

Kapitel 0

Einführung

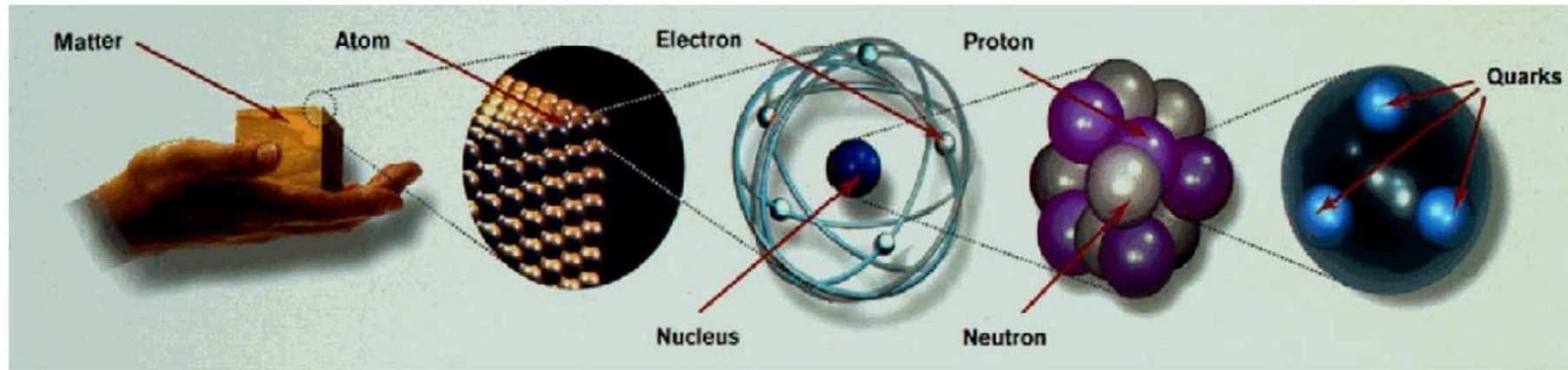
„Elementar“ ist zeitabhängig!

from the Greeks
until ~ 1850

1920

1930

~ 1970



$\sim 10^{-2}$ m

$\sim 10^{-8}$ m

$\sim 10^{-10}$ m
Atom

$\sim 10^{-14}$ m
Nucleus

$\sim 10^{-15}$ m
Proton, Neutron
 $< 10^{-18}$ m
Quarks

Space Dimension



now

Time

300 000 years

100 s 1s

BB

Bausteine der Materie

Teilchen

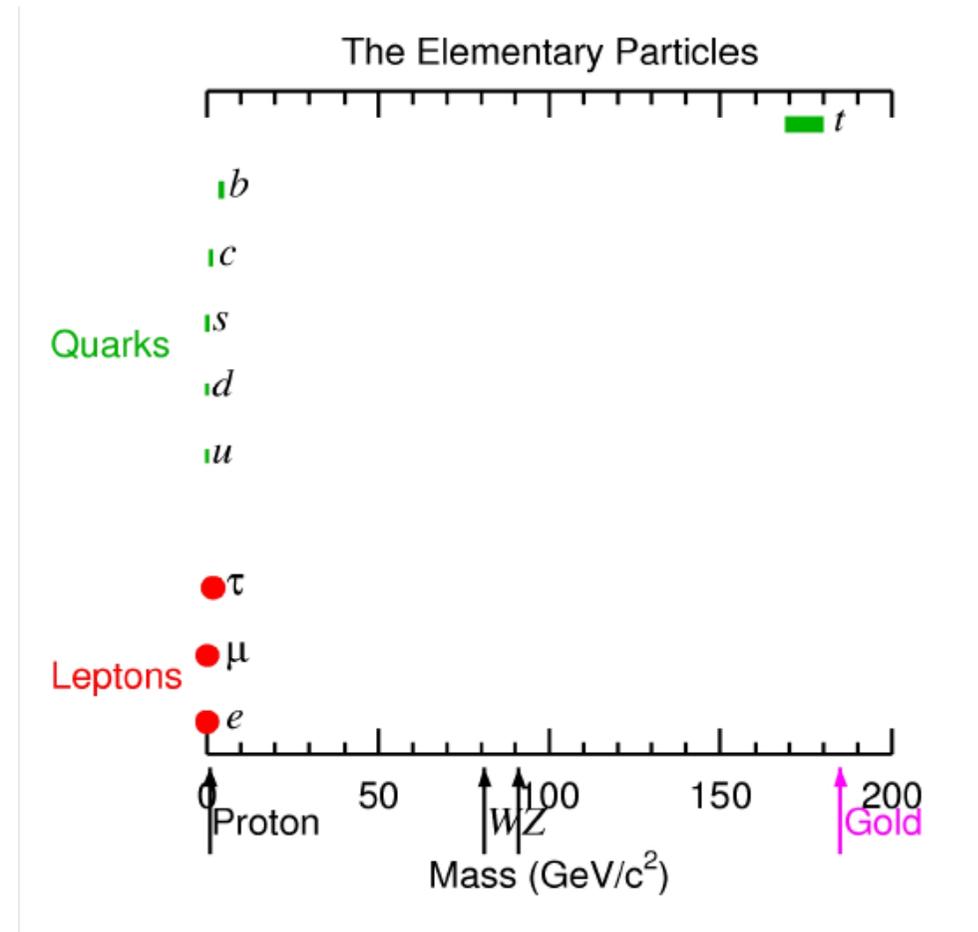
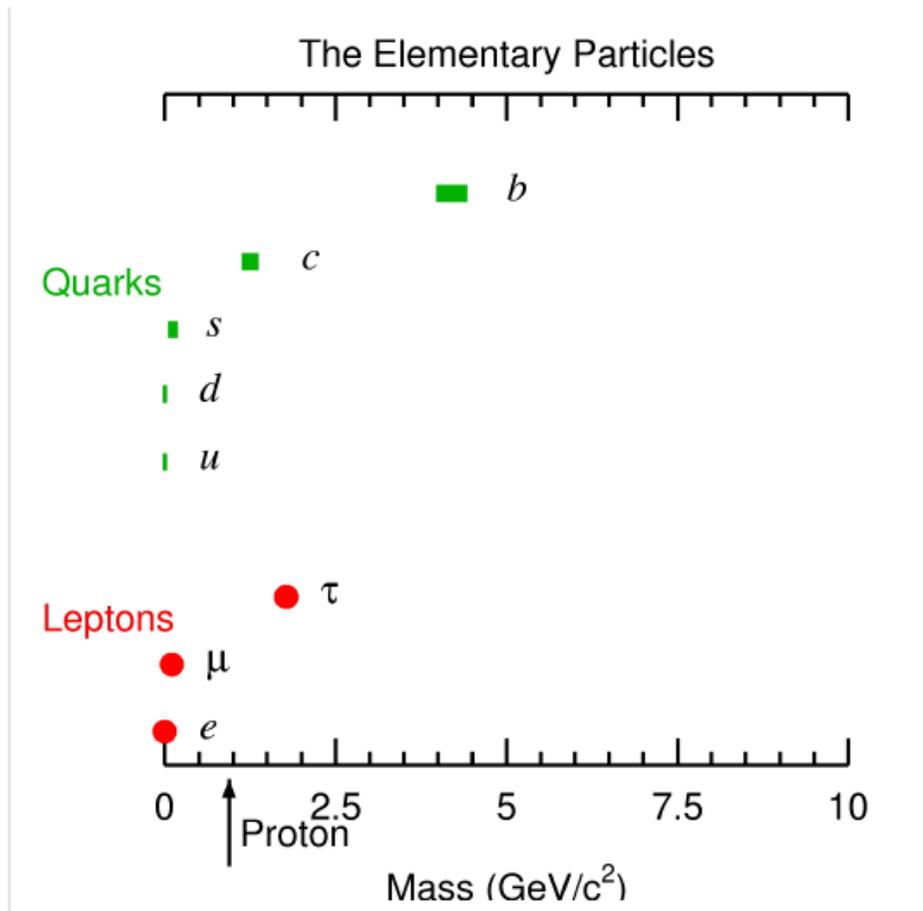
Antiteilchen

Leptonen:	$\begin{pmatrix} \nu_e \\ e^- \end{pmatrix}$	$\begin{pmatrix} \nu_\mu \\ \mu^- \end{pmatrix}$	$\begin{pmatrix} \nu_\tau \\ \tau^- \end{pmatrix}$	charge	$\begin{pmatrix} \bar{\nu}_e \\ e^+ \end{pmatrix}$	$\begin{pmatrix} \bar{\nu}_\mu \\ \mu^+ \end{pmatrix}$	$\begin{pmatrix} \bar{\nu}_\tau \\ \tau^+ \end{pmatrix}$
Quarks:	$\begin{pmatrix} u^{+\frac{2}{3}} \\ d^{-\frac{1}{3}} \end{pmatrix}$	$\begin{pmatrix} c^{+\frac{2}{3}} \\ s^{-\frac{1}{3}} \end{pmatrix}$	$\begin{pmatrix} t^{+\frac{2}{3}} \\ b^{-\frac{1}{3}} \end{pmatrix}$		$\begin{pmatrix} \bar{u}^{-\frac{2}{3}} \\ \bar{d}^{+\frac{1}{3}} \end{pmatrix}$	$\begin{pmatrix} \bar{c}^{-\frac{2}{3}} \\ \bar{s}^{+\frac{1}{3}} \end{pmatrix}$	$\begin{pmatrix} \bar{t}^{-\frac{2}{3}} \\ \bar{b}^{+\frac{1}{3}} \end{pmatrix}$

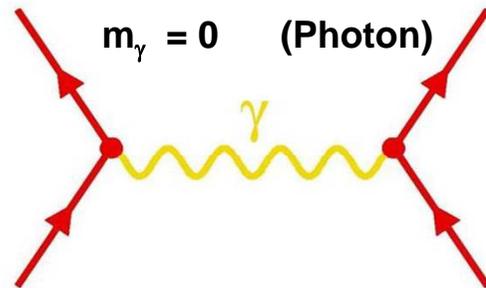
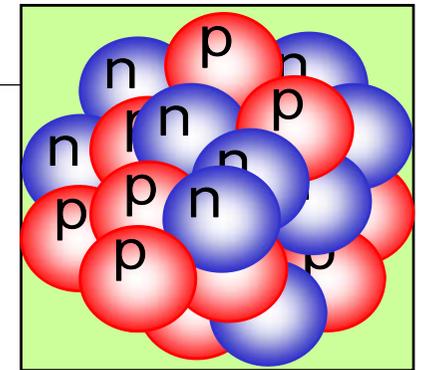
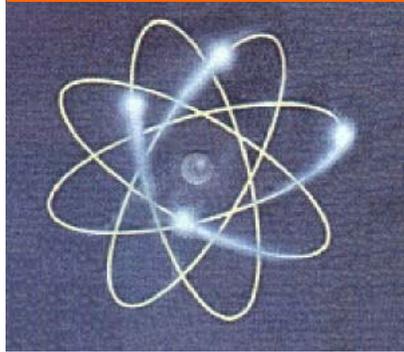
symmetry:

- 3 families
- every particle has an anti-particle
 - same mass
 - opposite charge

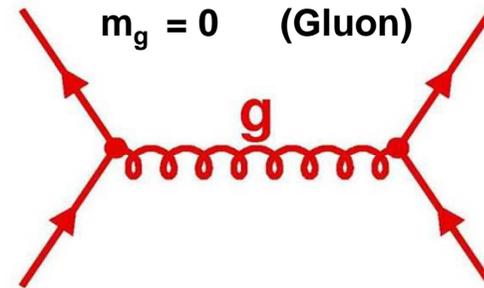
Masse der Elementarteilchen



Wechselwirkungen durch Teilchenaustausch

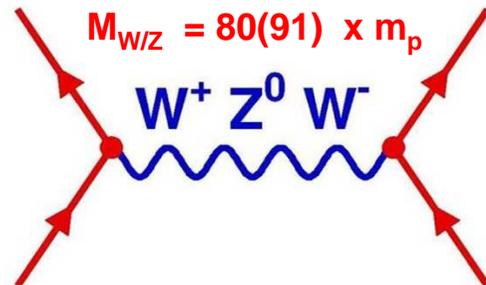


elektromagn. Kraft

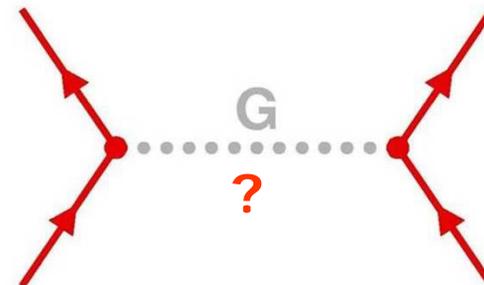


starke Kraft

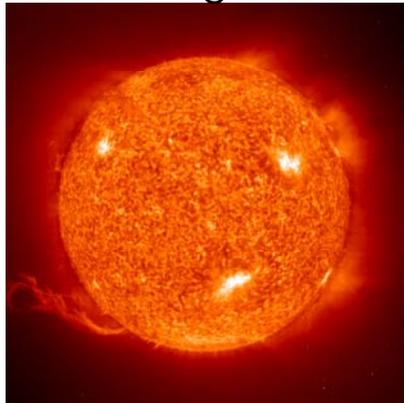
Stärke 1/10000
x el-mag. Kraft



schwache Kraft

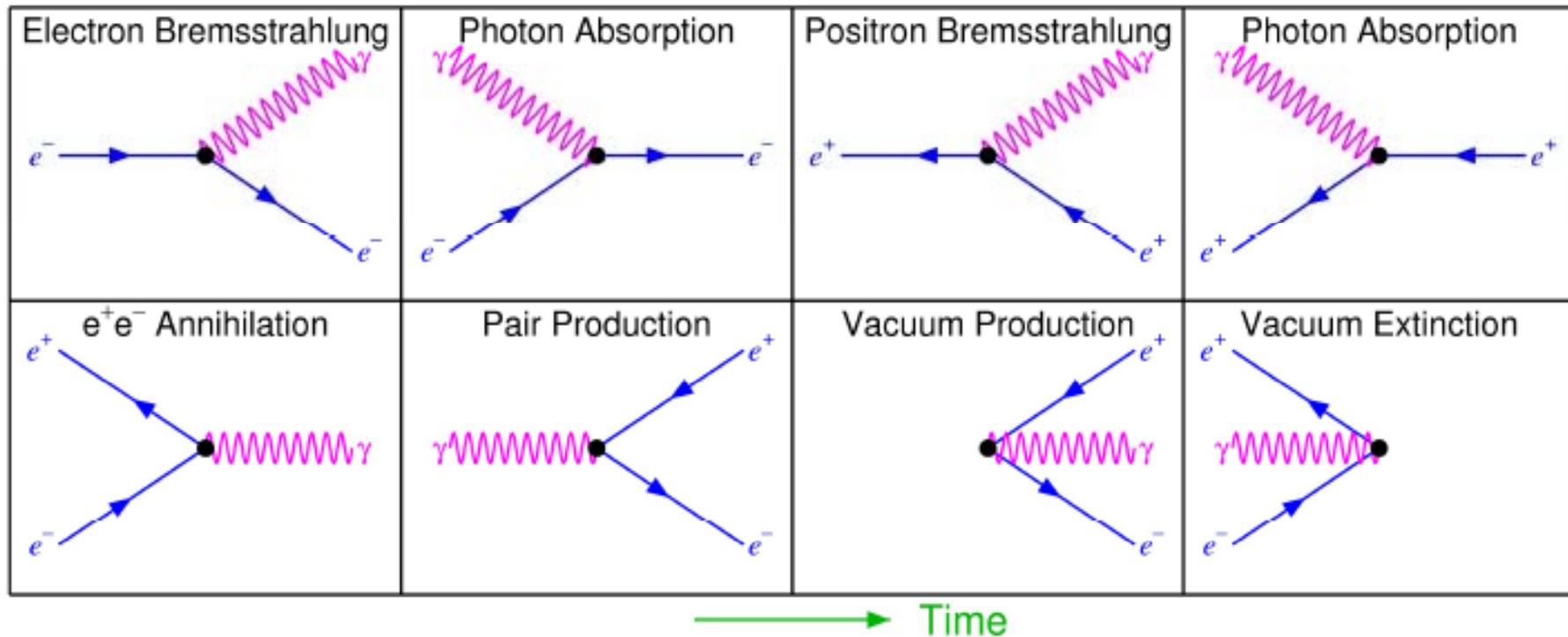


Gravitation

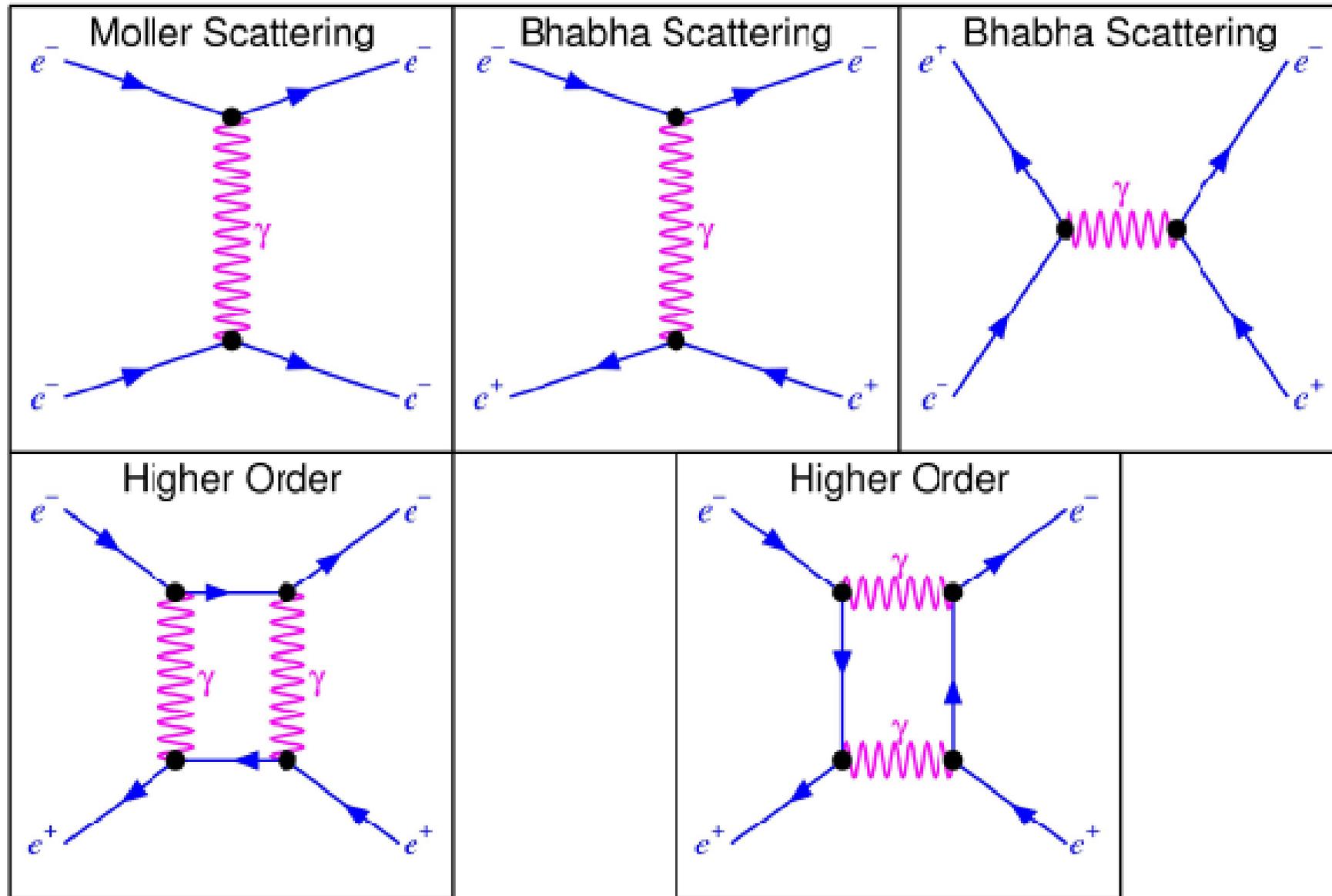


Beschreibung der Kräfte/Wechselwirkungen
und die Struktur der grundlegenden Gesetze
beruht auf abstrakten Symmetrien. Schön?!

QED Feynman-Diagramme

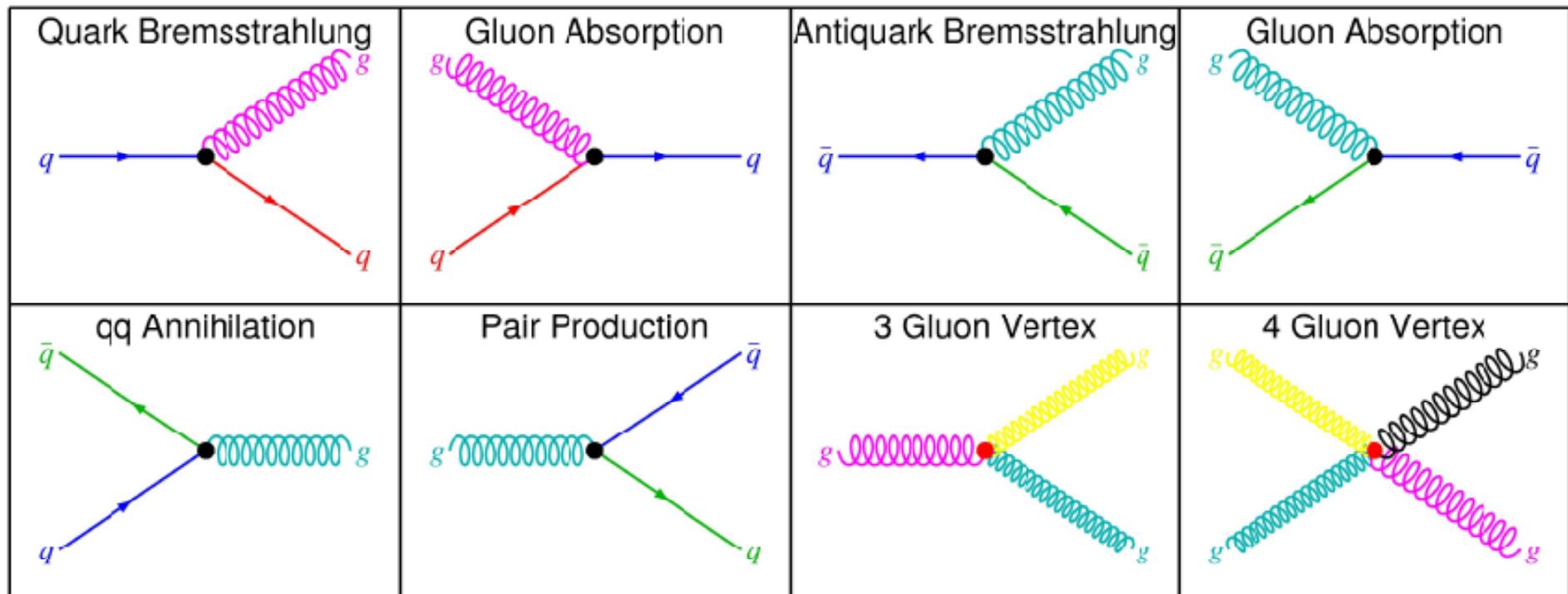


QED Prozesse

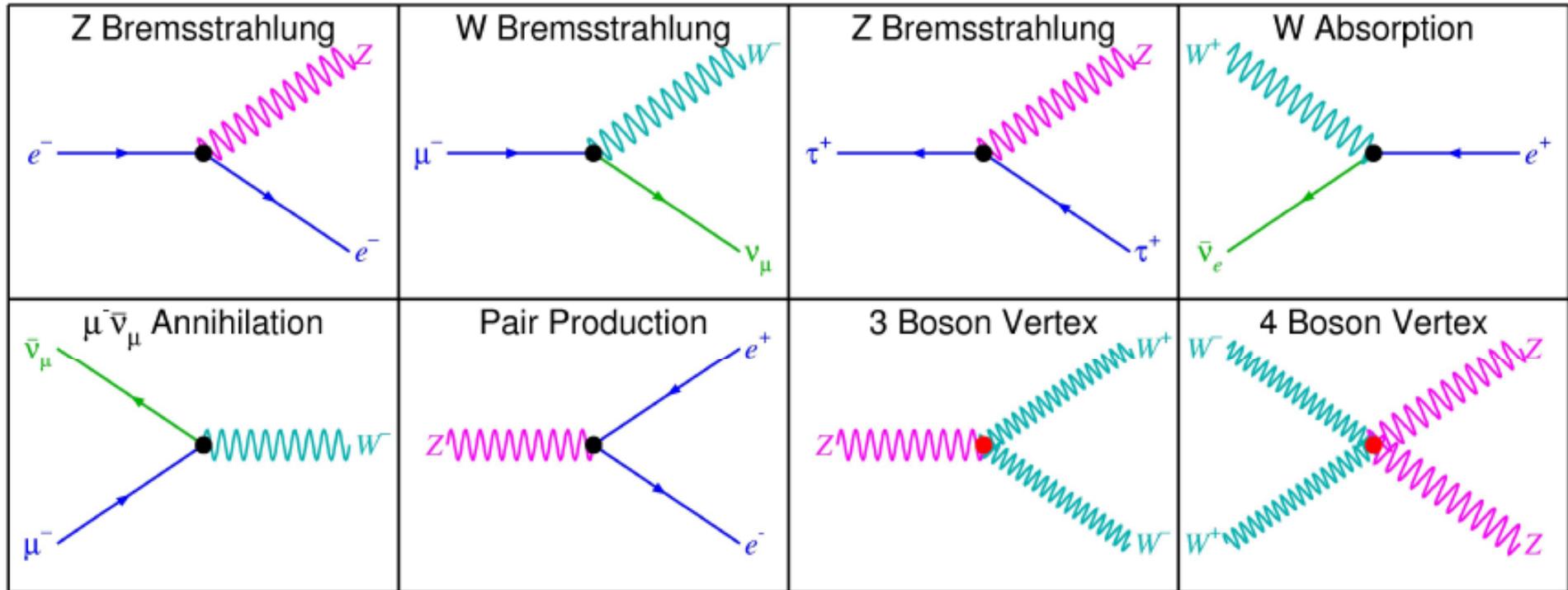


→ Time

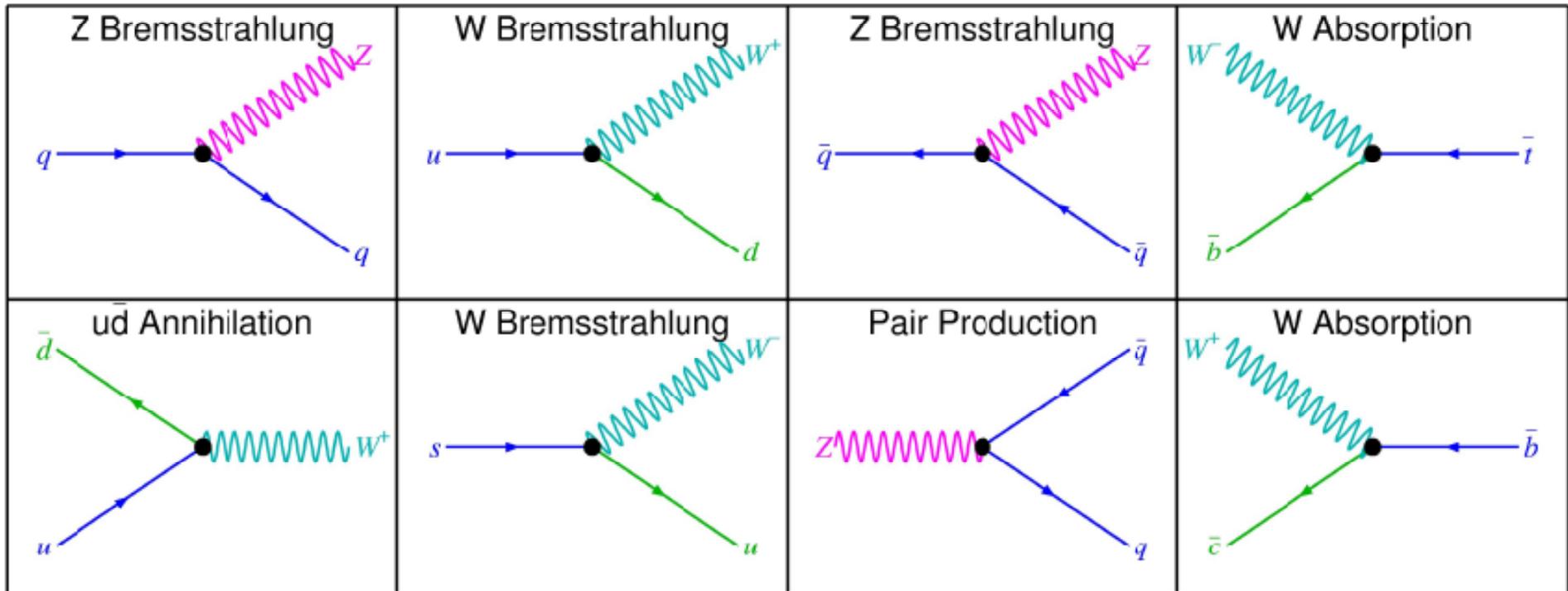
„Starke“ QCD Vertices



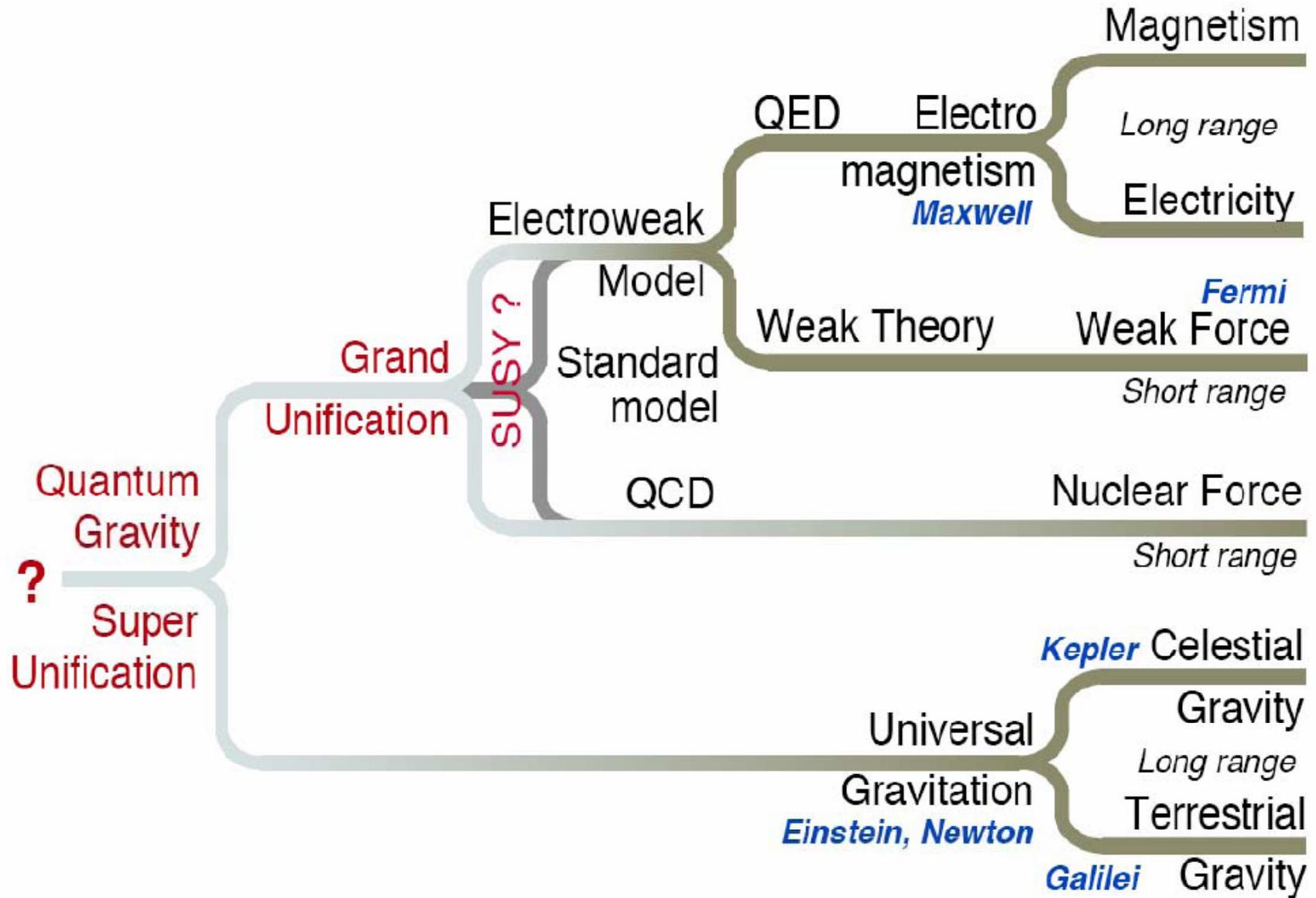
„Schwache“ Lepton Vertices



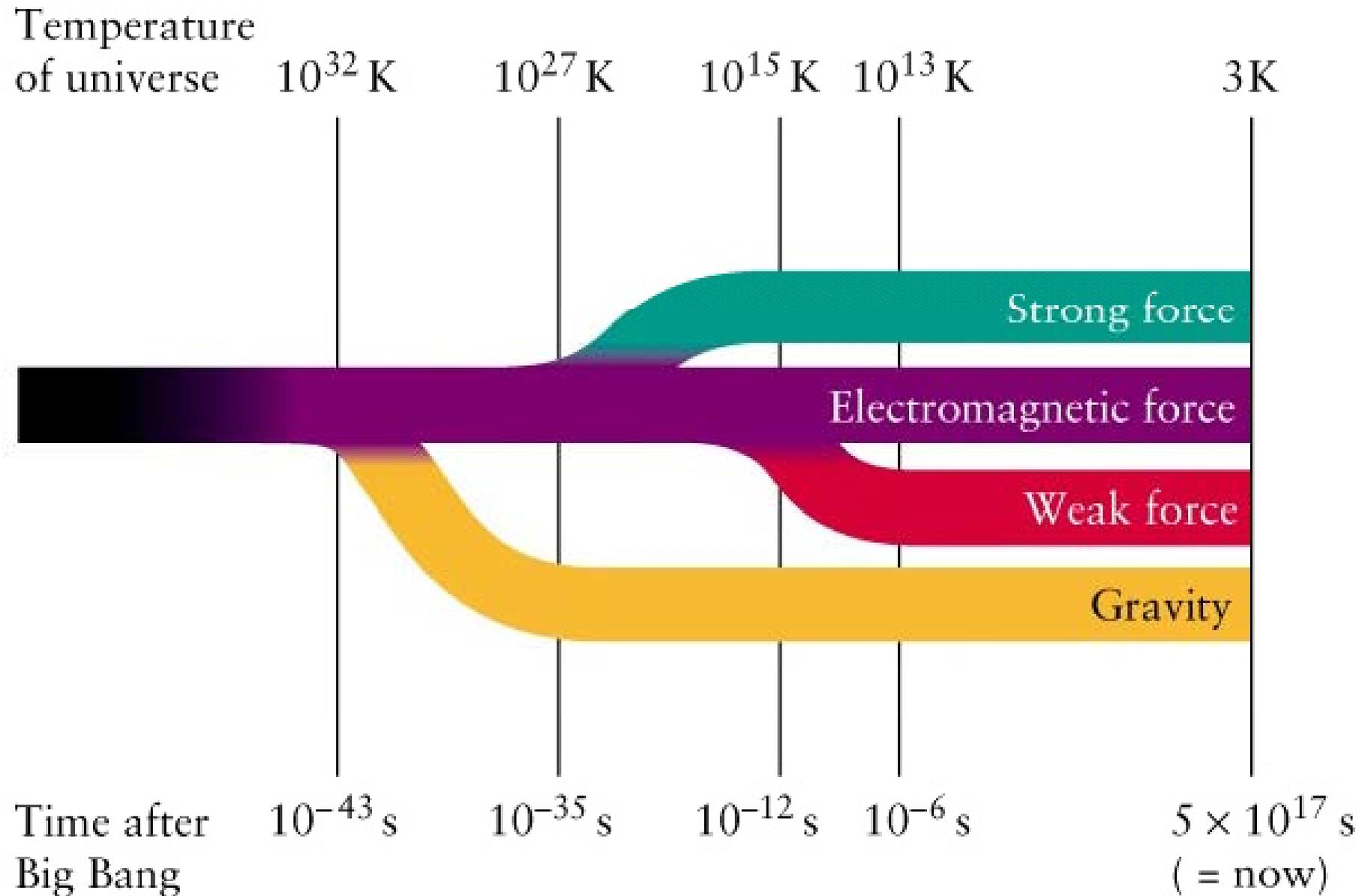
„Schwache“ Quark Vertices



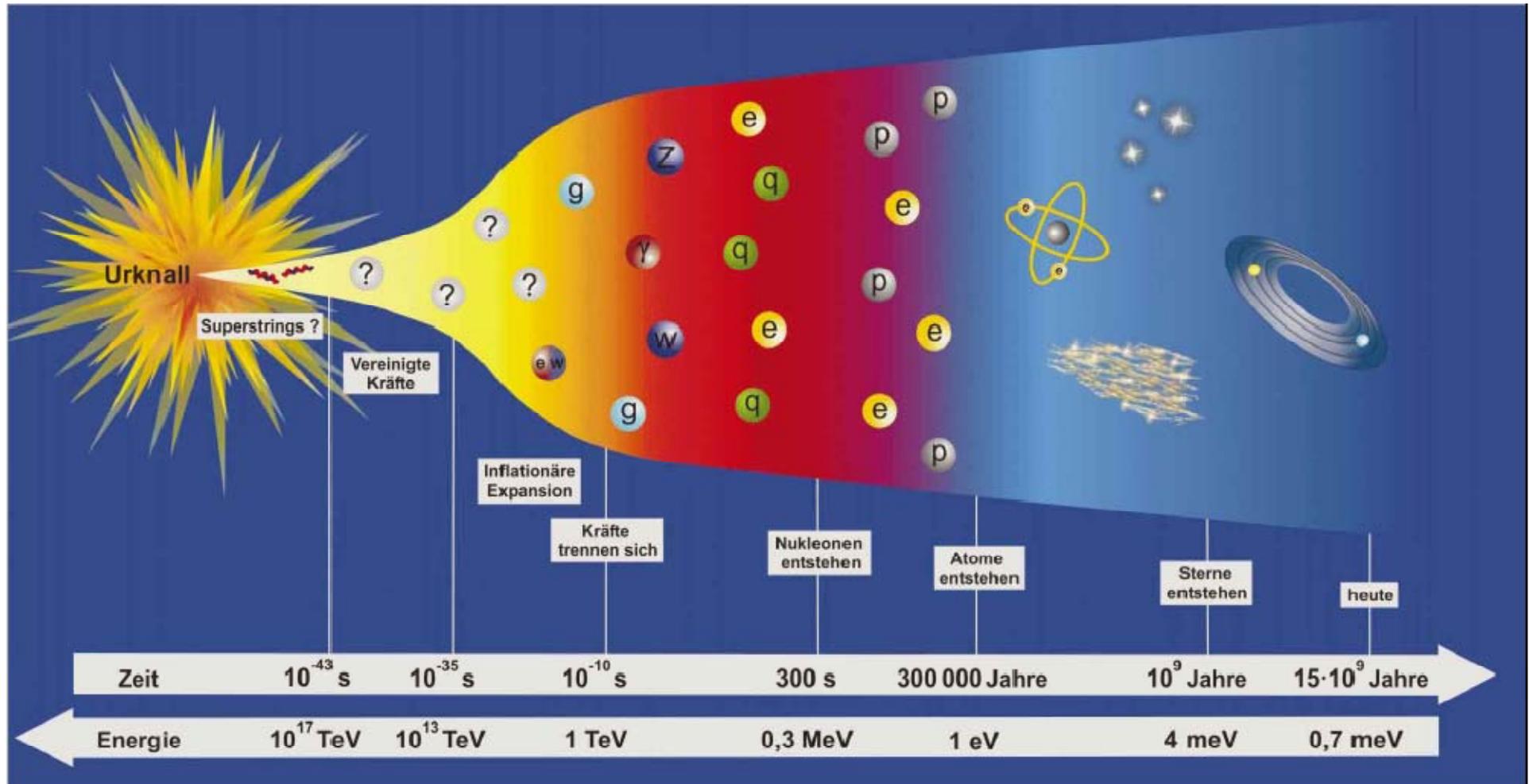
Vereinigung der Kräfte



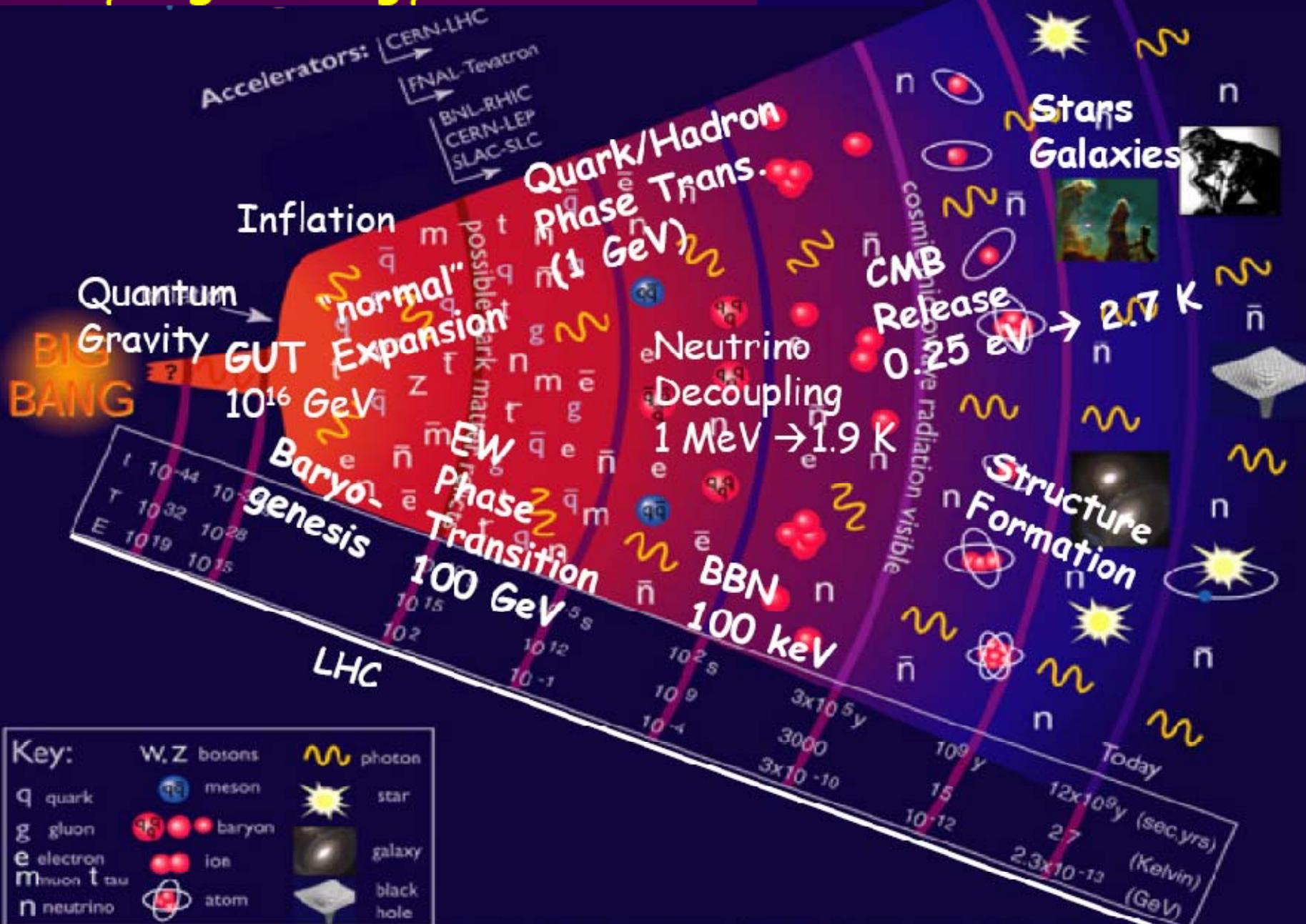
Grosse Vereinigung



Entwicklung des Universums



Why high energy collisions ?



Energiezusammensetzung des Universums

Our present view of
the universe

