Self Introduction: My name is Amanda Cook, and I am a fourth-year Astrophysics PhD candidate at the University of Toronto and a member of CHIME/FRB. My supervisors are Prof. Bryan Gaensler, Prof. Gwen Eadie, and Dr. Paul Scholz. I come from a magnetar and pulsar background and I consider the ultimate goal of my career to answer the question '*Are all FRBs magnetars?*' My PhD thesis aims to use statistics to learn about the nature of FRBs as well as the foreground media that they illuminate. The first part of my thesis focuses on using extragalactic FRBs as probes of the ionized media in the Milky Way's halo, which is too diffuse to image directly using X-ray telescopes. Pulsar dispersion measures (DMs) have long been used to constrain the ionized plasma in the Galactic disk, however one does not expect the detectable pulsar population to extend far into the halo. FRBs, however, travel through the entire MW halo and hence we can use the lowest-DM FRBs to provide upper limits on the Galactic halo contribution to the DM. This allows us to place limits on the total mass and extent of the halo. A key question in understanding repeating FRBs is to determine just what fraction of FRBs repeat, and how frequently these repetitions occur. This is a difficult problem, because large numbers of FRBs are needed to obtain sufficient statistics, but large numbers of FRBs mean that there is a significant probability of seeing two bursts from the same position and DM, but which are from unrelated FRBs. My second thesis project is to establish a method, starting from first principles, to calculate the probability that an observed cluster of FRBs is physically related. These probability calculations play a vital role in defining the sample for CHIME/FRBs repeater catalogues, but are applicable in multiple disciplines like epidemiology. Finally, I coordinate and analyze high energy observations of repeating FRBs, in hopes to detect a prompt transient counterpart to a radio burst. Using CHIME/FRB as an activity monitor, we target nearby ($< 100\,\mathrm{Mpc}$), active, sub-arcsecond localized repeating FRBs for contemporaneous observations with X-ray telescopes and pointed radio telescopes like Effelsberg and GBT. We've secured one *XMM-Newton* ToO trigger for these purposes, and await a promising source.

Abstract: The CHIME/FRB project has detected hundreds of fast radio bursts (FRBs) providing an unparalleled population to statistically probe the foreground media that they illuminate. One such foreground medium is the ionized halo of the Milky Way (MW) which connects the intergalactic medium to the Galactic disk. We estimate the Galactic DM boundary from FRBs as a function of Galactic latitude using four different estimators, including ones that assume spherical symmetry of the ionized MW halo and ones that imply more variation in density. Our upper limits for the DM contribution of the halo, depending on the Galactic latitude and selected model, range between 52 and $111\,\mathrm{pc\,cm^{-3}}$. This implies observation-based high-latitude constraints on the total Galactic DM contribution which range over $87.8-141\,\mathrm{pc\,cm^{-3}}$.

If we impose additional priors, we can derive a maen MW halo DM estimate of $33^{+25}_{-22}\mathrm{pc\,cm^{-3}}$ from a joint Bayesian analysis. However, this relies on assumptions about the halo DM distribution and the DMs of FRB host galaxies. We discuss the viability of various gas density profiles for the MW halo that have been used to estimate the halo's contribution to DMs of extragalactic sources. Several models overestimate the DM contribution, especially when assuming higher halo gas masses ($3.5 \times 10^{12} M_{\odot}$). Some models are inconsistent with our observations unless the effect of feedback is increased within them, highlighting the impact of feedback processes in galaxy formation.

References

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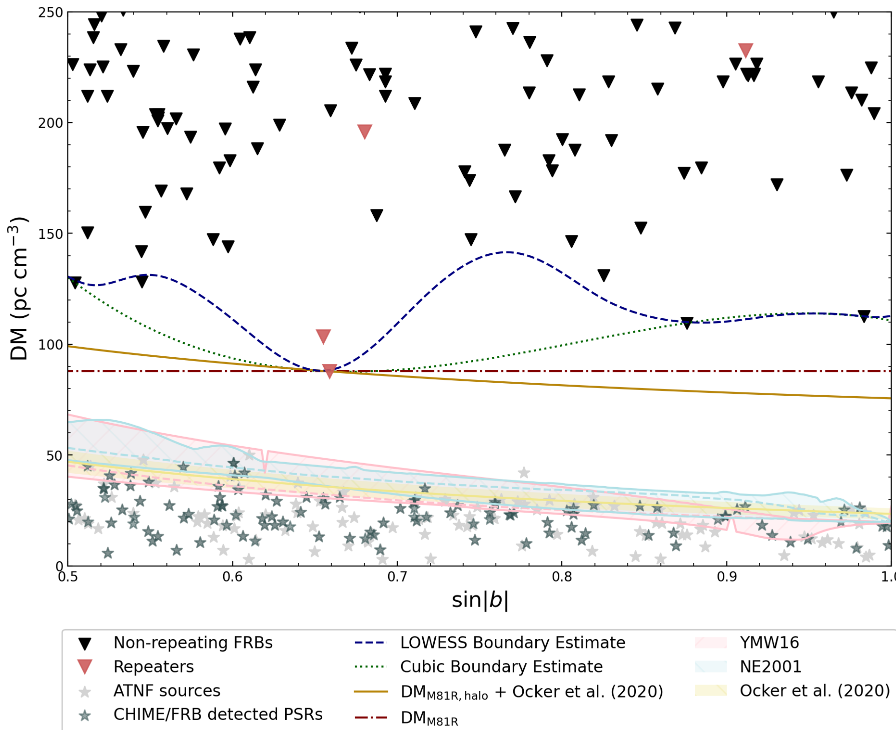

Figure 1: Total measured DM as a function of $\sin|b|$ for $|b| \geq 30°$ for FRBs detected by CHIME/FRB with DM less than $250\,\mathrm{pc\,cm^{-3}}$ through February 2021. Non-repeating FRBs are represented with black triangles and repeating FRB sources represented with red triangles. Galactic sources, namely pulsars from the ATNF Pulsar Catalogue (light gray) (Manchester et al., 2005) and all Galactic sources detected by CHIME/FRB's realtime pipeline (dark gray) are shown (Good et al., 2021). We do not plot, however, sources from lines of sight with very high emission measure as measured by Planck (Planck Collaboration et al., 2016) to avoid higher-than-representative DMs due to contamination by H2 regions and other small scale, local structure. Similarly, sources with declination $< -11°$ are not plotted as they are outside of CHIME/FRBs field-of-view, such that longitudinal variation is comparable between the Galactic and extragalactic samples. Representative positional errors are shown for sources in the top gray band. The DM errors of the FRBs are much smaller than the markers so we do not plot them. A clear gap in DM is visible between the triangles and stars. The total expected Galactic contribution to the DM from the two Galactic free electron density models, NE2001 and YMW16 are plotted in blue and pink respectively, where the shaded regions bounded by solid lines represent the range in values for lines of sight which vary with Galactic longitude (Cordes & Lazio, 2002; Yao et al., 2017). The pink, yellow, and blue dotted lines show the median value of the YMW16, Ocker et al. (2020), and NE2001 respectively at each Galactic latitude. The implied DM of the WIM disk component as a function of Galactic latitude found by Ocker et al. (2020) is shown in yellow. Four simple boundary models of $\mathrm{DM_{Gal}}$ are shown, which display the most conservative estimates supported by CHIME/FRBs extragalactic DM sample, using different fitting methods and polynomial