

PREFRBLE: way to interpret FRBs

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PhD defense in September

FRB2020 online conference

slides at *github.com/shackste/publications* in *talks*

M Brüggen, F. Vazza, B. Gaensler, A. Piro, L. Rodrigues, ...

July 07th, 2020

Quest

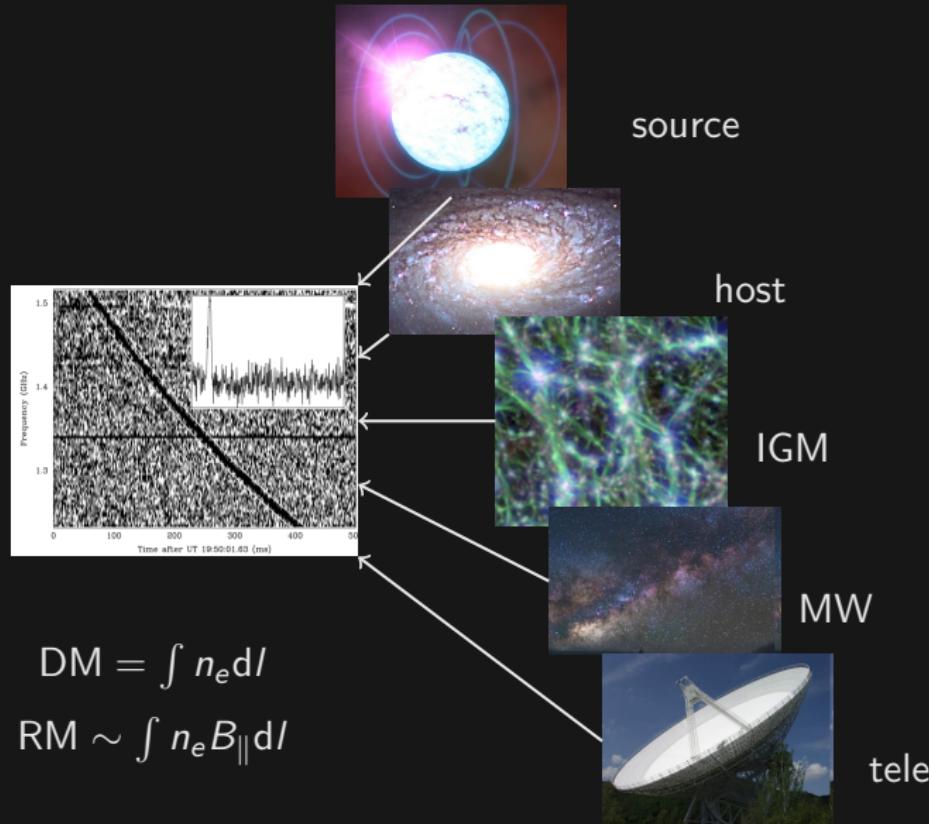
interpretation of FRB measures to learn about

- ▶ population(s)
- ▶ progenitors
- ▶ host galaxies
- ▶ **cosmological questions:**

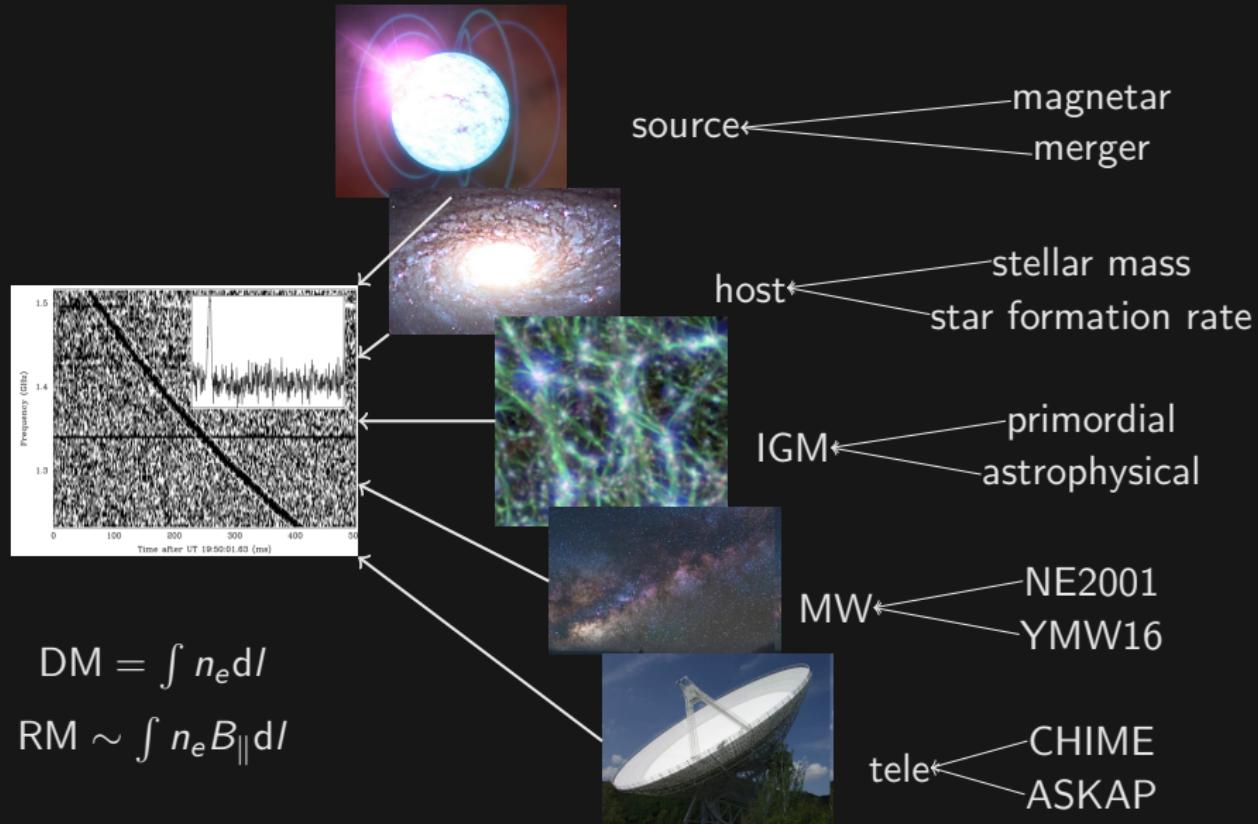
Macquart relation (Macquart+20, Li+20)

measure intergalactic magnetic field (Akahori+16, Vazza+18)

Problem: lots of regions



Problem: lots of regions, lots of candidates & models



Solution

Approximate Bayesian Computation:

- ▶ reference table of models / parameters
- ▶ marginal likelihood *of A to occur in scenario B*
- ▶ compare & find trends

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Compiled in easy-to-use open source python software package

PREFRBLE

“Probability Estimates for FRBs →model Likelihood Estimates”

github.com/shackste/PreFRBLE

benchmark scenario

Source magnetar (Piro&Gaensler'18, Hackstein+19)

IGM constrained MHD simulation (Hackstein+18,'19)

Host galaxy ensemble, > 90% of galaxies & evolution
(Lacey+16,Rodrigues+18)

Intervening galaxy ensemble, intersection probability (*Thanks J-P!*)

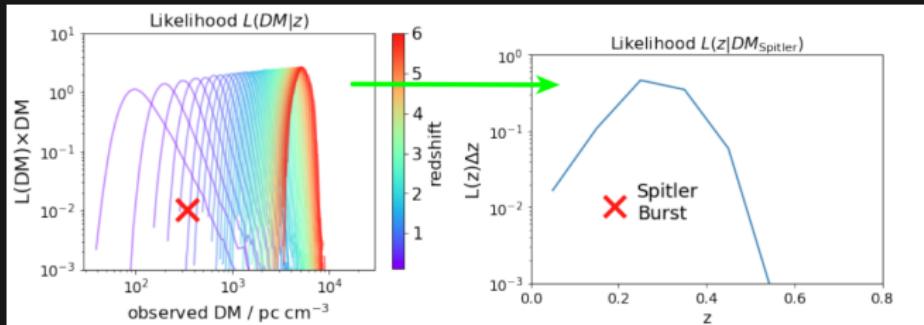
Redshift distribution $\pi(z)$ (FRBPOPPY, Gardenier+19)

→ **most realistic estimate** on distribution of
DM, RM and τ
observed by
Parkes, ASKAP, CHIME, ...

Outline

Results

Redshift inference

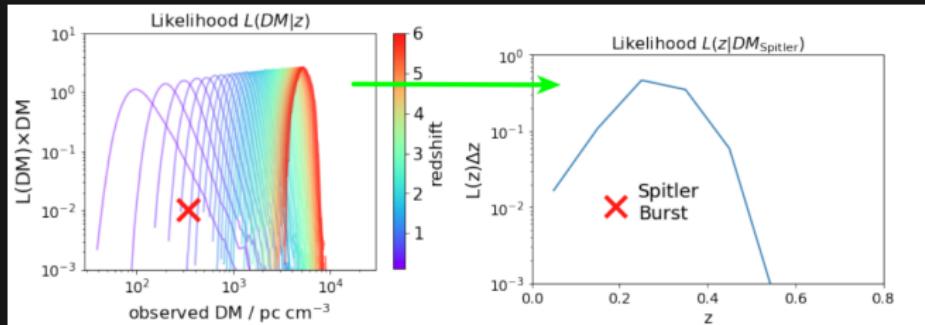


predict DM for host at redshift z : $L(DM|z)$

observe DM → likelihood of z to provide DM

→ redshift estimate?

Redshift inference



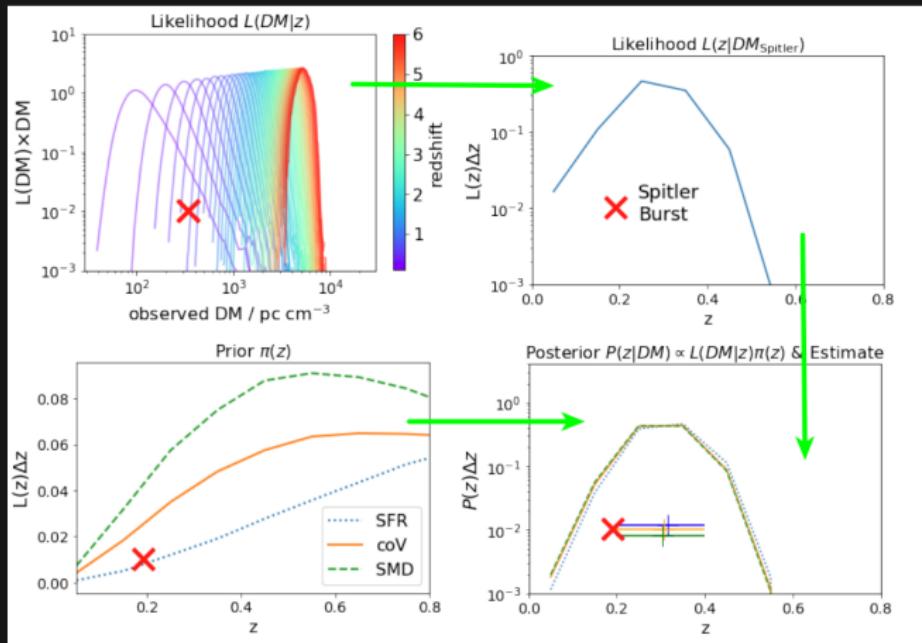
predict DM for host at redshift z : $L(DM|z)$

observe DM → likelihood of z to provide DM

→redshift estimate?

What about history of sources?
selection effects?
increase of probed volume with z ?

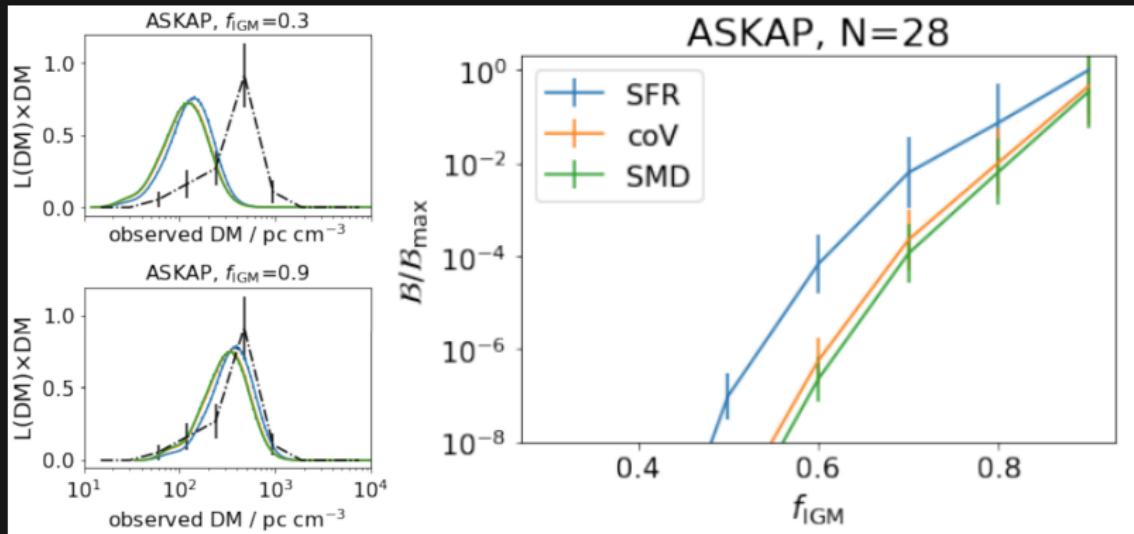
Redshift inference



Bayes theorem: $P(z|DM) \propto L(DM|z) \pi(z)$
⇒ z lower limits for > 30 FRBs (Hackstein+20, in subm.)
(see also Walker+18)

Missing Baryons

baryons in ionized IGM? constrain $f_{\text{IGM}} = \Omega_{\text{IGM}}/\Omega_b$
 $L(\text{DM}) = \int L(\text{DM}|z) \pi(z) dz,$ $\text{DM}(z) \propto f_{\text{IGM}} \int \rho dl$

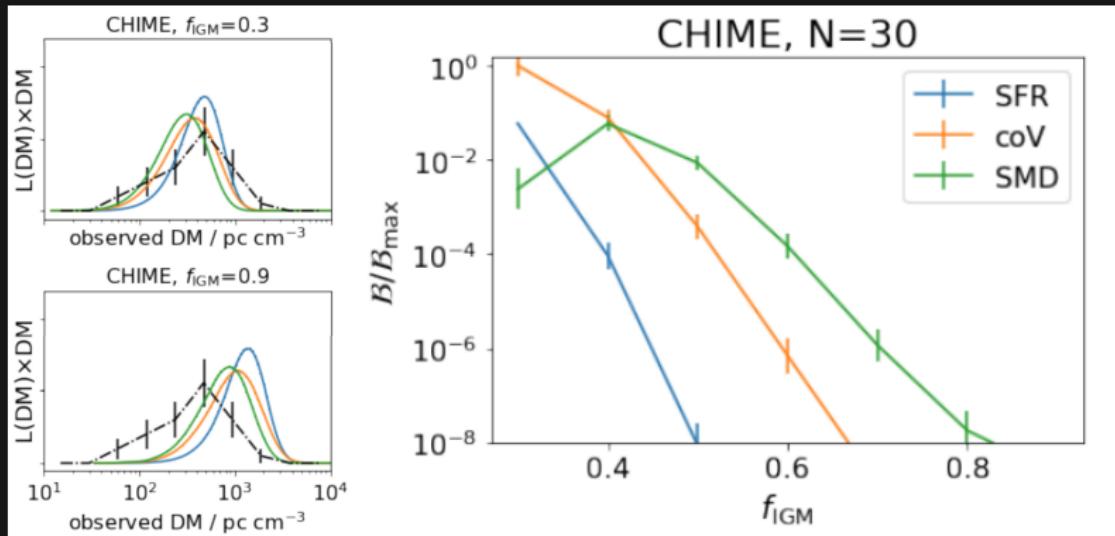


expected \approx observed $L(\text{DM}) ? \rightarrow$ Bayes factor \mathcal{B}

ASKAP prefers **high** $f_{\text{IGM}} > 0.8$ (missing baryons in ionized IGM)

Missing Baryons

baryons in ionized IGM? constrain $f_{\text{IGM}} = \Omega_{\text{IGM}}/\Omega_b$
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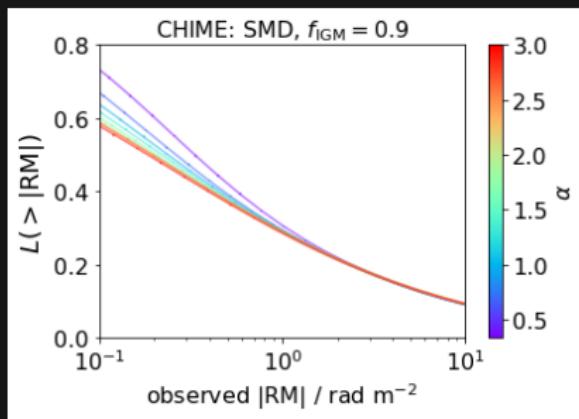
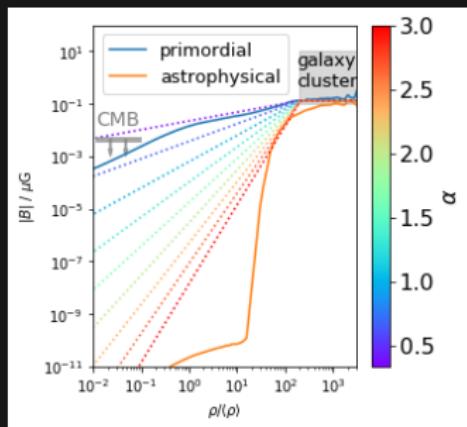


expected \approx observed $L(\text{DM}) ? \rightarrow$ Bayes factor \mathcal{B}

CHIME prefers **low** $f_{\text{IGM}} < 0.6$ (missing baryons **not** in IGM) ⚡
Do ASKAP and CHIME observe different populations?

Intergalactic Magnetic Field

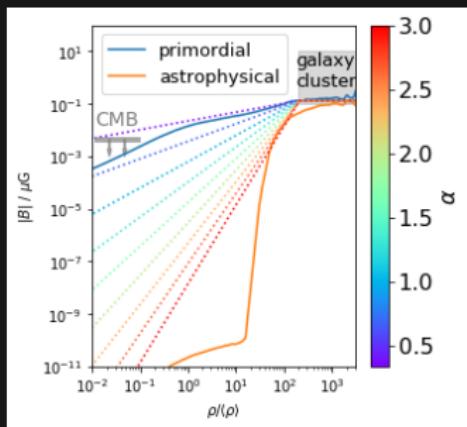
model IGMF ($B \propto \rho^\alpha$)
→ measurable signal in RM



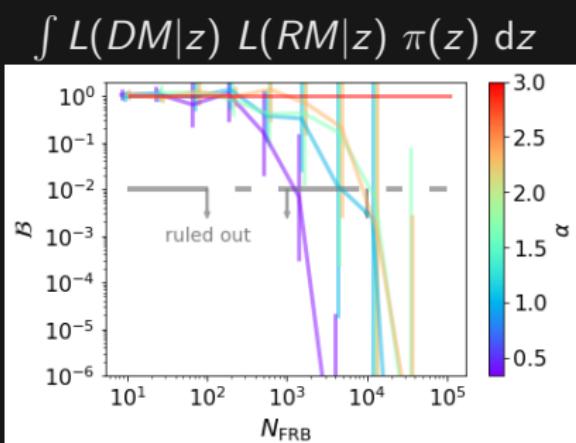
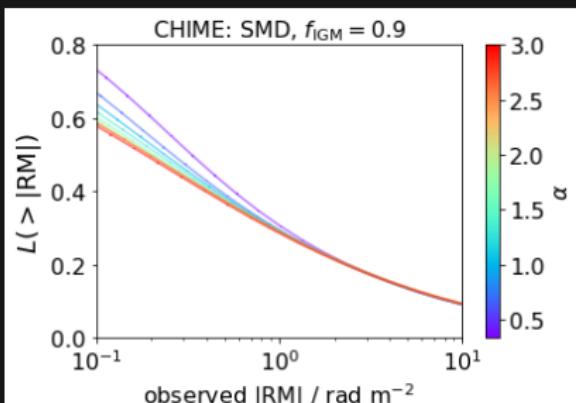
Hackstein+ 20, in subm.
preview:
github.com/shackste/PreFRBLE
in notebooks (no download req.)

Intergalactic Magnetic Field

model IGMF ($B \propto \rho^\alpha$)
→ measurable signal in RM



→ probe IGMF whole range
Hackstein+ 20, in subm.
preview:
github.com/shackste/PreFRBLE
in notebooks (no download req.)



Conclusion

- ▶ PREFRBLE:
 - interpret FRBs / test models for observers & theorists
 - github.com/shackste/PreFRBLE
- ▶ can answer many pressing questions (FRB distribution, missing baryons, IGMF strength, ...)
- ▶ more models & measures
→ improved results



