Relativistic Quantum Field Theories

Free Theories

- Free scalars
- Free spinors
- Free vectors

...

The "particles": All enumerated representations of the Lorentz group.

Interacting Theories

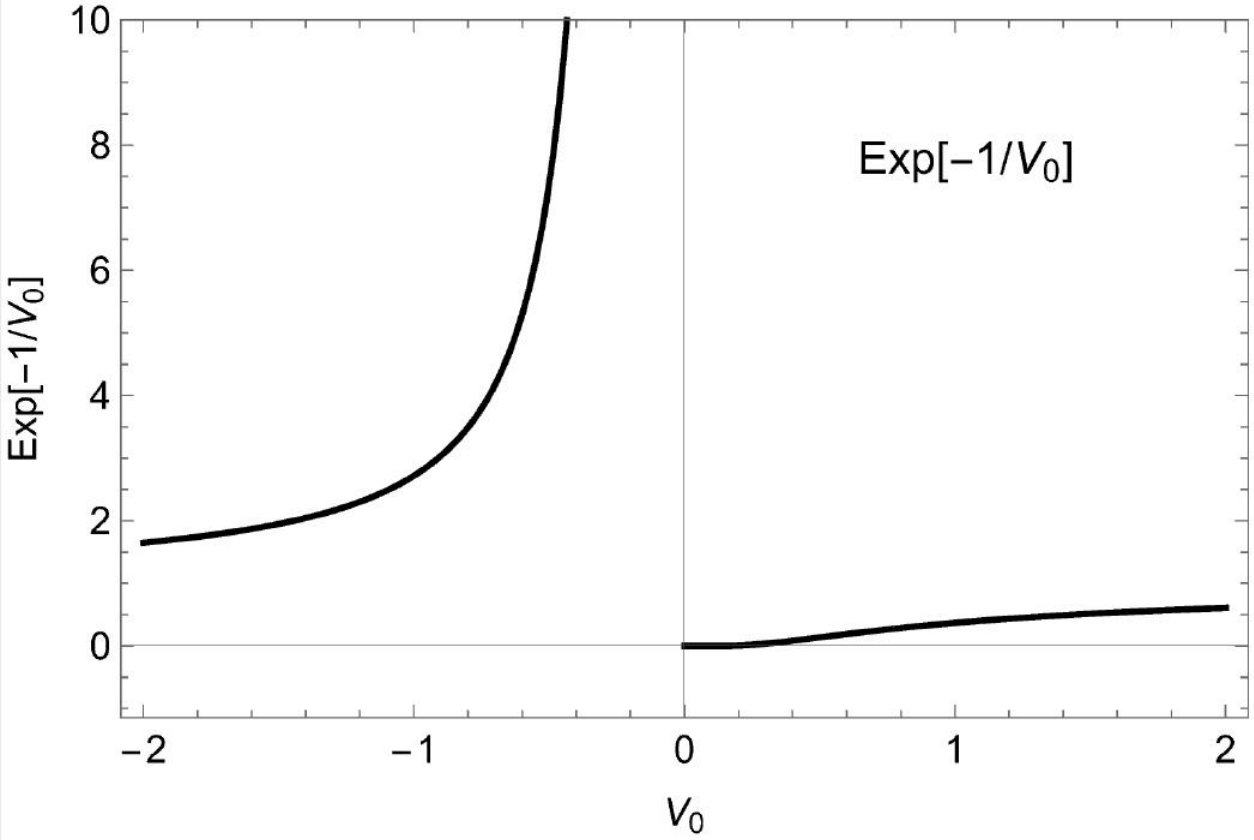
- ϕ^3, ϕ^4 theories
- Yukawa theory

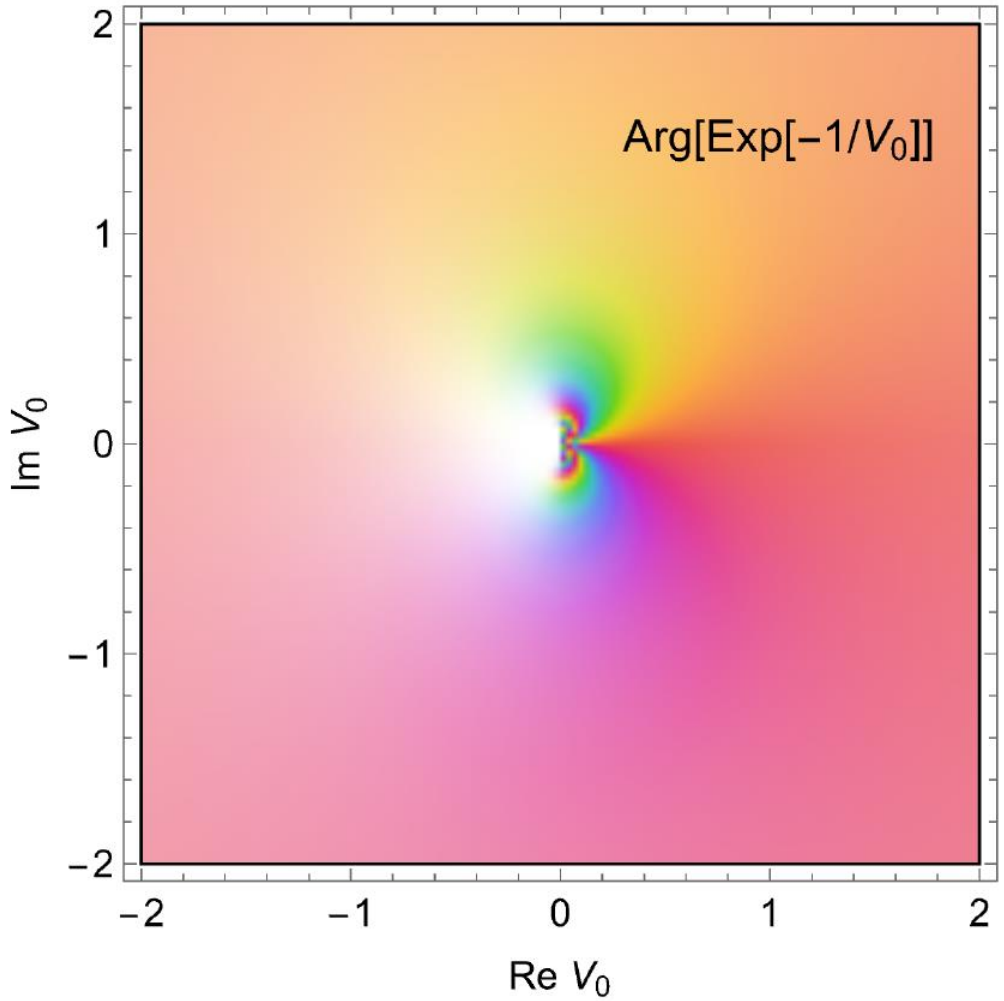
Gauge Theories

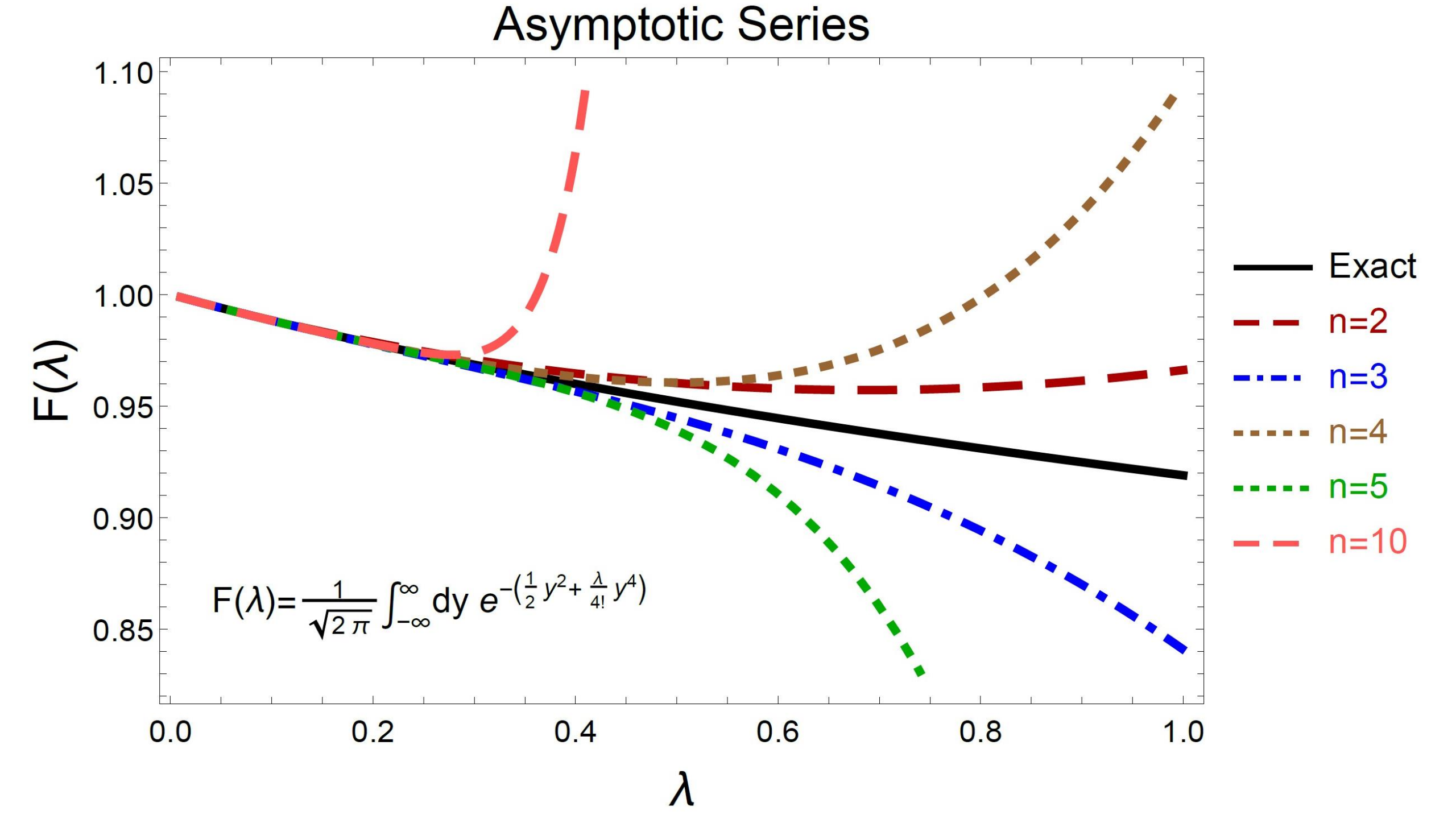
$U(1)$: ***QED***

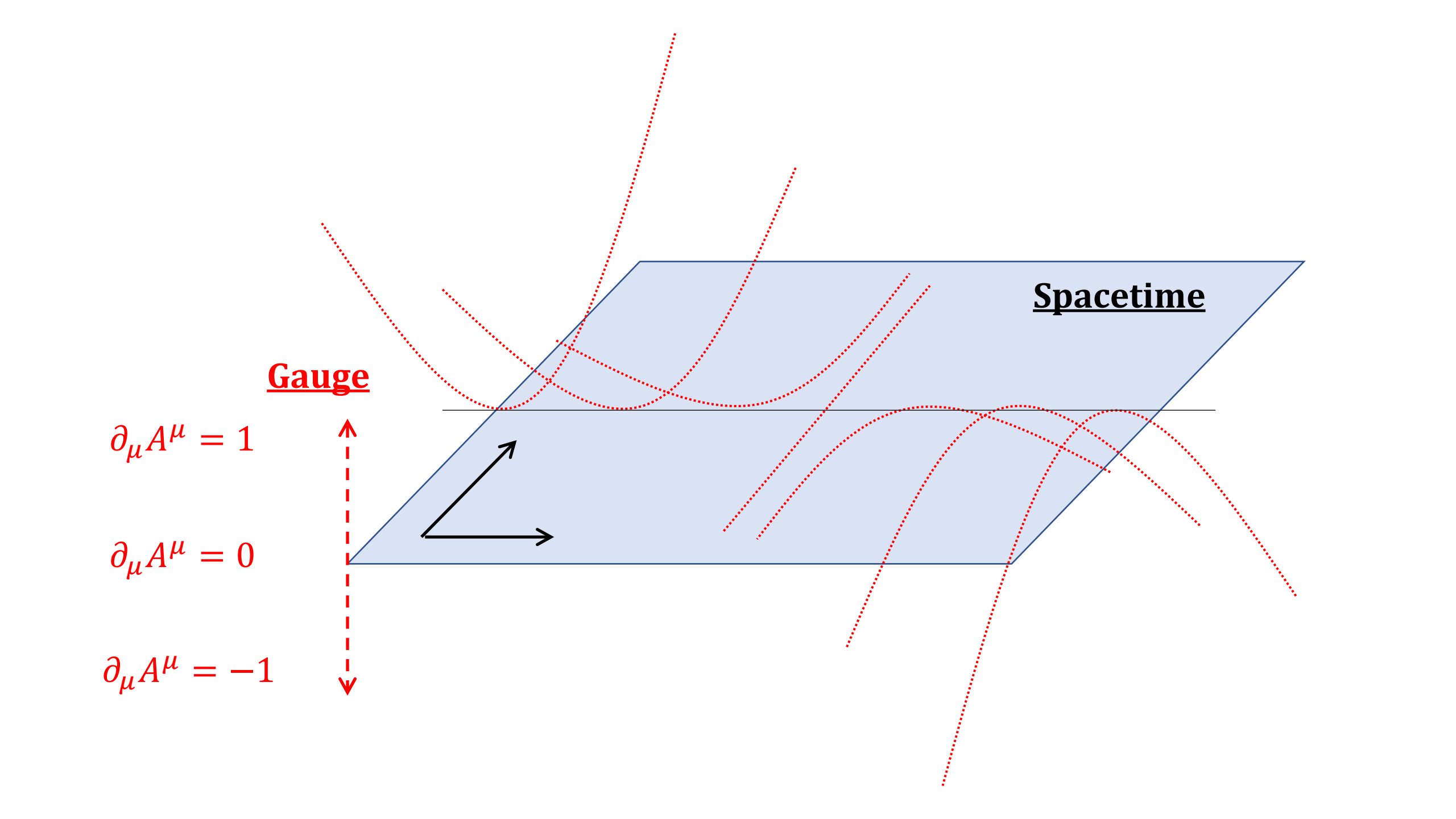
You are here

★ $SU(3)$: ***QCD***

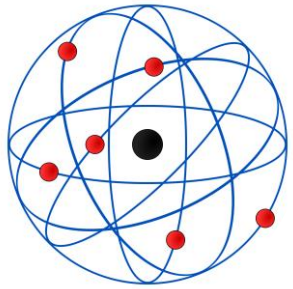

Exp[−1/V_0]
Exp[−1/V_0]
V_0
10
8
6
4
2
0
−2
−1
0
1
2


Arg[Exp[−1/V_0]]
Im V_0
Re V_0
2
1
0
−1
−2
−2
−1
0
1
2


Asymptotic Series
1.10
1.05
1.00
0.95
0.90
0.85
F(λ)
0.0
0.2
0.4
0.6
0.8
1.0
λ
$F(\lambda)=\frac{1}{\sqrt{2\pi}}\int_{-\infty}^{\infty} dy\, e^{-\left(\frac{1}{2}y^2+\frac{\lambda}{4!}y^4\right)}$
Exact
n=2
n=3
n=4
n=5
n=10

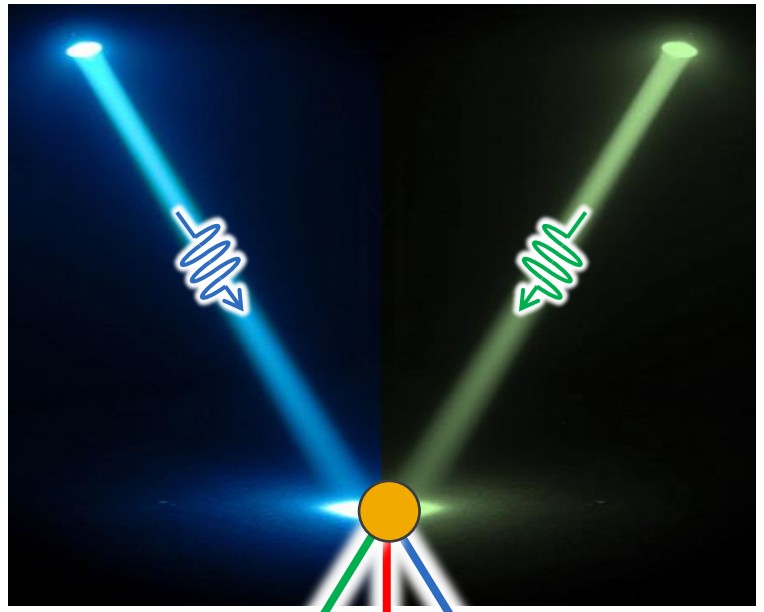

Spacetime
Gauge
$\partial_\mu A^\mu = 1$
$\partial_\mu A^\mu = 0$
$\partial_\mu A^\mu = -1$

Electro-Dynamics: Charges + Fields

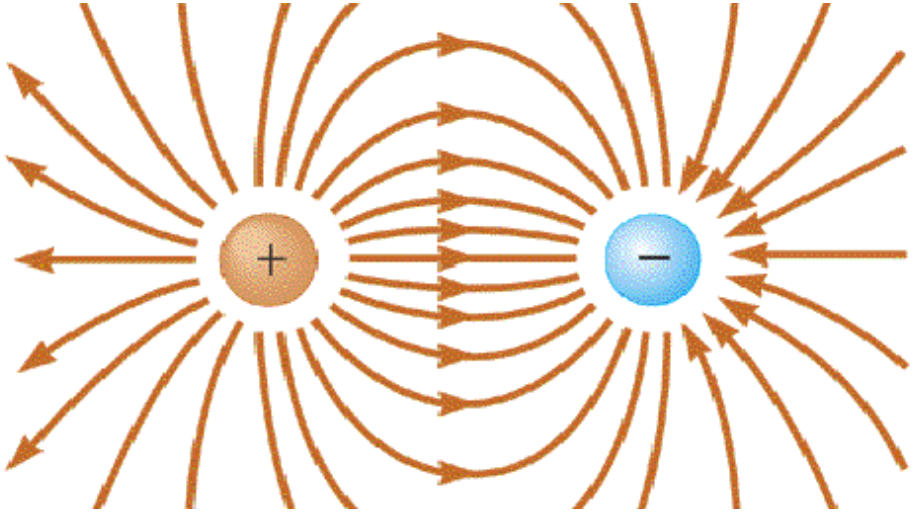


Atom: Electrodynamics

electrons



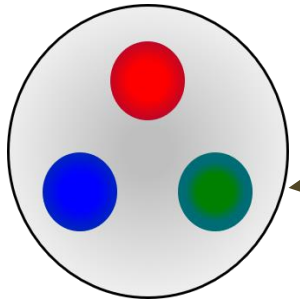
- **Charges** (electrons) radiate **fields** (photons)
- Electric charge is a **scalar (+/−)**



Linear:
Superposition
Principle

$\vec{E}_1$ $\vec{E}_2$ $\vec{E}_1 + \vec{E}_2$

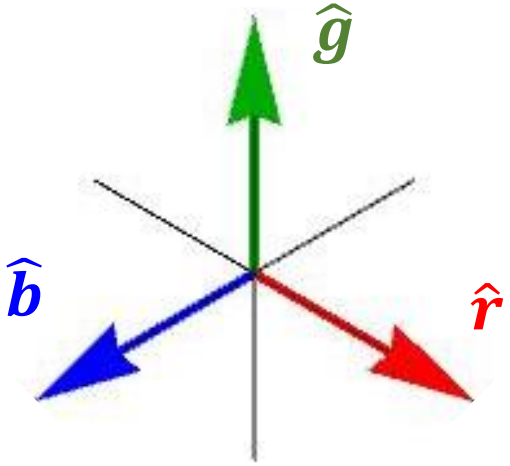
Chromo-Dynamics: One Crucial Difference



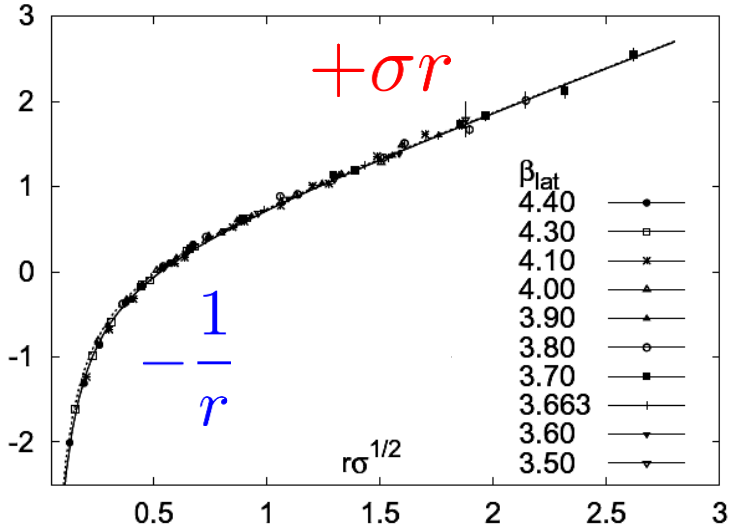
Proton: Chromodynamics

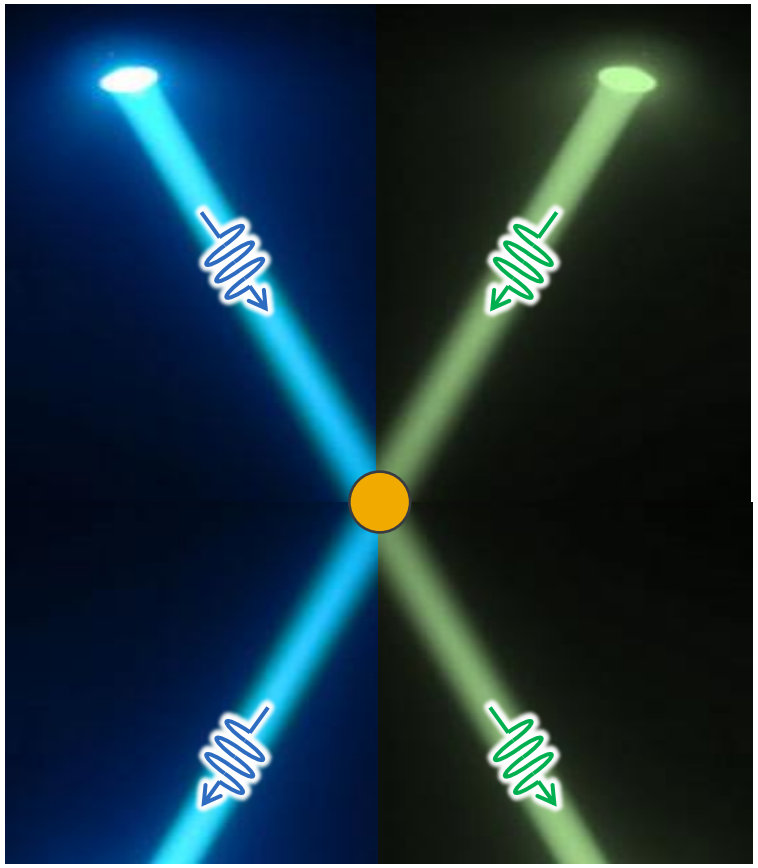
"quarks"

- **Charges** (quarks) radiate **fields** (gluons)
- Color charge is a **vector**



$V(r)$





Non-Linear:
Self-interactions of fields