Evidence for a Dominant Formation Channel for FRBs

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On behalf of the CHIME/FRB collaboration

AAS 243 Press-briefing: Jan 11, 2024

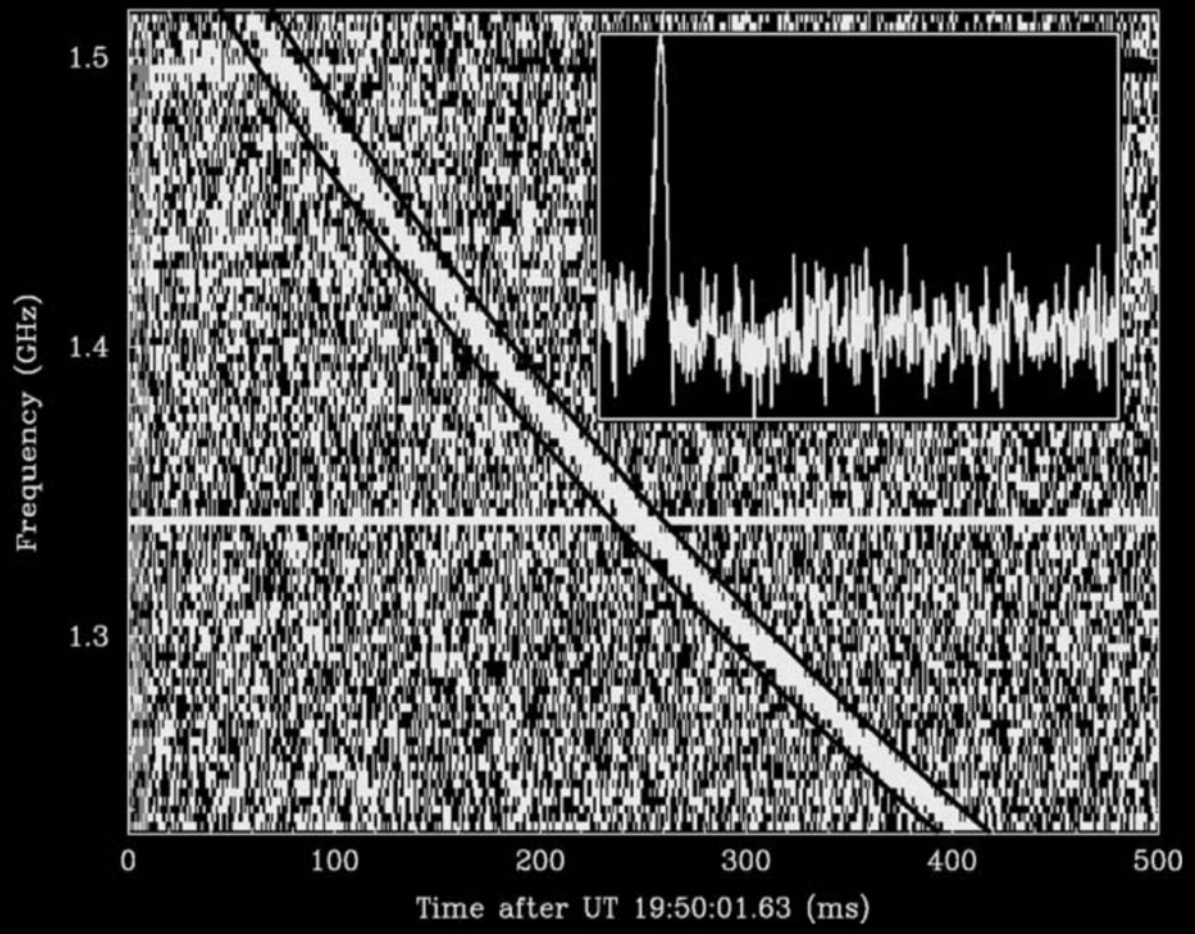
chime

What are FRBs?

Bright radio pulses of millisecond duration

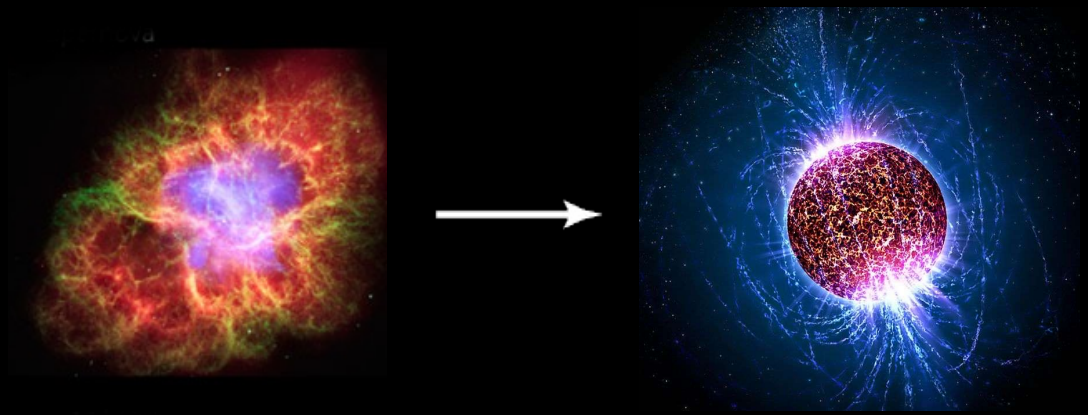
Origins unknown, but some likely produced by magnetars

Intervening material distorts radio signal due to dispersion



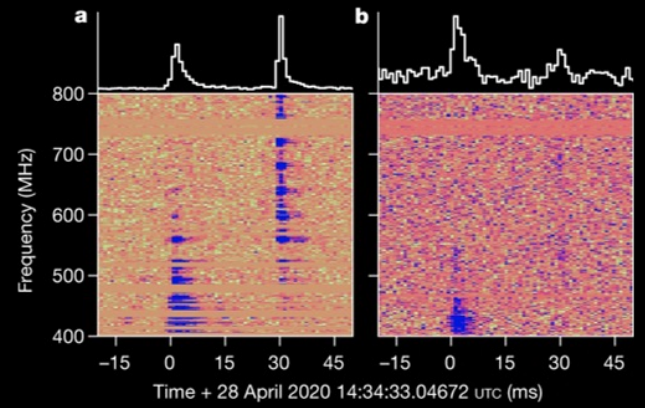
Lorimer et al. (2007), *Science*

Multiple Formation Channels?

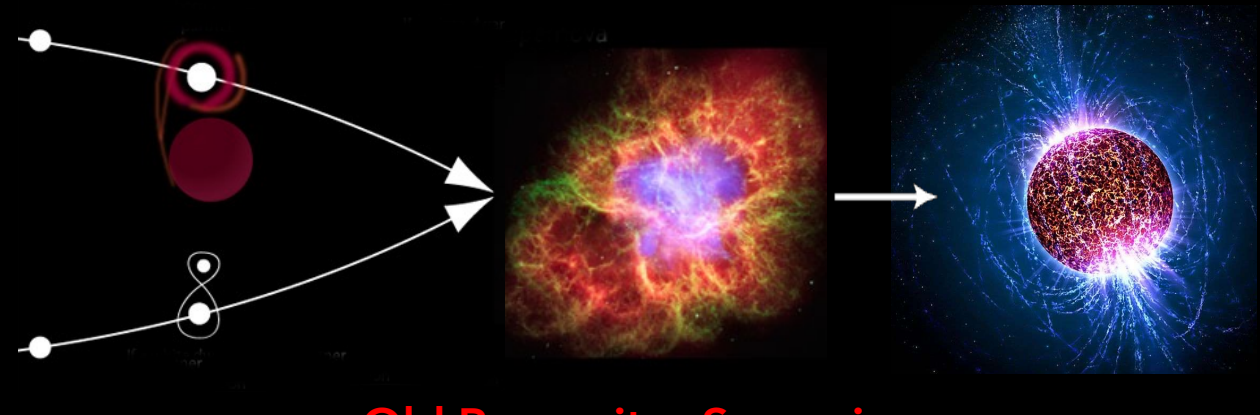


Young Progenitor Scenario

FRB-like radio bursts from SGR 1935+2154

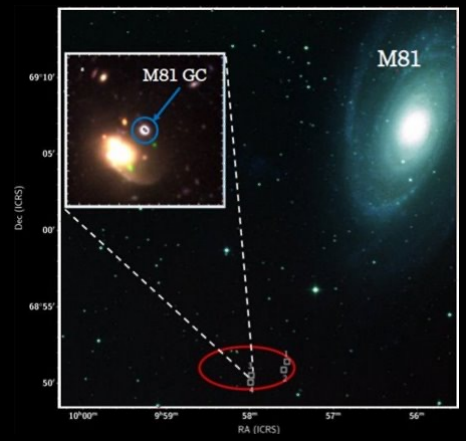


CHIME/FRB Collaboration et al. (2020), *Nature* Bochenek et al. (2020), *Nature*



Old Progenitor Scenario

FRB located in a globular cluster of M81



Bhardwaj et. al (2021a), ApJL
Kristen et al. (2022), *Nature*

CHIME/FRB is detecting 100 FRBs / month

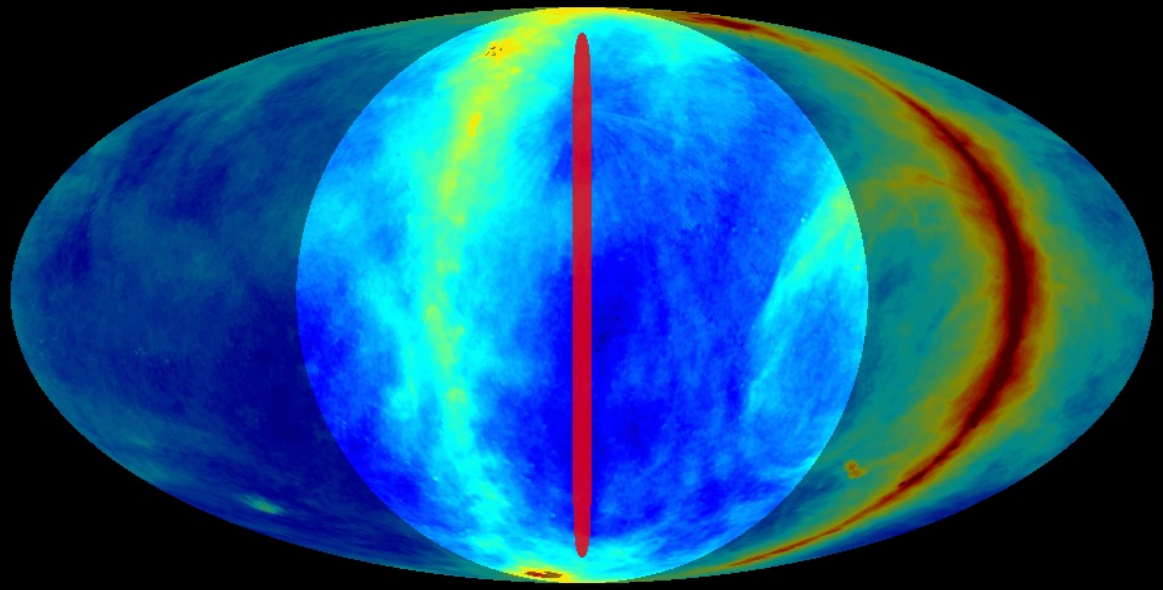
CHIME/FRB Project:
Collaboration of ~80 Scientists

CHIME: Radio telescope located in Penticton, Canada

Searching for FRBs in real-time

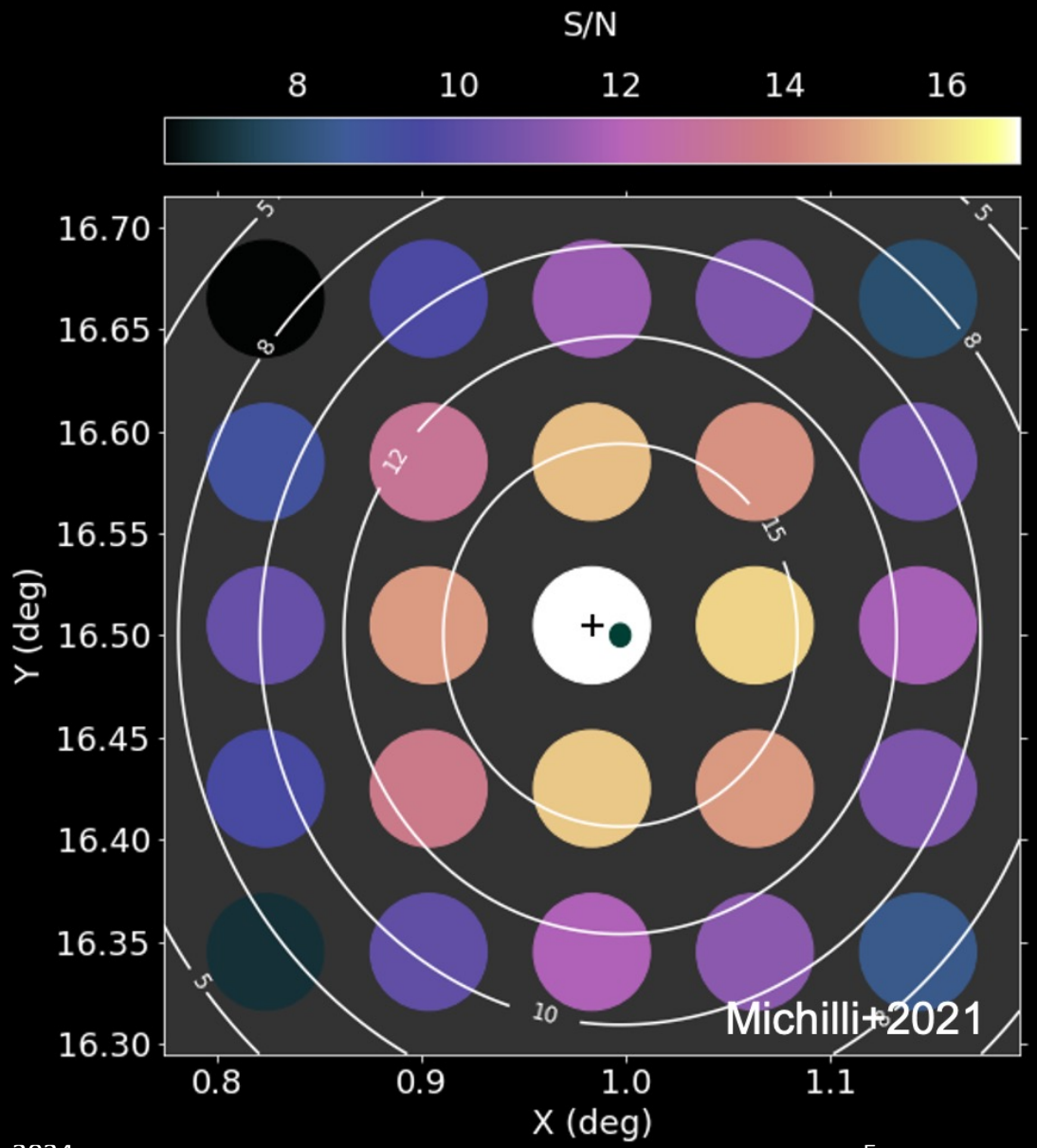
Pinpointing the Source Position

~220 deg^2 *instantaneous* field-of-view



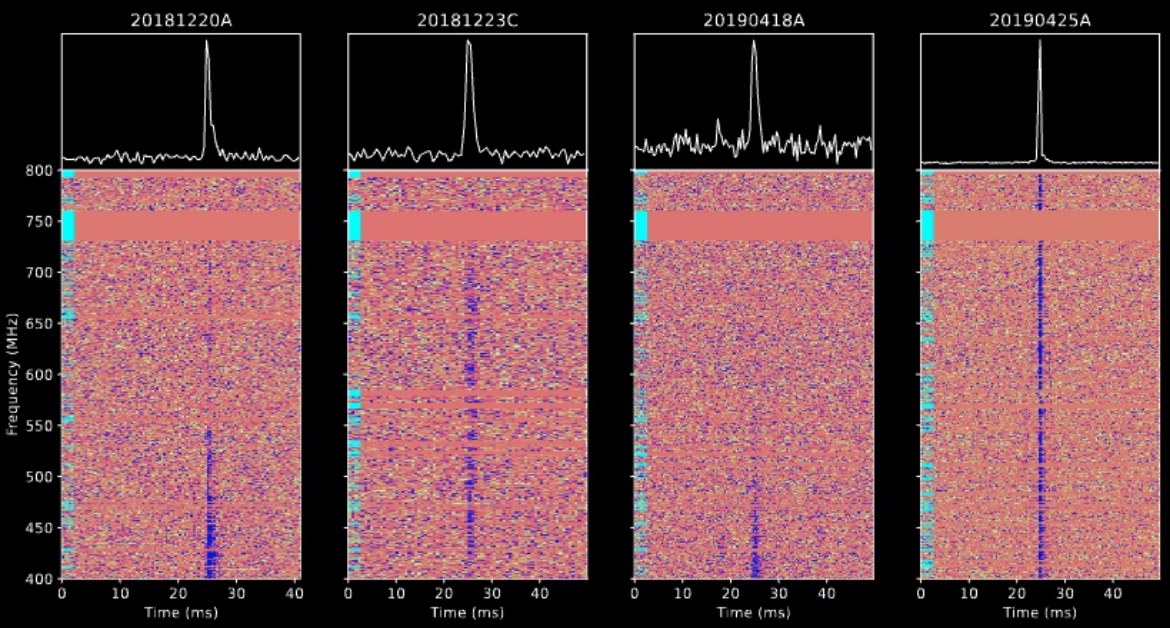
Host galaxies of nearby FRBs can be identified by combining voltage data from all antennas

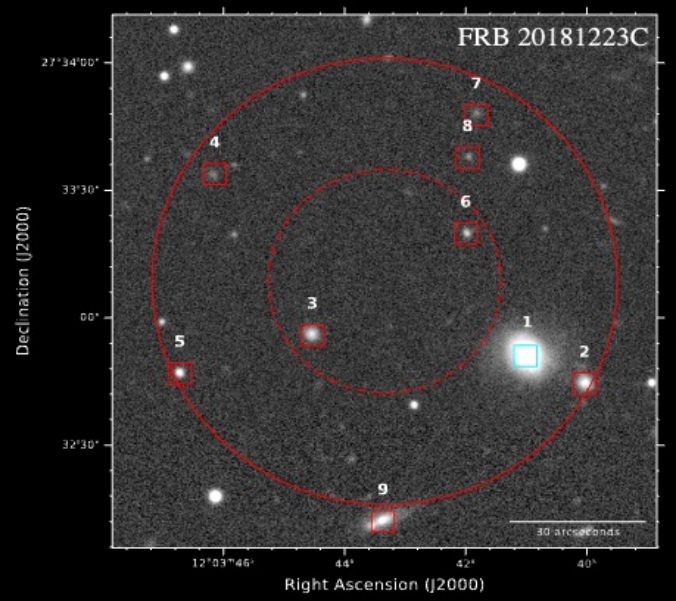
Typical Localization Precision: ~1 arcmin

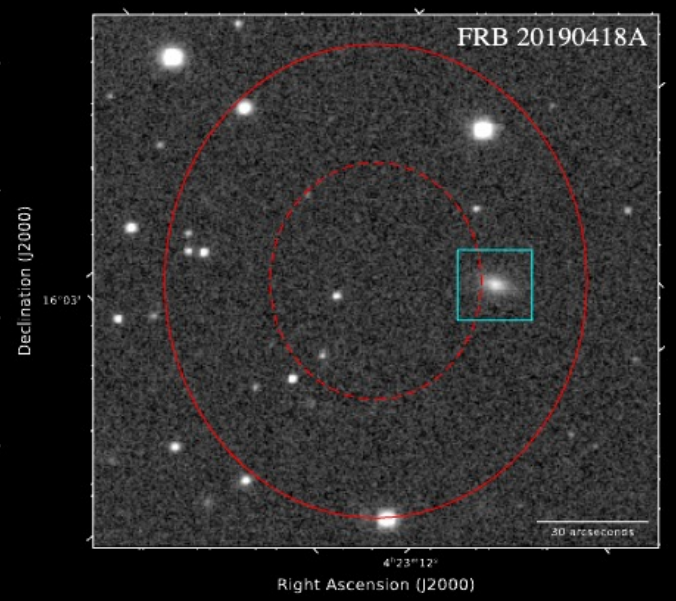


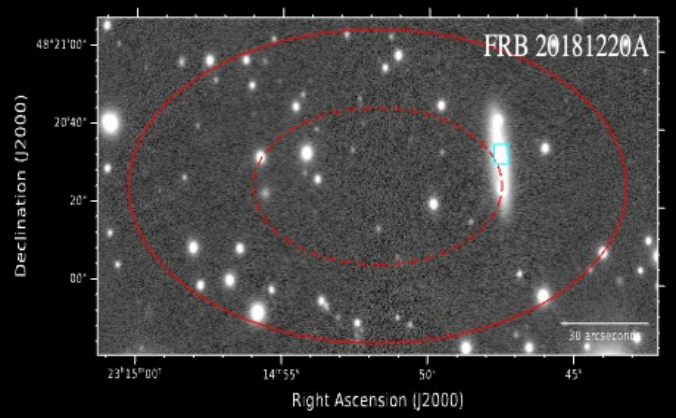
Nearby Hosts of Four CHIME FRBs

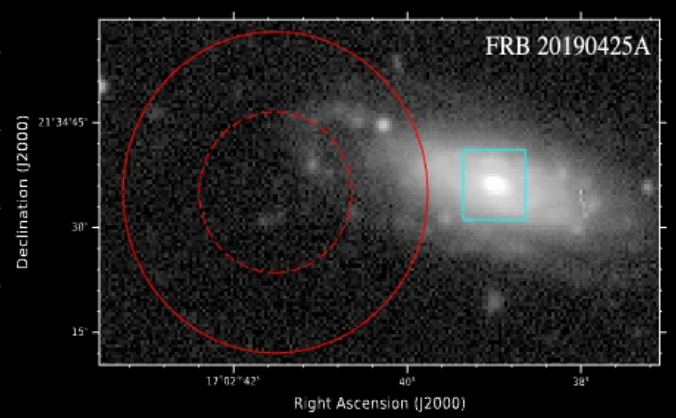
We associate 4 CHIME FRBs with nearby spiral galaxies











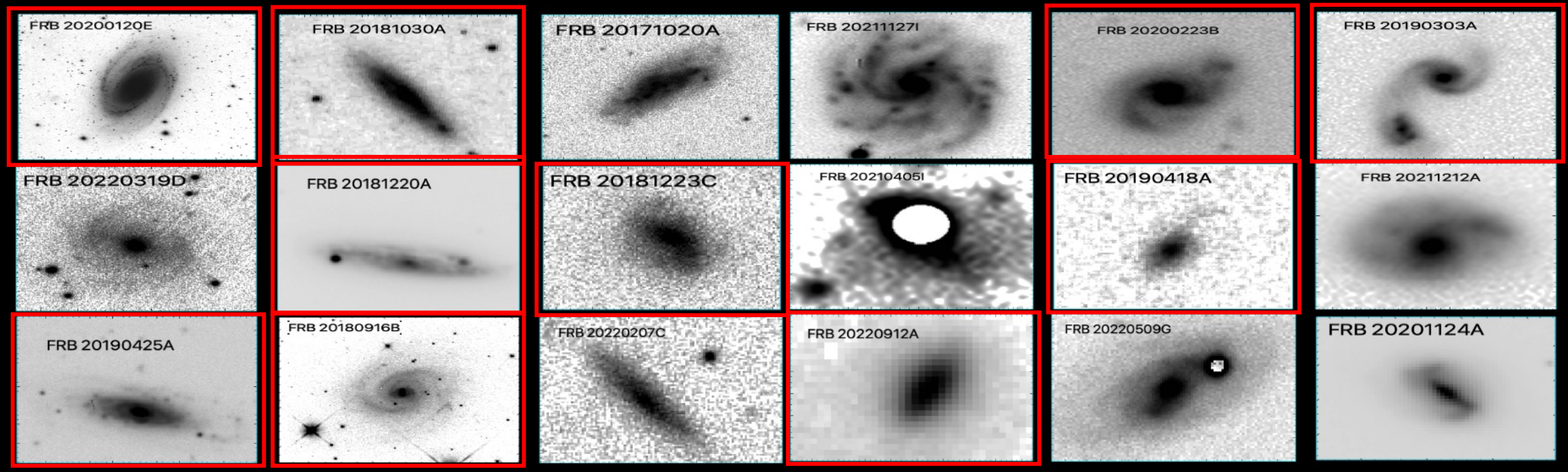
Bhardwaj et al. (submitted to ApJL)

Local Universe FRB Hosts (z<0.1)

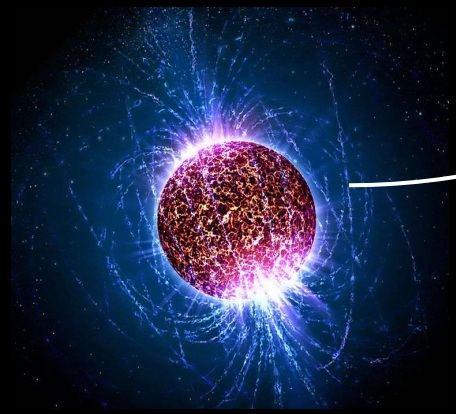
18 local Universe FRBs with robust host association published till July 2023.

Over 50% were discovered by CHIME/FRB (highlighted in red boxes)

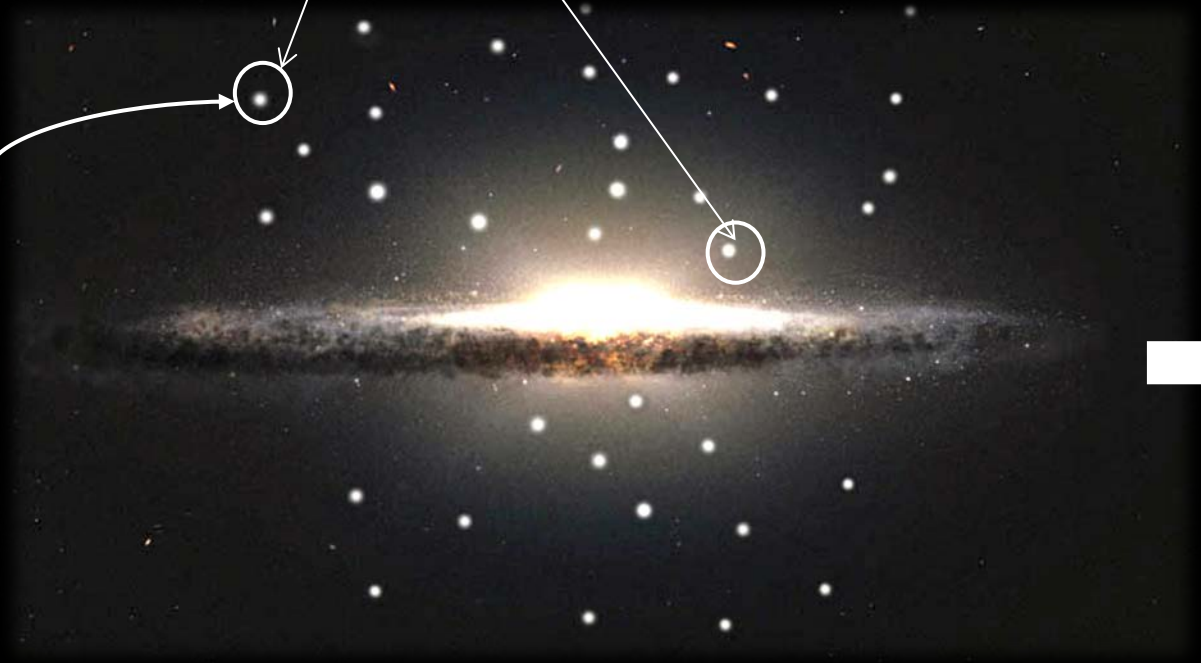
All are late-type (spiral) galaxies!



Origin of FRBs
Globular Cluster Origin

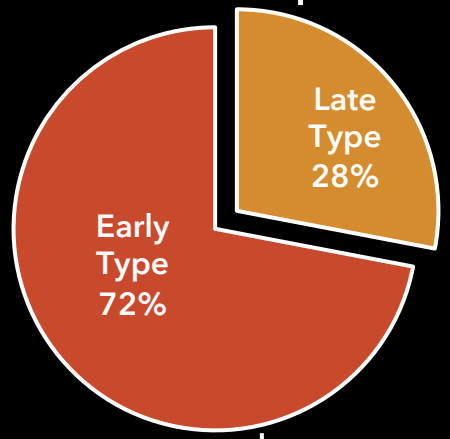


Fast Radio Burst Source



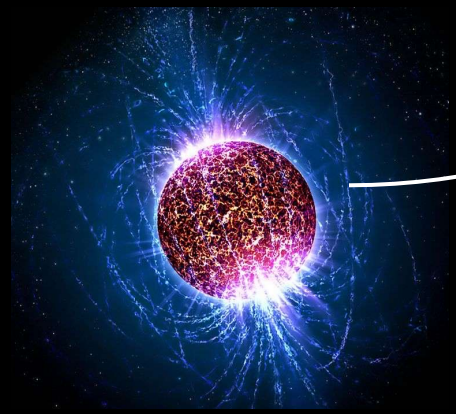
Irregular

Spiral



Elliptical

Origin of FRBs
Globular Cluster Origin



Fast Radio Burst Source

Irregular

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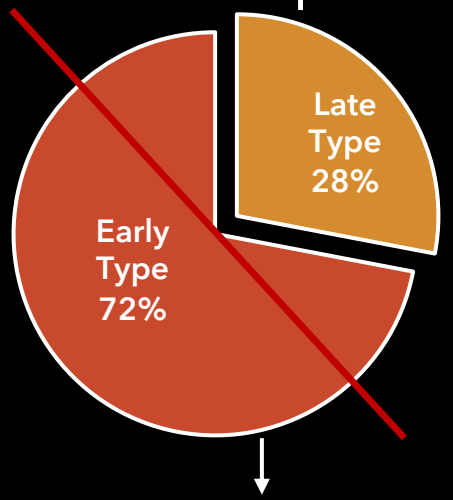
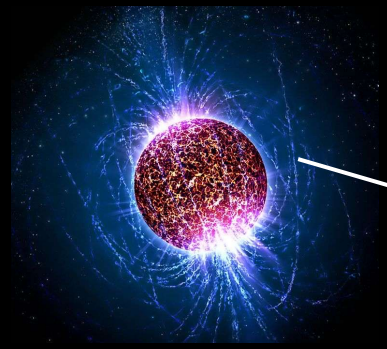


Elliptical

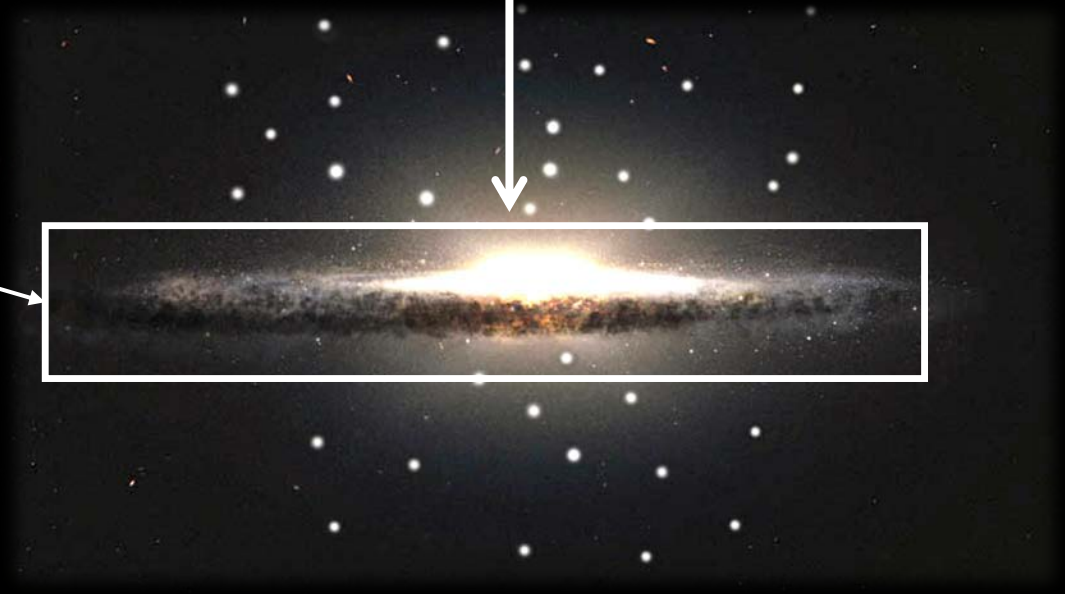
None of the FRB hosts is an early-type galaxy!
Most FRBs do not have globular cluster origin

Origin of FRBs

Disk Origin



Fast Radio Burst Source

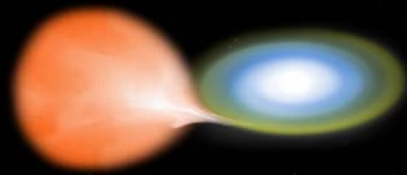


SLSNe and long LGRBs

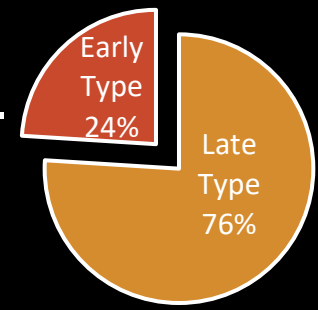
Core-collapse supernovae

≳ 99% late-type

AIC of white dwarfs



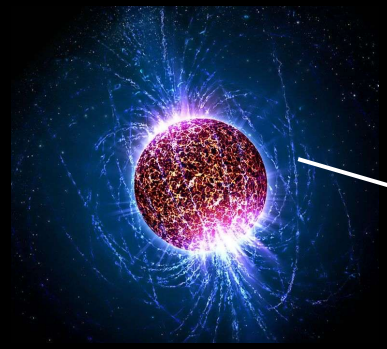
Mergers of white dwarfs



Mergers of neutron stars

Origin of FRBs

Disk Origin



Fast Radio Burst Source

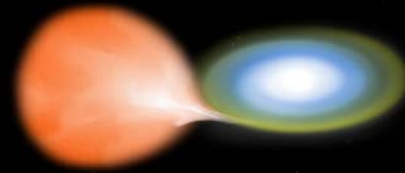
SLSNe and long LGRBs

Insufficient all-sky rate

Core-collapse supernovae

≳ 99% late-type

AIC of white dwarfs



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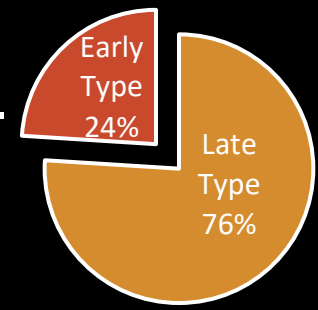

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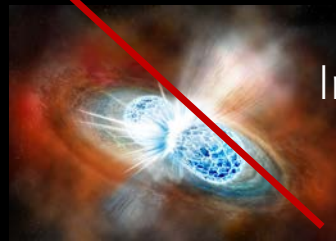
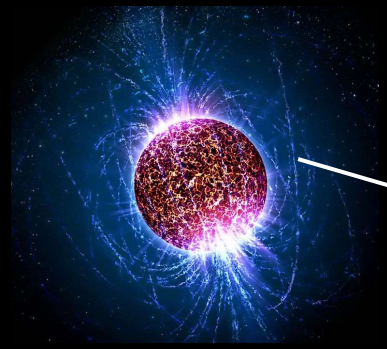


Insufficient all-sky rate

SLSNe and GRBs have insufficient all-sky rates to form most FRB sources

Origin of FRBs

Disk Origin



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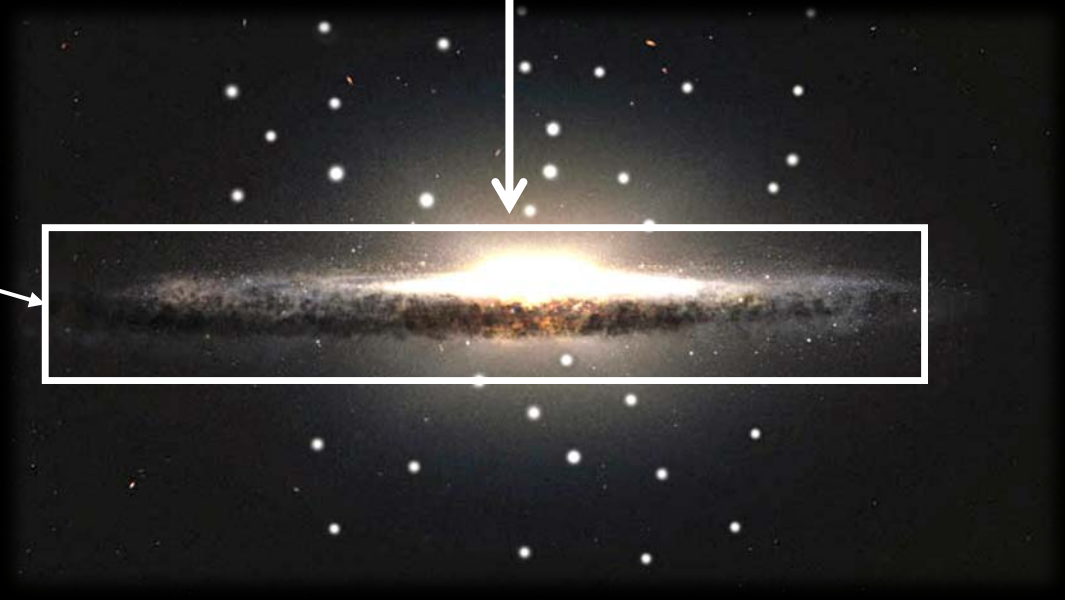
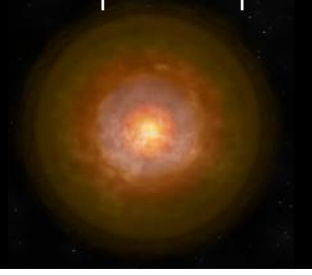


SLSNe and long LGRBs

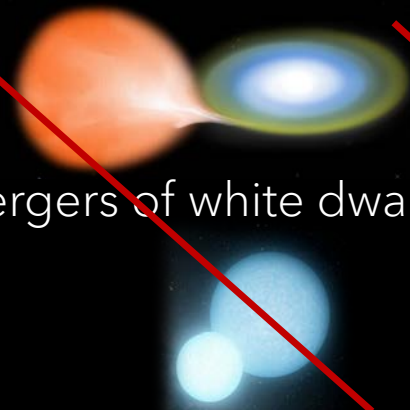
Insufficient all-sky rate

Core-collapse supernovae

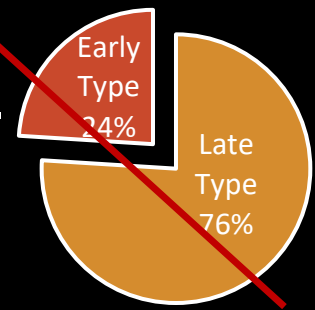


≳ 99% late-type

AIC of white dwarfs



Mergers of white dwarfs

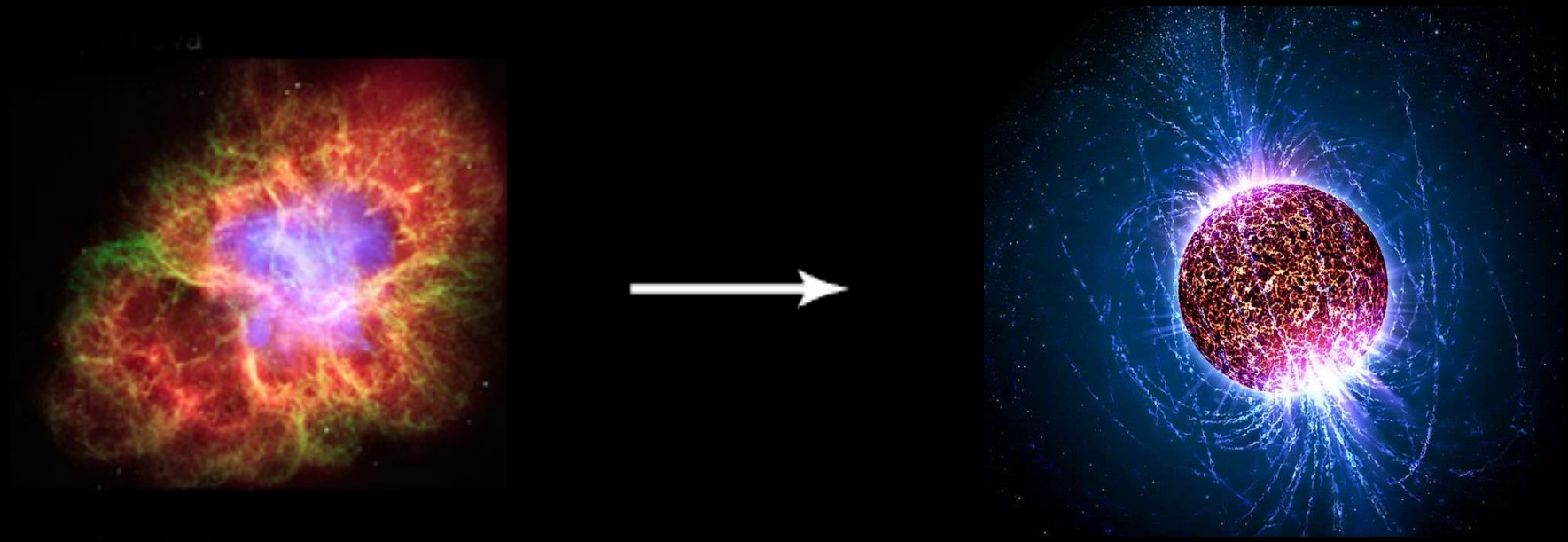


Mergers of neutron stars

Insufficient all-sky rate

Core-collapse supernovae are likely the dominant formation channel for FRBs

Core-collapse Supernovae as Dominant Formation Channel



Direct collapse of massive stars to form FRB sources

Summary

Local Universe FRBs are the very promising candidates to uncover the origins of FRBs.

We have associated four CHIME FRBs to nearby spiral galaxies.

Prevalence of spiral hosts in the local Universe FRB sample.

Core-collapse supernovae are likely the dominant FRB formation channel.

We need more FRB host localizations to confirm our finding and identify other (sub-dominant) formation channels.

We will soon localize 100s of FRBs every year using the upcoming CHIME/FRB Outrigger telescopes.

FRBs have a bright future!