

X-Ray Binaries as Candidate Technosignatures: Metabolism, Navigation and Migration



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Modulating X-ray binaries



(Lacki et al. 2020)

“These sources have been practically ignored in SETI, but they are among the most powerful and dynamic objects in our Galaxy and others. Including them allows us to start probing the idea that they draw energy-hungry ETIs.”

Neutron star Interstellar signaling (Fabian 1977)

Modulate XRBs (Corbet 1997)

Modulate pulsar signals (Chennamangalam et al. 2015; Haliki 2019)

Lens around LMXBs (Lacki 2020)

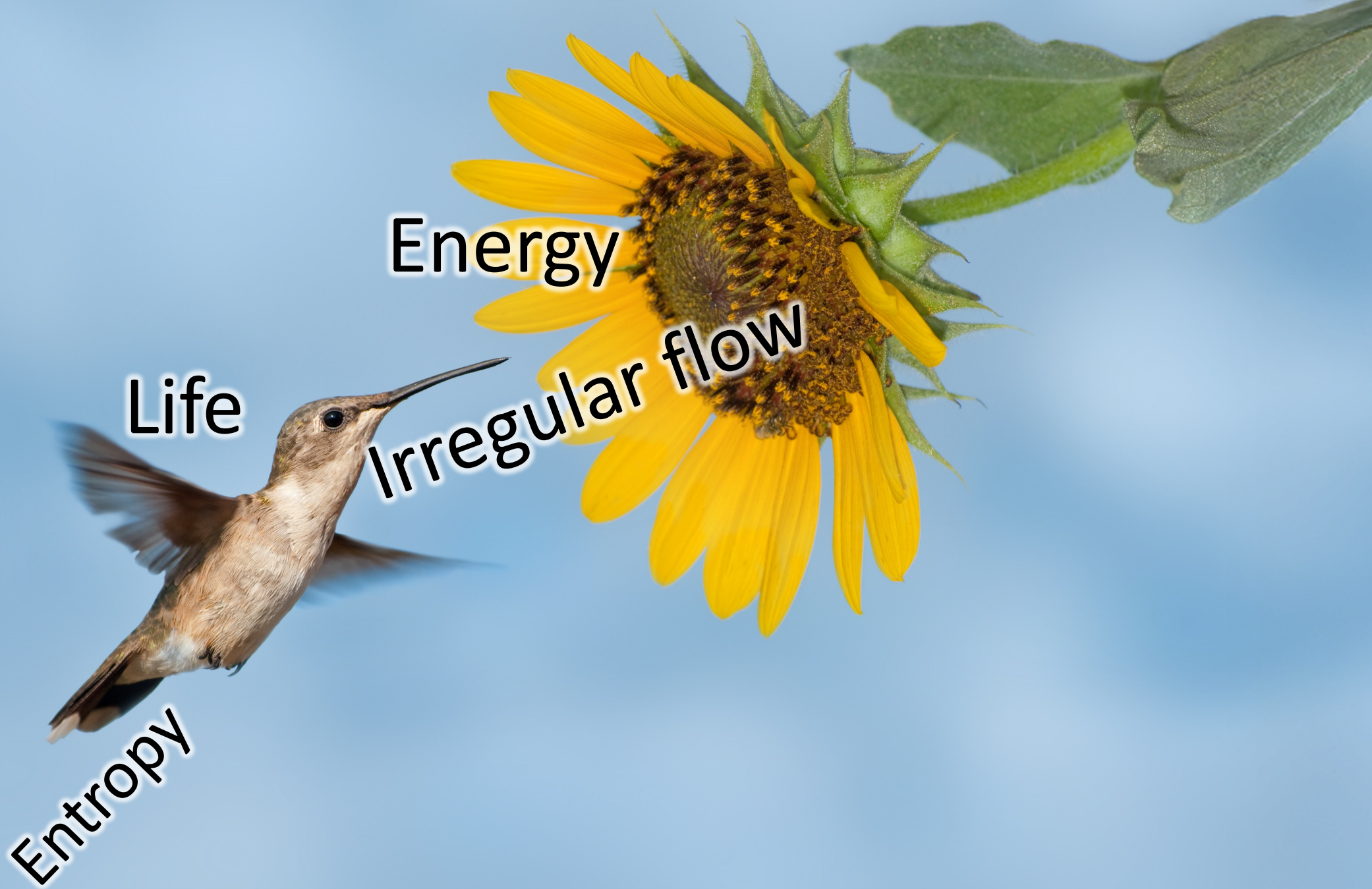
Review (Lacki DiKerby 2025)

What anomalies?

What classes of technosignatures?

1. Metabolism
2. Navigation
3. Migration

1. Metabolism



Energy

Life

Irregular flow

Entropy

Stellivore hypothesis



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(Vidal 2016)

High entropy waste products? Enhanced CNO in CO white dwarf ejecta

$\text{CNO}/\text{H} \sim 1.7$

Accretion - ejection cycles are too short

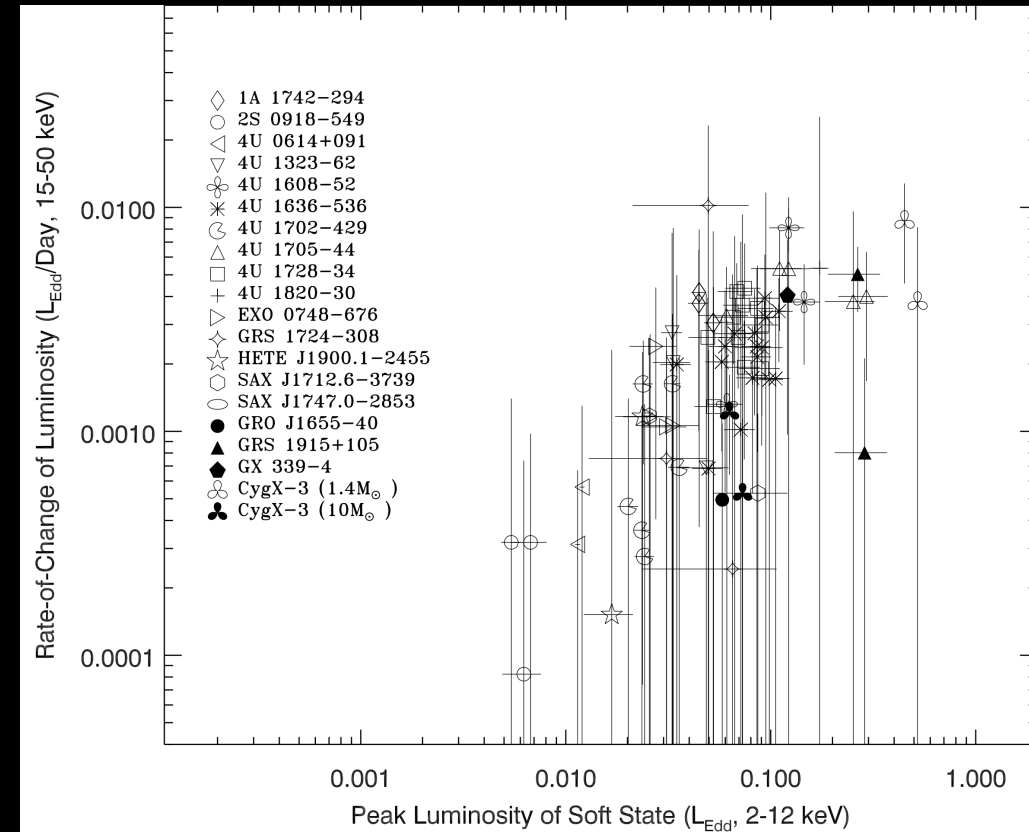
H and He

An artistic rendering of a white dwarf accreting from a companion star. On the right, a large, bright orange-yellow sphere represents the white dwarf. On the left, a smaller, blue-white object represents the companion star, surrounded by concentric rings. A stream of material, labeled 'H and He', flows from the companion star towards the white dwarf. The background is dark space with some faint stars.

(e.g. Iben Fujimoto 2018)

Foreknowledge in accreting XRBs?

I know how much I want to eat

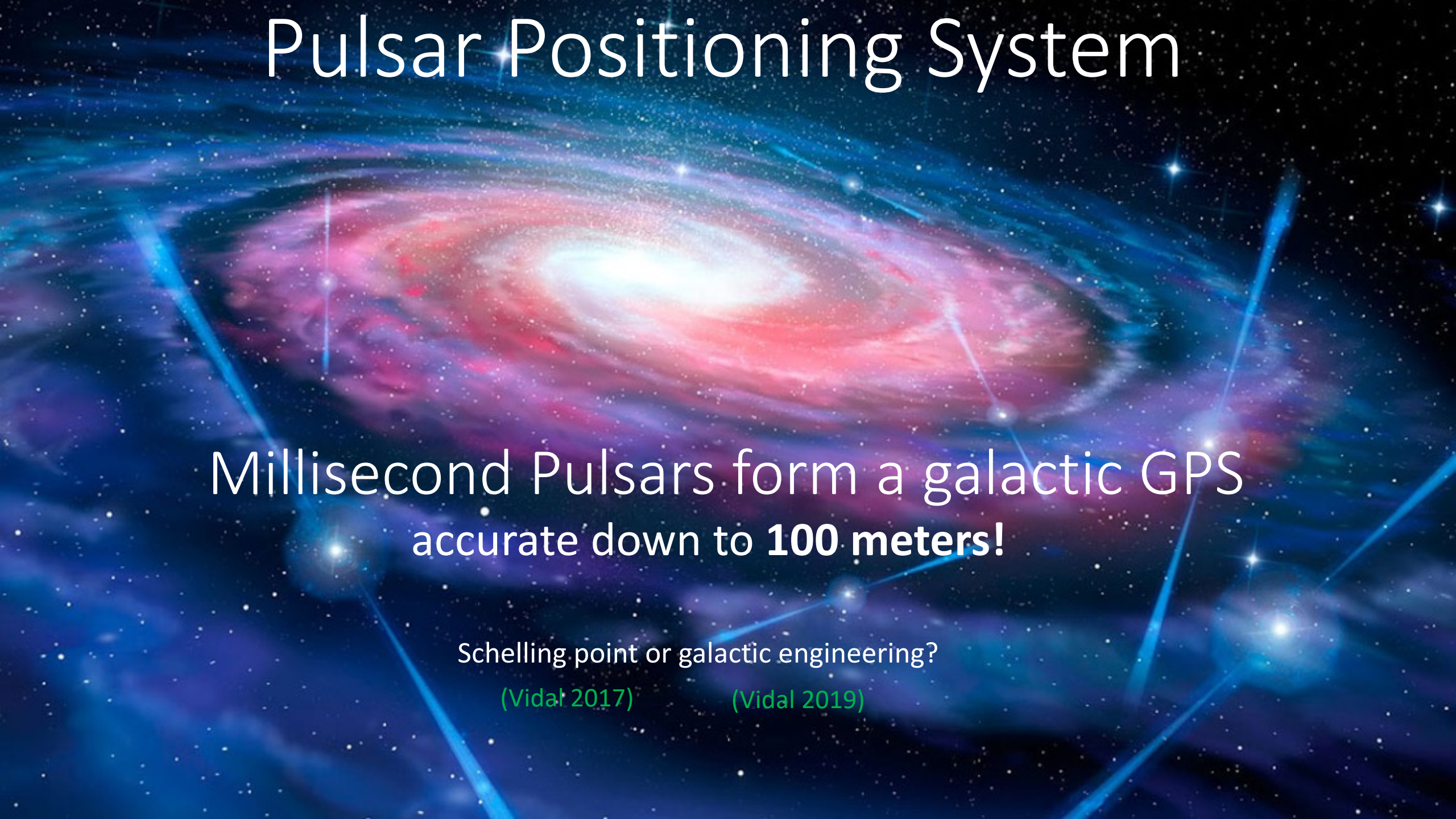


“So somehow, at the time of the transition, the system already seems to have a knowledge of the maximum mass accretion rate that is going to be reached later on.”

(Homan 2010) commenting on (Yu et al. 2009)

2. Navigation

Pulsar Positioning System



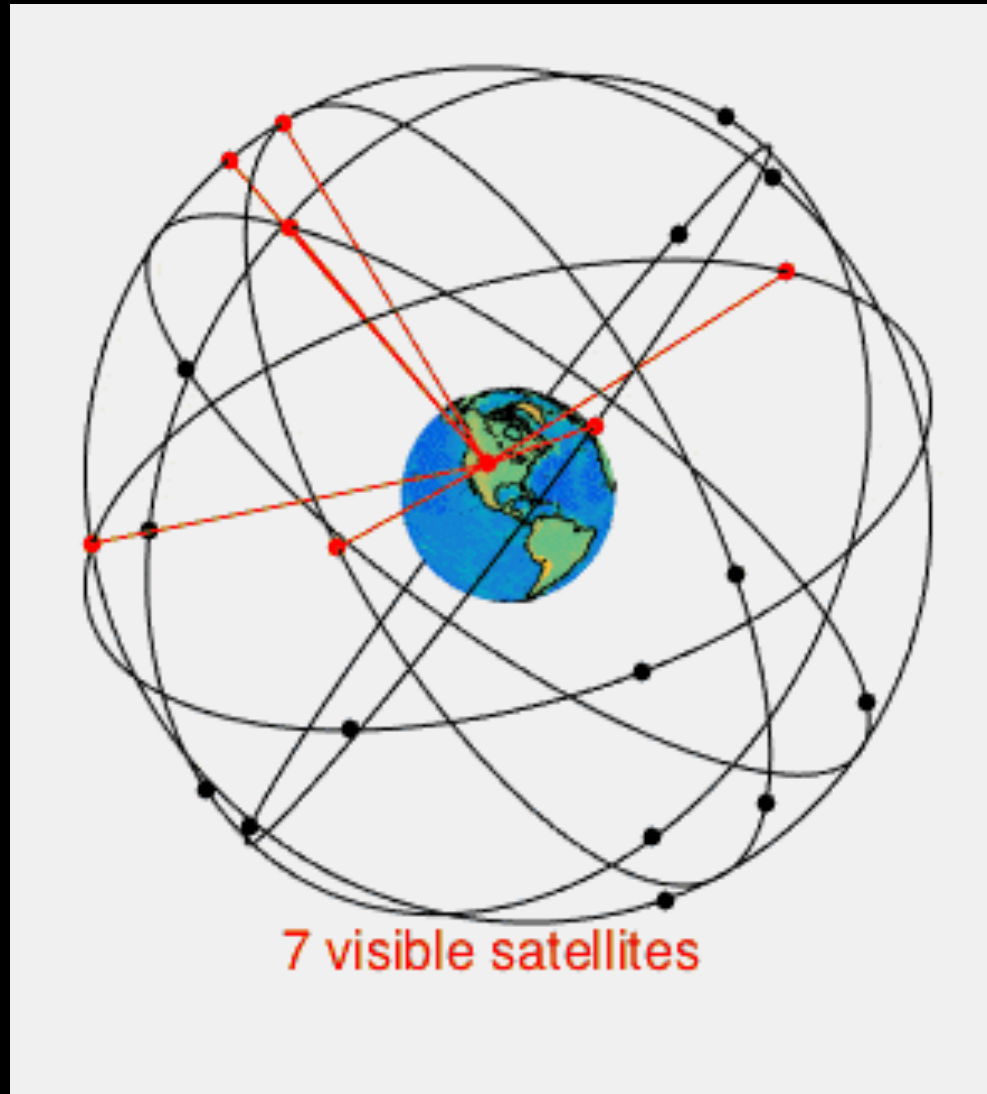
Millisecond Pulsars form a galactic GPS
accurate down to **100 meters!**

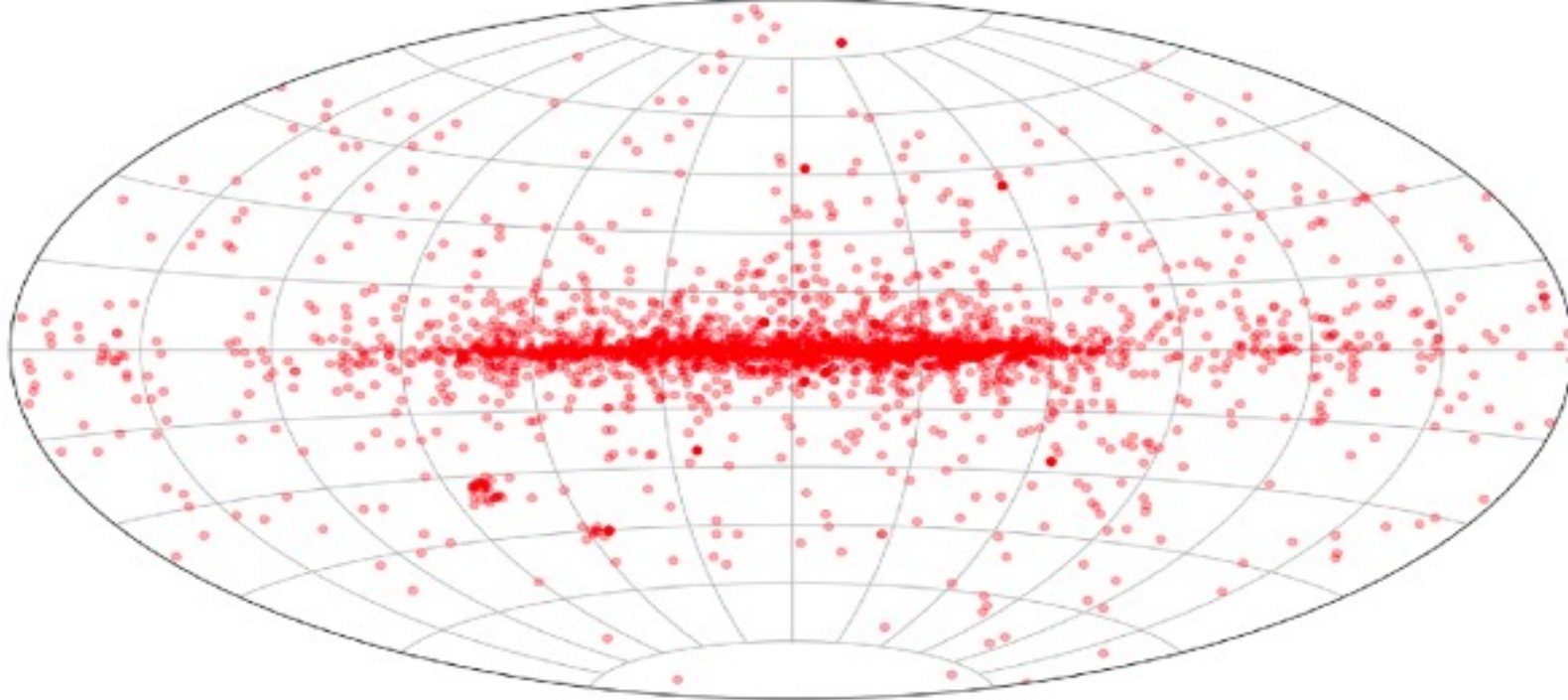
Schelling point or galactic engineering?

(Vidal 2017)

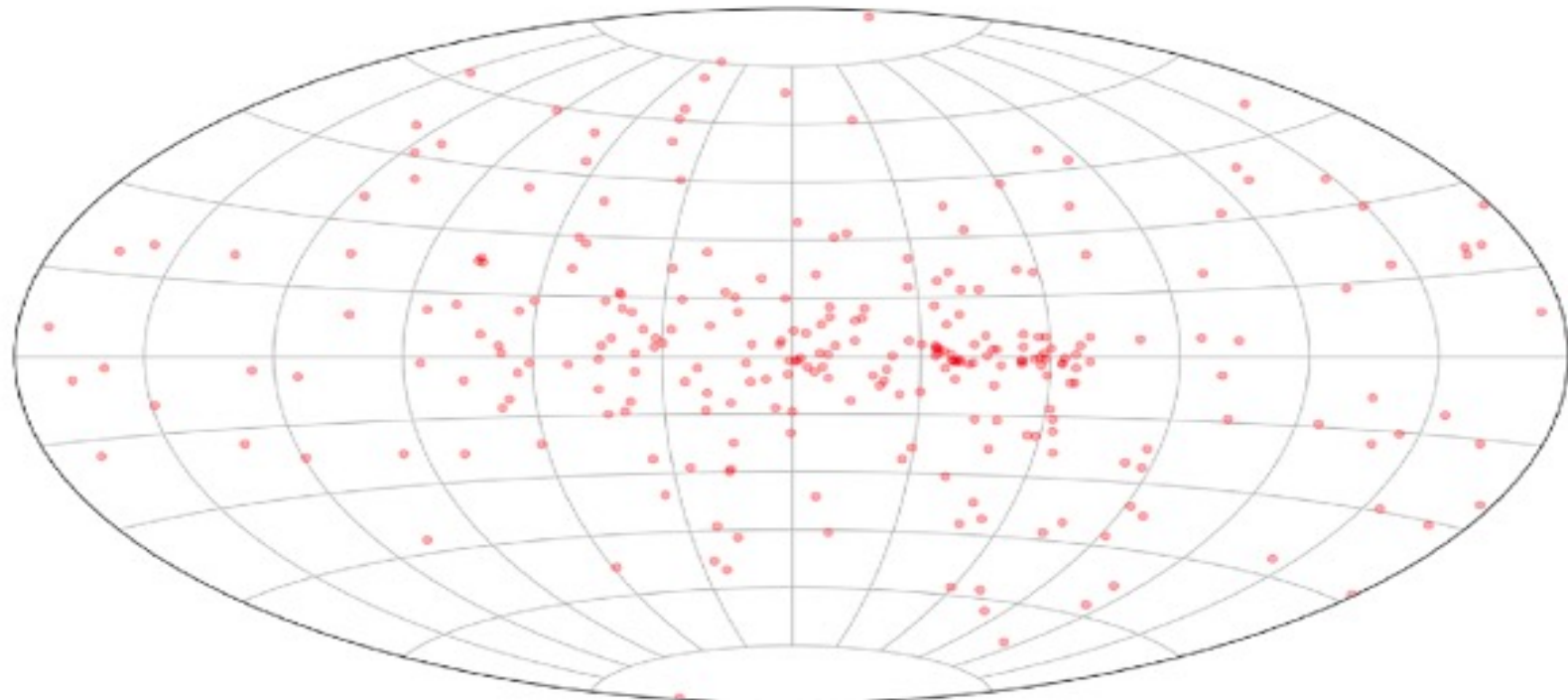
(Vidal 2019)

Spatial distribution of GPS satellites





Normal pulsars

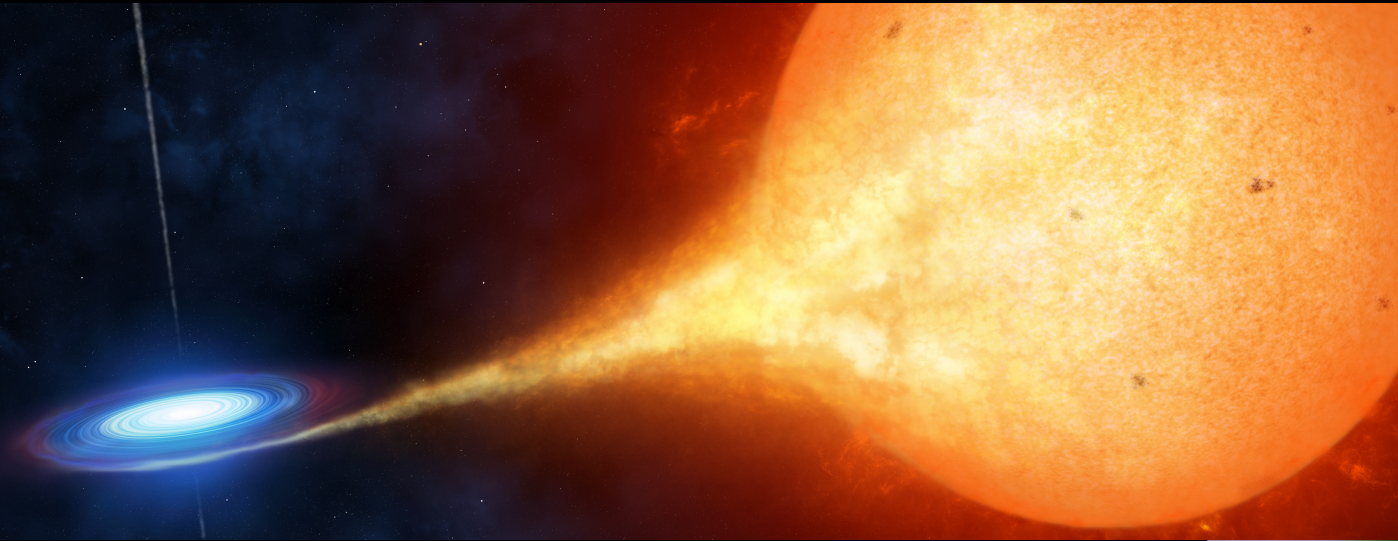


Millisecond pulsars

(excluding globular clusters)

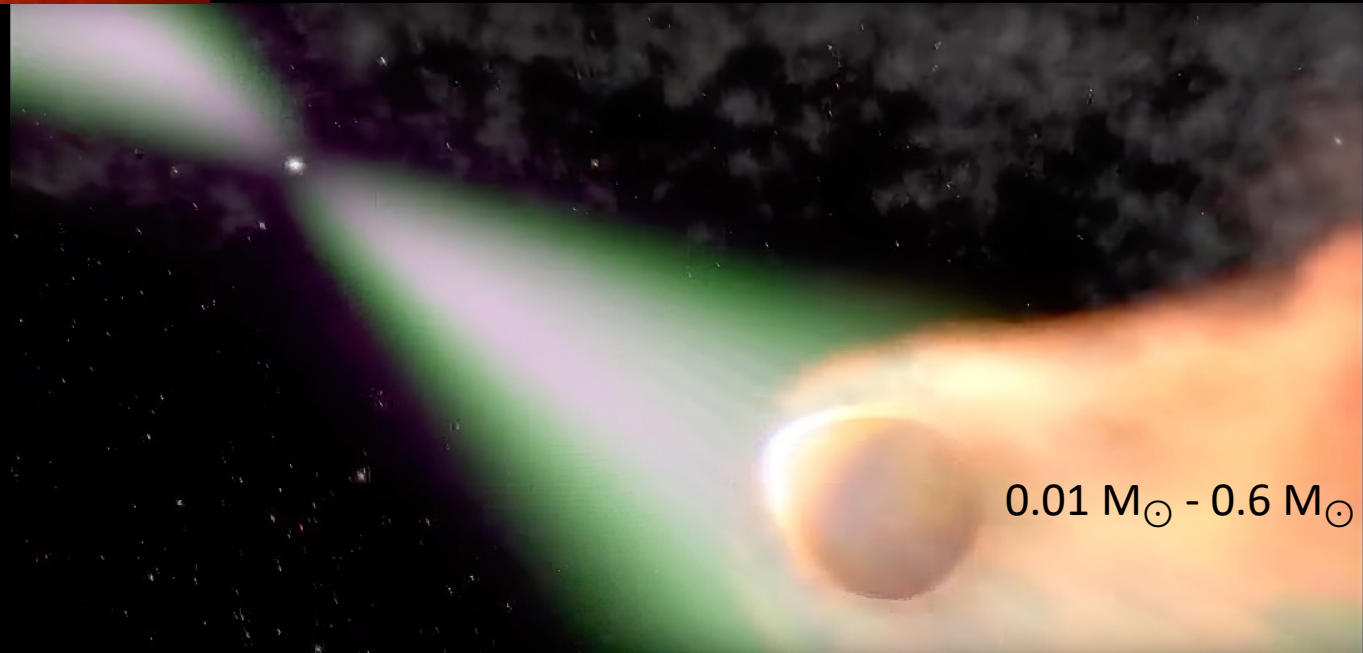
3. Migration

Spider pulsars: evaporation



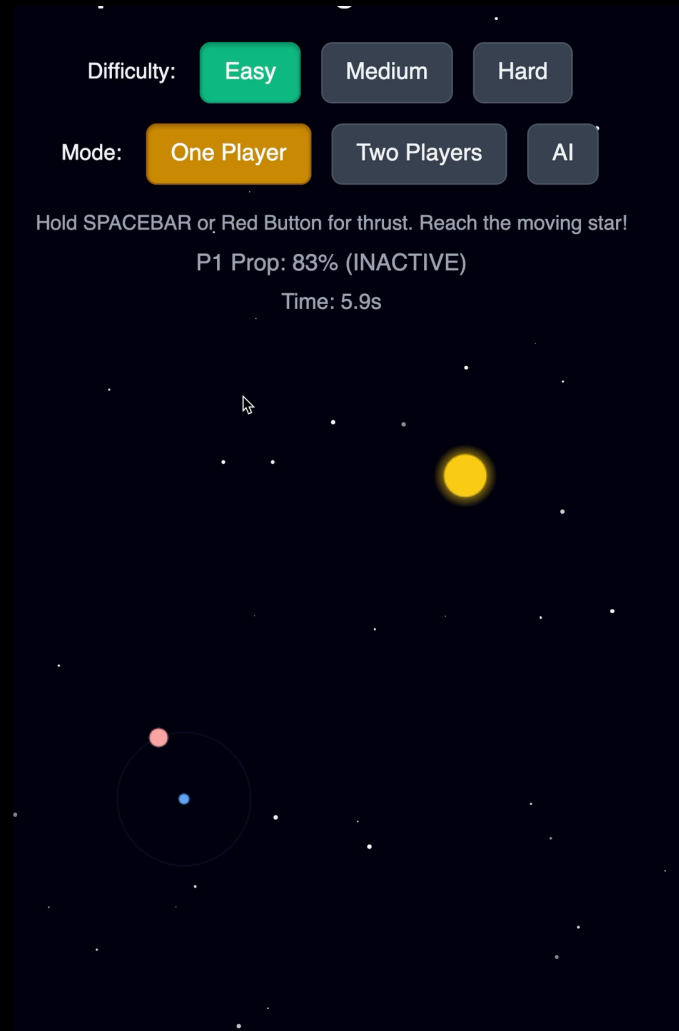
Accretion

Evaporation



$0.01 M_{\odot} - 0.6 M_{\odot}$

Spider Stellar Engine

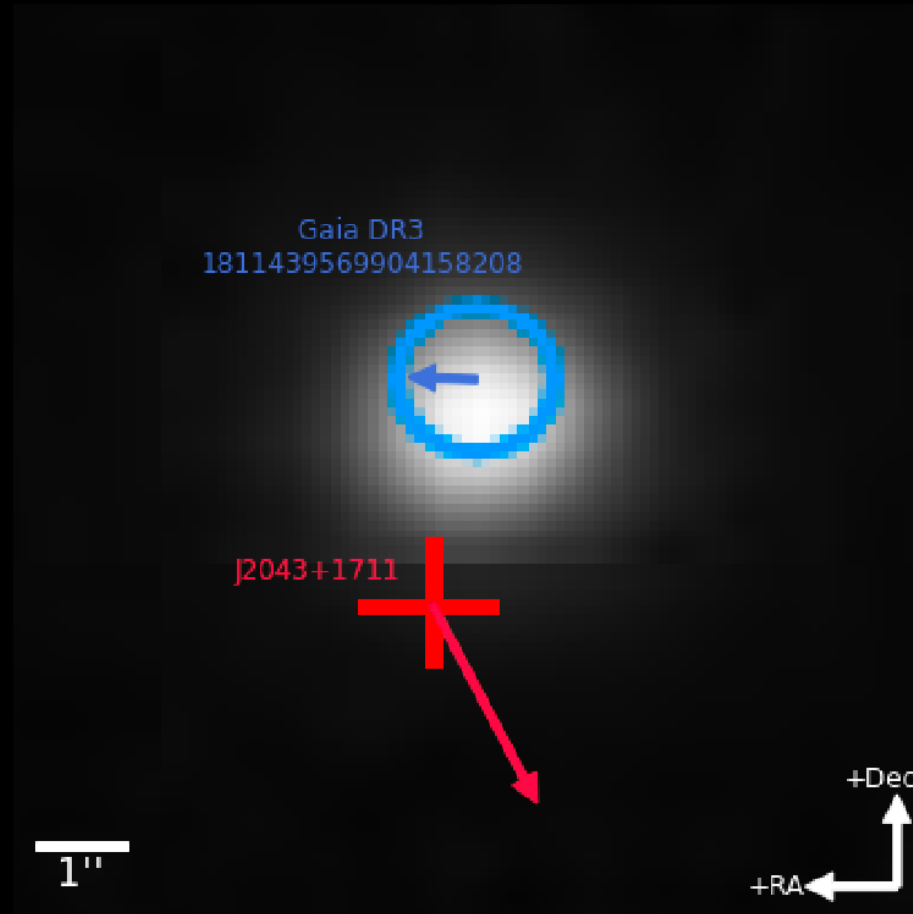


<https://tinyurl.com/game-sse>

<https://github.com/clemvidal/spider-stellar-engine-the-game/>



PSR J2043+1711 : anomalous acceleration?



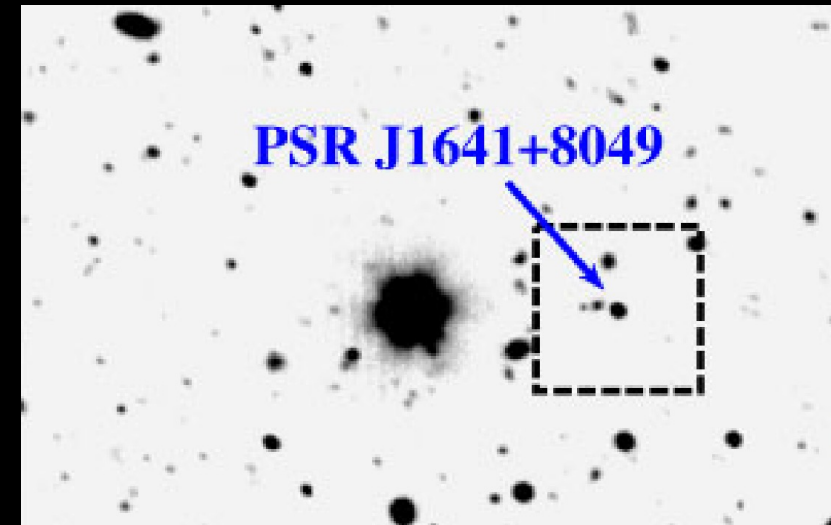
$$a_{\text{los}} = 3.5 \pm 0.8 \text{ mm.s}^{-1}.\text{yr}^{-1}$$

PSR J1641+8049 : anomalous deceleration?

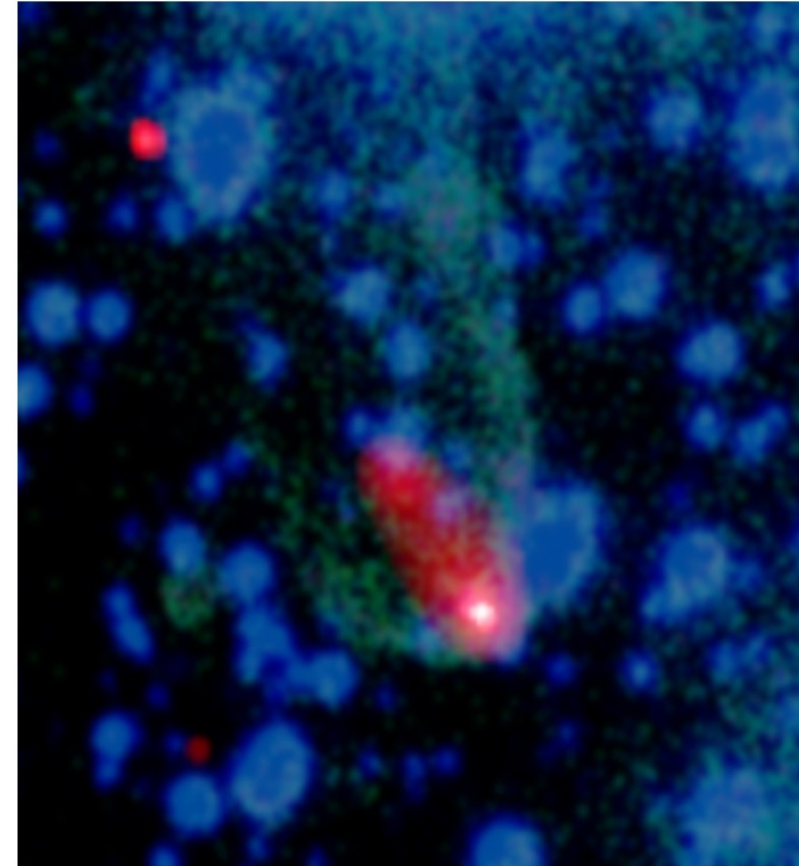
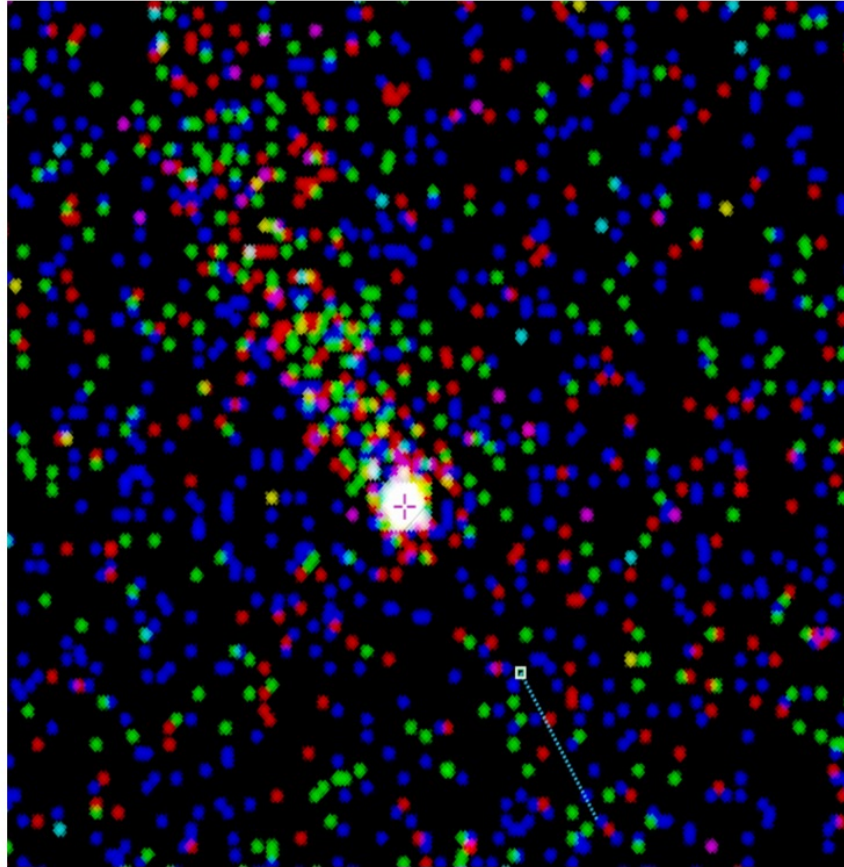
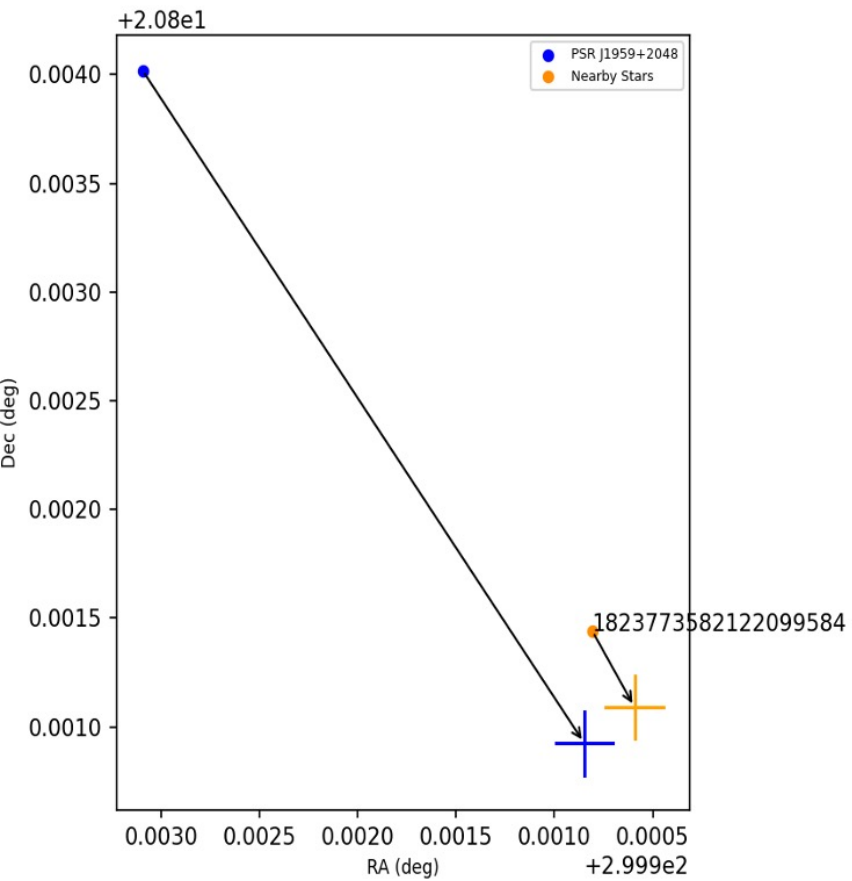
- Proper motion changed

$$\mu = 39(3) \text{ mas.yr}^{-1} \text{ (Lynch et al. 2018)}$$

$$\mu = 2.02(10) \text{ mas.yr}^{-1} \text{ (Kirichenko et al. 2023)}$$



PSR J1959+2048: close encounter in 420y?



(Vidal, Nilipour, Hoang 2023; Vidal 2024)

Multiwavelength search for stellivores

Metabolism: Accretion-ejection cycles

- Input/output composition
- Observatories: Radio/IR/Optical/UV/X-Ray/Gamma-ray

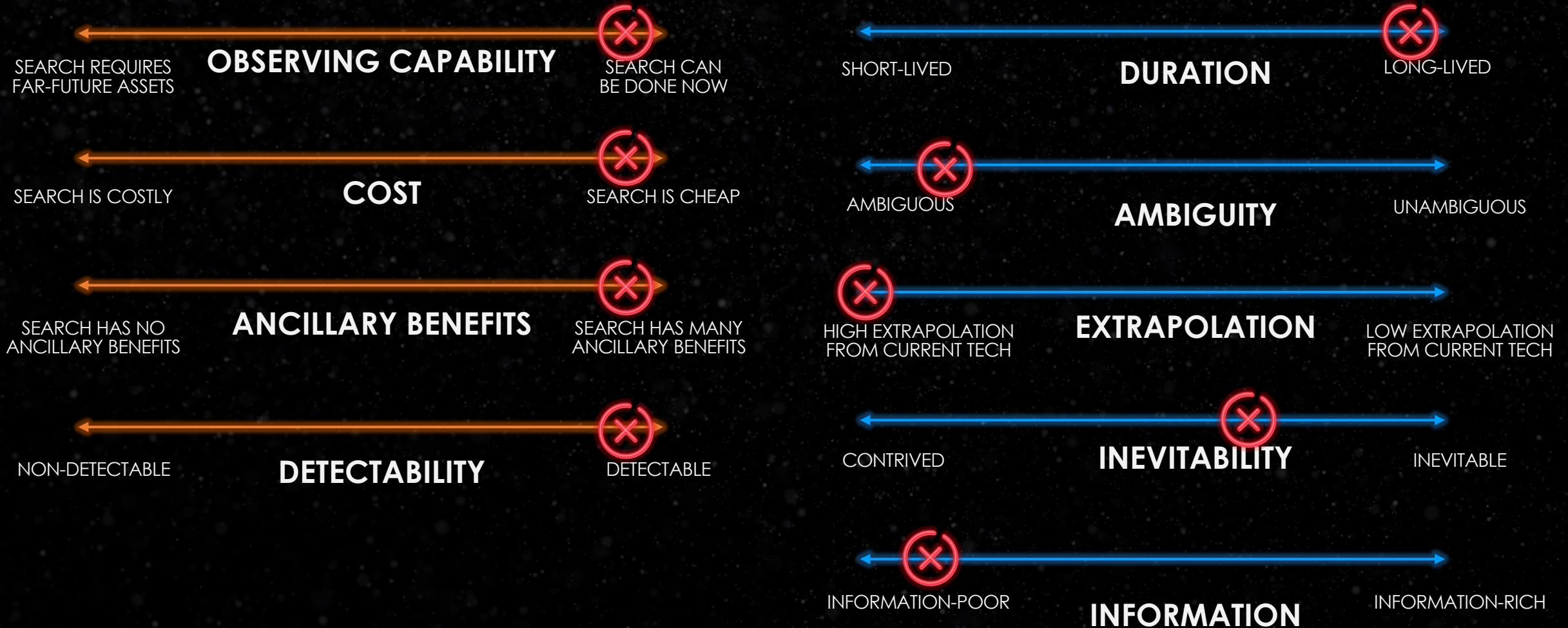
Navigation: Pulsar positioning system

- Coverage and distribution: natural or artificial?
- Observatories: X-ray, Radio

Travel: Spider stellar engine

- Kinetics of spider pulsars
- accelerations & decelerations
- close encounters
- Observatories: Gaia DR1-2-3-4-(5), VLBI, HST.

Axes of merit applied to stellivores



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