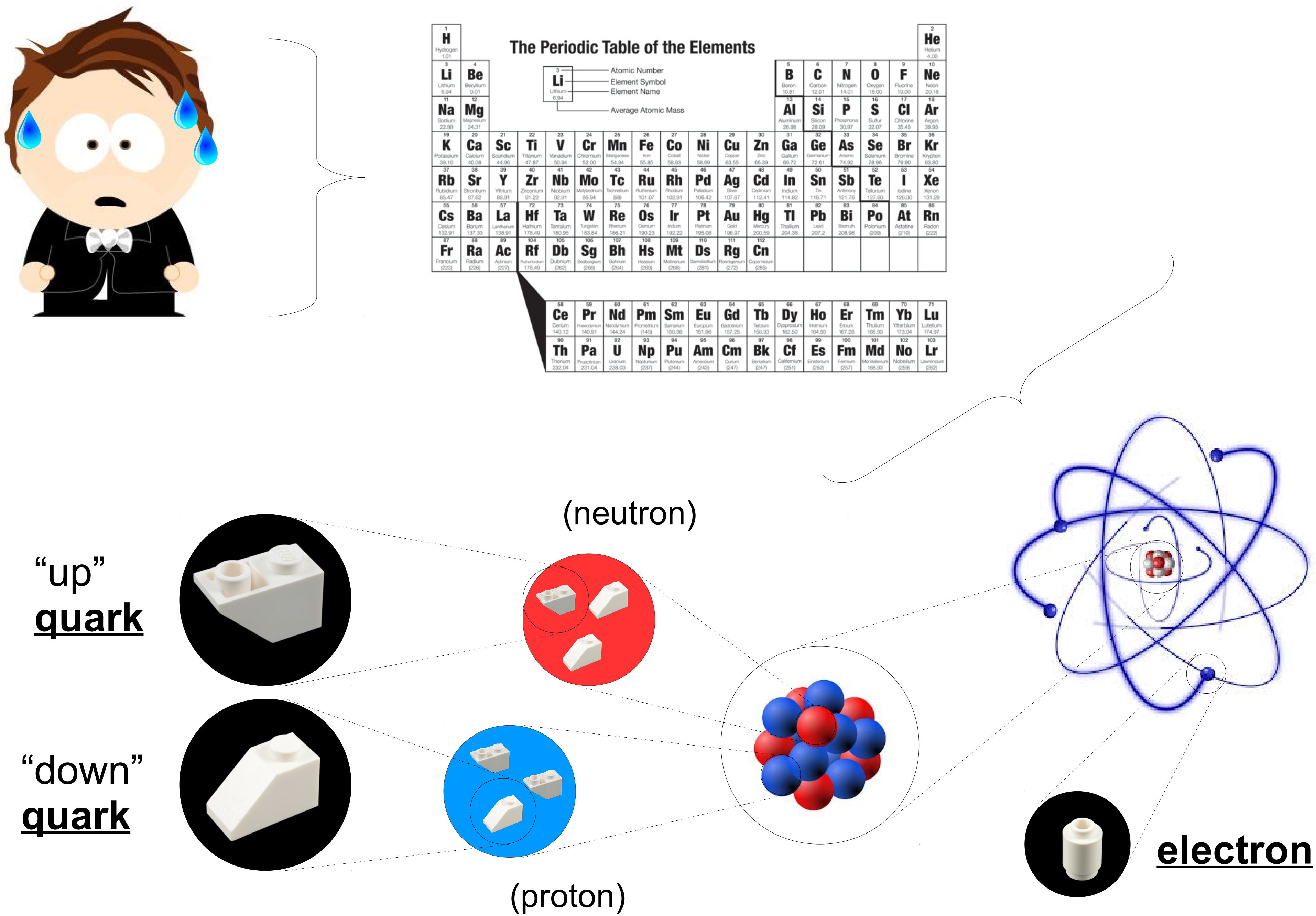
Strategies to Hunt for New Physics with Strange Beauty Mesons

Robert Knegjens

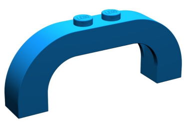
Particle Physics



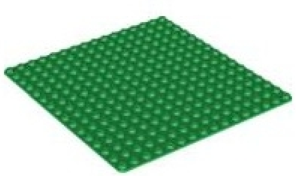
The Standard Model

Bosons

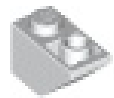

photon
(electromagentism)

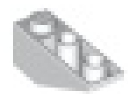

W boson
(weak nuclear force)

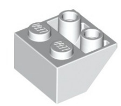

gluon
(strong nuclear force)

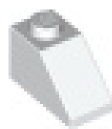

Higgs boson

Quarks


up


charm


top


down

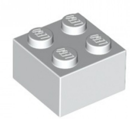

strange


beauty

Leptons


electron

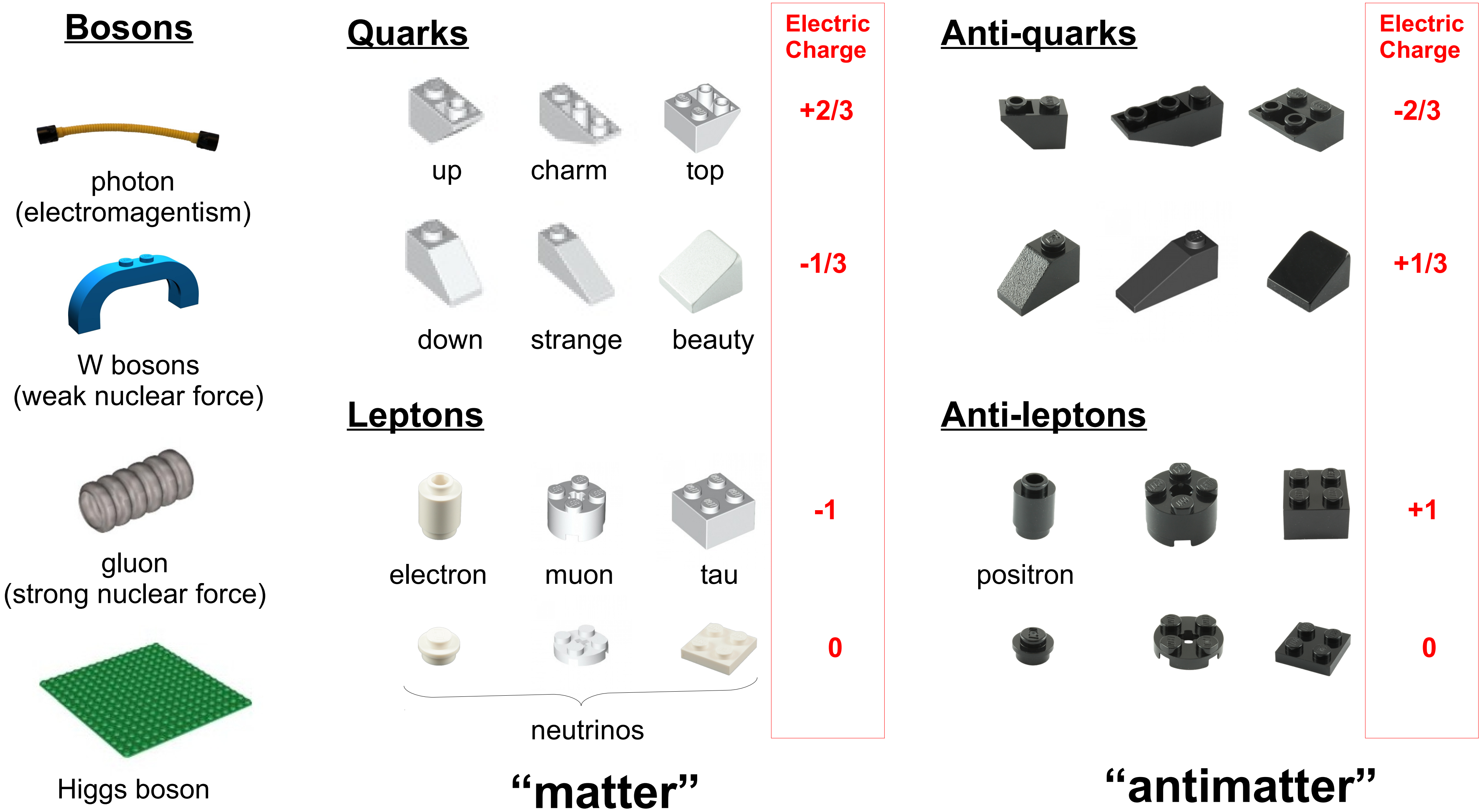

muon


tau




neutrinos

The Standard Model



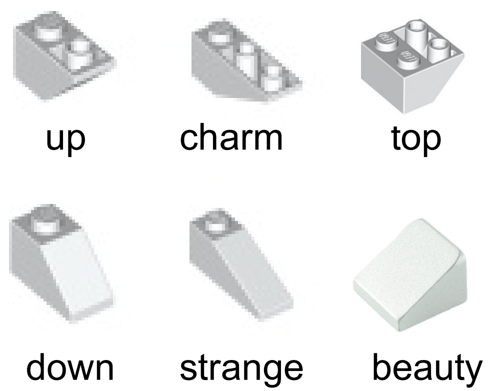
$$(i\gamma^{\mu}\partial_{\mu}-m)\psi=0$$

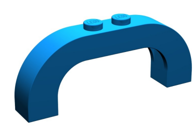
Paul Dirac (1928)


MATTER
ANTI-MATTER
S. Harris


The Standard Model
✦ ~1975
† ?
?
New Forces
NEW FORCES
Cluedo?
New Matter
NEW MATTER
Cluedo?
“New Physics”

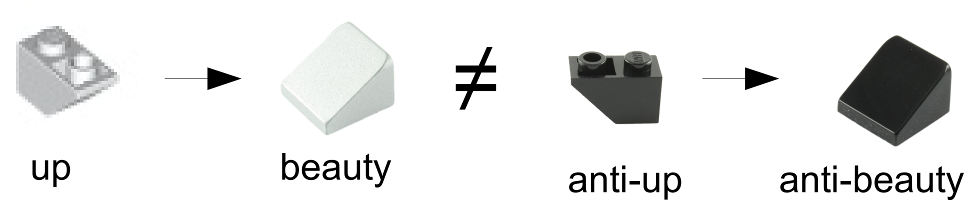
Quark flavours



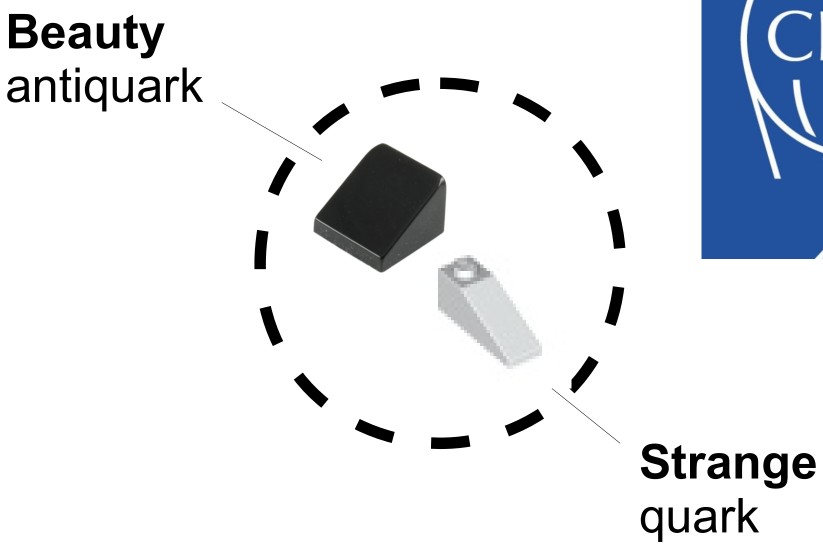
Change flavour via **weak force**  in Standard Model

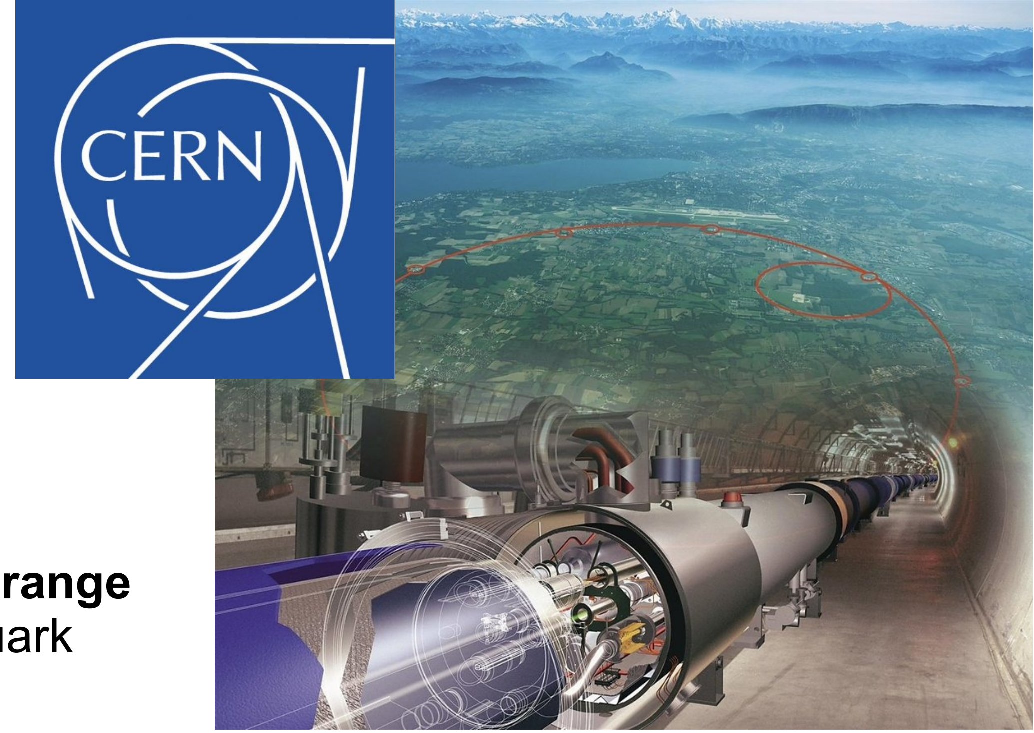
Behave asymmetrically

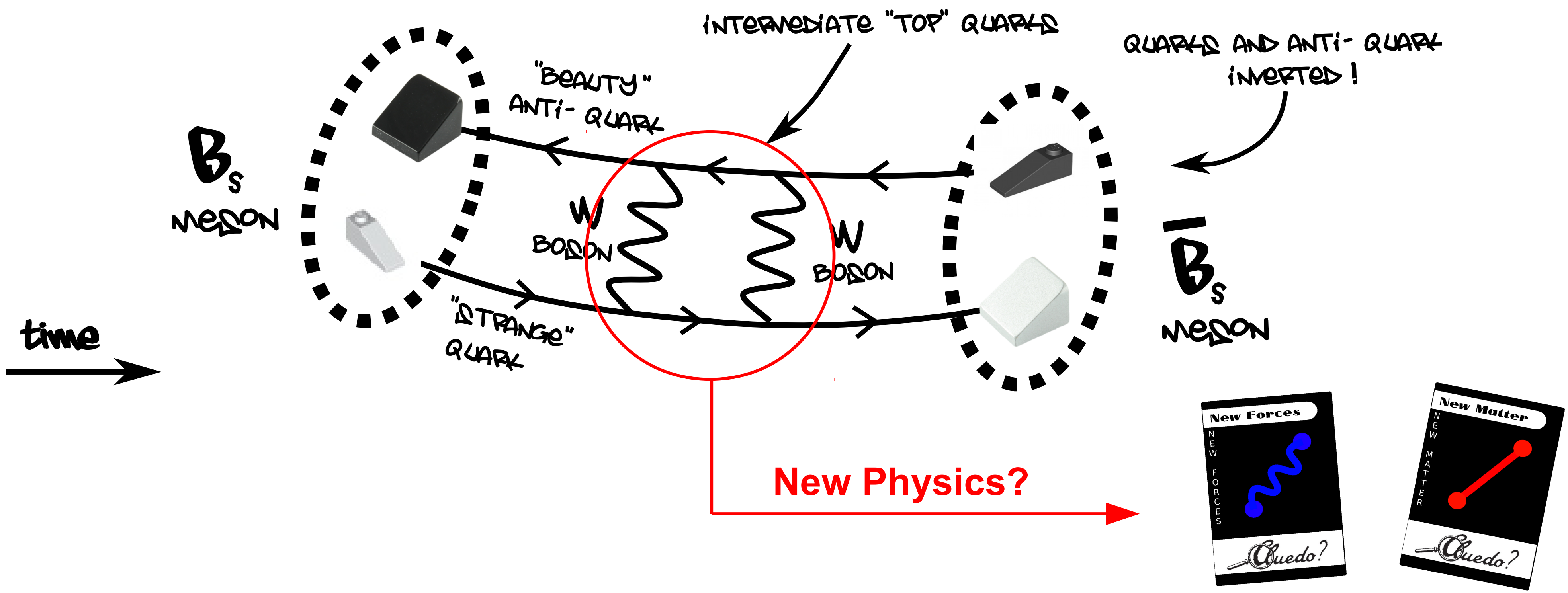
(violate "CP symmetry")



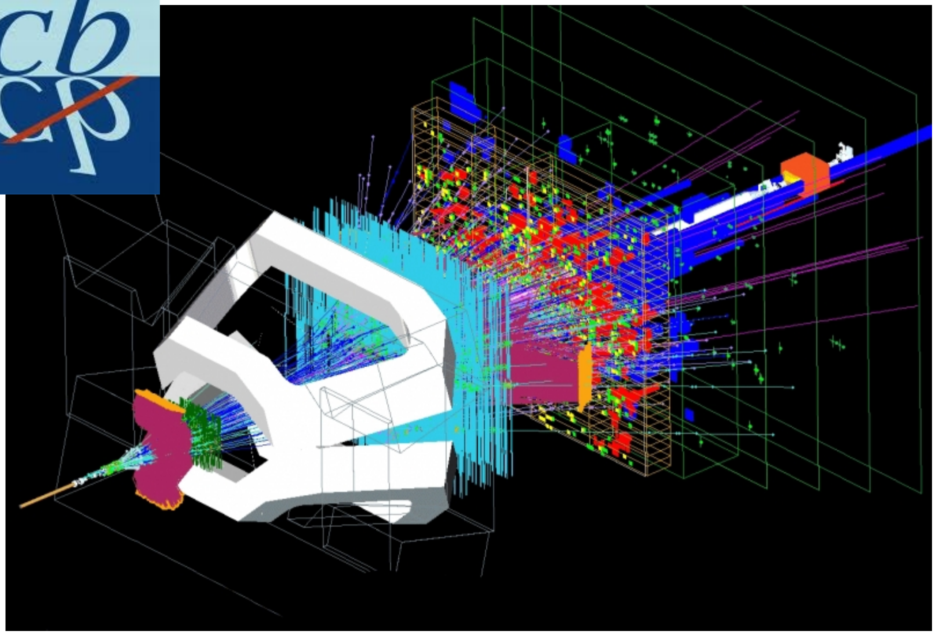
Strange Beauty Mesons

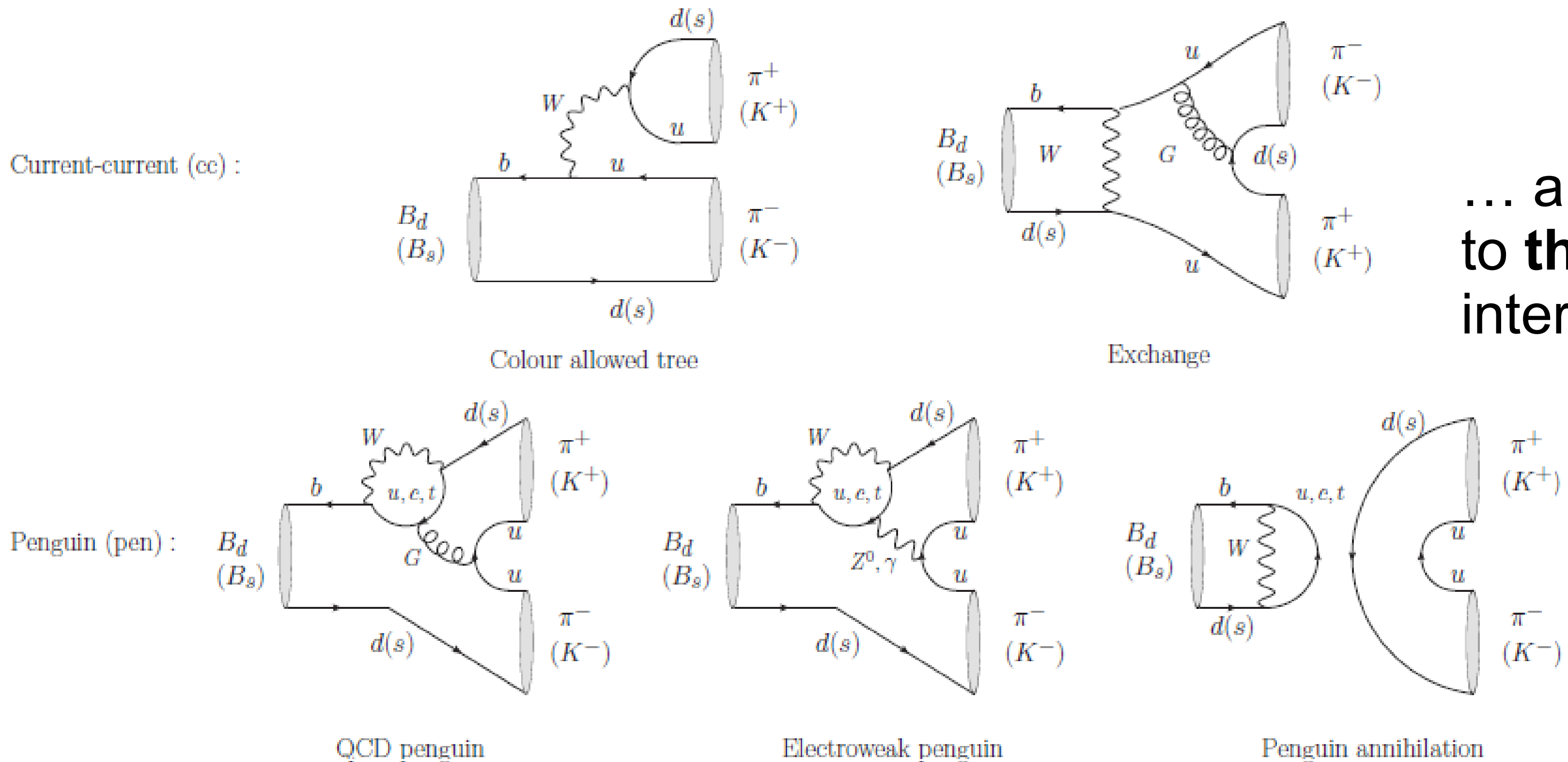




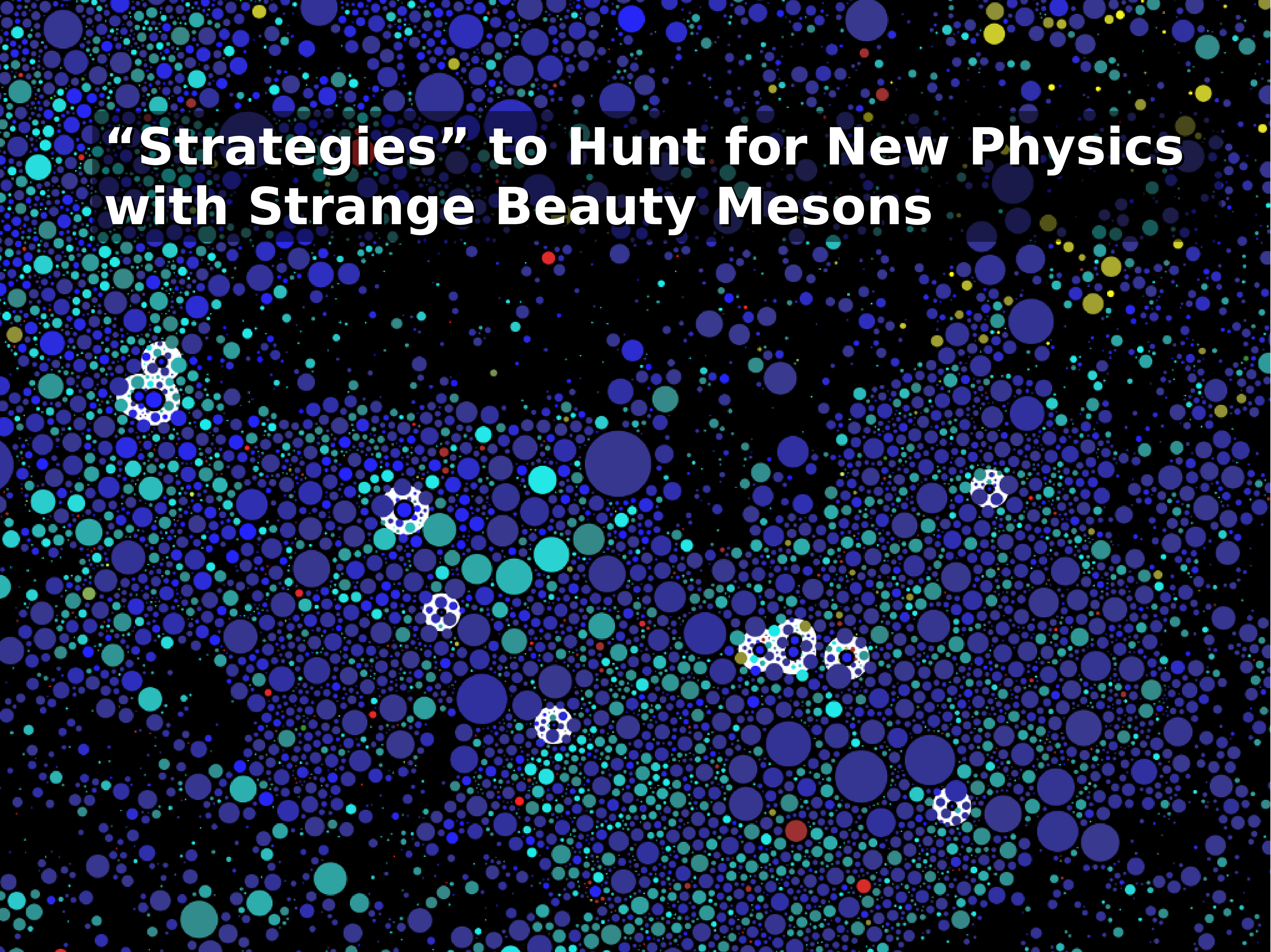


Challenging to **experimentally** measure ...





… and challenging to **theoretically** interpret

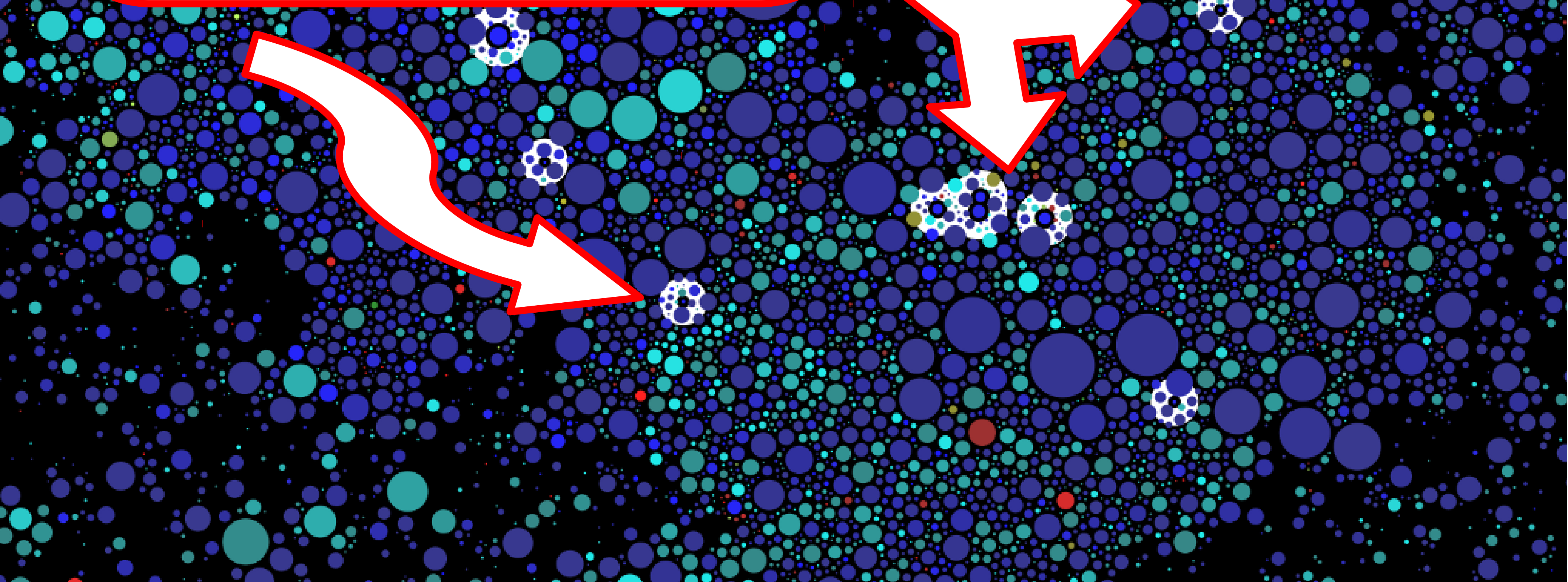

“Strategies” to Hunt for New Physics
with Strange Beauty Mesons

Using quark flavour symmetries

Approximate symmetry lets us puzzle together various observations

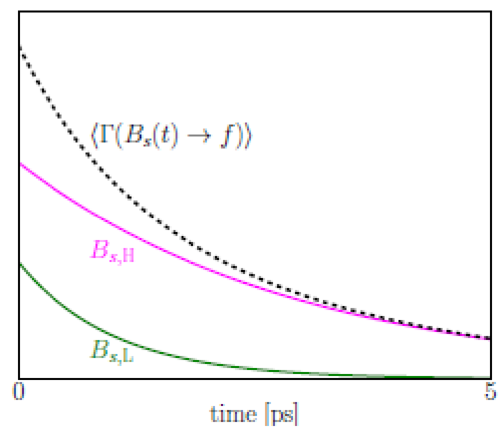
$B_s \to K^+ K^-$ ↔ $B_d \to \pi^+ \pi^-$

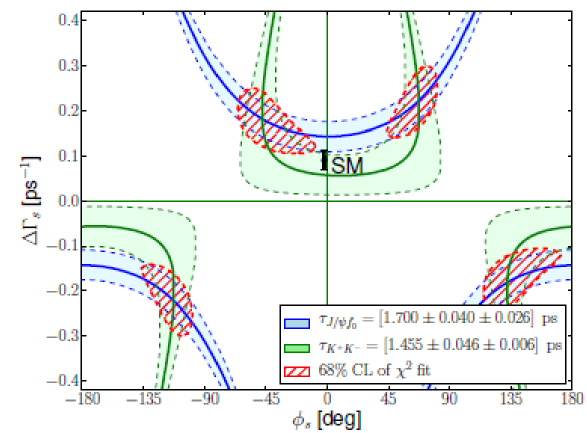
$B_s \to J/\psi$ (ss) ↔ $B_d \to J/\psi$ (dd)

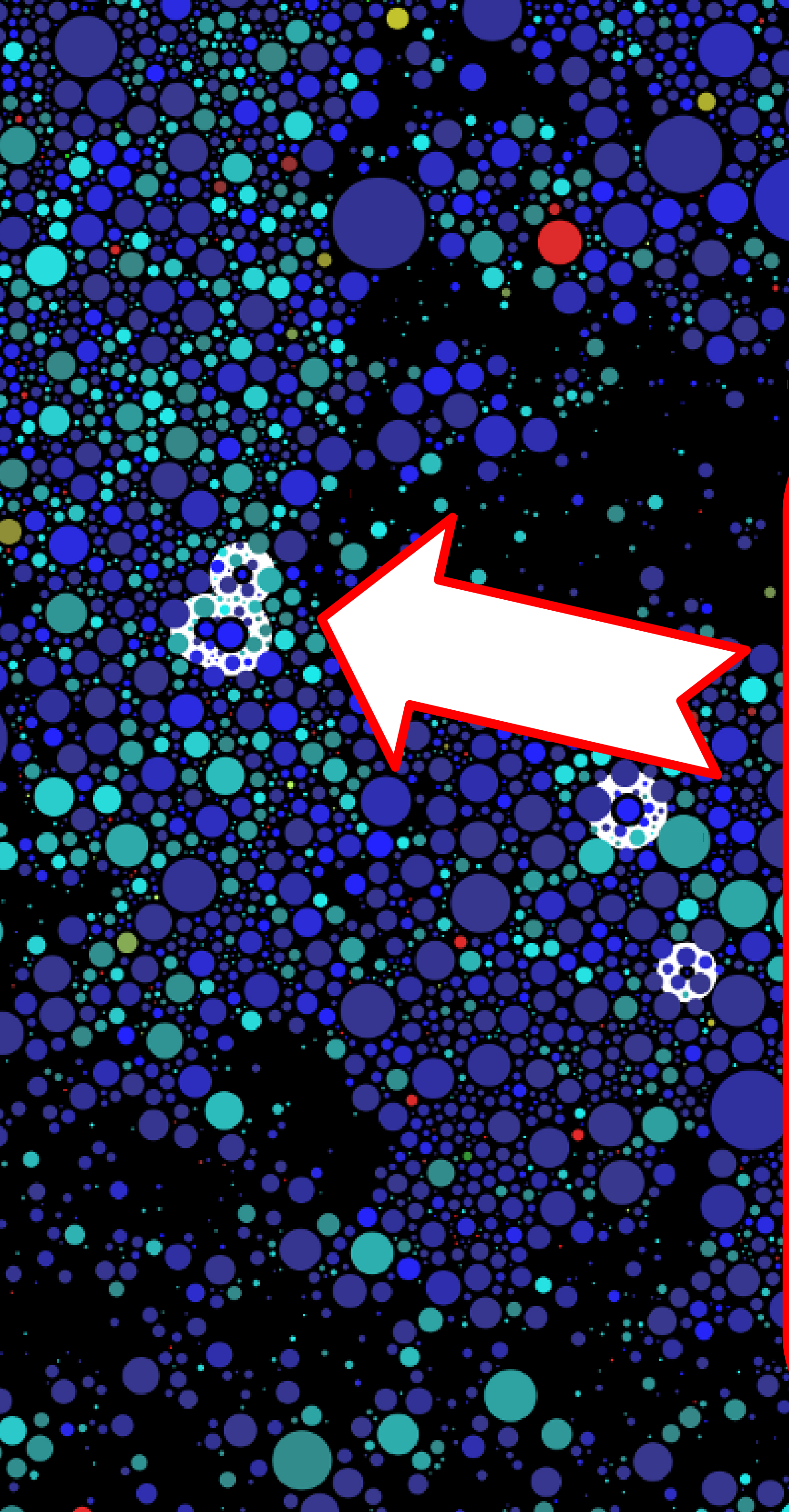


Using effective lifetimes

$$\tau_{\rm eff} \equiv \frac{\int_0^\infty t\,\langle \Gamma_f \rangle\, dt}{\int_0^\infty \langle \Gamma_f \rangle\, dt} = \frac{\tau_{B_s}}{1 - {y_s}^2}\left(\frac{1 + 2\,\mathcal{A}^f_{\Delta\Gamma}\,y_s + {y_s}^2}{1 + \mathcal{A}^f_{\Delta\Gamma}\,y_s}\right)$$

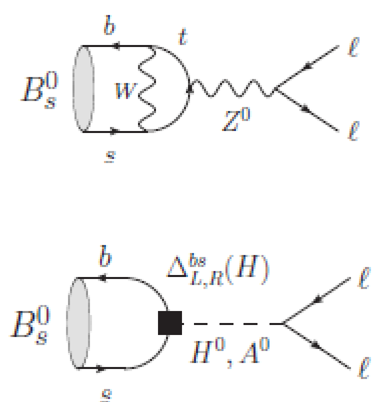


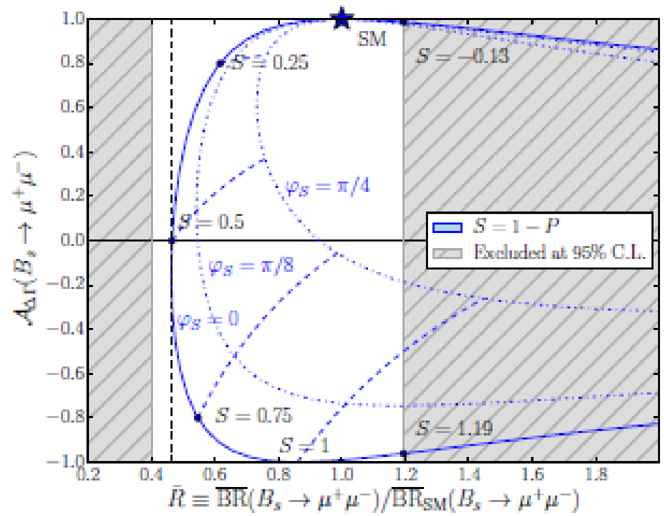




Using a rare decay

$B_s \to \mu^+ \mu^-$ occurs once in 300 million





Considered mass-eigenstate rate asymmetry:

$$|\langle \ell^+_\lambda \ell^-_\lambda | \mathcal{H}_{\mathrm{eff}} | B_{s,\mathrm{L}} \rangle|^2$$

$$= 2|N|^2 \left\{ |P|^2 \sin^2\left(\varphi_P - \phi_s^{\mathrm{NP}}/2\right) + |S|^2 \cos^2\left(\varphi_S - \phi_s^{\mathrm{NP}}/2\right) \right\}$$

In collaboration with ...

Andrzej Buras
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Fulvia De Fazio
Minoru Nagai

Robert Fleischer (**promotor**)

Kristof De Bruyn
Patrick Koppenburg
Marcel Merk
Antonio Pellegrino
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