Title: Particle Physics Lecture

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Collection: Particle Physics

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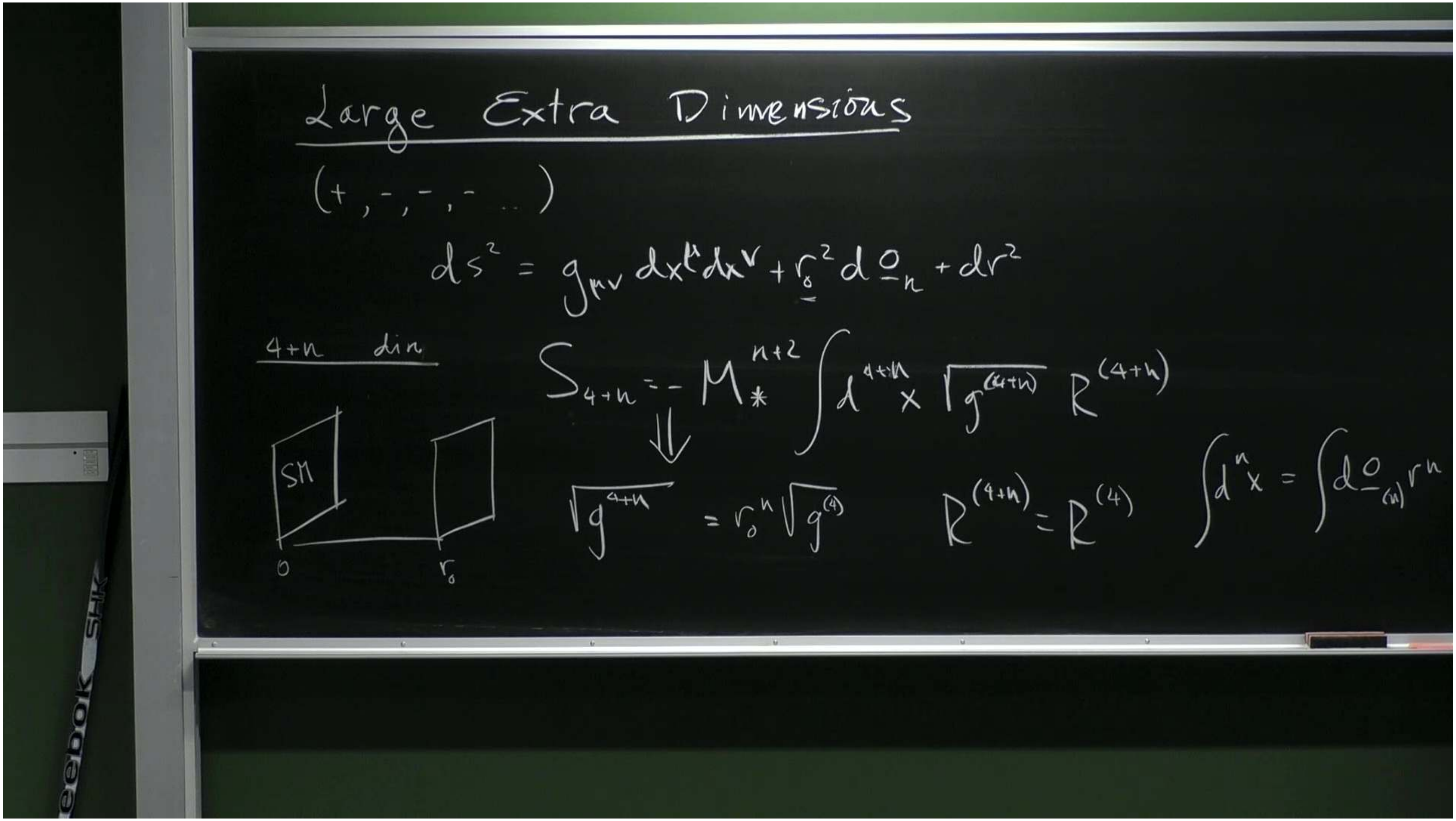

Large Extra Dimensions
$(+,-,-,- \ldots)$
$ds^2 = g_{\mu\nu} dx^\mu dx^\nu + r_0^2 d\Omega_n + dr^2$
4+n dim
SM
0
r_0
$S_{4+n} = -M_*^{n+2} \int d^{4+n}x \sqrt{g^{(4+n)}} R^{(4+n)}$
$\Downarrow$
$\sqrt{g^{4+n}} = r_0^n \sqrt{g^{(4)}}$
$R^{(4+n)} = R^{(4)}$
$\int d^n x = \int d\Omega_{(n)} r^n$

$$S_{4\,eff} = -\underbrace{M_*^{n+2} \int d\Omega_{(n)}\, r_0^n}_{\equiv\, M_{Pl}^2} \int d^4x \sqrt{g^{(4)}}\; R^{(4)}$$

$$M_{Pl}^2 = M_*^{n+2} (2\pi r_0)^n$$

$$r_0^{-1} = M_* \left(\frac{M_*}{M_{Pl}}\right)^{2/n}$$

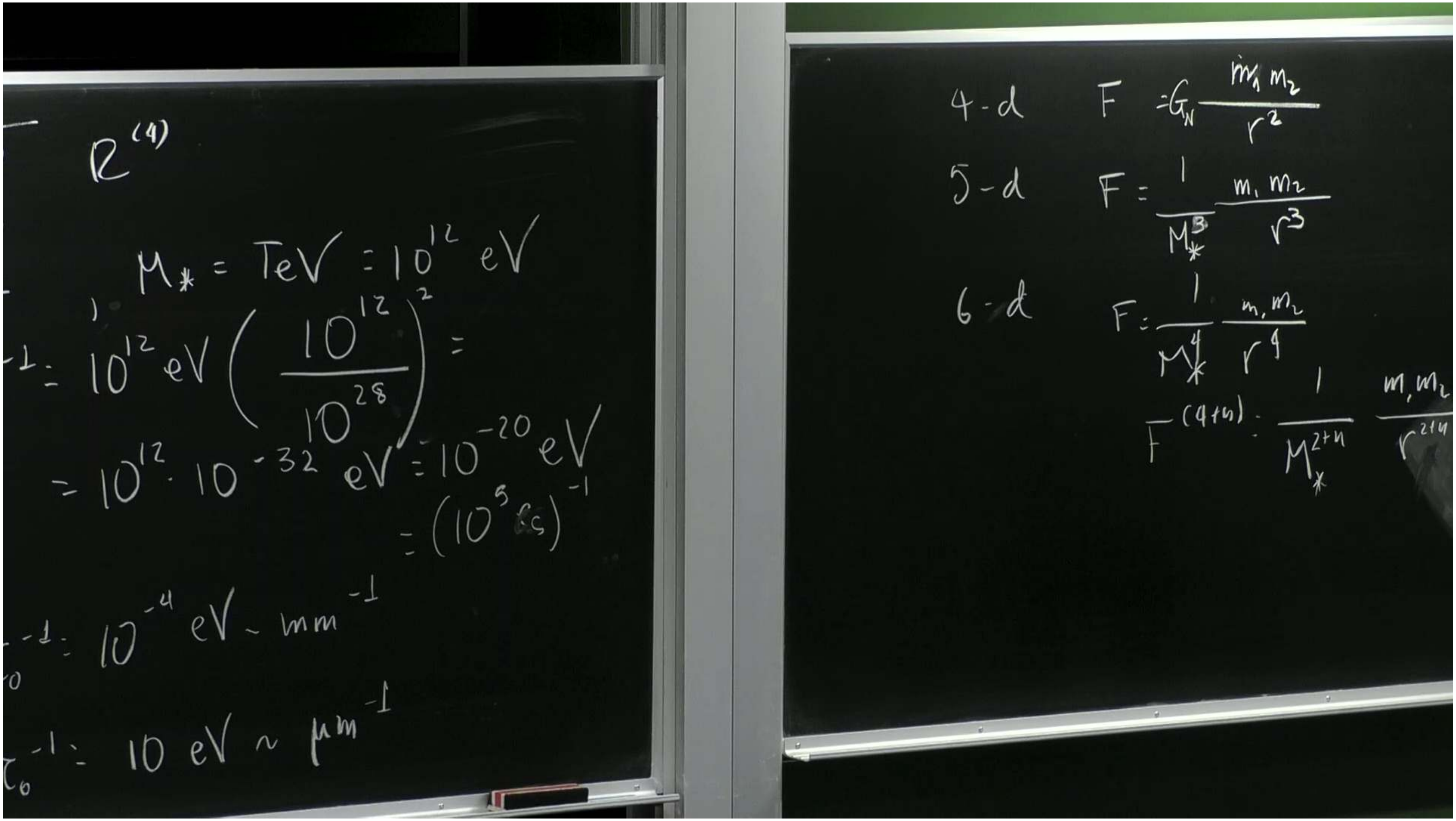
$n=1$, $M_* = \text{TeV} = 10^{12}\ \text{eV}$

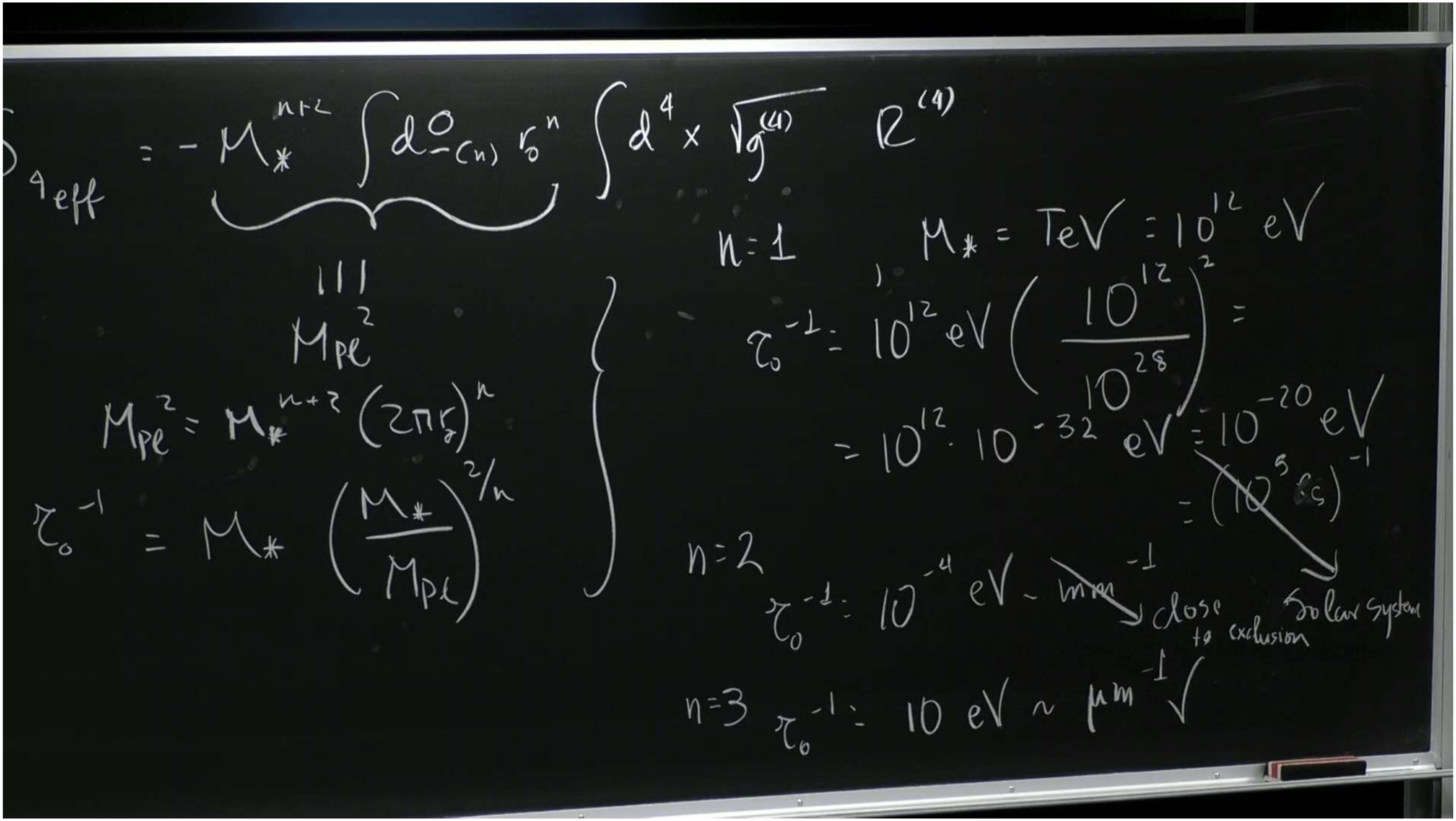
$$r_0^{-1} = 10^{12}\ \text{eV} \left(\frac{10^{12}}{10^{28}}\right)^2 = 10^{12} \cdot 10^{-32}\ \text{eV} = 10^{-20}\ \text{eV} = (10^5\ \text{ls})^{-1}$$

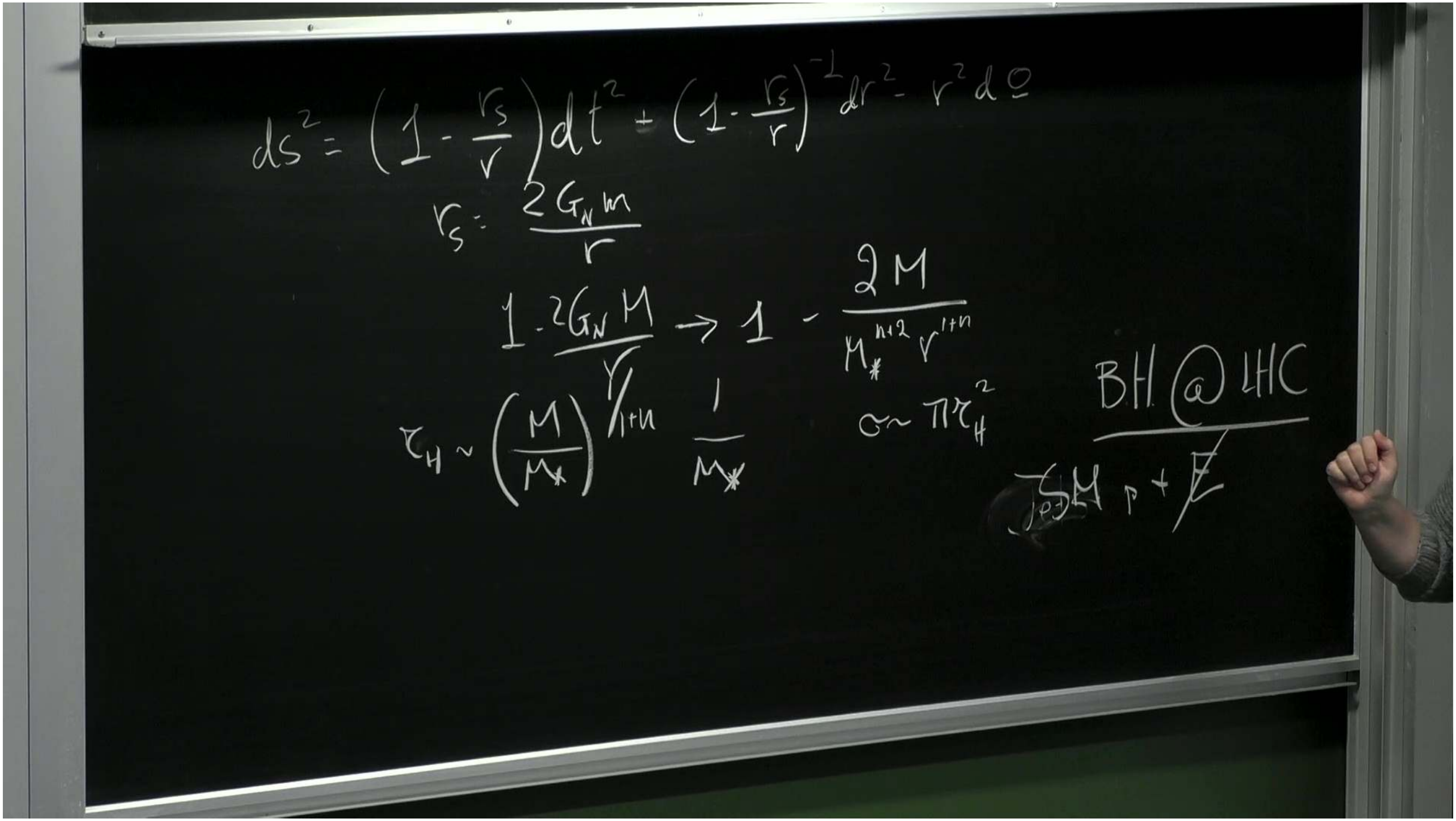
$n=2$

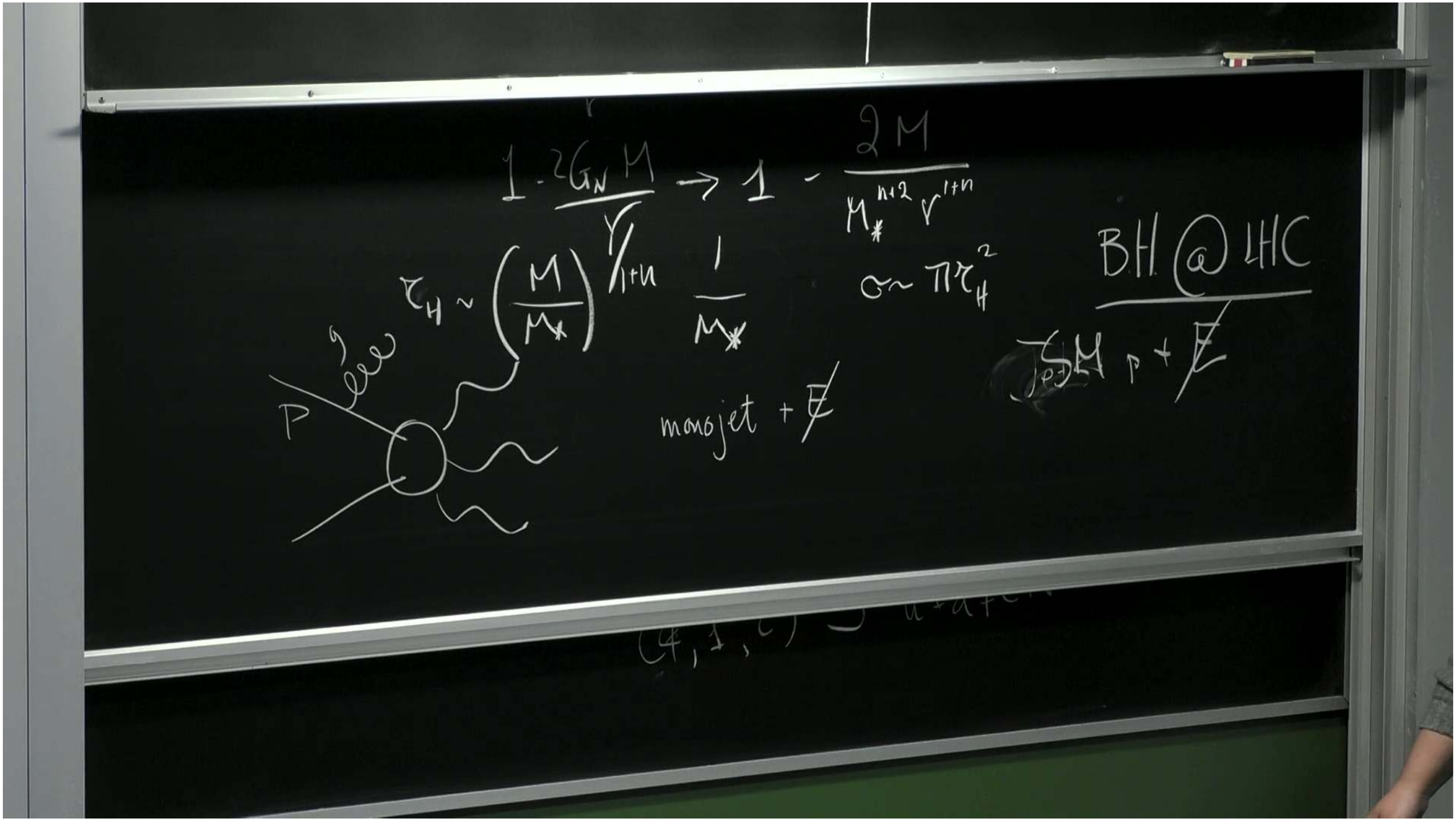
$$r_0^{-1} = 10^{-4}\ \text{eV} \sim \text{mm}^{-1}$$

$n=3$ $\quad r_0^{-1} = 10\ \text{eV} \sim \mu\text{m}^{-1}$

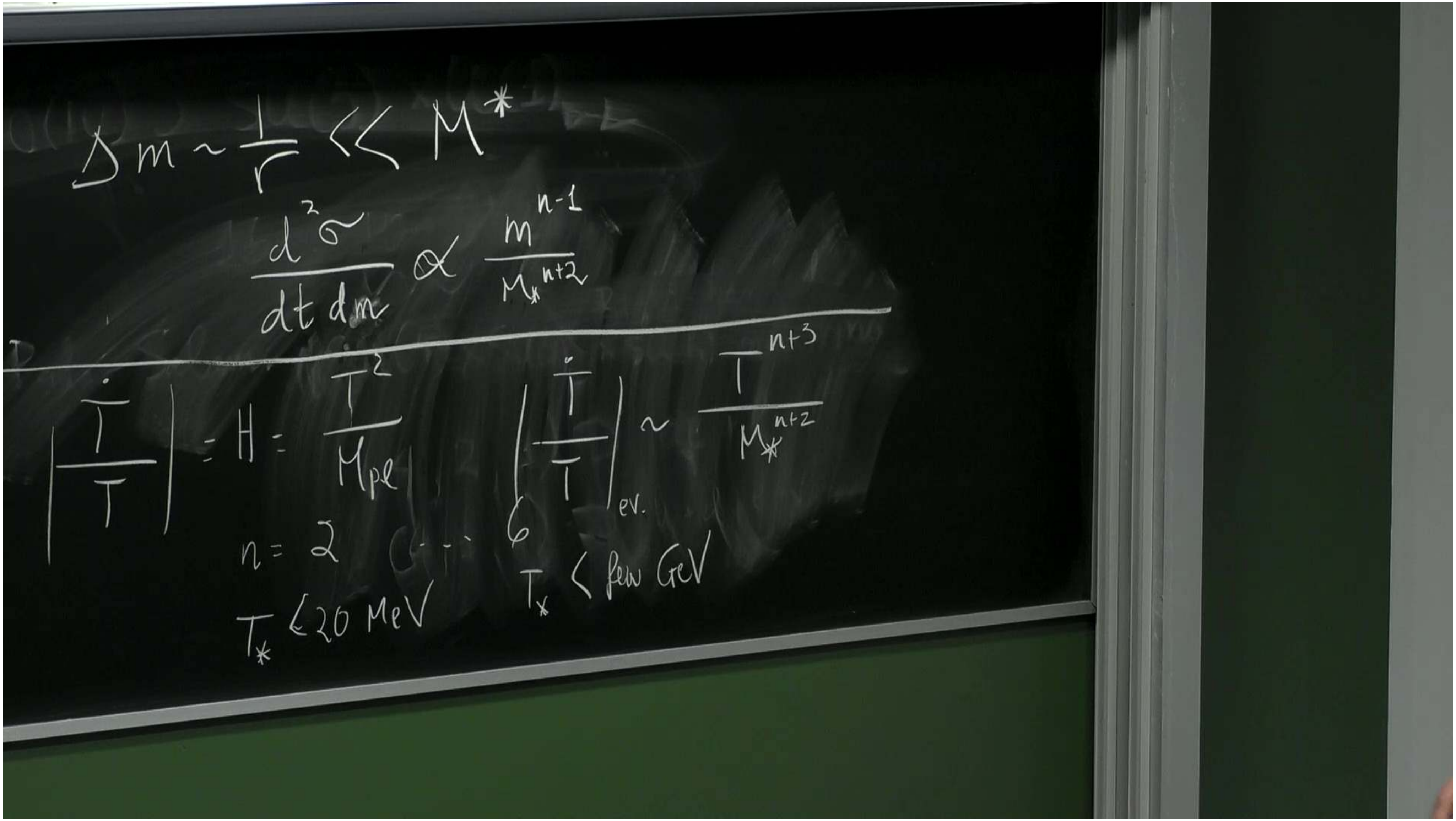

R^(4)
M* = TeV = 10^12 eV
= 10^12 eV (10^12 / 10^28)^2 =
= 10^12 · 10^-32 eV = 10^-20 eV
= (10^5 s)^-1
10^-4 eV ~ mm^-1
10 eV ~ μm^-1
4-d F = G_N m1 m2 / r^2
5-d F = 1/M*^3 m1 m2 / r^3
6-d F = 1/M*^4 m1 m2 / r^4
F^(4+n) = 1/M*^(2+n) m1 m2 / r^(2+n)

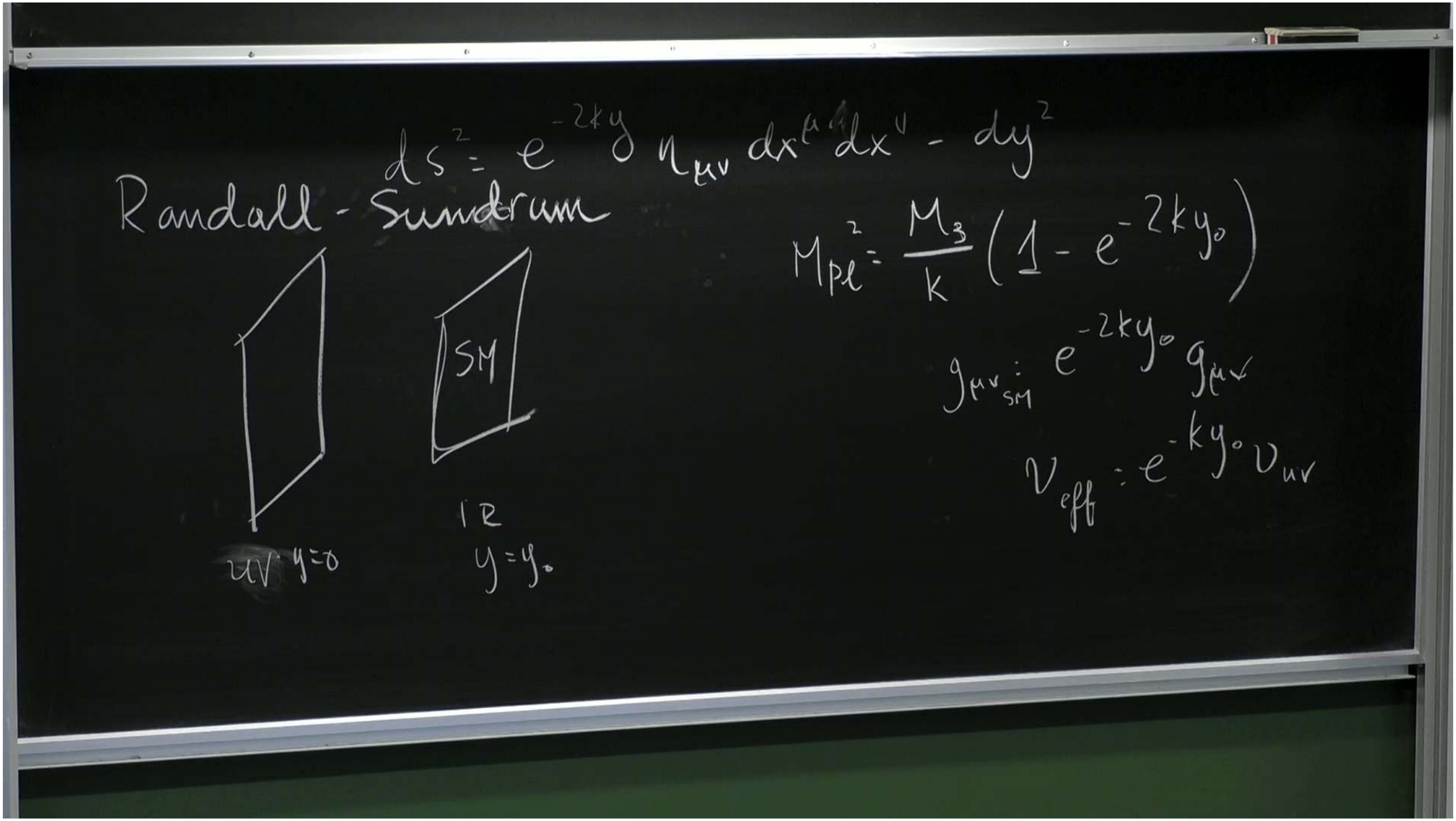

$S_{4\,eff} = -M_*^{n+2} \int d\Omega_{(n)} r_0^n \int d^4x \sqrt{g^{(4)}}\, R^{(4)}$
M_{pl}^2
$M_{pl}^2 = M_*^{n+2} (2\pi r_0)^n$
$r_0^{-1} = M_* \left(\frac{M_*}{M_{pl}}\right)^{2/n}$
$n=1$, $M_* = \mathrm{TeV} = 10^{12}\,\mathrm{eV}$
$r_0^{-1} = 10^{12}\,\mathrm{eV} \left(\frac{10^{12}}{10^{28}}\right)^2 = 10^{12} \cdot 10^{-32}\,\mathrm{eV} = 10^{-20}\,\mathrm{eV} = (10^5\,\mathrm{ls})^{-1}$
Solar System
$n=2$ $r_0^{-1} = 10^{-4}\,\mathrm{eV} \sim \mathrm{mm}^{-1}$
close to exclusion
$n=3$ $r_0^{-1} = 10\,\mathrm{eV} \sim \mu\mathrm{m}^{-1}$ ✓

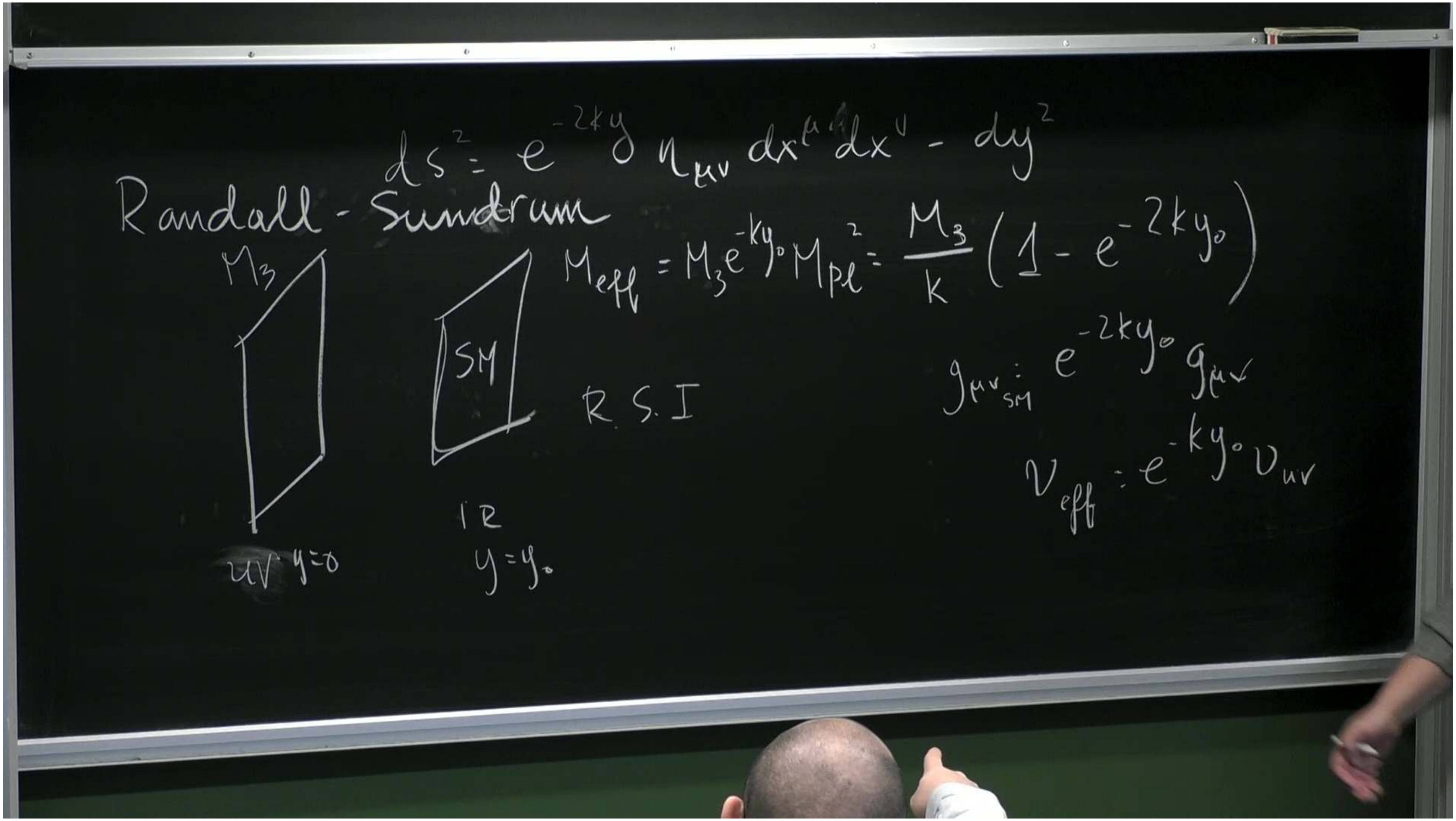

$ds^2 = \left(1 - \frac{r_s}{r}\right) dt^2 + \left(1 - \frac{r_s}{r}\right)^{-1} dr^2 - r^2 d\Omega$
$r_s = \frac{2 G_N m}{r}$
$1 - \frac{2 G_N M}{r} \rightarrow 1 - \frac{2M}{M_*^{n+2} r^{1+n}}$
$r_H \sim \left(\frac{M}{M_*}\right)^{1/1+n} \frac{1}{M_*}$
$\sigma \sim \pi r_H^2$
BH @ LHC
SM + $\not{E}$



$1 - \frac{2G_N M}{r} \to 1 - \frac{2M}{M_*^{n+2} r^{1+n}}$
$r_H \sim \left(\frac{M}{M_*}\right)^{1/1+n}$ $\frac{1}{M_*}$
$\sigma \sim \pi r_H^2$
BH @ LHC
SM $p + \not{E}$
monojet + $\not{E}$
p


$\Delta m \sim \frac{1}{r} \ll M^*$
$\frac{d^2\sigma}{dt\,dm} \propto \frac{m^{n-1}}{M_*^{n+2}}$
$\left|\frac{\dot{T}}{T}\right| = H = \frac{T^2}{M_{pl}}$
$\left|\frac{\dot{T}}{T}\right|_{ev.} \sim \frac{T^{n+3}}{M_*^{n+2}}$
$n = 2 \ldots 6$
$T_* \lesssim 20$ MeV
$T_* <$ few GeV


$ds^2 = e^{-2ky}\eta_{\mu\nu}dx^\mu dx^\nu - dy^2$
Randall - Sundrum
$M_{Pl}^2 = \frac{M_5}{k}(1 - e^{-2ky_0})$
SM
$g_{\mu\nu_{SM}} = e^{-2ky_0} g_{\mu\nu}$
$v_{eff} = e^{-ky_0} v_{UV}$
IR
UV $y=0$
$y=y_0$


$ds^2 = e^{-2ky} \eta_{\mu\nu} dx^\mu dx^\nu - dy^2$
Randall - Sundrum
M_3
SM
$M_{eff} = M_3 e^{-ky_0}$
$M_{pl}^2 = \frac{M_3}{k}\left(1 - e^{-2ky_0}\right)$
R. S. I
$g_{\mu\nu_{SM}} = e^{-2ky_0} g_{\mu\nu}$
$v_{eff} = e^{-ky_0} v_{uv}$
uv $y=0$
IR
$y = y_0$