

Lecture 2

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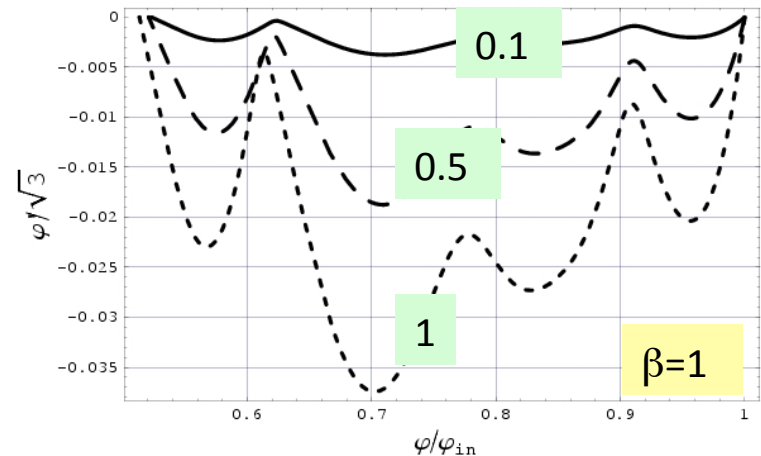
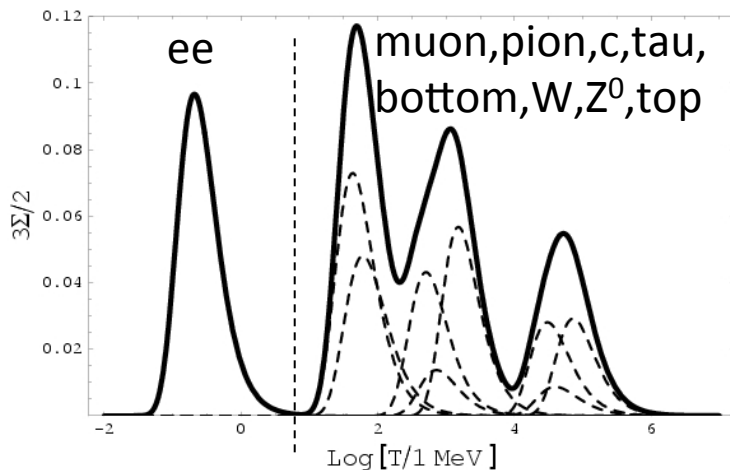


Mass thresholds: when $T \sim m$ the species become non-relativistic and induces a non-vanishing r.h.s.

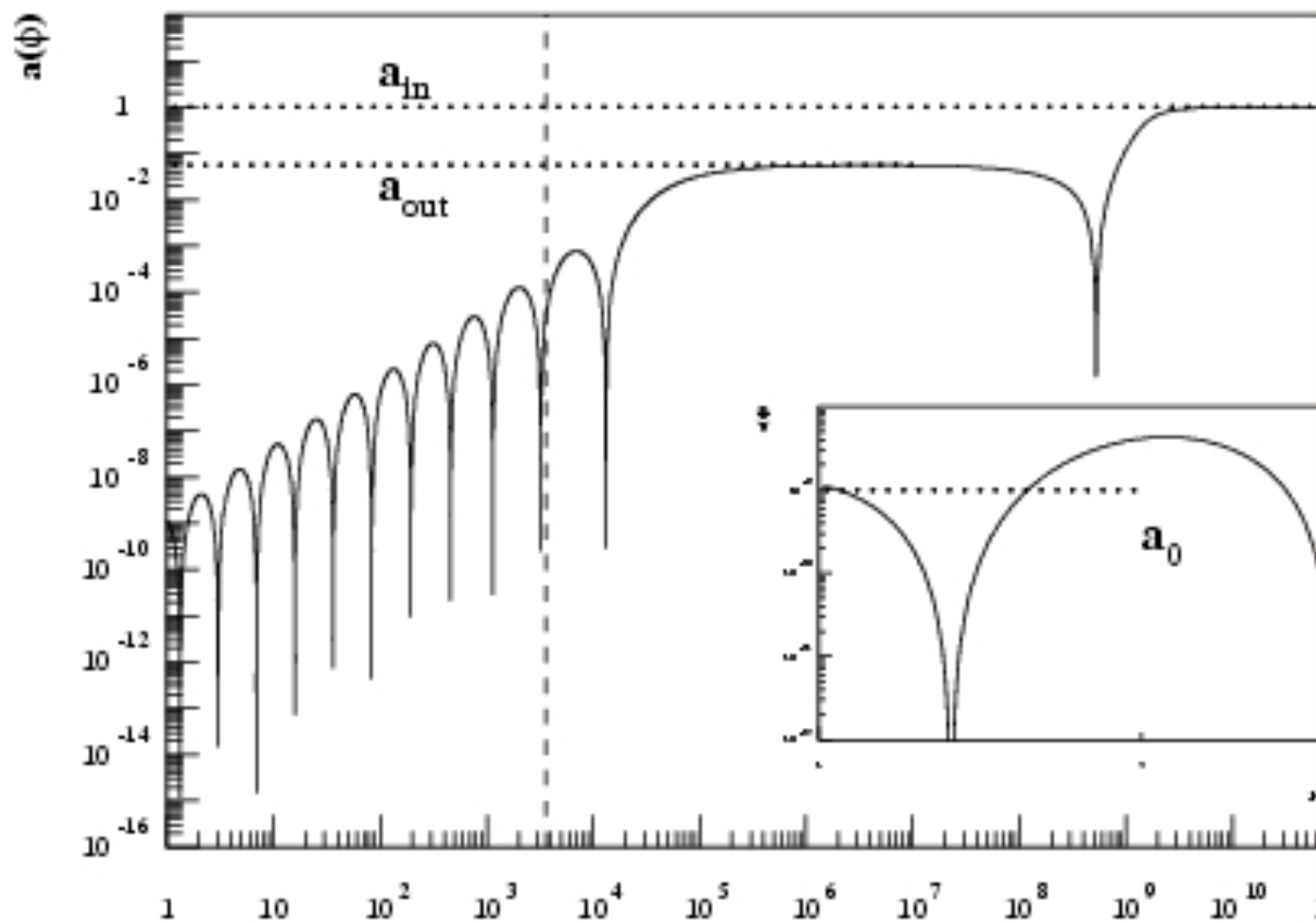
$$\rho_e - 3P_e = \frac{g_e}{2\pi^2} m_e^2 \int_0^\infty \frac{q^2}{e^{E/T} + 1} \frac{dq}{\sqrt{q^2 + m_e^2}}.$$

$$\frac{2}{3 - \varphi_*^2} \varphi_*'' + \frac{2}{3} \varphi_*' + \Sigma_e(T) \beta \varphi_* = 0.$$

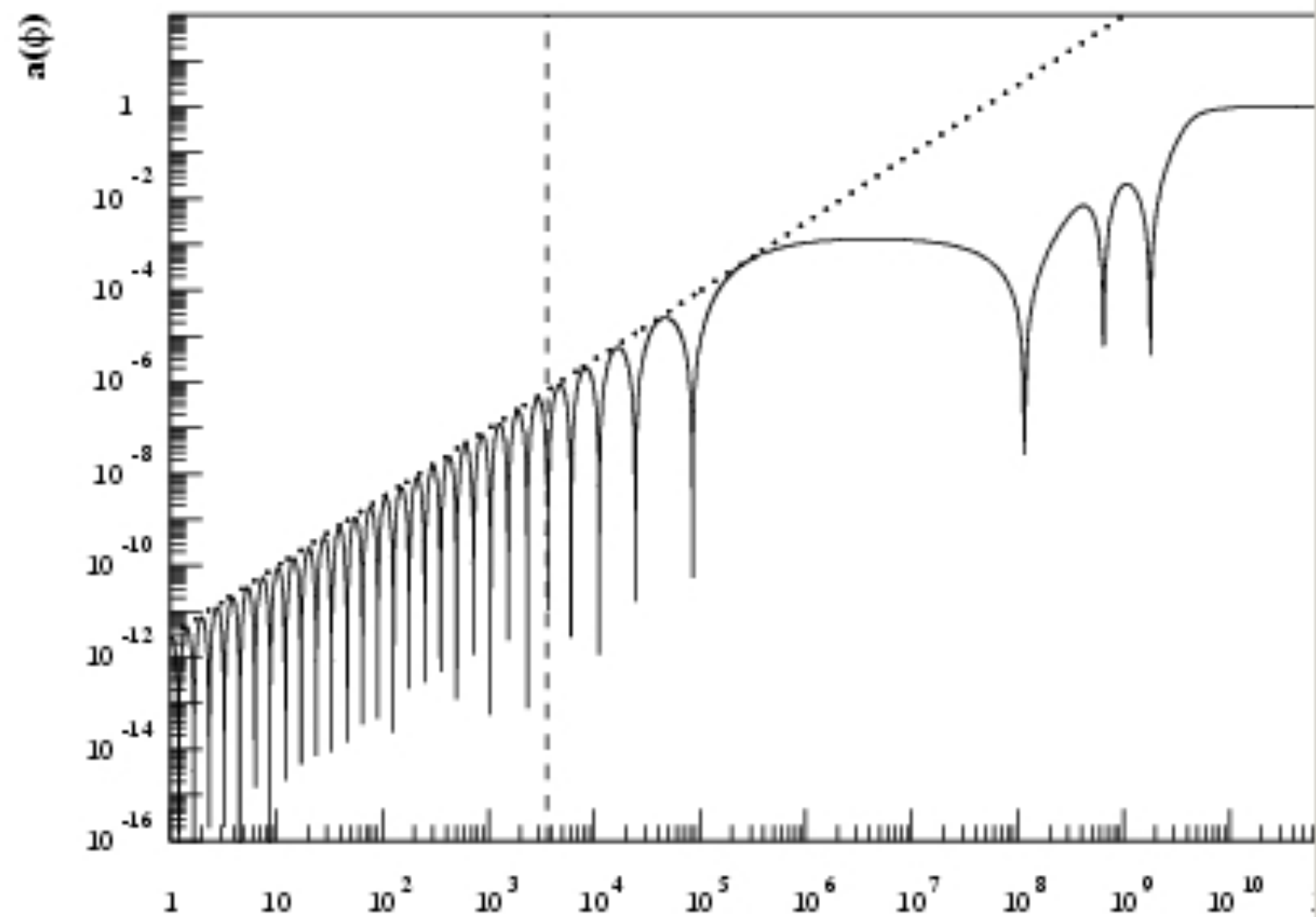
$$\Sigma_e(T) = \frac{15}{\pi^4} \frac{g_e}{g_*(T)} z_e^2 \int_{z_e}^\infty \frac{\sqrt{x^2 - z_e^2}}{e^x + 1} dx$$



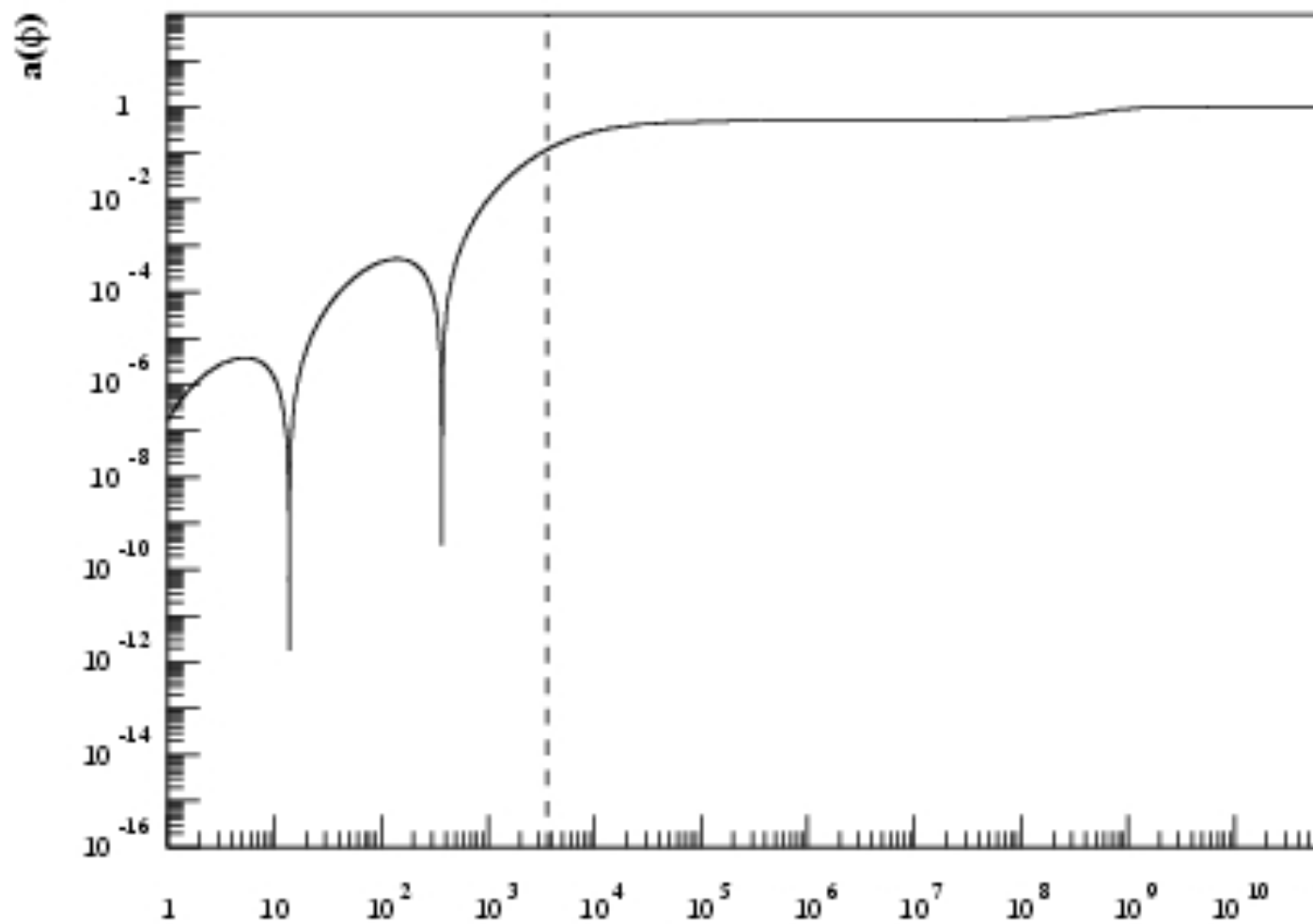
$$\Omega_m h^2 = 0.15, \Omega_\Lambda = 0, \beta = 10$$



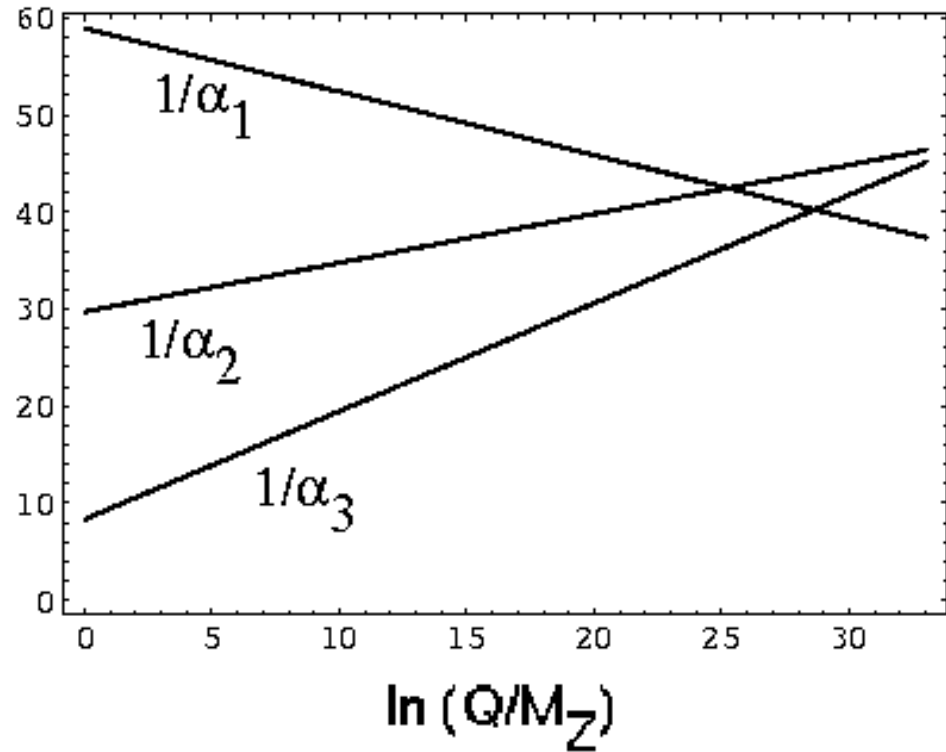
$$\Omega_m h^2 = 0.15, \Omega_\Lambda = 0, \beta = 60$$



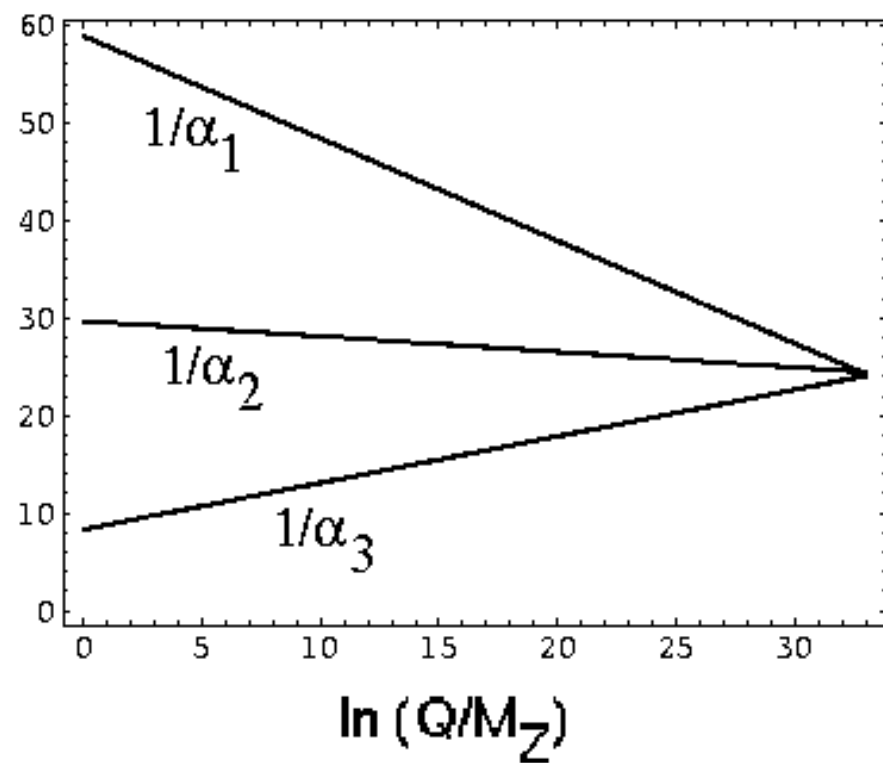
$$\Omega_m h^2 = 0.15, \Omega_\Lambda = 0, \beta = 1$$



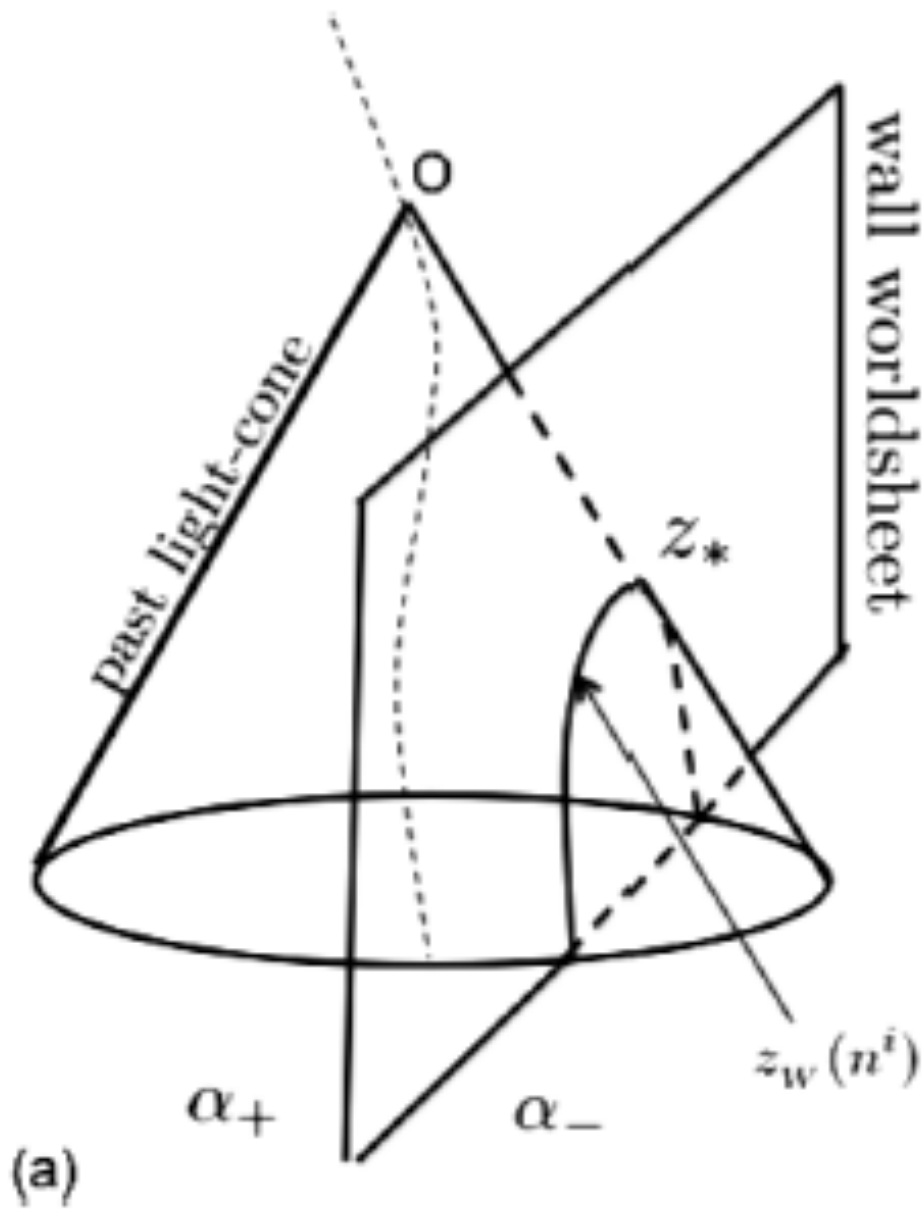
GUTs

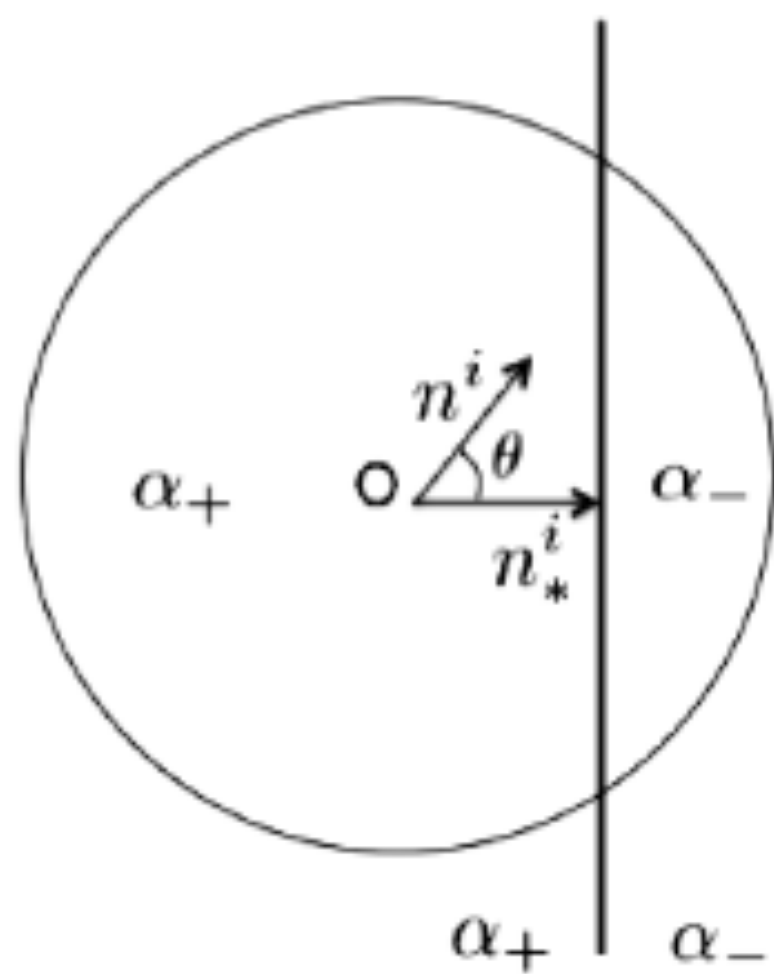


SUSY GUTs



$$\alpha^{-1} = \frac{5}{3}\alpha_1^{-1} + \alpha_2^{-1}$$





(b)