Constraining high-z reionization with Cosmological Data

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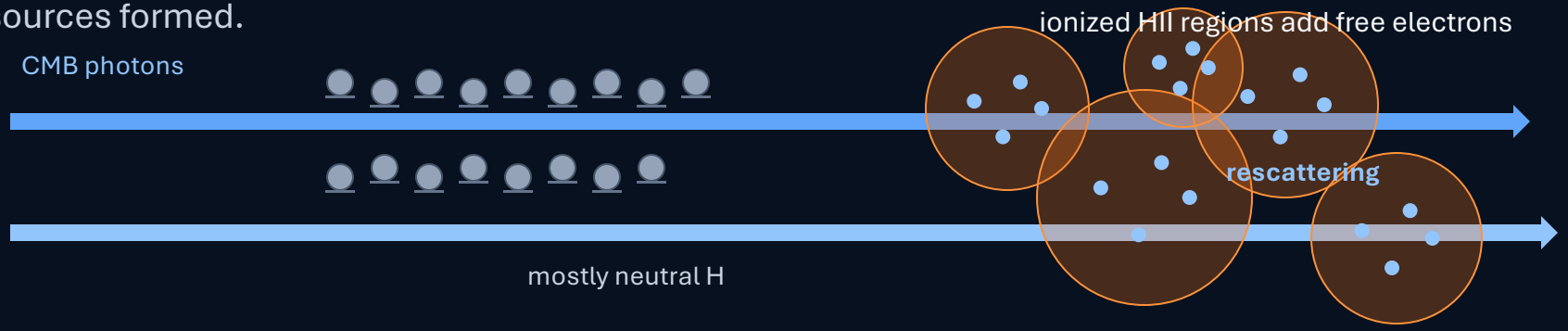
Reionization turns neutral gas into a second scattering screen.

CMB photons last scattered at recombination, then crossed an IGM that became ionized again when the first luminous sources formed.



What CMB sees

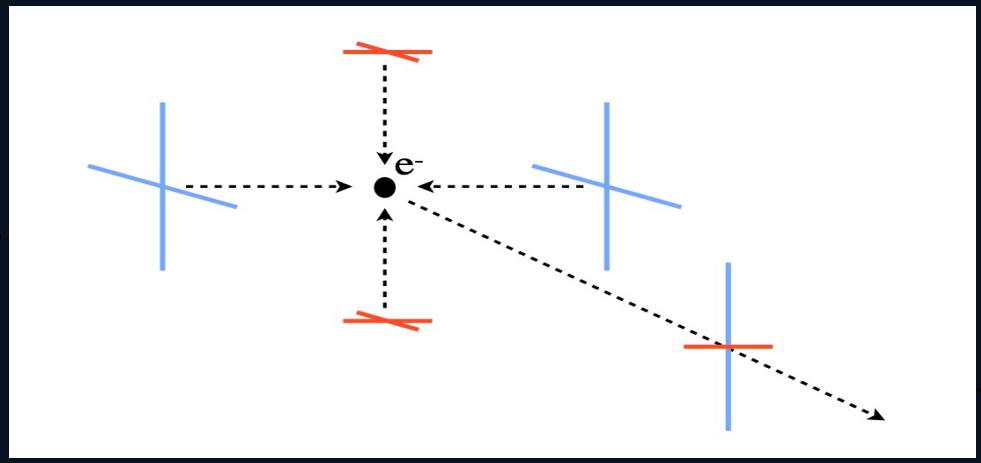
Xe(z) is the free-electron history.

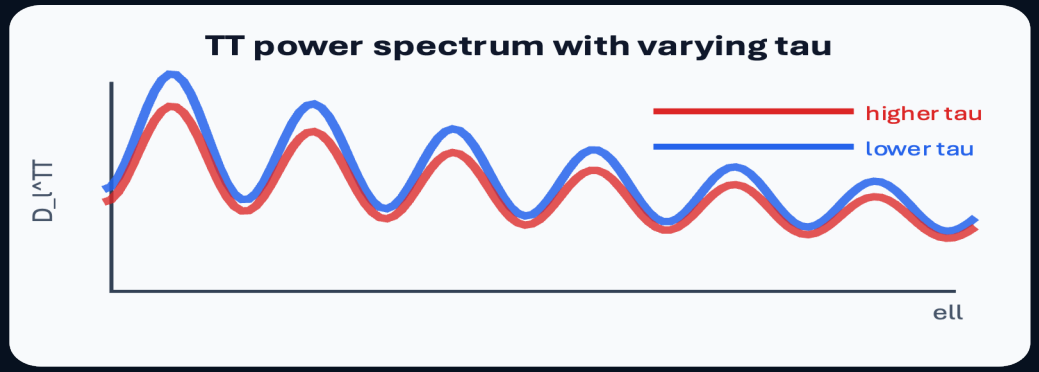
$$\tau(z) = \int_{t(z)}^{t_0} n_e \sigma_T c dt'$$

Aligned Xe(z): ionized at recombination, neutral during the dark ages, ionized again after first sources.

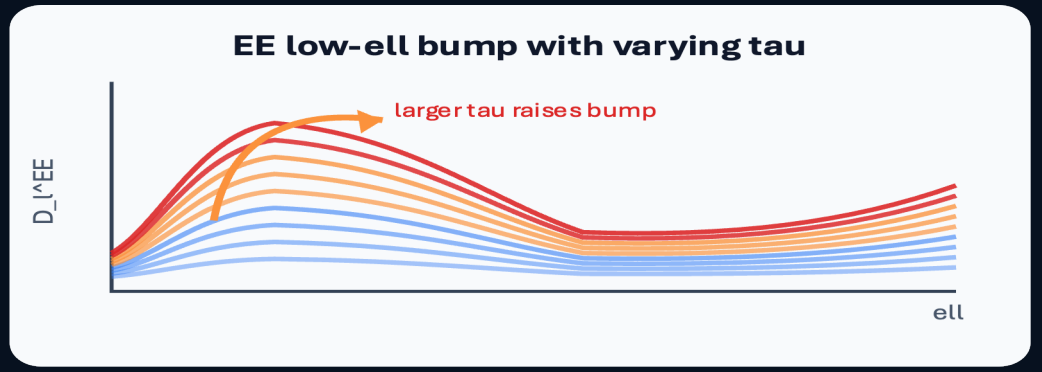
Thomson rescattering changes TT and EE in different ways.

Free electrons see a local quadrupole, redistribute CMB photons, and generate new large-scale polarization.





TT: primary acoustic peaks are damped at small angular scales.

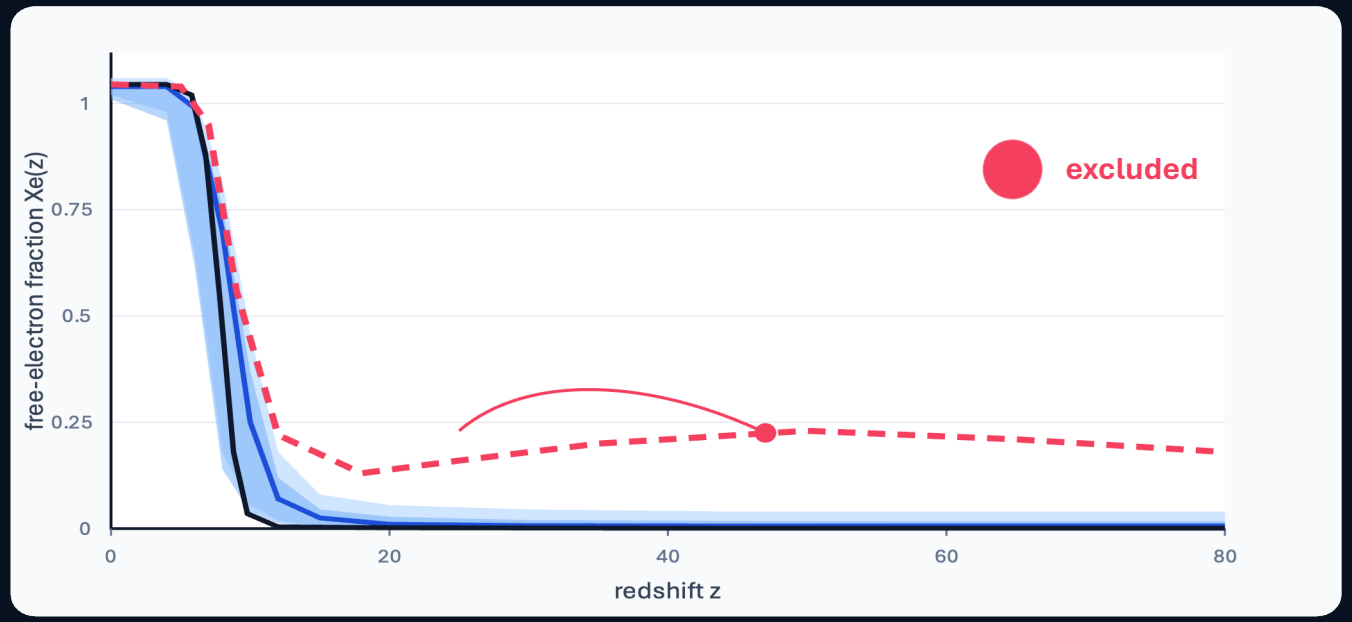


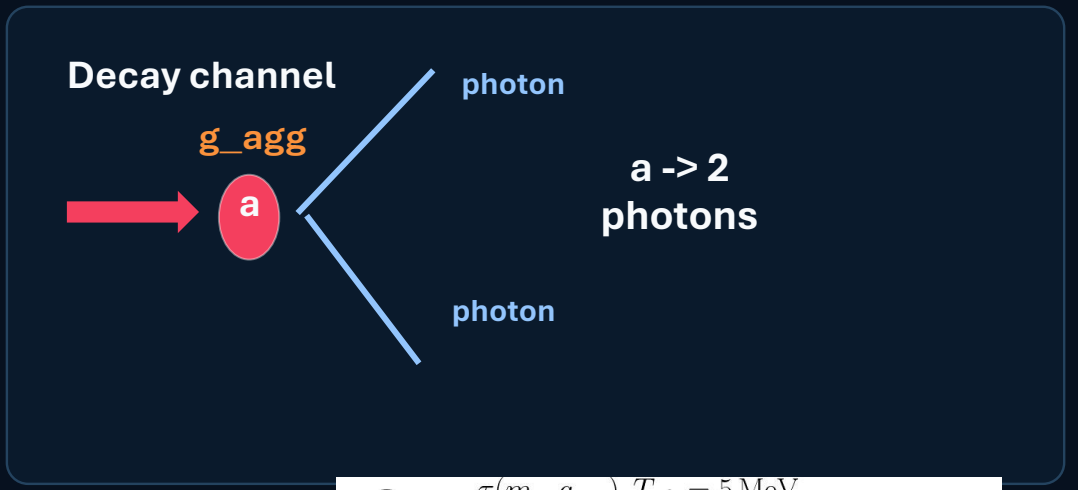
EE: the reionization bump grows at low multipoles.

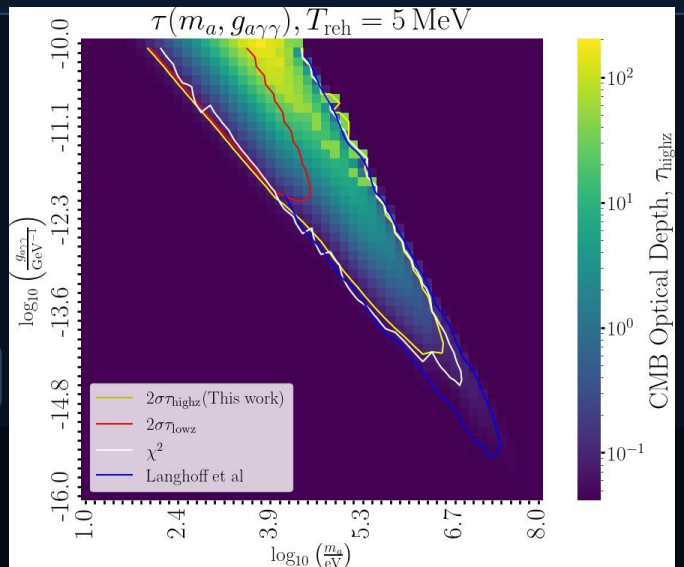
GPR TO AXION LIMITS

GPR reconstruction excludes axion histories that over-ionize high z.

A flexible CMB-driven reconstruction of Xe(z) can be compared directly to histories produced by decaying axions.







GPR Xe(z) → Planck low-ell EE → tau_highz posterior → axion limits