Is the universe fair?

B physics anomalies

* The collaboration in this presentation is fictitious. No identification with actual collaborations (ongoing or finished) is intended or should be inferred.

The Super* Collaboration

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IT Giovanni Padovano
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RU Dmitrii Kobylianskii
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Is the universe fair?

B physics anomalies

The Super* Collaboration

ביאטריס ריביירו לופז PT
שרלין רוז׳ייר FR
פדריקה קולומבינה IT
יאן פאן דר לינדן DE
גדי ניניו IL
ג׳ובאני פאדובנו IT
ג׳וליה מארינלי IT
נדב תמיר IL
ניק טאם DE
מקסימיליאן בורקארט DE
אוליבר מאטאנהו CZ
לוקאס בירווירת׳ DE
מארק בירוס SK
מיגלה מנטובאנו IT
דימיטרי קוביליאנסקי RU
היונג׳ין קים KR

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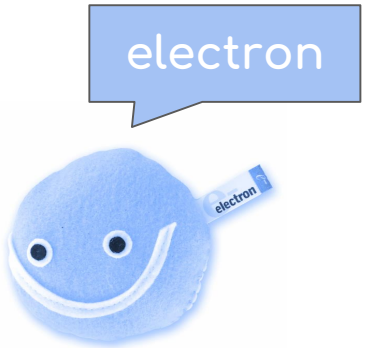
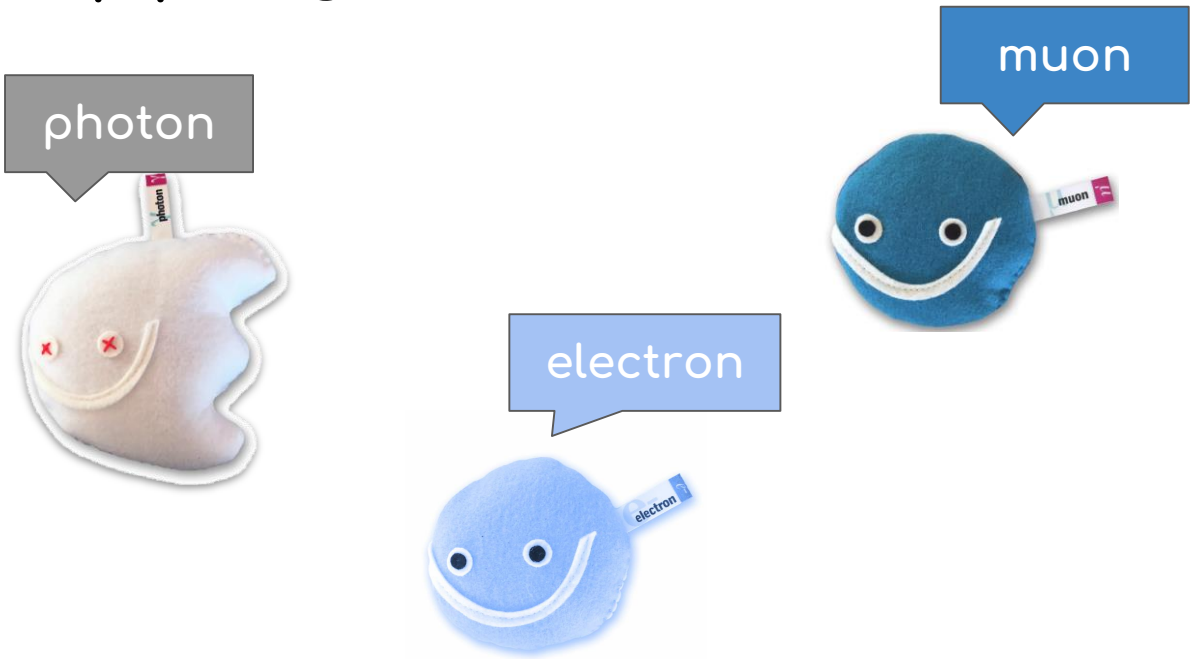
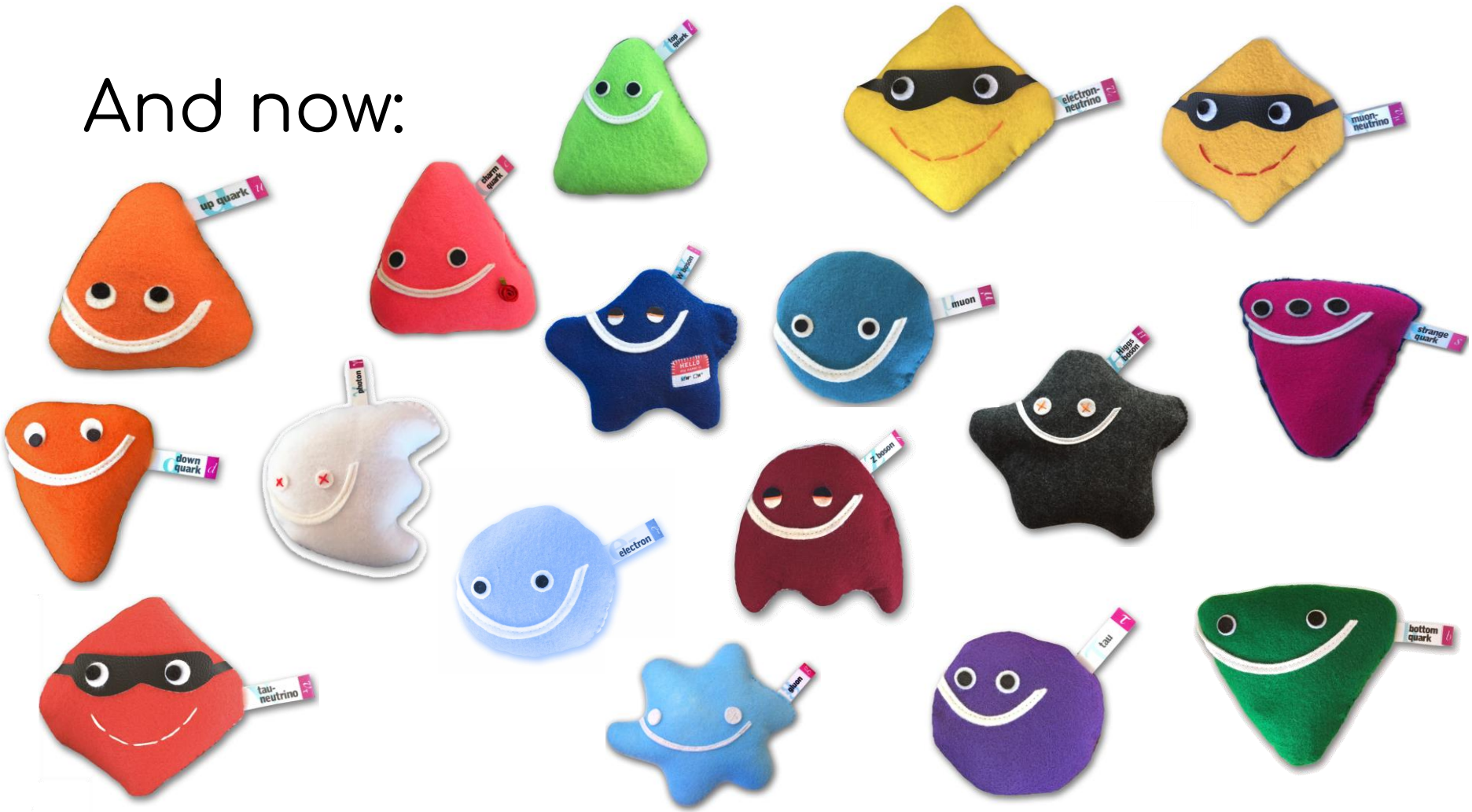
In 1897, we discovered the electrons...



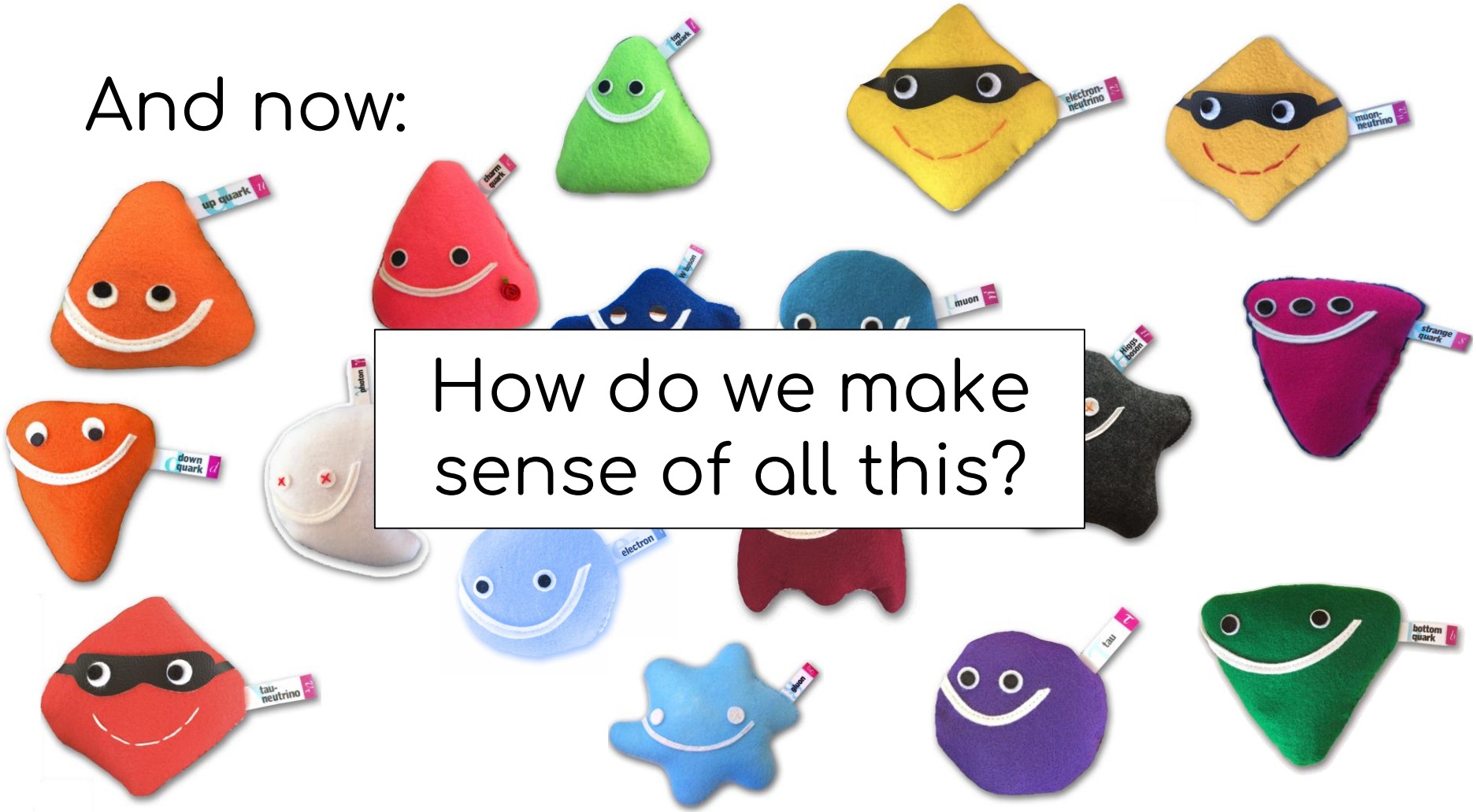
Skipping to 1937



And now:

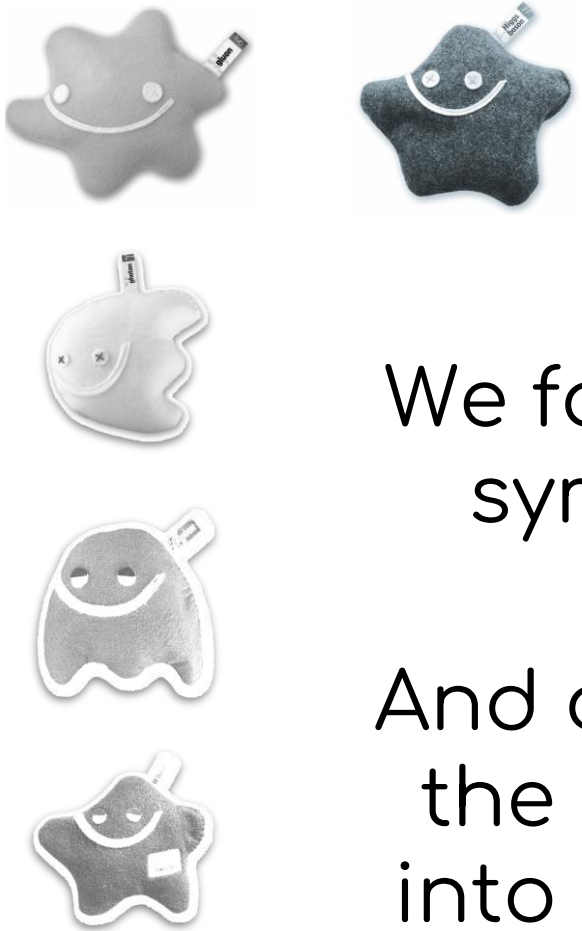

top quark
electron-neutrino
muon-neutrino
up quark
charm quark
W boson
muon
strange quark
down quark
photon
Higgs boson
Z boson
electron
tau-neutrino
gluon
tau
bottom quark

And now:



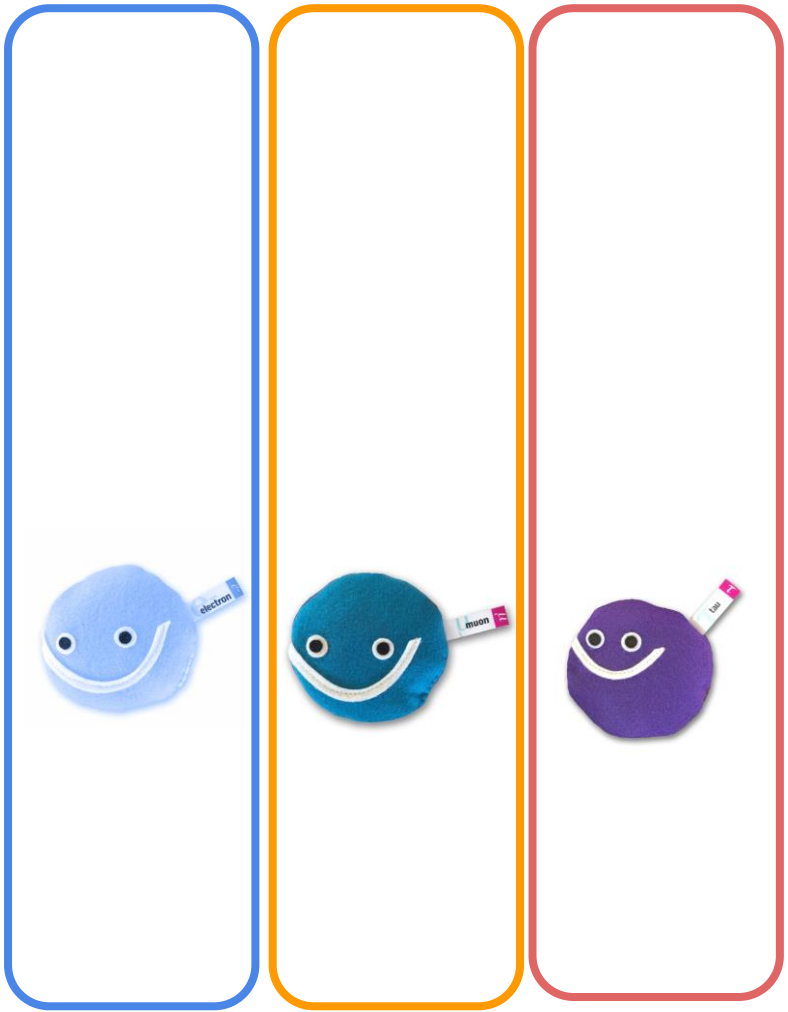
How do we make sense of all this?

We found some symmetries



We found some symmetries

And organized the particles into 3 families



Let’s focus on these 3

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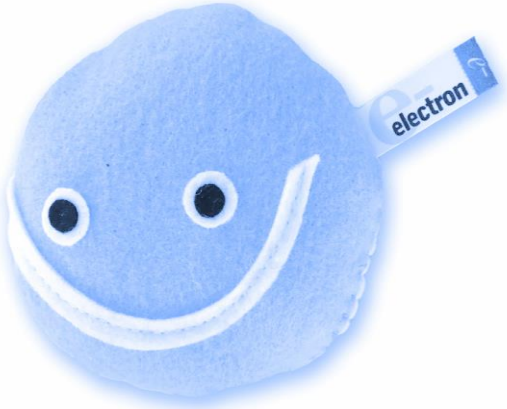
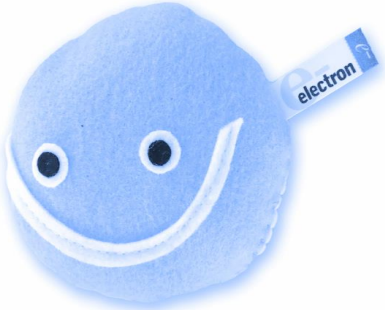


electron

muon (μ)

tau (τ)

We can think of them as flowers



electron (e)

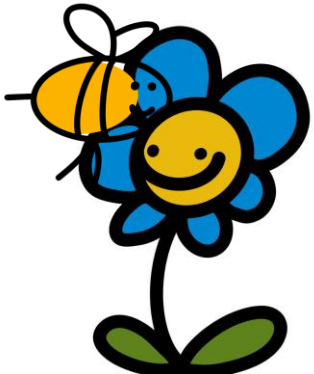
muon (μ)

tau (τ)

Let’s say a bee has to choose a flower

Let’s say a bee has to choose a flower

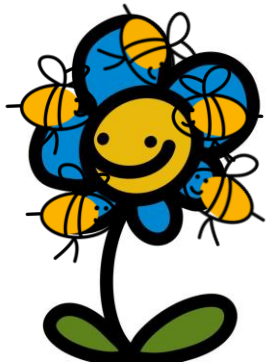
It should choose randomly...



Now let's say we have many bees

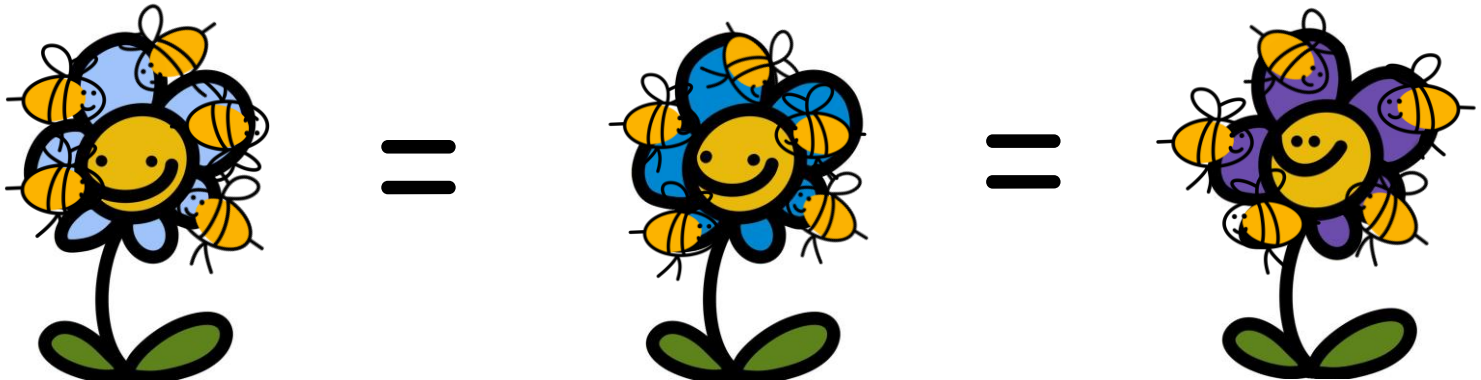
Now let's say we have many bees

In a fair universe...



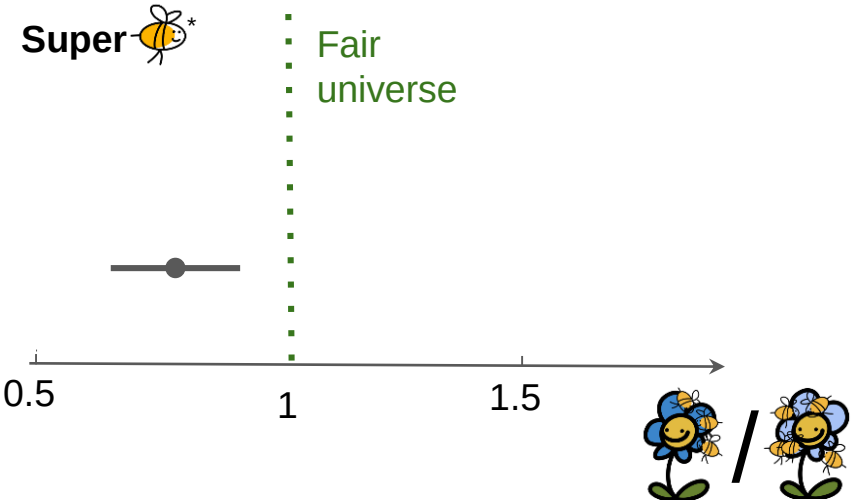
Now let's say we have many bees

In a fair universe...



Now let's say we have many bees

But what if?



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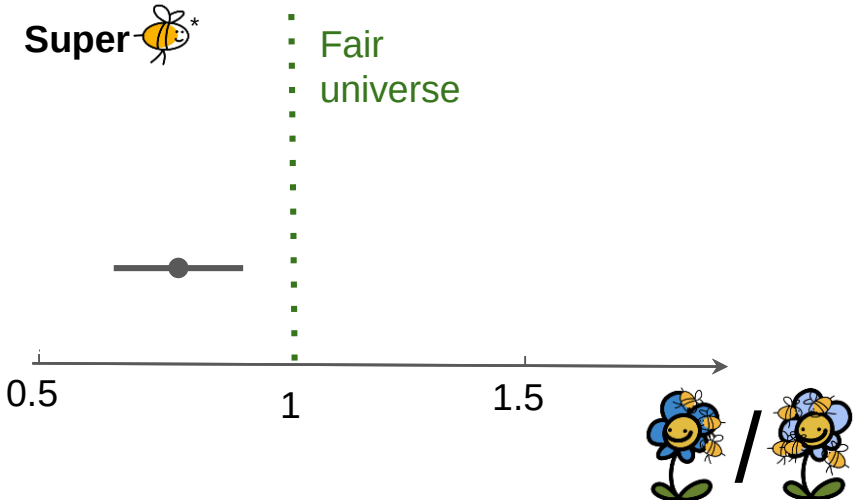

Could it be just a coincidence?

Or is there really a preference?

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Super

Fair universe

Could it be just a coincidence?

eally

e?

Time to go back to particles!

≠

≠

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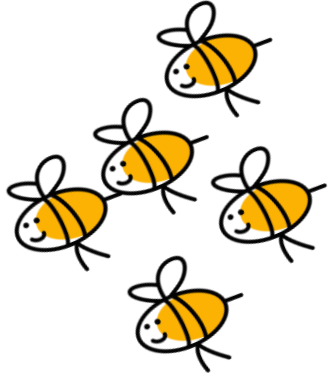
The flowers are the electron, muon and tau

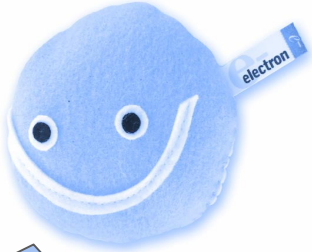


electron (e)

muon (μ)

tau (τ)

The bees are particles called B mesons



electron (e)

muon (μ)

tau (τ)

Physicists are testing if B mesons have a preference for one of the three families

electron (e)

muon (μ)

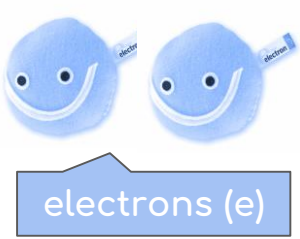
tau (τ)

We produce B mesons using large particle colliders

Particle collisions produce a lot of energy

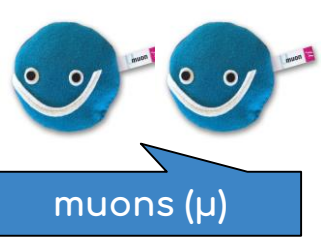
And many new particles appear... including B mesons

B mesons are not stable particles, they can decay to:



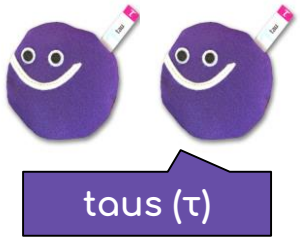
electrons (e)

or



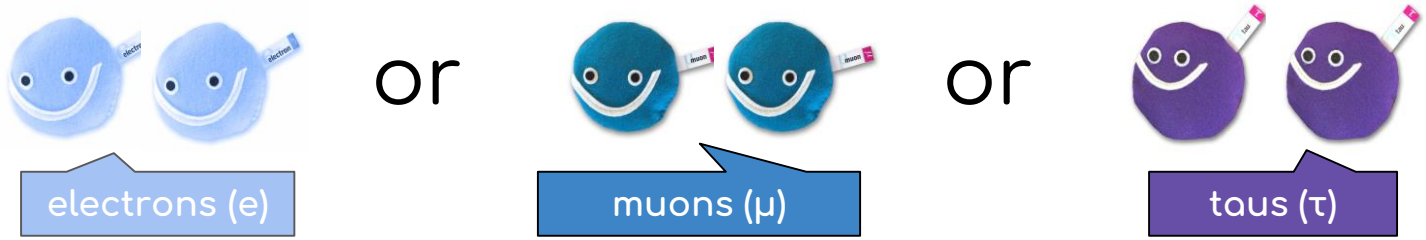
muons (μ)

or

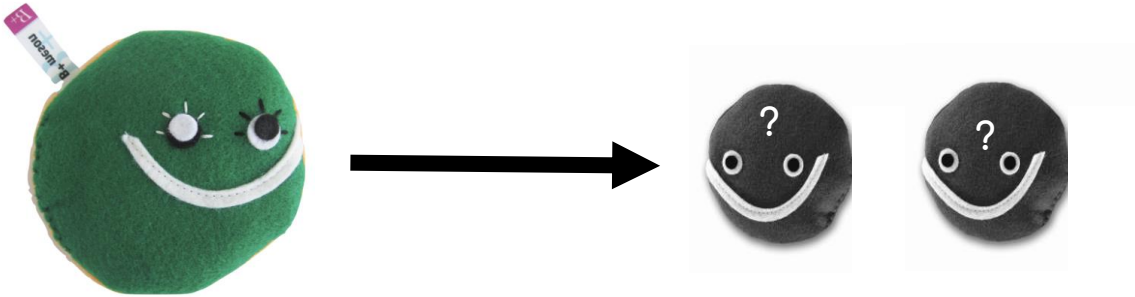


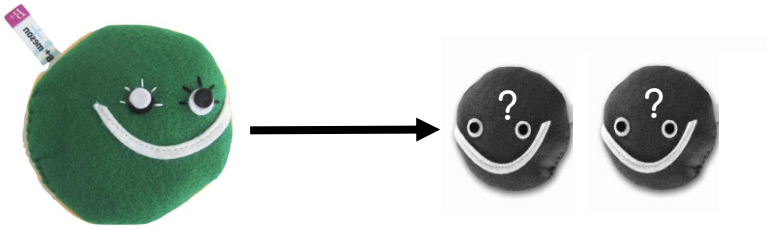
taus (τ)

B mesons are not stable particles, they can decay to:



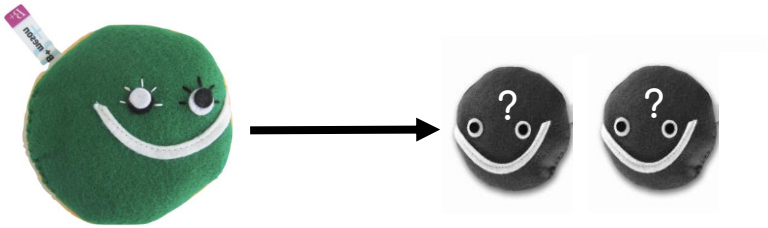
With our detectors we can look for:





And like with the flowers, calculate a ratio:

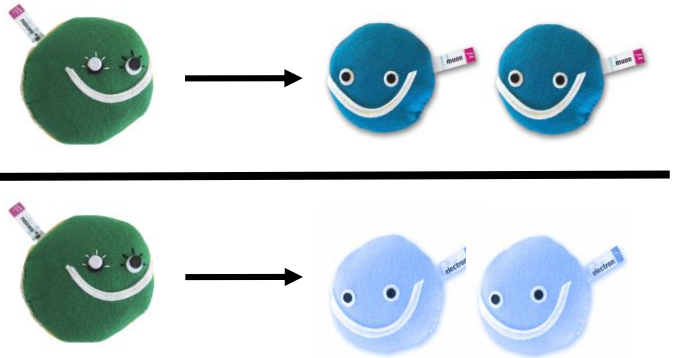
$$R_K = \frac{\mathcal{B}\ (B^+ \to K^+\mu^+\mu^-)}{\mathcal{B}\ (B^+ \to J/\psi(\to \mu^+\mu^-)K^+)} \Big/ \frac{\mathcal{B}\ (B^+ \to K^+e^+e^-)}{\mathcal{B}\ (B^+ \to J/\psi(\to e^+e^-)K^+)}$$

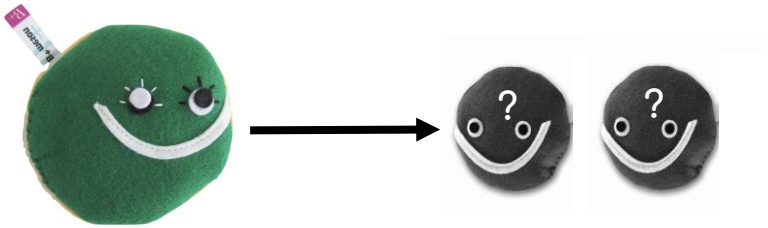


And like with the flowers, calculate a ratio:

Too complicated!

$R_K \sim$





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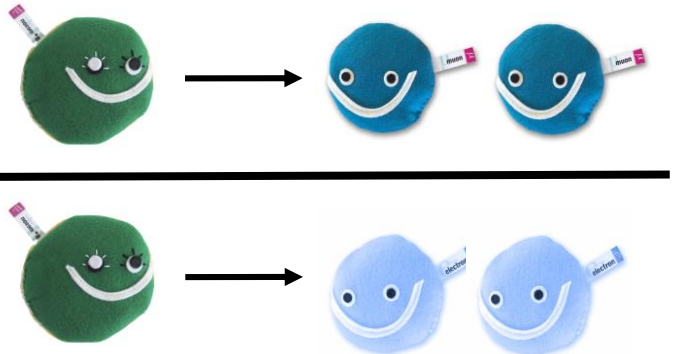
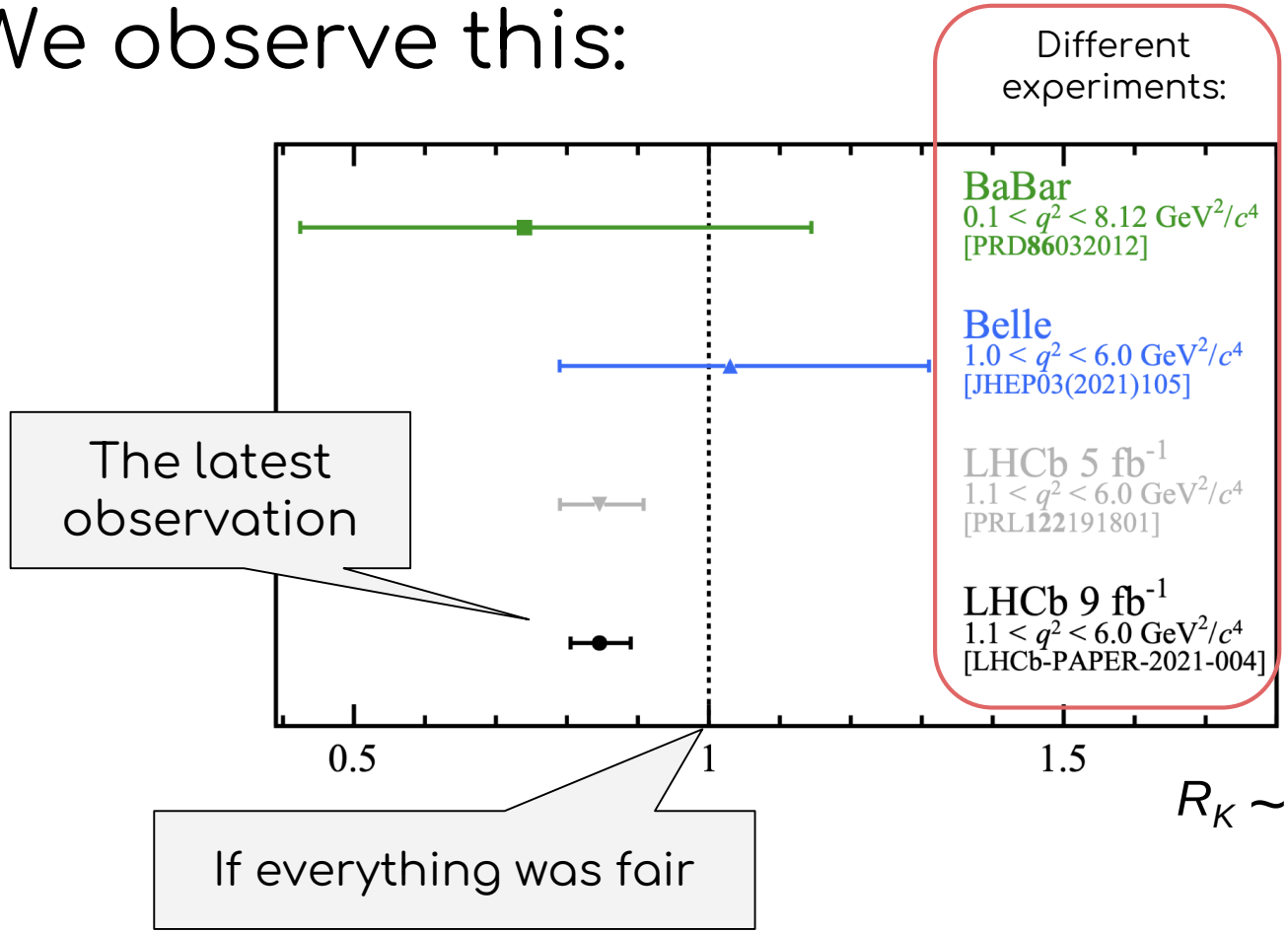
$R_K \sim$ 

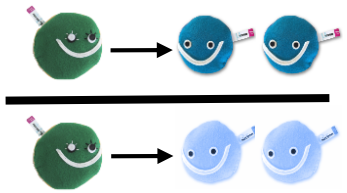
Bs prefer electrons or muons?

If no preference, R_K=1

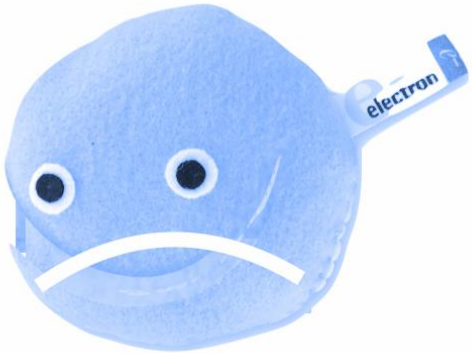
We observe this:



$R_K \sim$



There is indication that the universe might not be fair...



But we are still not sure...
we need more bees!

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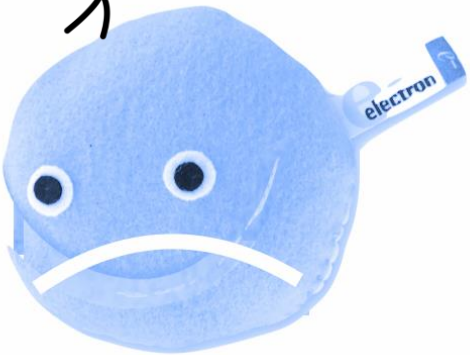

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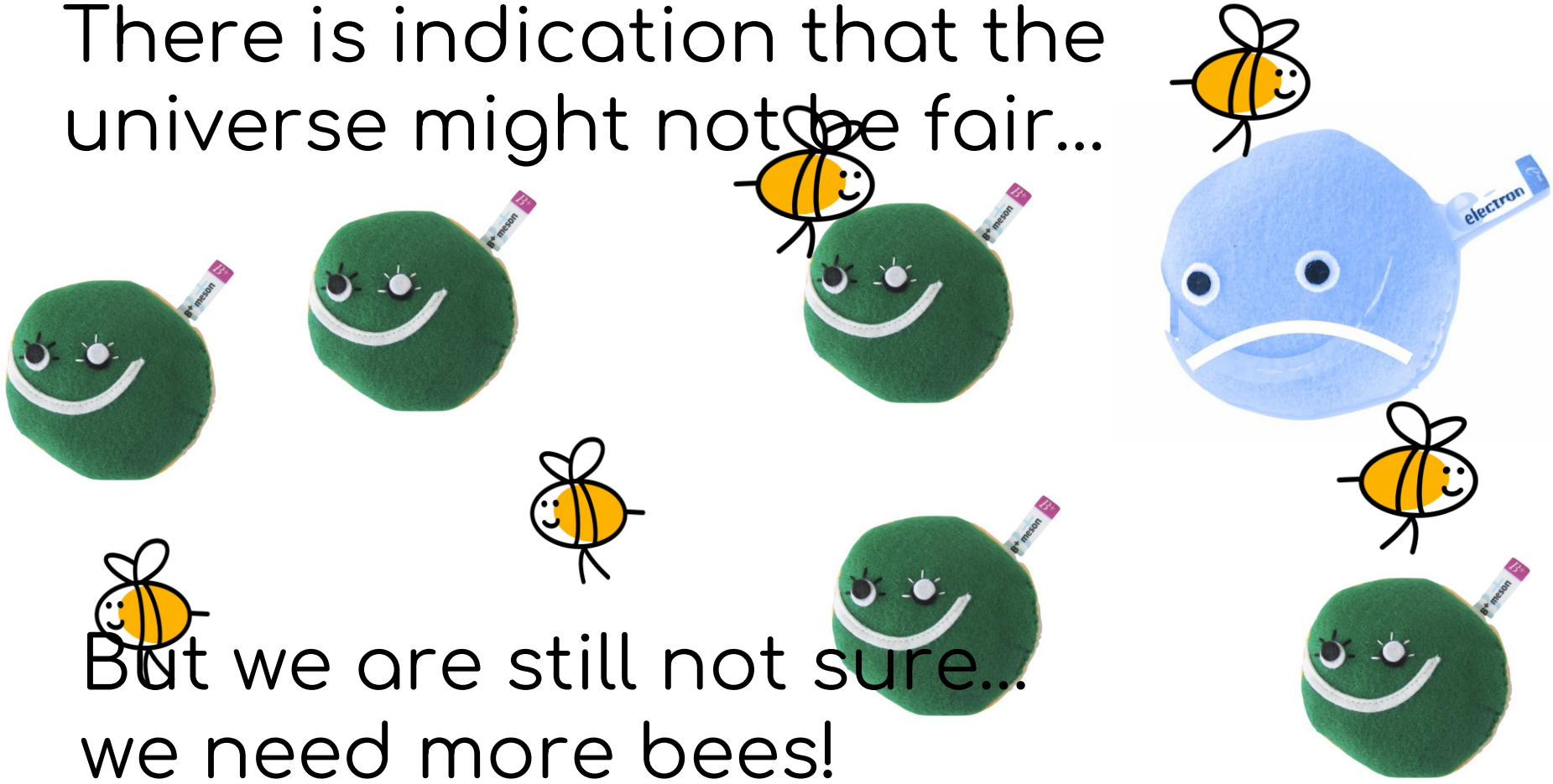

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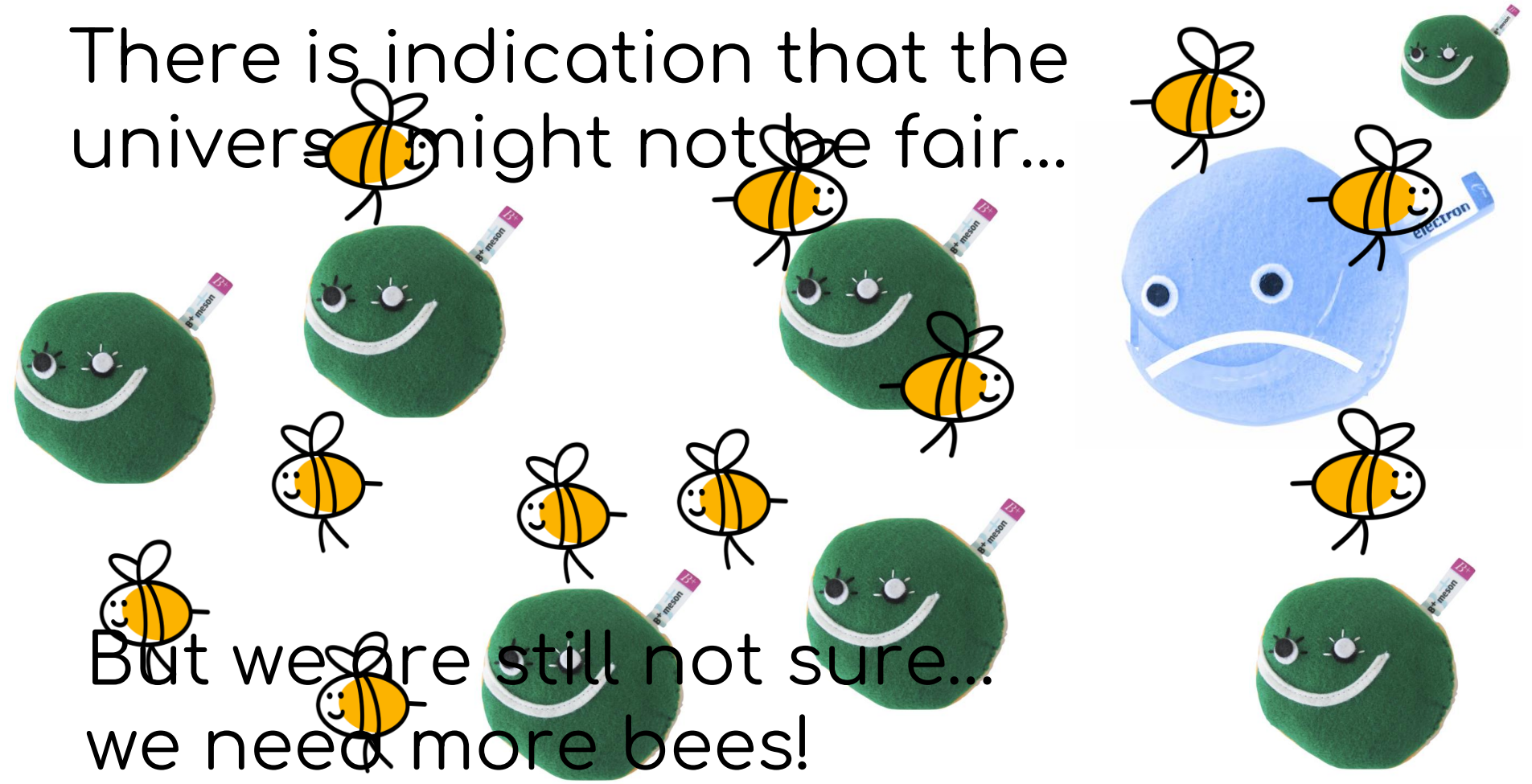

But we are still not sure...
we need more bees!

There is indication that the universe might not be fair...

But we are still not sure...
we need more bees

There is indication that the universe might not be fine...
but we are still not sure
we need more bees

There is indication that the universe might not be flat...

Stay tuned for more exciting results!

but we are still not sure we need more bees