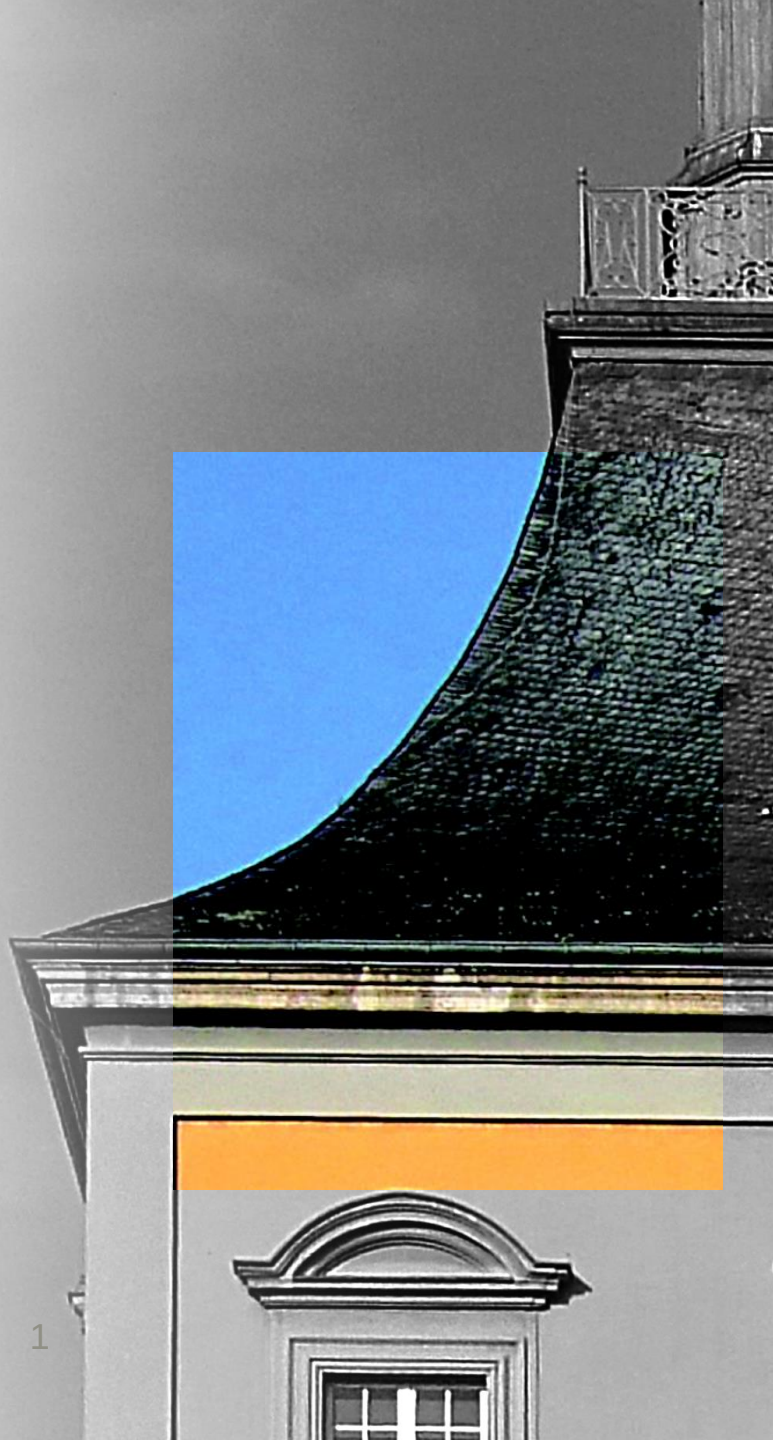
UNIVERSITÄT BONN

Belle II

INTRODUCTION TO THE ANALYSIS OF BELLE II DATA (PT 1)

BELLE-II MASTERCLASS

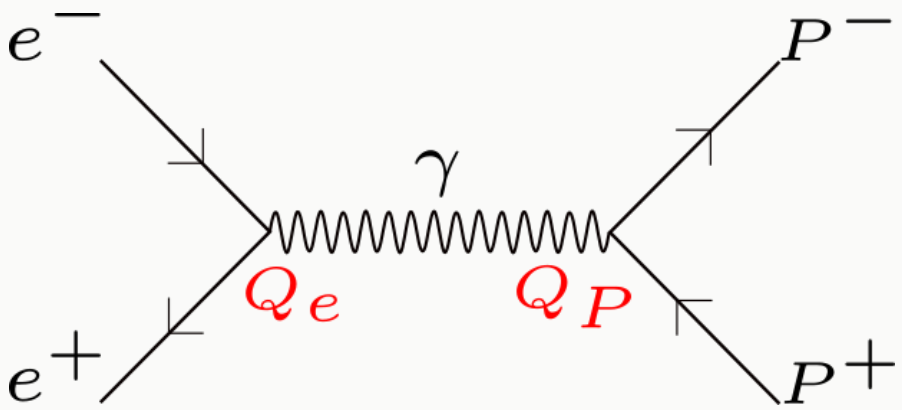


THE COLOURS OF A QUARK

How many colours does a quark come in? — the R-value…

THE COLOURS OF A QUARK

- R-value is directly linked to the number of quark colours. BUT WHAT IS IT?
- Need to know what happens in particle collisions (more later…).
- Electron/positron collision -> photon -> particle/particle.
- Number of particle/antiparticle pairs produced -> proportional to the square of the charge of the particle.



THE COLOURS OF A QUARK

- R-value: ratio of quark/antiquark pairs to muon/antimuon pairs
- Let's work this out!

THE COLOURS OF A QUARK

- a)

$$N\left(e^+e^- \to \gamma \to u\bar{u}\right) = 4/9 \cdot XY$$

$$N\left(e^+e^- \to \gamma \to s\bar{s}\right) = 1/9 \cdot XY$$

$$N\left(e^+e^- \to \gamma \to \tau^+\tau^-\right) = 1 \cdot XY$$

THE COLOURS OF A QUARK

- b)

$$N\left(e^+e^- \to \gamma \to P\bar{P}\right) = \left(\frac{2}{3}\right)^2 \cdot XY = \frac{4}{9} \cdot XY \qquad P = u\bar{u}, c\bar{c}, t\bar{t}$$

THE COLOURS OF A QUARK

- c)

$$N\left(e^+e^- \to \gamma \to u\bar{u}/d\bar{d}/s\bar{s}\right) = 2/3 \cdot XY$$

$$N\left(e^+e^- \to \gamma \to u\bar{u}/d\bar{d}/s\bar{s}/c\bar{c}\right) = 10/9 \cdot XY$$

THE COLOURS OF A QUARK

- d)

$$\frac{N\left(e^+e^- \to \gamma \to u\bar{u}\right)}{N\left(e^+e^- \to \gamma \to s\bar{s}\right)} = 4$$

$$\frac{N\left(e^+e^- \to \gamma \to \tau^+\tau^-\right)}{N\left(e^+e^- \to \gamma \to \mu^+\mu^-\right)} = 1$$

THE COLOURS OF A QUARK

– e)

$$\frac{N\left(e^+e^- \to \gamma \to u\bar{u}/d\bar{d}/s\bar{s}/c\bar{c}\right)}{N\left(e^+e^- \to \gamma \to \tau^+\tau^-\right)} = 10/9$$

$$R = \frac{N\left(e^+e^- \to \gamma \to u\bar{u}/d\bar{d}/s\bar{s}/c\bar{c}\right)}{\frac{1}{2}\cdot\left[N\left(e^+e^- \to \gamma \to \mu^+\mu^-\right) + N\left(e^+e^- \to \gamma \to \tau^+\tau^-\right)\right]} = 10/9$$

THE COLOURS OF A QUARK

- f)

$$R = \frac{N\left(e^+e^- \to \gamma \to u\bar{u}/d\bar{d}/s\bar{s}/c\bar{c}\right)}{\frac{1}{2}\cdot\left[N\left(e^+e^- \to \gamma \to \mu^+\mu^-\right) + N\left(e^+e^- \to \gamma \to \tau^+\tau^-\right)\right]} = 50/9$$

$$R = \frac{N\left(e^+e^- \to \gamma \to u\bar{u}/d\bar{d}/s\bar{s}/c\bar{c}\right)}{\frac{1}{2}\cdot\left[N\left(e^+e^- \to \gamma \to \mu^+\mu^-\right) + N\left(e^+e^- \to \gamma \to \tau^+\tau^-\right)\right]} = 10/3$$

THE COLOURS OF A QUARK

– But…how is this done in practice? 🤔