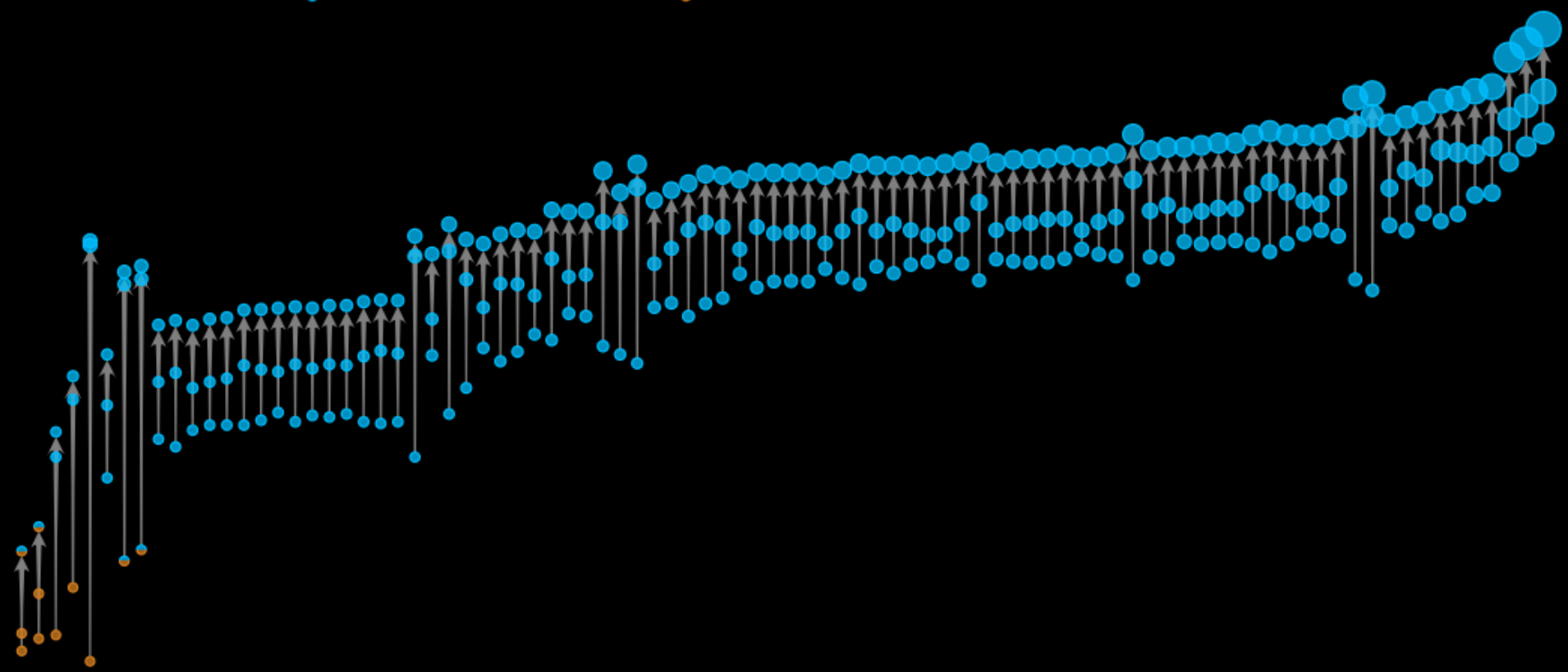
Stripped Star plus Compact Object Binaries: Identifying the Progenitors of Neutron Star Mergers

Maria R. Drout
University of Toronto
Carnegie Observatories

Masses in the Stellar Graveyard

LIGO-Virgo-KAGRA Black Holes *LIGO-Virgo-KAGRA Neutron Stars*



LIGO-Virgo-KAGRA | Aaron Geller | Northwestern

The Evolutionary Path to a BNS

There are multiple stages with (large) uncertainties

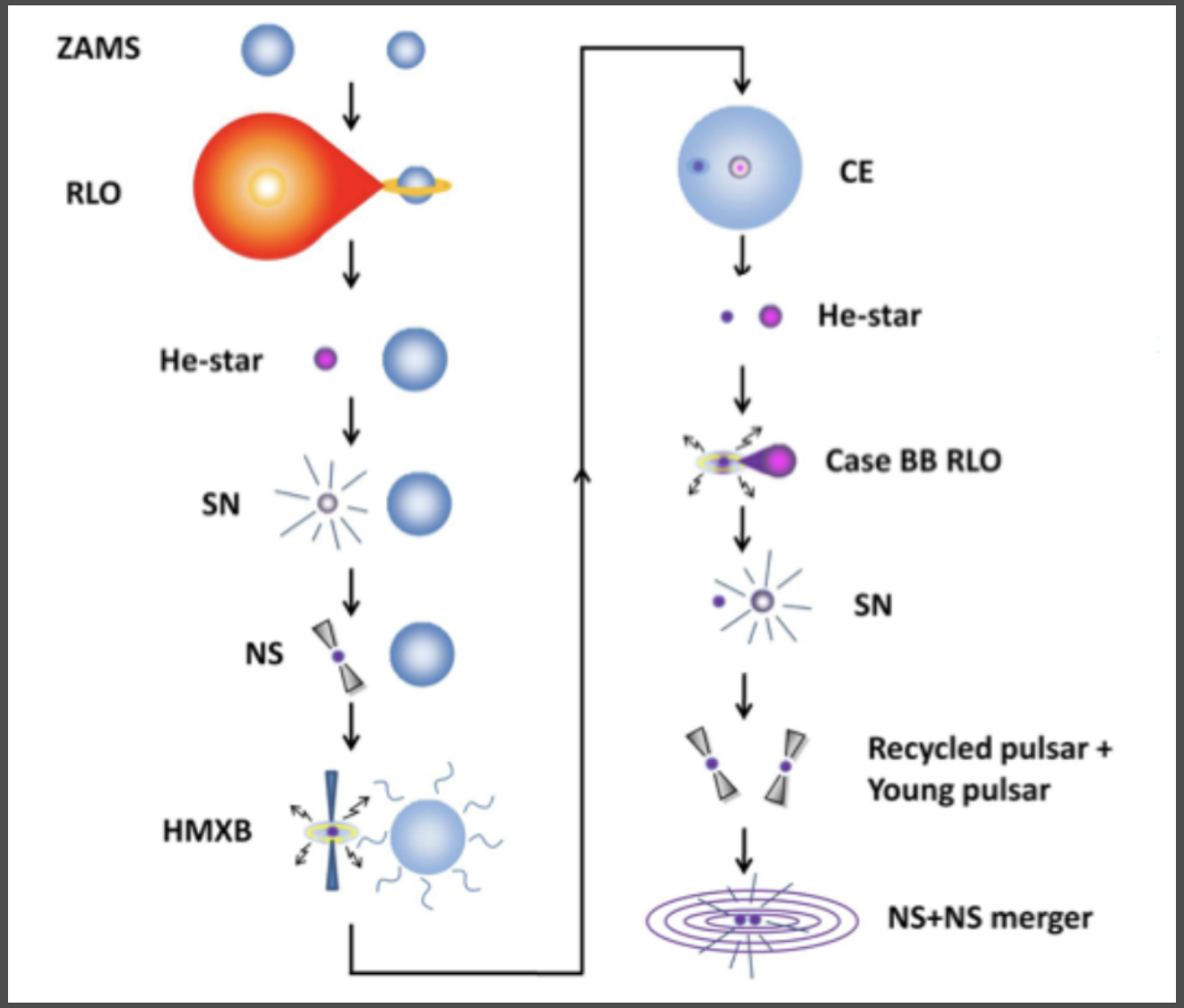


Image courtesy of T. Tauris

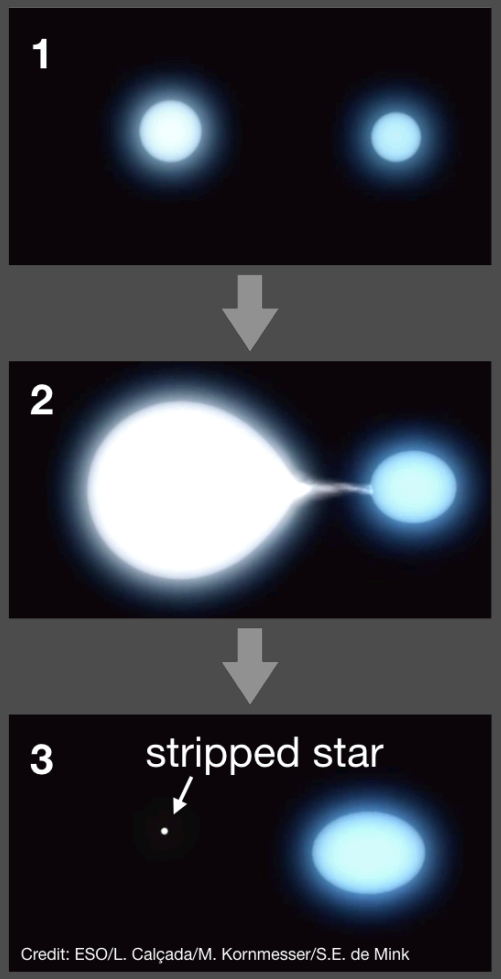
What are Stripped Stars?

How Can They Help?

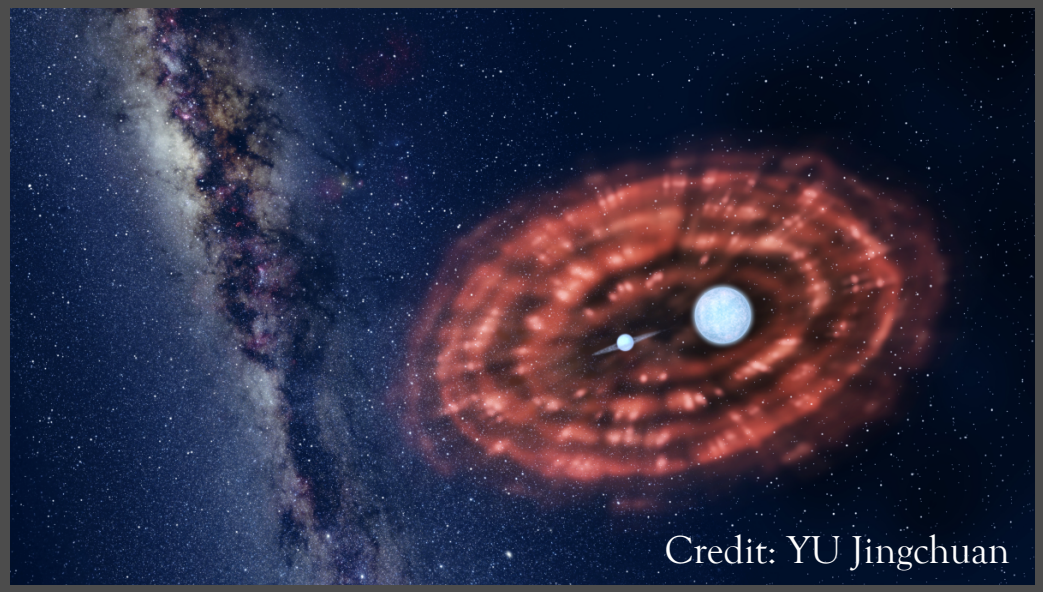
What are Stripped Stars?

Hydrogen-rich envelopes removed via binary interaction

Roche-Lobe Overflow



Common Envelope Evolution



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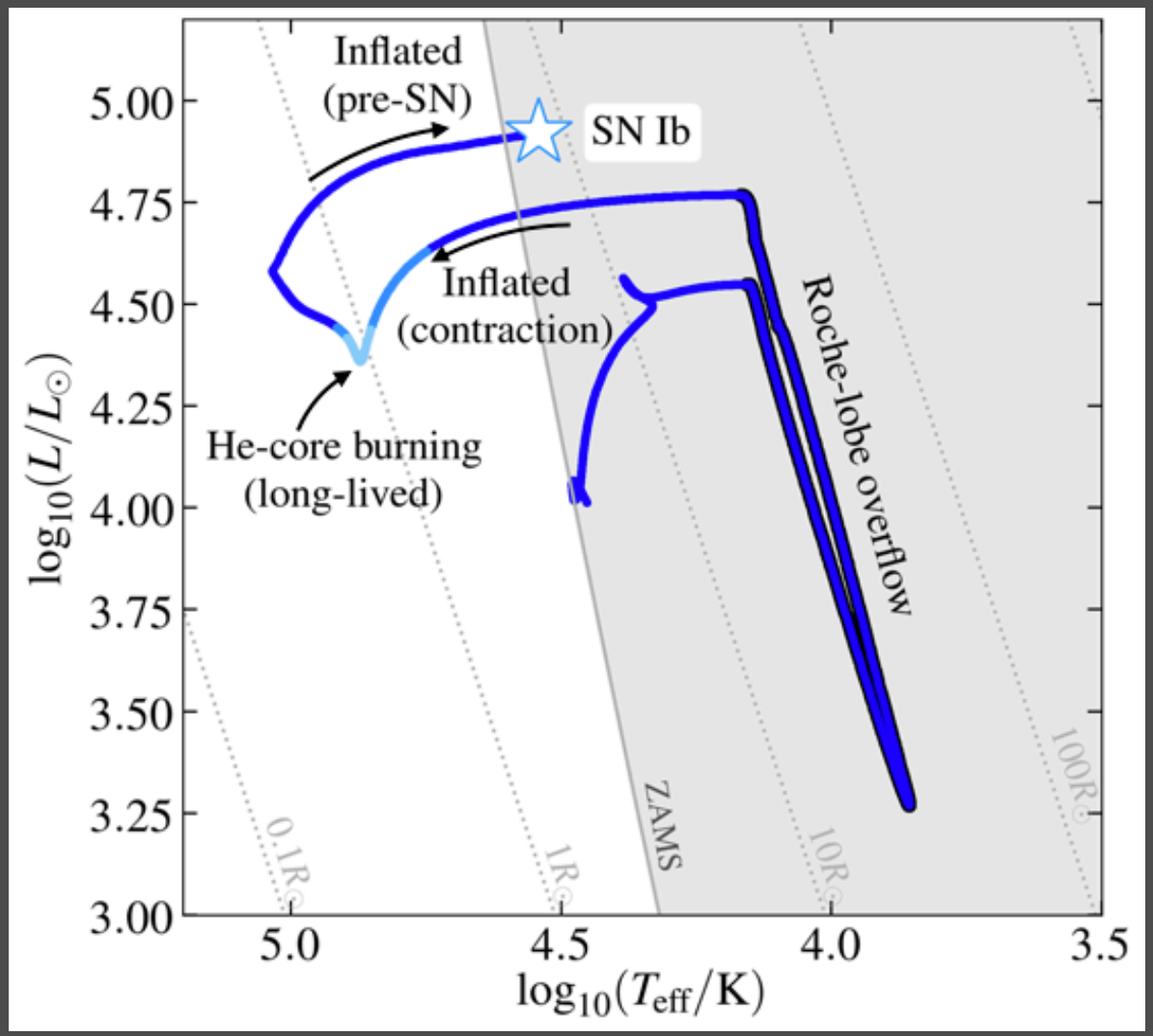


Stripped cores are hot and compact

The Evolutionary Path to a BNS

Multiple Phases of Envelope Stripping are Required

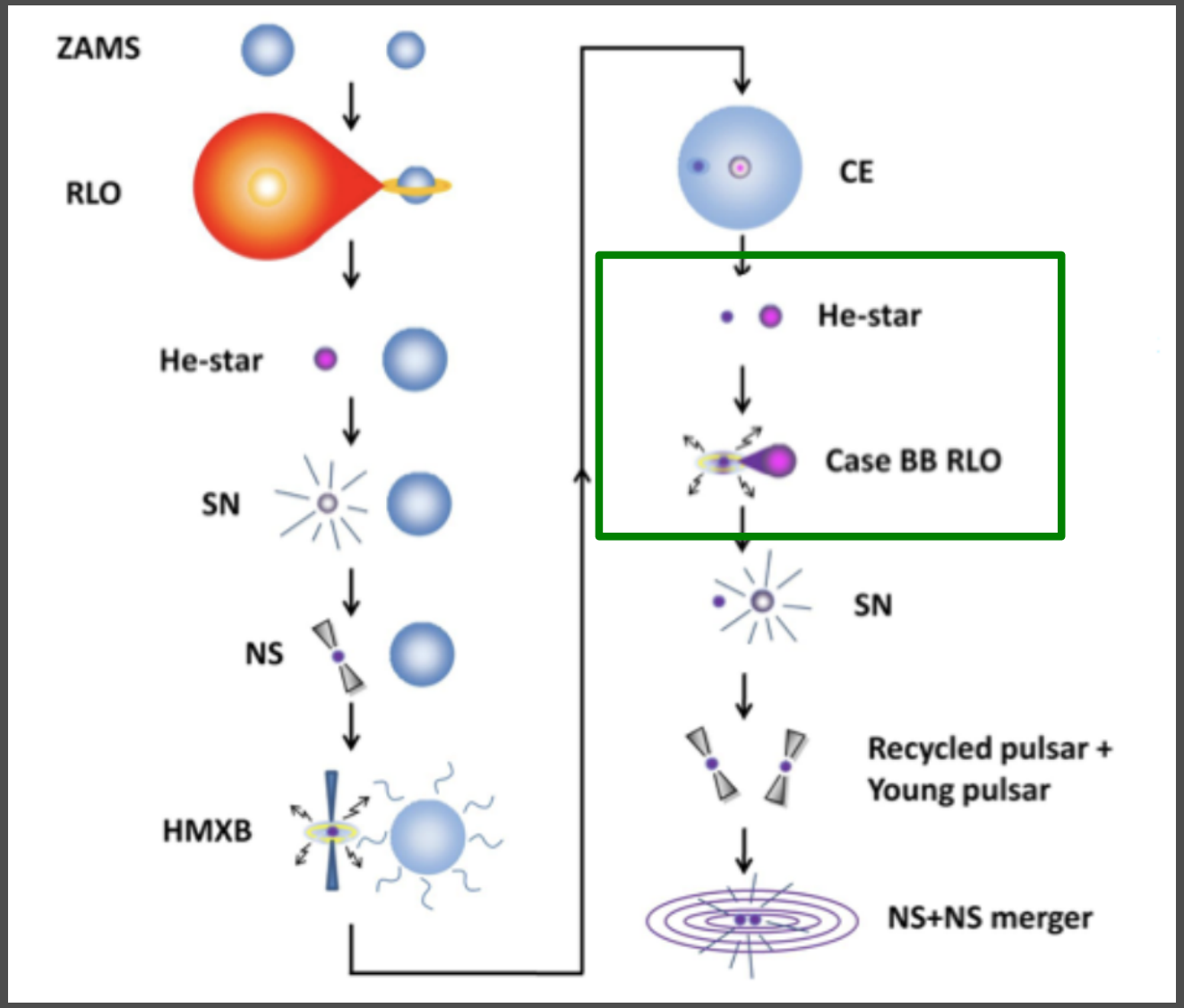
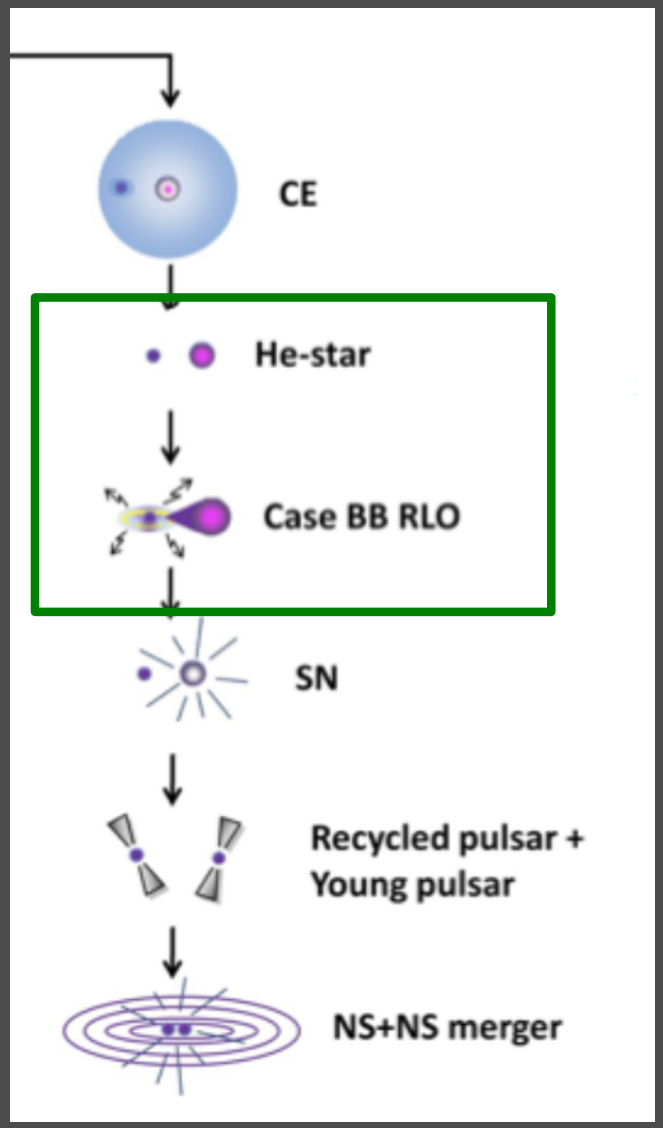


Image courtesy of T. Tauris

Stripped Star Compact Object Binaries:

Can Serve Multiple Scientific Purposes

They probe of the outcomes of the common envelope stage and the physical configuration of the system prior to the second supernovae



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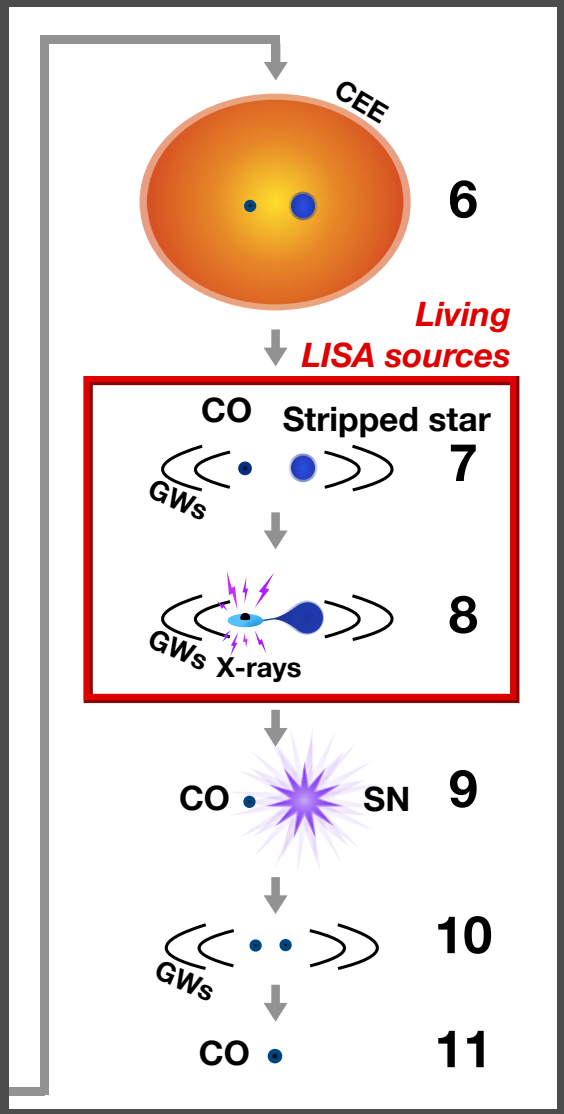

Y. Götberg et al. (2020)

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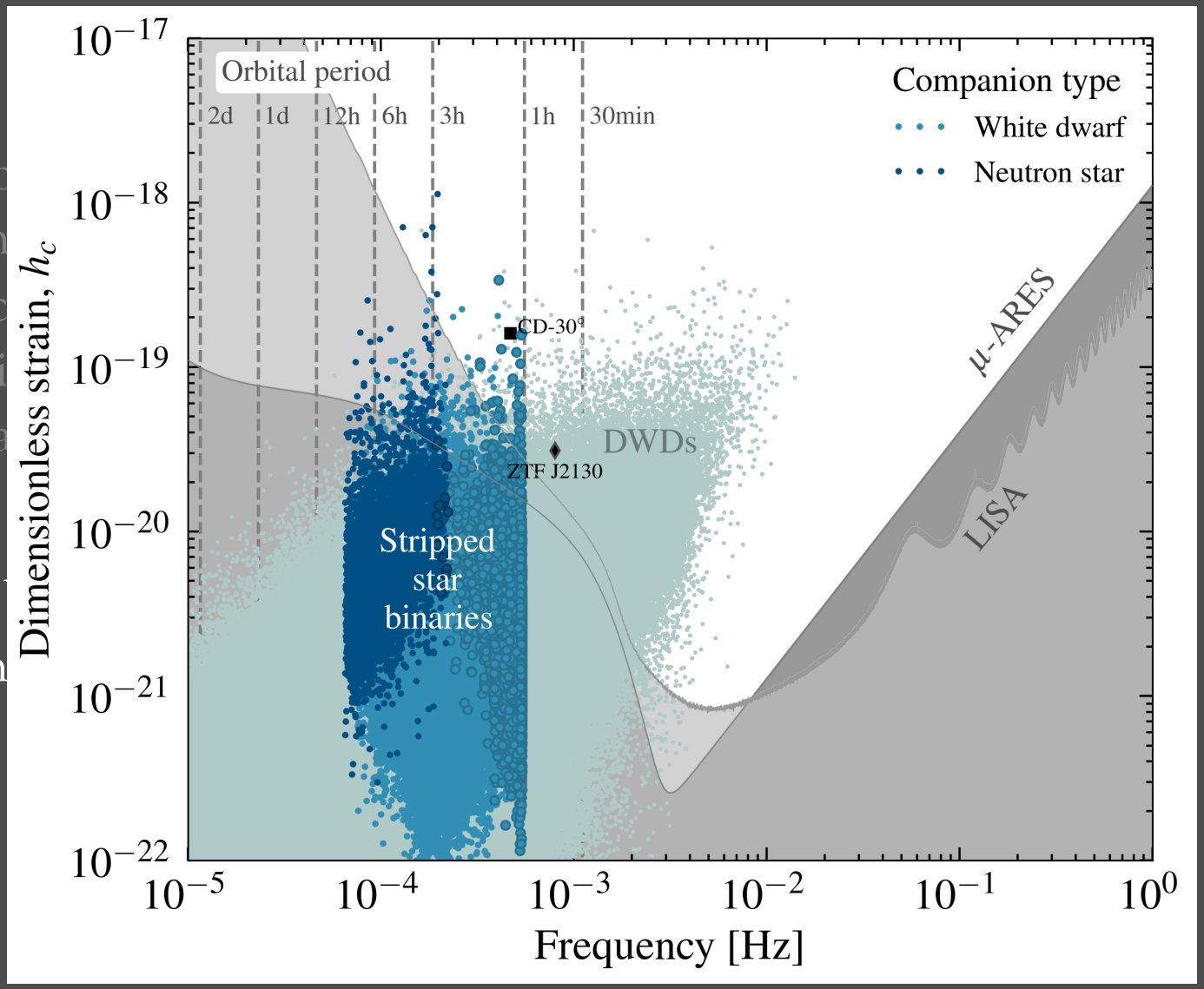

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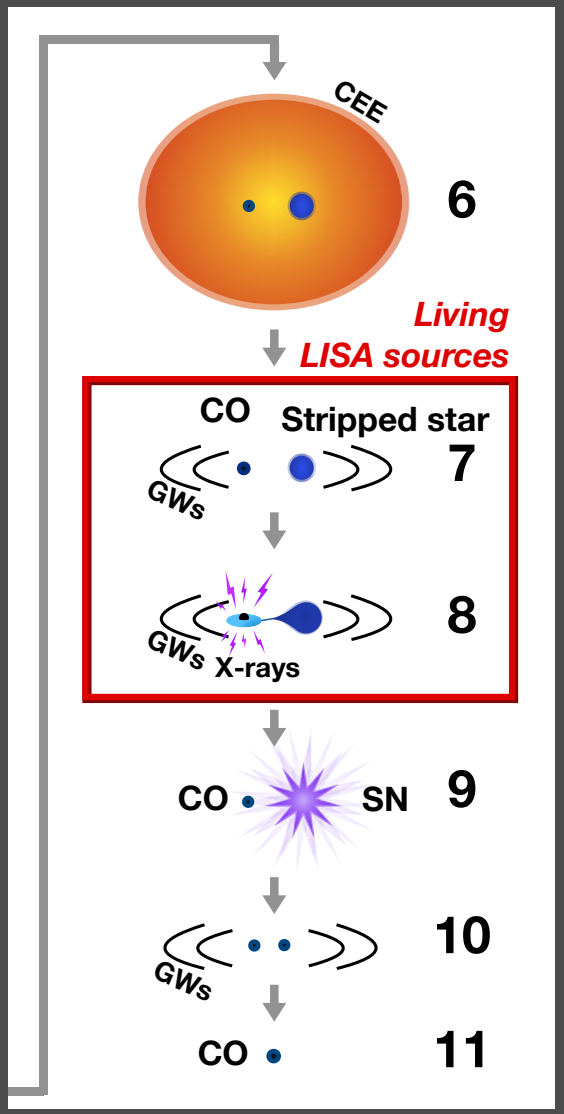
GW source	Number	Frequency	Chirp mass	Distance
Stripped star + NS[a]	~ 0 – 4* (SNR > 5)	< 0.2 mHz	1.6 – 2.6 $M_\odot$	$\lesssim$ 1 kpc
Stripped star + WD[a]	~ 0 – 100* (SNR > 5)	< 0.6 mHz	0.3 – 1.6 $M_\odot$	$\lesssim$ 1 kpc



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Stripped Star Compact Object Binaries:

What do we (broadly) need to do science with these objects?

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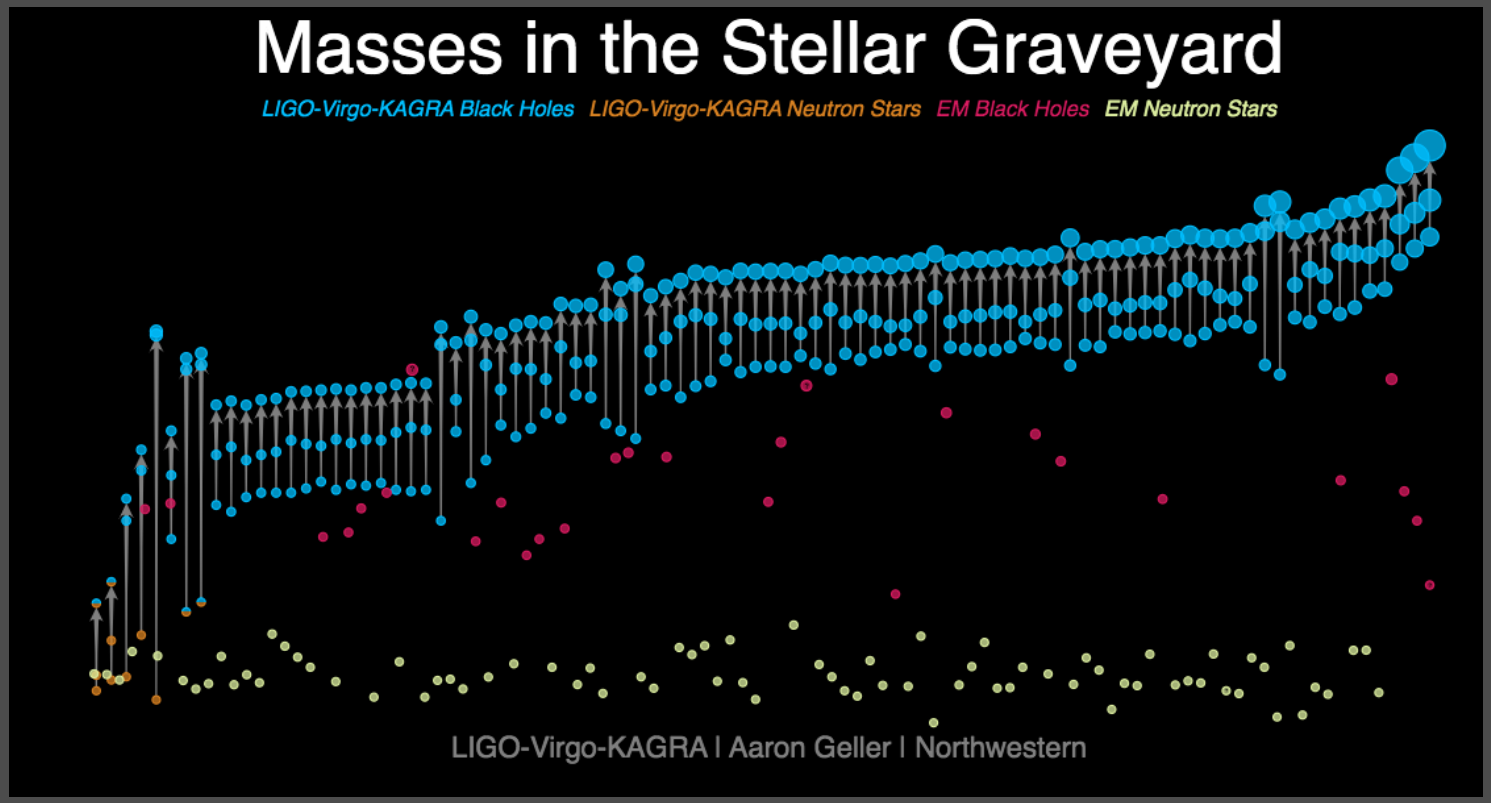

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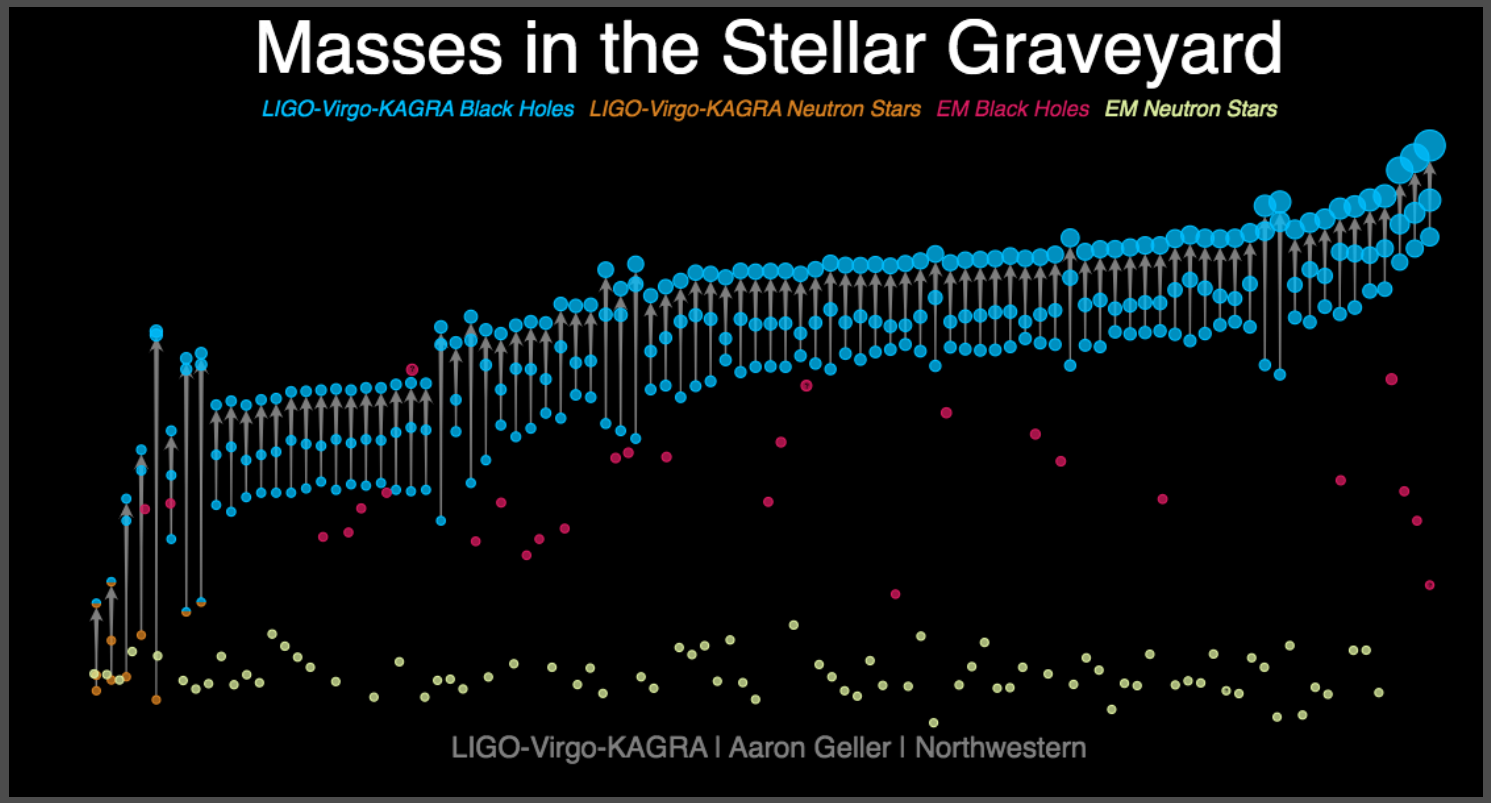

There are currently no confirmed stripped star + NS/BH binaries

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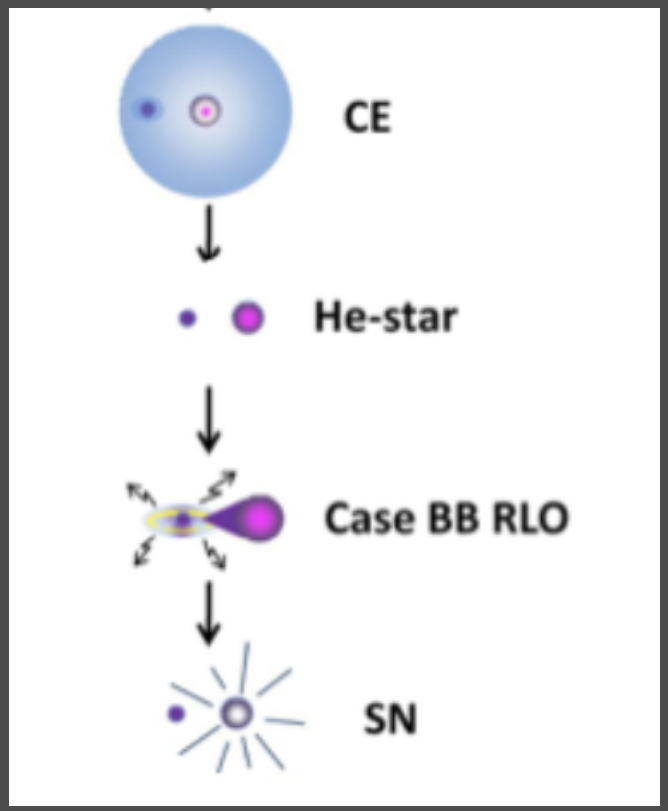

Image courtesy of T. Tauris

Stripped Star Compact Object Binaries:

What (specific) time-domain/multi-wavelength observations?

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Local Group Galaxies & Galactic Plane

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Image Credit: NASA/Swift/S. Immler (Goddard) and M. Siegel (Penn State)

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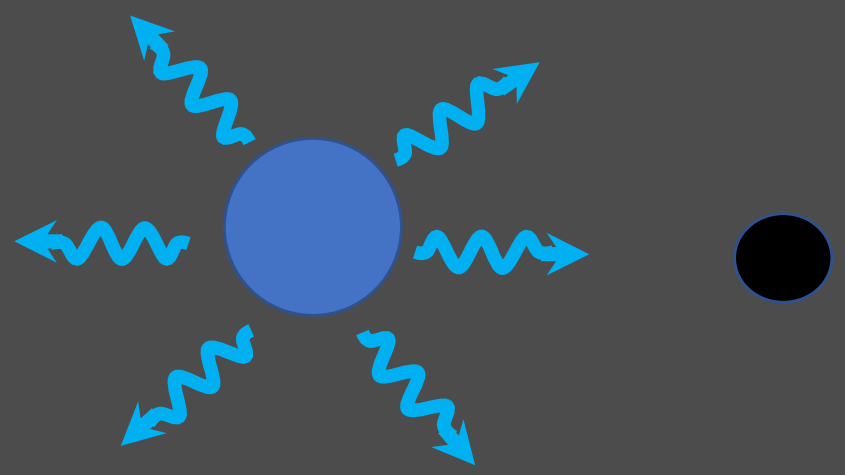
Where to Look? | For What? | Stripped Star | Accretion



Stripped Star (w/ wind) NS/BH

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Ultraviolet is key

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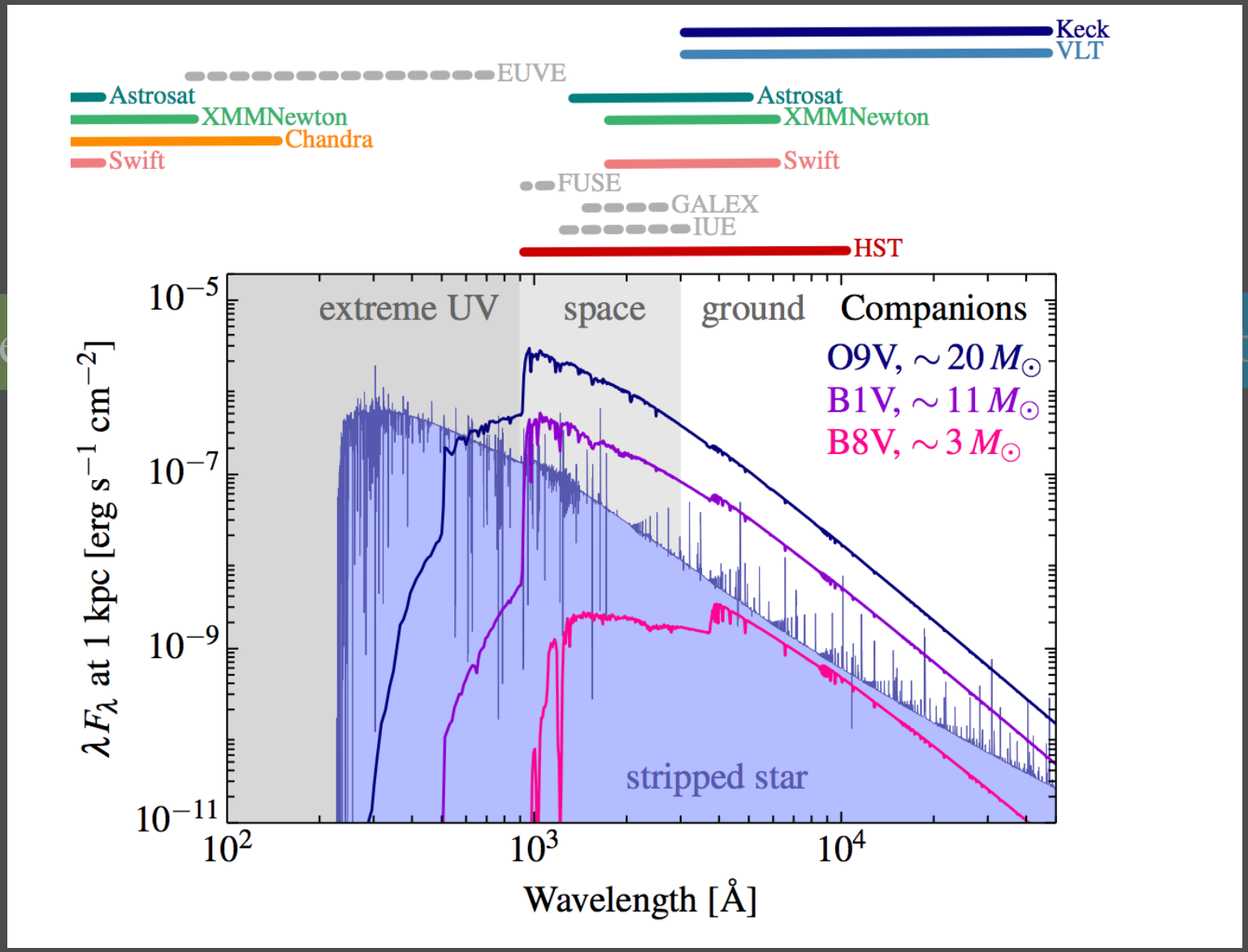

Y. Gotberg et al. (2016, 2018)

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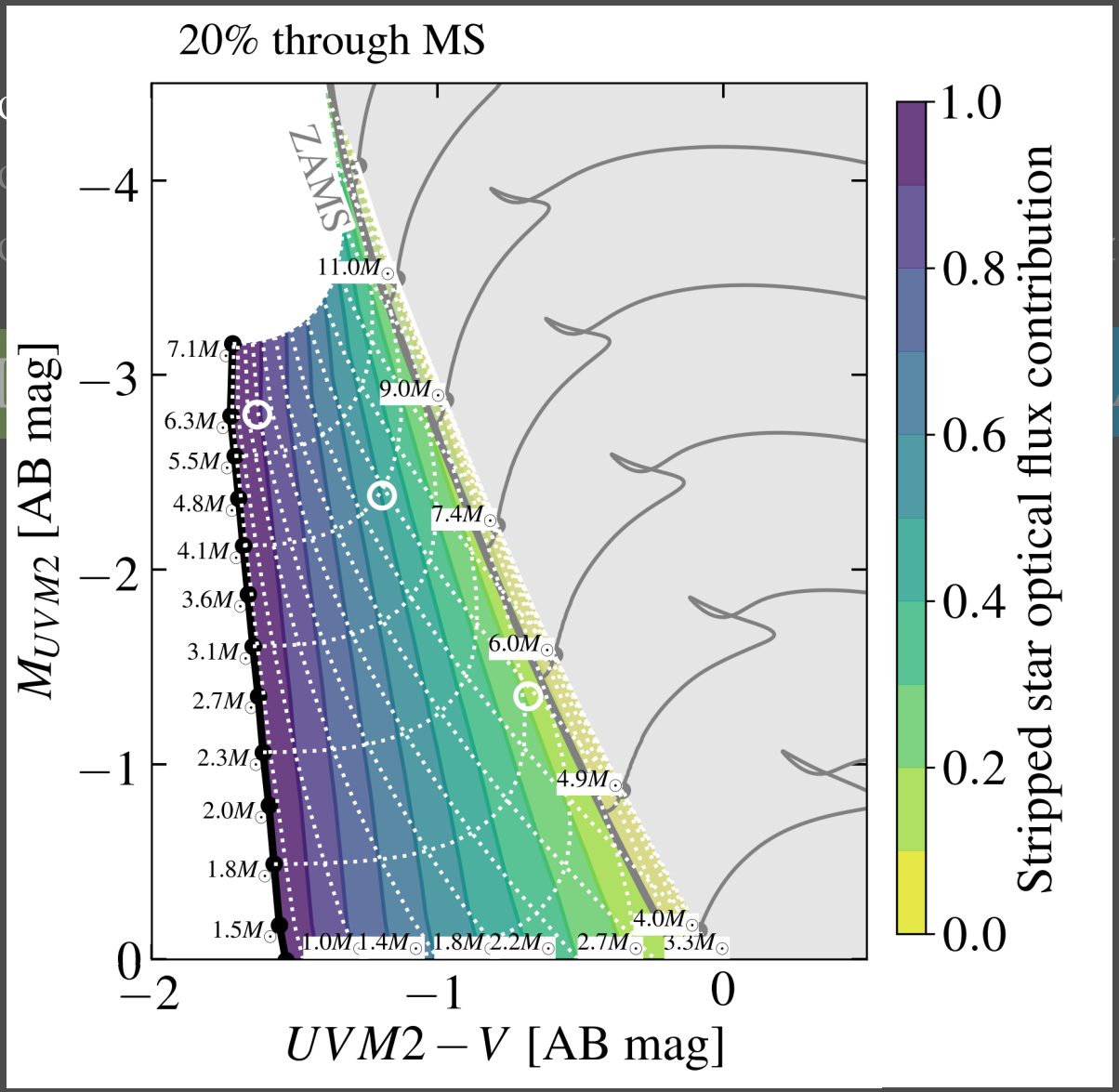

Drout, Götberg, et al. *submitted*

Stripped Star Compact Object Binaries:

Proof of Concept Search in the Magellanic Clouds

Image Credit: NASA/Swift/S. Immler (Goddard) and M. Siegel (Penn State)

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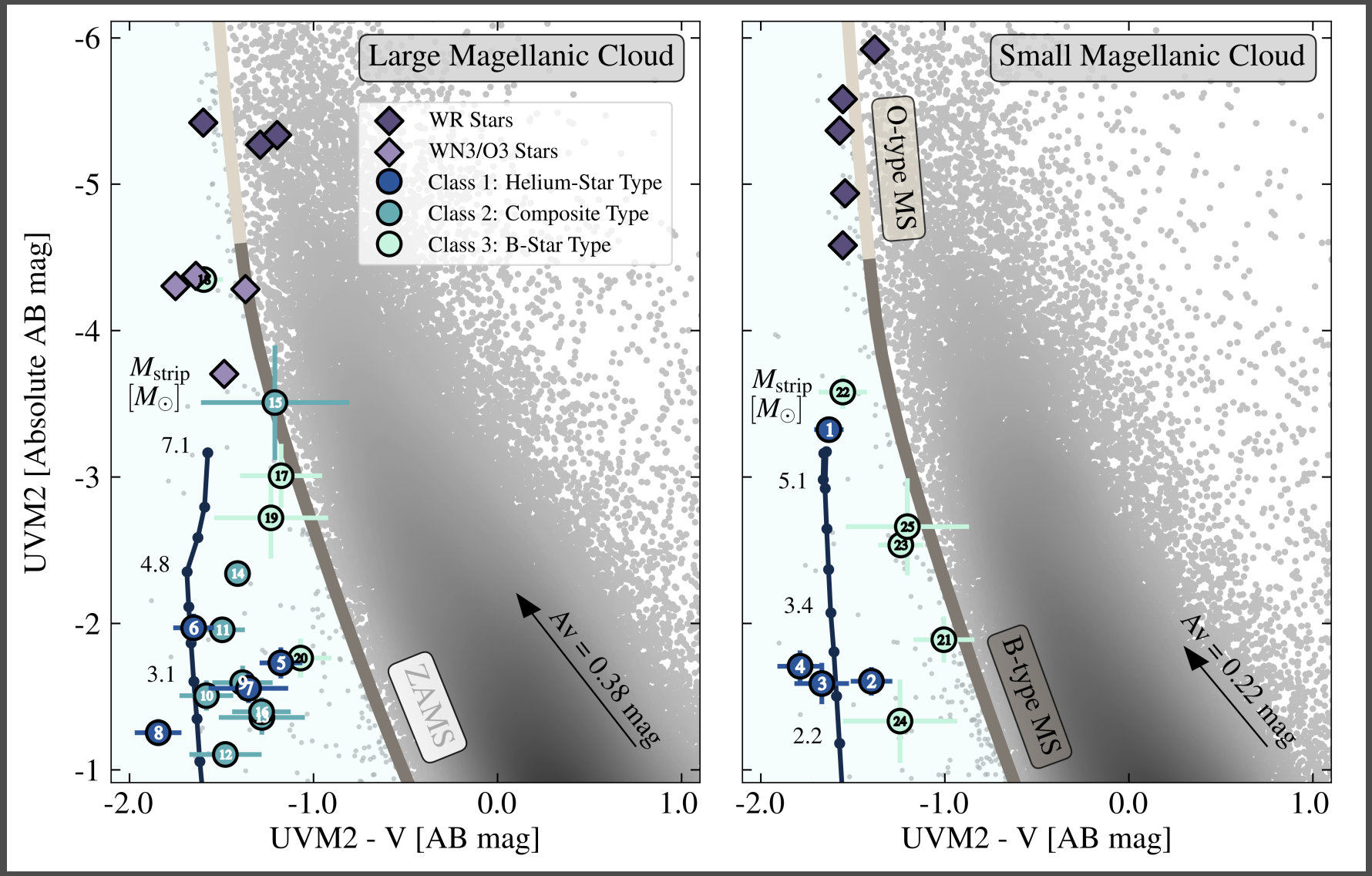

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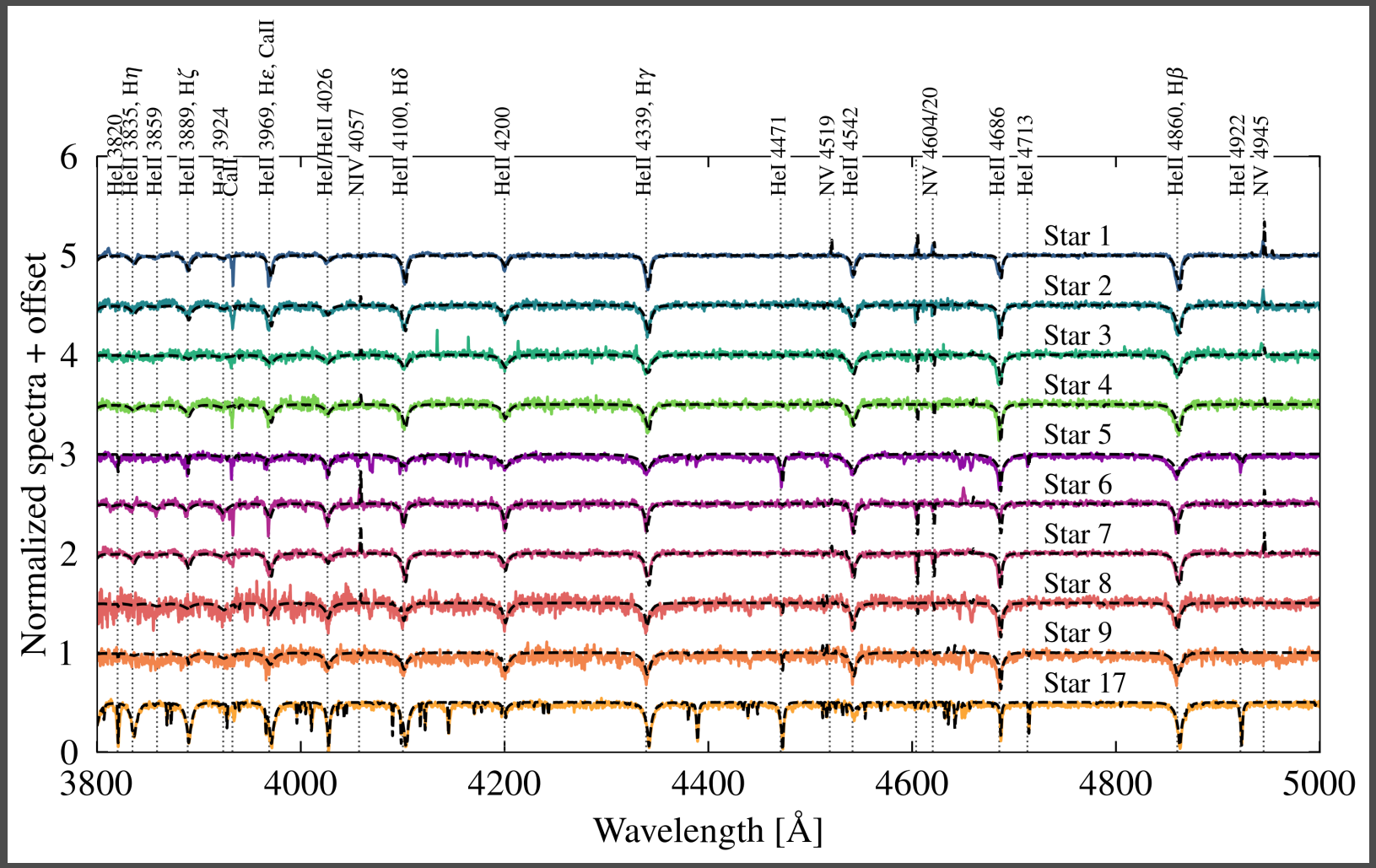

A subset of stars have spectra consistent with models for "isolated" helium stars.
They have "dark" companions

Götberg, Drout, et al. *submitted*

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Wide-Field *High-Resolution* UV Imager

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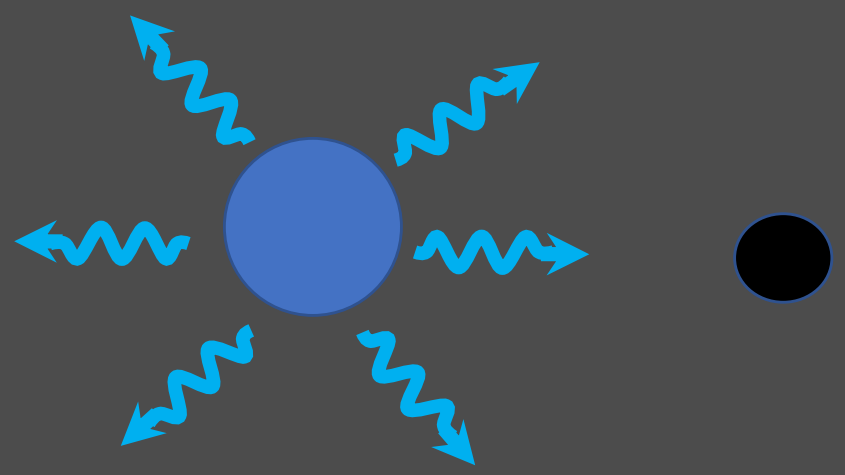

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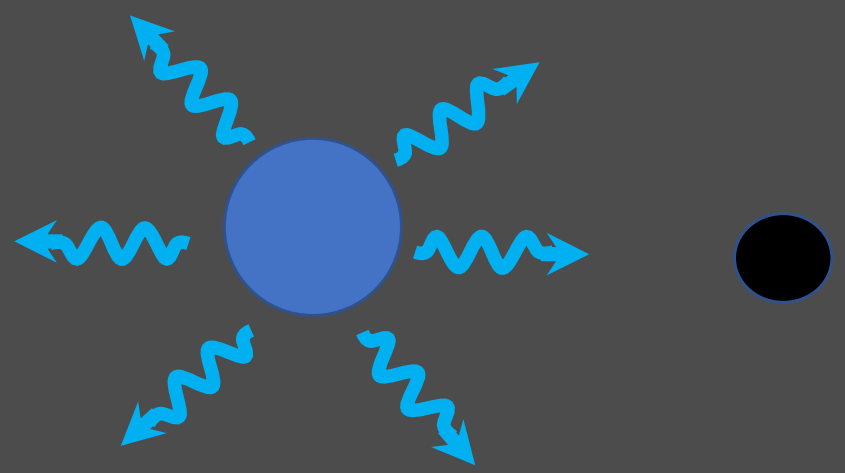

Sources should be (weak-ish) X-ray binaries

Stripped Star Compact Object Binaries:

What (specific) time-domain/multi-wavelength observations?

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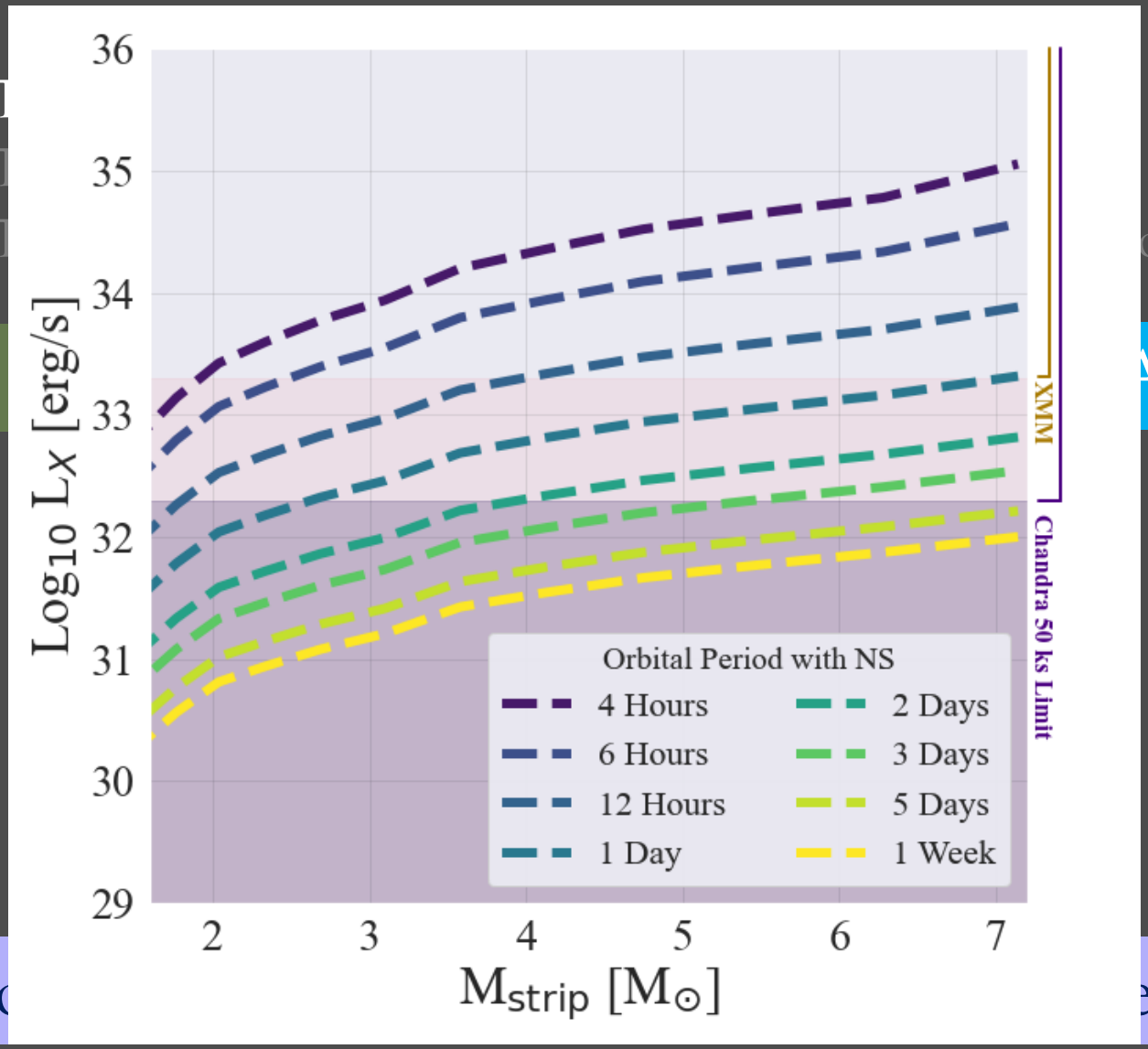

Image Credit: B. Ludwig (Toronto)

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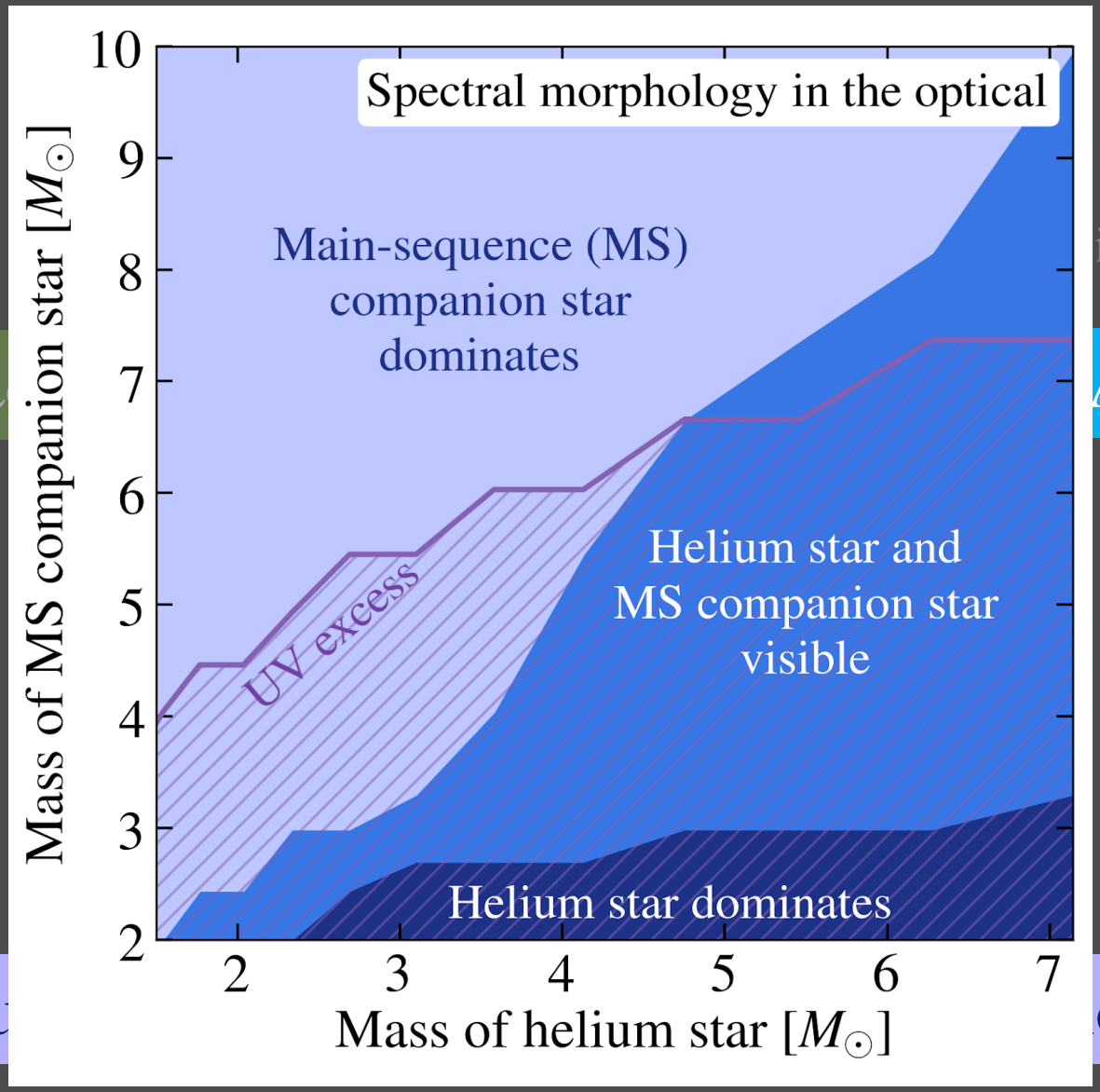

Image Credit: Y. Gotberg (Carnegie)

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Critical to Maintain High-Sensitivity High-Resolution X-ray Capabilities

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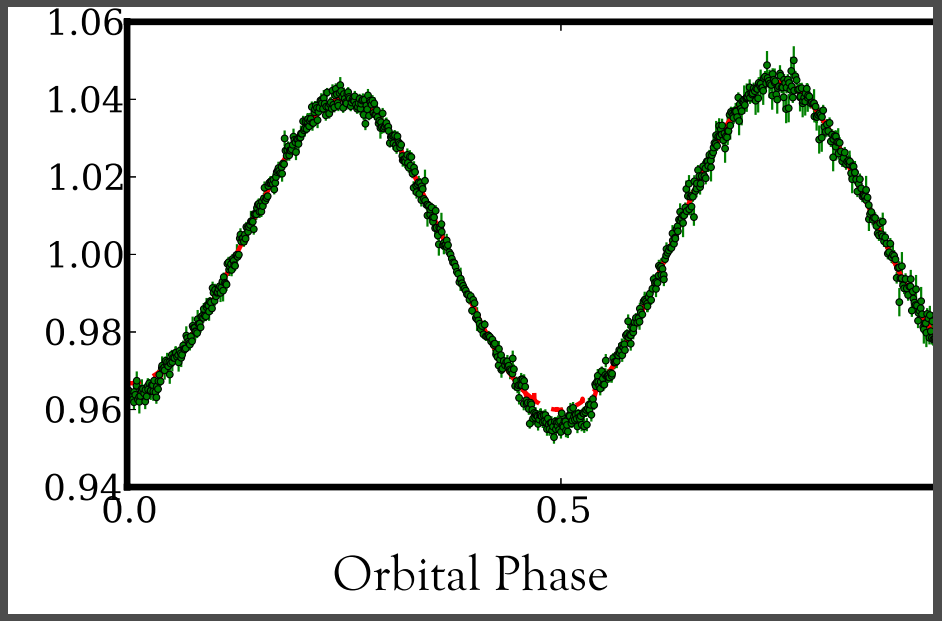

Geier et al. (2013)

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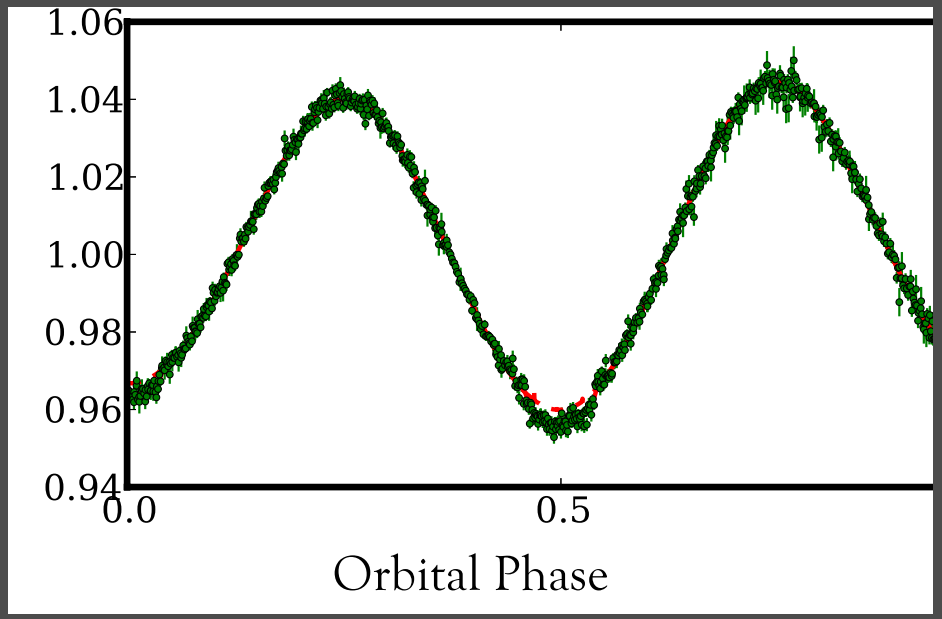

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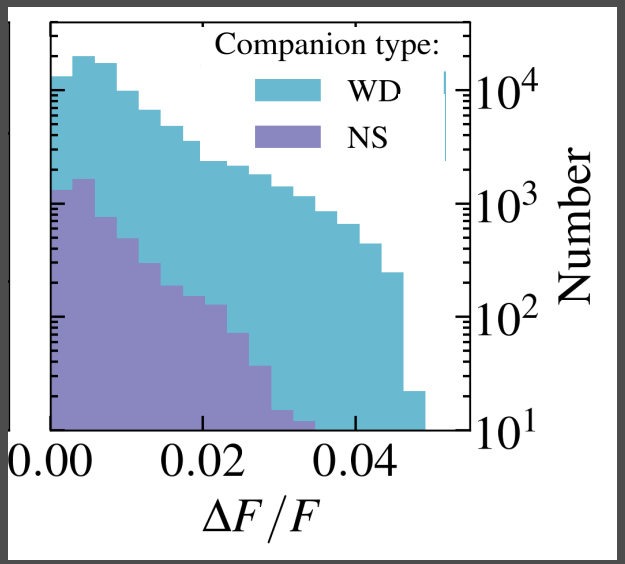

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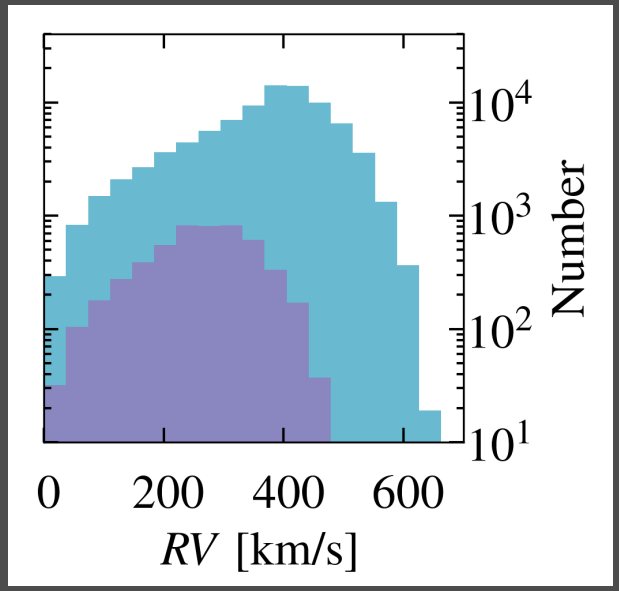

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(UV) High Cadence Monitoring
Moderate Resolution Spectroscopic Monitoring

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Where to Look? | For What? | Spectral (Wind) Features

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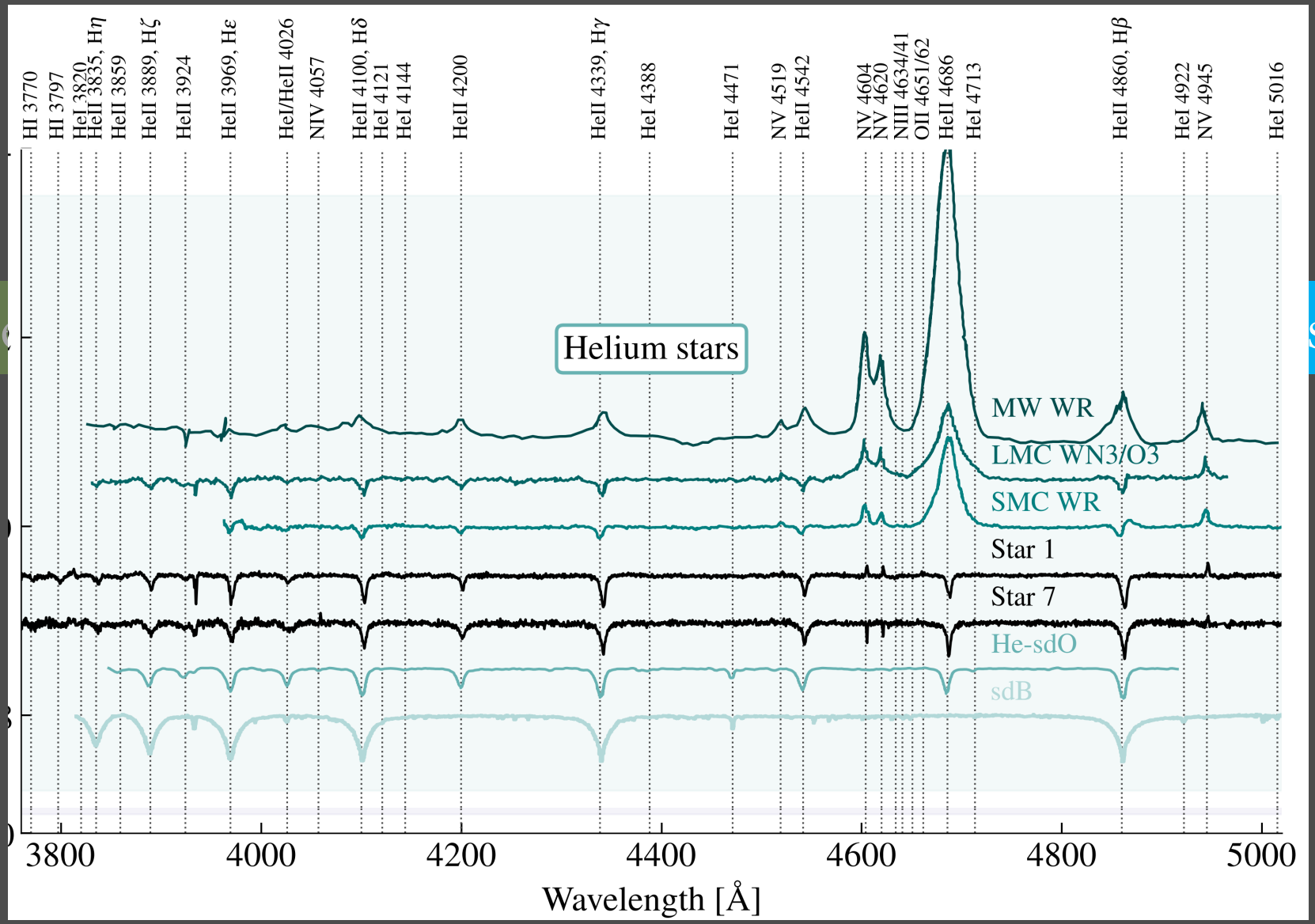

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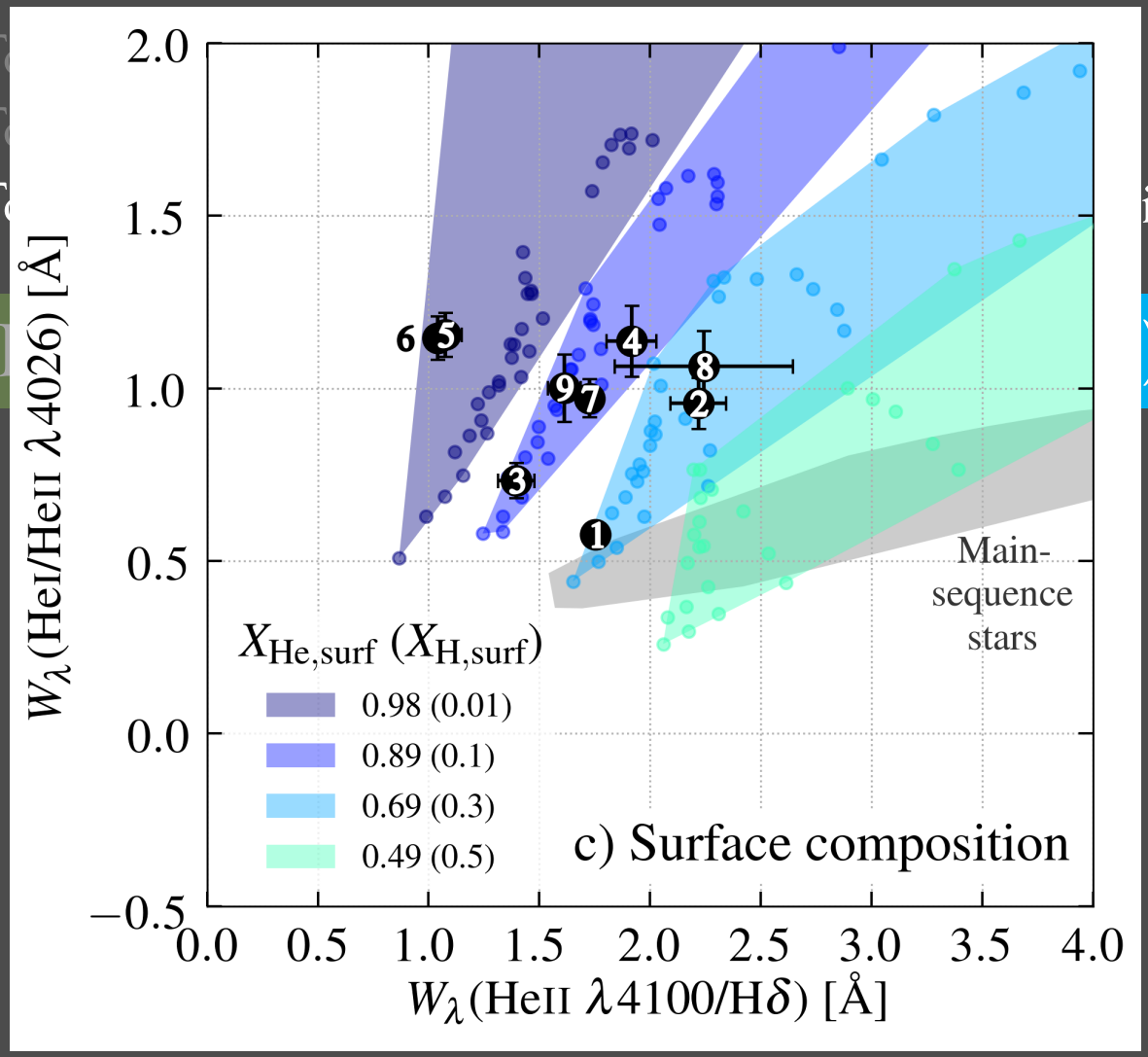

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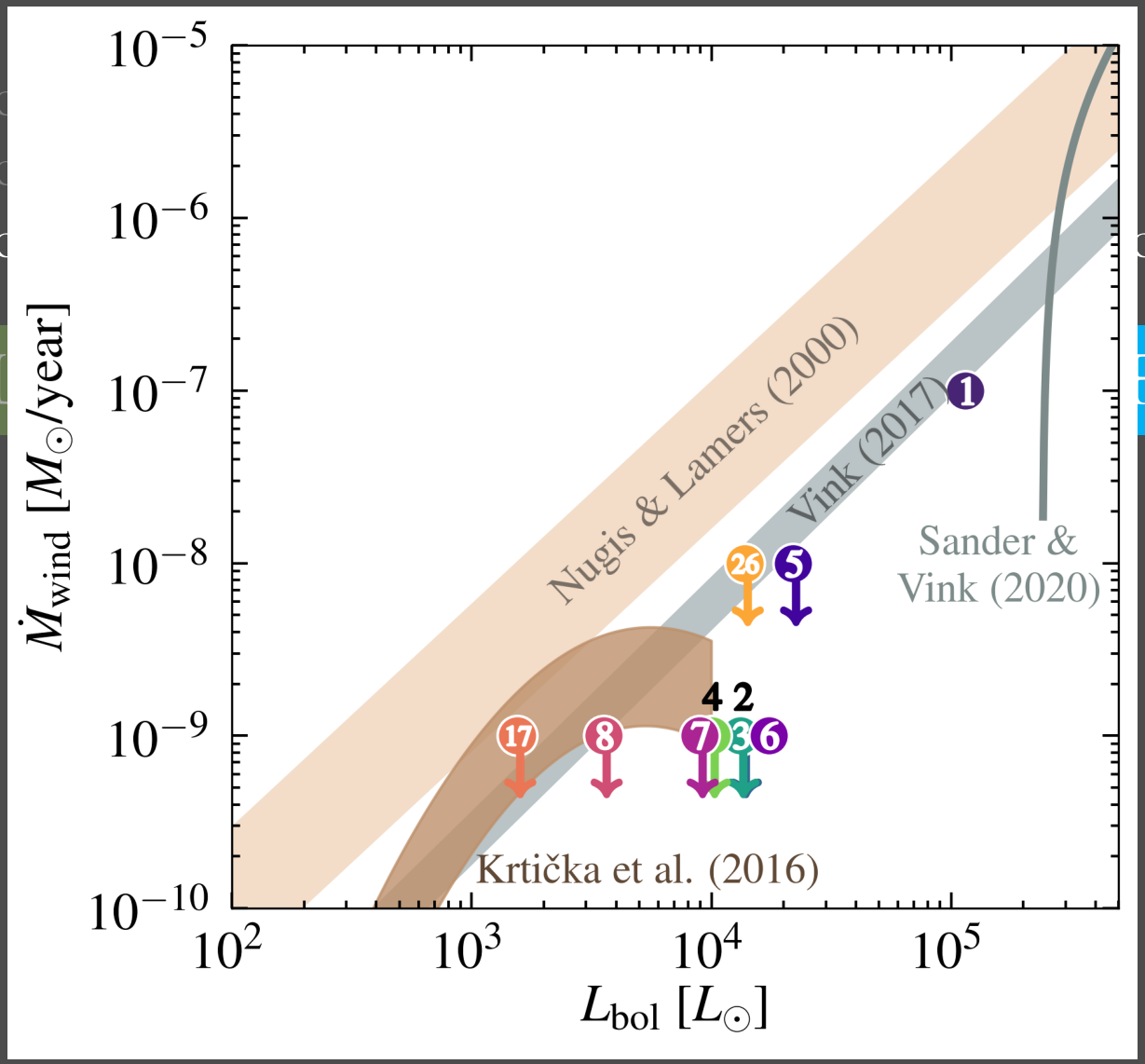

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Moderate resolution UV spectroscopy is *critical*

Stripped Star Compact Object Binaries:

What type of instruments/missions?

Wide-Field *High-Resolution* UV Imager

High-Sensitivity High-Resolution X-ray Capabilities

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Moderate Resolution Spectroscopic Monitoring

Moderate resolution UV spectroscopy

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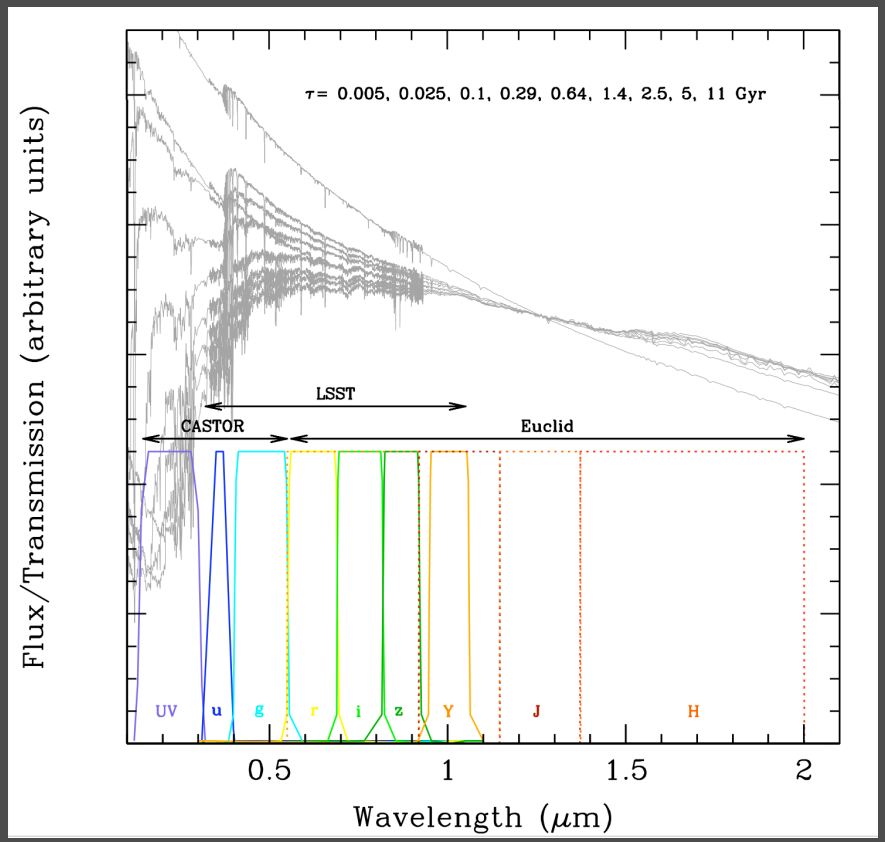
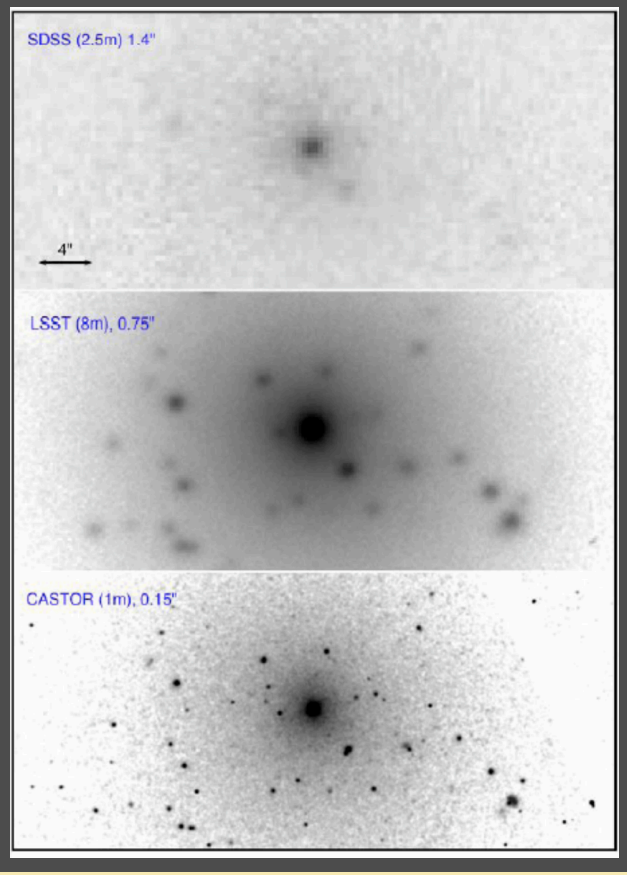
Stripped Star Compact Object Binaries:

CASTOR: A Wide-Field UV Telescope





Bandpasses	UV (150-300nm), u' (300-400 nm), g (400-550 nm)
Field of View	0.44 deg x 0.56 deg = 0.25 sq. deg
Image Quality	~0.15" FWHM
Observing Modes	wide-field imaging; grism and 2D spectroscopy; precision photometry

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