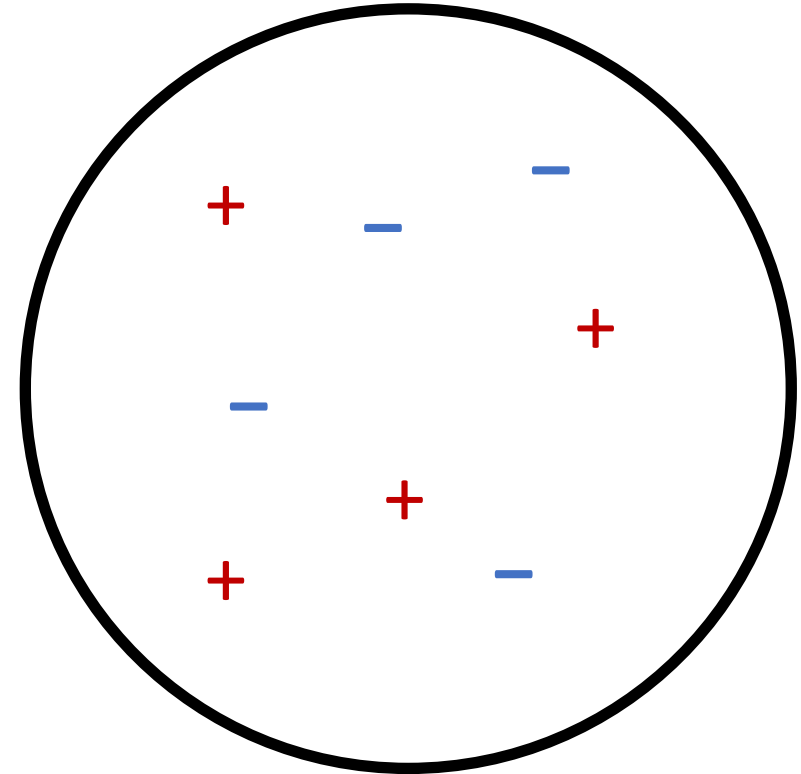
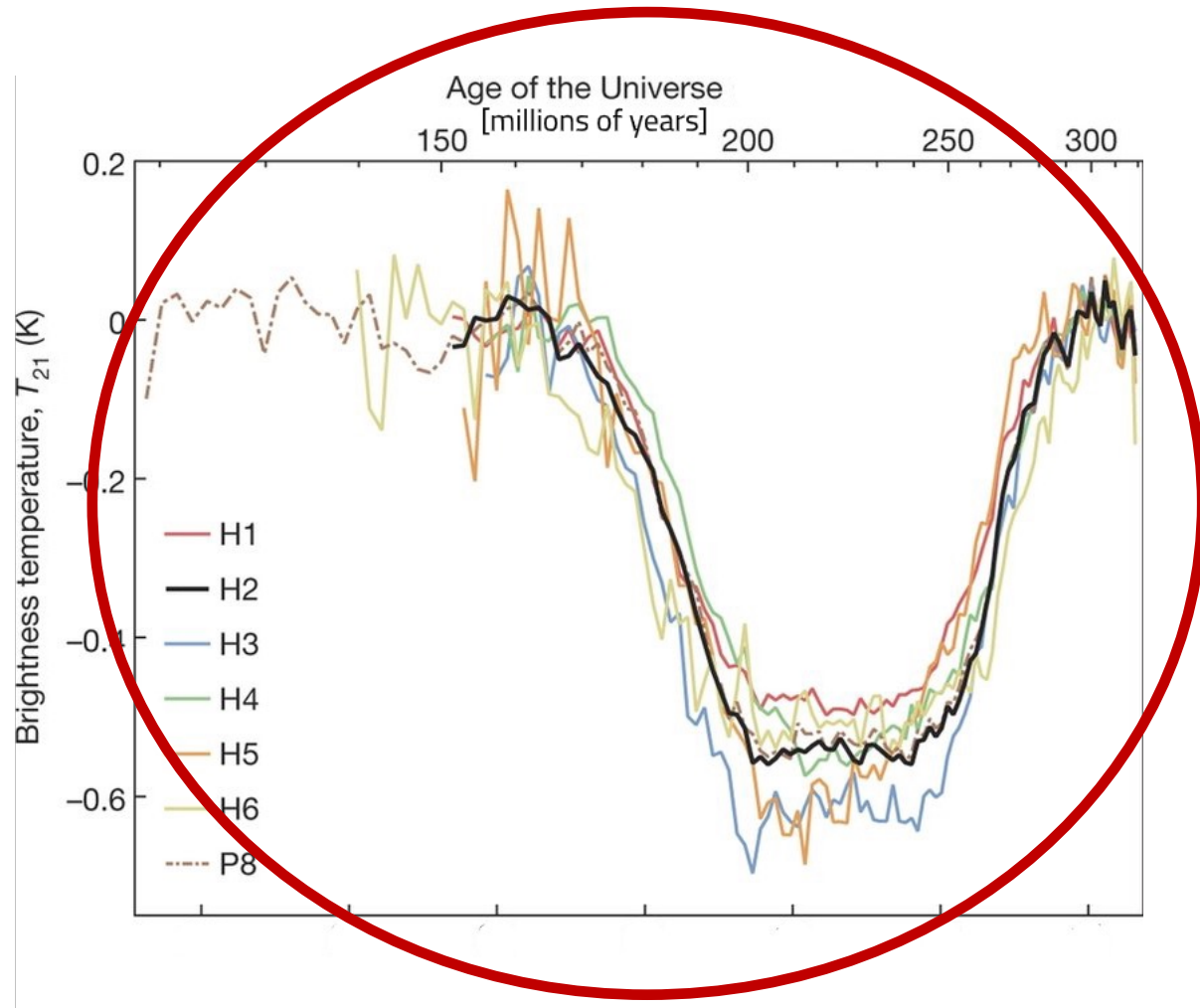


# Signatures of Electromagnetic Charge in the Universe

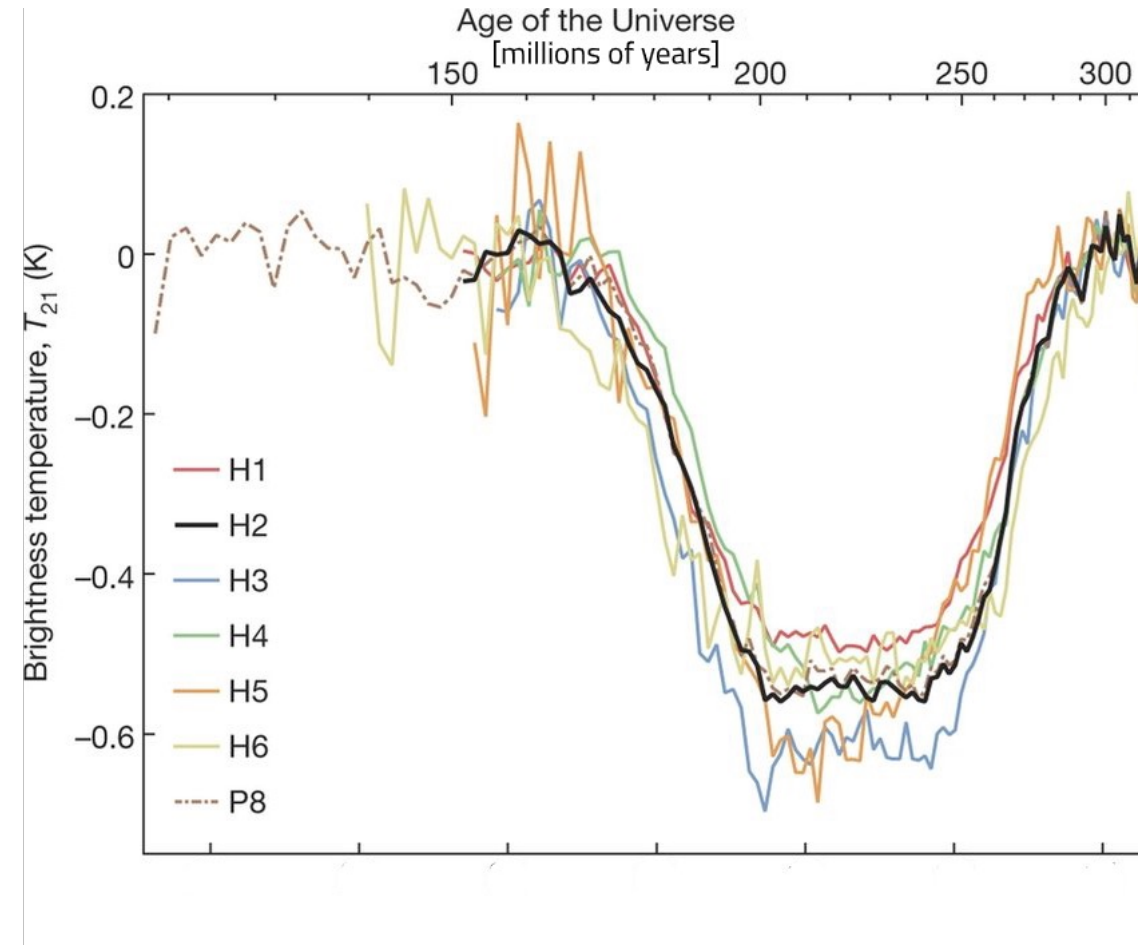
Cyril Creque-Sarbinowski

Collaborators: Ely Kovetz, Lingyuan Ji, Marc Kamionkowski

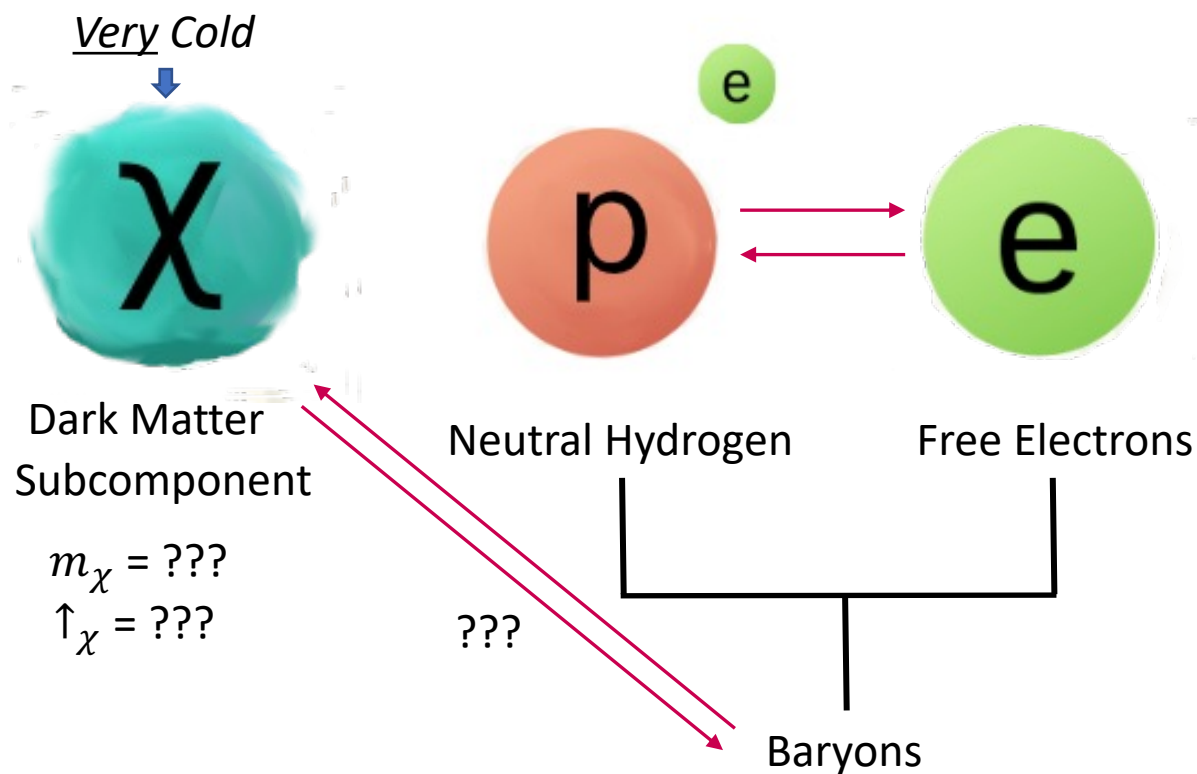
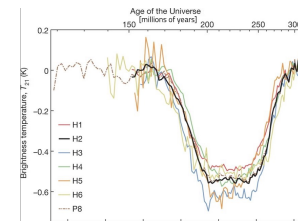
# What Electromagnetic Signatures?



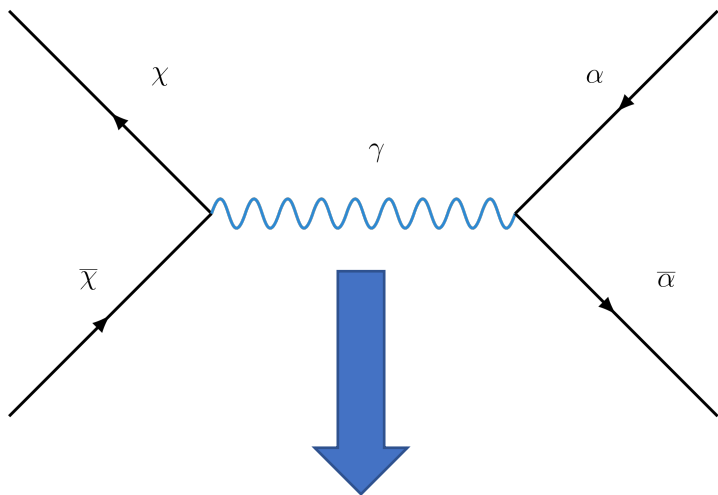
# What is the EDGES Anomalous Signal?



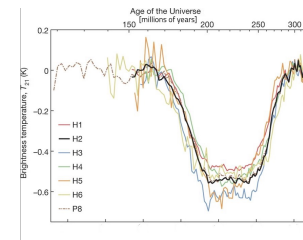
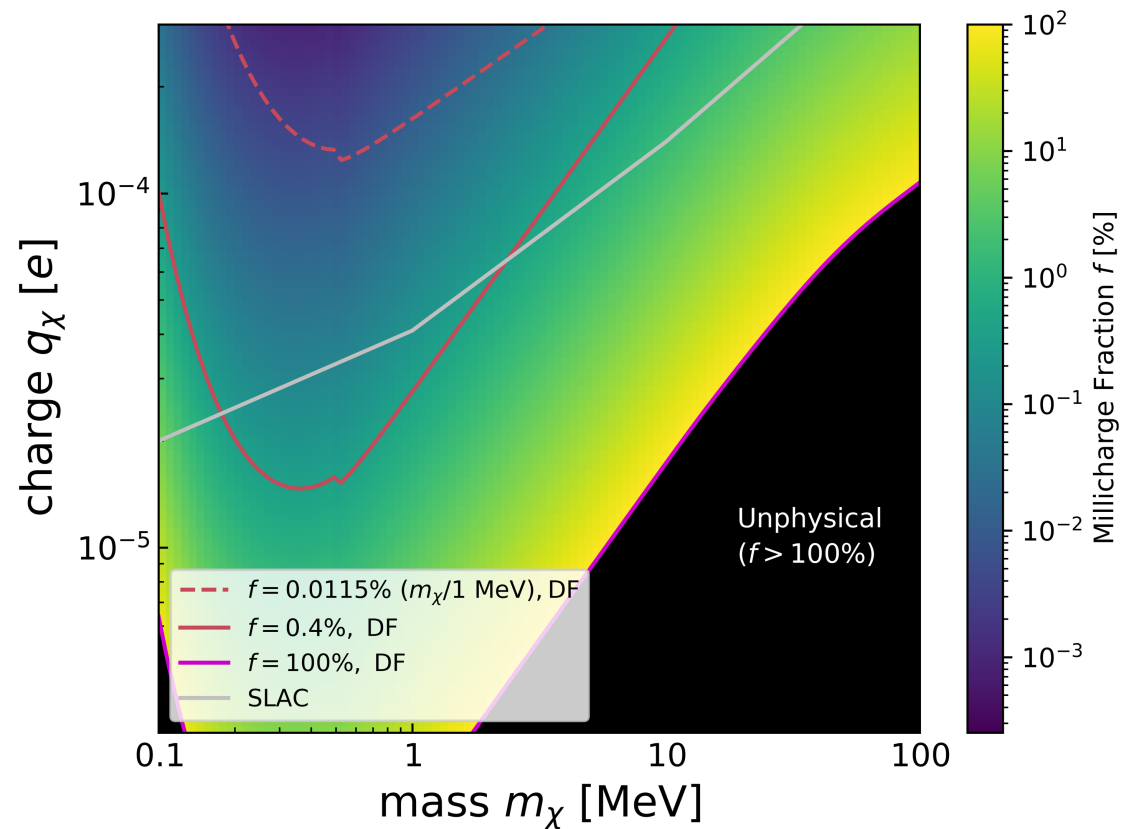
# Proposed Solution to Anomalous Signal



# Abundance Constraint

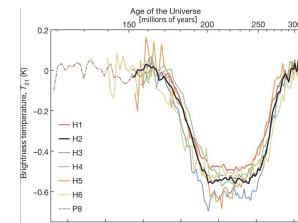
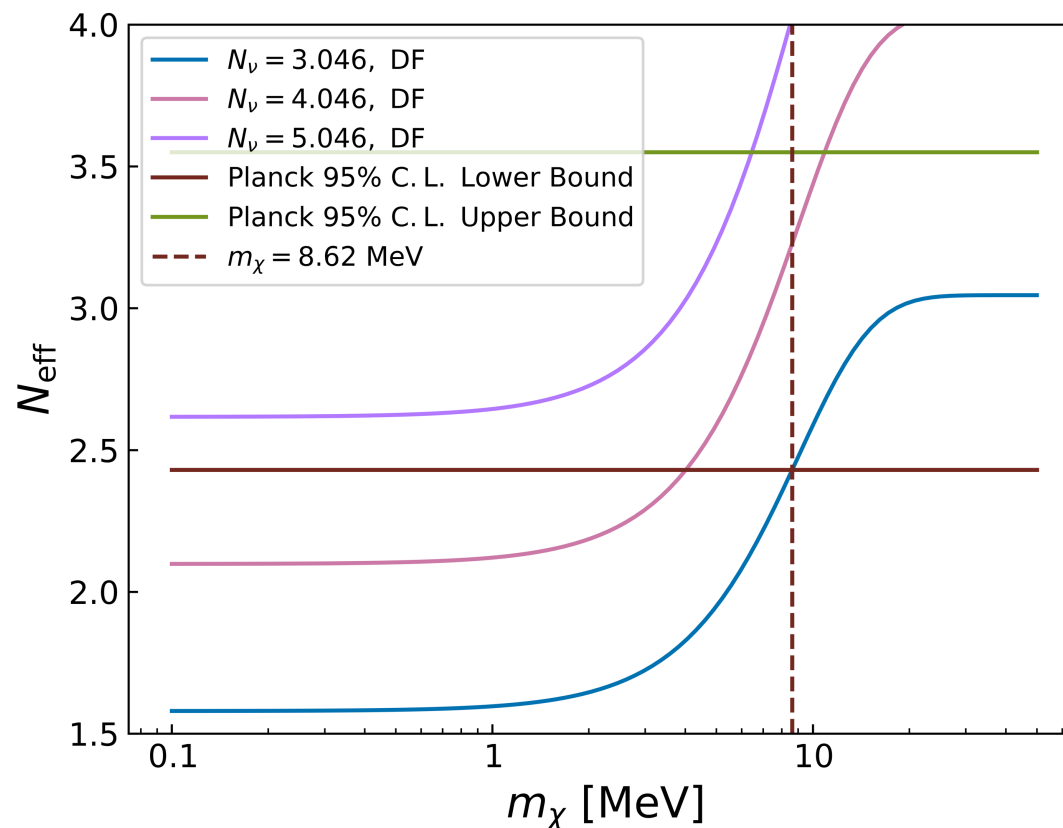
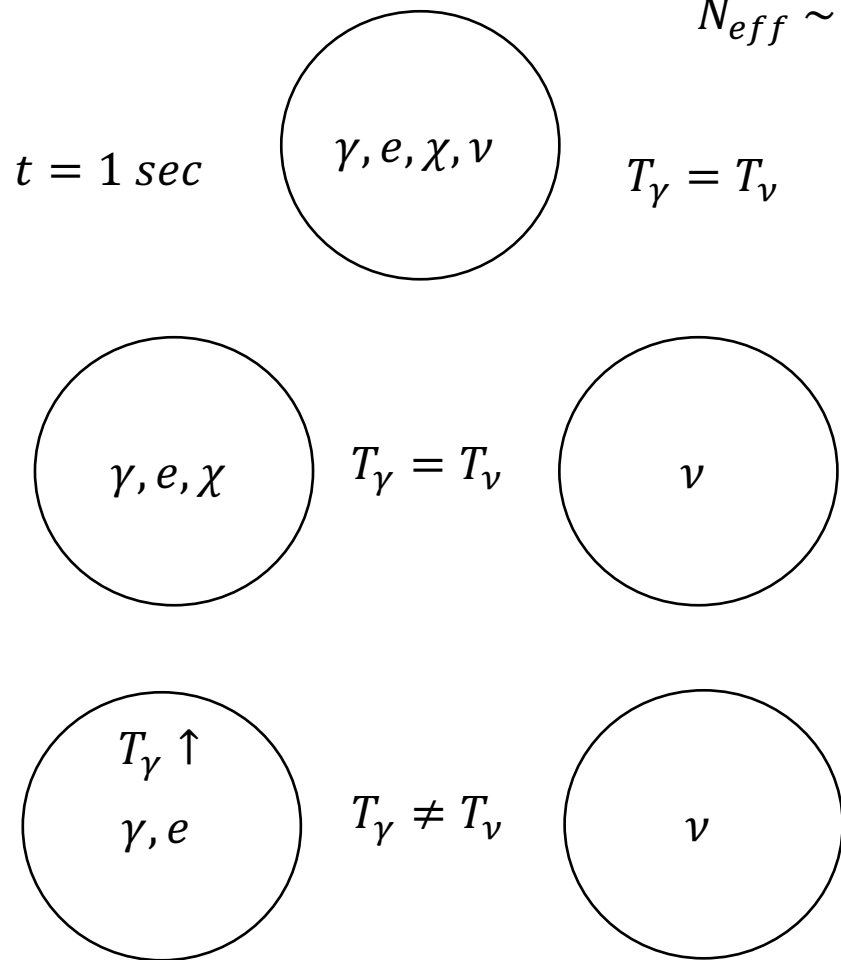


$$f = F[\sigma(m_\chi, q_\chi)]$$

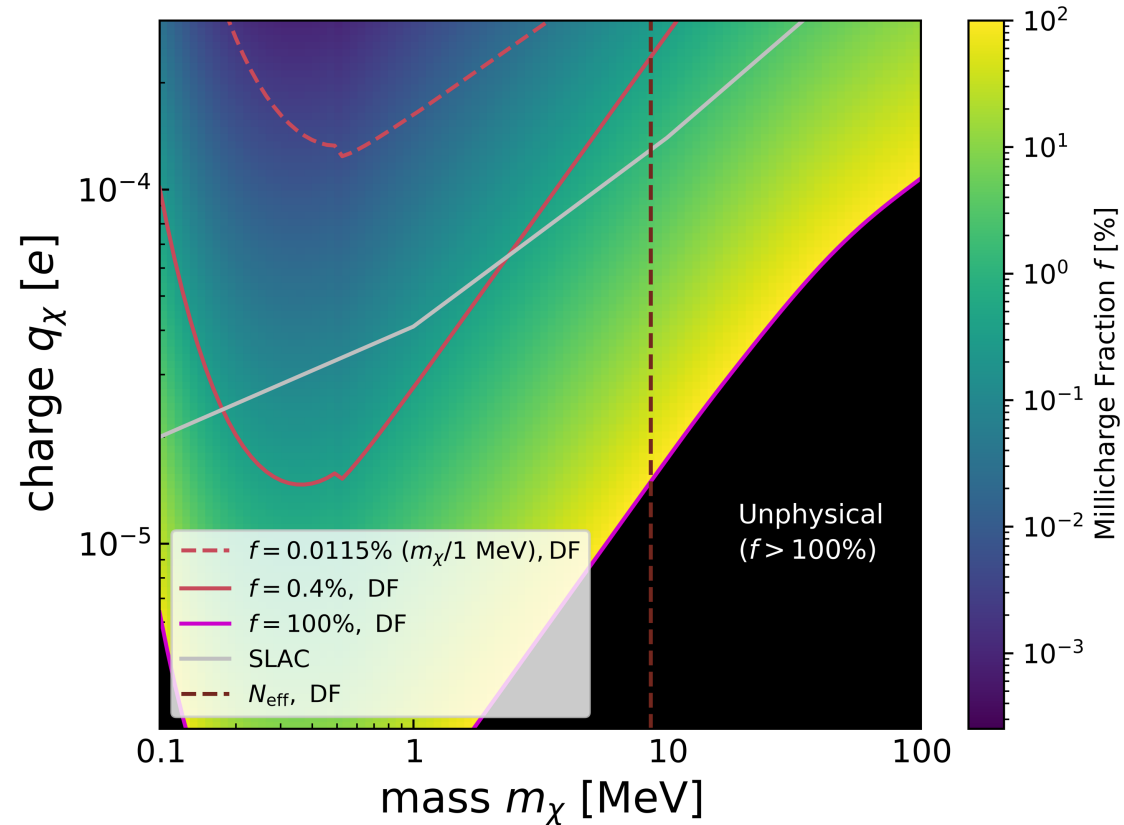
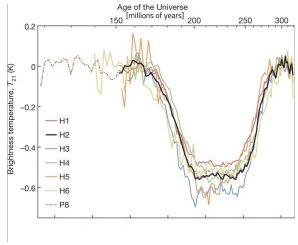


# Effective # of Relativistic d.o.f Constraint

$$N_{eff} \sim \#particle\ d.o.f \times (T_{particle}/T_\gamma)$$

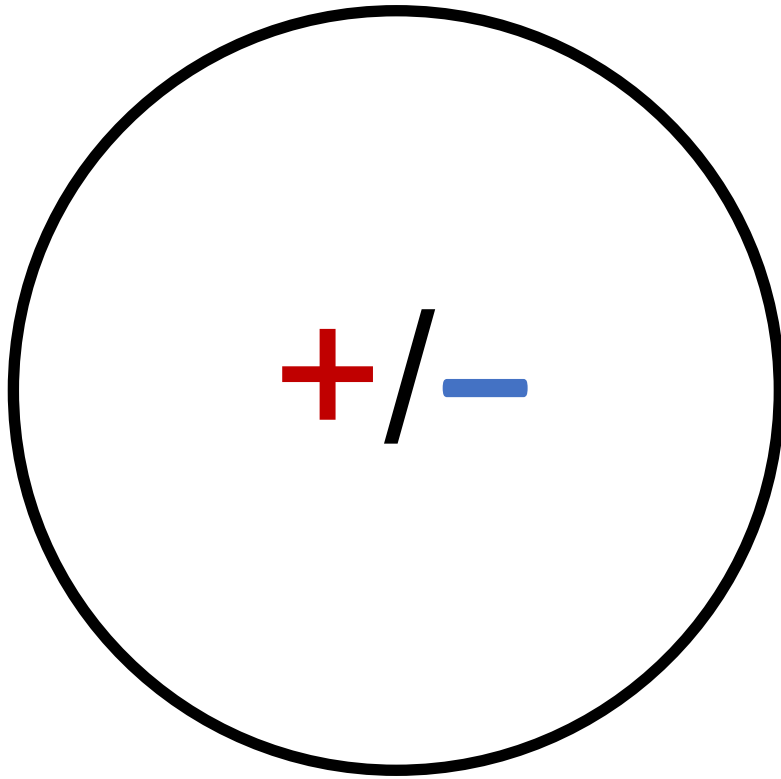


# Effective # of Relativistic d.o.f Constraint



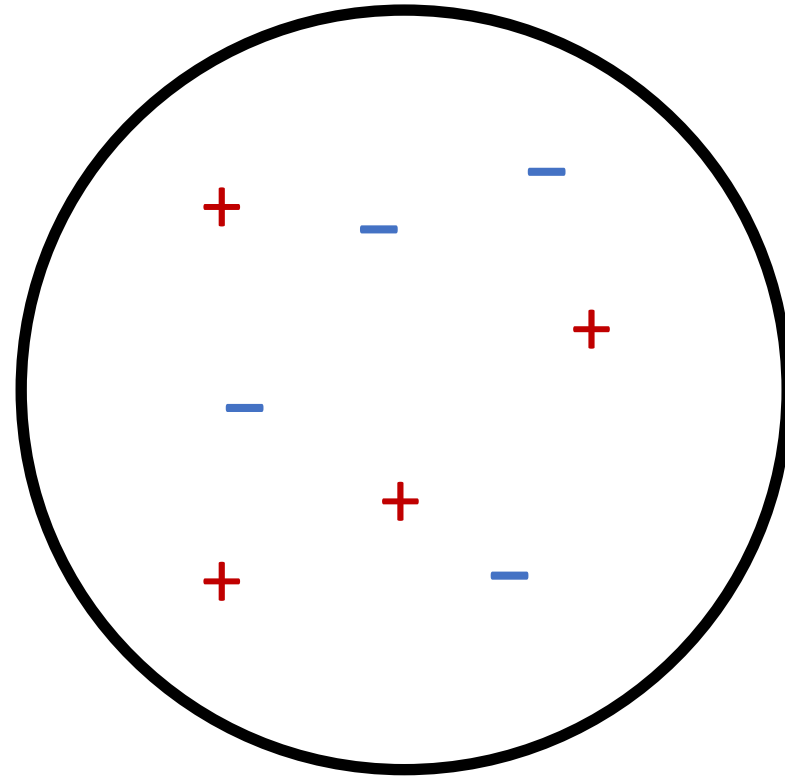
# What are Charge Fluctuations?

Homogeneous



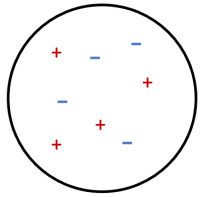
$$n_q/n_b < 10^{-26}e$$

Inhomogeneous

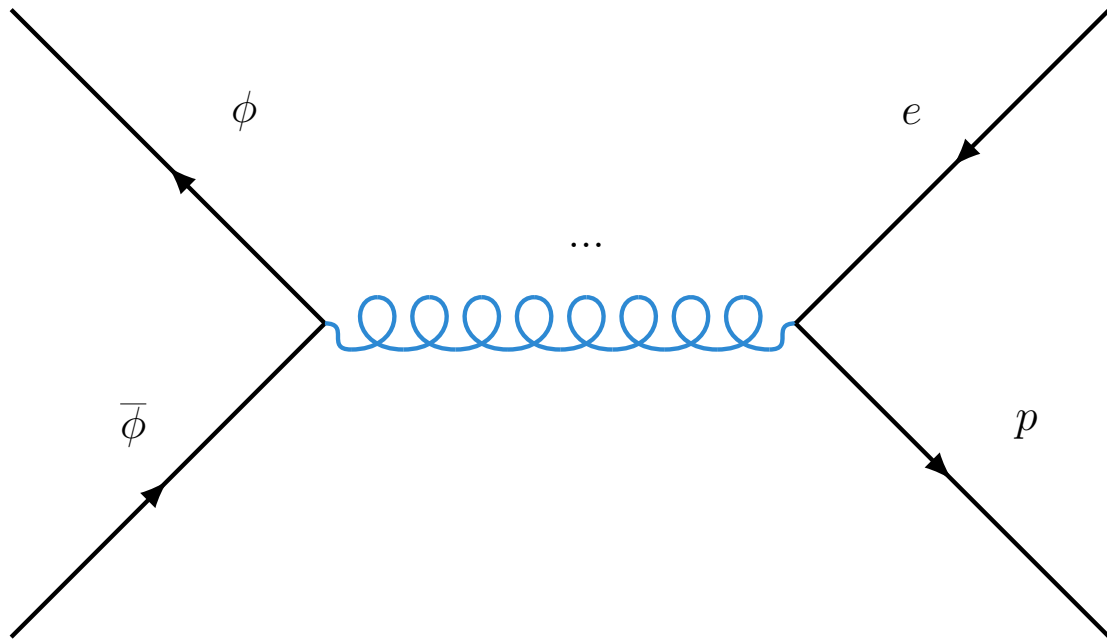




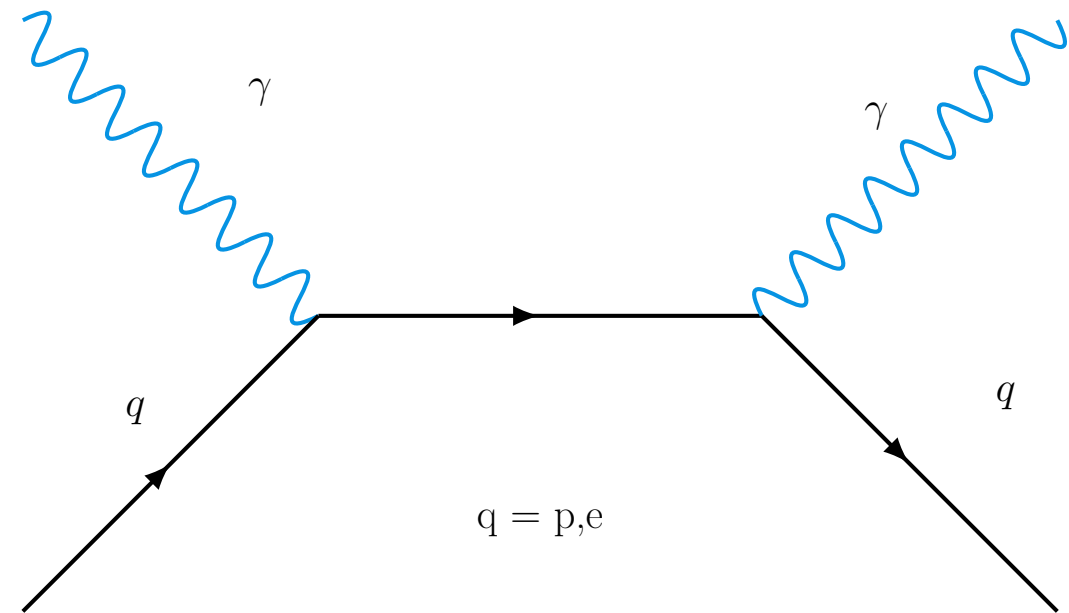
# Sources of Charge Fluctuations



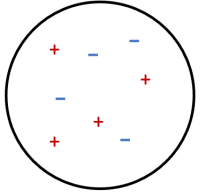
Inflation



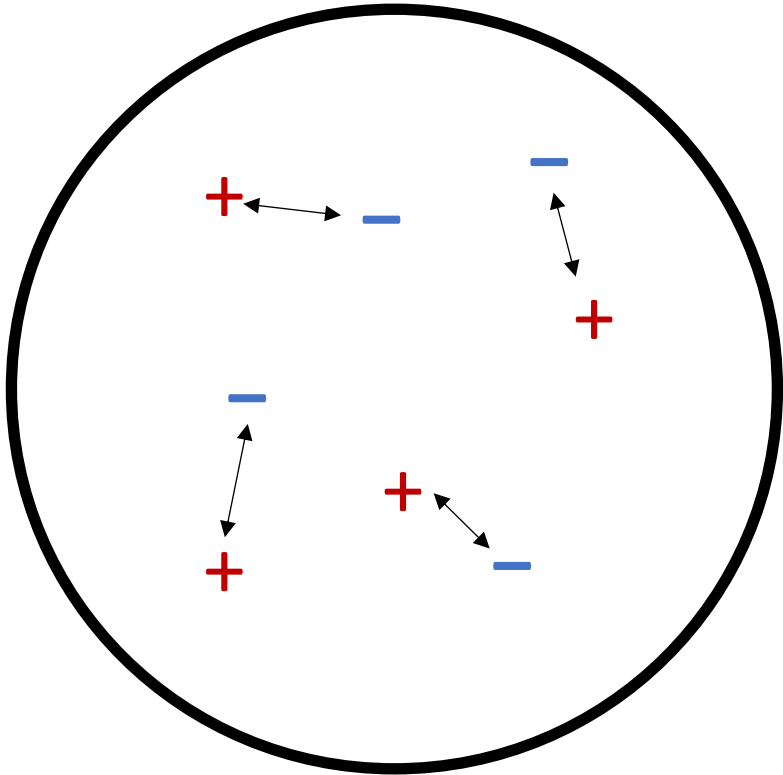
Thomson Scattering



# Lifetime of Charge Fluctuations

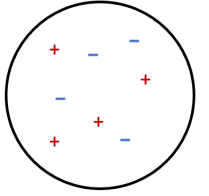
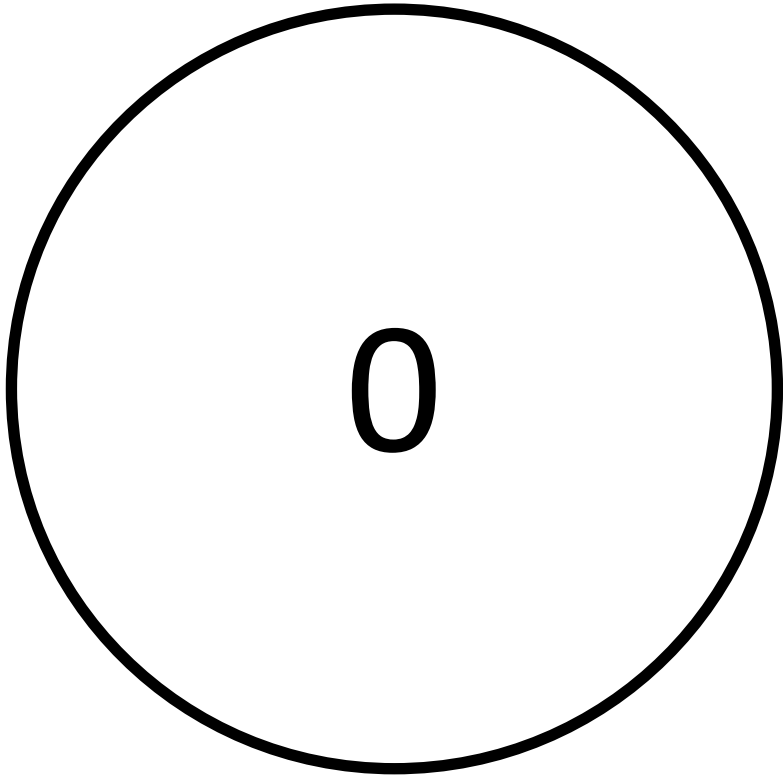


Free Charges

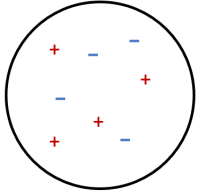


# Lifetime of Charge Fluctuations

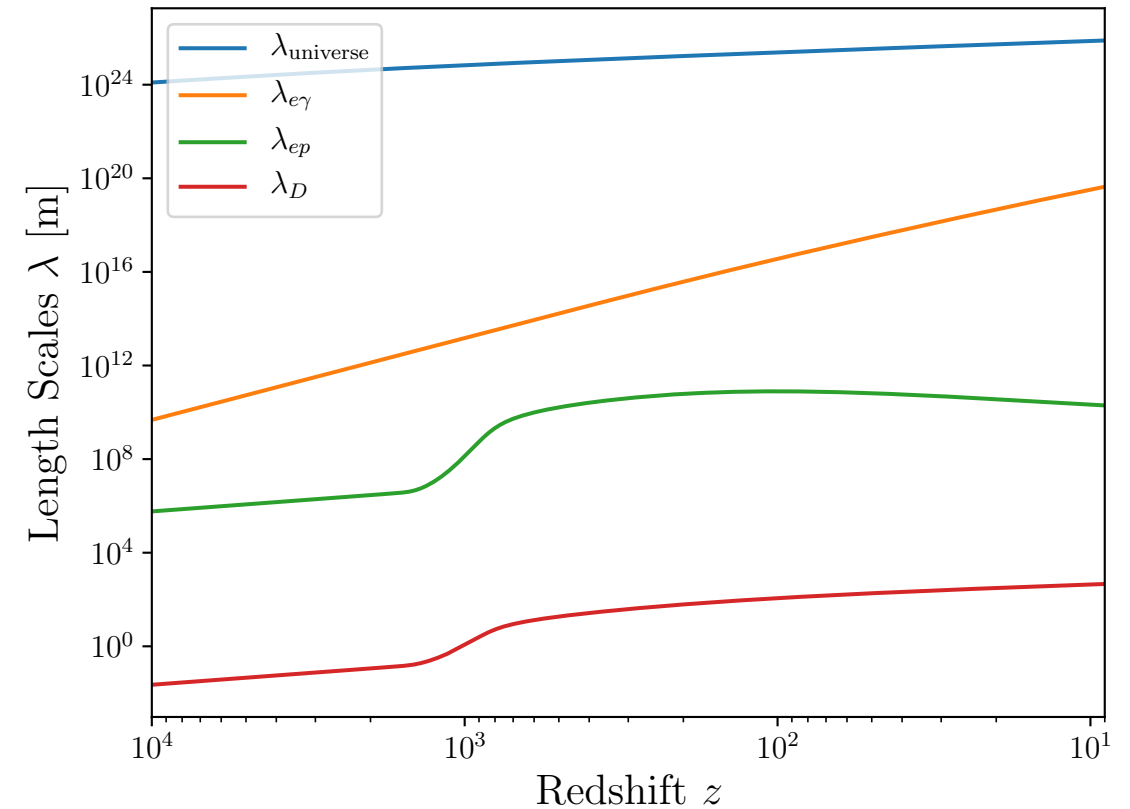
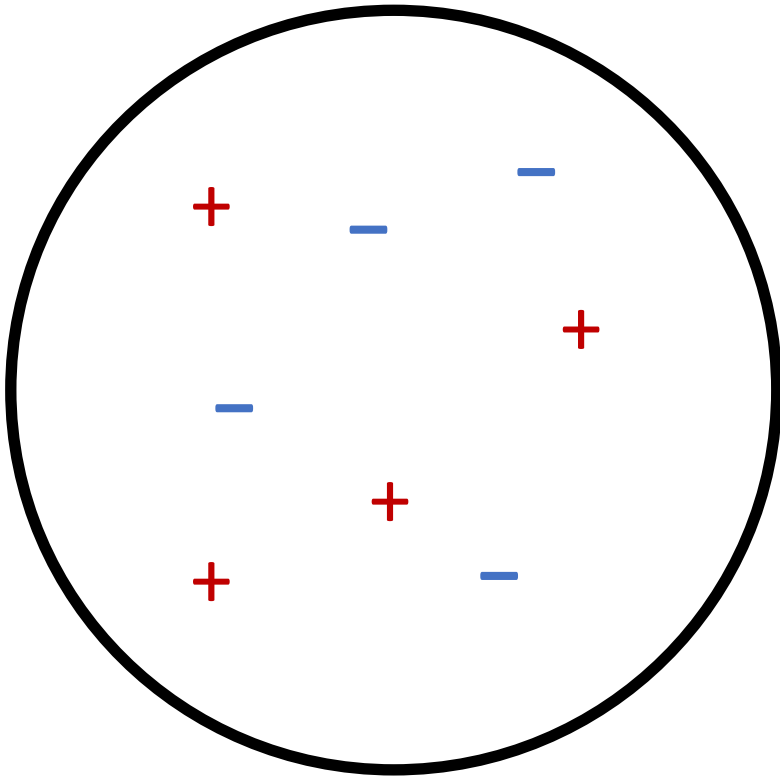
Free Charges



# Lifetime of Charge Fluctuations

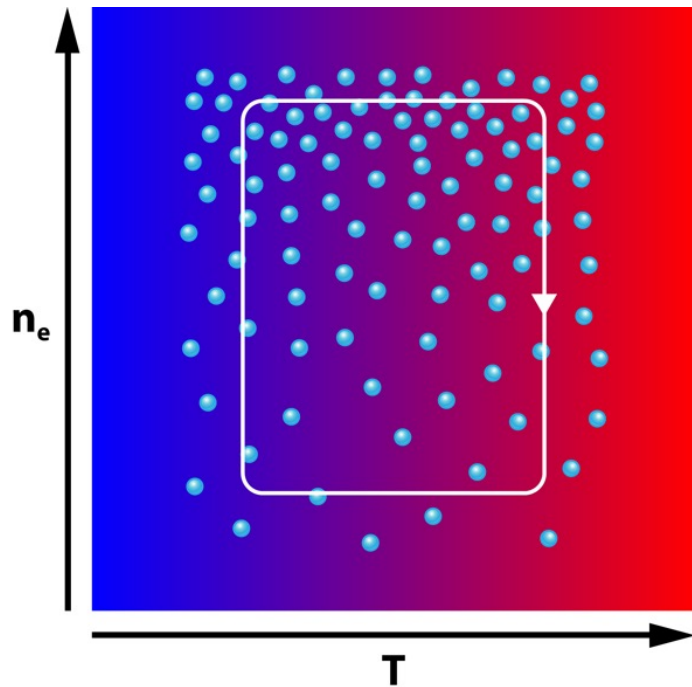
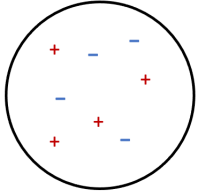


Plasma



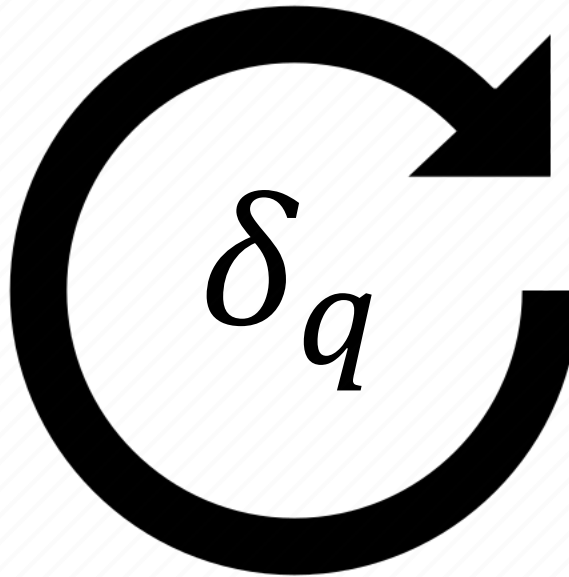
$\Rightarrow$  Lifetime  $\rightarrow$  Infinite

# Signatures of Charge Fluctuations

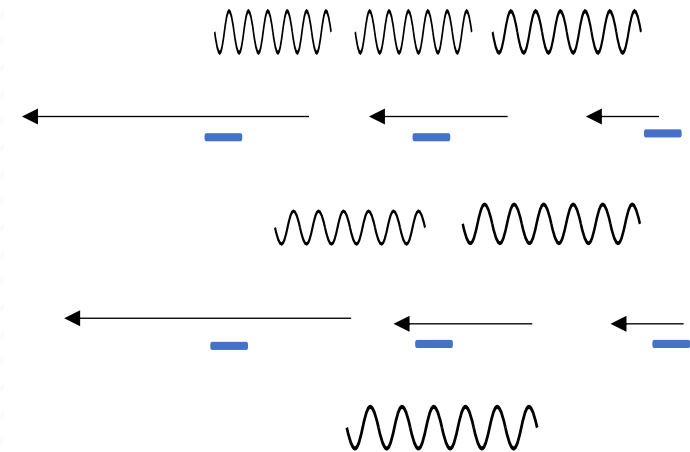


Biermann Battery

Primordial Magnetic Field



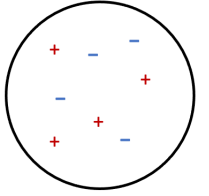
Charge Separation



Thomson Scattering

Photon Fluctuations

# Detectability of Charge Fluctuations



WIP

Spatially varying CMB power spectrum

Intensity Mapping