V.5. Physical effects controlling shape of C_ℓ's:

(As in the rest, we assume minimal ΛCDM with no neutrinos)

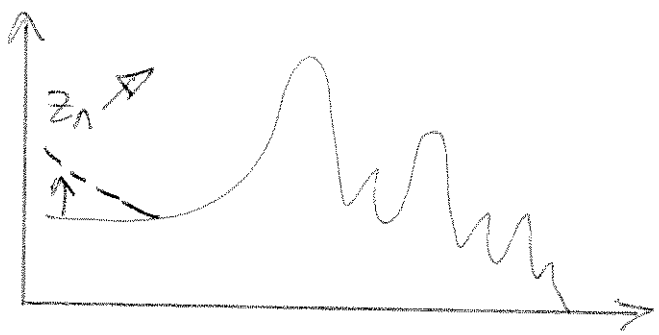
The shape of the C_ℓ's depends on 4 quantities only, plus the shape of the primordial spectrum:

(1) Time of equality between radiation and matter: η_{eq}

If $\eta_{eq} \nearrow$, equality takes place closer to decoupling. This implies a larger time-variation of ϕ and ψ just before and during decoupling - Because of source term in Θ_0 equation AND of early ISW, this tends to boost the 1st peak (ℓ's corresponding to modes $k = \frac{\ell}{\eta_0 - \eta_{dec}}$ crossing Hubble radius near decoupling). But all peaks are enhanced because there is less damping in intermediate epoch $\eta_{eq} < \eta < \eta_{dec}$ -

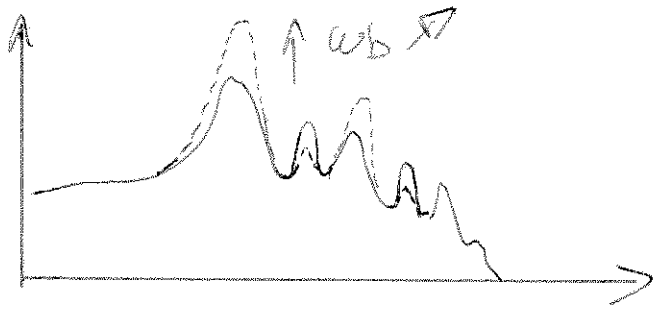
(2) Time of equality between matter and Λ (or DE): η_Λ

If $z_\Lambda \nearrow$, Λ domination starts earlier: there can be more late ISW effect.



(3) Balance between gravity and pressure

If $\rho_b/\rho_\gamma \nearrow$ near decoupling (ie if $\omega_b/\omega_r \nearrow$), more asymmetry between odd and even peaks



(4) Angular scale of sound horizon at recombination

Scale $\theta \sim \frac{\pi}{\ell}$ of peaks depends on $d_s^{\text{comoving}}(\eta_{dec})/d_A(\eta_{dec})$

with $d_s^{\text{comoving}}(\eta_{dec}) = \int_0^{\eta_{dec}} \frac{dt}{a} c_s$, with $c_s^2 = \frac{1}{3(1+R(t))}$

$d_A^{(\eta_{dec})} = \frac{1}{1+z_{dec}} \int_0^{z_{dec}} \frac{dz}{H(z)}$

d_s^{co} controlled mainly by ω_b ($\Rightarrow R = \frac{3\omega_b}{4\omega_r}\frac{a}{a_0}$)

d_A " " " " H_0, Ω_Λ (and Ω_k if spatial curvature)

NOTE k_D is fixed; if $d_s \searrow$, $\theta \searrow$, $\ell \nearrow$ and peaks more affected by Silk Dampening

(5) Primordial spectrum:

Trivial effect: if $\mathcal{S}_R(k) = A\, k^{n-1}$, A controls overall amplitude of C_ℓ's, and n overall shape