Velocity dipoles in FIRE stellar haloes

Should we worry about substructure?

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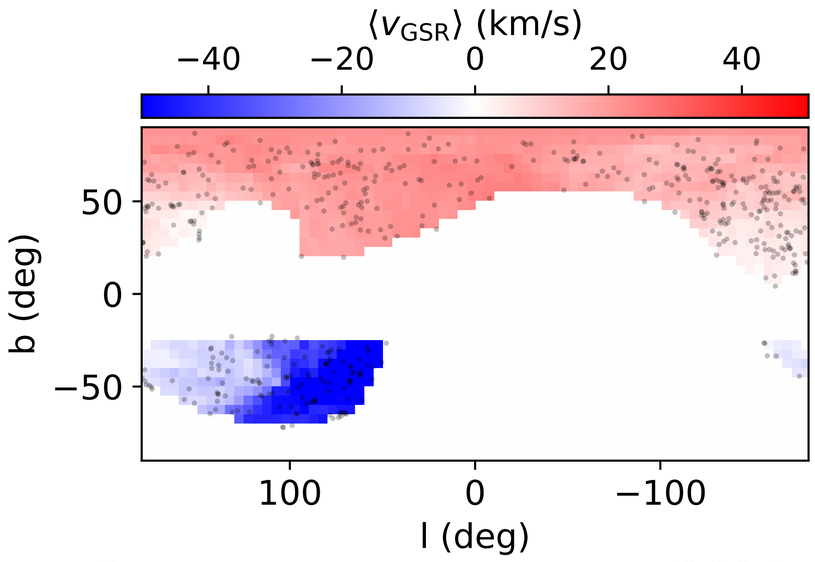
Velocity dipole in the Milky Way halo

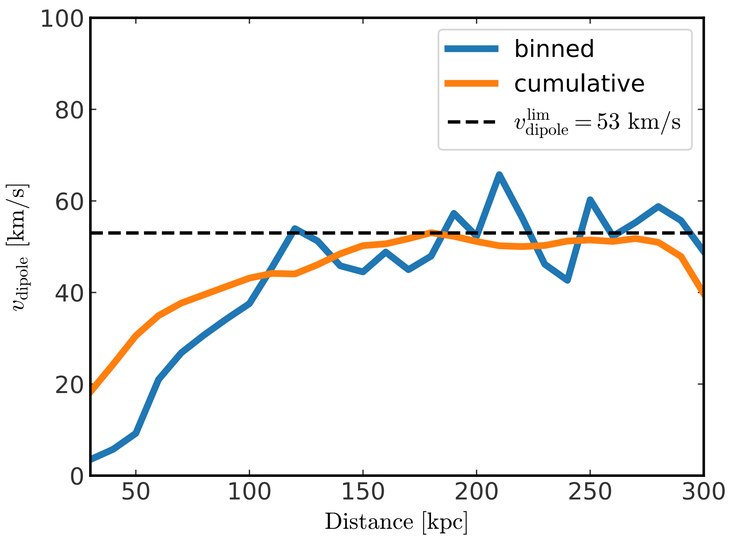


Dipole signal in Erkal et al. (2021)

- Net motion of stellar disk relative to outer halo tracers (r_{GC} > 40-50 kpc)
- Direction and magnitude generally agree between tracers (BHBs, K giants, satellite galaxies)
- Interpreted as reflex motion of MW-LMC interaction predicted by tailored N-body simulations

Erkal et al. (2021)
MNRAS, 506, 2677
Petersen & Peñarrubia (2021)
Nature Astronomy, 5, 251

Dipole recovered in cosmological MW+LMC

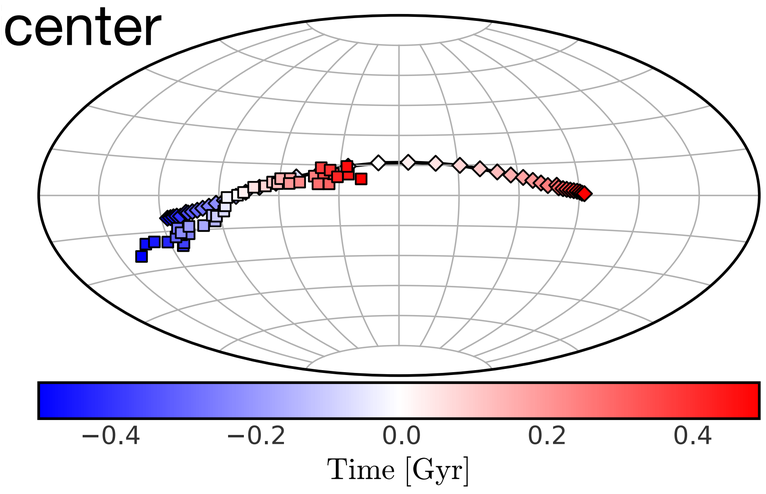


m12f dipole signal at LMC pericenter snapshot

- m12f: LMC-like pericenter at z~0.2
- Use stars in radial shells (binned) or all stars beyond some distance (cumulative)
- Dipole magnitude peaks at pericenter
- Dipole direction trails LMC sky position, similar to MW signal
- Matches simple two-body approximation to constrain MW-LMC mass ratio

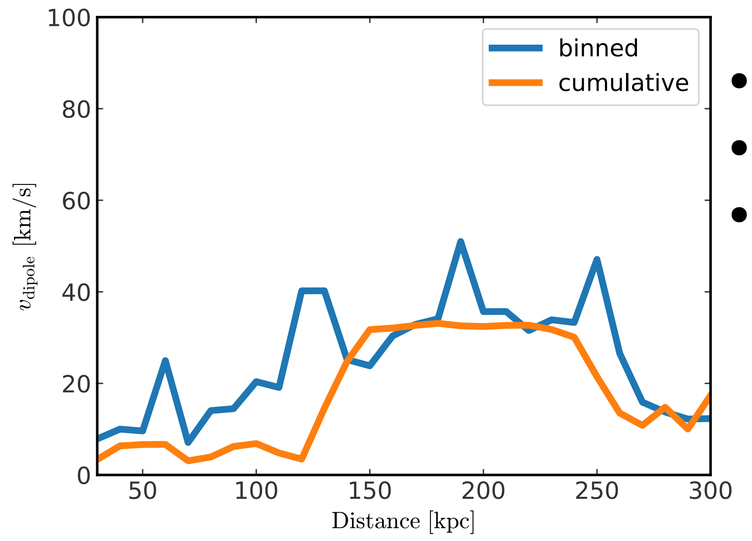
$$v_{dipole}^{lim} \simeq \frac{M_{LMC}}{M_{MW}} \times v_{LMC}$$

Wetzel et al. (2016)
ApJ, 827, 23



LMC trajectory (diamonds) and dipole orientation (squares) along sky

Where things get complicated



m12i (no LMC) dipole signal at z=0

- Haloes without LMC can have dipole signals from substructure
- Cumulative signal mitigates the effect, still ~10 km/s “floor”
- Observational uncertainties might bias inferred dipole signal by up to 30% in magnitude and 30 deg in direction

m12f at z~0.2 with RGB-like errors: 10% d_{hel}, 5 km/s v_{LOS}, PM errors from Gaia model