Session 4

Connecting FRBs with the local cosmic web, from megaparsecs up to a gigaparsec.

Chairs: Nick Bataglia, Sterl Phinney
Speakers: Joeri van Leeuwen, Kiyoshi Masui, Stella Ocker, *Pawan Kumar*

Discussion

- What do we hope to learn by connecting FRBs with the local cosmic web?
- What are the dominant systematic and modeling uncertainties, and selection effects, that would inhibit our ability to "connect" FRBs with the local cosmic web.
- What are the best tools for diagnosing the DM contributions from the FRB environment, the host galaxy, the Milky Way, intervening halos and the cosmic web/IGM: scintillation, scattering, RM, lensing, anything else ...?
  - What else can we reasonably expect to learn besides $\int n_e \, dl$? – refracting and diffracting clumps, turbulence, magnetic fields?

Discussion -2

- What are the expected timelines for rates of bursts discovered with ~10" localization (DSA-110, ASKAP, ...?) – 1/week now?
  - 10" is <10kpc at D<200Mpc (z<0.04).
- What are the expected timelines for rates of bursts discovered with <0.1" localization (CHIME outriggers, DSA 2000...)?
- What is the plausible rate of spectroscopic followup (limited by telescope allocations?)
- Can photo-z's (SPHEREx, Rubin...) suffice –for what purposes?
- How many localized FRBs are enough?
  - What else do we want of them? Multi-frequencies, multiple bursts for time-dependence?
  - Rosetta Stones with both a quasar *and* an FRB behind a single halo or cluster, to compare columns inferred from QSO absorption lines, shattering clumps (cf Vedantham & Phinney)?
  - Gravitationally lensed FRBs to compare lines of sight (cf Pawan Kumar)

Discussion -3

- What are we missing due to selection effects?
  - Low DM FRBs? [Milky Way model...]
  - Can intervening material on some lines of sight scatter-broaden pulses so much that they lose S/N or don't pass selection criteria?
    - Impact parameters, redshifts, intervening galaxy environments
- Don't ignore legacy measurements of IGM: quasar and GRB absorption lines (OVI, CIV, Mg II in galactic halos, Ly α forest...) vs DM $C_{eg}(k)$.
  - DM sensitive to e^- column.
  - abs lines sensitive to clumping.
  - Halo lines require 10^5 clumping factor!

$$\alpha n_e n_{i+1} = n_i \sigma_{PI} J_\nu$$

$$\rightarrow \int n_i dl \propto A \frac{\int n_e^2 dl}{J_\nu}$$

What firm results do we have now?

- Milky Way halo DM <10 $cm^{-3}pc$, not the 50-100 predicted by some simulators and some QSO absorption line studies.
  - DSA-110 FRBs; M81
  - Variance: are there reliably higher DM lines of sight (cf Cook, S5)?
- Gas around galaxy groups may contribute DM~100-300 $cm^{-3}pc$ (CHIME FRBs with foreground galaxies have excess: Connor & Ravi 2022), and around clusters DM~1000 $cm^{-3}pc$ (CHIME: correlations of high DM FRBs with z<0.2 galaxies).
  - Both a few times higher than expected.
  - Mess up DM-z relation for mean IGM plasma
    - e.g. arxiv: 2210:04680, FRB 20220610A, z=1.02, DM=1458=82(MW)+750(<IGM>)+650(host+intervening)
    - DM 650 at z=1 ➤ DM= 1300 $cm^{-3}pc$ rest frame!
- Anything else?