Moderni fysiikka B **Kaavakokoelma**

$$1 \text{ eV} = 11600 \text{ K} = 1.60 \times 10^{-19} \text{ J} = 5.07 \times 10^{6} \text{ m}^{-1} = 1.52 \times 10^{15} \text{ s}^{-1} = 1.78 \times 10^{-36} \text{ kg}$$

$\hbar = 1 = 197$ MeV fm

$c = 1 = 3.00 \times 10^{8}$ m/s

$M_{\rm P} = (8\pi G_{\rm N})^{-1/2} = 2.436 \times 10^{18}$ GeV

$1 \text{ pc} = 3.09 \times 10^{16}$ m

$1\ a = 3.156 \times 10^{7}$ s

$(100 \text{ km/s/Mpc})^{-1} = 9.78 \times 10^{9} \text{ a} = 2998$ Mpc

$$t' = \gamma\left(t - \frac{v}{c^2}x\right) \quad , \quad x' = \gamma\,(x - vt) \quad , \quad \gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$\ell = \gamma^{-1}\ell_0 \quad , \quad \Delta t' = \gamma^{-1}\Delta t$$

$$v = \frac{v_1 + v_2}{1 + \frac{v_1 v_2}{c^2}} \quad , \quad f_{\rm obs} = f_{\rm em}\sqrt{\frac{1 \mp \beta}{1 \pm \beta}} \quad , \quad \beta = \frac{v}{c}$$

$$\mathrm{d}s^2 = c^2\,\mathrm{d}t^2 - \mathrm{d}x^2 - \mathrm{d}y^2 - \mathrm{d}z^2 \quad , \quad c^2\,\mathrm{d}\tau^2 = \mathrm{d}s^2$$

$$u = \frac{\mathrm{d}x}{\mathrm{d}\tau} = \gamma(c, \bar{v}) \quad , \quad u \cdot u = c^2 \quad , \quad a = \frac{\mathrm{d}^2 x}{\mathrm{d}\tau^2}$$

$$p = mu = \left(\frac{E}{c}, \bar{p}\right) \quad , \quad \frac{\mathrm{d}p}{\mathrm{d}\tau} = F$$

$$E = m\gamma c^2 = \sqrt{m^2c^4 + |\bar{p}|^2c^2} \quad , \quad E = \frac{hc}{\lambda}$$

$$E_B = (ZM(^1H) + Nm_n - M(^AX))c^2$$

$m_p = 938.3$ MeV , $m_n = 939.6$ MeV

$m_e = 0.511$ MeV , $m_\mu = 105.7$ MeV

$m_\tau = 1776.9$ MeV ,

$u = 931.5 \text{ MeV}/c^2$, ${}^{A}_{Z}X_N$

$Q(u) = 2/3e$, $Q(d) = -1/3e$,

$$\frac{\mathrm{d}N}{\mathrm{d}t} = -\lambda N \quad , \quad \tau_{1/2} = \frac{1}{\lambda}\ln 2 \quad , \quad A(t) = \left|\frac{\mathrm{d}N}{\mathrm{d}t}\right|$$

$$\mathrm{d}s^2 = c^2\,\mathrm{d}t^2 - a^2(t)\left(\mathrm{d}x^2 + \mathrm{d}y^2 + \mathrm{d}z^2\right)$$

$$H^2 \equiv \left(\frac{\dot{a}}{a}\right)^2 = \frac{\rho}{3M_{\rm P}^2}$$

$$\frac{\ddot{a}}{a} = -\frac{\rho + 3p}{6M_{\rm P}^2}$$

$$\dot{\rho} = -3\frac{\dot{a}}{a}(\rho + p) \quad , \quad w = p/\rho$$

$$\rho = \rho_0\left(\frac{a_0}{a}\right)^{3(w+1)}$$

$$\rho = \frac{\pi^2}{30}g_* T^4$$

$$t = \frac{2.4}{\sqrt{g_*(T)}}\left(\frac{T}{\rm MeV}\right)^{-2} \ s$$