31 May 2001 - Zita
Universe box 28.2

Planck time is as far back as we can see & make sense of

Particle (e.g. black hole model for pre-big-bang state) "typically cannot be precisely located within a distance $\lambda_c = \frac{\hbar}{mc}$" from $\left(\underset{\text{wave}}{E = \frac{hc}{\lambda}}\right) = \left(\underset{\text{particle}}{E} = mc^2\right)$

p. 704

Solve for λ:

Event horizon of black hole $D = 2GM/c^2$ from escape velocity: kinetic energy = gravitational energy

$\frac{1}{2}mv^2 = GmM/D$ Let $v = c$

Solve for D:

The smallest black hole that makes sense ($D \geq \lambda_c$) has a mass m_p = Planck mass $= \sqrt{\frac{\hbar c}{G}} = 5.5 \times 10^{-8}$ kg

Let $D = \lambda_c$, solve for m_p:

The corresponding size (smallest universe state we can make sense of) has $\lambda_p = \sqrt{\frac{G\hbar}{c^3}}$ = Planck length $\sim 4 \times 10^{-35}$ m

Sub m_p into D:

Earliest time we can make sense of: $t_p = \frac{\lambda_p}{c} = \sqrt{\frac{G\hbar}{c^5}}$

$t_p \sim 10^{-43}$ s