

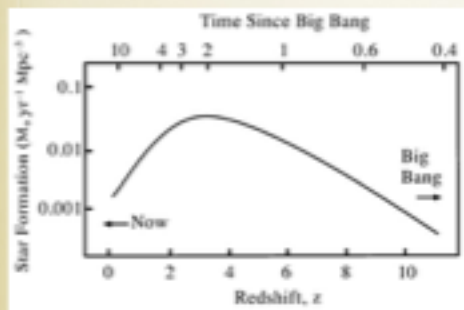
Fast Radio Bursts!

- A study in:
 - Tools for understanding new discoveries.
 - Interstellar medium effects.
 - Discussing mystery objects.

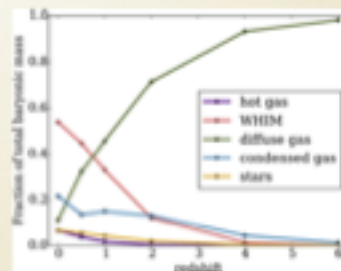
Background 1: Radio source counts

Radio source counts

Many things change as the Universe evolves.

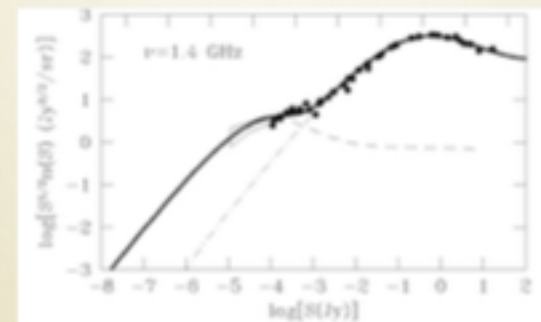


Star formation rate changes with time.



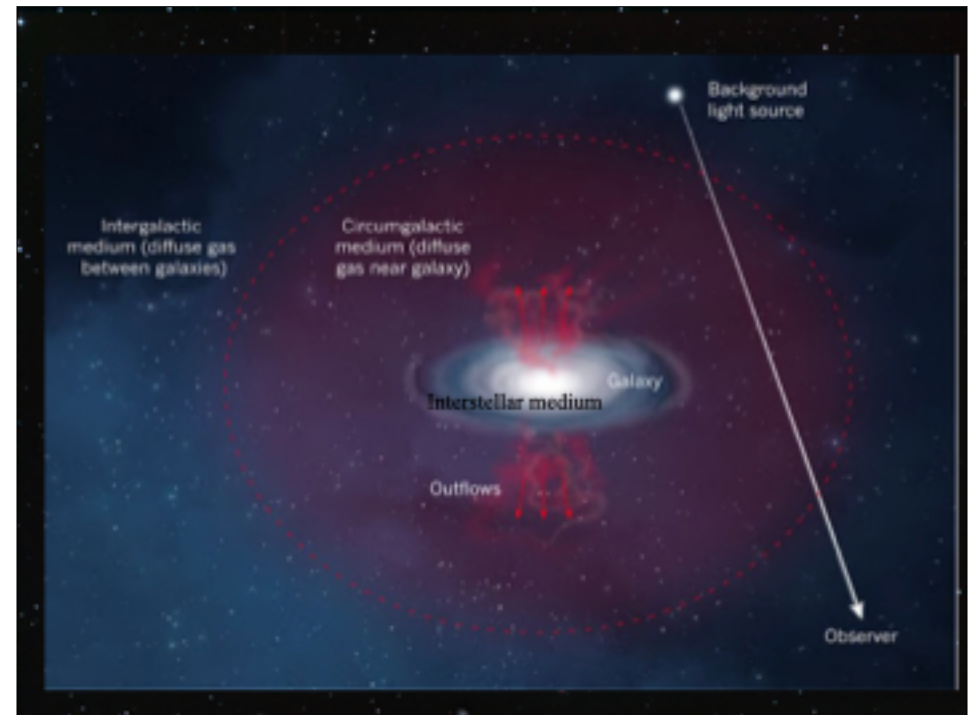
Radio source counts

We conduct a survey and find a new source class. What could it be?

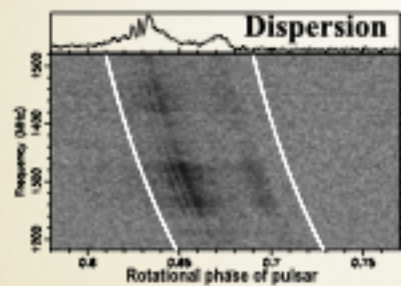


Horizontal line means no evolution;
deviation, significant cosmological influence or significant luminosity evolution.

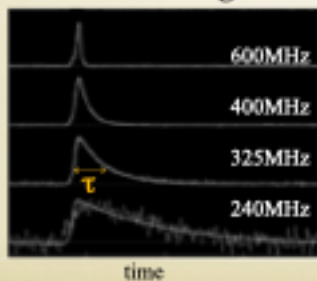
Background 2: Interstellar medium



Interstellar medium effects

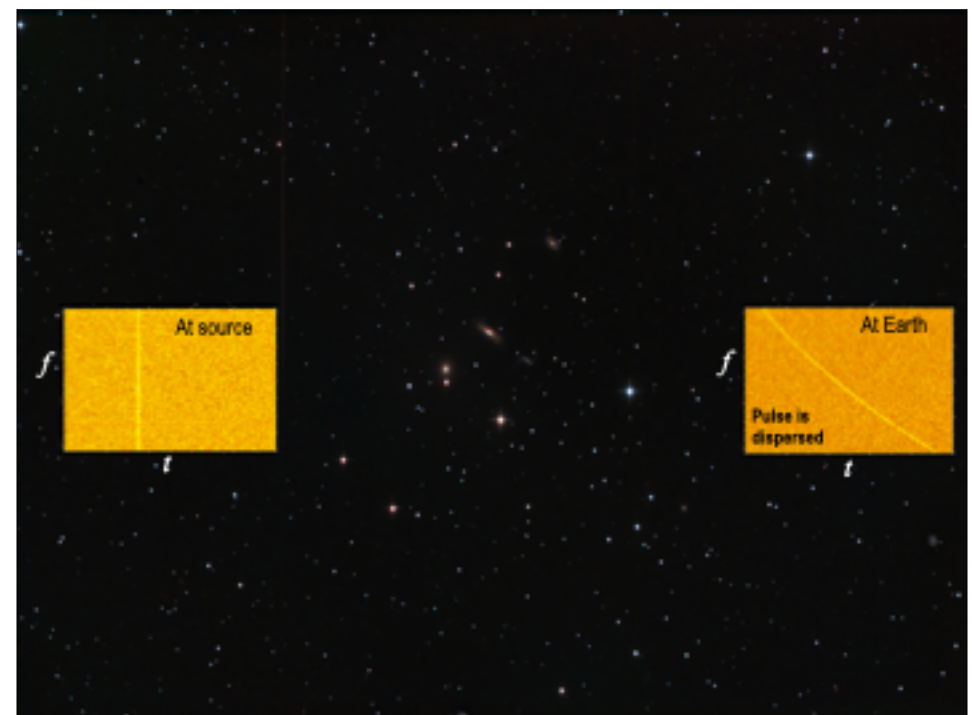
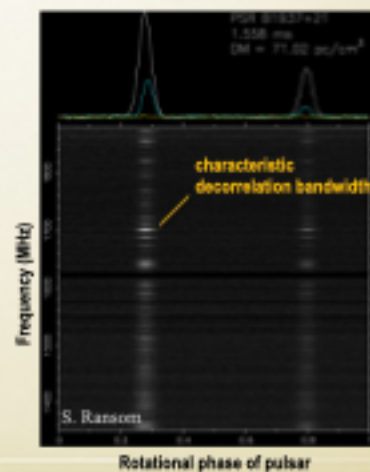


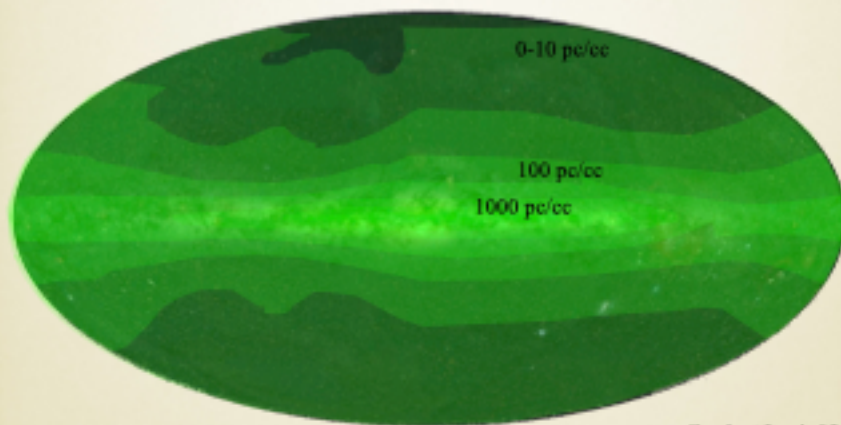
Scattering



Loimer
and
Kramer
(2005)

Scintillation

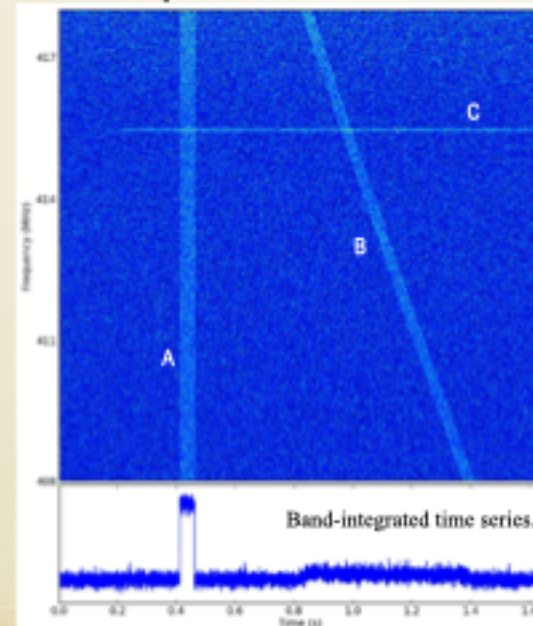




Cordes+Lazio02

A rough dispersion map of the Milky Way
for a source @ 30kpc

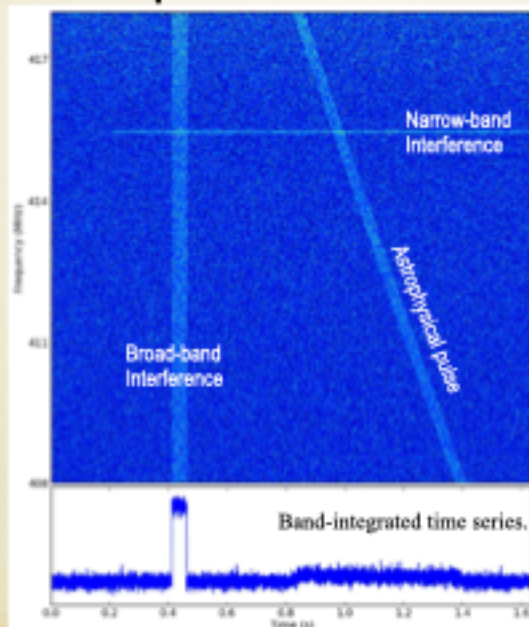
Dispersion can help!



Random fast-sampled
observation
from
telescope...

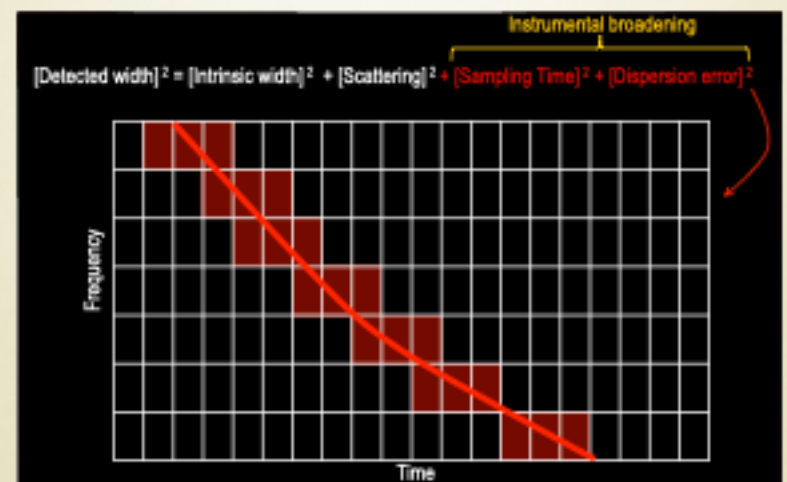
Which pulse
would you bet
on, and what
would you bet?

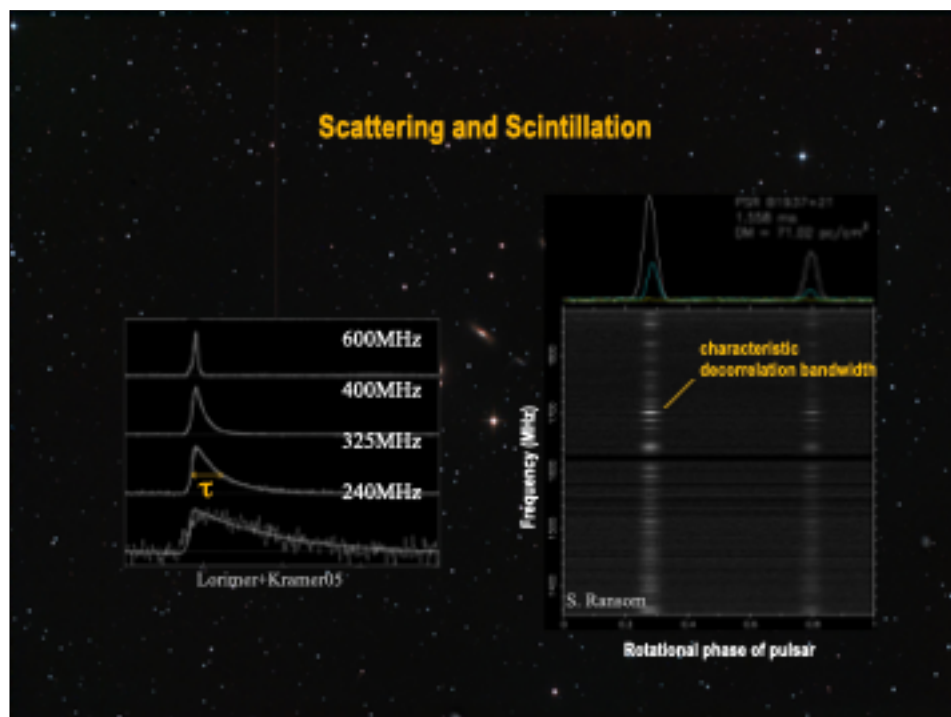
Dispersion can help!



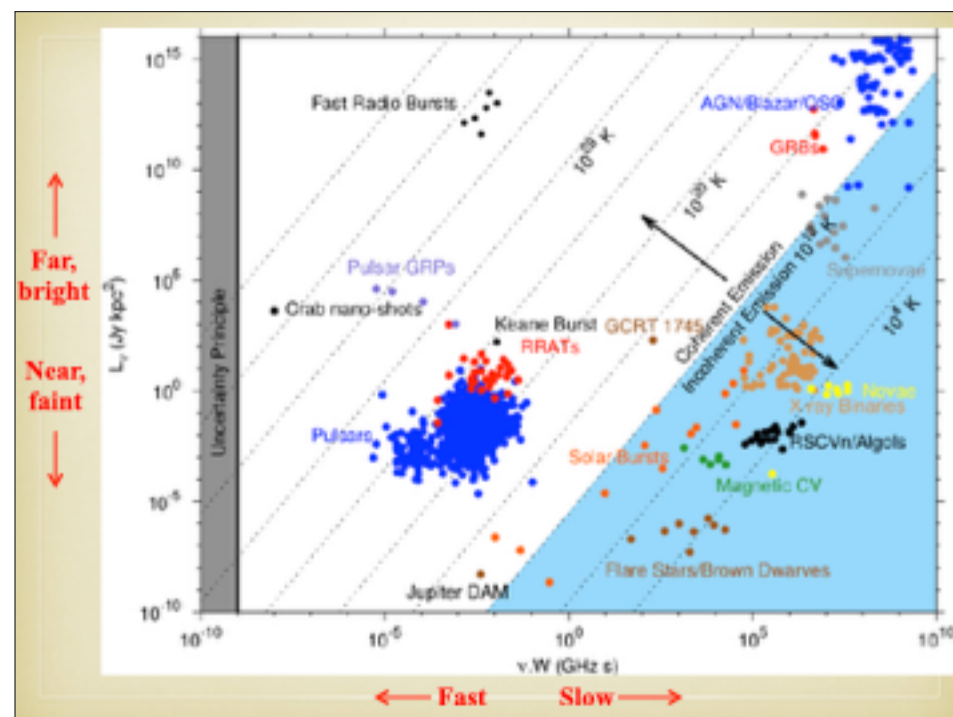
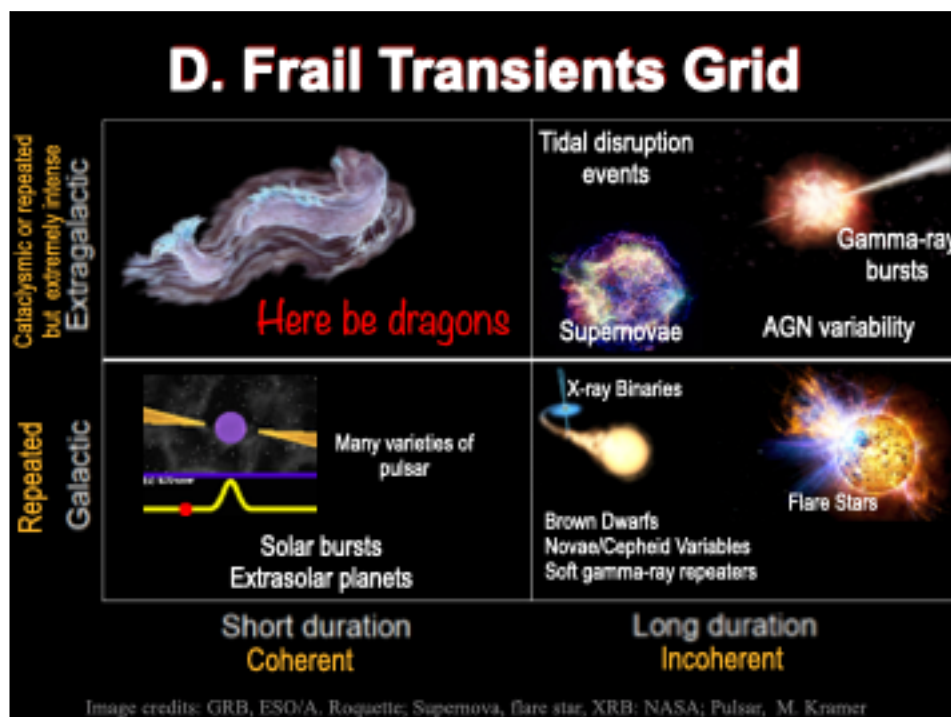
Random fast-sampled
observation
from
telescope...

Dispersion can hurt!

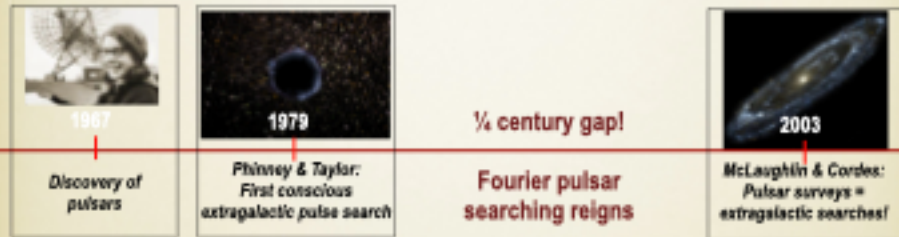




Background 3: Radio transients



Extragalactic pulse history



1/2 century gap!

Fourier pulsar
searching reigns

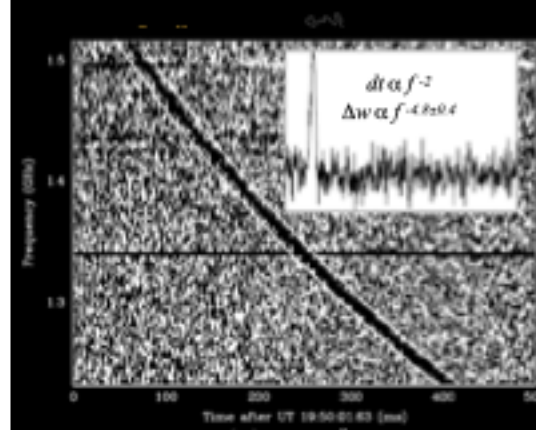
Single pulse search resurgence: ~2003 – present

Archival pulsar surveys

New targeted surveys

New INSTRUMENTS for single pulses!

Fast Radio Bursts History

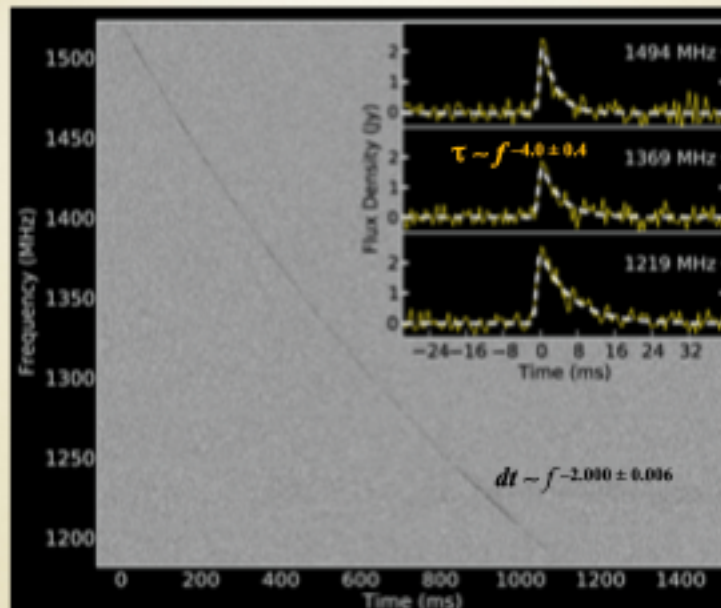


- 30 Jy burst
→ 100x det. Limit
→ 12 ms duration

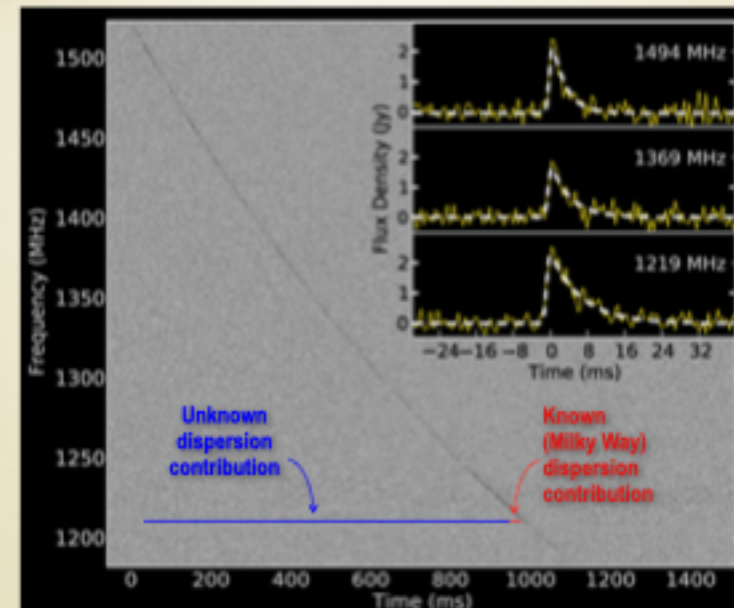
- High Dispersion Measure
→ 375 pc/cc
→ 600 Mpc!

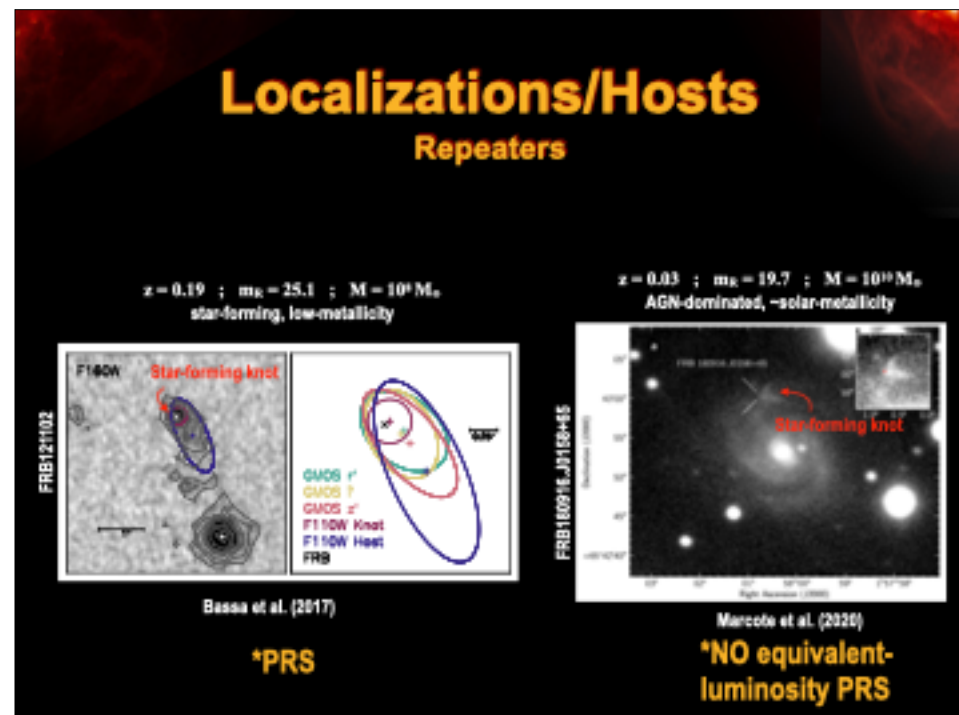
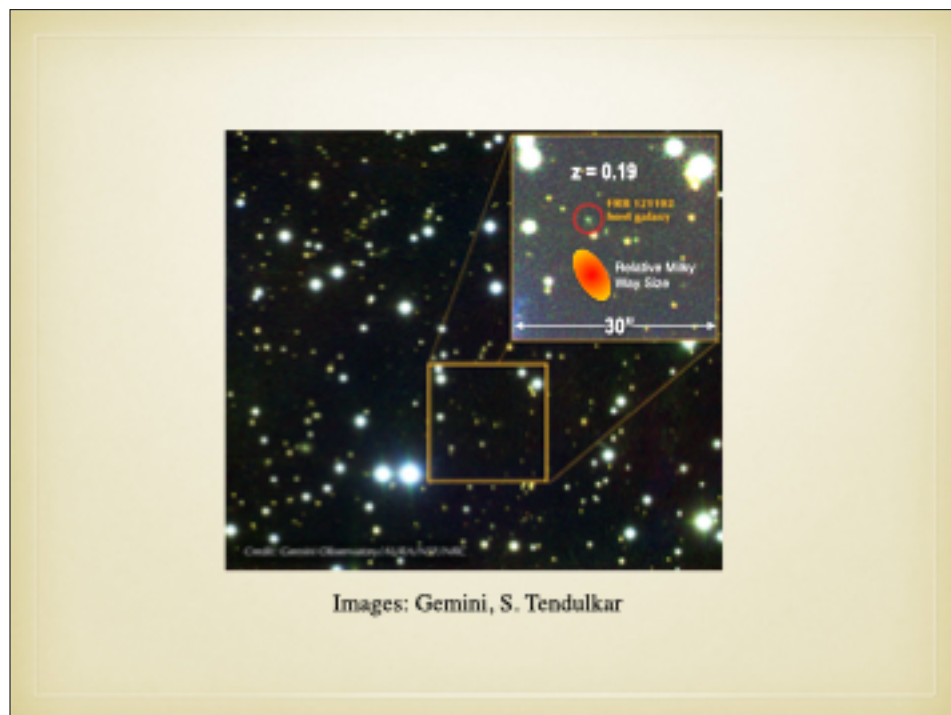
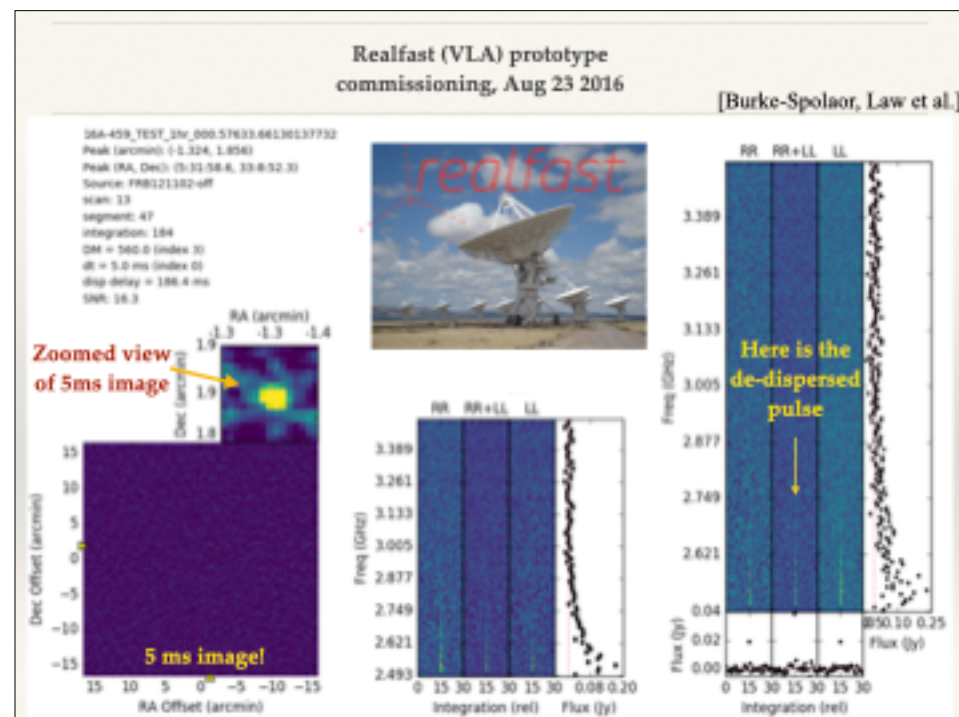
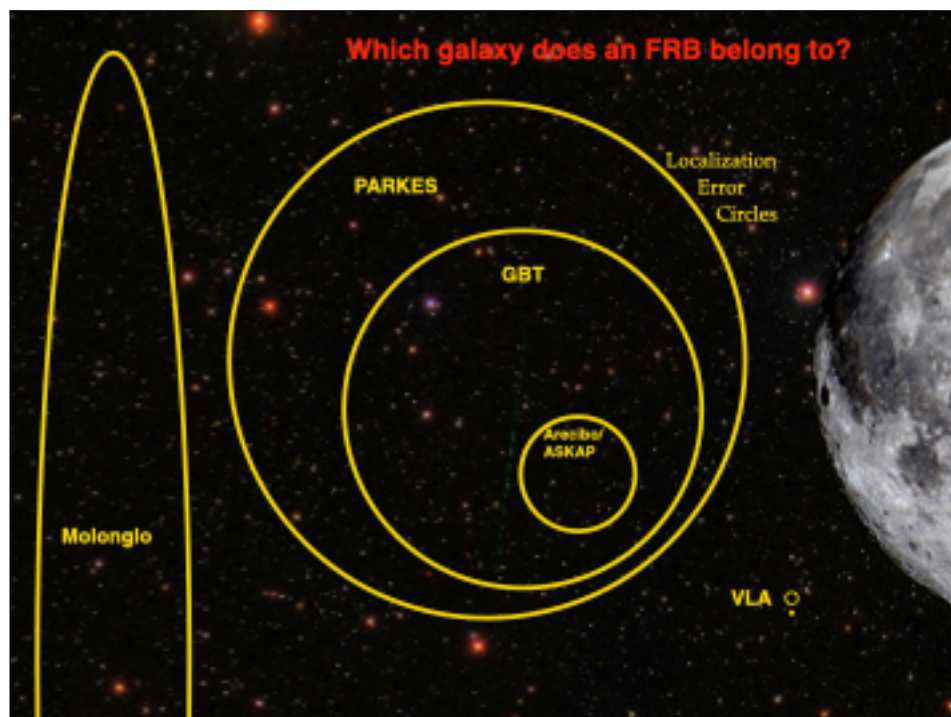
Wow!!!

Lorimer et al. 2007, Science
Instrument: Parkes Multibeam Receiver, analog backend



Thornton et al. (2013)

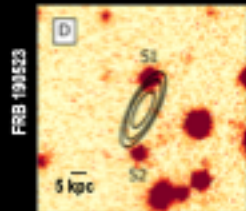




Localizations/Hosts

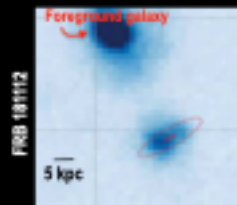
Non-repeating?

$z = 0.66$; $m_B = 22.1$; $M = 10^{11} M_\odot$
Low SFR, low-metallicity



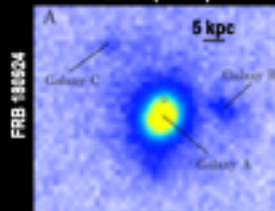
Ravi et al. (2019)

$z = 0.47$; $m_B = 21.7$; $M = 3 \times 10^9 M_\odot$
star-forming (metallicity not quoted)



Prochaska et al. (2019)

$z = 0.32$; $m_B = 20.5$; $M = 2 \times 10^{11} M_\odot$
LINER (SFR=0)

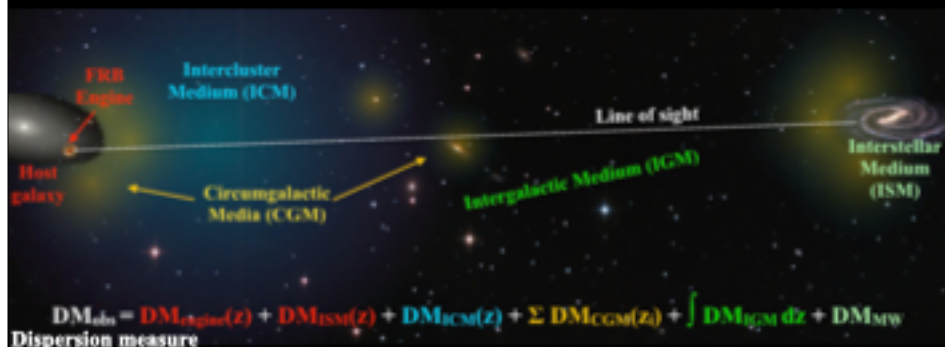


Bannister et al. (2019)

*NO equivalent-luminosity PRS

Group Exercise: an FRB's Journey.

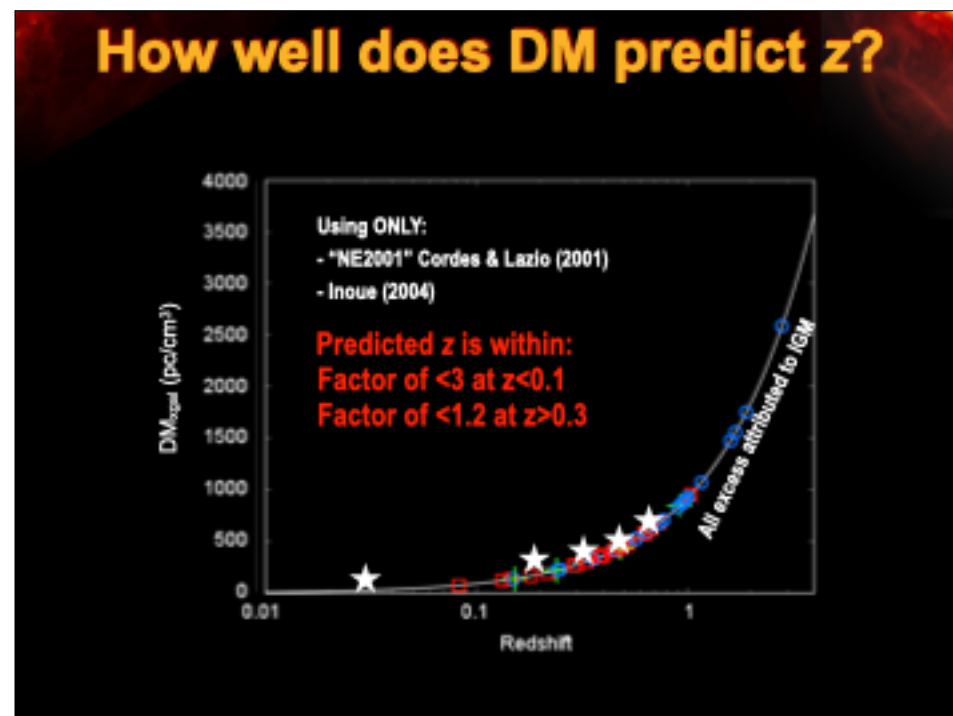
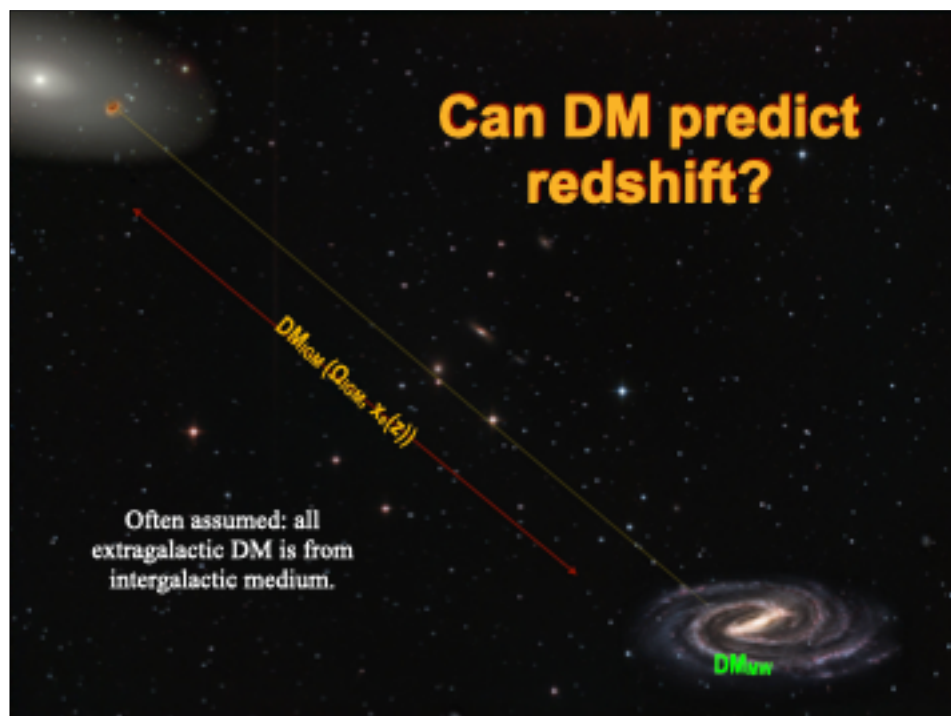
An FRB's Journey...



Ravi et al. (ASTRO2020 whitepaper)

Information we have.

- **Dispersion Measure** - n_e , distance
- **Source counts** ($dN \sim dS^\gamma$) - luminosity/distance evolution
- **Scattering tail/timescale**, τ - scatterer properties
- **Scattering index**, μ ; $\tau \sim f^{-\mu}$ - intervening medium turbulence
- **Scintillation bandwidth**, $\Delta f \sim 1/(2 \pi \tau)$ - scatterer properties
- **Rotation measure**, $RM \sim B_{\parallel} n_e(l) dl$ - n_e , distance, B-field
- **Polarization fraction** (circular, linear) - source characteristics
- **Polarization angle** (vs. time) - source characteristics
- **Spectral index limits** - source, and progenitor absorption/density
- **Pulse duration** - limits on source size



What we don't know

Video: NRAO

WHAT are they?

Extreme physical conditions!

Thousands in the sky per day!

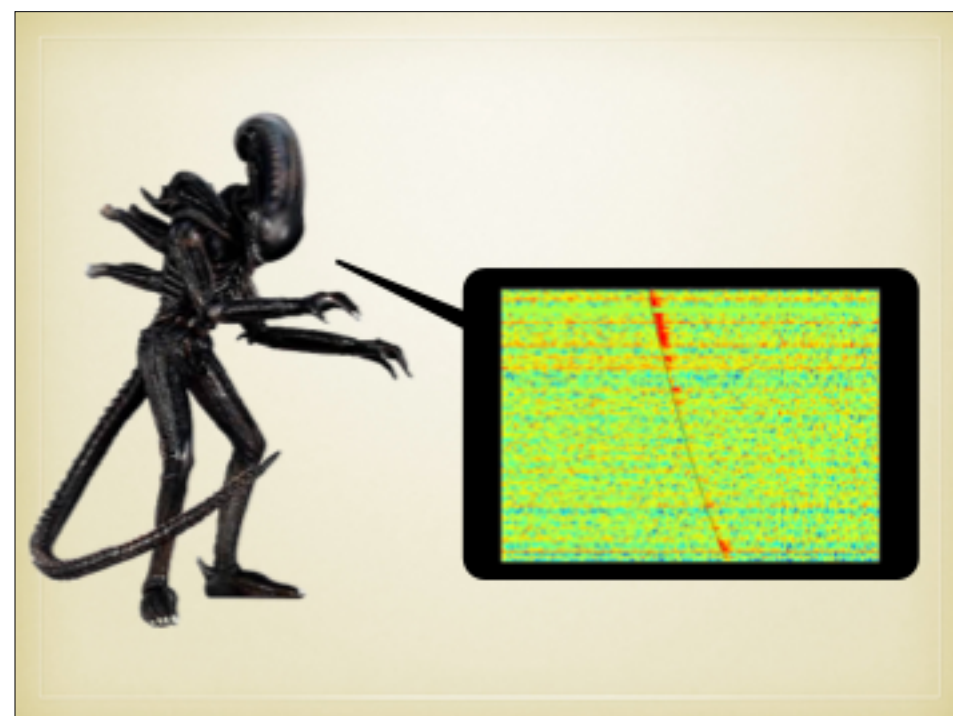
Is there more than one source origin?

HOW can we use them?

Cosmic ionization history

Intergalactic medium turbulence and magnetism

Probe of Galactic halo



Getting organized



FRB Catalogue

<http://frbcatalog.org/>



https://github.com/ebpetroff/FRB_VOEvent
(live triggers)



<https://frbtheorycat.org/>



<http://www.astronomerstelegam.org/>

***CHIME may develop own tools.**