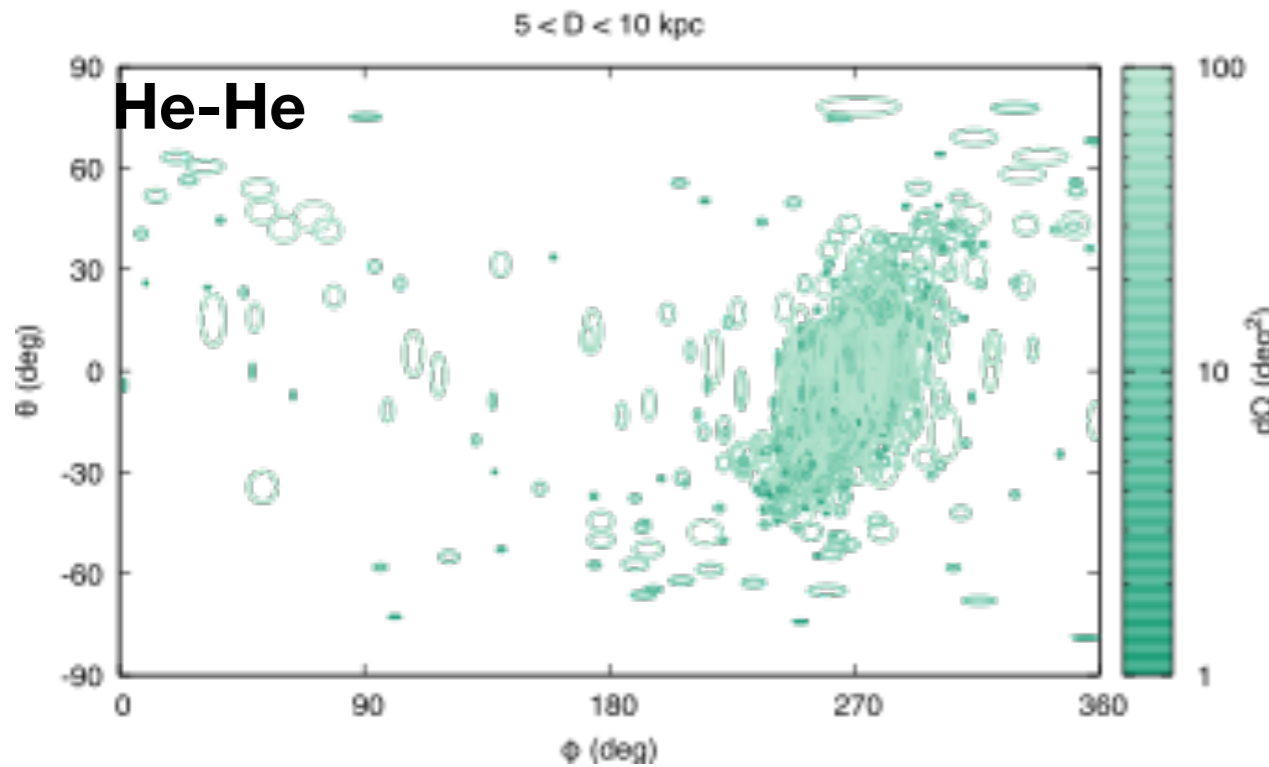
Using lightcurves with eclipses (DR4)  
Systems within 2 kpc  
A few hundred binaries  
No preferred location at this scale

He-He are bigger : easier  
For EM

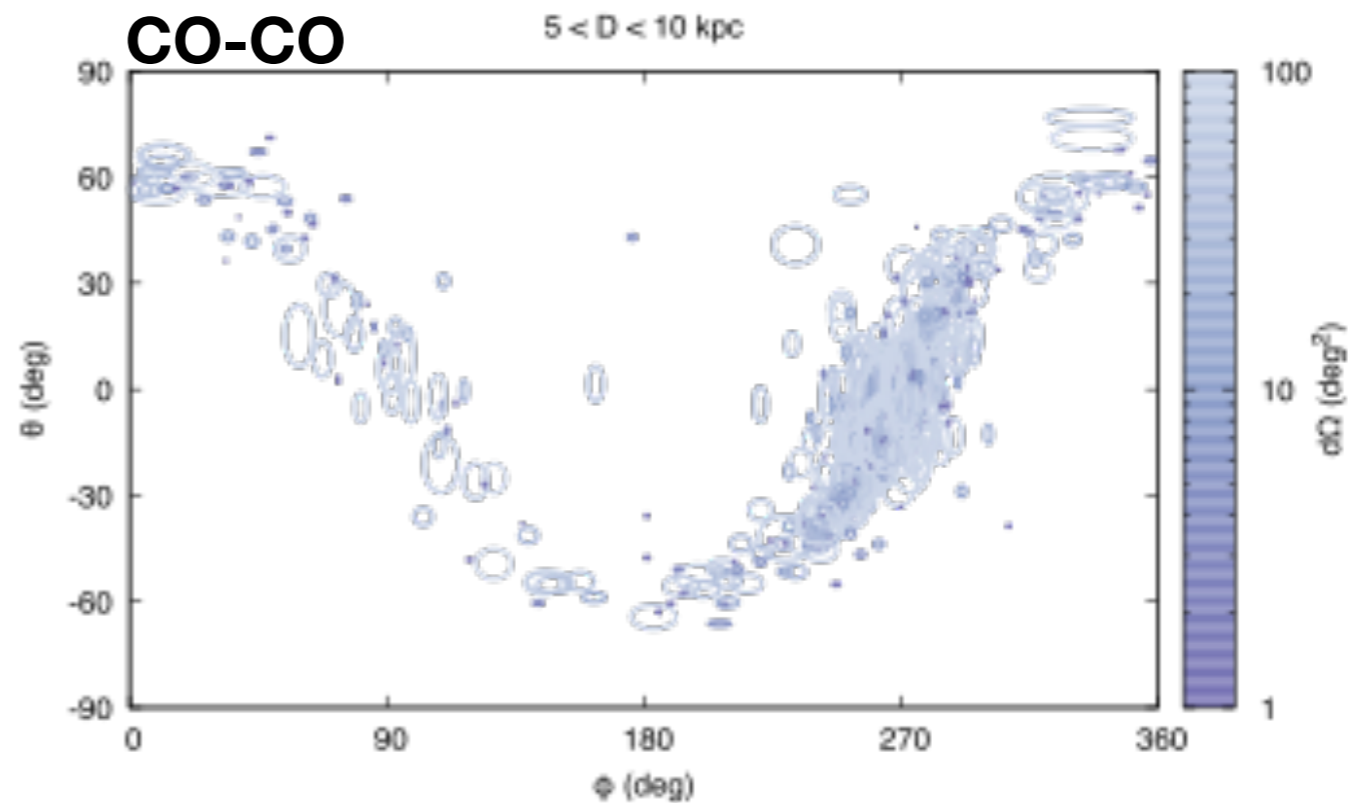
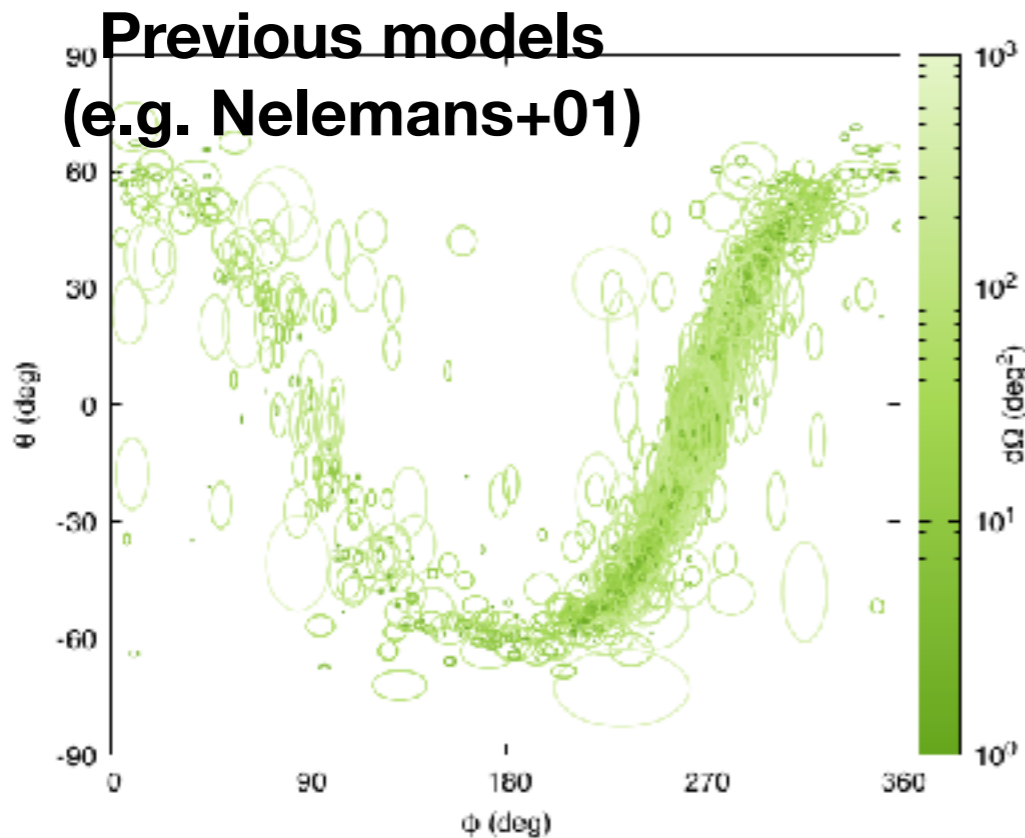


See also Korol+17

# BEYOND GAIA (LSST)



Systems within 10 kpc (limit for stacked pointings)  
Potentially few thousand systems  
Different spatial distributions:  
Search strategies



# OPTIMIZED EM SEARCHES BEFORE LISA

Complete catalog down to  $\sim$  few mHz  
Galactic structure, including halo

Potential for multi messenger :

Gaia (+ spectro surveys), ZTF/BlackGem, LSST...

Preparing LISA : Using current surveys to prepare :  
verification binaries, estimate of foreground from  
binary evolution