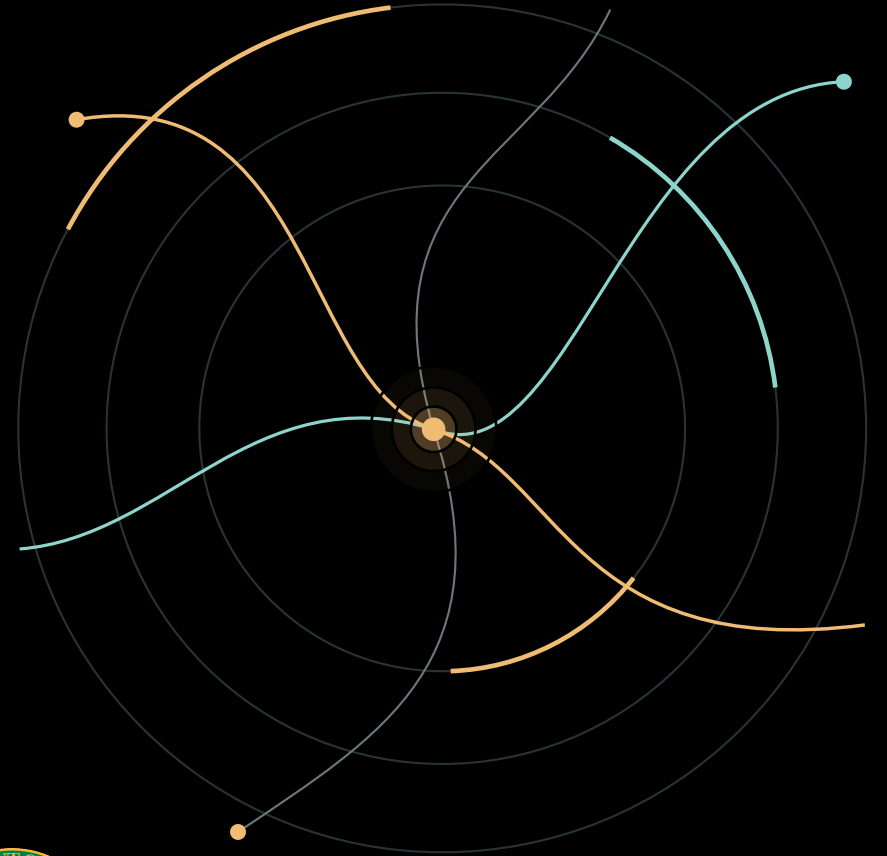


Big Questions, Tiny Particles

A first look at research
in particle physics phenomenology

Andreas Papaefstathiou
Kennesaw State University



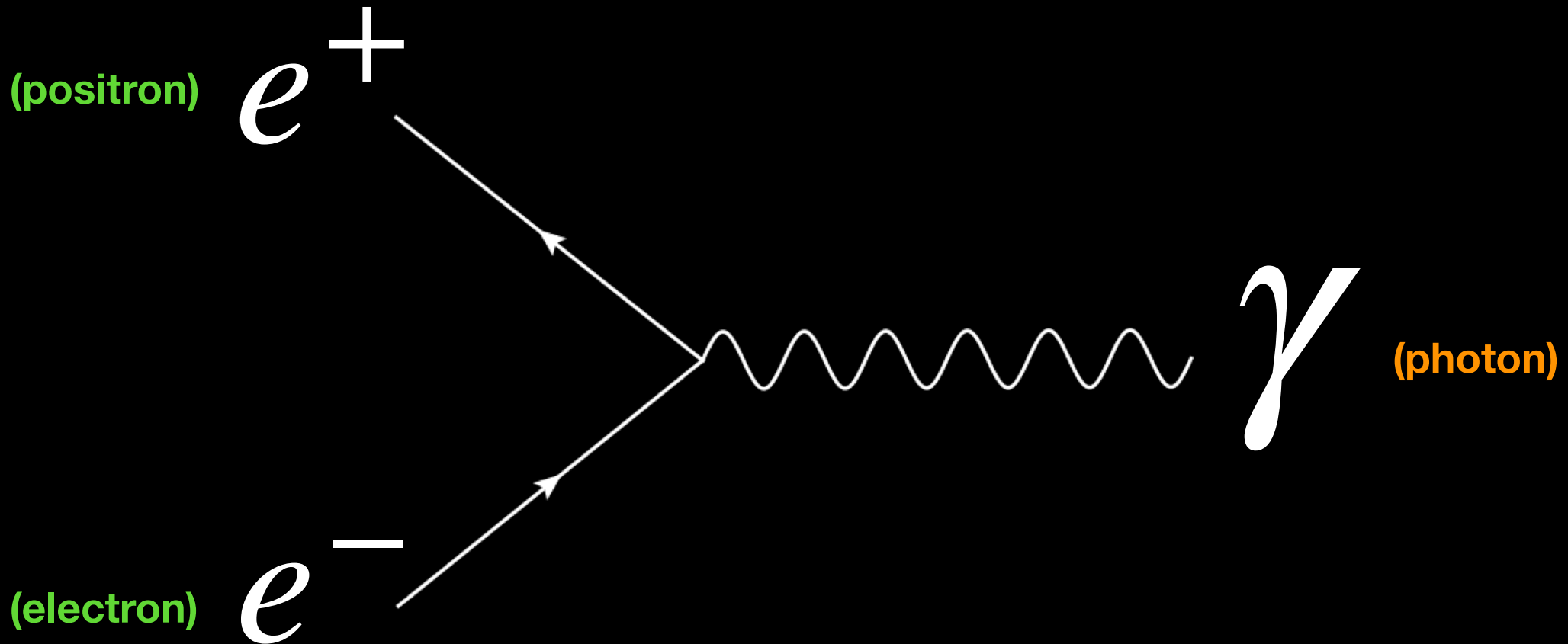
Asking the right questions

In a physics problem set, someone usually knows the answer.

In research, the answer may not be known, and sometimes the first challenge is deciding exactly *what question to ask*.

We usually start with **big questions** and we break them down **into smaller ones!**

What happens when a particle and its anti-particle collide?



Why is our universe dominated by matter?

Simple questions inspired by an observations!

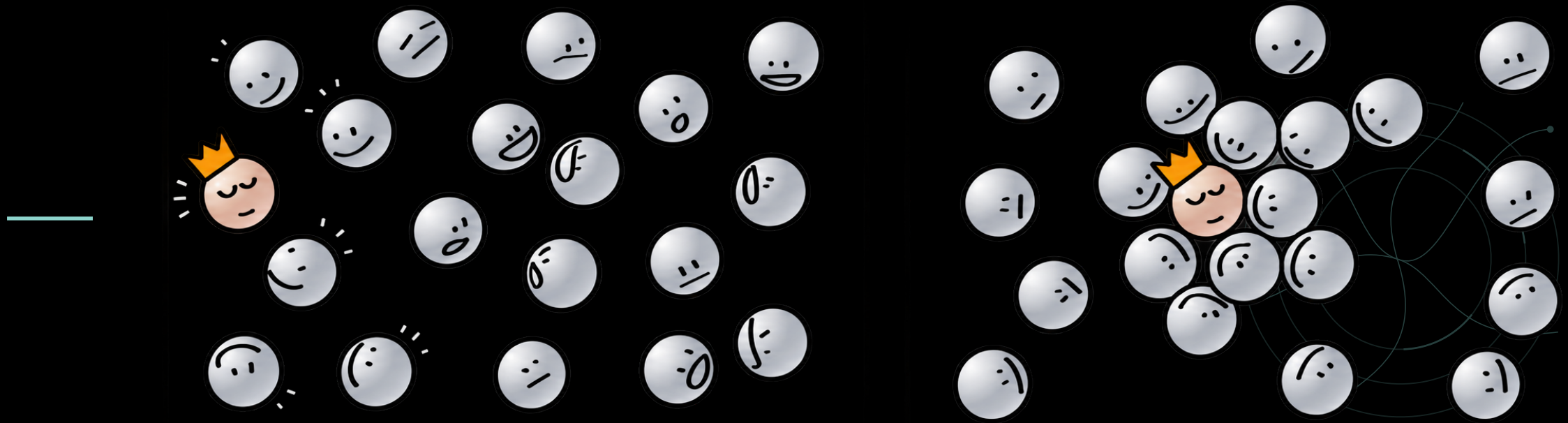


Why is our universe dominated by matter?

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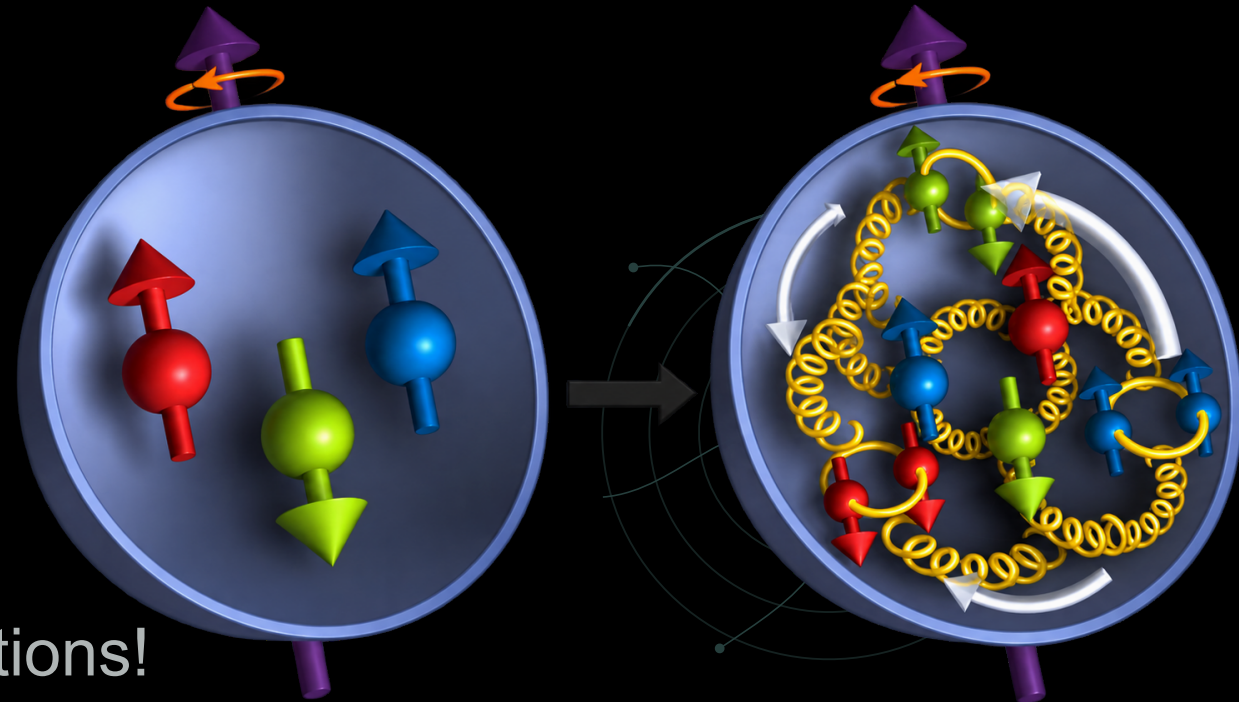
How do particles acquire mass? (The Higgs Mechanism)



“The cocktail party analogy”

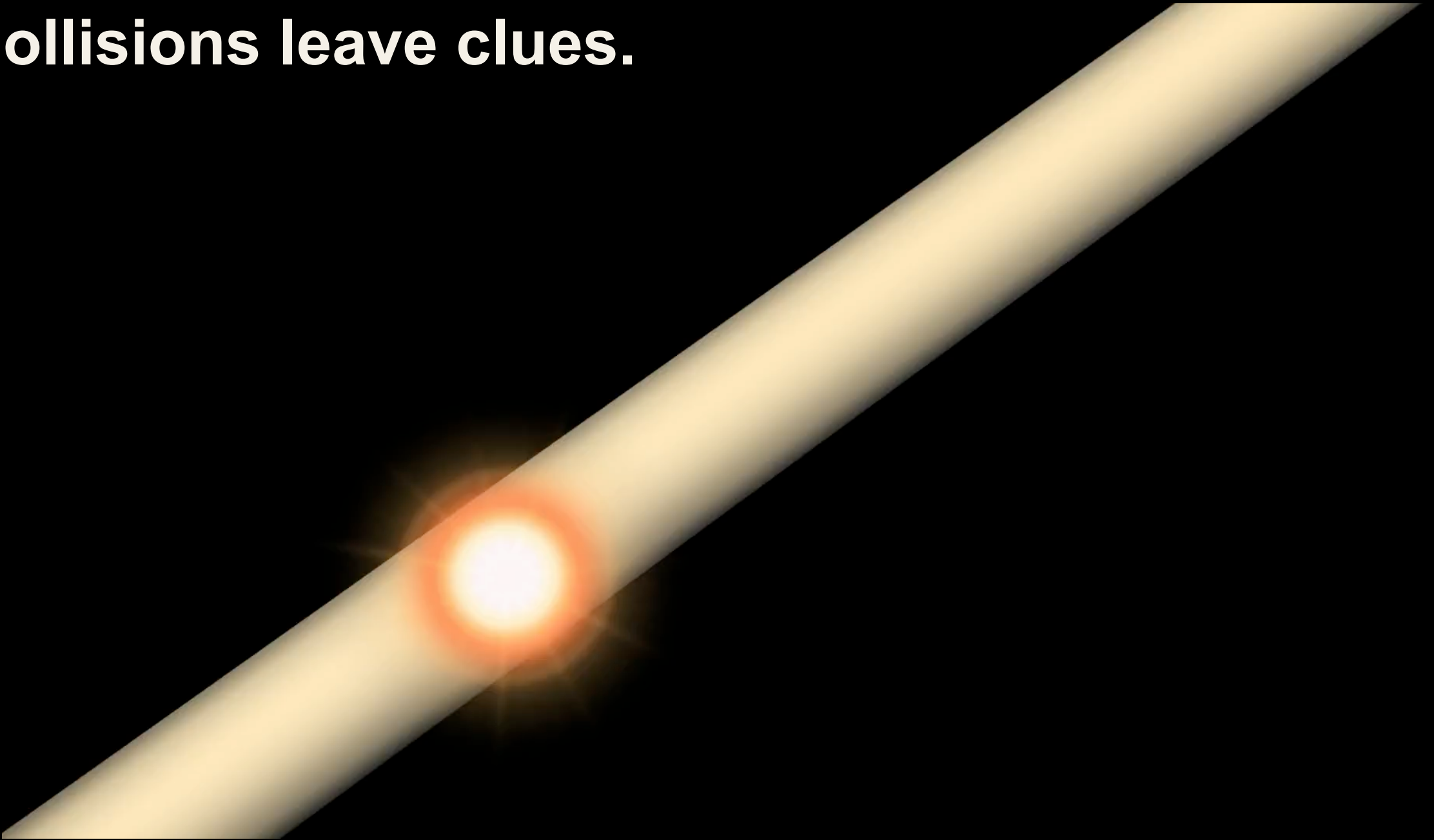
[CERN]

Where does the proton spin come from?

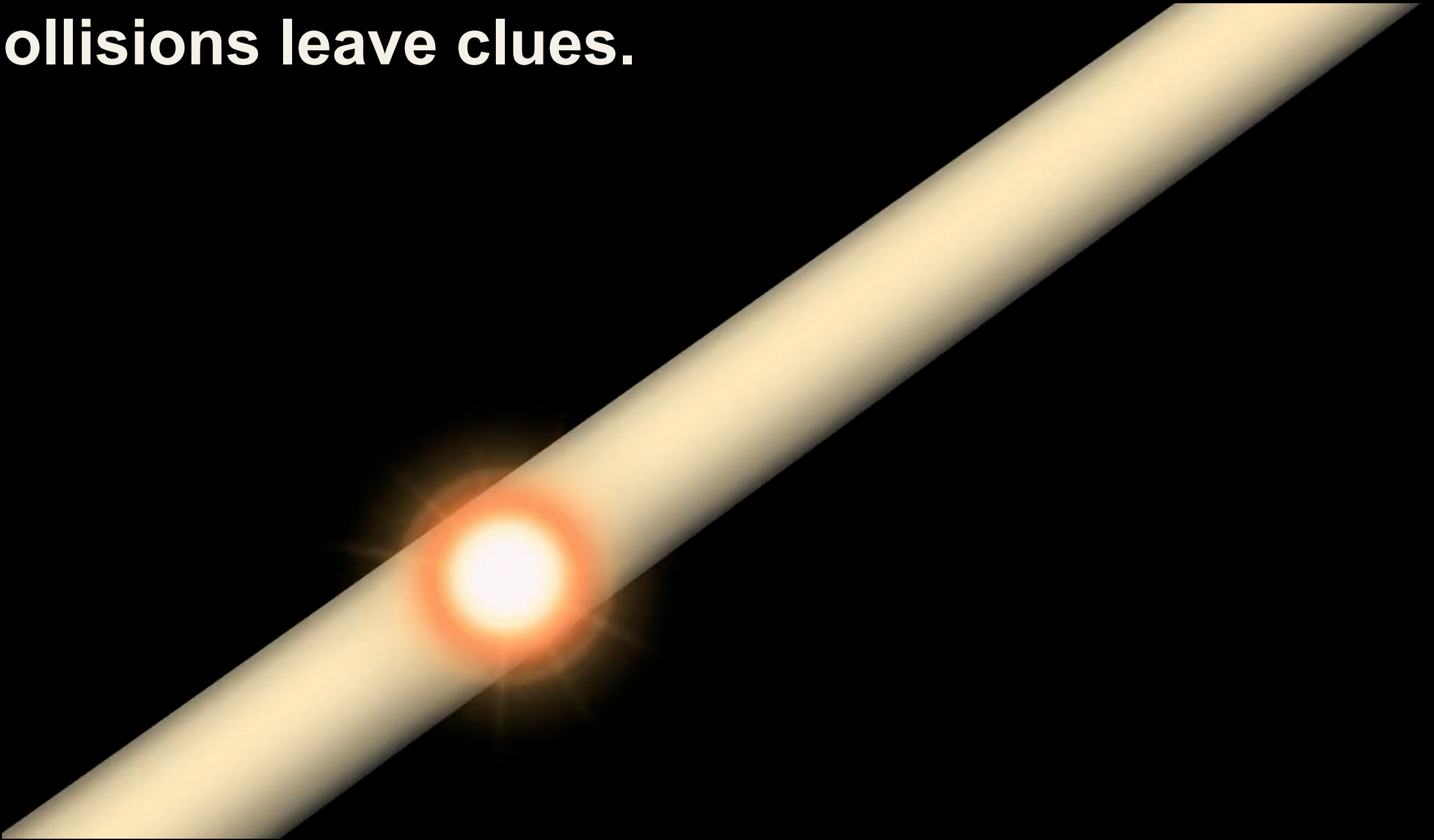


Simple questions inspired by an observations!

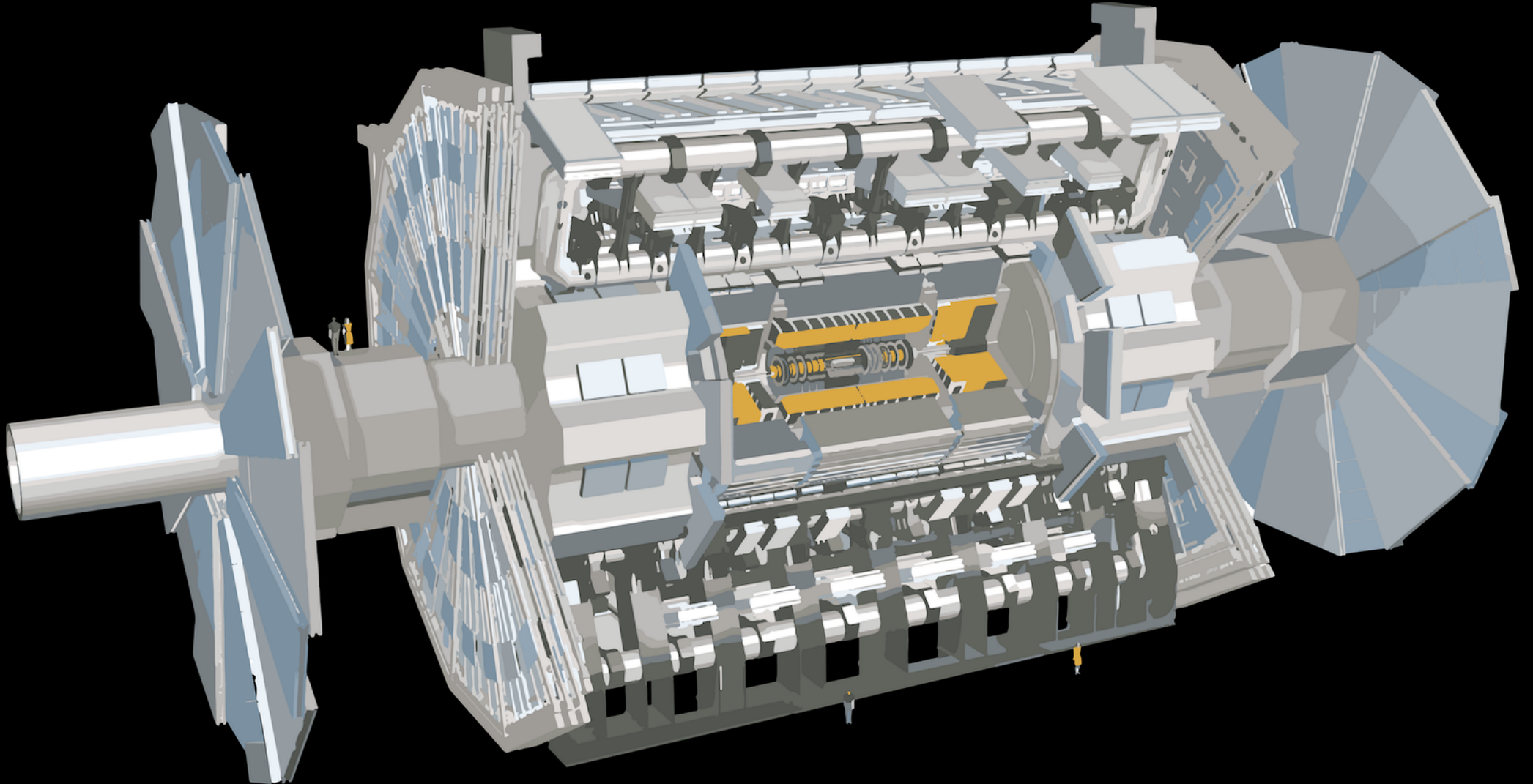
Collisions leave clues.



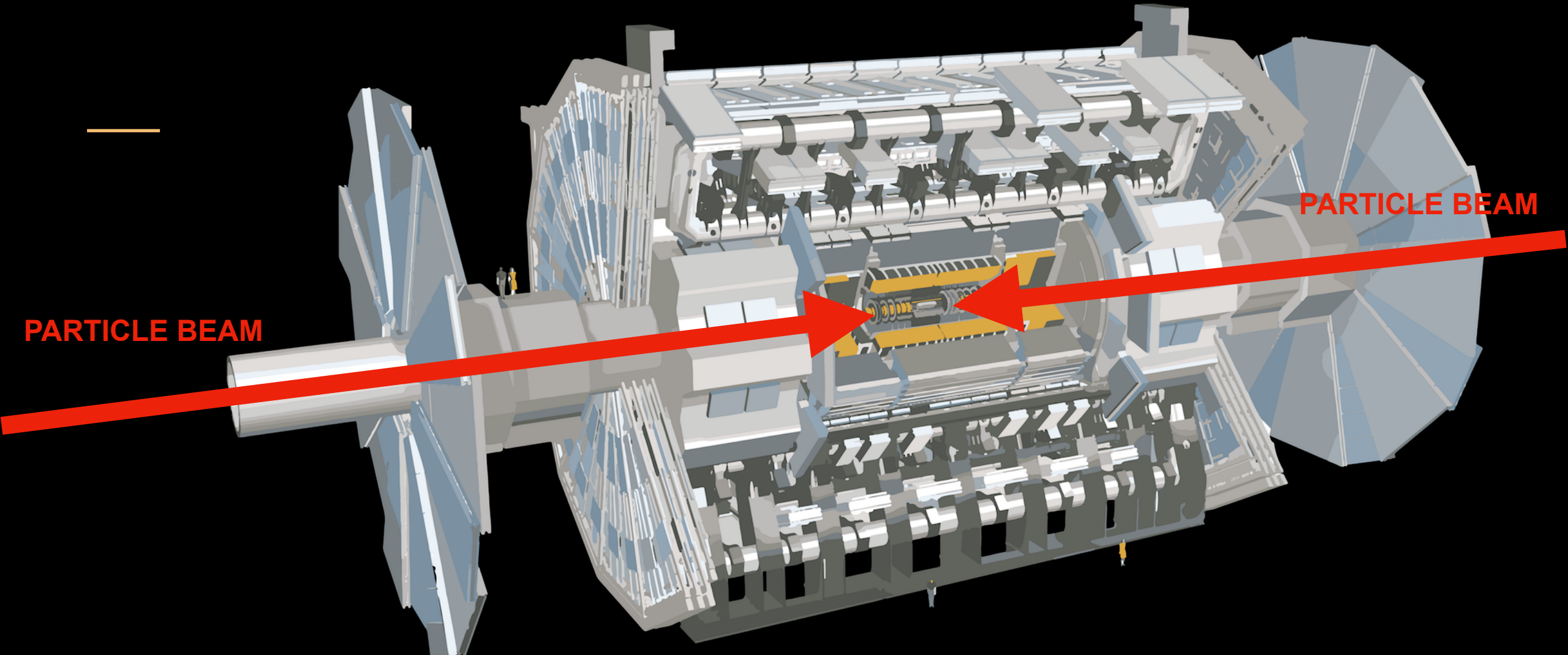
Collisions leave clues.



Collisions leave clues.



Collisions leave clues.



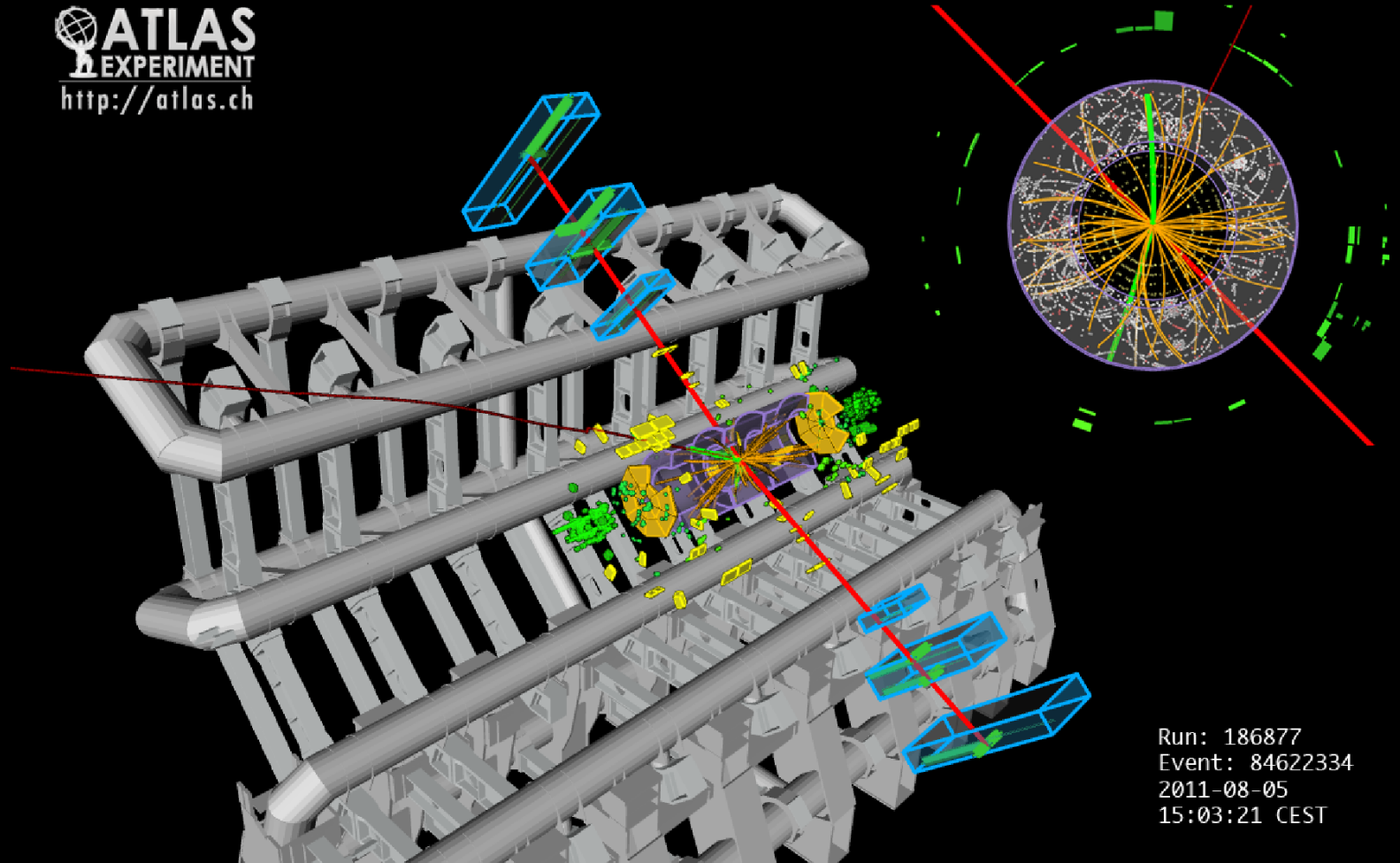
LOOK CLOSELY

Collisions leave clues.



What would
you look for?

Take a moment.
Notice a pattern?



Run: 186877
Event: 84622334
2011-08-05
15:03:21 CEST

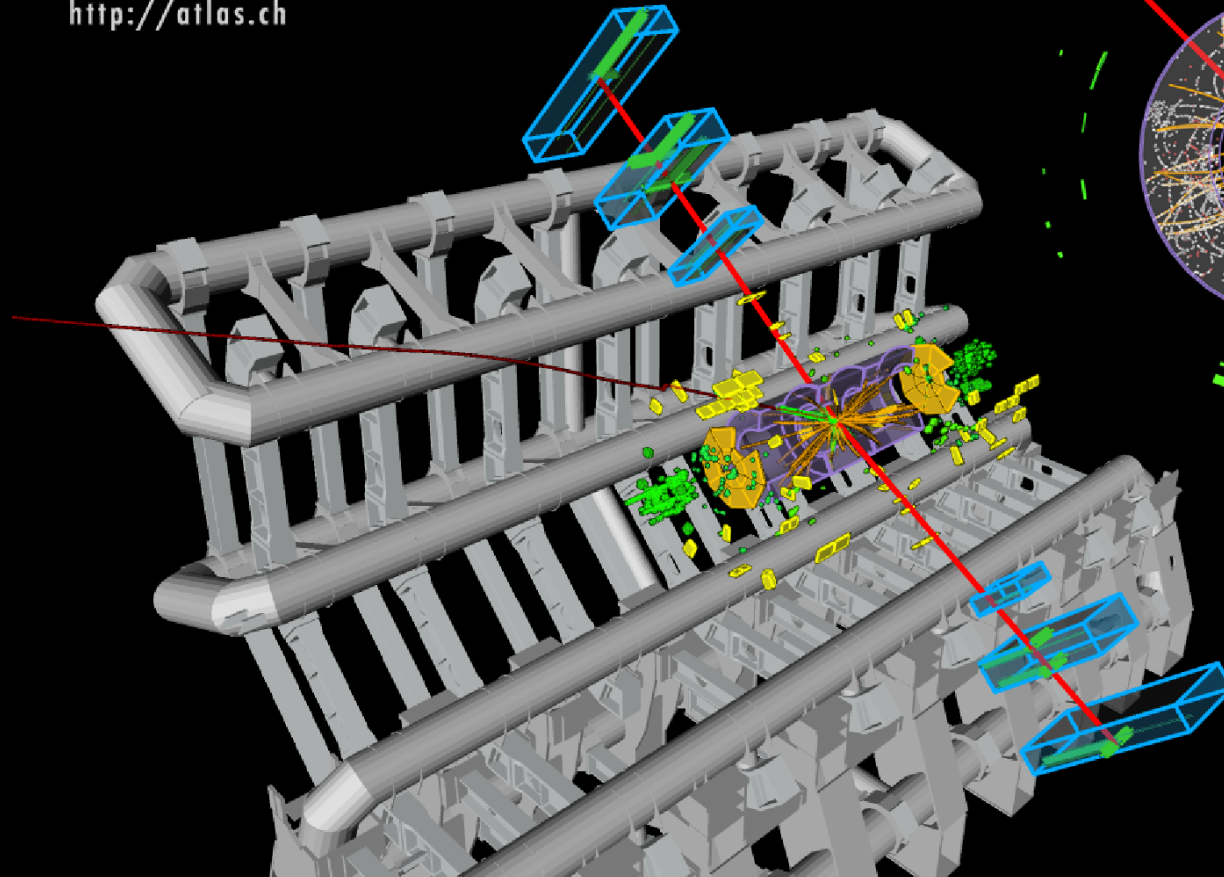
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Collisions leave clues.

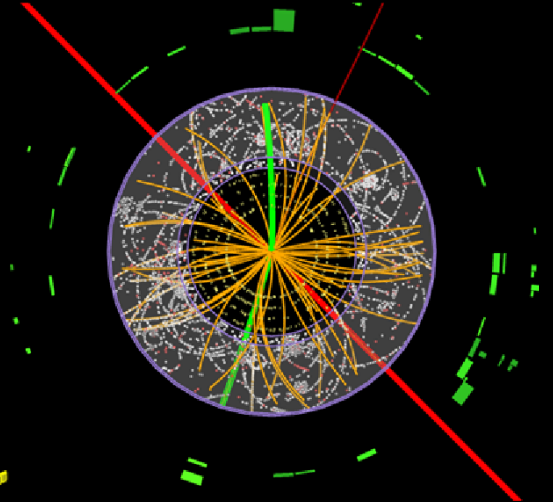


What would
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Notice a pattern?



μ



μ

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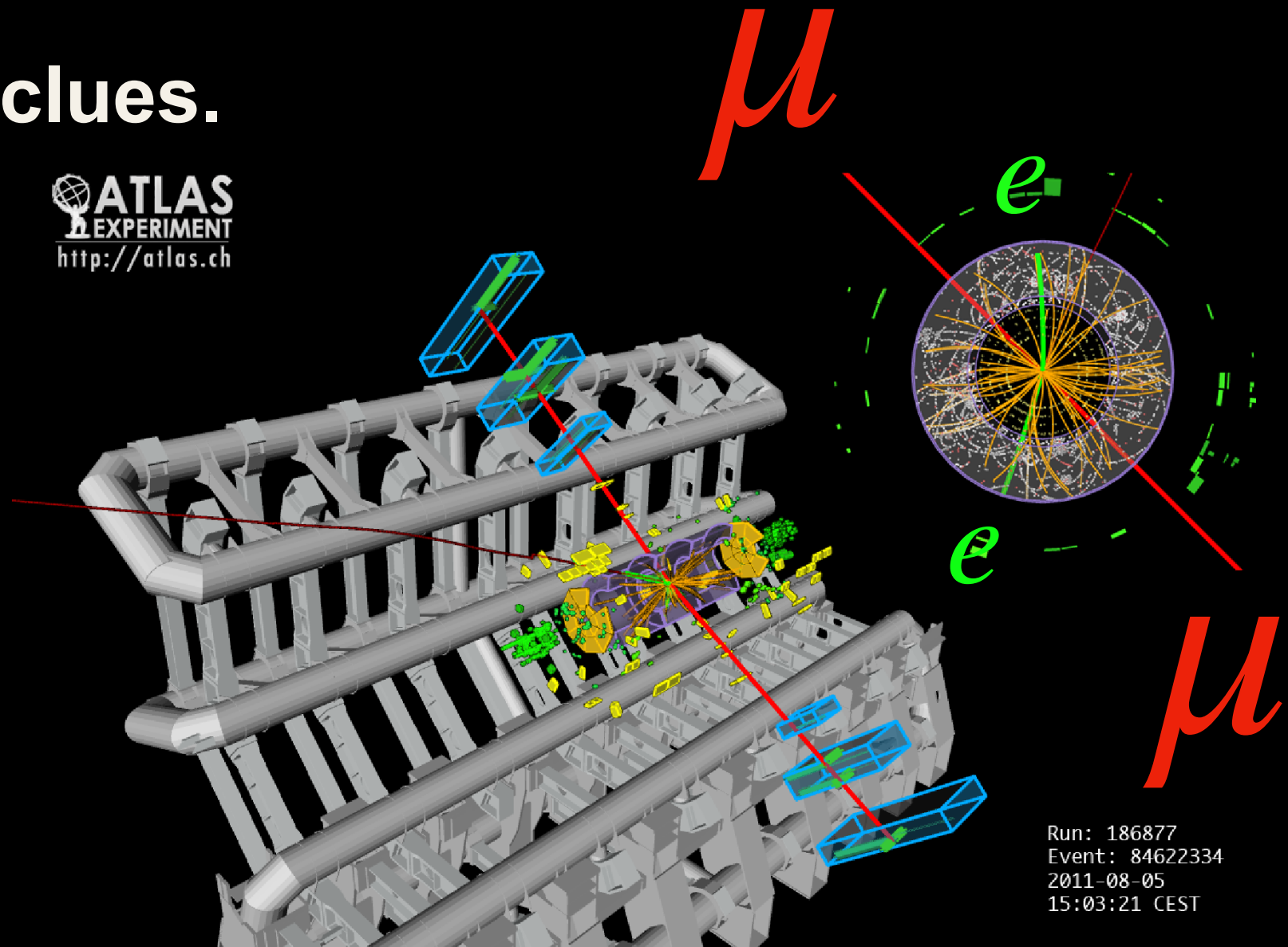
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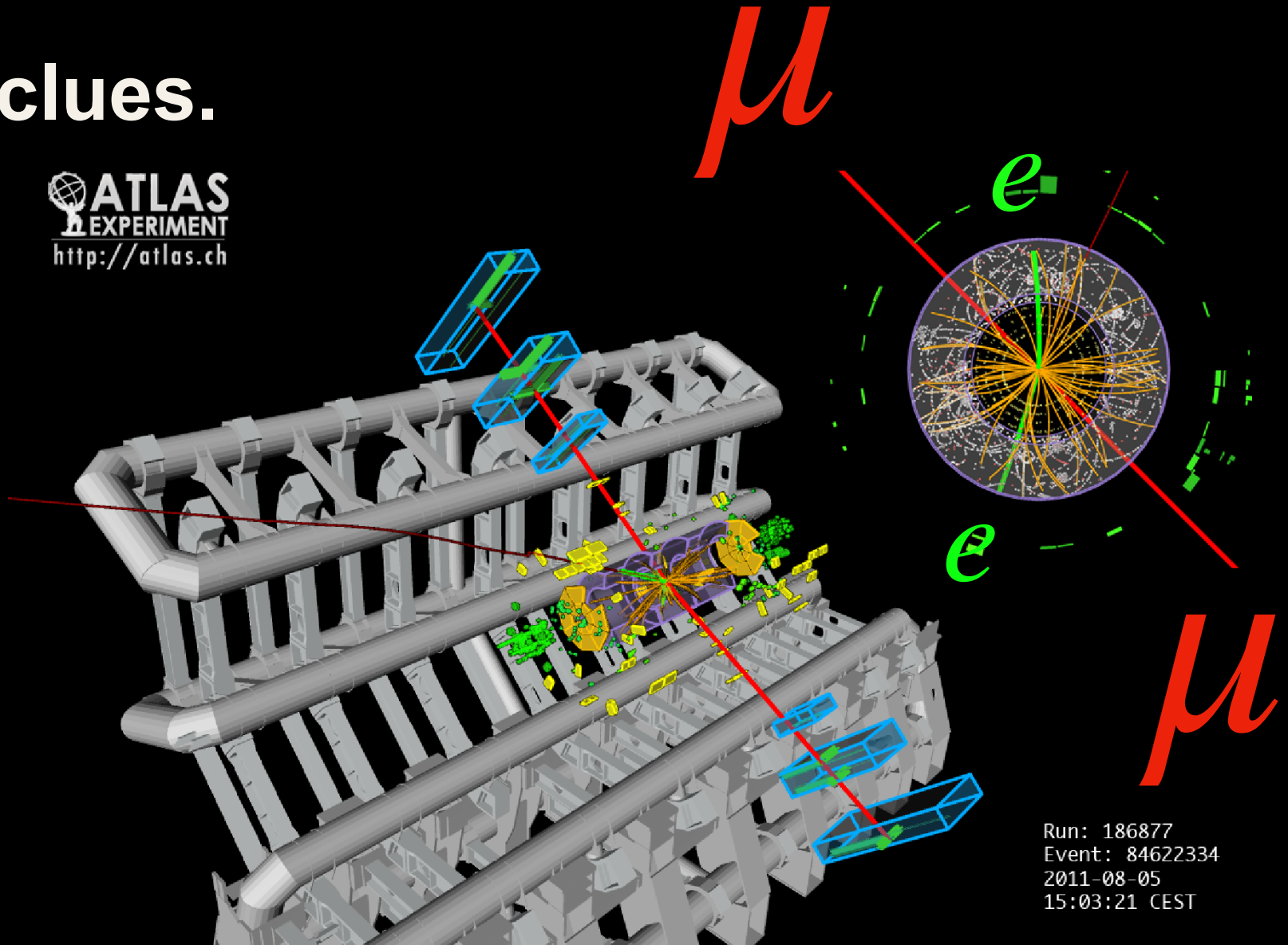
Collisions leave clues.



What would
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$$h \rightarrow \mu\mu ee$$



Run: 186877
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2011-08-05
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How do we make sense of it all?



Theory

Ask how nature could behave.

Simulation

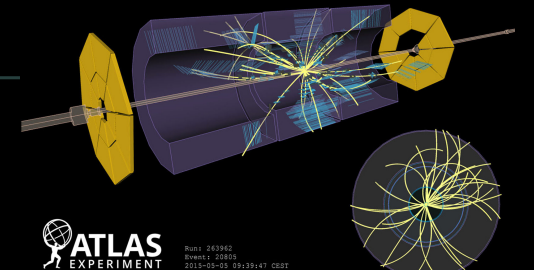
Predict what we would see.

Experiment

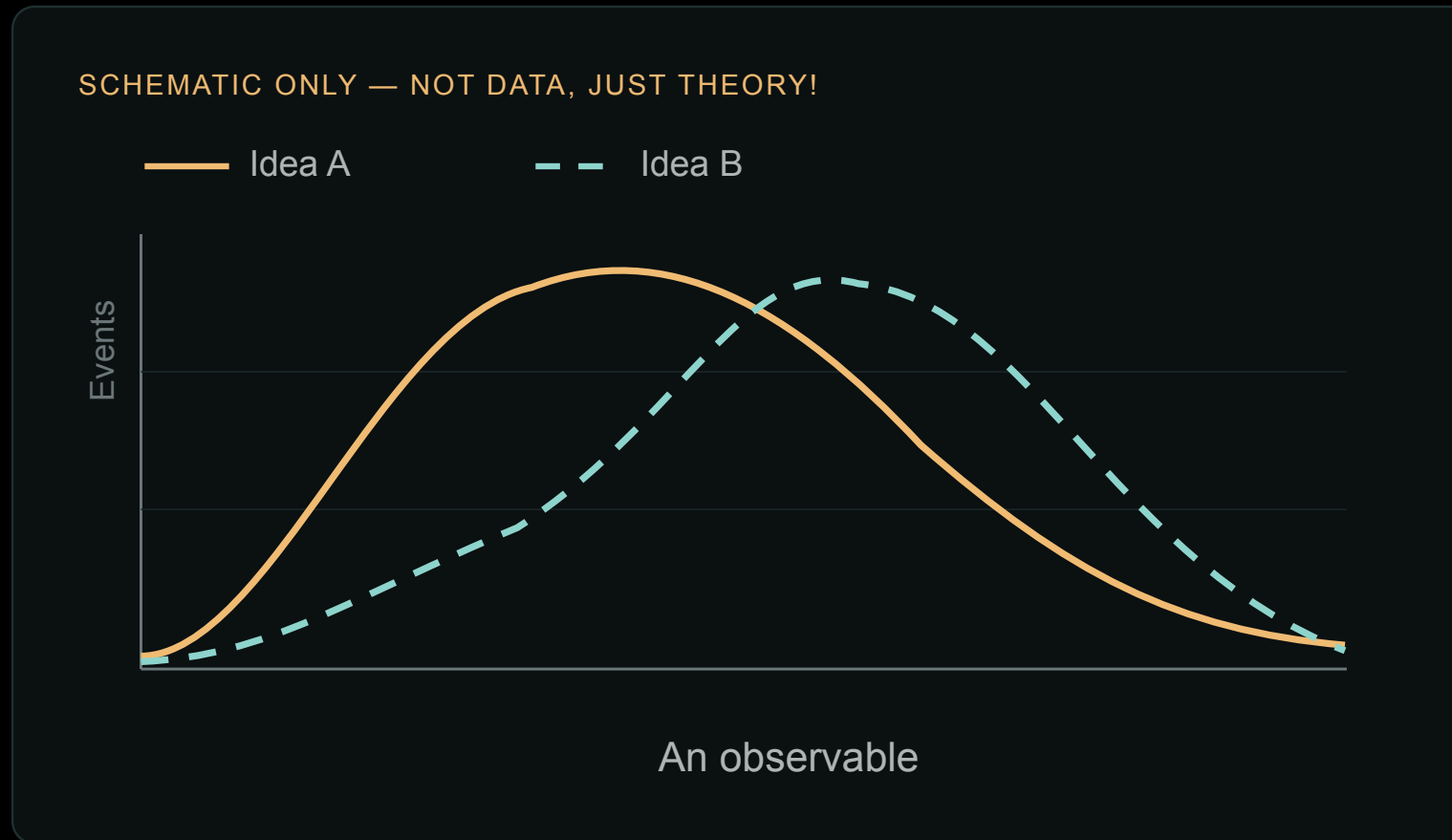
Compare with what we observe.



Then check the assumptions — and ask again.



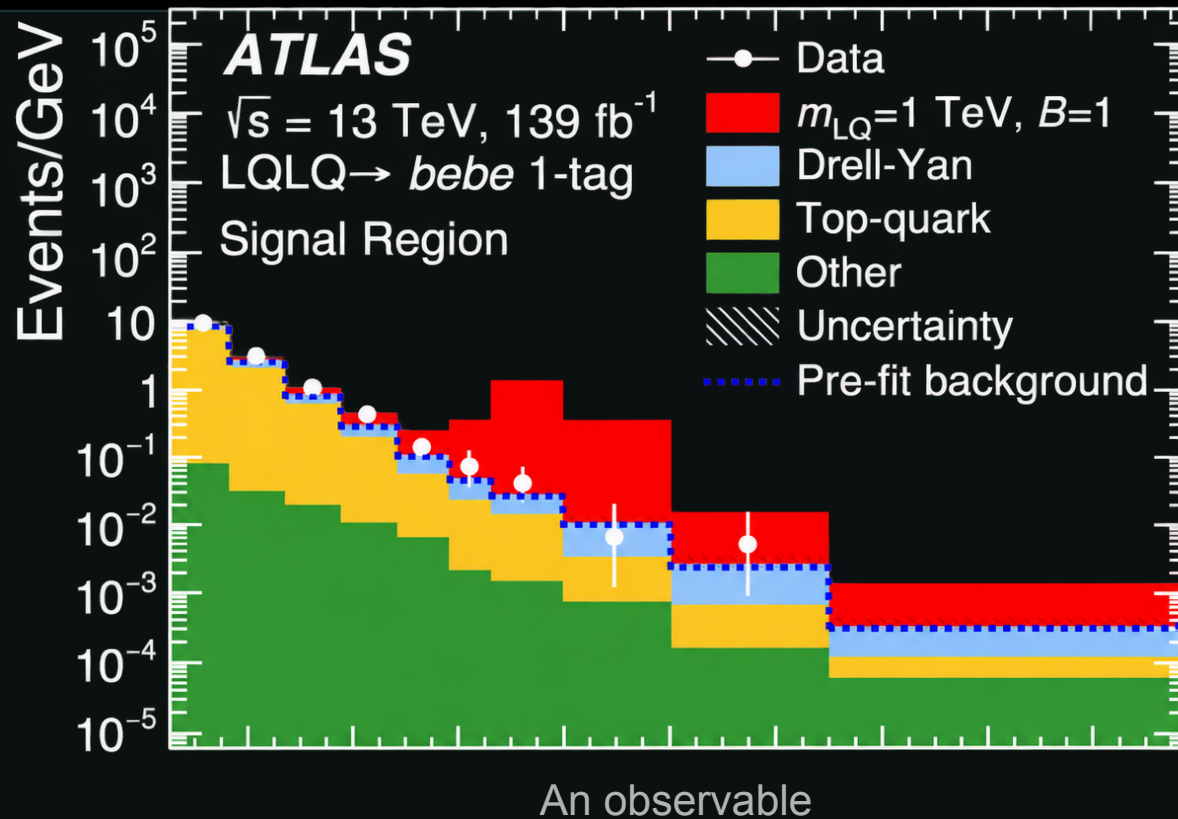
Which prediction could we distinguish?



**The shape
can tell a story.**

Choose one feature.
Explain why it matters.

Which prediction could we distinguish?



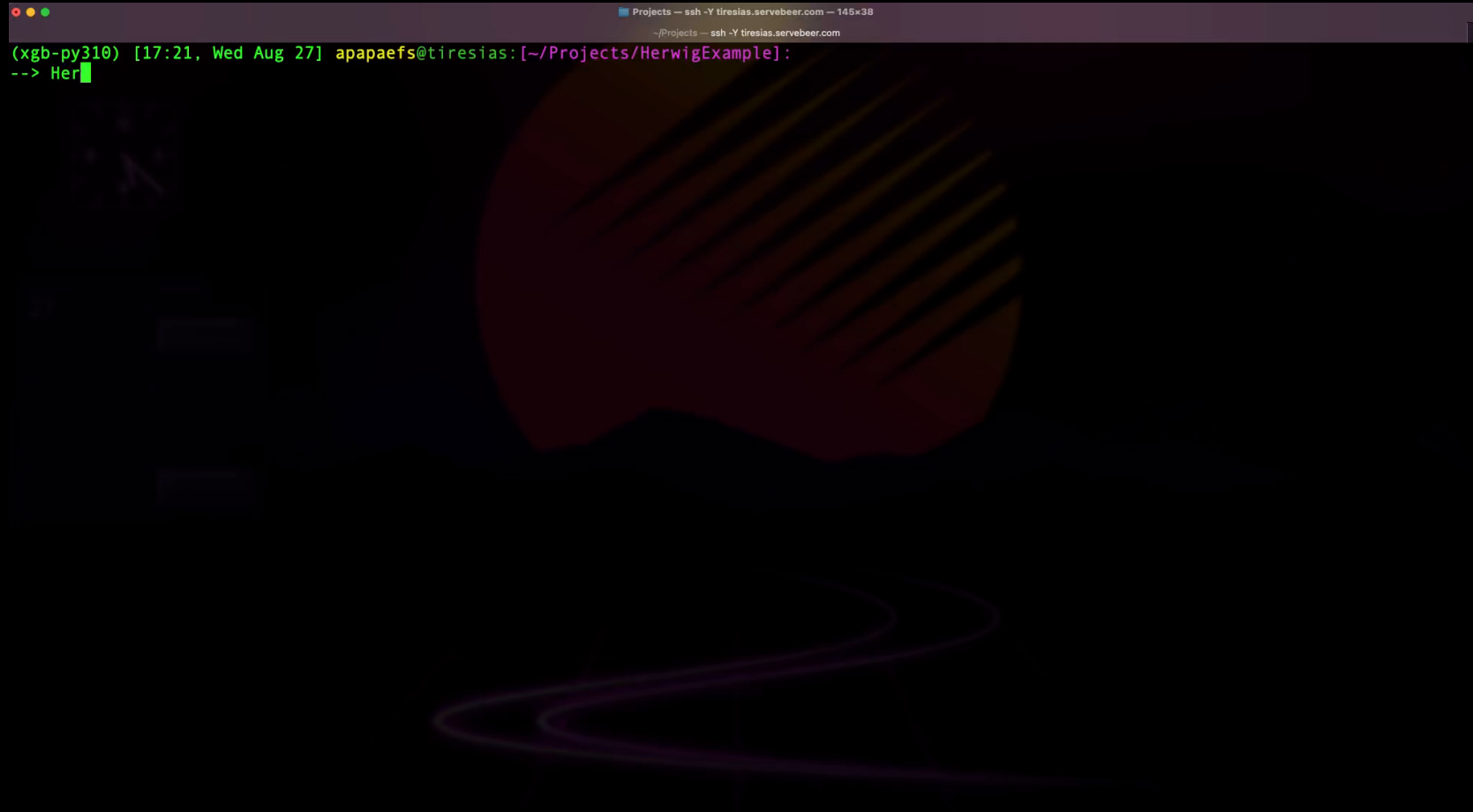
**The shape
can help!**

Red: a new
hypothetical
particle!

everything else:
stuff we know
exists.

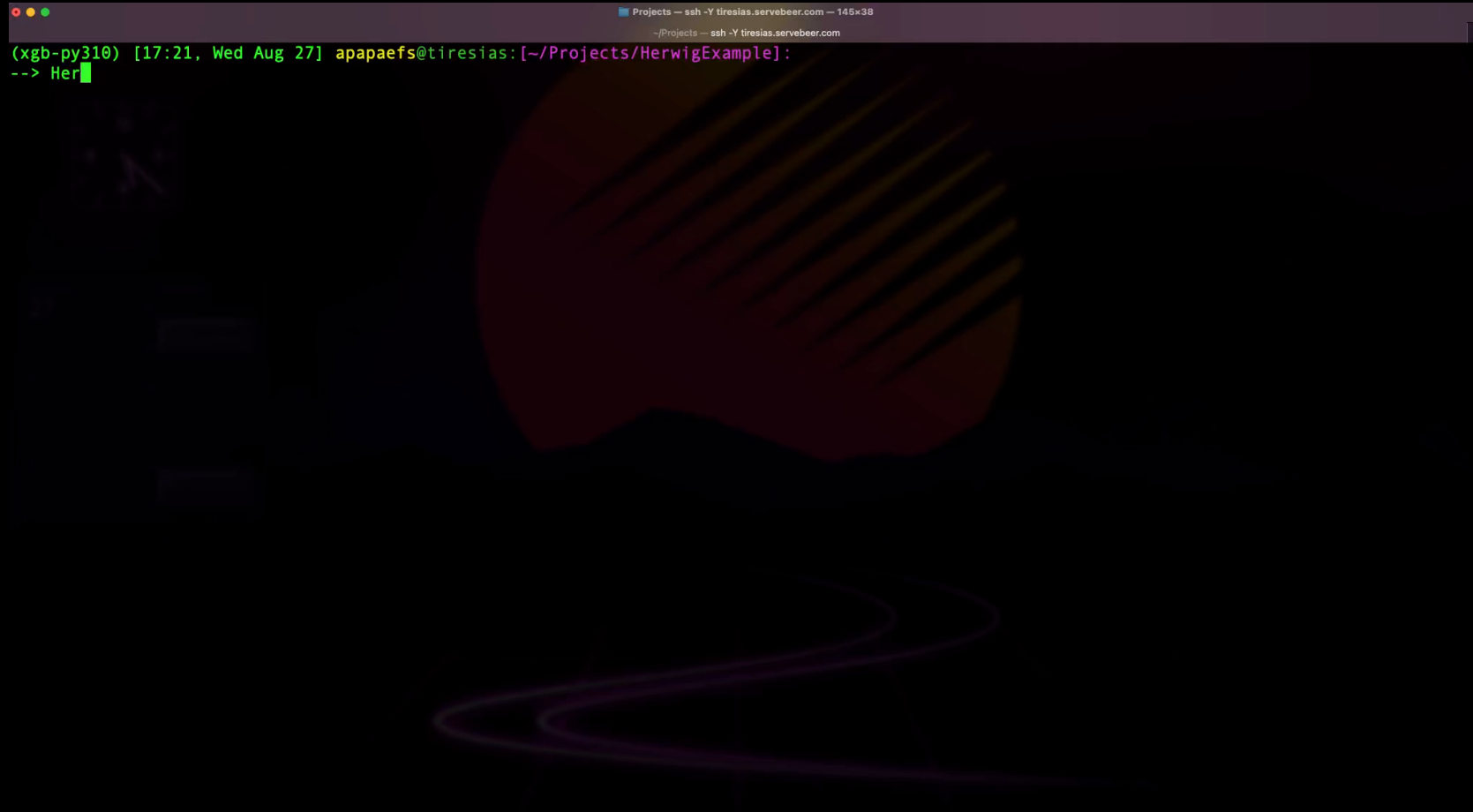
white dots
represent real data!

A Monte Carlo Event Generator



```
Projects — ssh -Y tpiresias.servebeer.com — 145x38
~/.Projects — ssh -Y tpiresias.servebeer.com
(xgb-py310) [17:21, Wed Aug 27] apapaefs@tiressias: [~/Projects/HerwigExample]:
--> Her
```

A Monte Carlo Event Generator



Getting started...

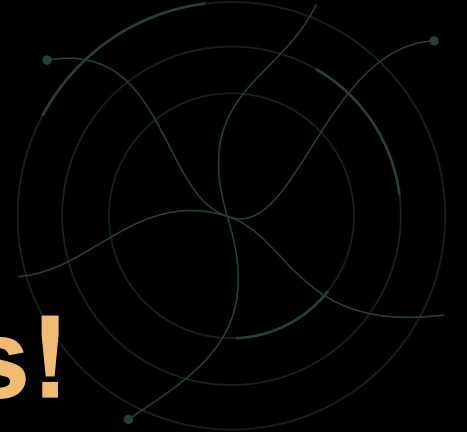
Learn a **tool** (e.g. a Monte Carlo event generator),

Make a **prediction**, **test** an assumption.

That is the place to begin!

The questions are big.

But you can start with small steps!



Start with a question!

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SCAN ME!