X-Ray Astronomy
Implications for SETI

Rosanne Di Stefano

"Breakthrough Initiative"

24 June 2025

Chandra

XMM-Newton

Chandra

(0.1-10) keV

XMM-Newton

Chandra

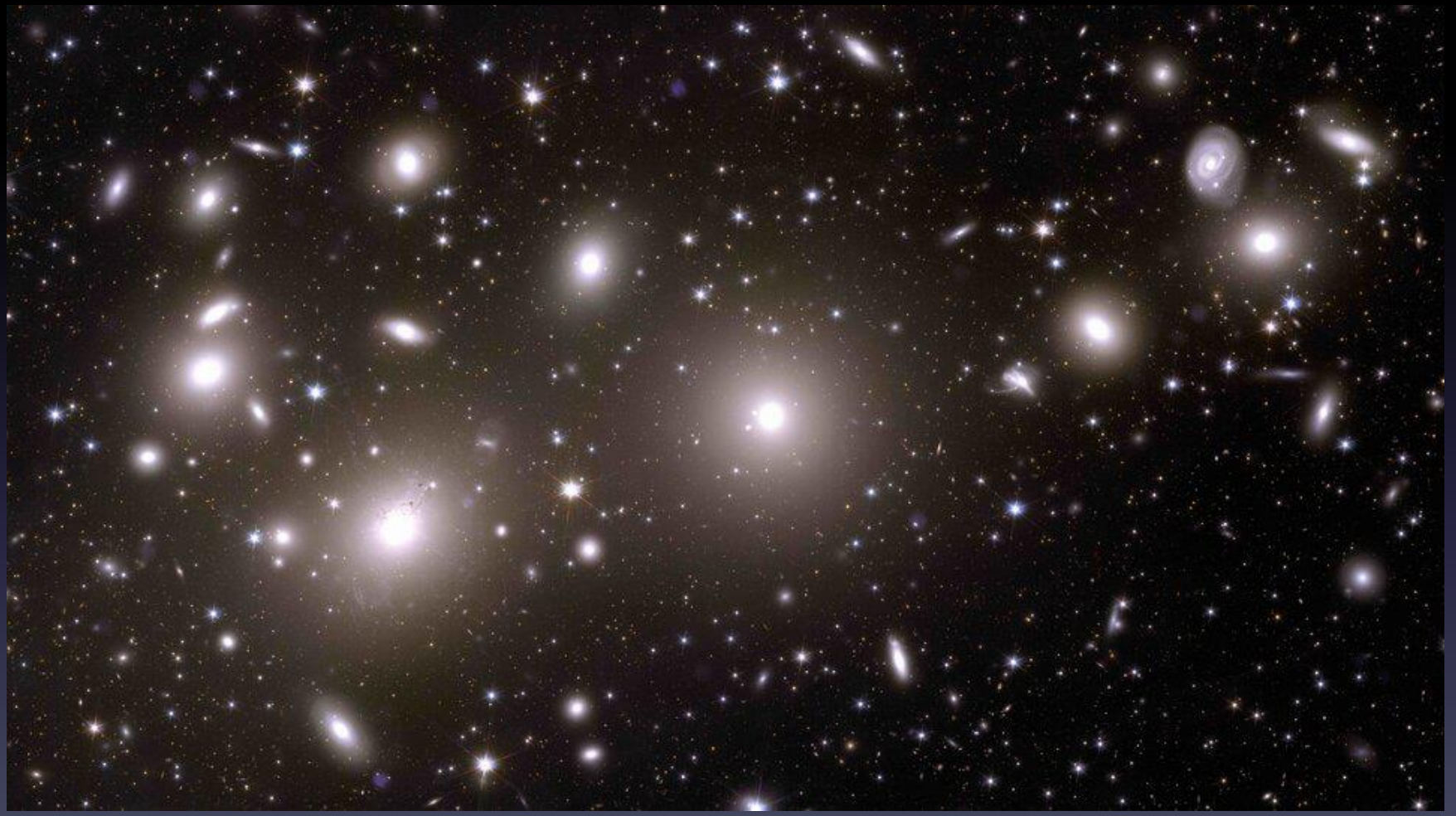
photon poor

XMM-Newton

Chandra

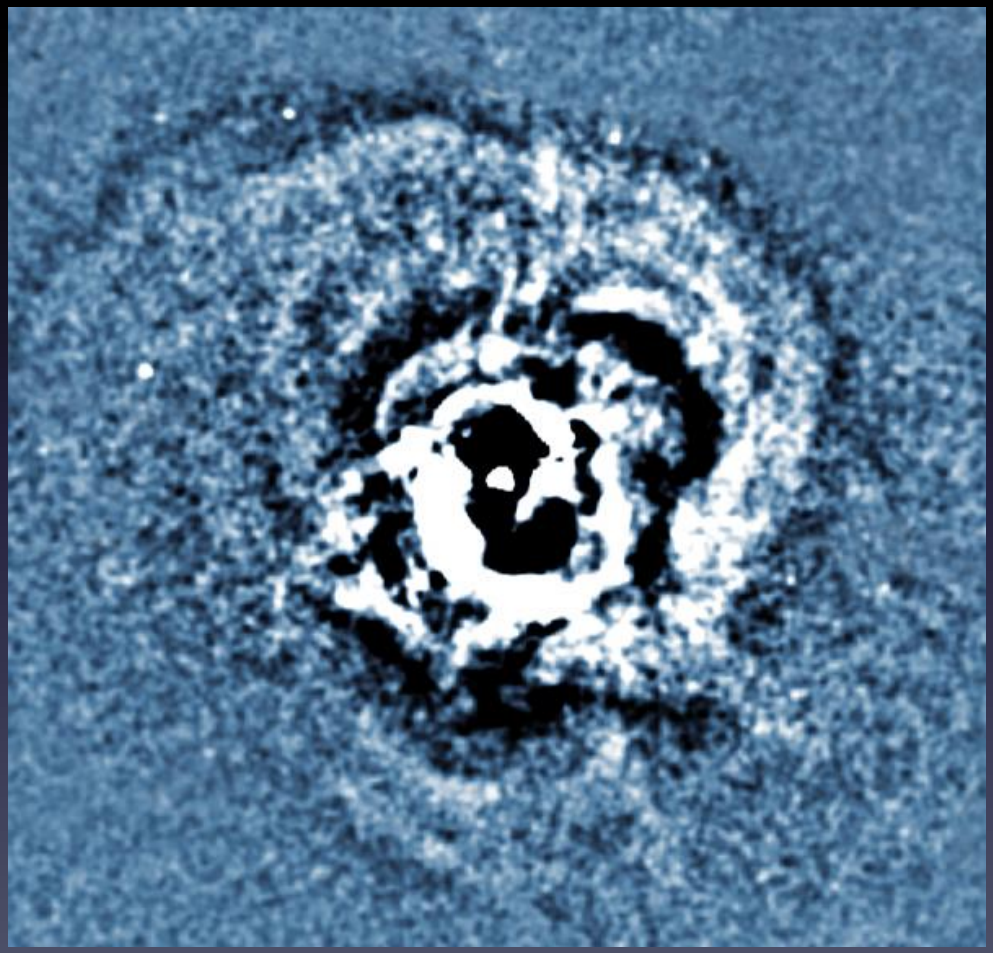
hot

XMM-Newton



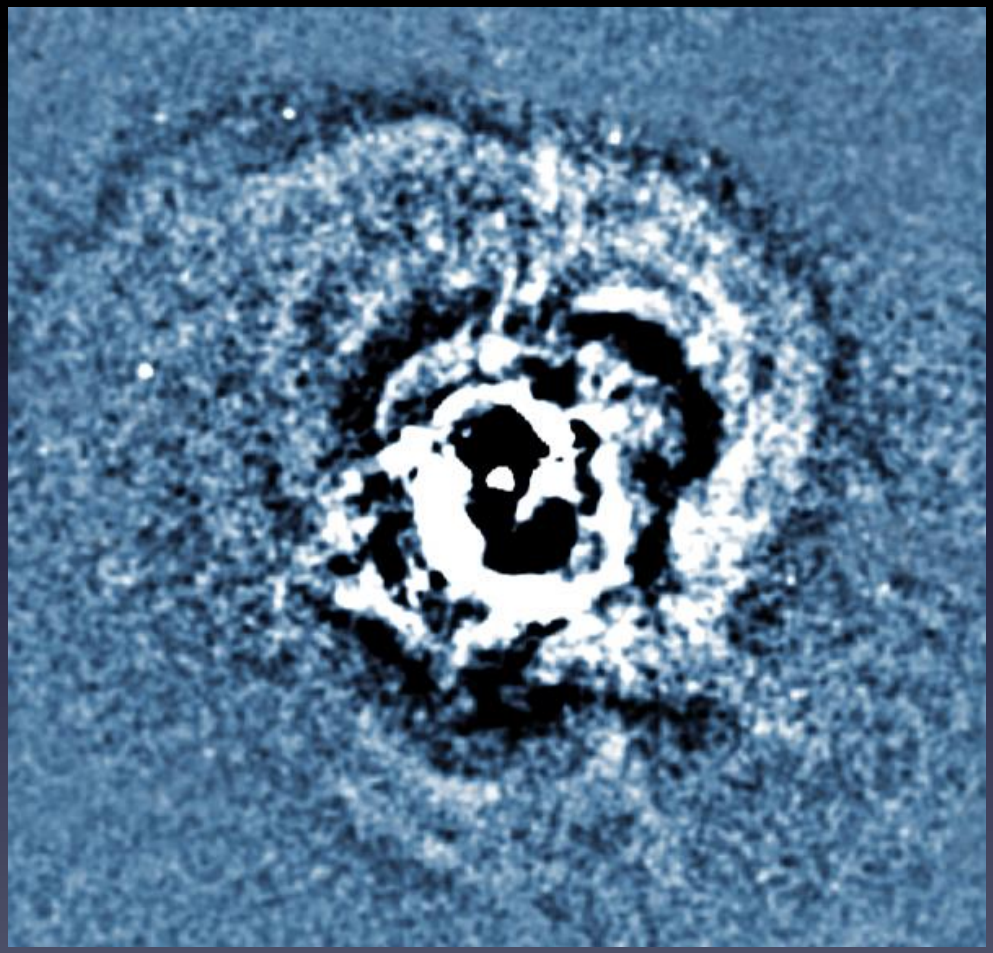
In Perseus and other clusters, we trace cosmic history.

Implications for SETI?

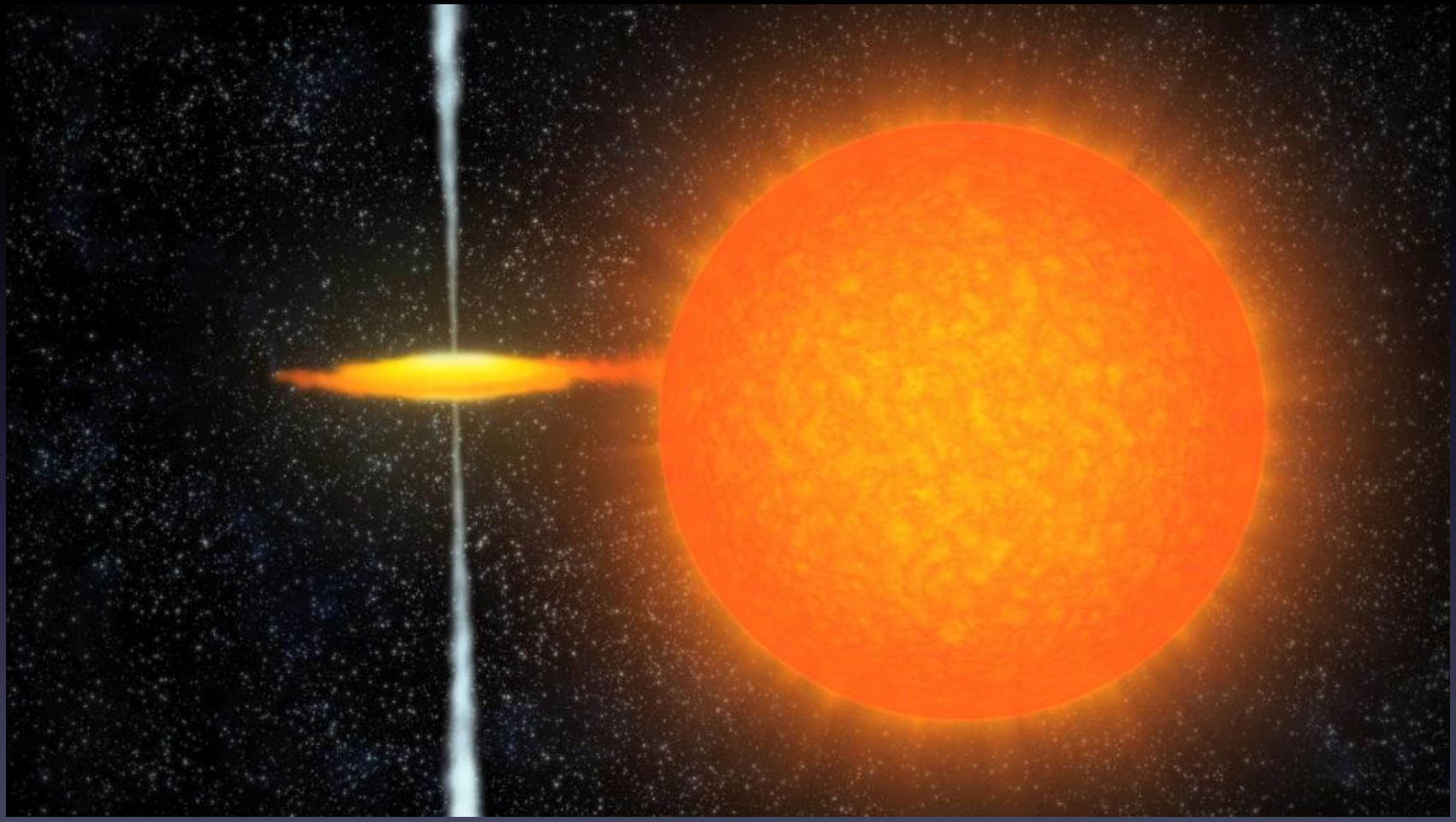


Implications for SETI?

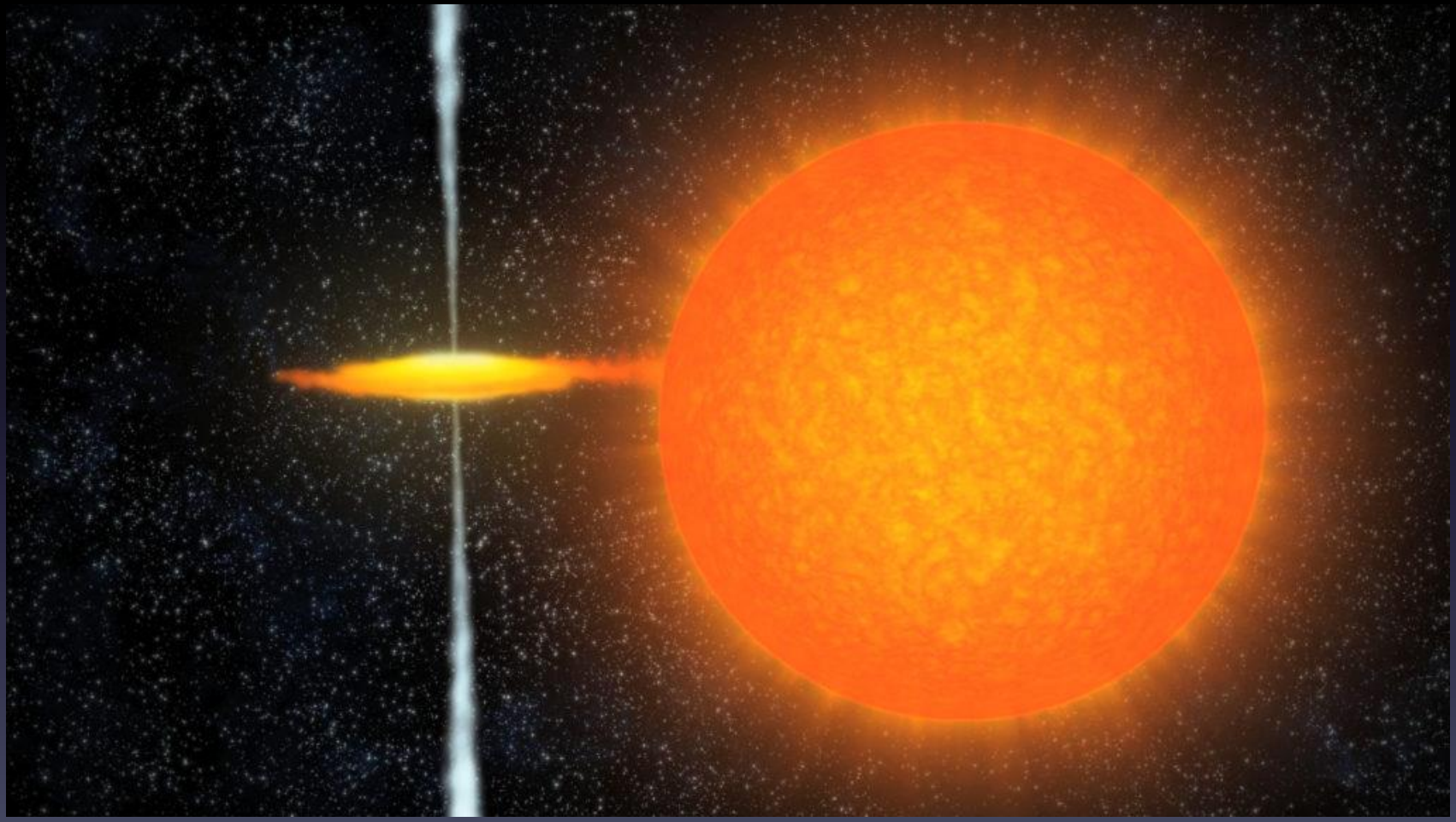
Imprinting Signatures Would Require Vast Amounts Of Energy And Time



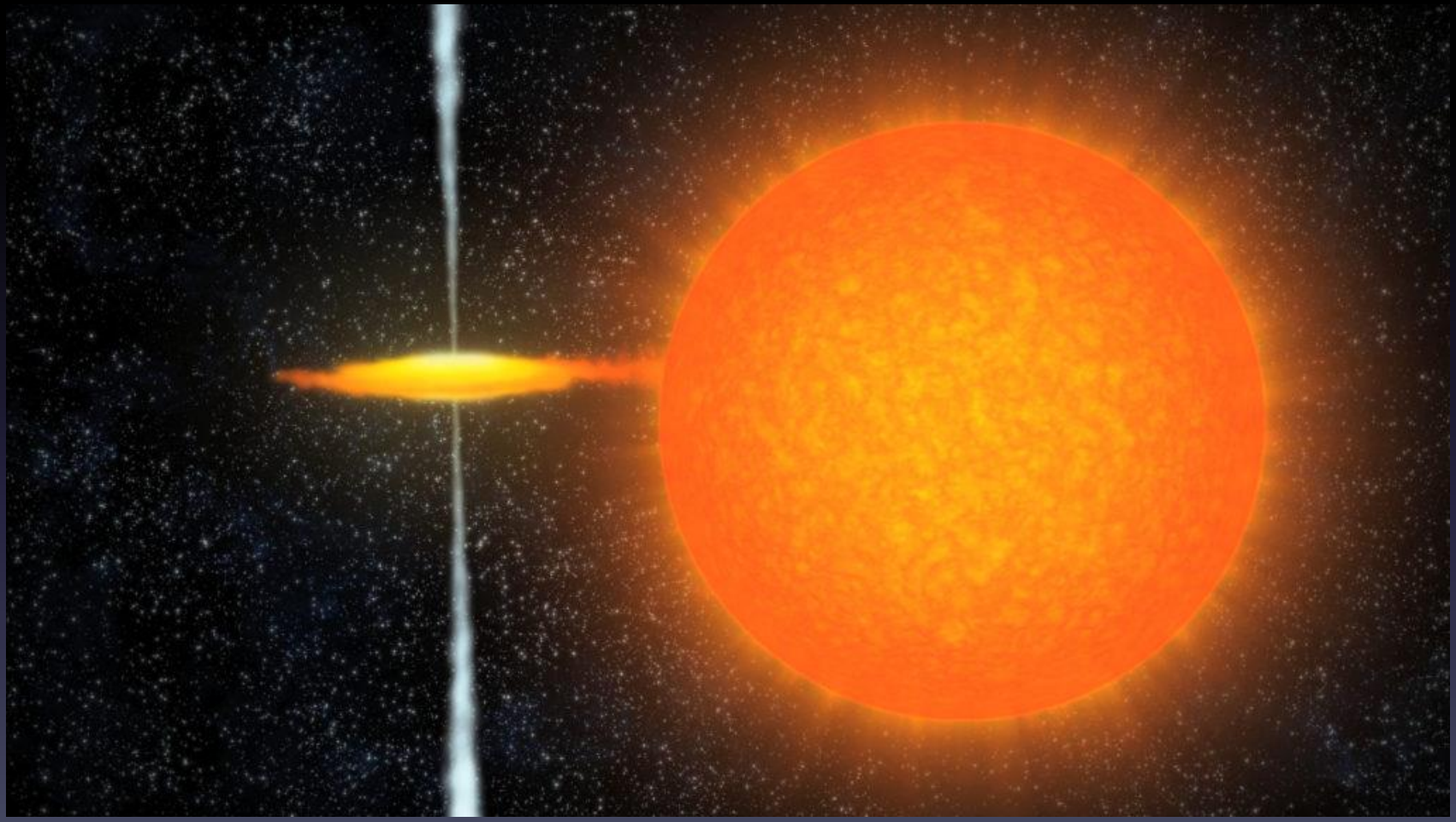
X-Ray Binaries



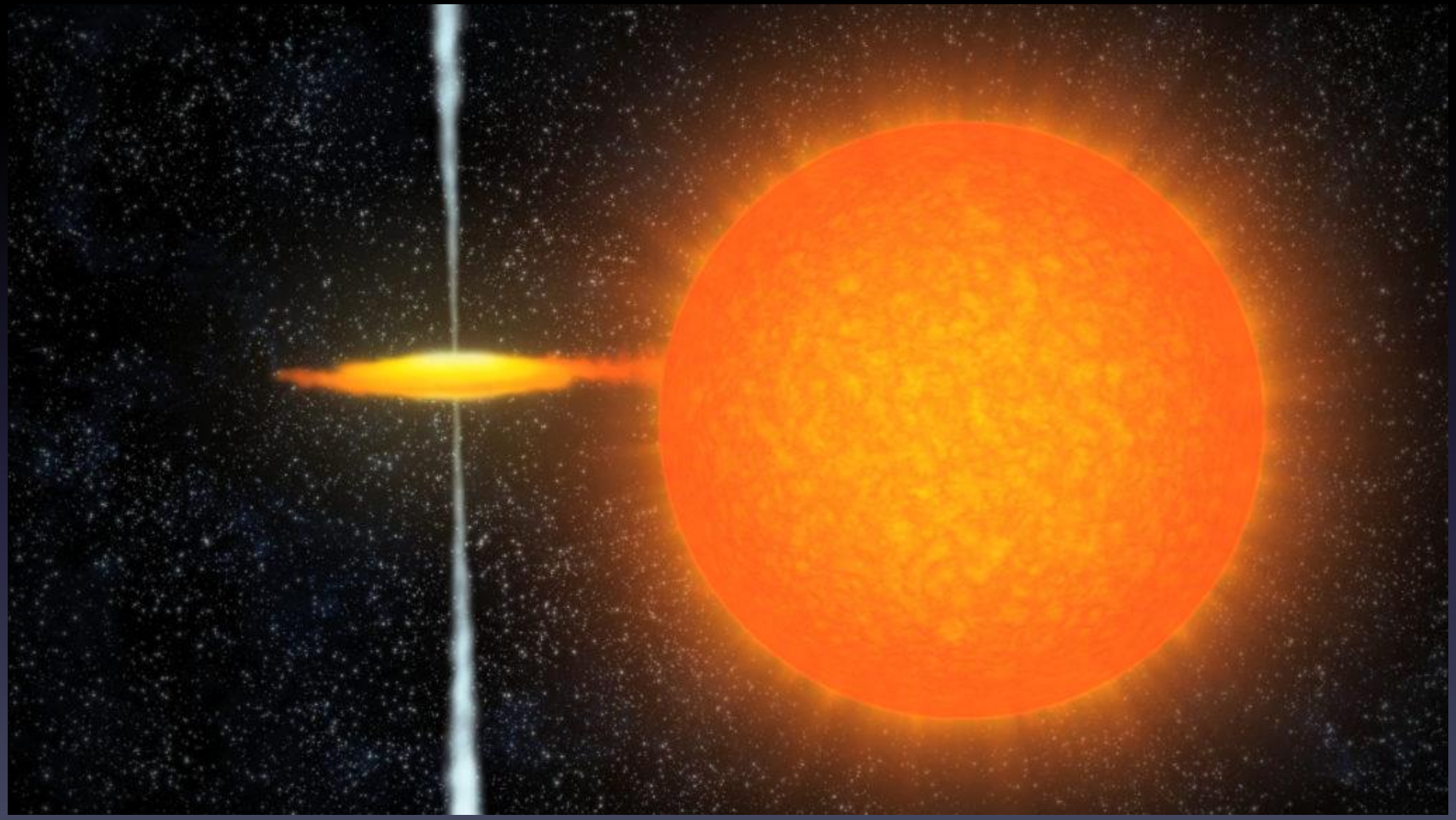
White Dwarf, Neutron Star, Black Hole



Brown Dwarf, M-S Star, Giant



Stable Mass Transfer, Winds



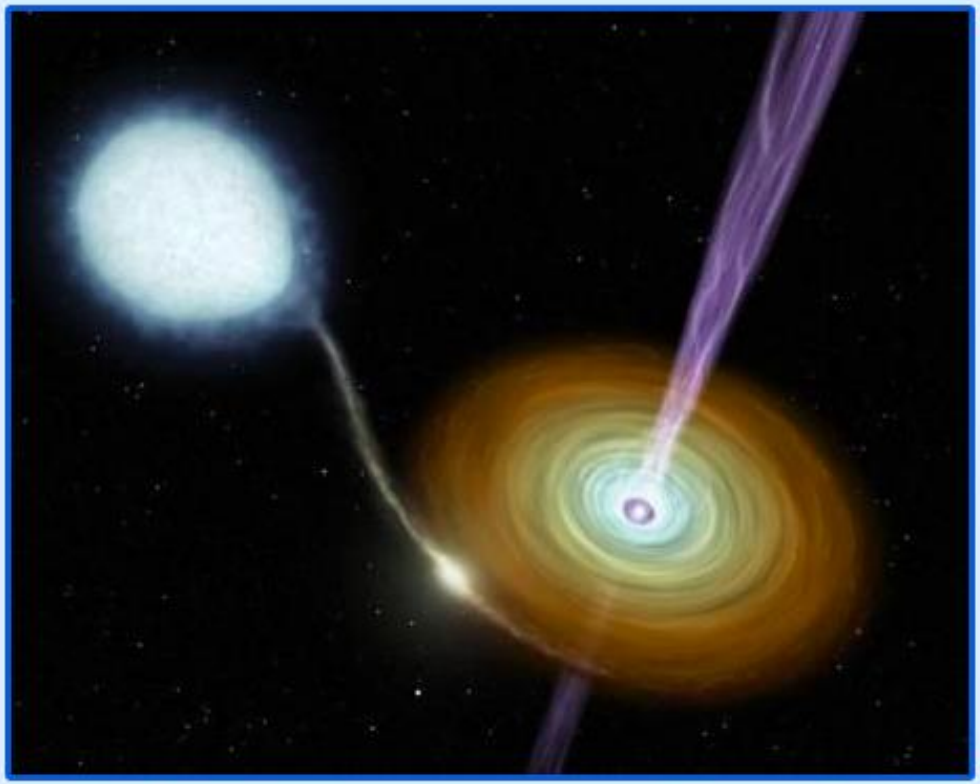
CV, Low-mass XRB, High-mass XRB

Luminosities can be above 10^{39} erg/s.

The size of the X-ray-emitting region can be comparable to the dimensions of planets.

The passage of a planet in front of an XRS can produce a total or near-total eclipse.

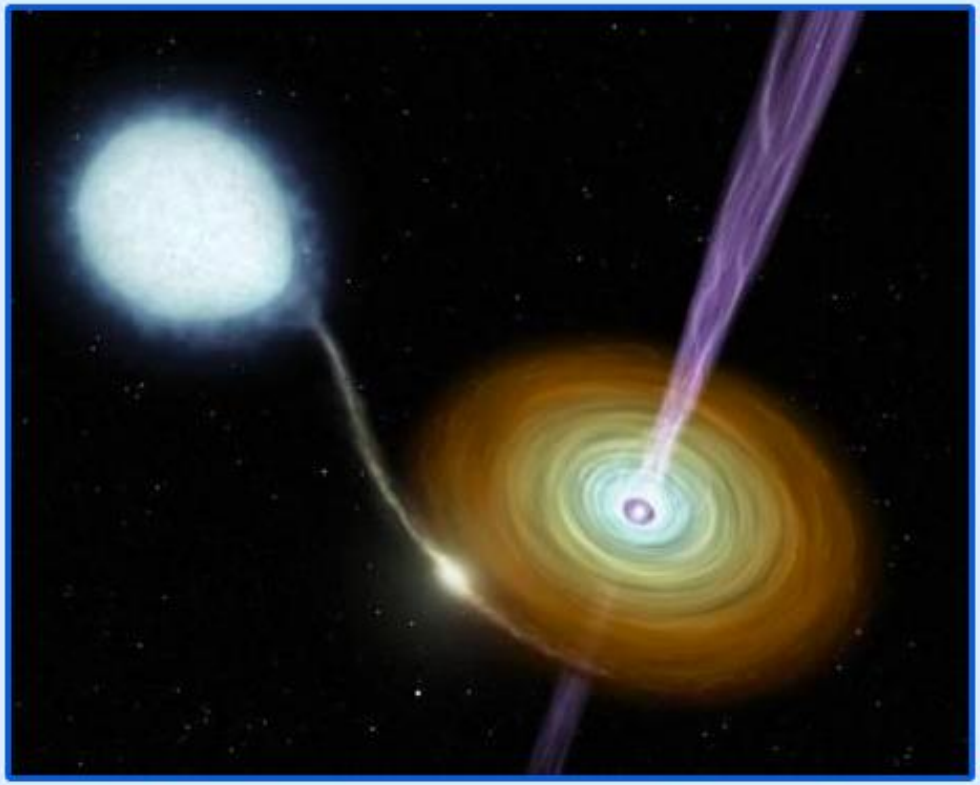
Imara & Di Stefano 2018



Artist's impression of an X-ray binary system accompanied by a continuous jet of matter.
(Credits: NASA/JPL-Caltech/R. Hurt (SSC))

Implications for SETI?

Short-Duration Time Signals From XRBs Can Be Detected By Civilizations like ours



Artist's impression of an X-ray binary system accompanied by a continuous jet of matter.
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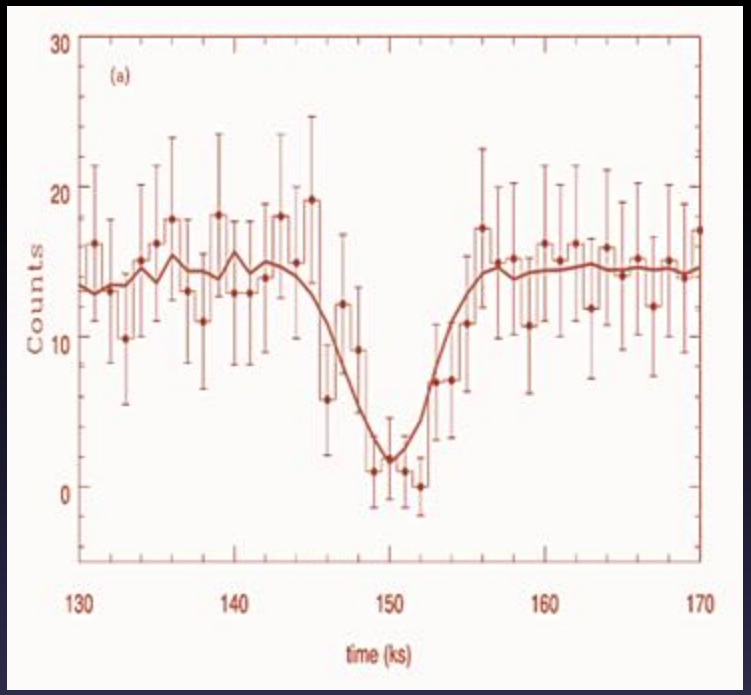
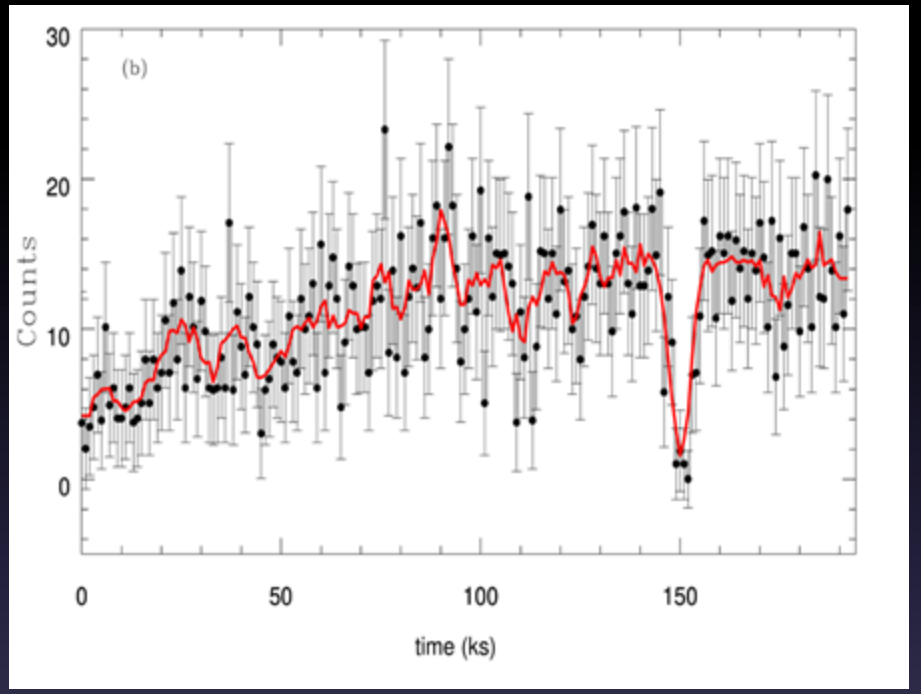
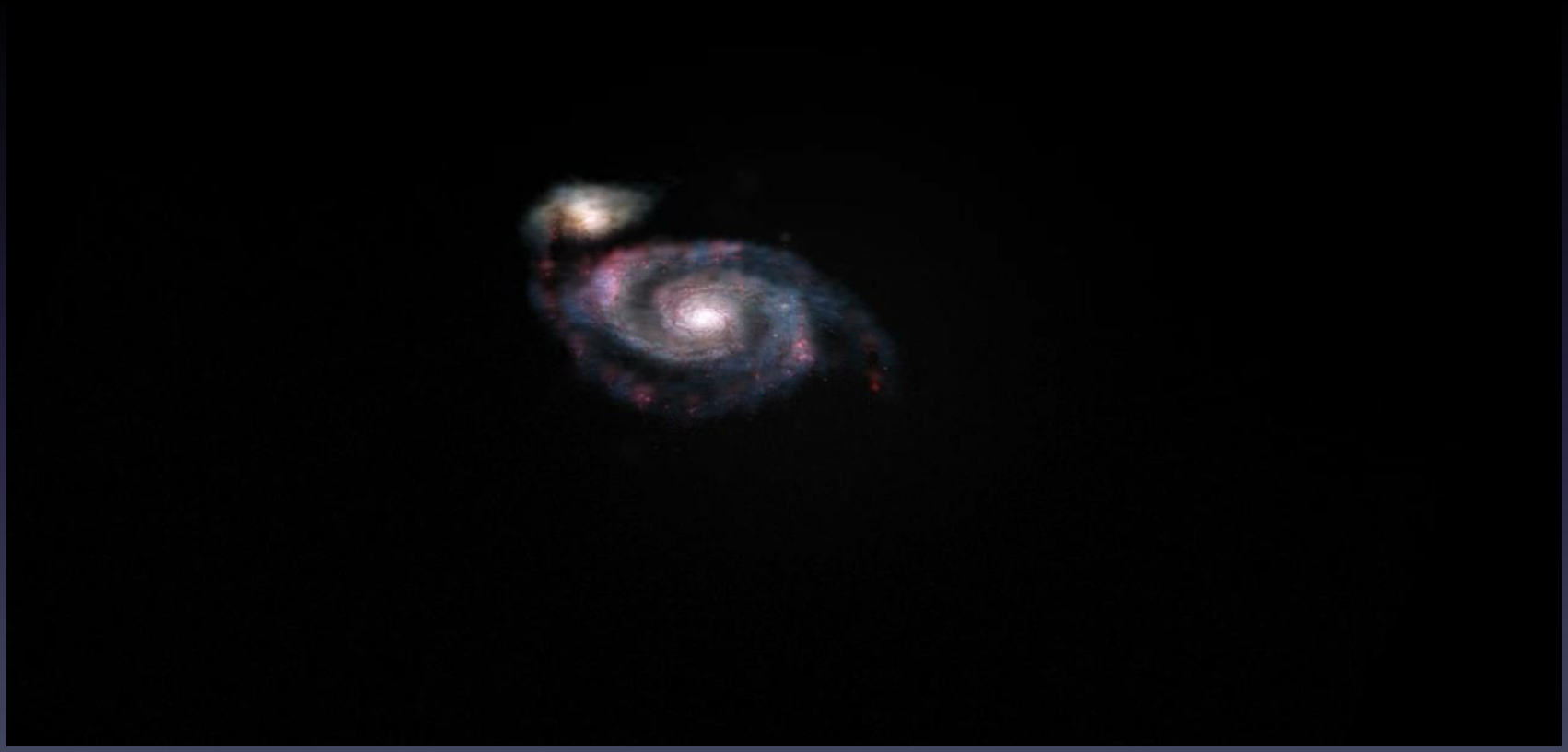
M51-ULS-1b



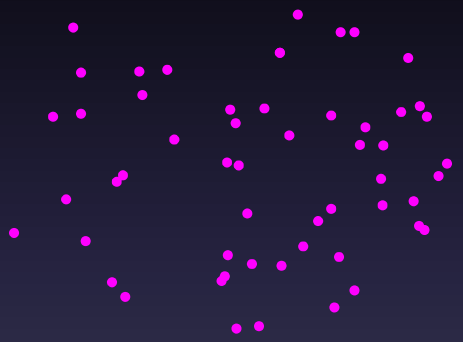


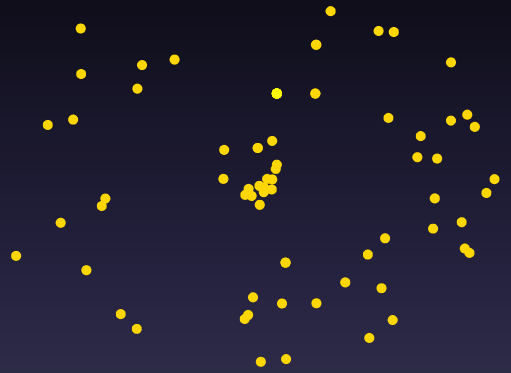
Di Stefano et al. 2021 NatAs 5, 1297


XRSs can be resolved in M51 and other nearby galaxies.
Multiwavelength
X-Ray

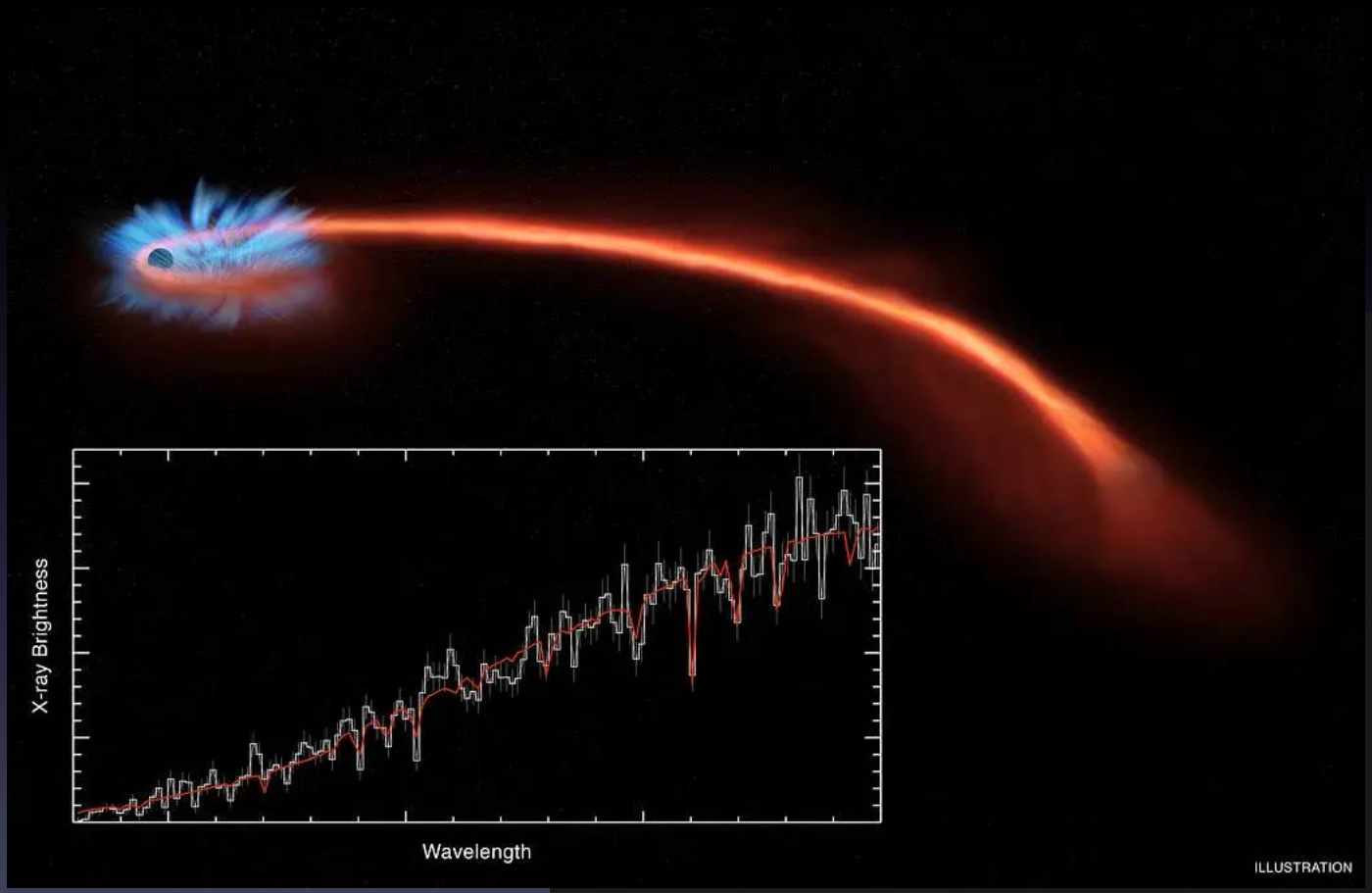


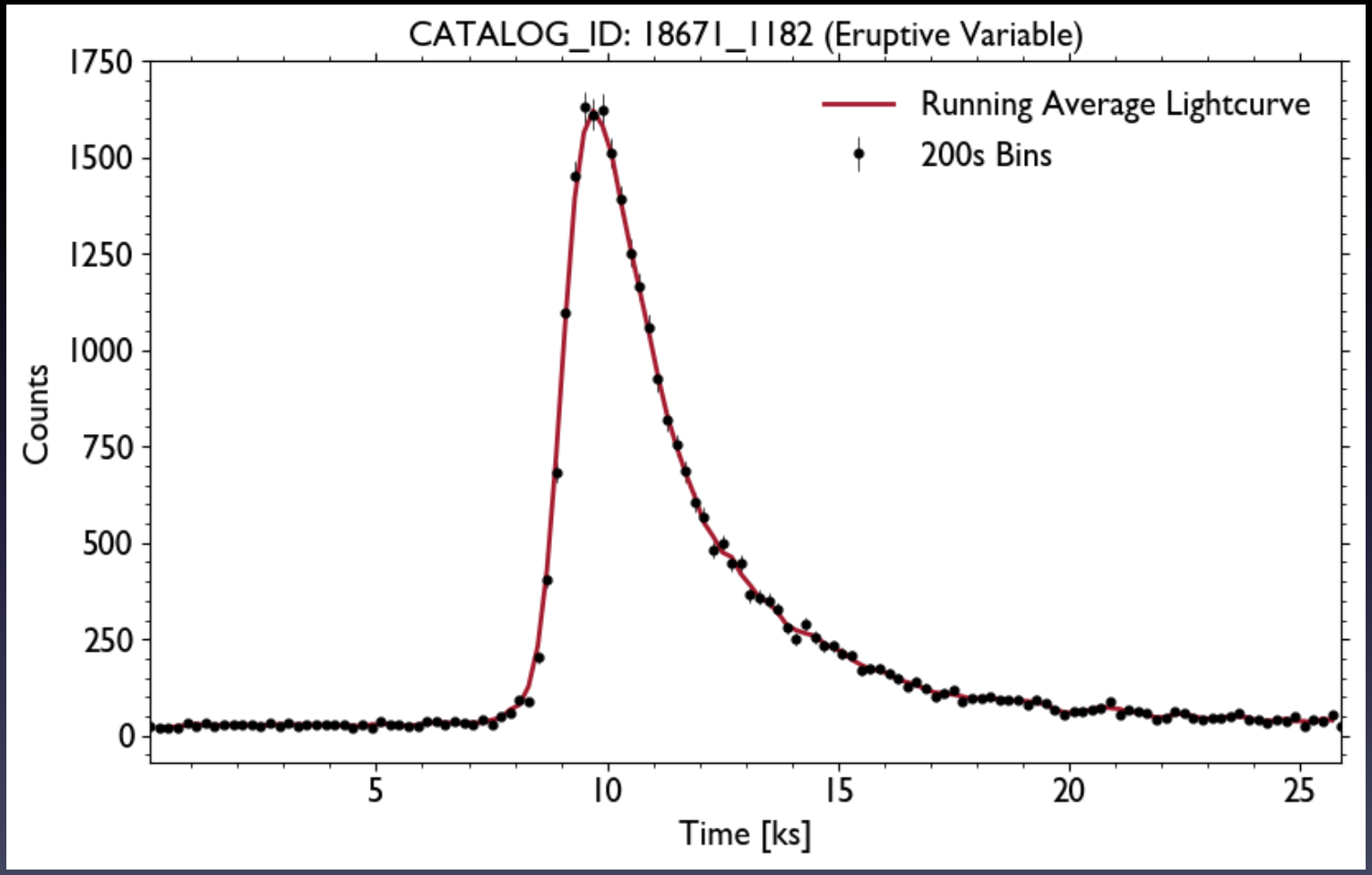
Implications for SETI?





Tidal disruptions could provide other clues---
also sources of power and potential ways to communicate.



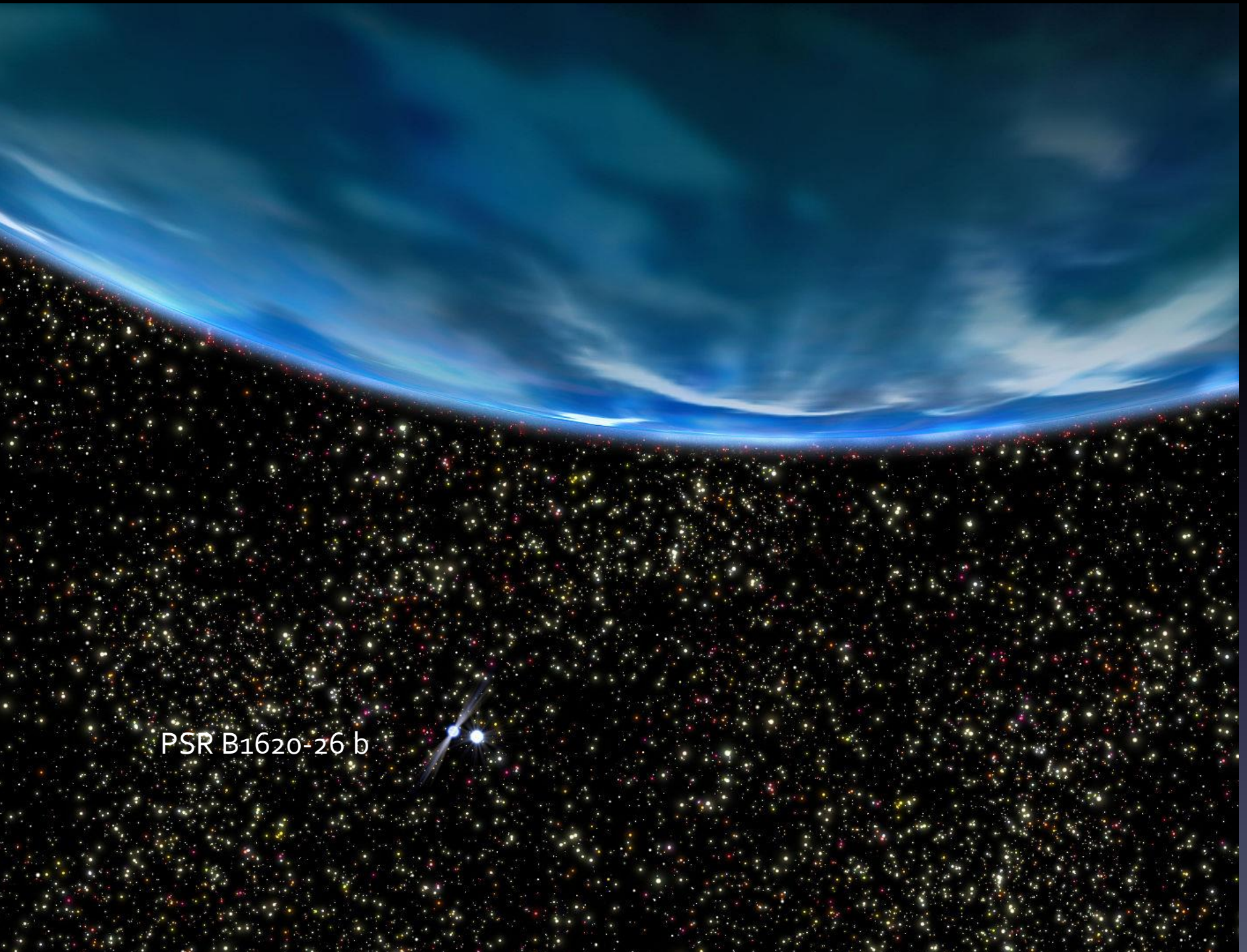


Dillman et al. 2025

Globular Clusters:
about 100 times richer in XRBs than the field.

Globular Clusters:
extremely dense and extremely old

Planets exist in globular clusters.


PSR B1620-26 b

Planets in the habitable zones of globular cluster stars can survive. *(Di Stefano and Ray 2016)*

Globular Clusters may be among the best places for SETI.

We can discover anomalies, if they are there.

- We have discovered "extra" eclipses (possibly due to a third mass) in two globular cluster LMXBs (Painter et al. 2024).