

Transforming UCB Modeling with LGWA

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2025



Ultracompact Binaries

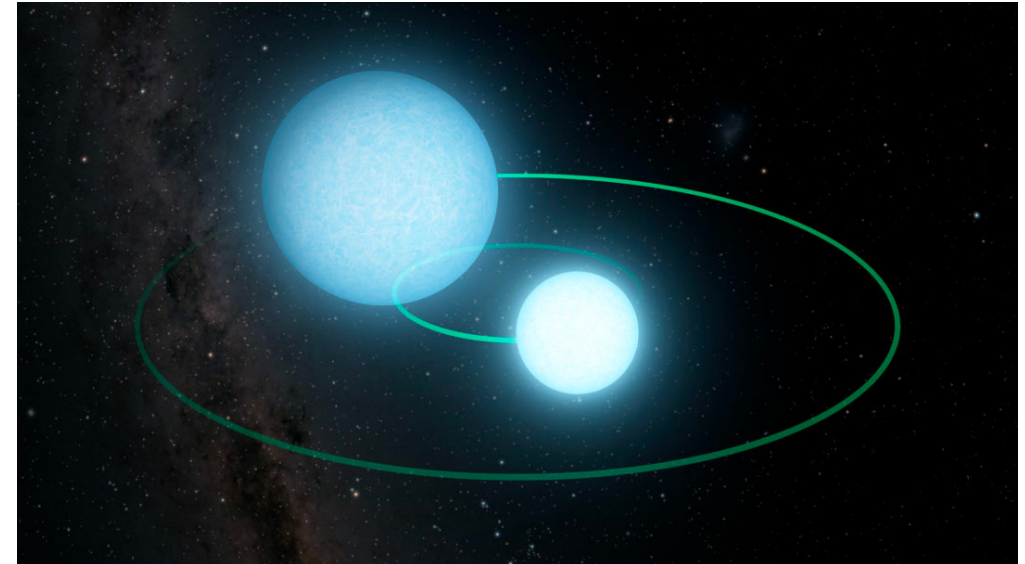
- Orbital period < 1 hour
- Also: UCBs

Subclasses:

- WD+WD/NS/BH
- NS+NS/BH
- BH+BH
- He Star + WD/NS/BH

Observed in:

- Radio
- Optically
- In UV, X-ray, GW



Credit: [Caltech/IPAC](#)



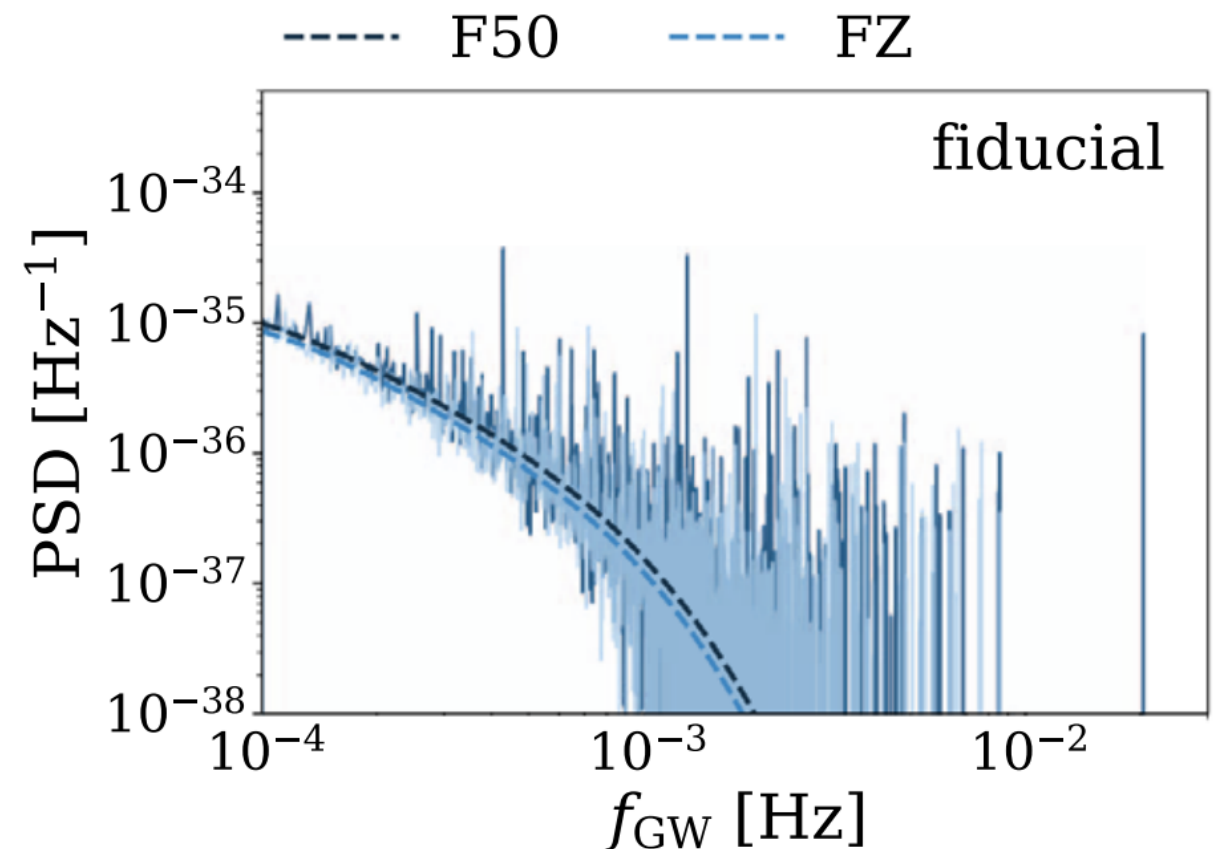
Credit: [M.Garlick](#)



Ultracompact Binaries

If detached:

- Spiral in due to GWs
- Except for He stars
- Pass the LISA band
- Few 10^4 DWDs resolved
- Few 10^6 DWDs unresolved



Credit: [Thiele+23](#)

$$\tau_{\text{GW}} = 2.4 \text{ Gyr} \left(\frac{M_c}{M_\odot} \right)^{-5/3} \left(\frac{P_{\text{GW}}}{1 \text{ h}} \right)^{8/3}$$

[Peters64](#)

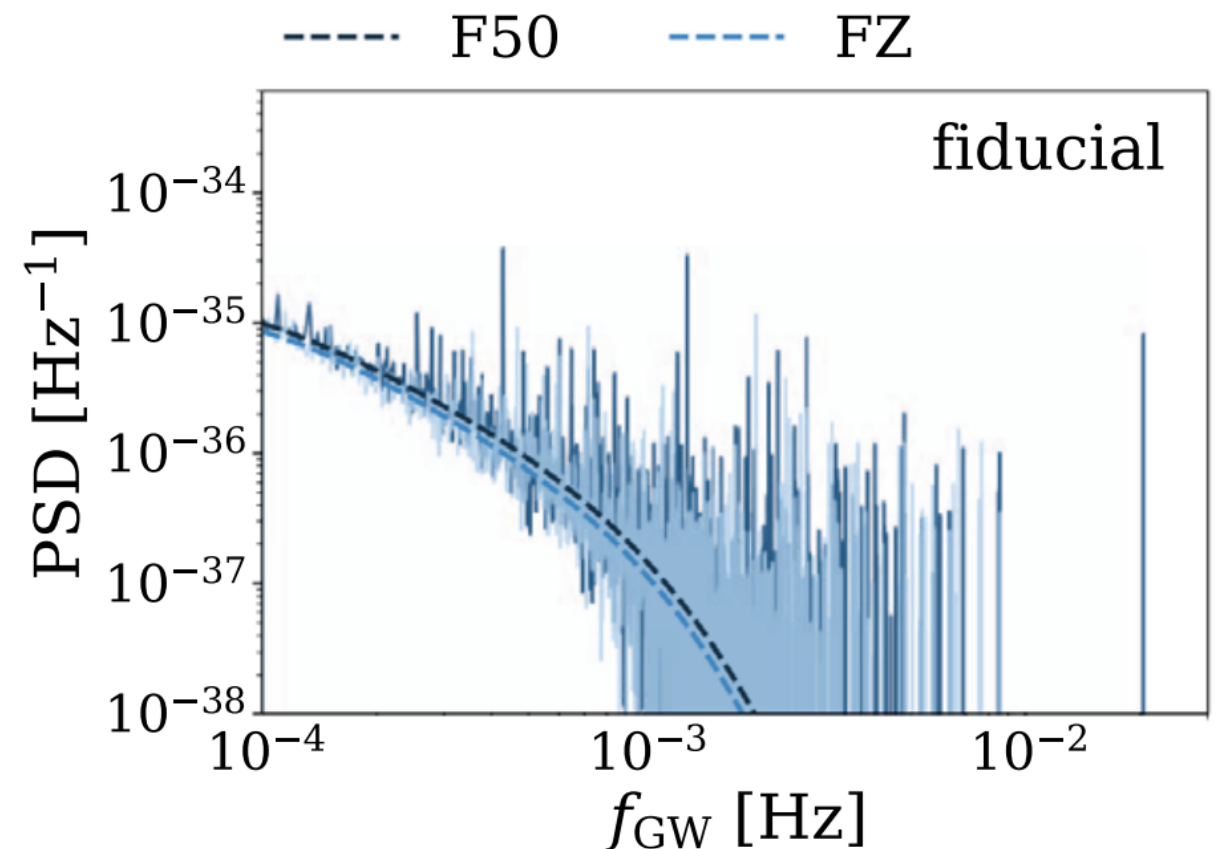


See also: [LISA Synthetic UCB Catalogs Project](#)

Ultracompact Binaries

If detached:

- **Spiral in due to GWs**
- **Except for He stars**
- **Pass the LISA band**
- **Few 10^4 DWDs resolved**
- **Few 10^6 DWDs unresolved**
- **Have to interact**
- **Interact in the dHz band**



Credit: **Thiele+23**

$$\tau_{\text{GW}} = 2.4 \text{ Gyr} \left(\frac{M_c}{M_\odot} \right)^{-5/3} \left(\frac{P_{\text{GW}}}{1 \text{ h}} \right)^{8/3} = 5 \text{ yr} \left(\frac{M_c}{M_\odot} \right)^{-5/3} \left(\frac{f_{\text{GW}}}{0.1 \text{ Hz}} \right)^{-8/3}$$

Peters64

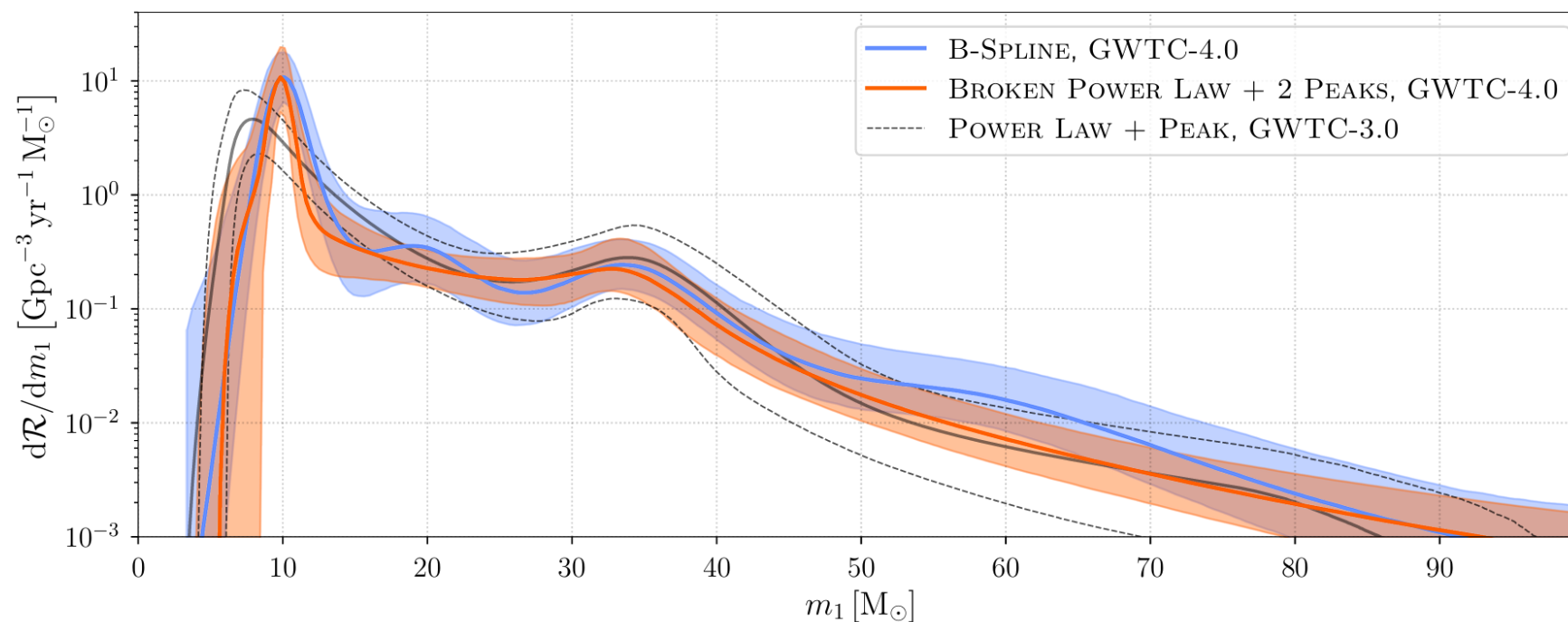
Mandel+17



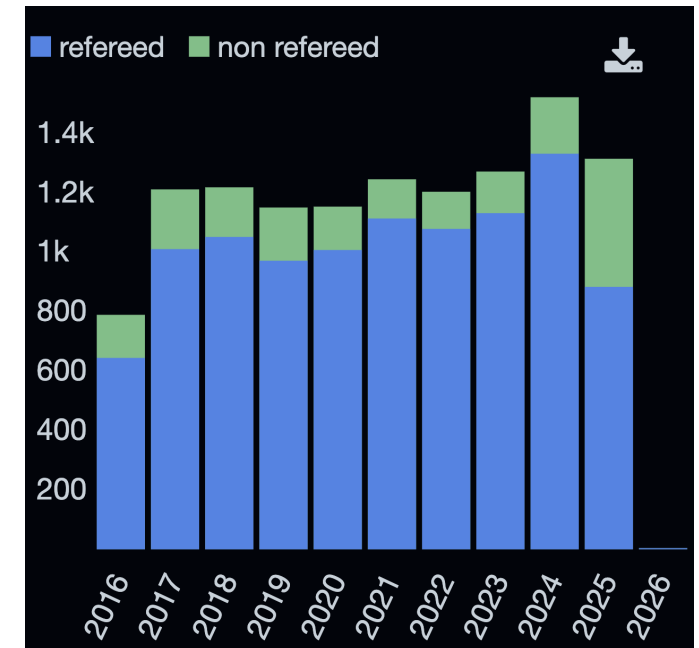
LIGO Example

BBH status (O4a):

- **Multiple channels possible**



Credit: LVK25



Credit: NASA ads

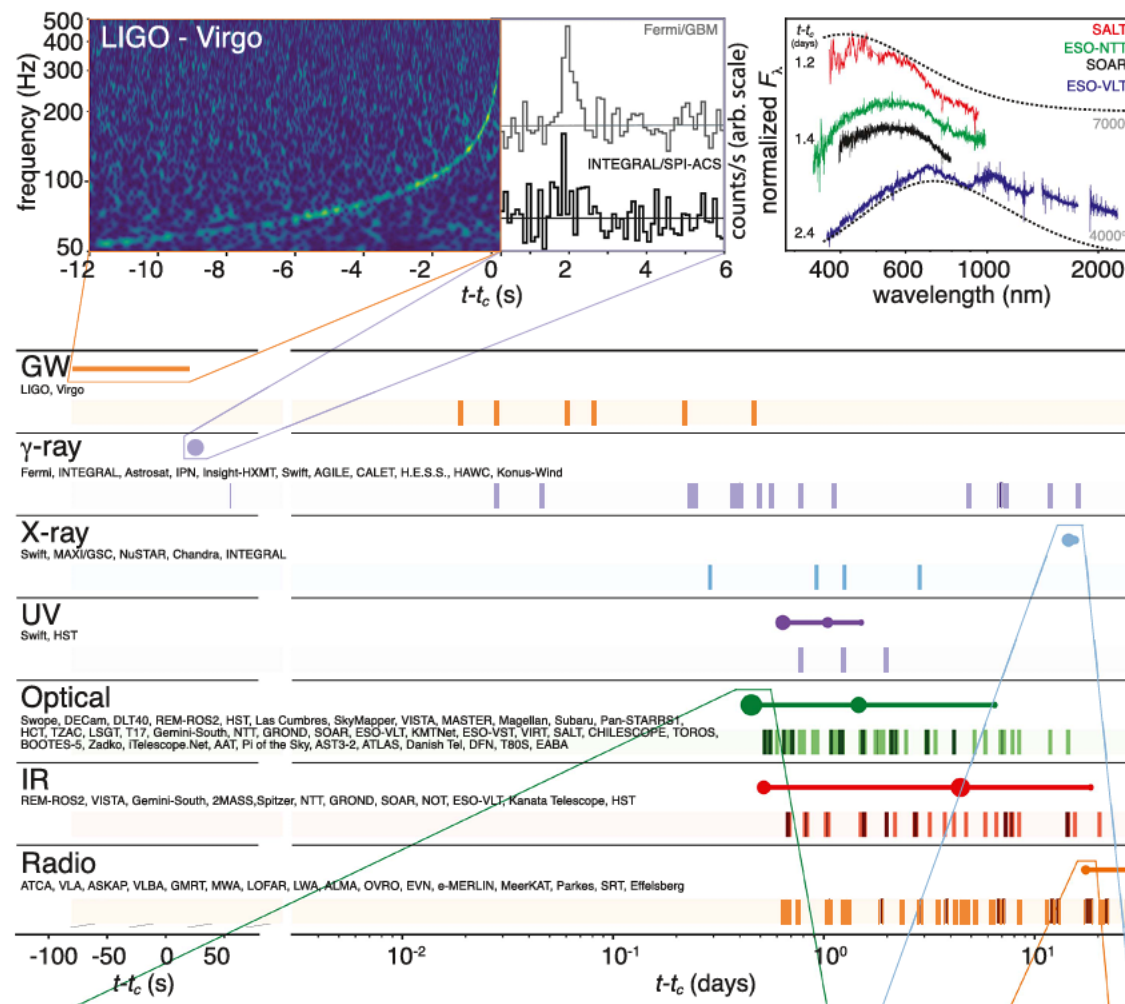


See also: G. Iorio's talk

LIGO Example

DNS status:

- **Origin for kilonovae and sGRBs**



Credit: LVK17

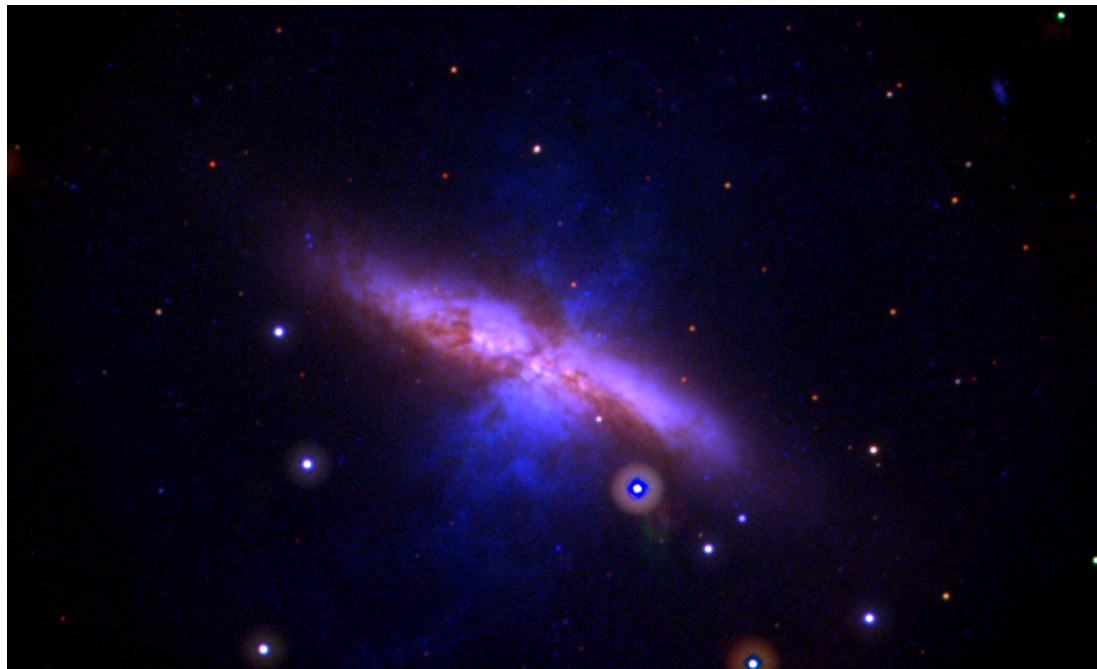


Credit: NASA/Swift/Dana Berry

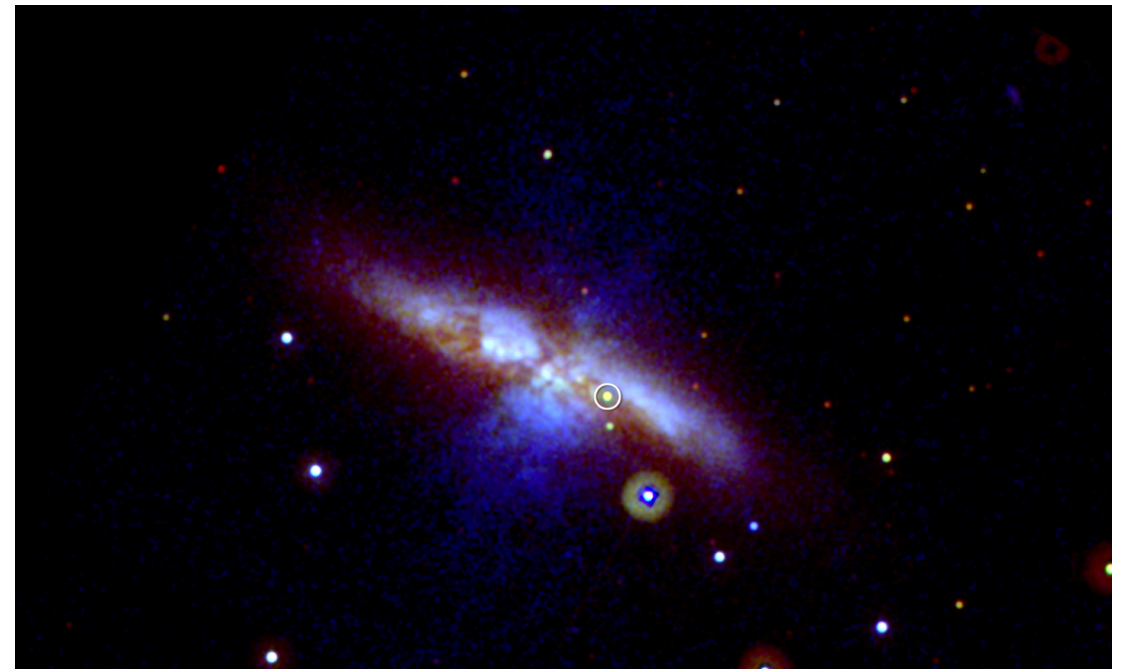


Transient Sky Example

Swift UVOT, M82 image



2013

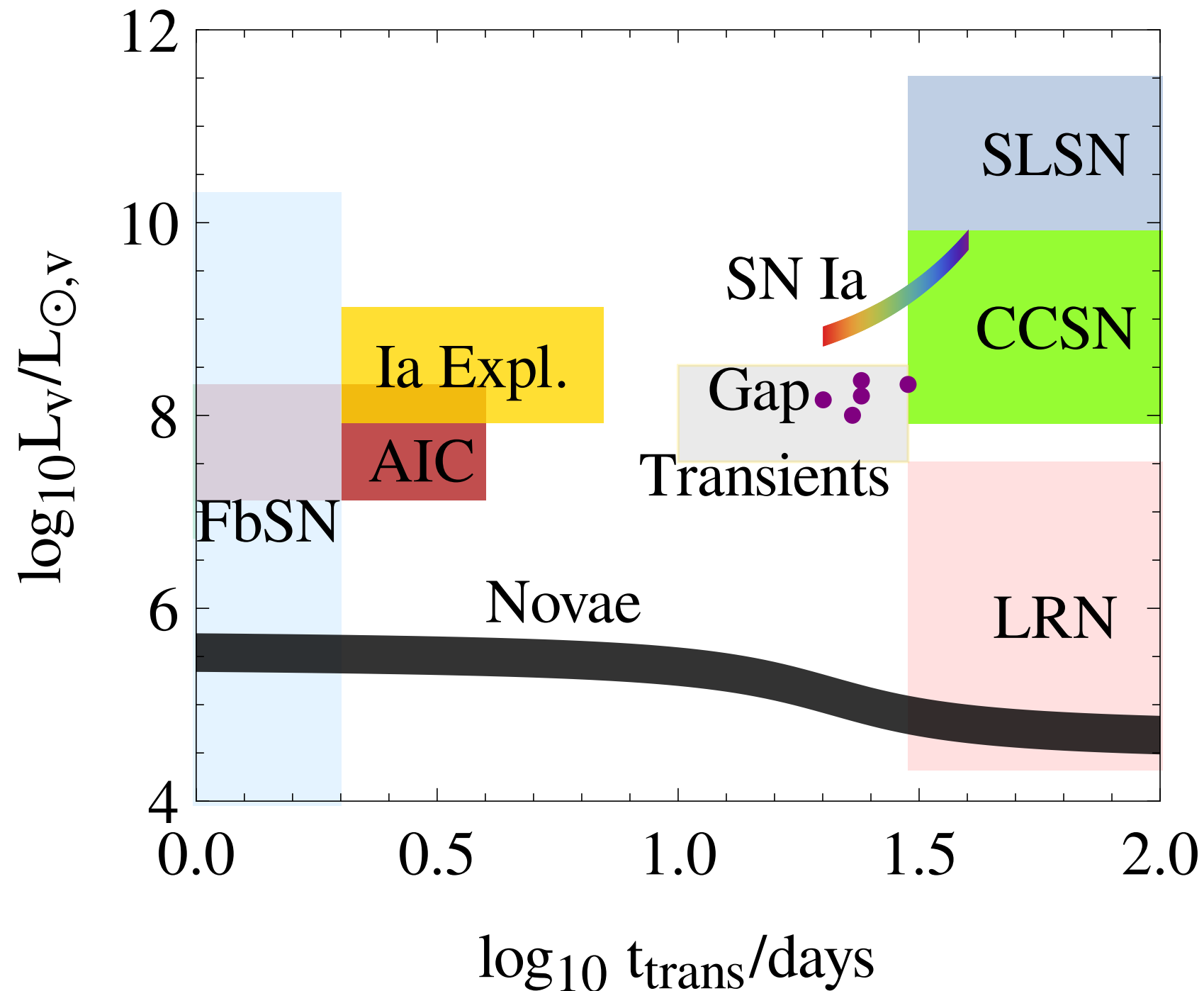


2014

Credit: [NASA](#)

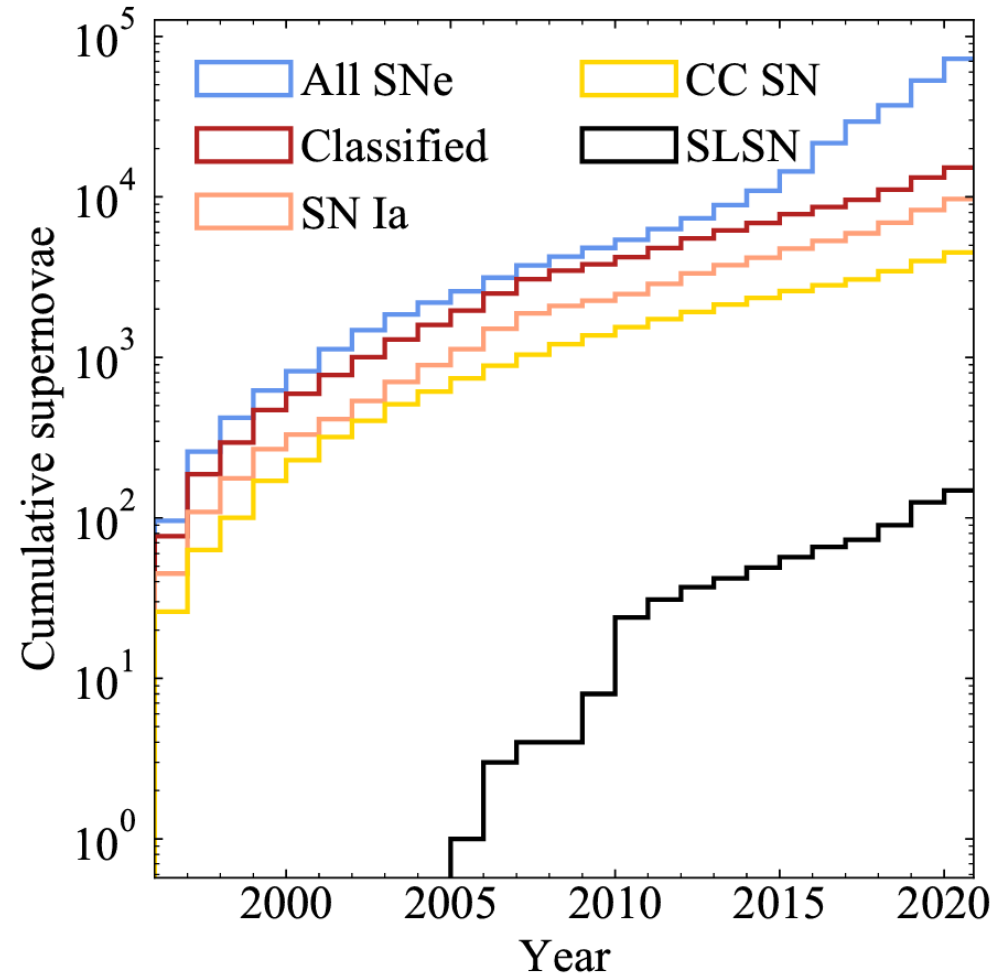
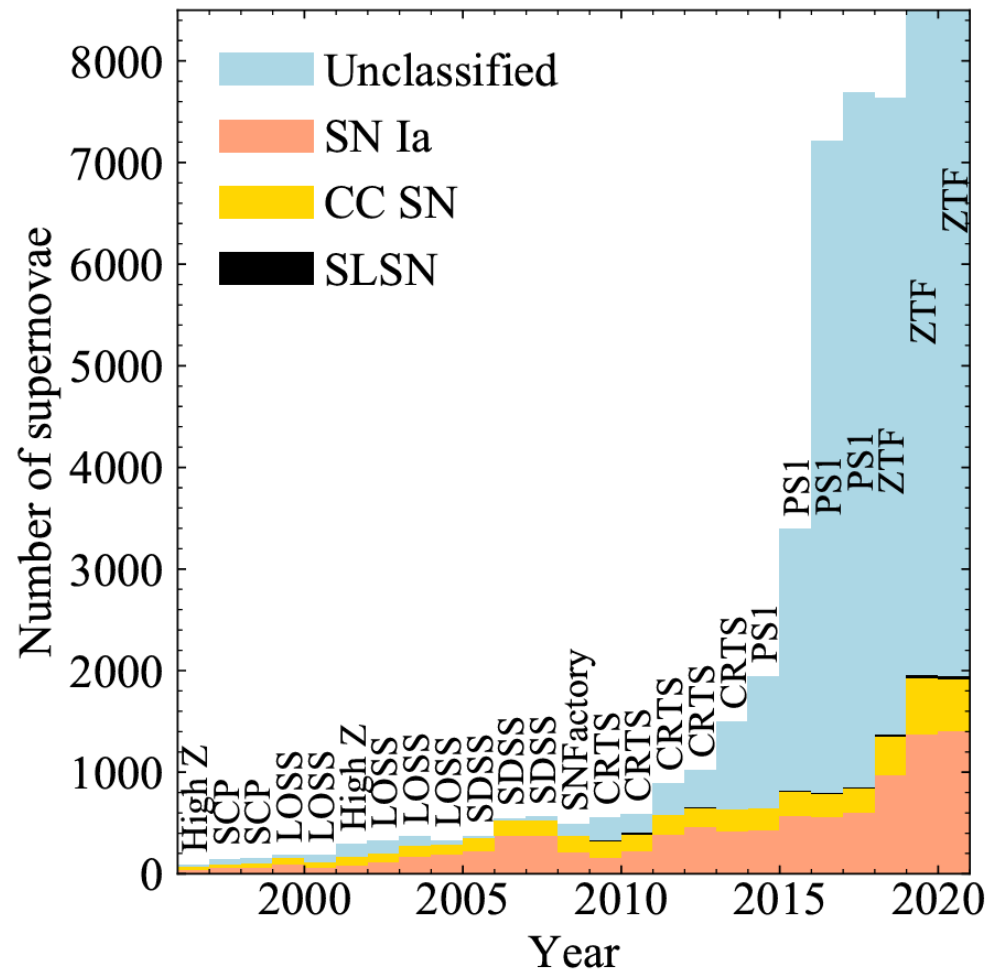


Transient Sky Example



Credit: **AB**, inspired by **M.Kasliwal**

Transient Sky Example



Credit: [Nichol21](#)

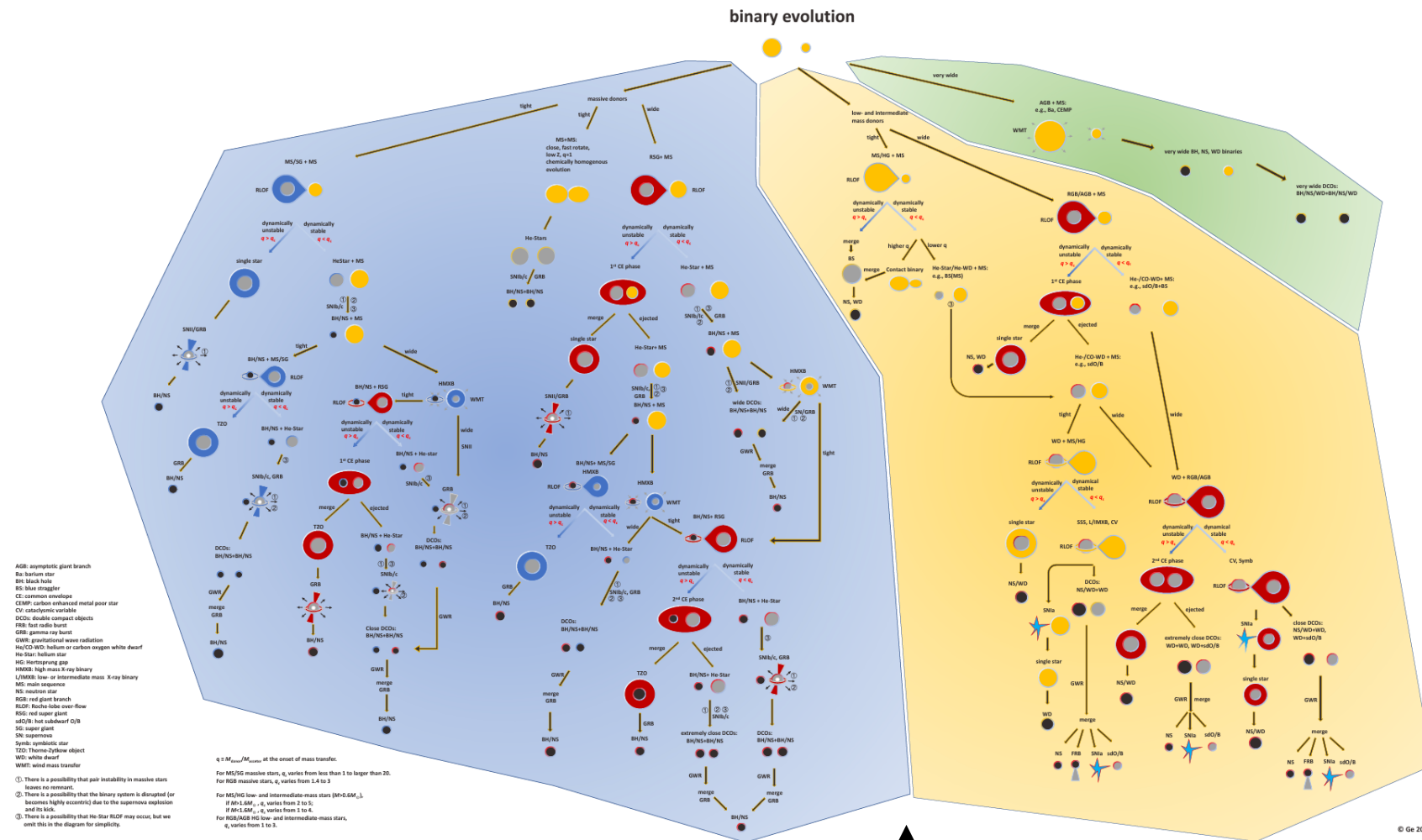
LSST: 10^6 per night!

E.g. [Fraga+24](#)

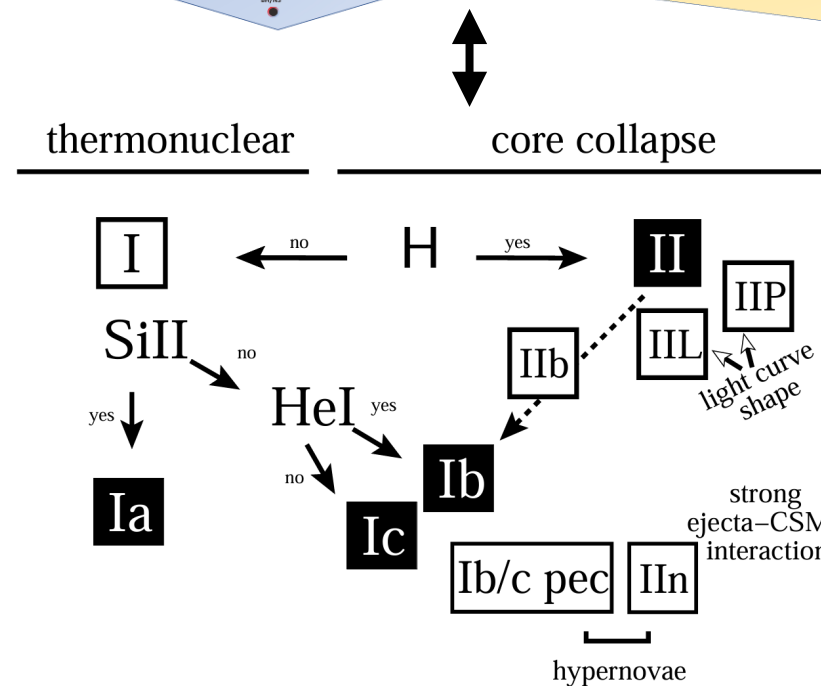
See also: Talk by [F. Roepke](#)



Detailed Classifications Needed

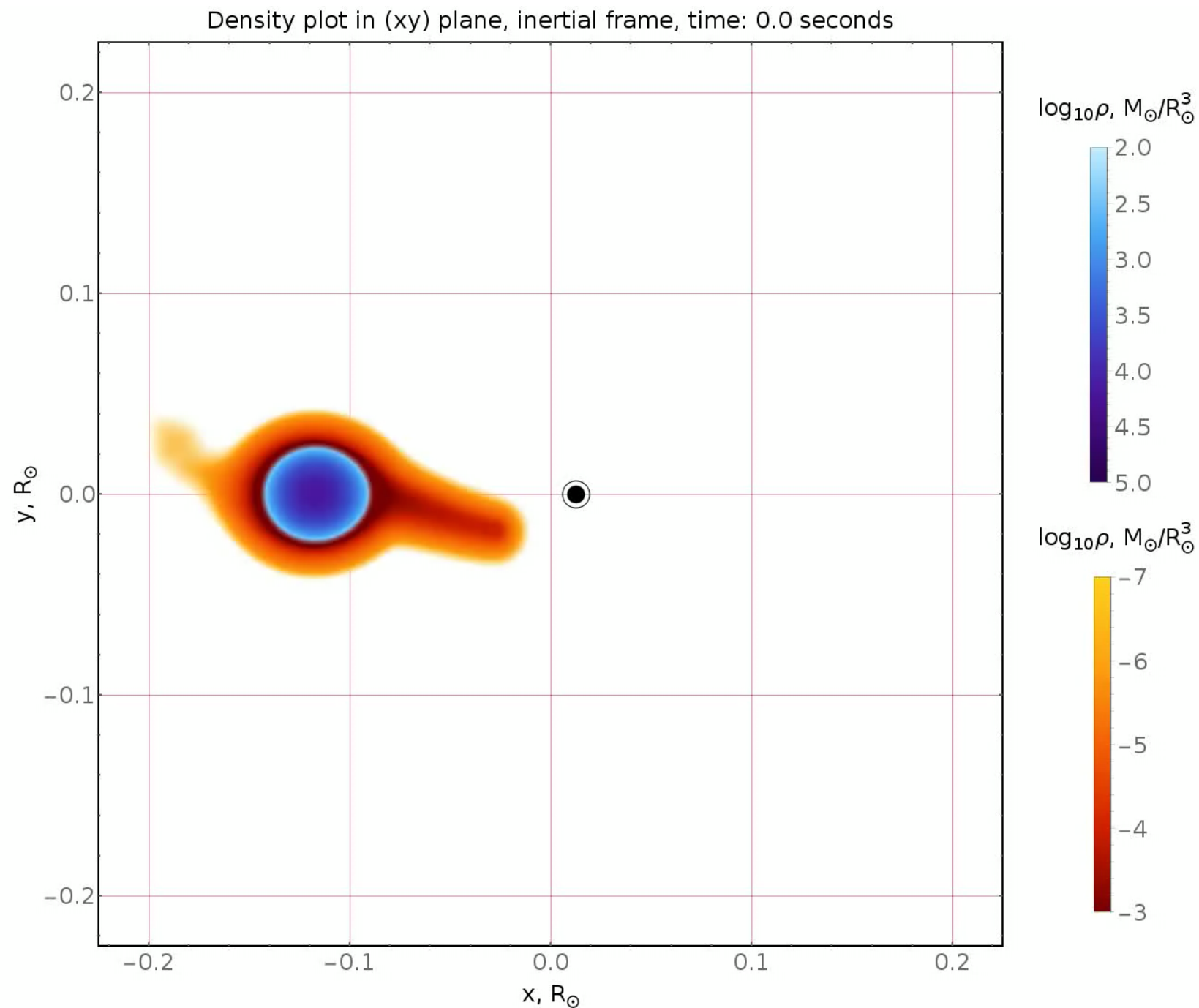


Credit: Han+20



Credit: Bersten10

Modelling Mass Transfer



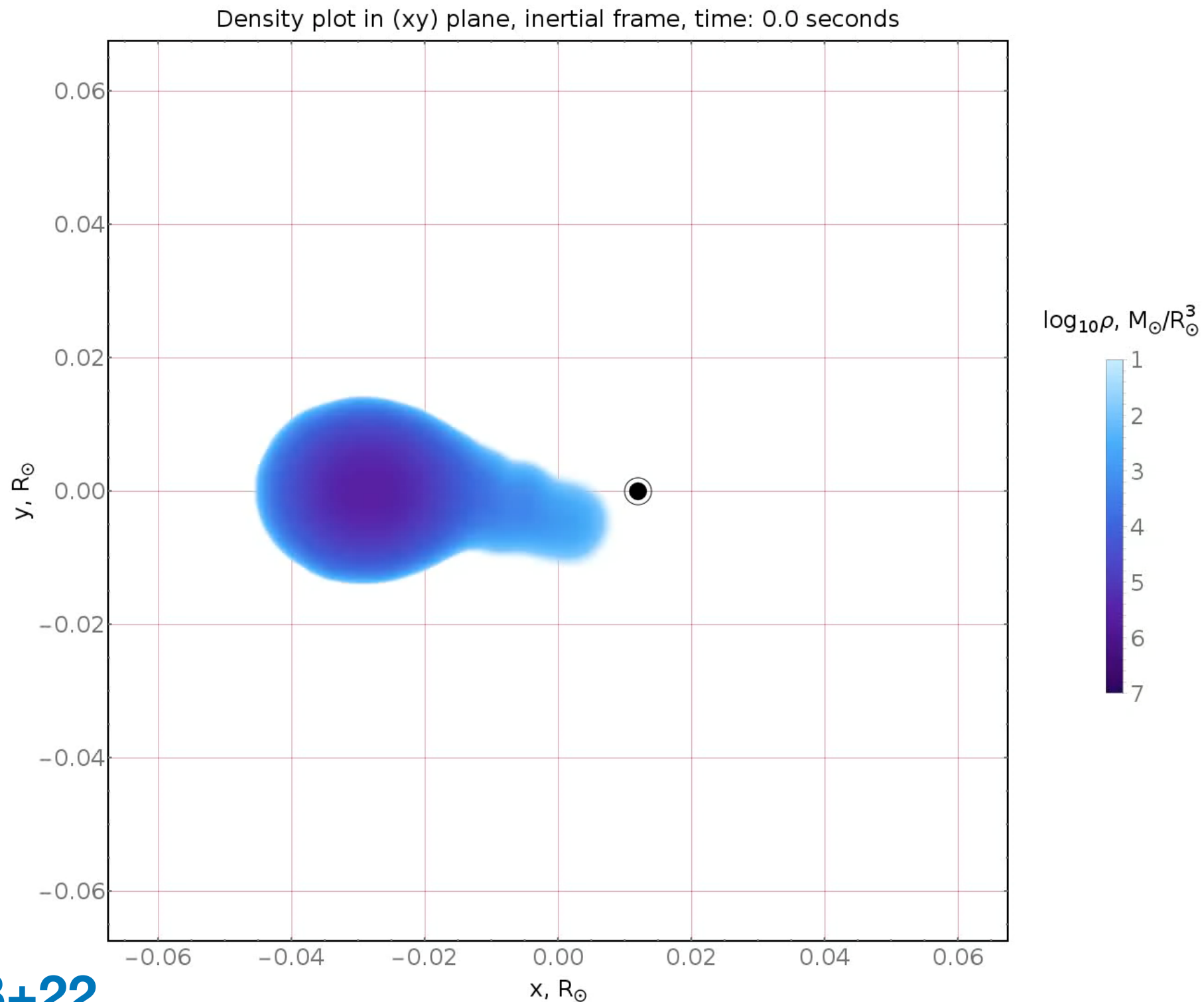
From AB+17

See also Church+09

He WD ($0.15 M_{\odot}$)



CO WD-NS Mergers

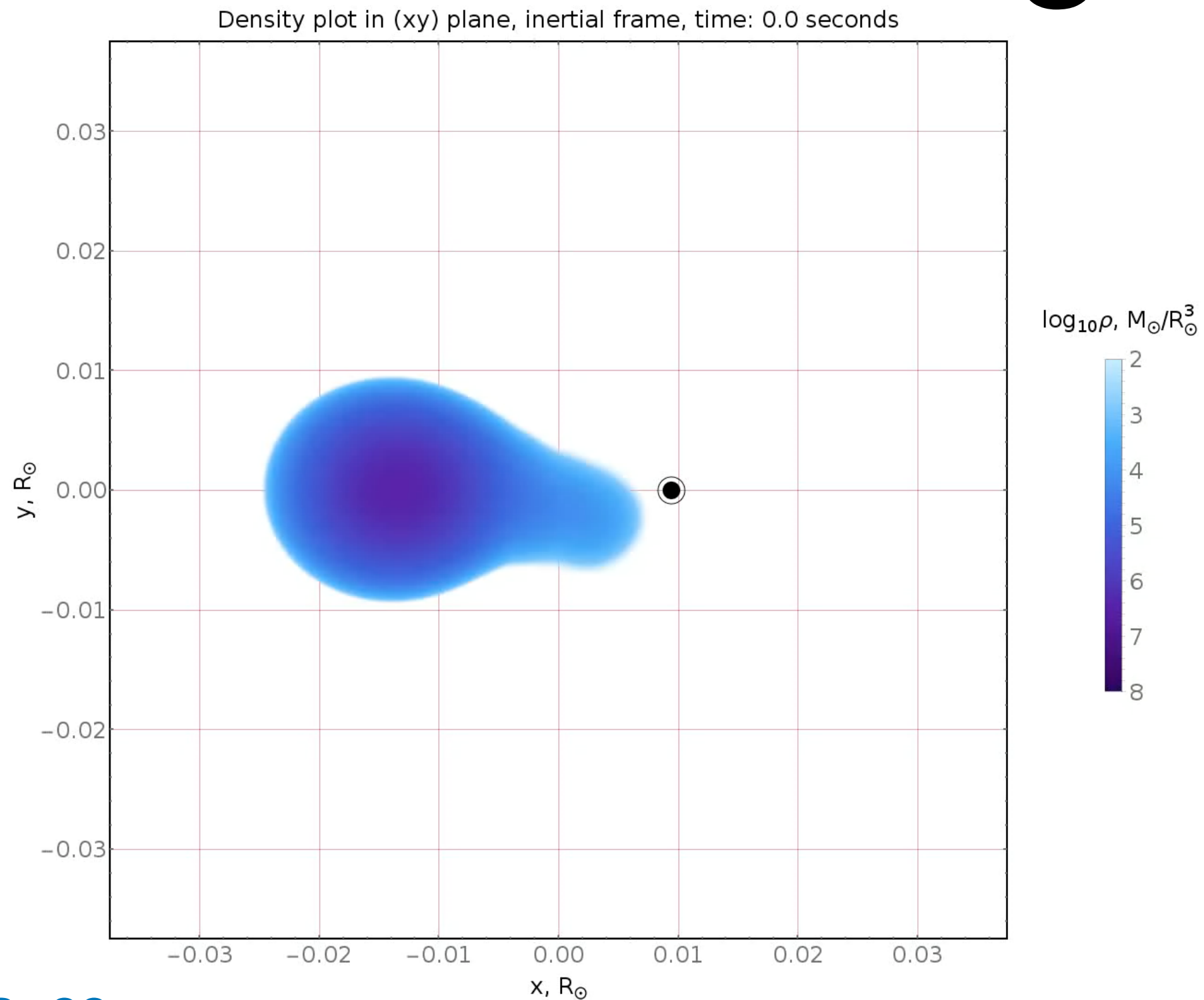


From AB+22

See also Zenati, AB & Perets20



ONe WD-NS Mergers

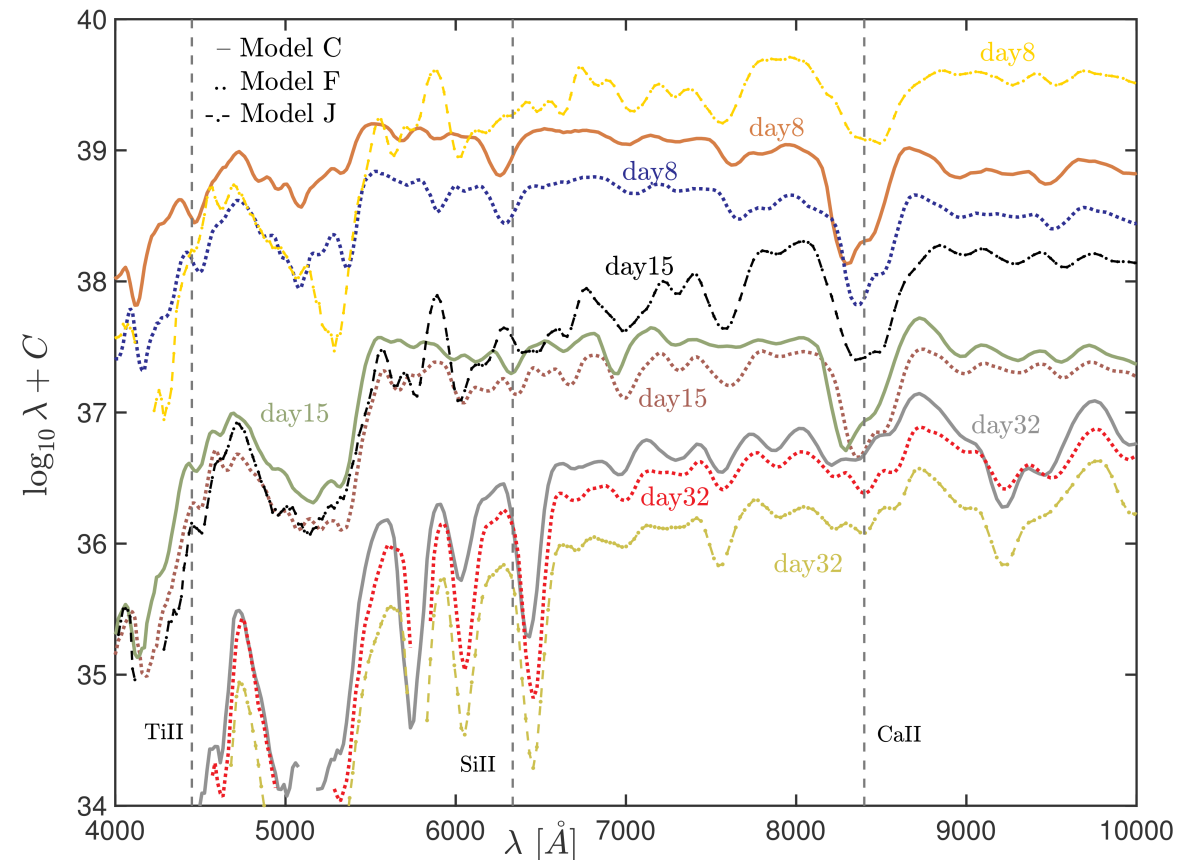
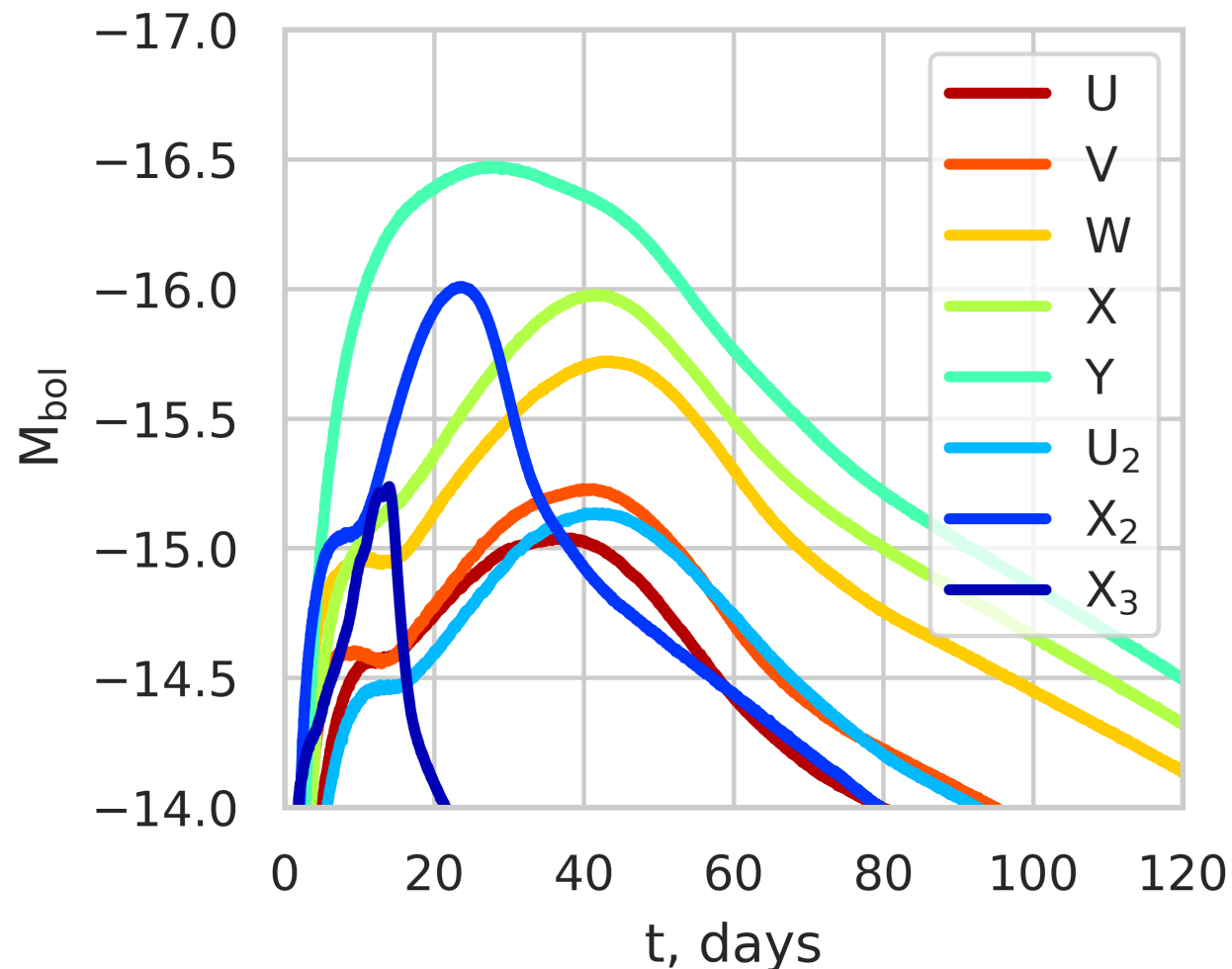


From AB+22

See also Zenati, AB & Perets20



Rapid Red Transients



- Radiative Transfer
- Lightcurves & Spectra
- Best agreement with faint SN lax's
- Up to 1000s per year with LSST

SuperNu Code

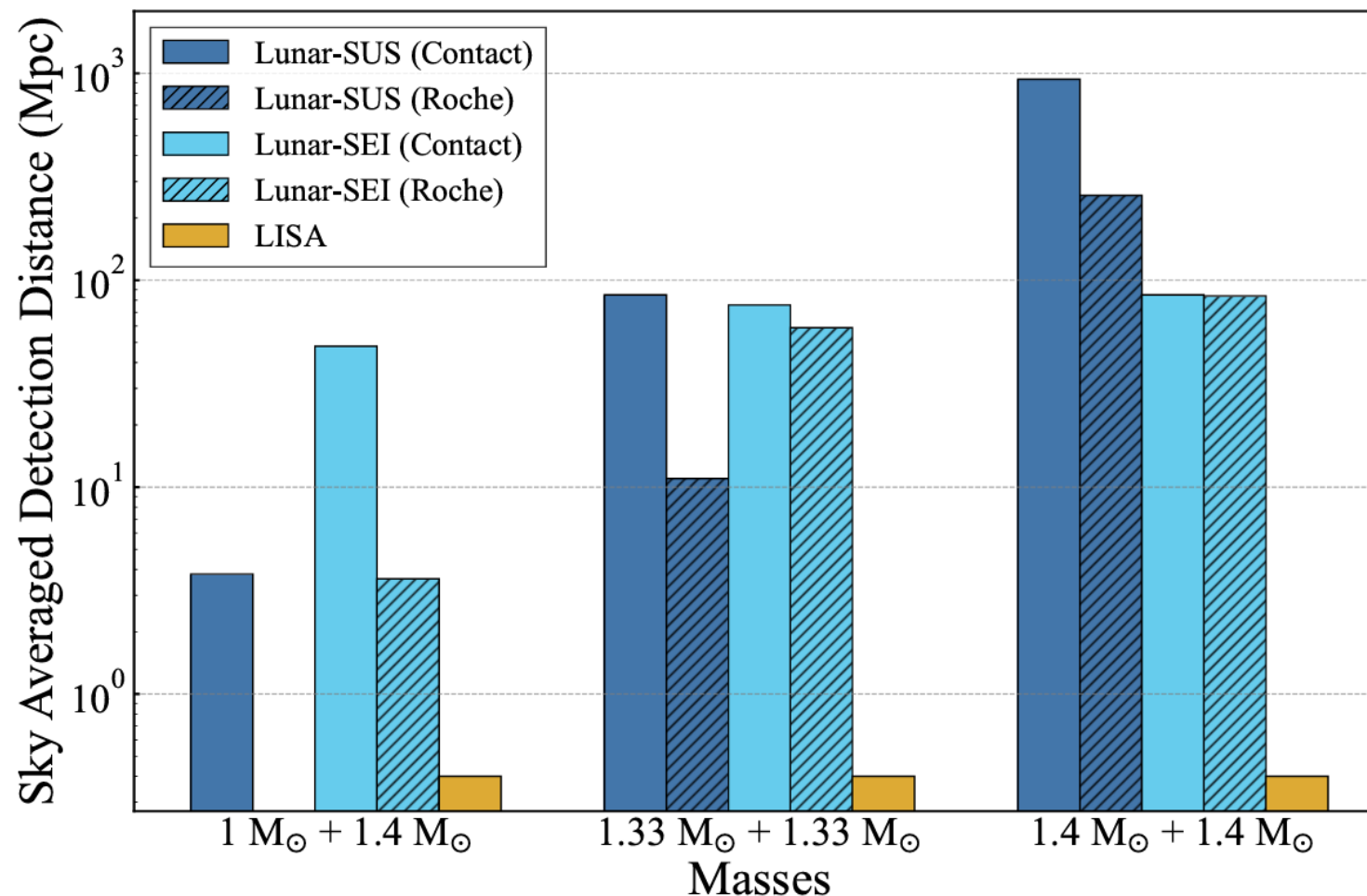
van Rossum +16

Credit: AB+22



See also: Morán Frailes+24

LGWA Expectation



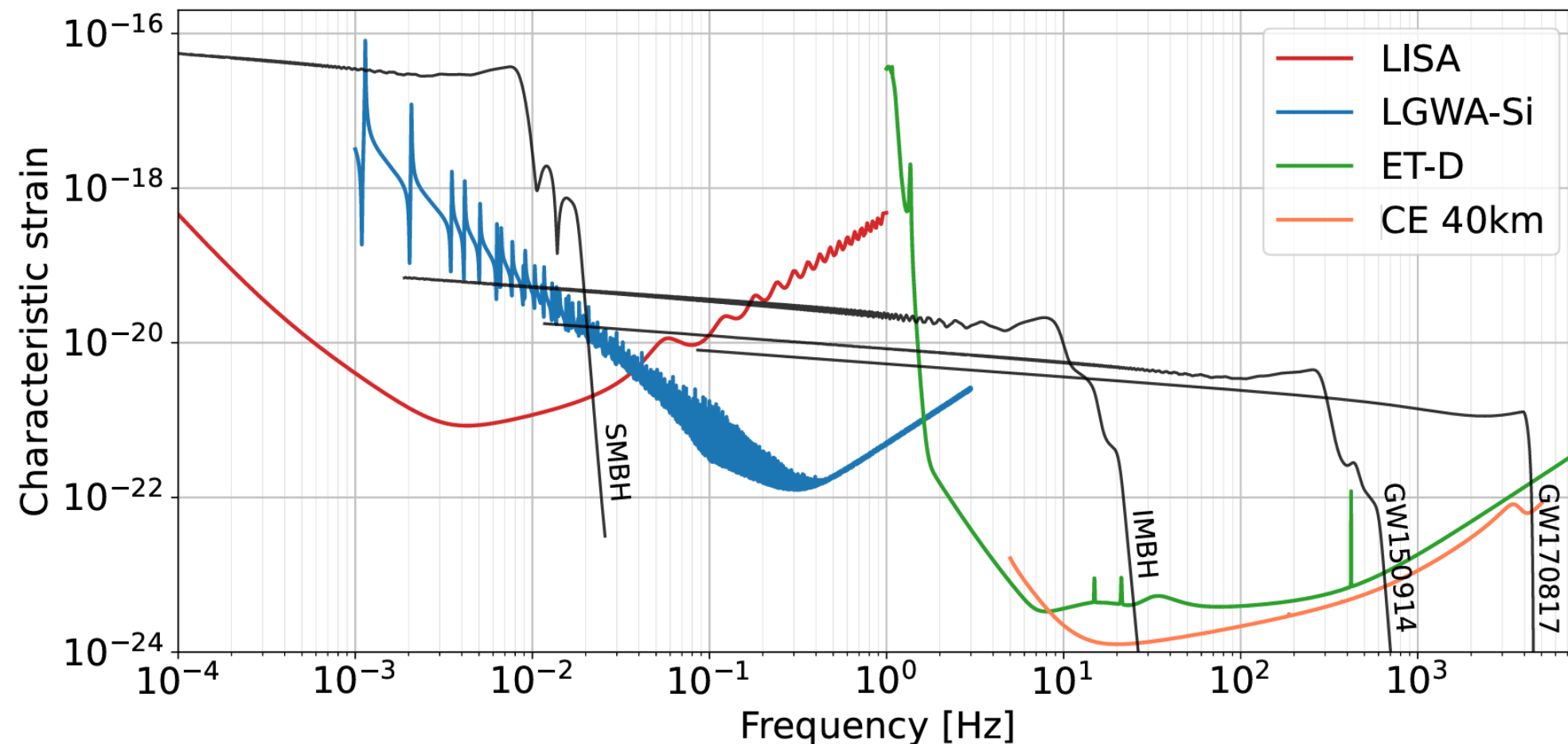
Credit: [Pichardo Marcano+25](#)

- Clear identification of progenitors
- Diversity of outcomes per UCB class
- Surviving systems again in the band
- Few 10s in the MW, 10+ extragalactic

[Benetti+25](#)



Multiband



Credit: [Ajith+24](#)

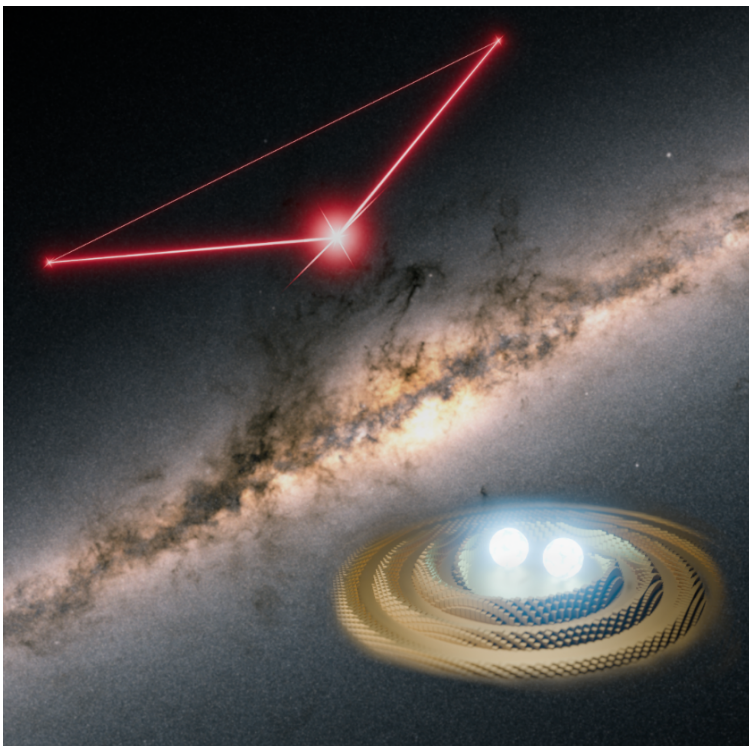
- **Better waveform use for CE/ET**
- **Eccentric UCBs**
- **Simultaneous detection**

See also: Talk by P. Ajith

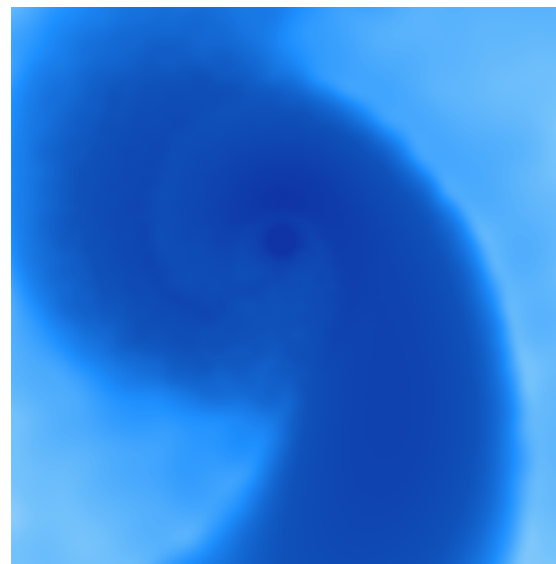


Key Points

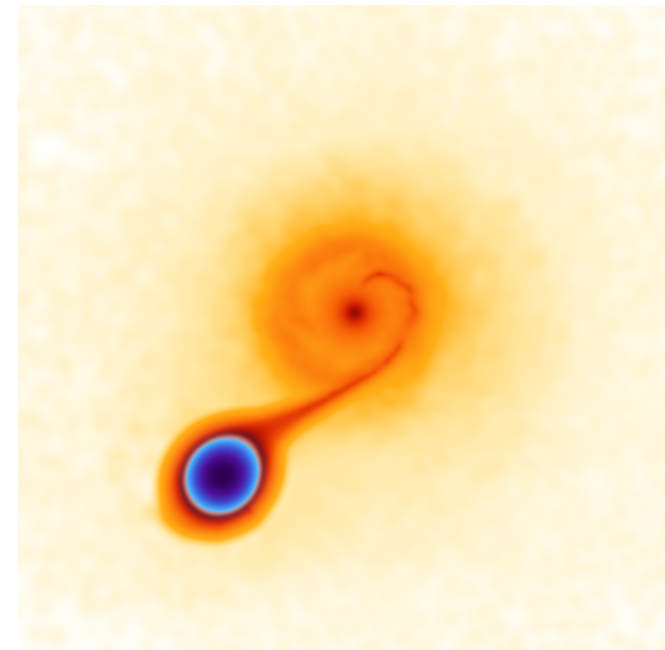
- **LGWA: what happens to merging UCBs**
- **Clean determination of progenitors**
- **Transforming the UCB science**
- **Missing piece**



Credit: **V. Korol**



Credit: **AB**



Credit: **AB**

