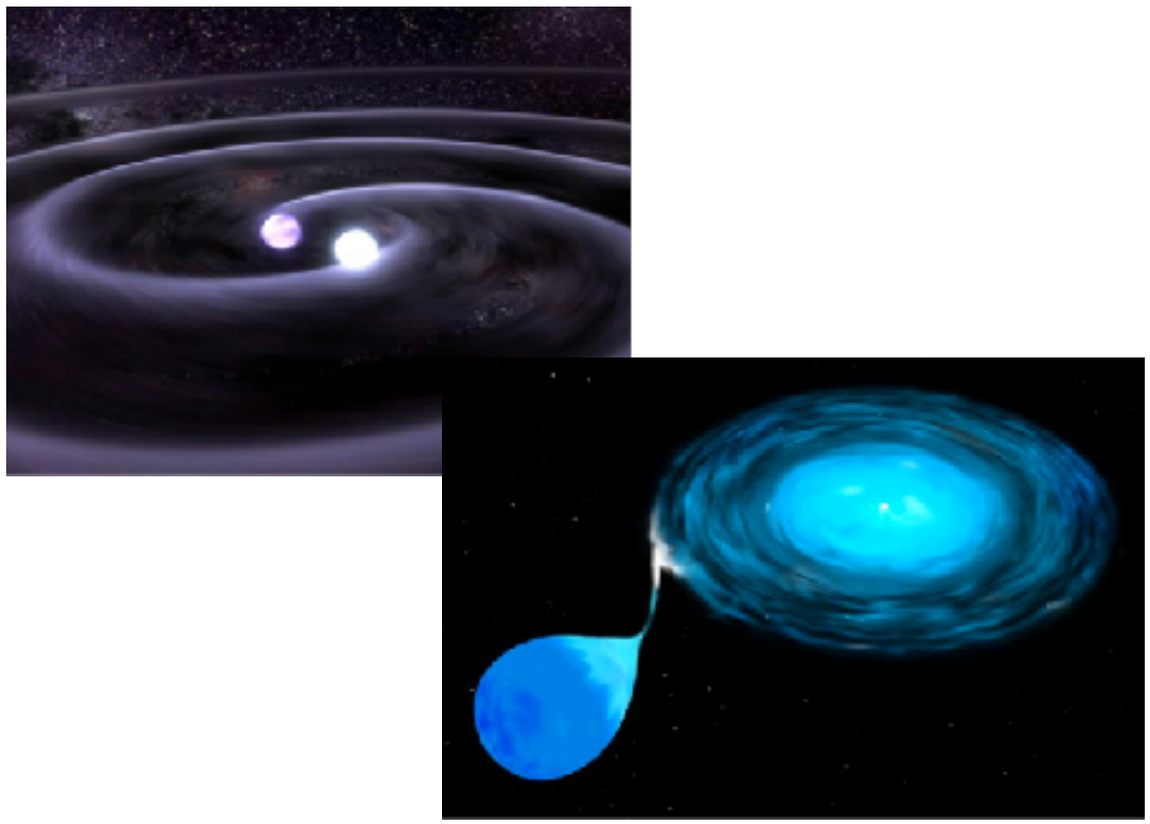
The Zwicky Transient Facility high-cadence Galactic Plane survey



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ZWICKY TRANSIENT FACILITY

The Palomar time-domain machinery

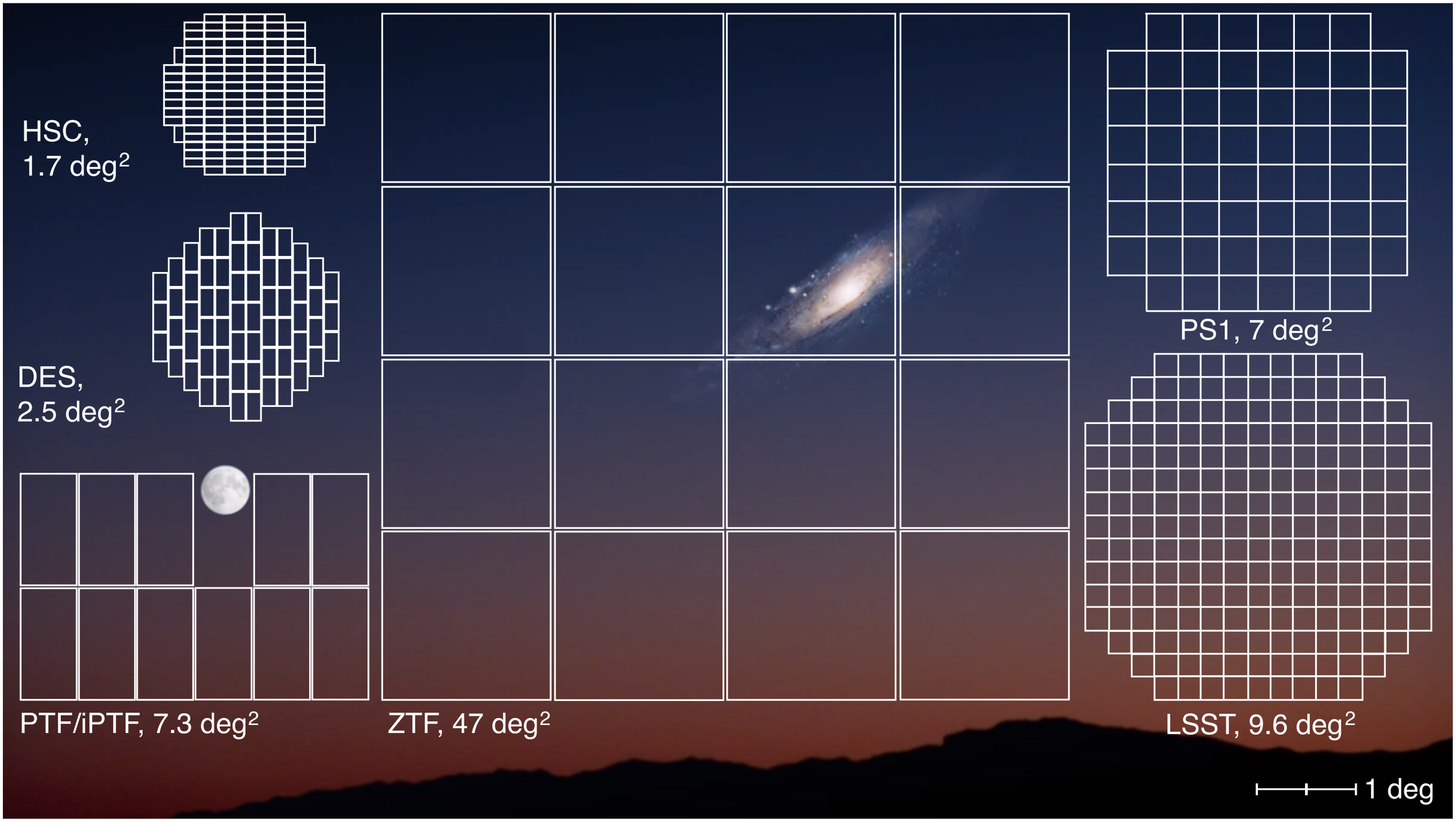
P48: Discovery

P60: Followup

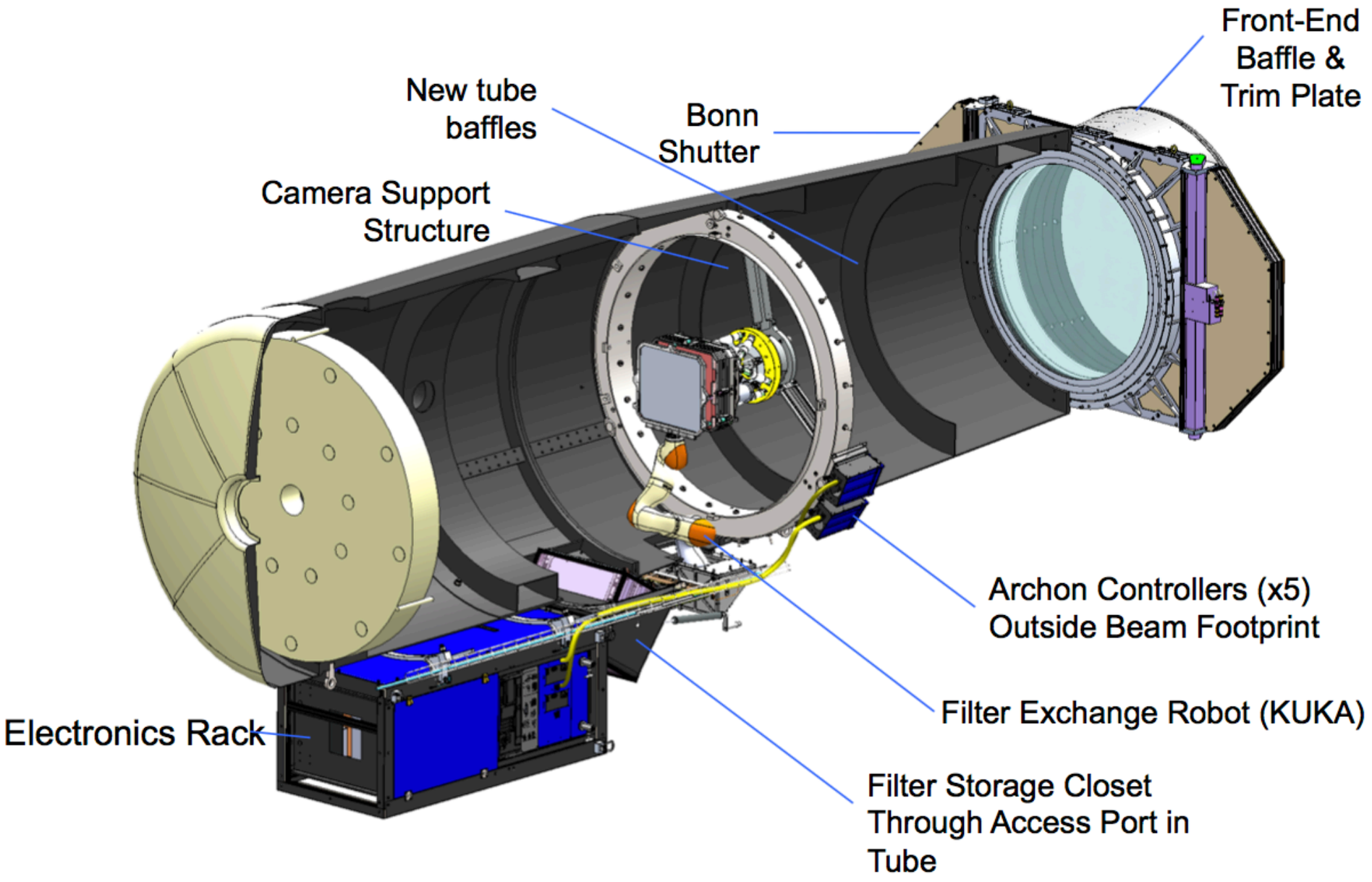
P200: Classification

The Zwicky Transient Facility

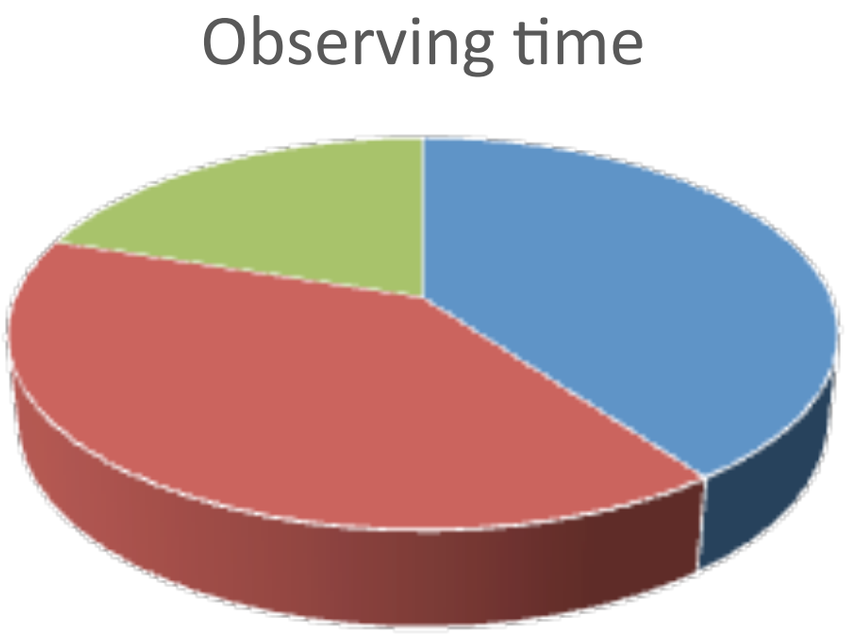
- 30 sec exposure to reach 20.5 - 21mag
- Started March 2018

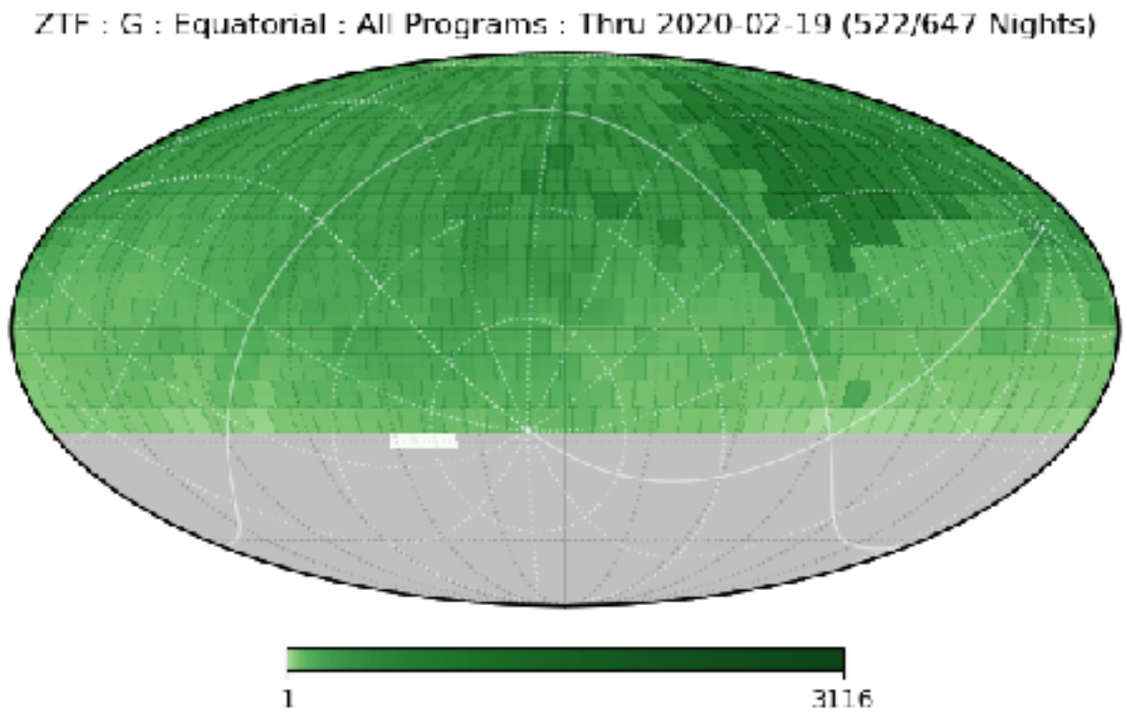


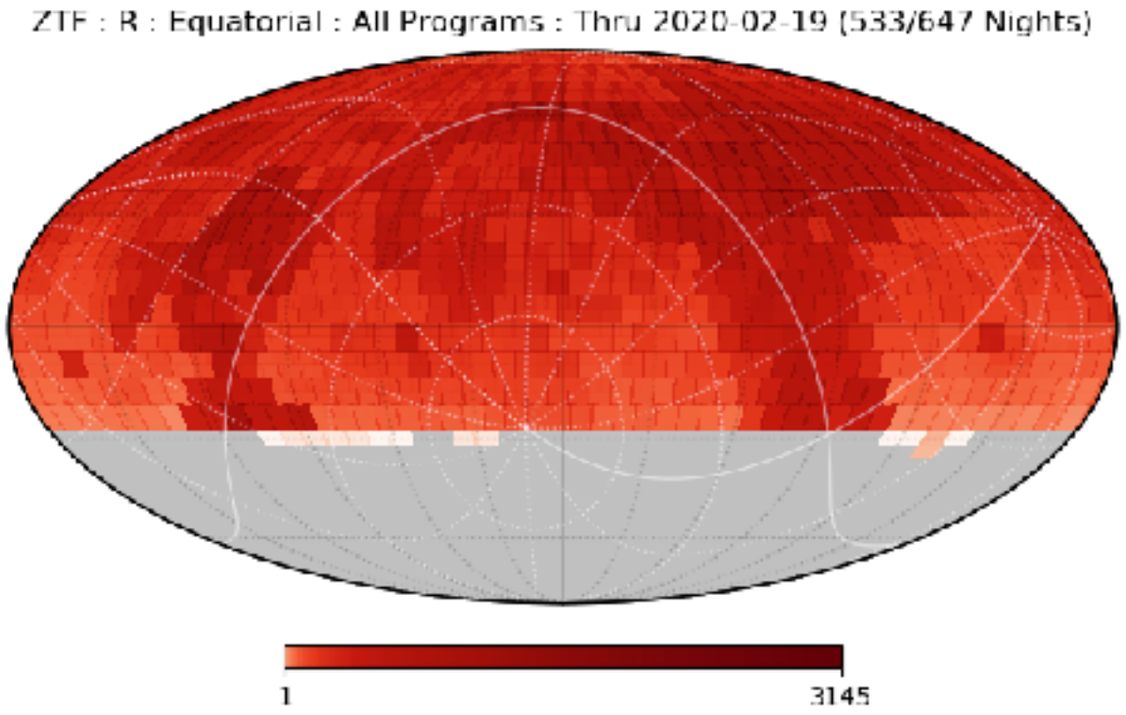
Schematic overview

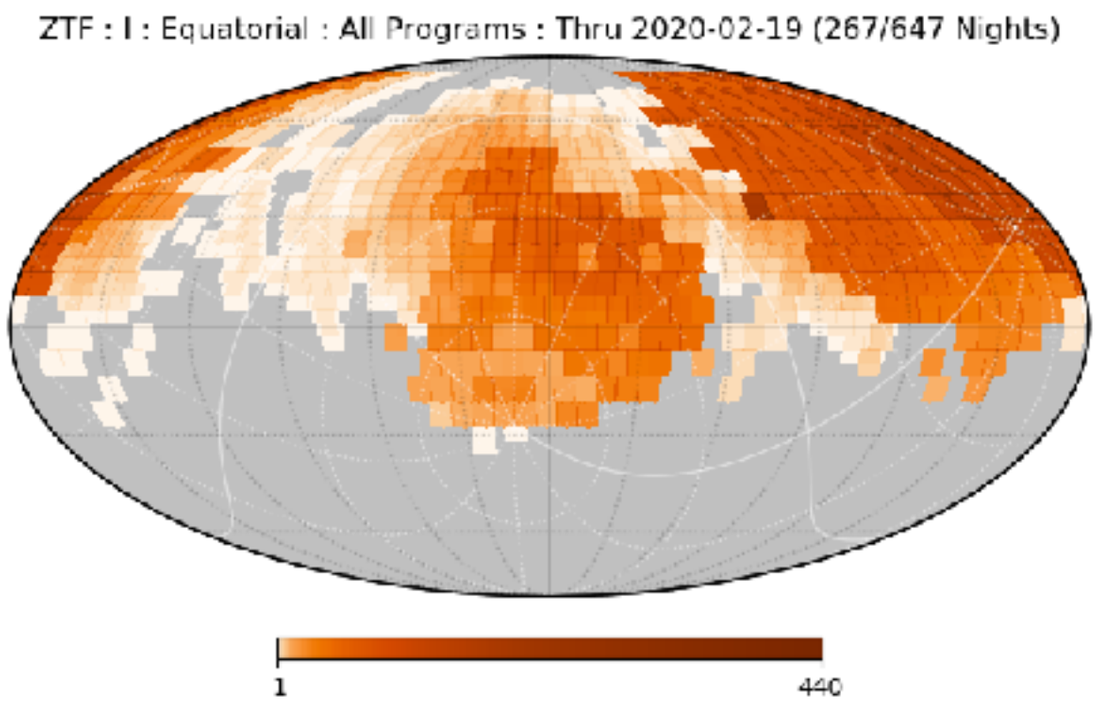


What are we doing



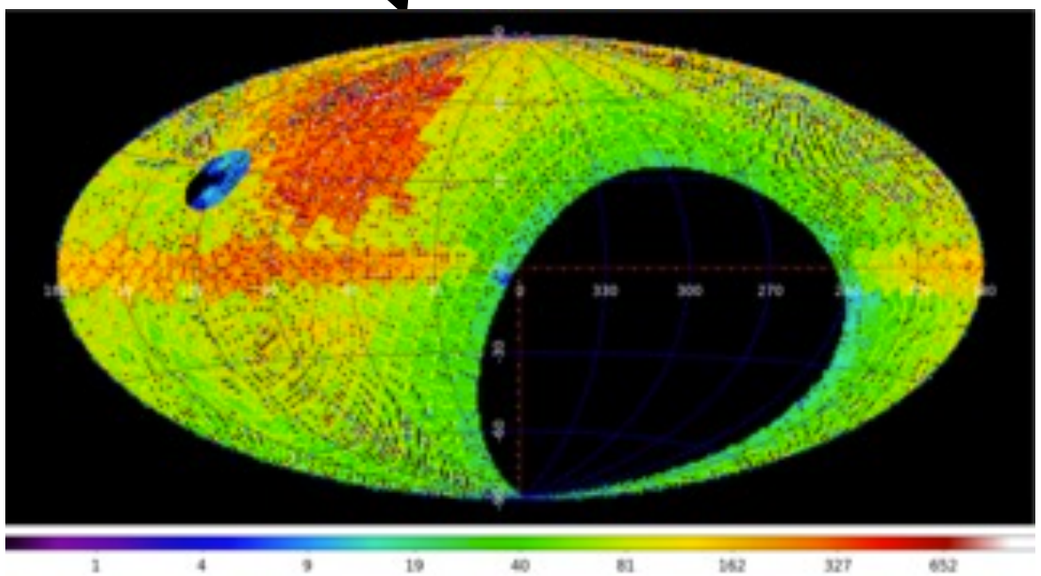


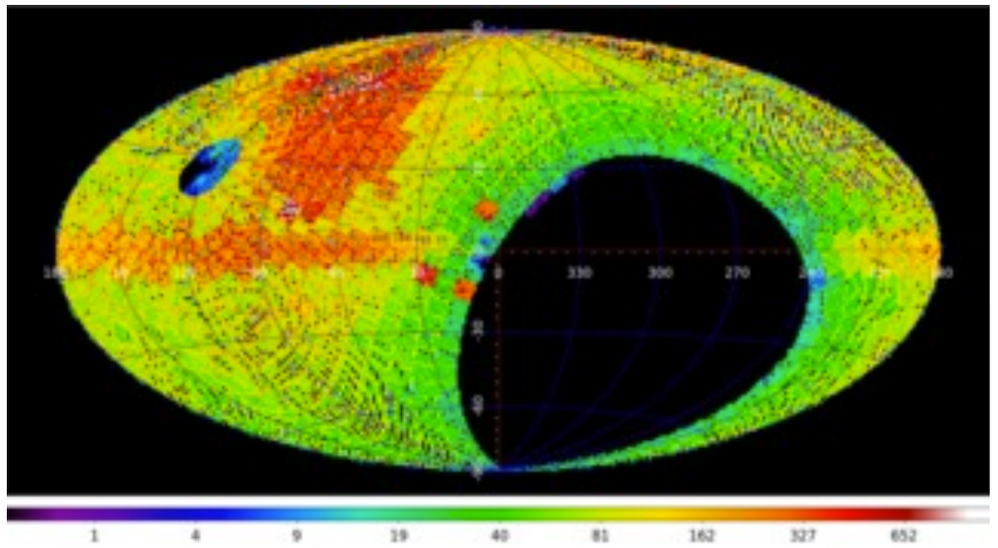




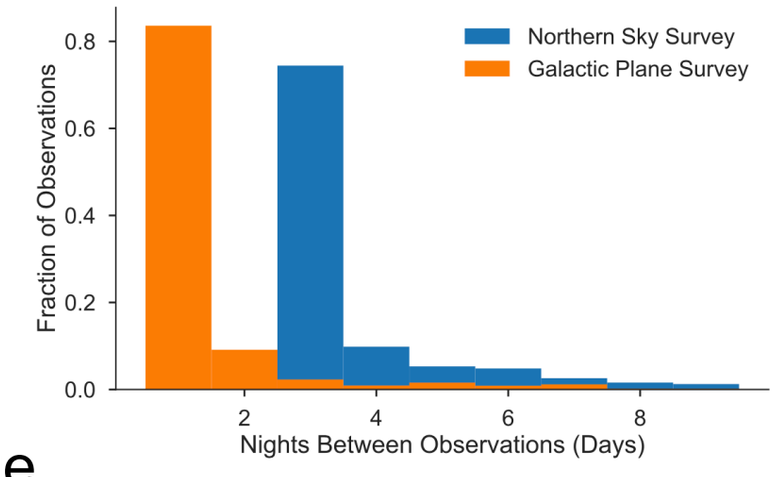
Public surveys - 40% of the total time

g-band





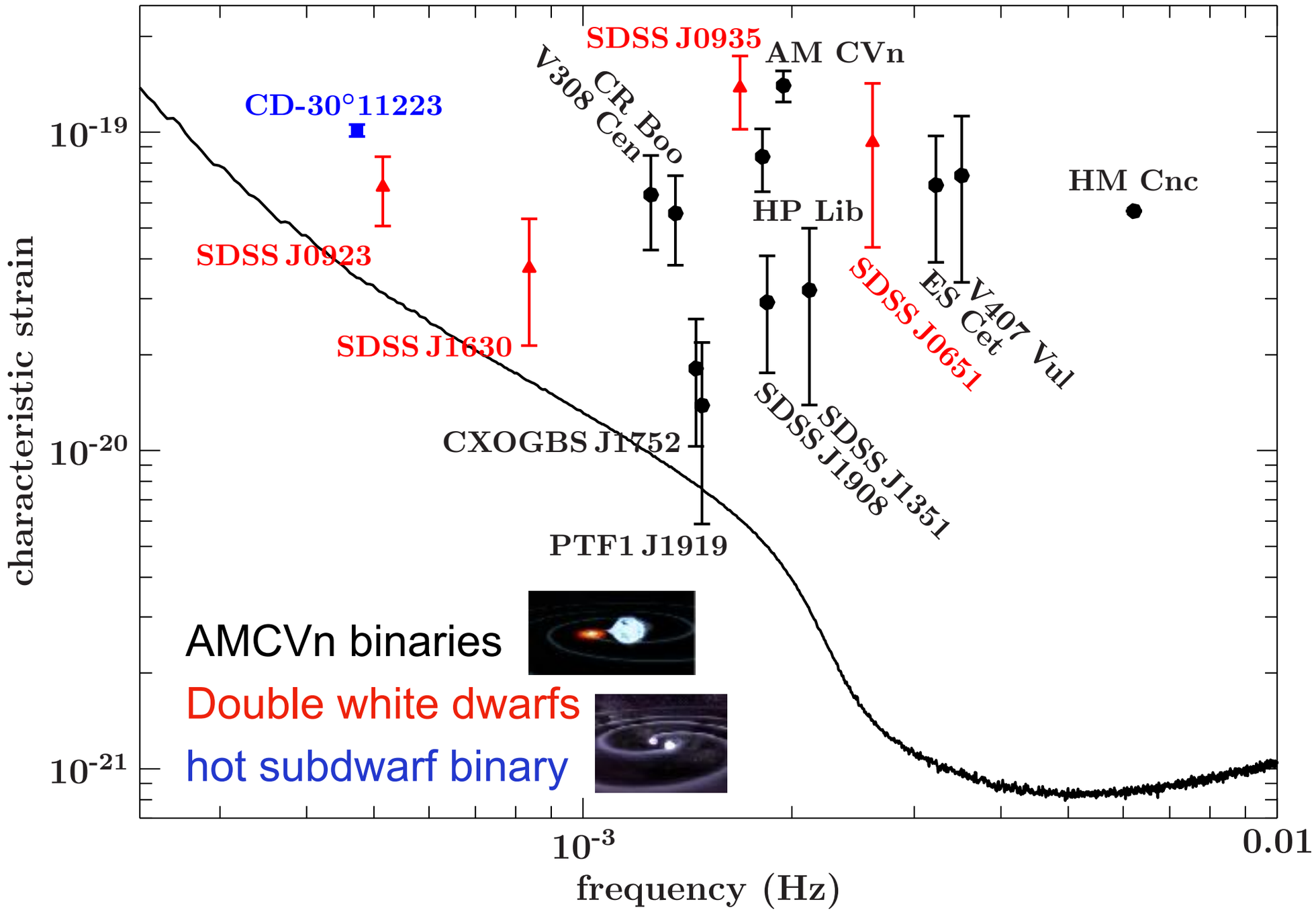
r-band



- **<u>Northern sky survey:</u>**
  - Two visits/night (g+r) for asteroid rejection => 3-day average
  - 23,675 deg² total footprint; 85% time; 4325 deg² average/night
- **<u>Galactic Plane survey</u>**
  - Nightly sweep of the Galactic Plane (|b|<7; nightly g+r)
  - ~2,800 deg² total footprint; 15% time; 1475 deg² average/night

-> Second full data release (images, catalogs, lightcurves: were released Dec 11

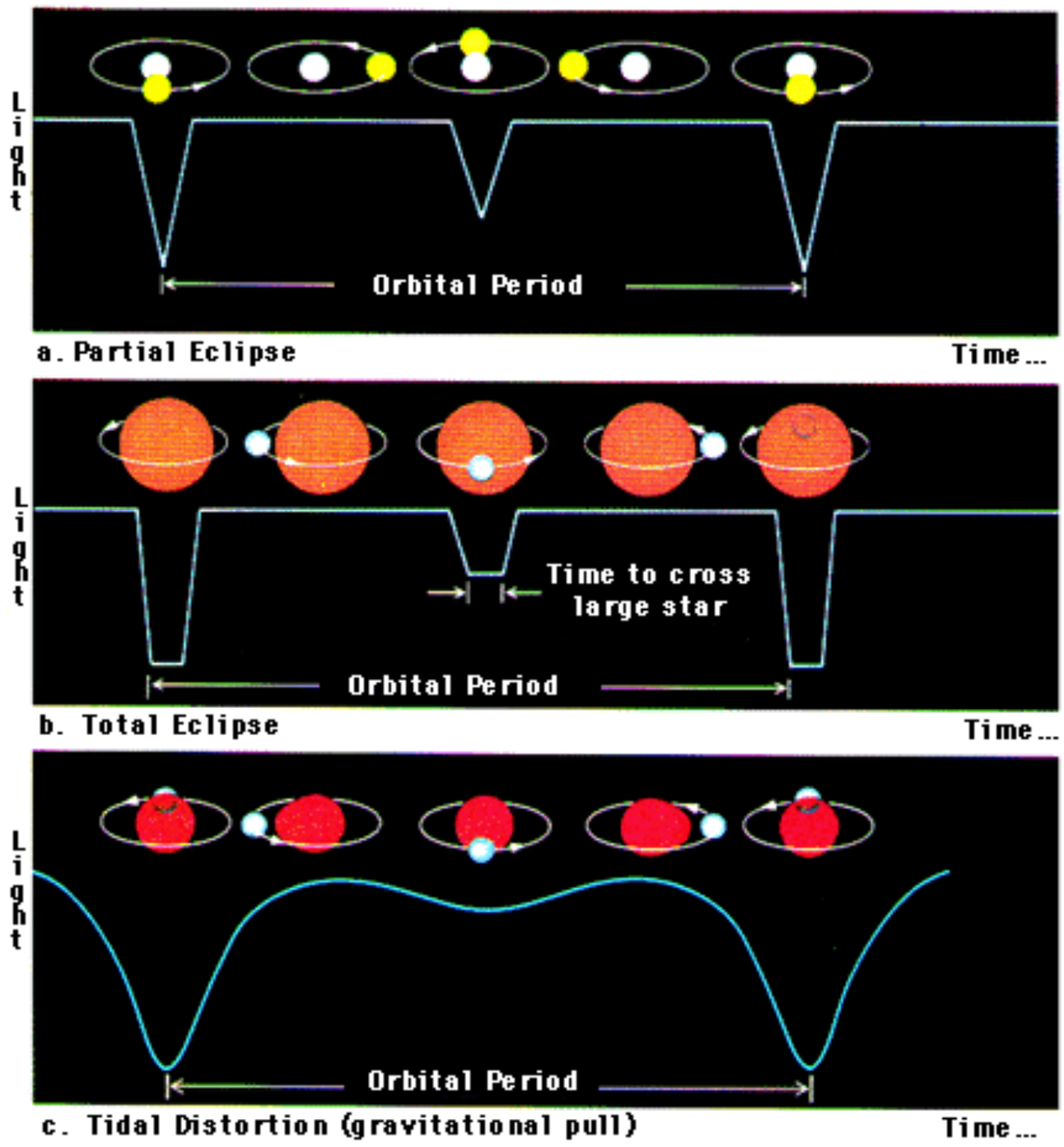
Known verification binaries



- We calculated strain/SNR for ~50 systems
- 16 systems expected to have signal to noise around 5 or larger

modified from Kupfer et al. 2018

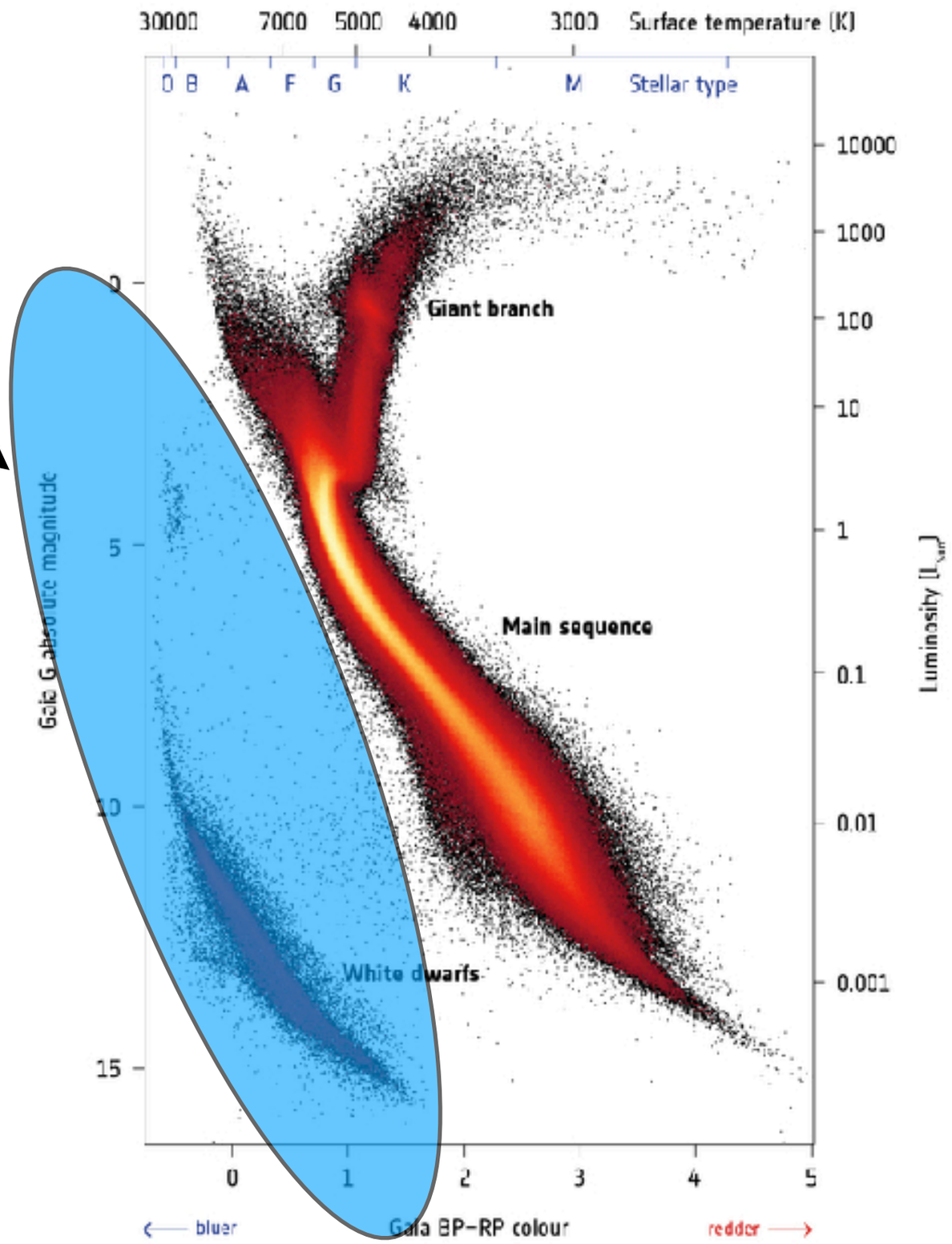
Lightcurve variability of binary stars



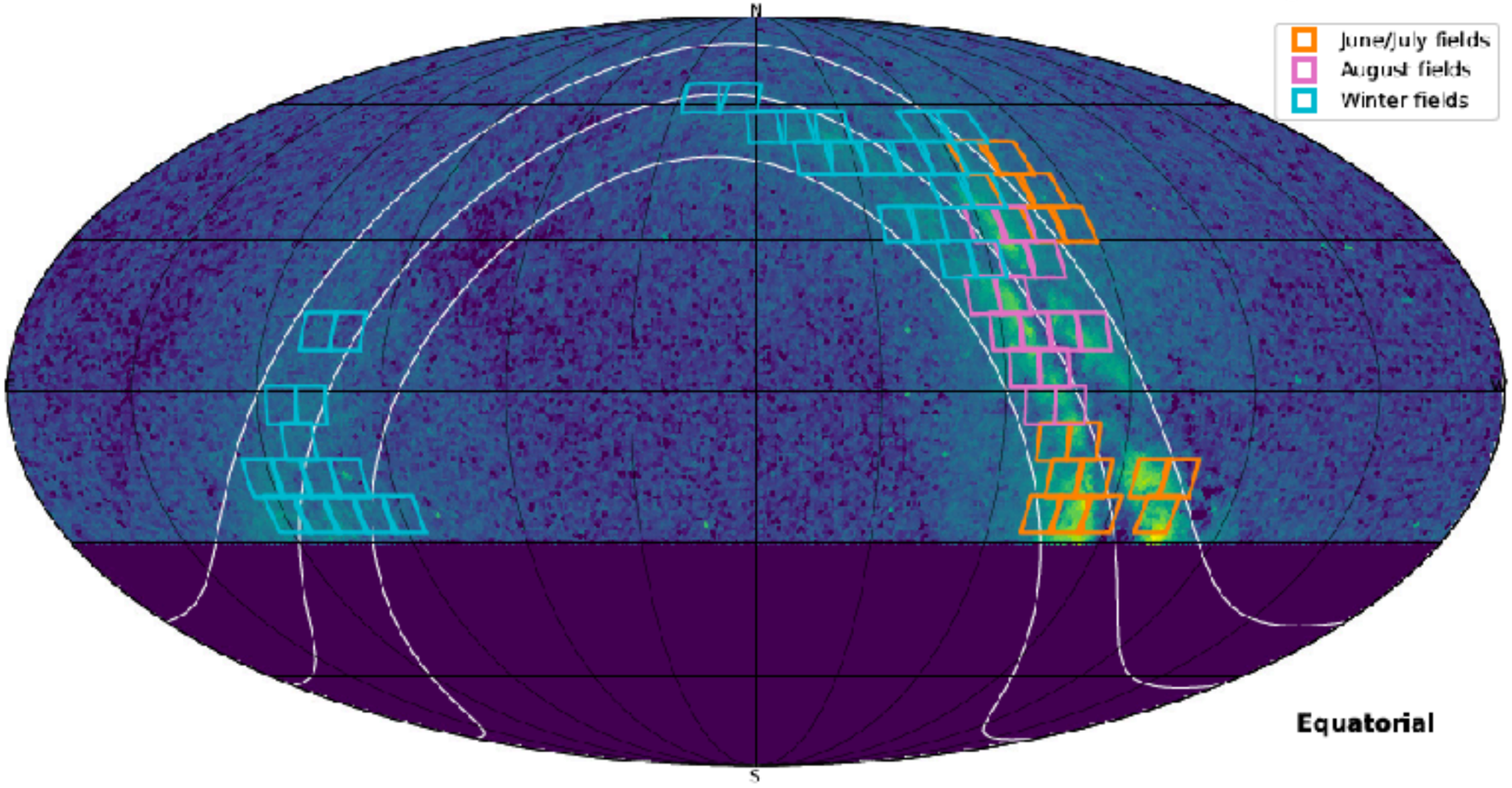
as tight as Earth - Moon distance
Periods: minutes to hours

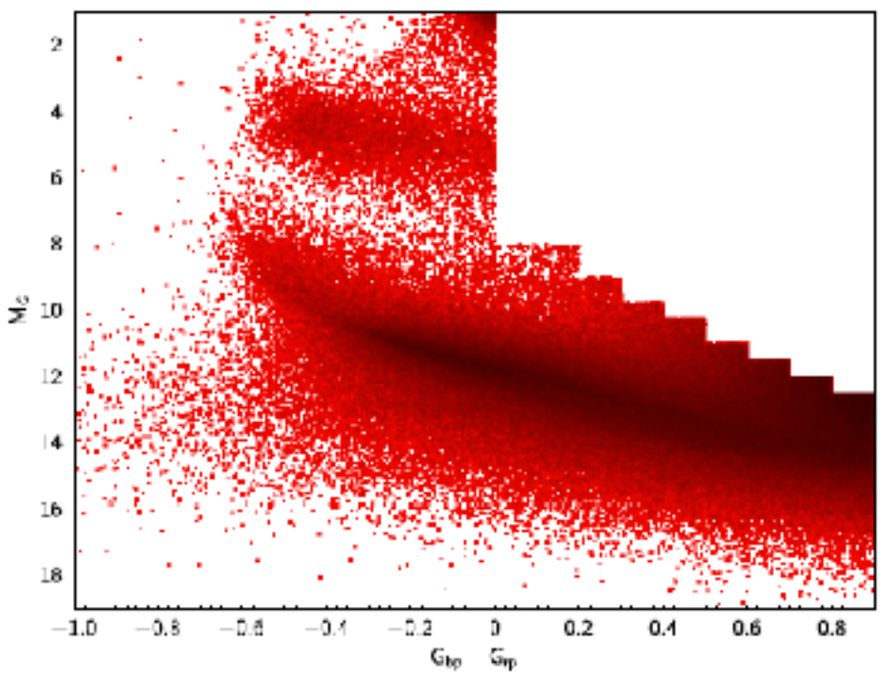
Where are the potential candidates

Here our potential candidates



The ZTF Galactic Plane survey



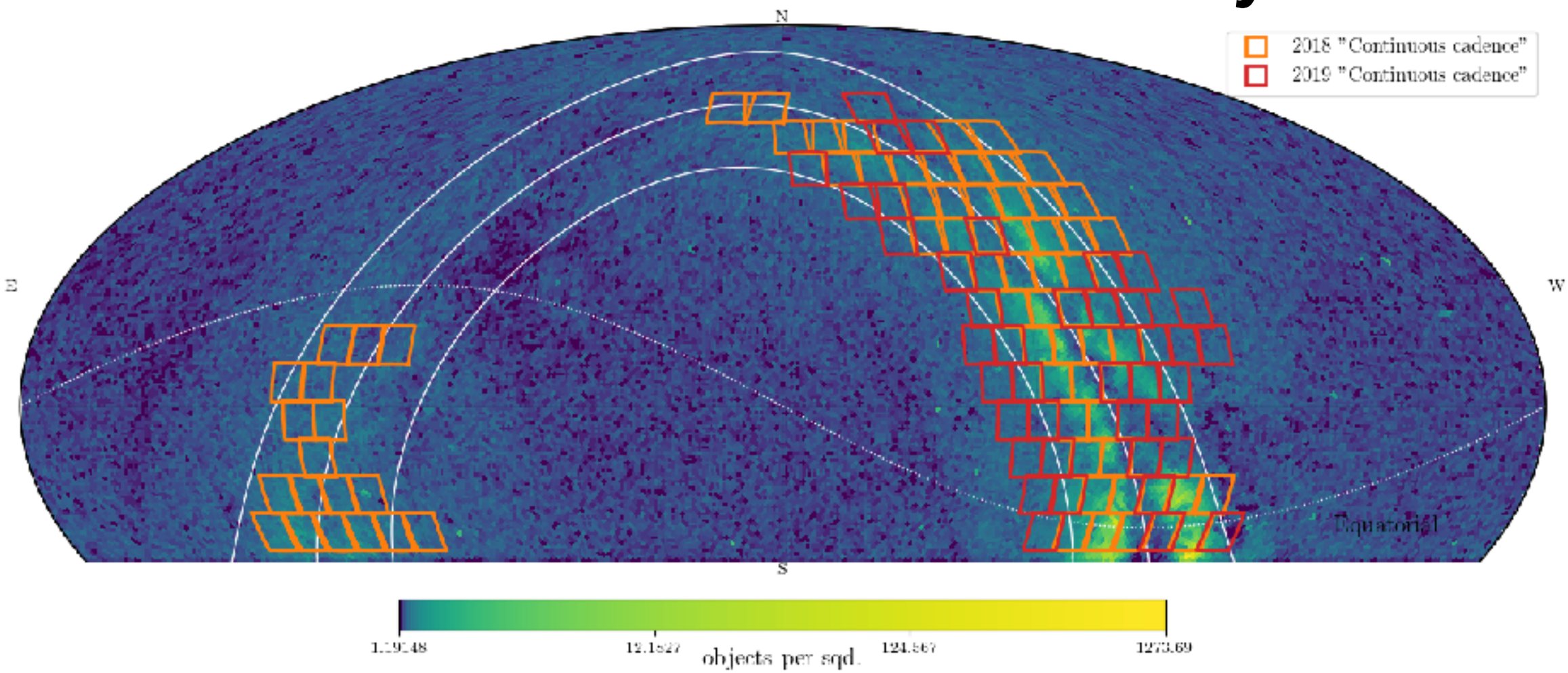


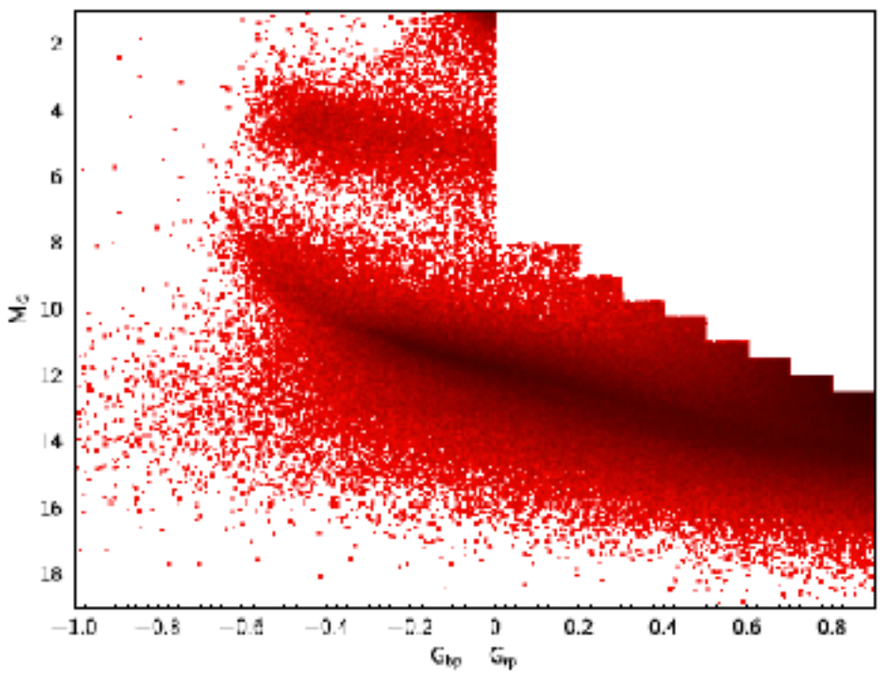
A fast cadence survey of the Galactic Plane

- **Time period:** mid 2018 - spring 2019
- **Cadence:** continuous for 2 - 3 hrs
- **Coverage:** ~2500 sqd
- **Number of stars:** ~hundred million

Kupfer et al. in prep.

The ZTF Galactic Plane survey

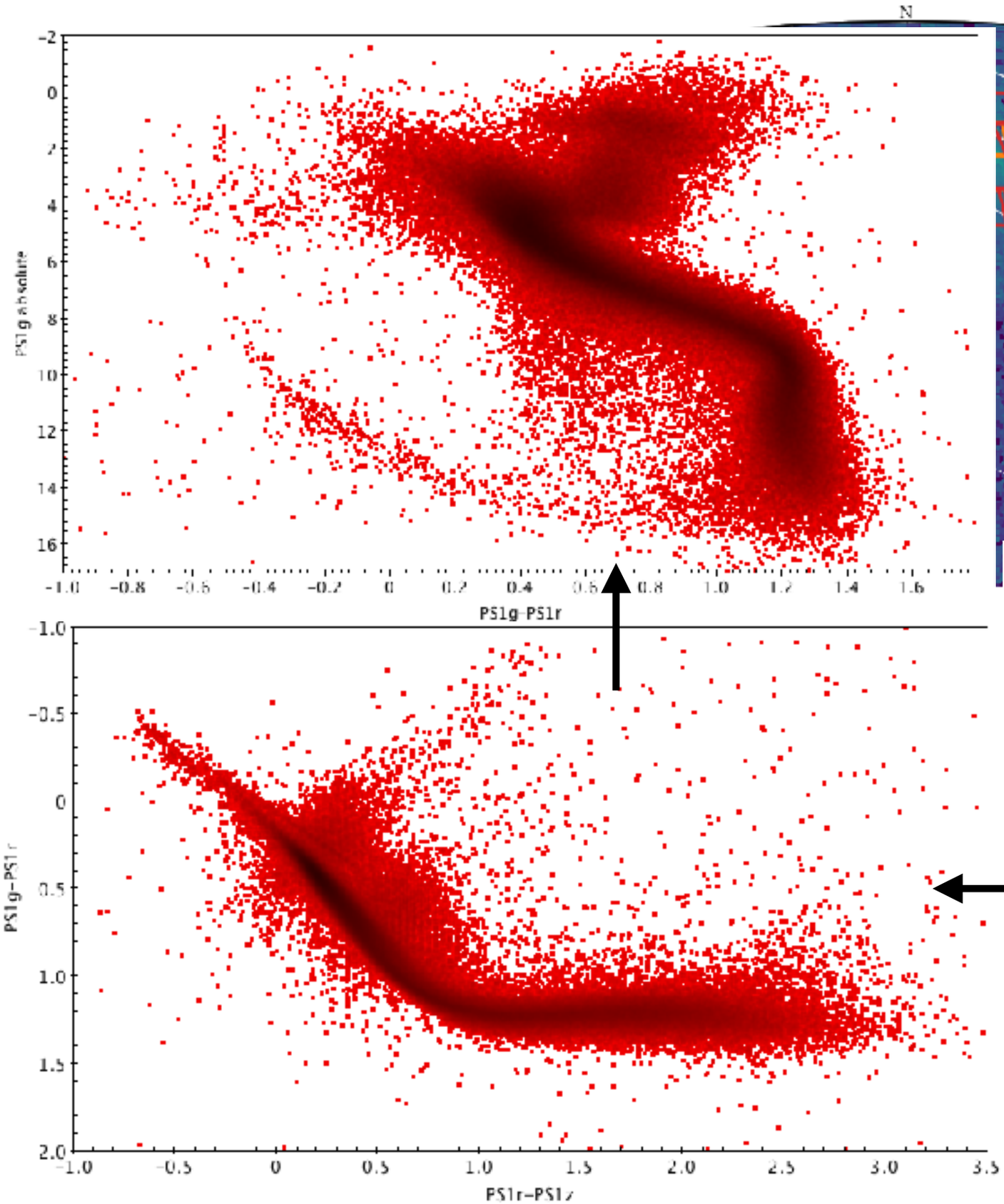


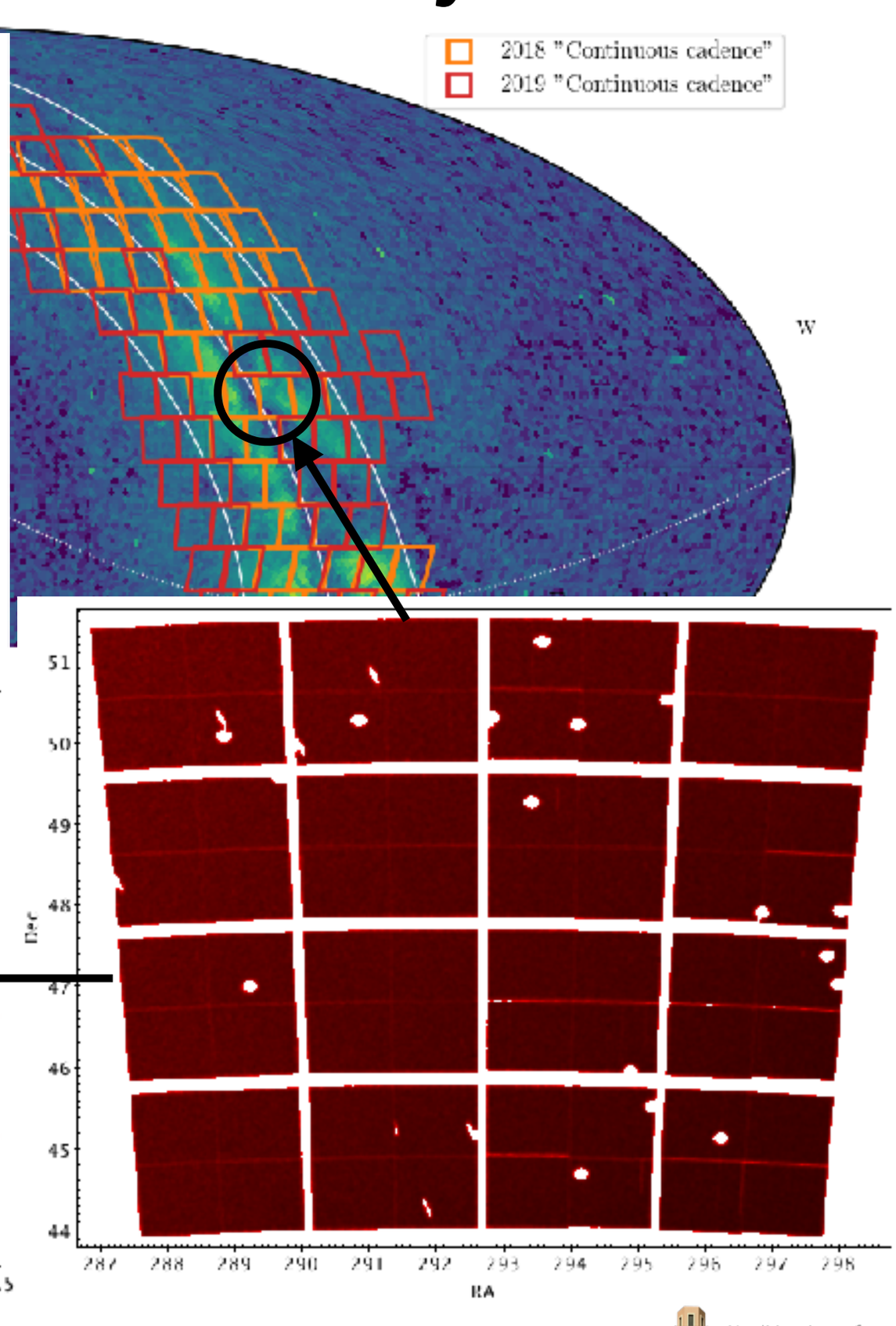


A fast cadence survey of the Galactic Plane (2019)

- **Time period:** summer 2019
- **Cadence:** continuous for 1.5 hrs
- **Coverage:** ~4900 sqd
- **Number of stars:** >hundred million

The ZTF Galactic Plane survey





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The ZTF Galactic Plane survey is a real treasure box

stripped-star +white dwarf P=39min
Kupfer et al. (2020)

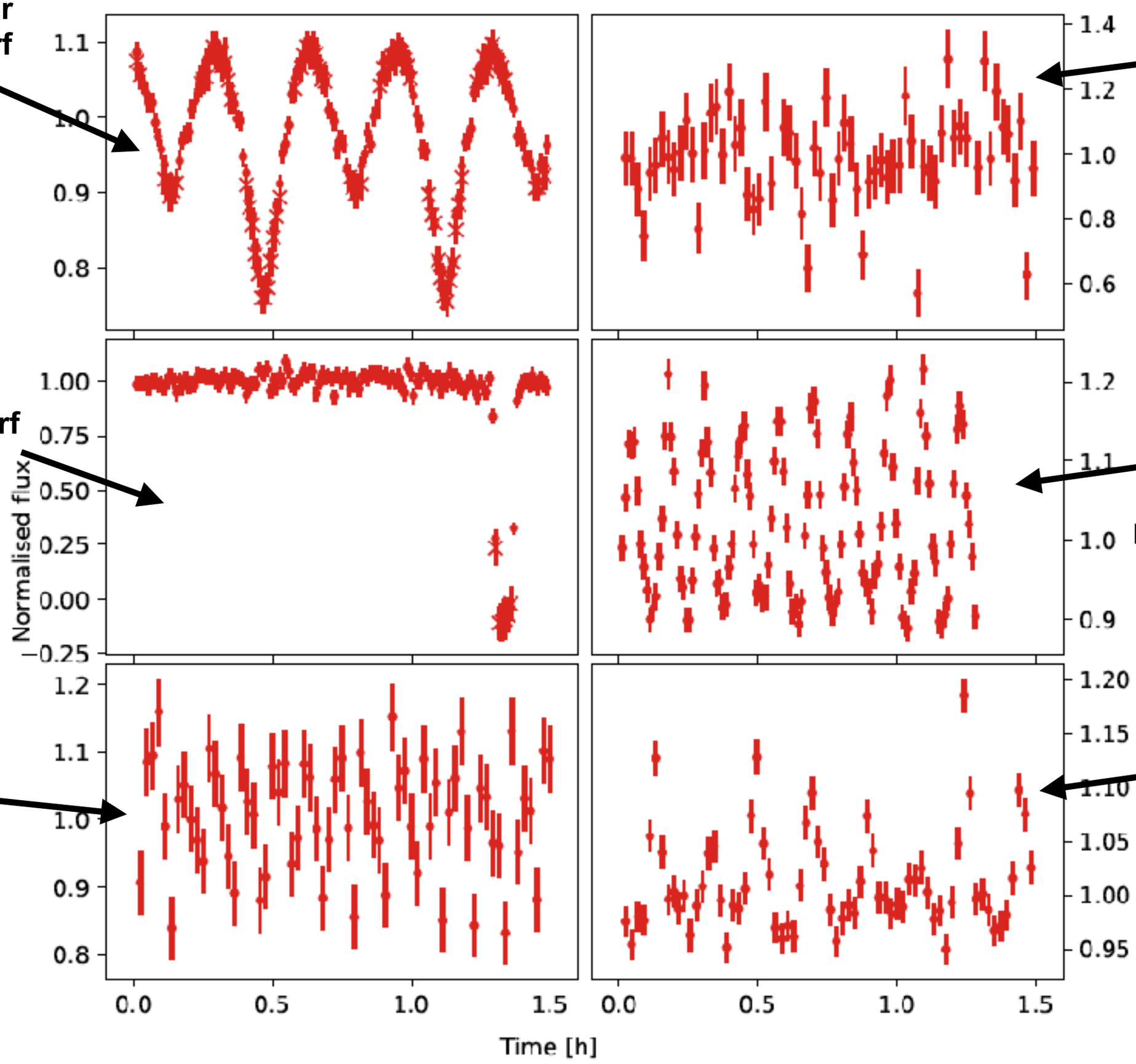
white dwarf +white dwarf P~24min

White dwarf +brown dwarf P~80min

new class of He-star pulsator P = 3-8min
Kupfer et al. (2019)

white dwarf rotator

white dwarf pulsator



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Stripped stars as LISA sources

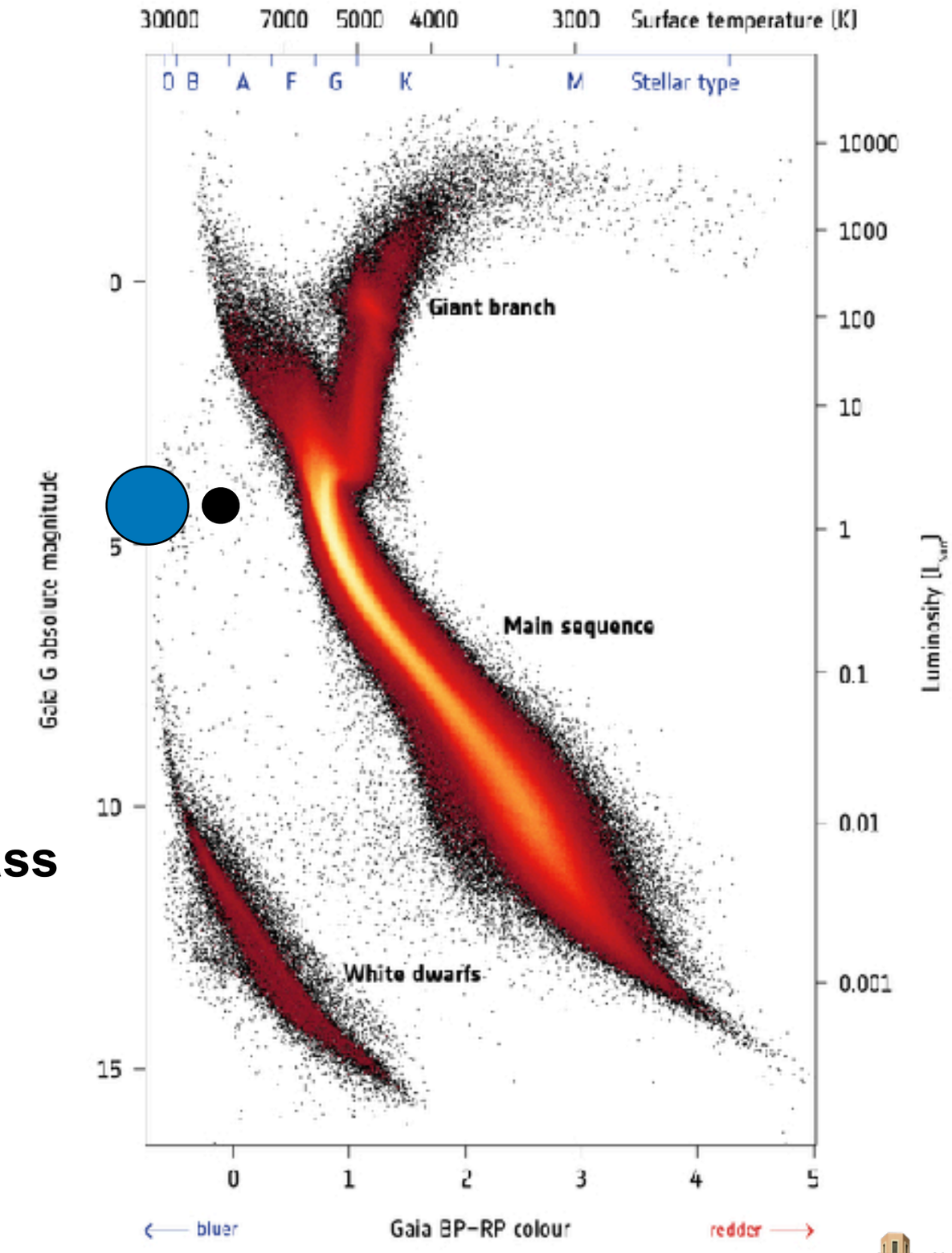
- Main sequence + companion:
  <u>orbital period < few years</u>

- Star evolves to become a red giant
  -> <u>forms a common envelope</u>
- removes hydrogen envelope

<u>If helium burning **has** started:</u>

- common envelope forms compact helium core burning star (stripped star or sdB/sdO stars)

- **Type Ia supernova progenitors**
- **Well established main-sequence mass vs. He-core mass relation**
- **Important for binary evolution**
- **Some will be seen by LISA**



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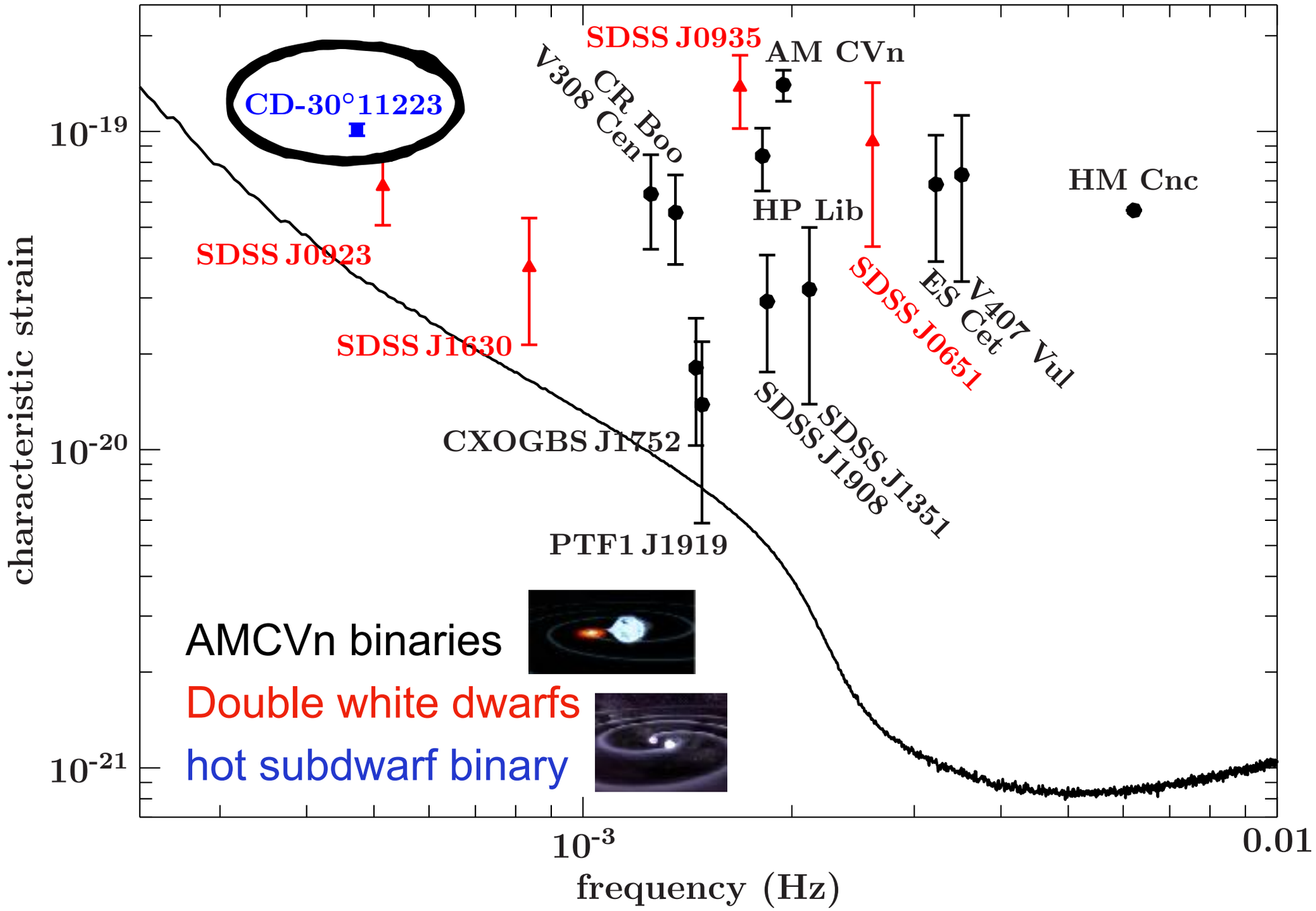

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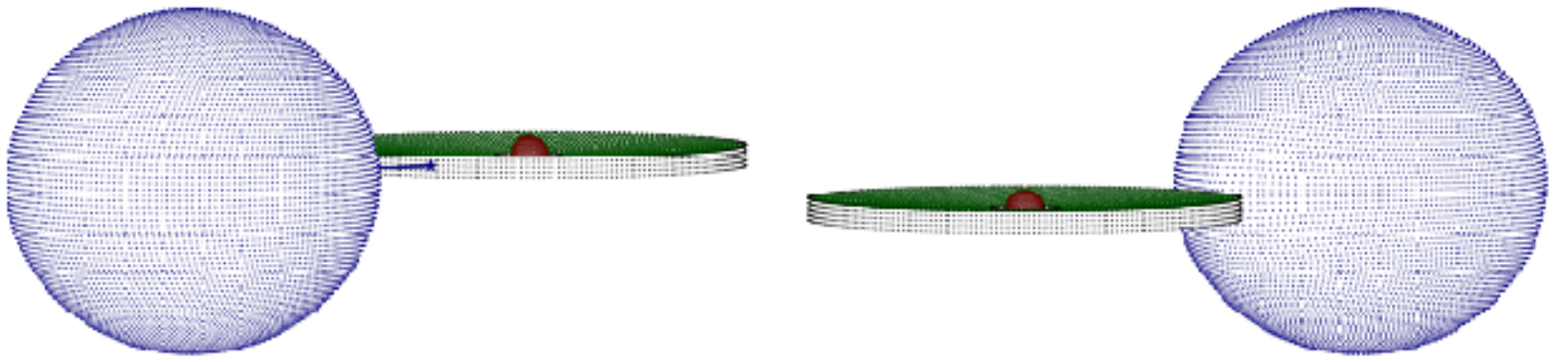
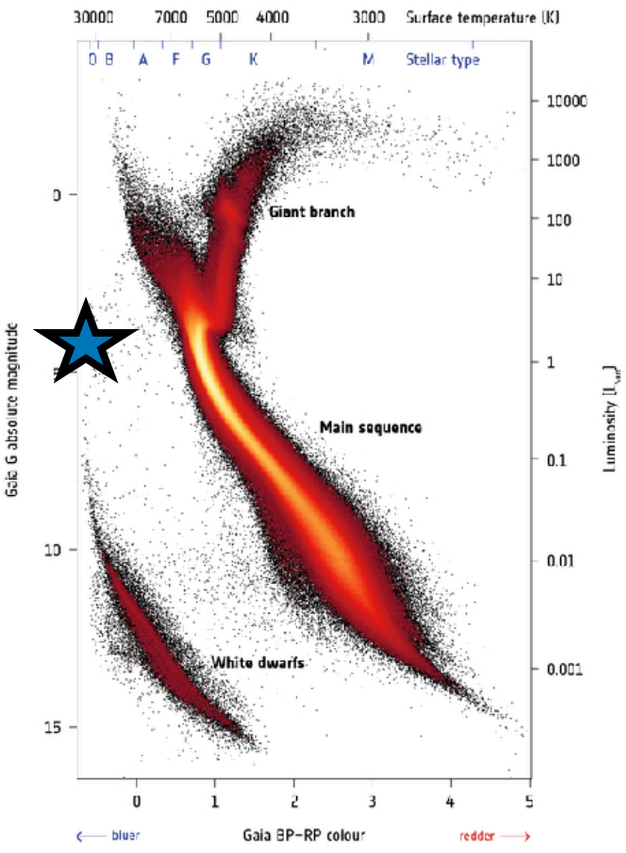
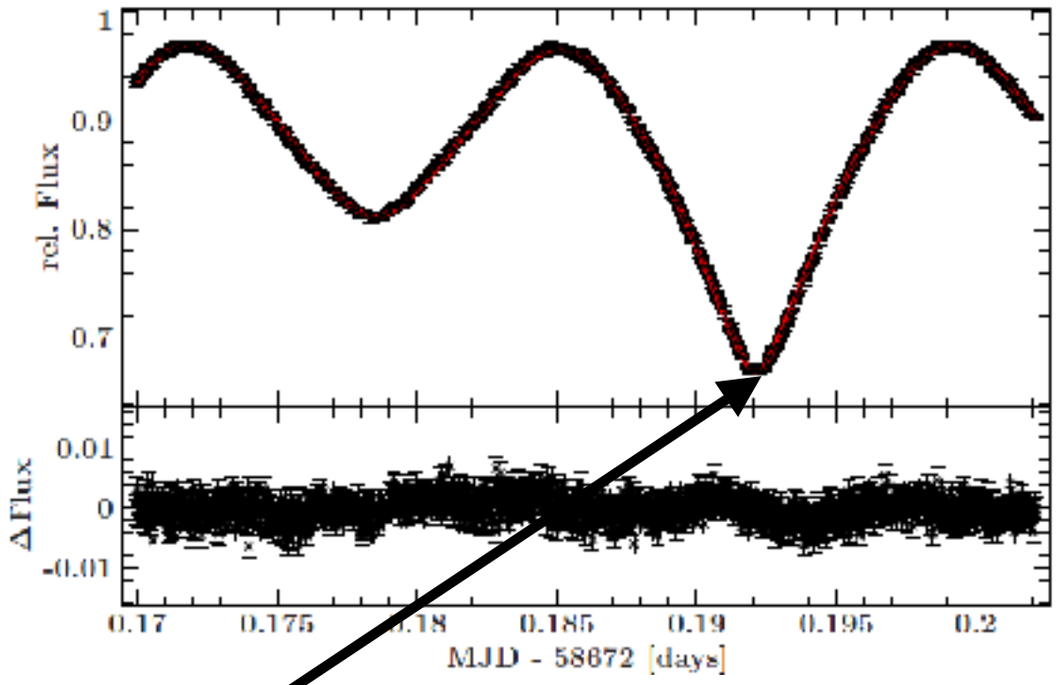
modified from Kupfer et al. 2018

ZTFJ2130 - The most compact stripped star binary - P_{orb}=39min -



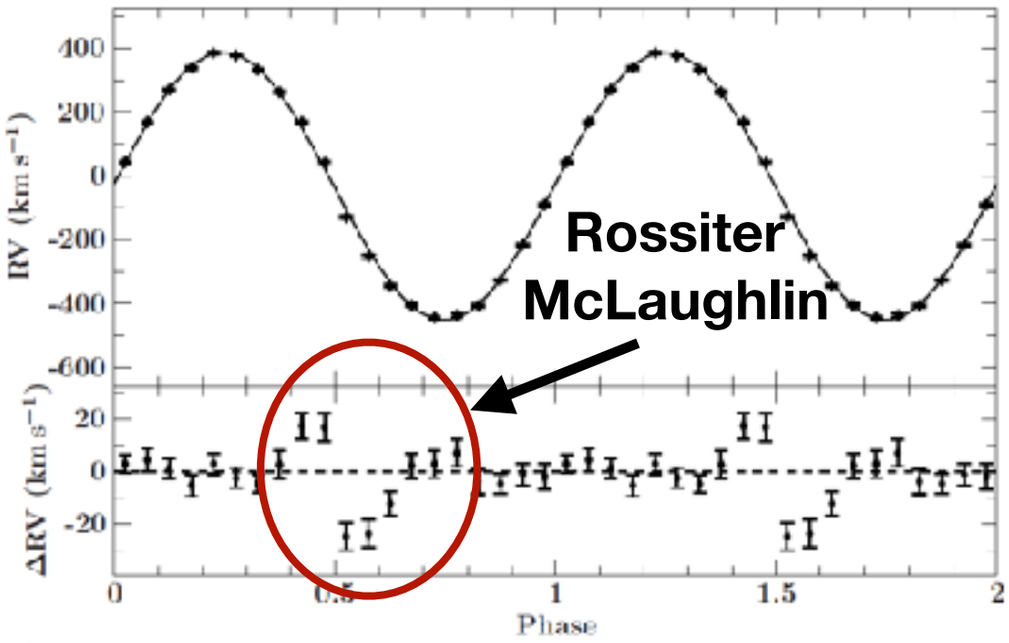


Light curve:



eclipse of He-star by accretion disc

Spectroscopy:



- velocity semi-amplitude = **419 km/s**
- WD is not very massive: 0.55 +/- 0.02 M_{sun}
- He-star is rather low mass: 0.33 +/- 0.02 M_{sun} -> evolved from 2.5-2.8 M_{sun} star

Kupfer et al. (2020)

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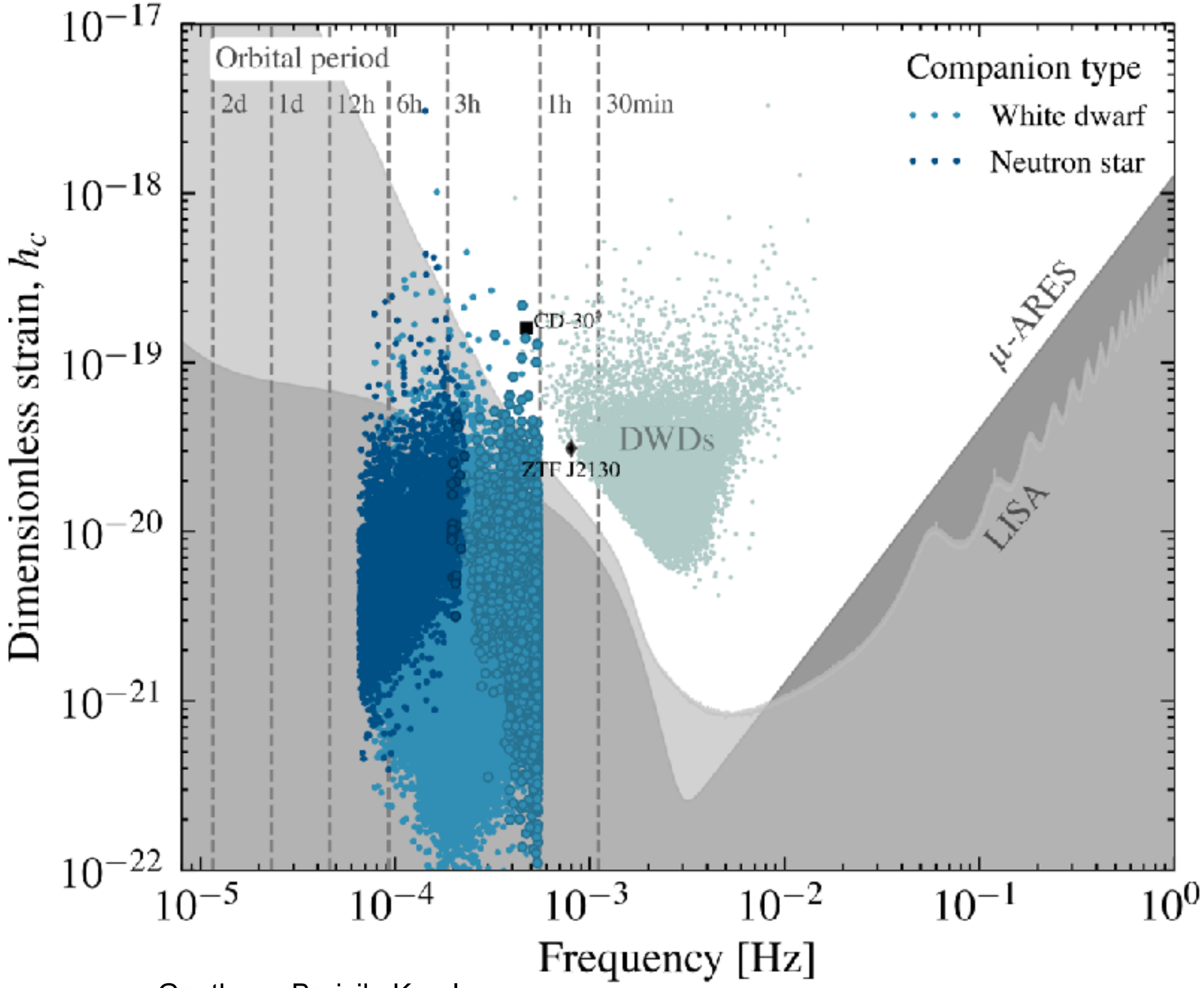
Stripped stars as LISA sources



Goetberg, Breivik, Korol, Lamberts, Kupfer in prep.