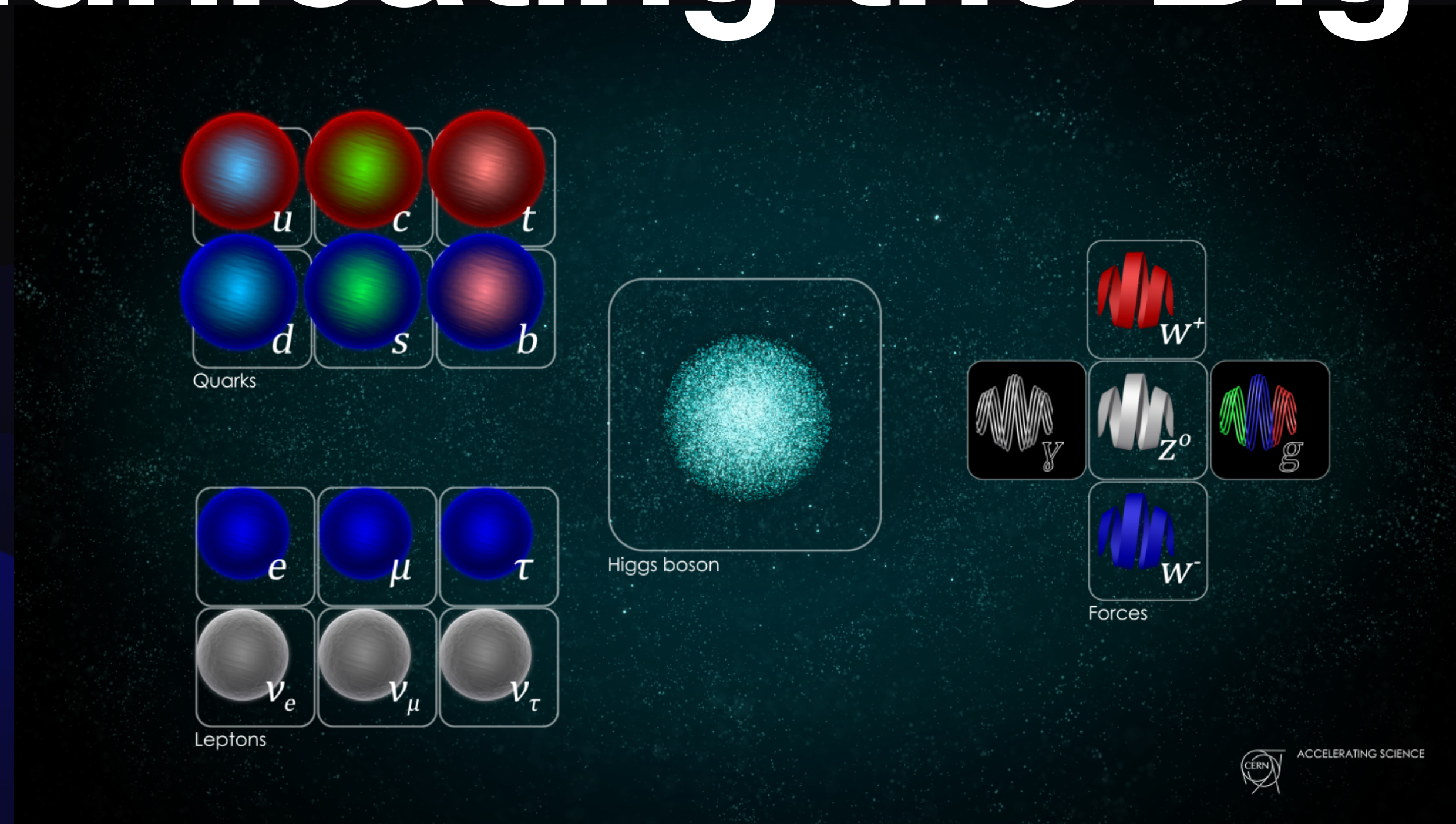


Communicating the Big Picture



Opportunities and responsibilities for Particle Physicists

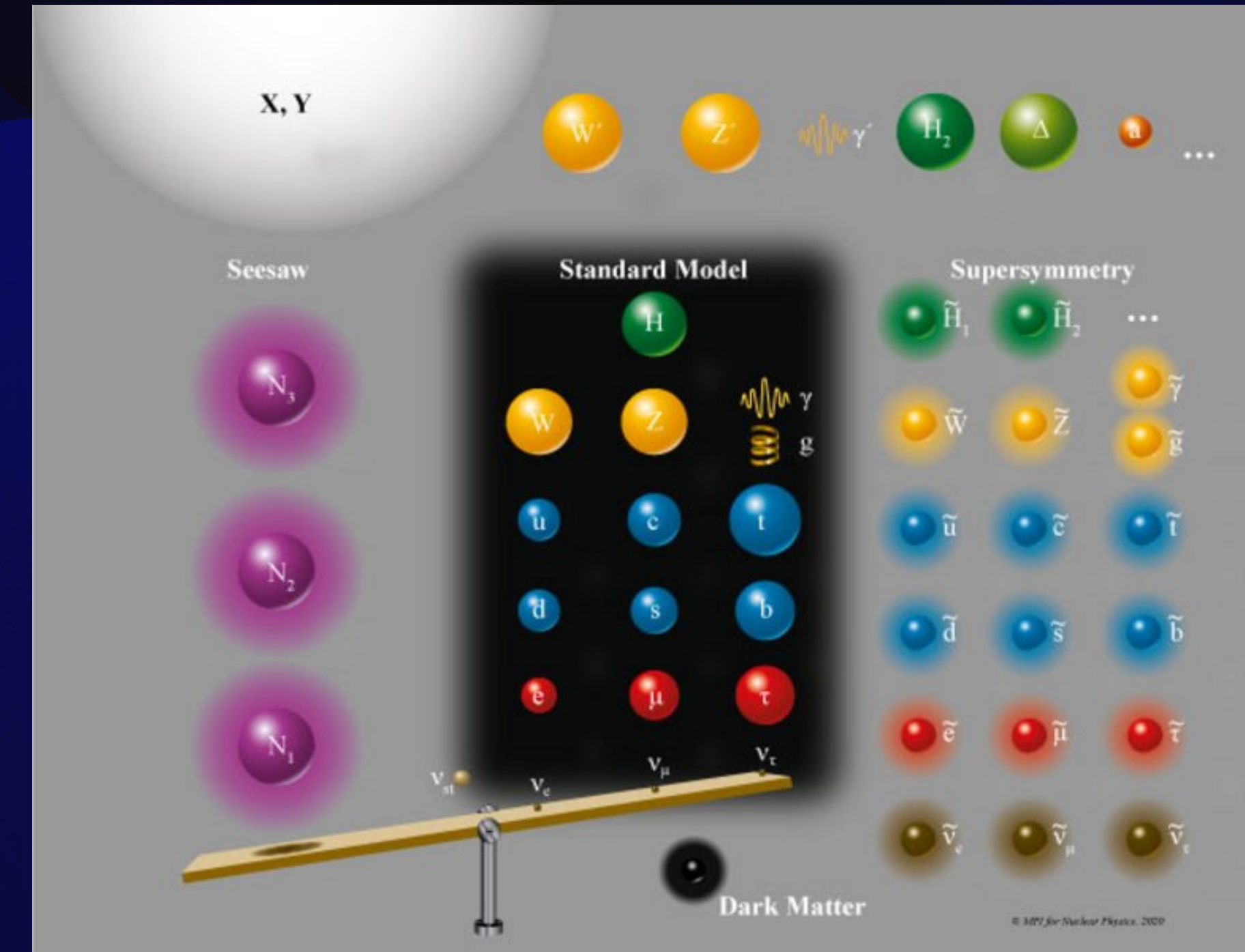
Ethan Siegel, PhD

March 25, 2024

Aspen, CO

Communicating the Big Picture

- What matters most in communication?
 - How trust erodes and the truth gets lost as we vie for attention
- The Big Picture of our Universe
 - What we know today and hope to find tomorrow
- The value of what we do as physicists
 - The value of theoretical ideas
 - The indispensable value of experimental data
- The point of it all
 - Increase the scope of what we know about reality



What matters most in communication?





What matters most in communication?

The message



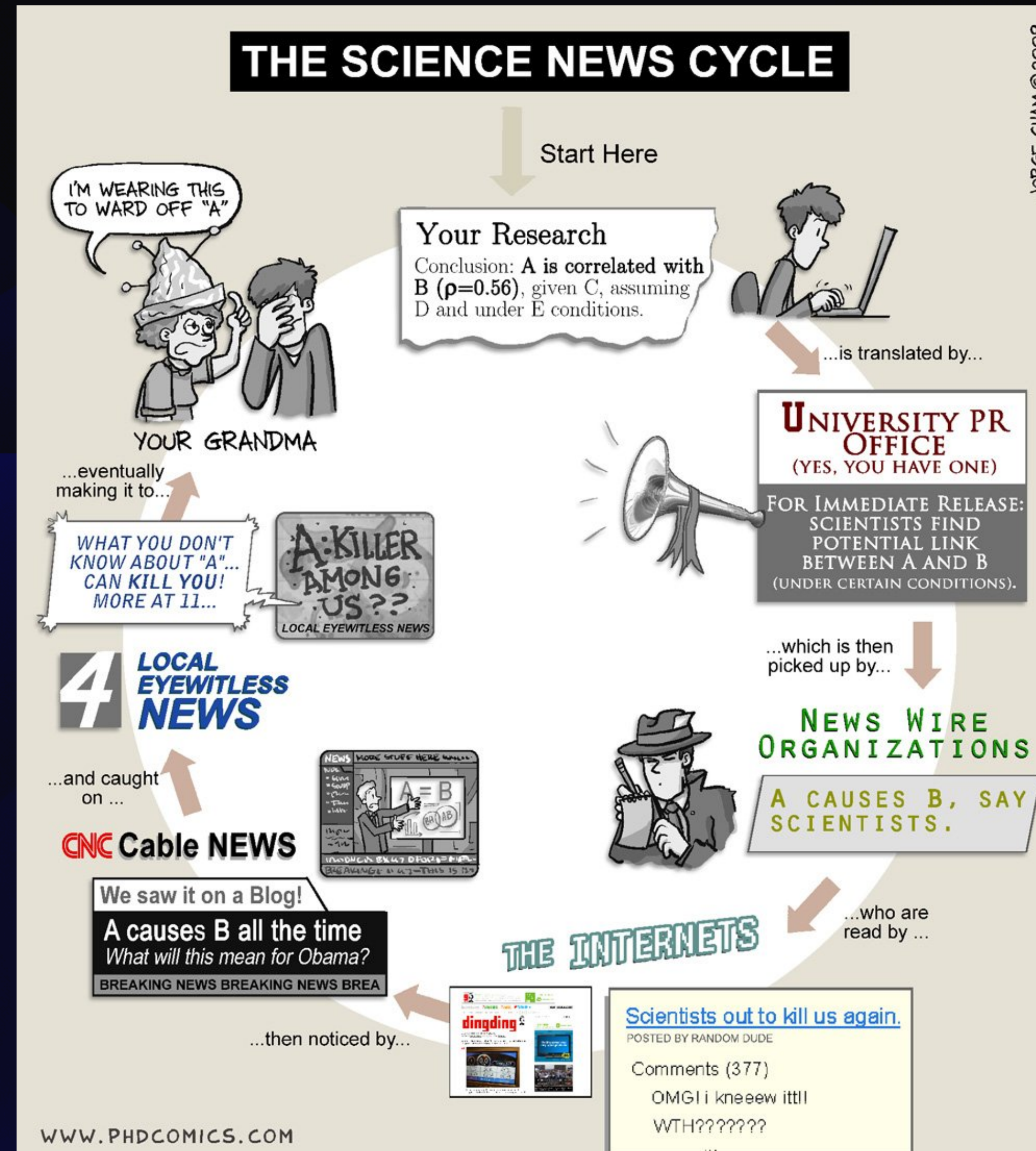
What matters most in communication?

The substance and clarity of the message






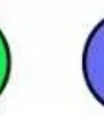








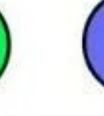























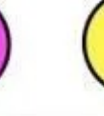



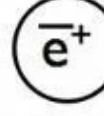

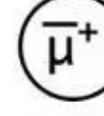

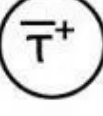




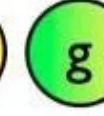



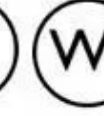


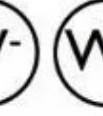
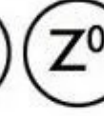


The big problem

- People want a sensational story
 - Readers want it, journalists want it, even many of us in this room want it
 - Sensational, simple, and with a “scientists were wrong” headline
- The most sensational claims get the most play
 - Particularly true if you PhD’d in the 80s, 90s, or 00s
- Historically, this type of sensationalism has been rewarded
- Big ideas = bigger claims = more publicity = more fame = more funding
- But none of this equates to actual scientific value

The cycle of how news is made



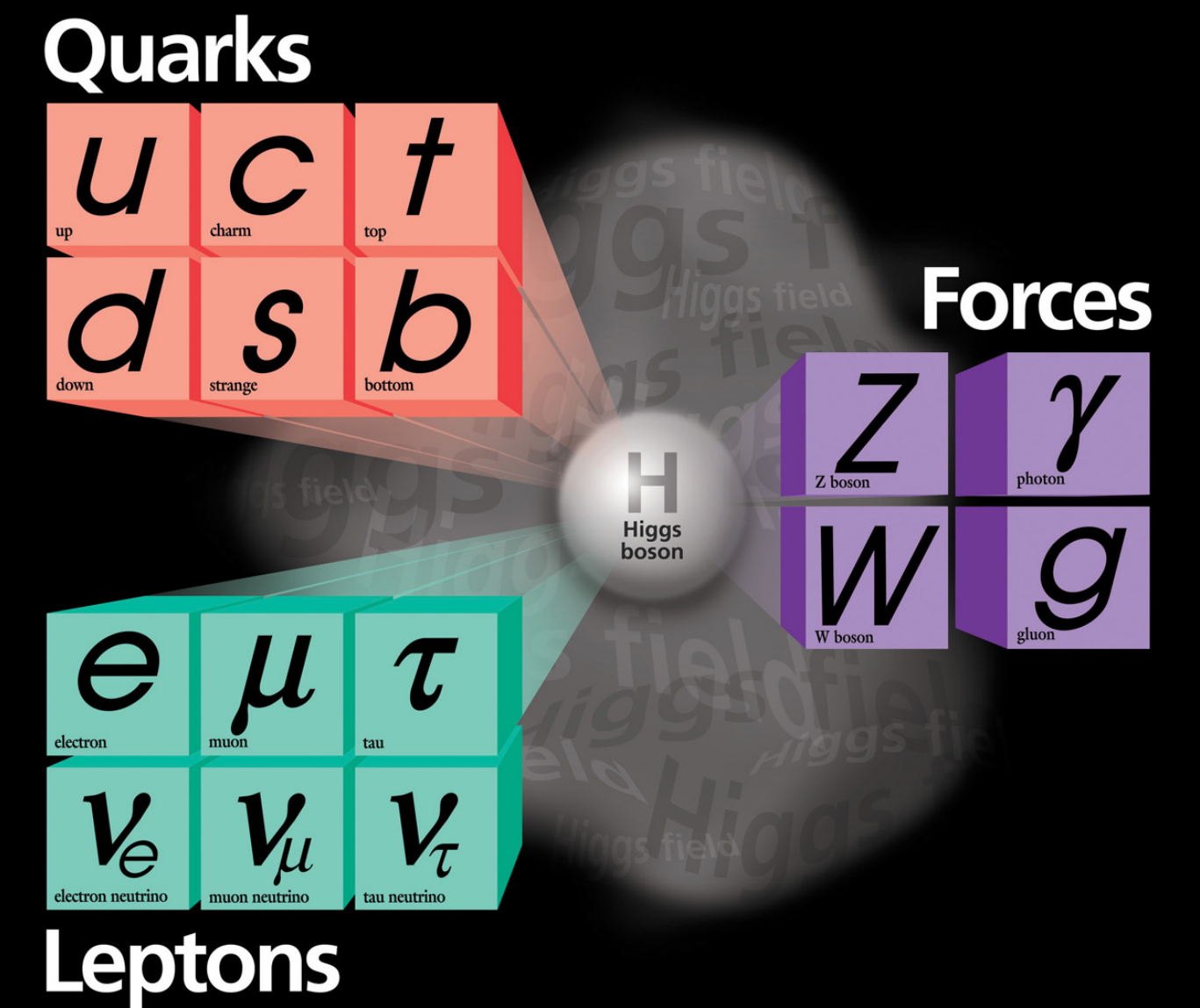
The result

  	  	  	Quarks
  	  	  	
 	 	 	Leptons
  	  	  	Anti-Quarks
  	  	  	
 	 	 	Anti-Leptons
        		   	Bosons

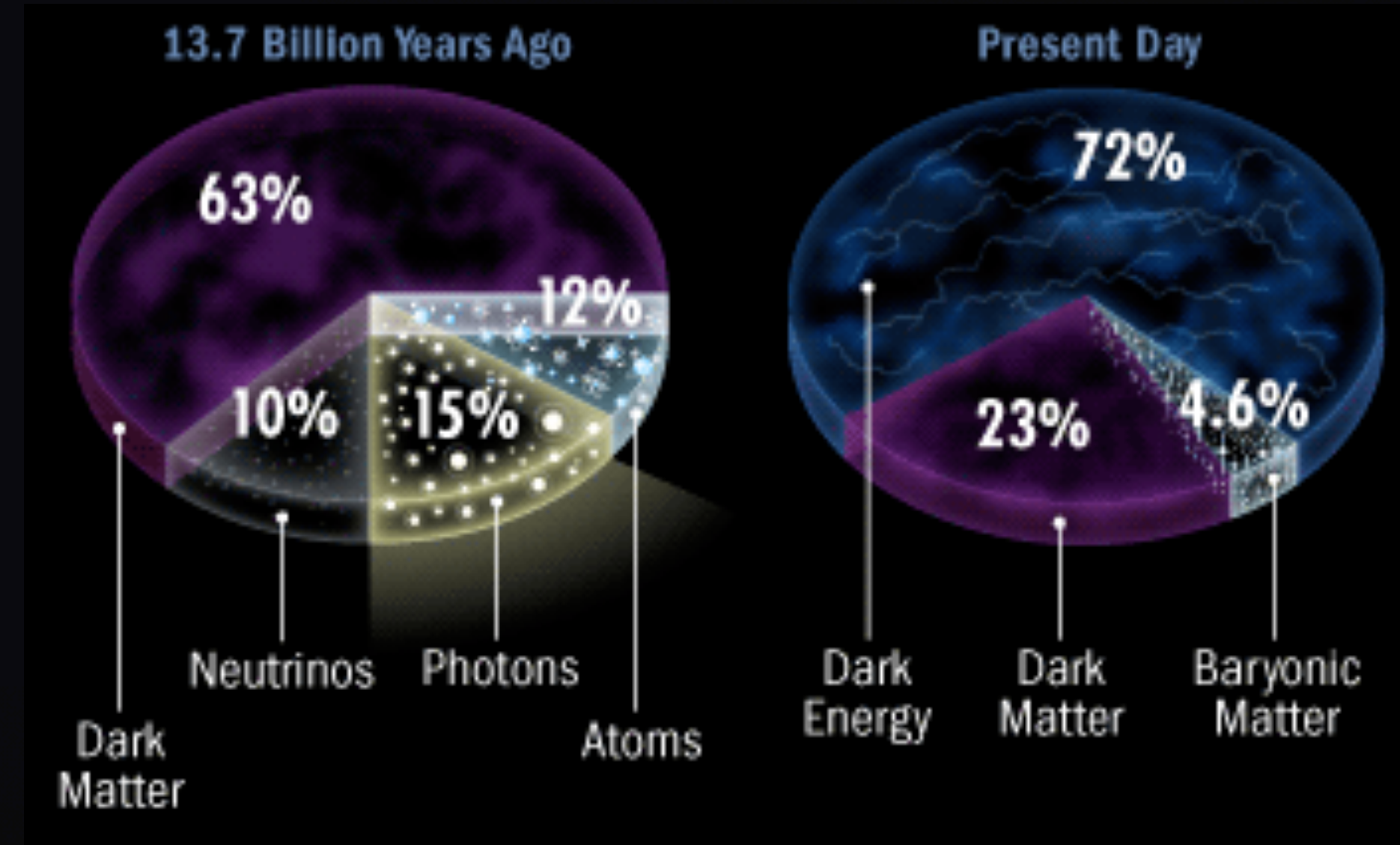
- People think:
 - With the Standard Model now complete, fundamental science is over
 - Theorists all work only on bad ideas that aren't supported by reality
 - (E.g., SUSY, GUTs, String Theory, Extra Dimensions, etc.)
 - Experimentalists just keep finding “nothing” to better precision
 - And no “real” progress has been made in particle physics in forever

The truth?

- People are only partly (and not mostly) right
 - Standard Model really is now complete!
 - Most theory work really is irrelevant for our reality
 - So what? Sandboxing and theory development are vital tools!
- Experimentalists are pushing the frontiers with what they're measuring
 - Decay channels, branching ratios, CP-violation, quark/neutrino mixing, constraints on BSM scenarios and exotics
- Both represent real, incremental progress that we should all be proud of!



What we know today



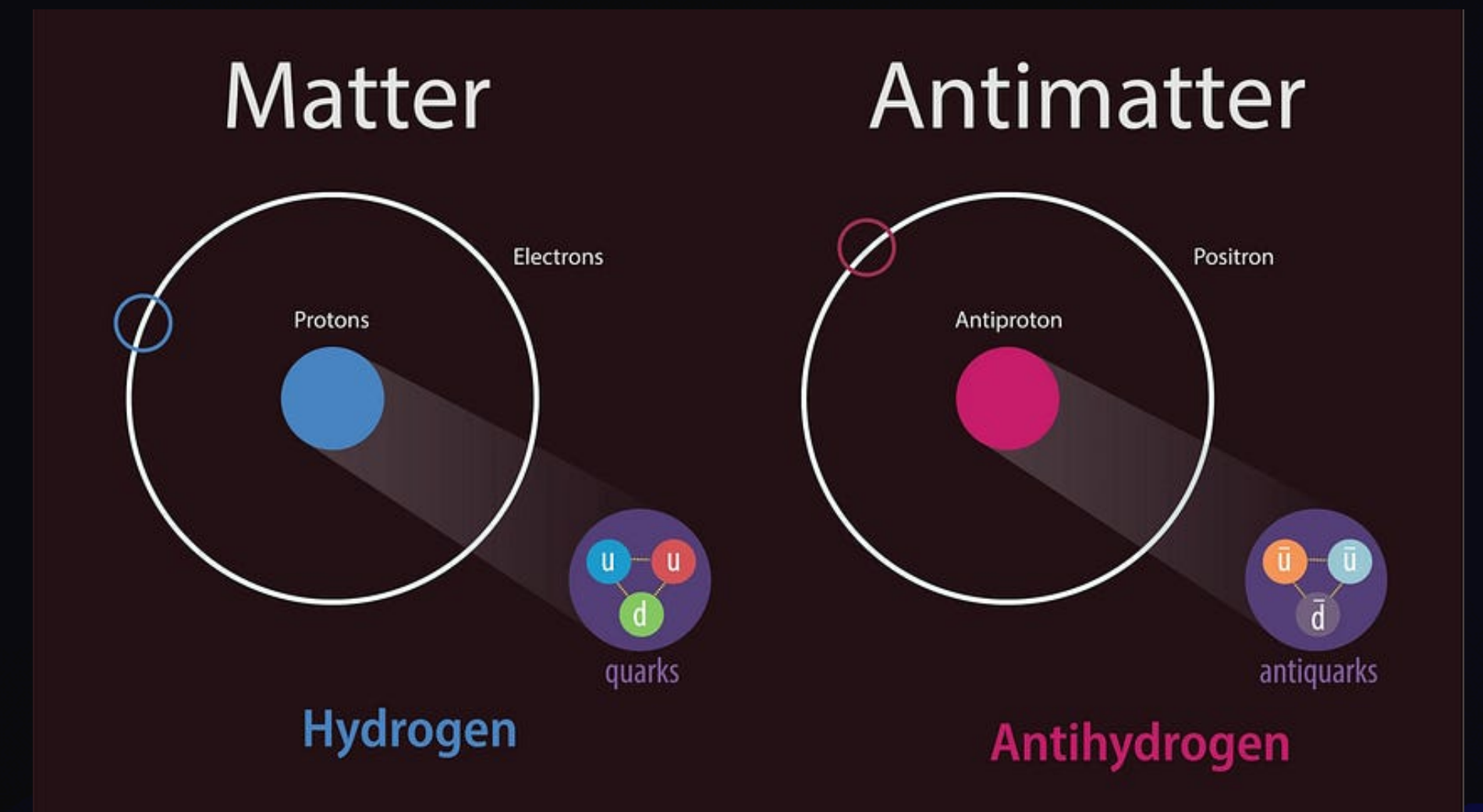
- Standard Model of Particle Physics

- Quarks, leptons, bosons
- Matter-antimatter asymmetries
- Badly broken EW symmetry at low energy
- Massive neutrinos; mass eigenstates differ from flavor
- Severe constraints on alternatives

- Standard Model of Cosmology

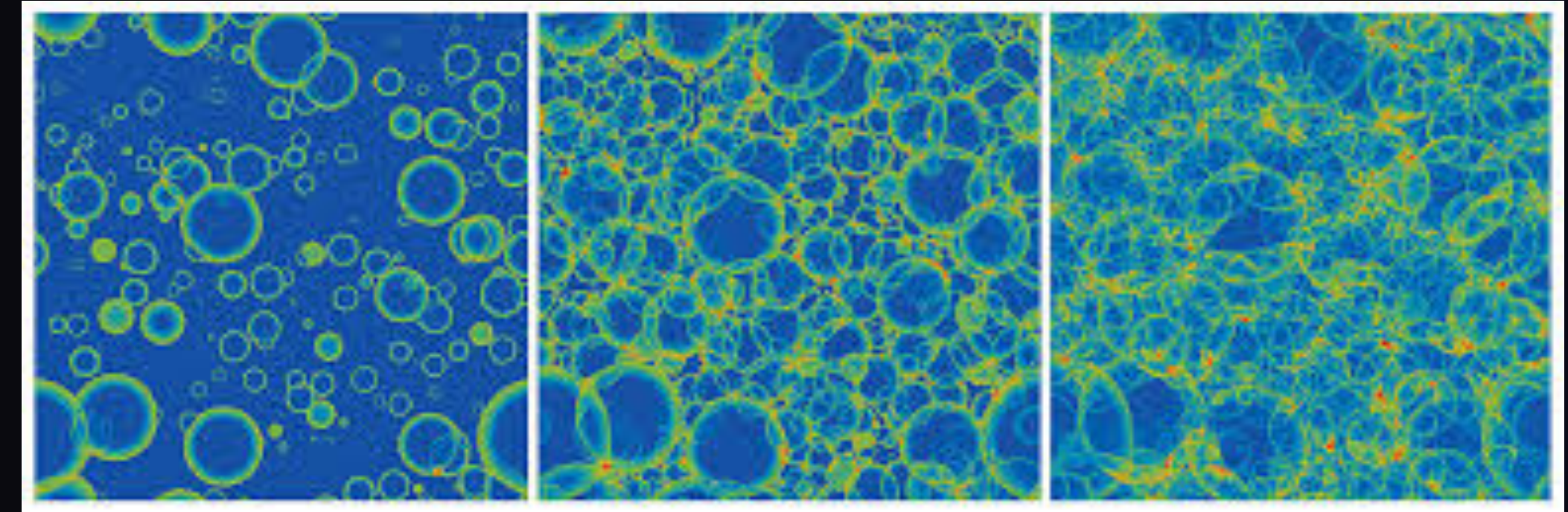
- Standard Model particles, plus dark matter and dark energy
- Out-of-equilibrium Universe
- Big Bang preceded by inflation, maximum reheat temperature
- Cosmic web + structure formation
- Severe constraints on alternatives

What we hope to find out



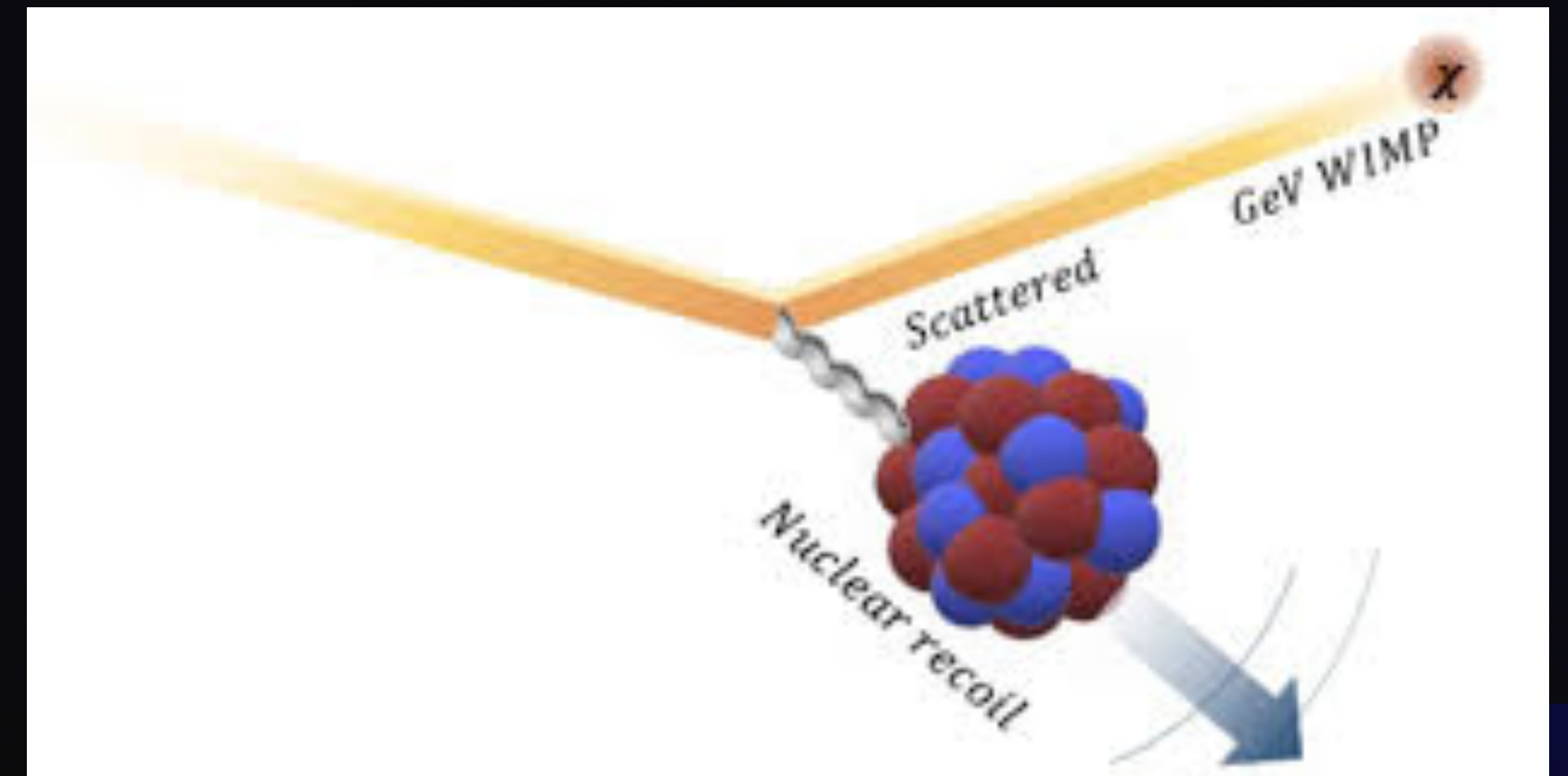
- Particle physics
 - Particles exhibiting BSM behavior
 - Reactions enabling baryogenesis
 - Explanation for hierarchy problems
 - Any new information about DM/DE
 - Experiments to test, constrain, or validate BSM scenarios
- Cosmology
 - BSM relics from the early Universe
 - Environments for baryogenesis
 - Explanation for fine-tuning problems
 - Any new information about DM/DE
 - Observations to test, constrain, or validate BSM scenarios

The value of what we do



- What people think:
 - Physicists love and are wedded to untrue ideas
 - SUSY, Extra Dimensions, String Theory, GUTs, Technicolor, Magnetic monopoles
 - These things aren't real, so why even bother
- What's actually true:
 - Physicists want to understand reality
 - Theorists explore ideas to resolve paradoxes, incompletenesses, and inconsistencies
 - Experiments push the frontiers of what is known beyond their current boundaries

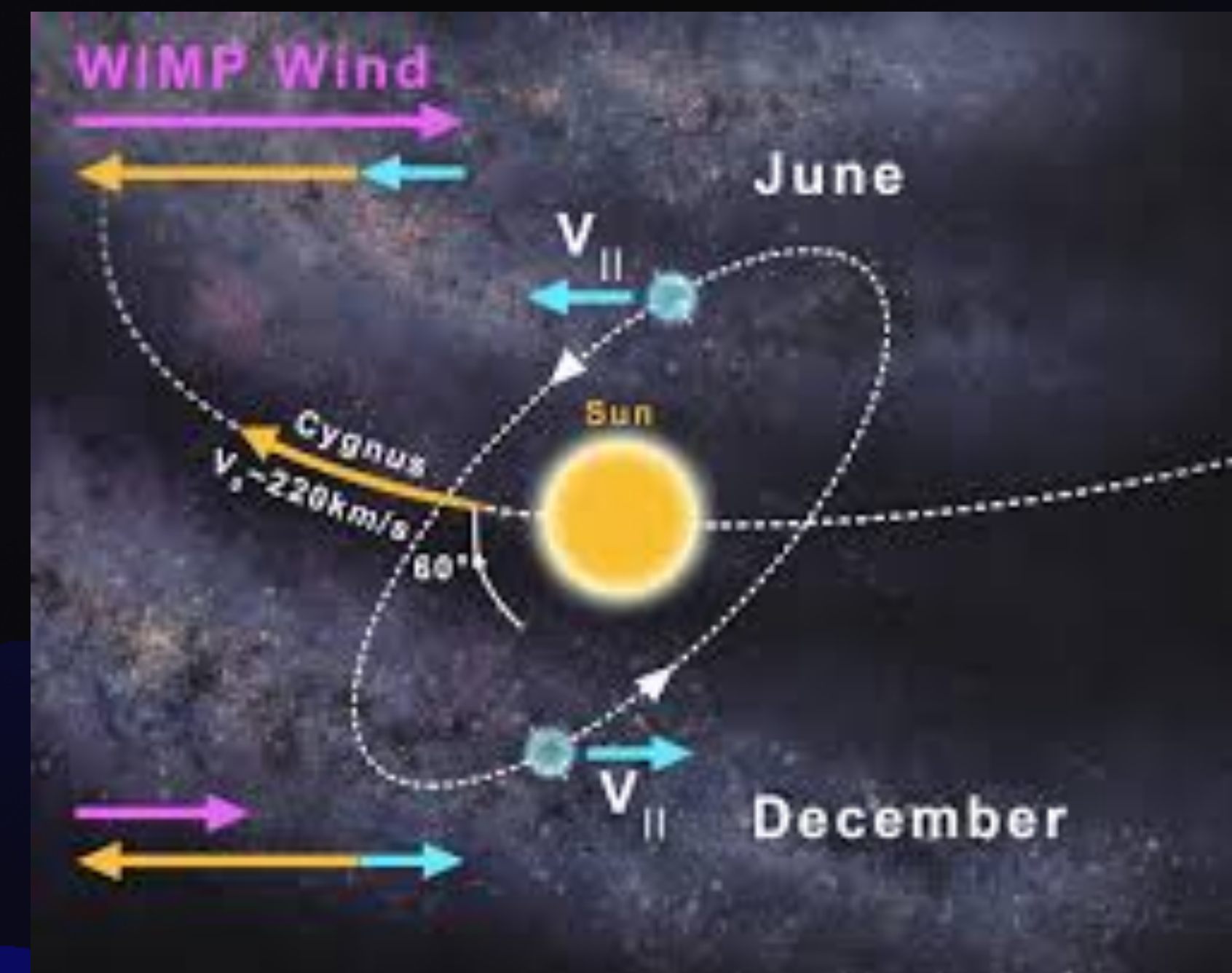
The value of theory



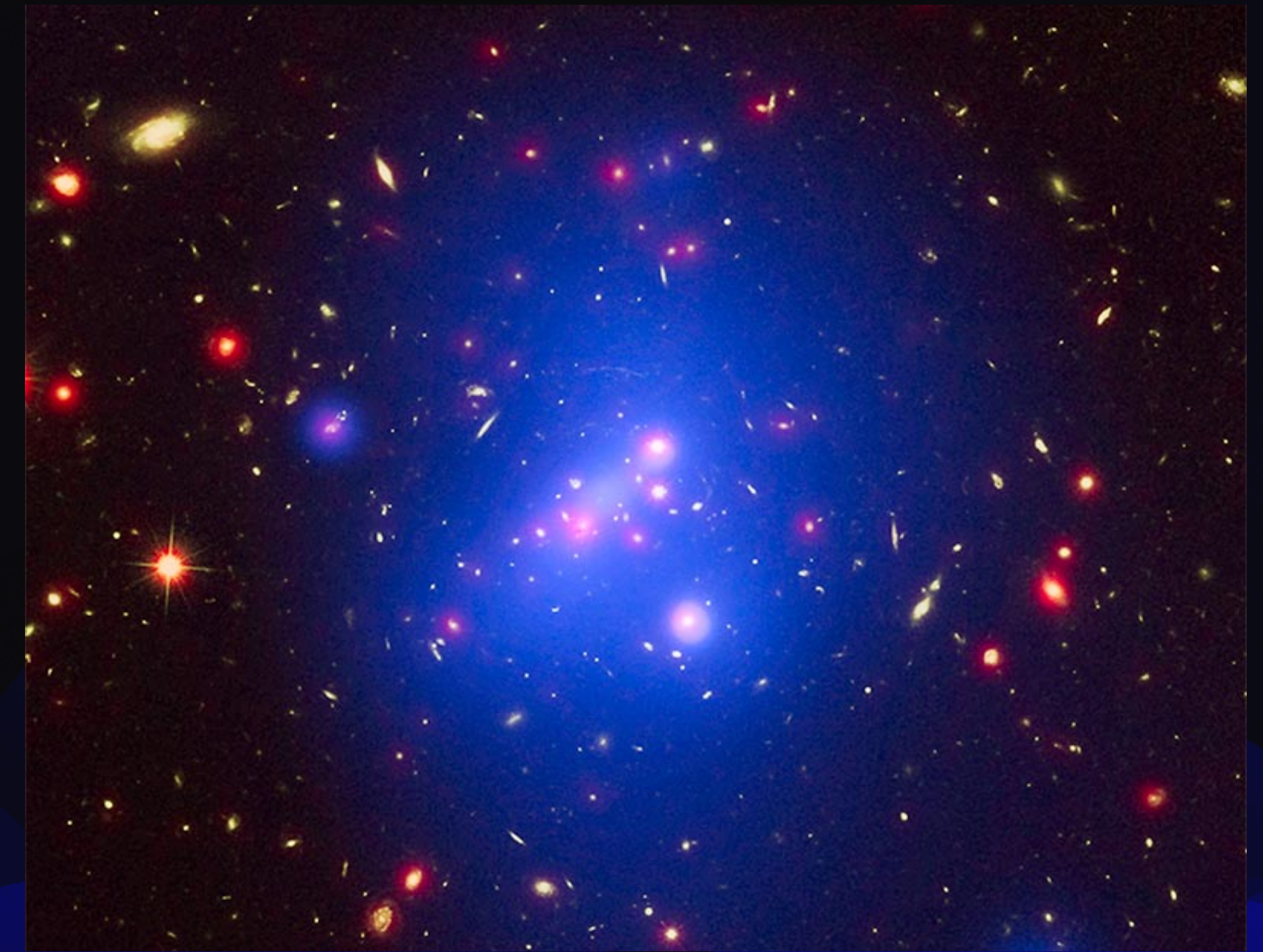
- We are physicists: we want to know **how** nature works
- “How” means understanding the mechanism that generates what we observe
- The beauty of theory lies in its utility: what can/does this theory do?
- Theory informs experimentalists what they should be searching for and attempting to measure
- Theory tells us what should happen and by how much in each new scenario

The goal of theoretical work

- Develop an idea to make testable predictions
- Predictions must be consistent with what's already been observed/measured
- Predictions should account for at least one hitherto unexplained phenomenon
 - Should make sure this is a *real* phenomenon, not ambulance-chasing
- Predictions should be able to go head-to-head against the Standard Model
 - What can we potentially observe/measure that differs from the SM?



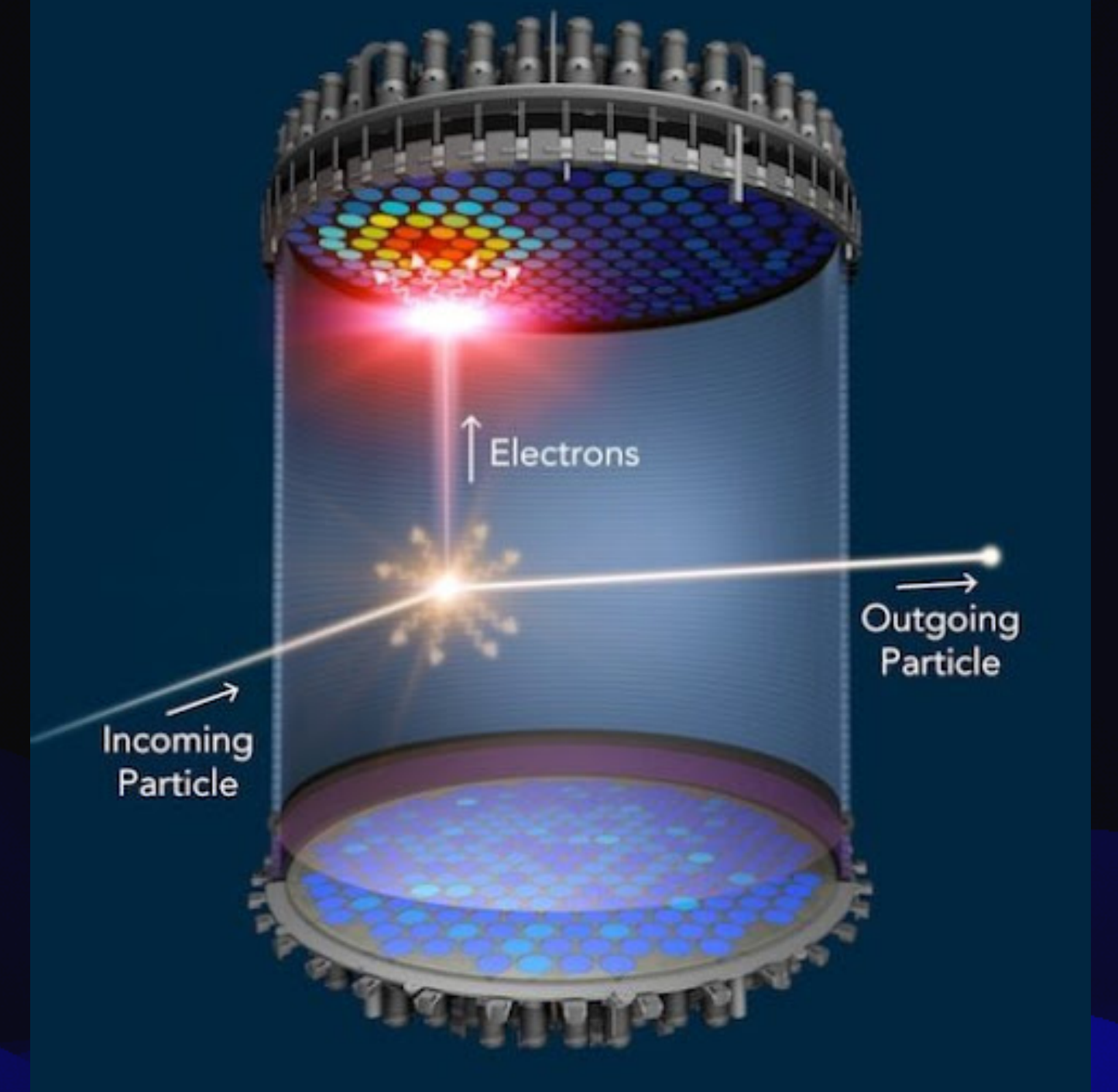
The theoretical holy grail



- A new theoretical idea, framework, or model, that simultaneously
 - Reproduces all of the successes of the prevailing theory
 - Successfully accounts for a phenomenon that current theory cannot explain
 - Makes at least one novel prediction that differs from the the old theory, or makes a concrete prediction where the old theory makes none
 - That can be tested with current or near-future technology

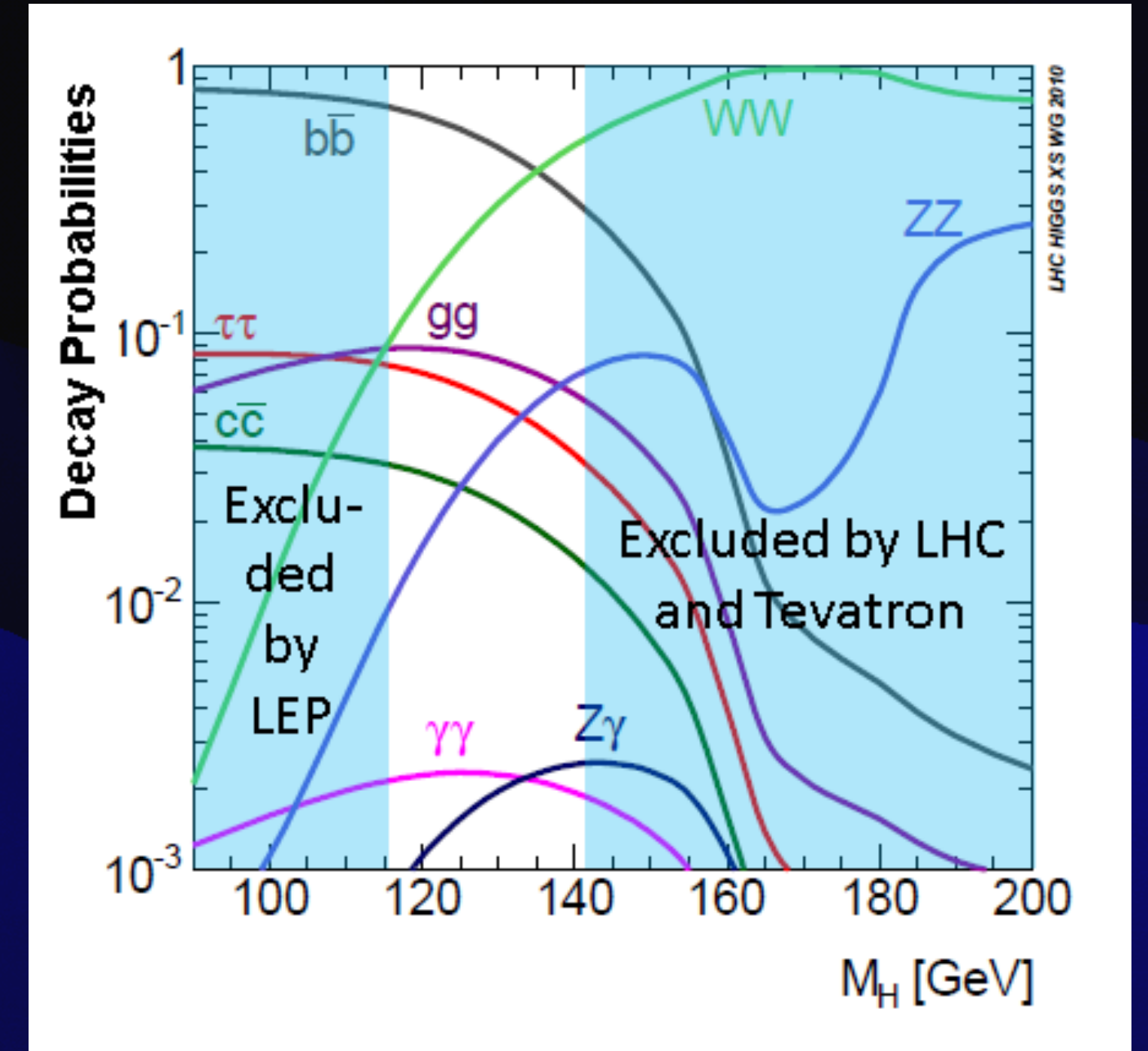
The value of experiment (and observation)

- Provides data to confront our theories with
- More data, better data, and data under new conditions has inherent value
 - But more value if that data is capable of discerning between different theoretical ideas or constraining BSM scenarios
- Provides opportunities for pleasant surprises
 - Who ordered *that*?
- Rules out theoretical scenarios that are incompatible with our actual reality



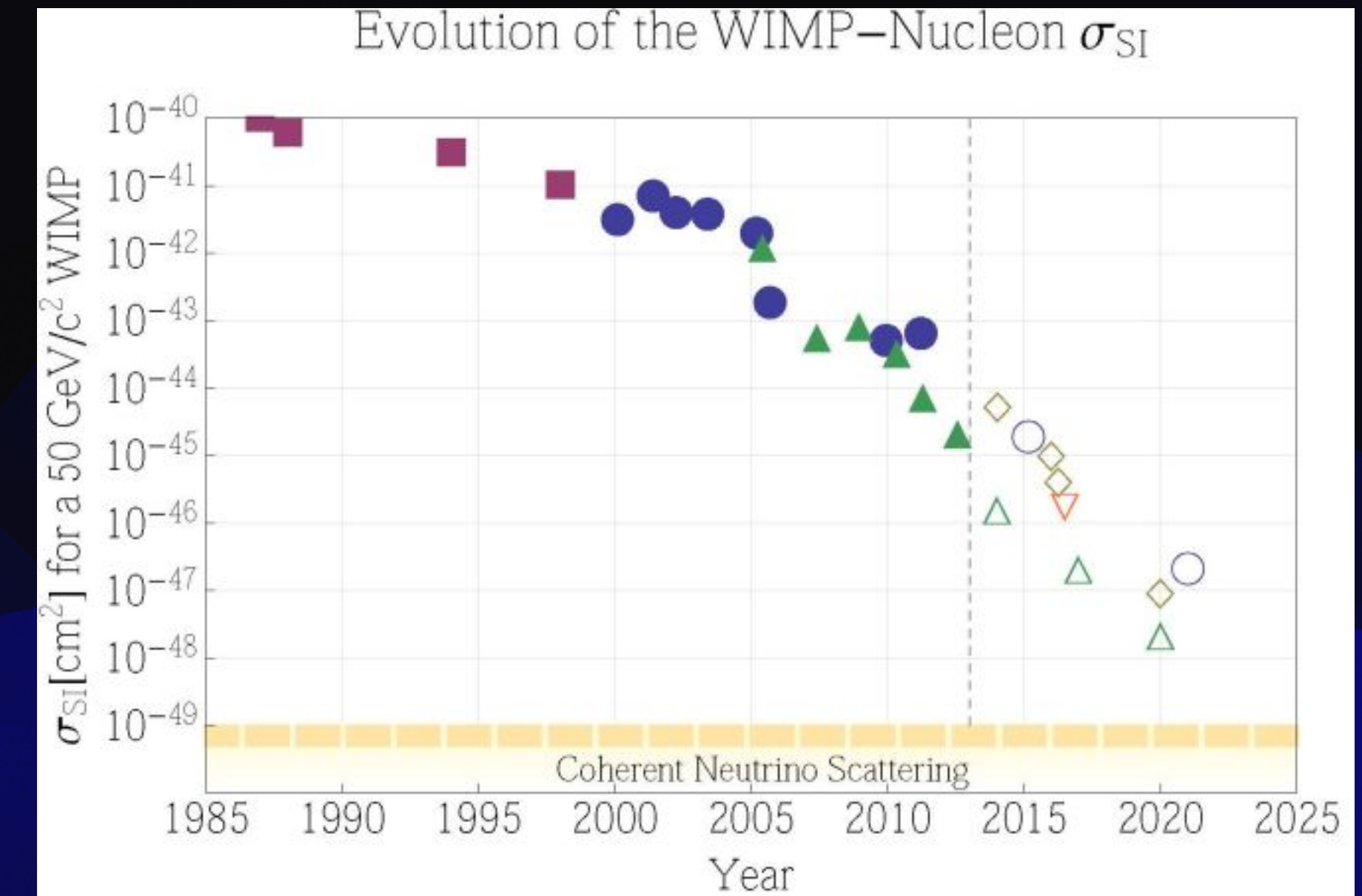
Experimental results that matter

- Positive results
 - Most exciting: discovery!
- Null results
 - Also exciting! New best-in-the-world constraints!
- Bad results (Atomki anomaly, DAMA experiment, OPERA FTL neutrinos)
 - Still a learning opportunity!
 - Physicists love correcting the mistakes of others!



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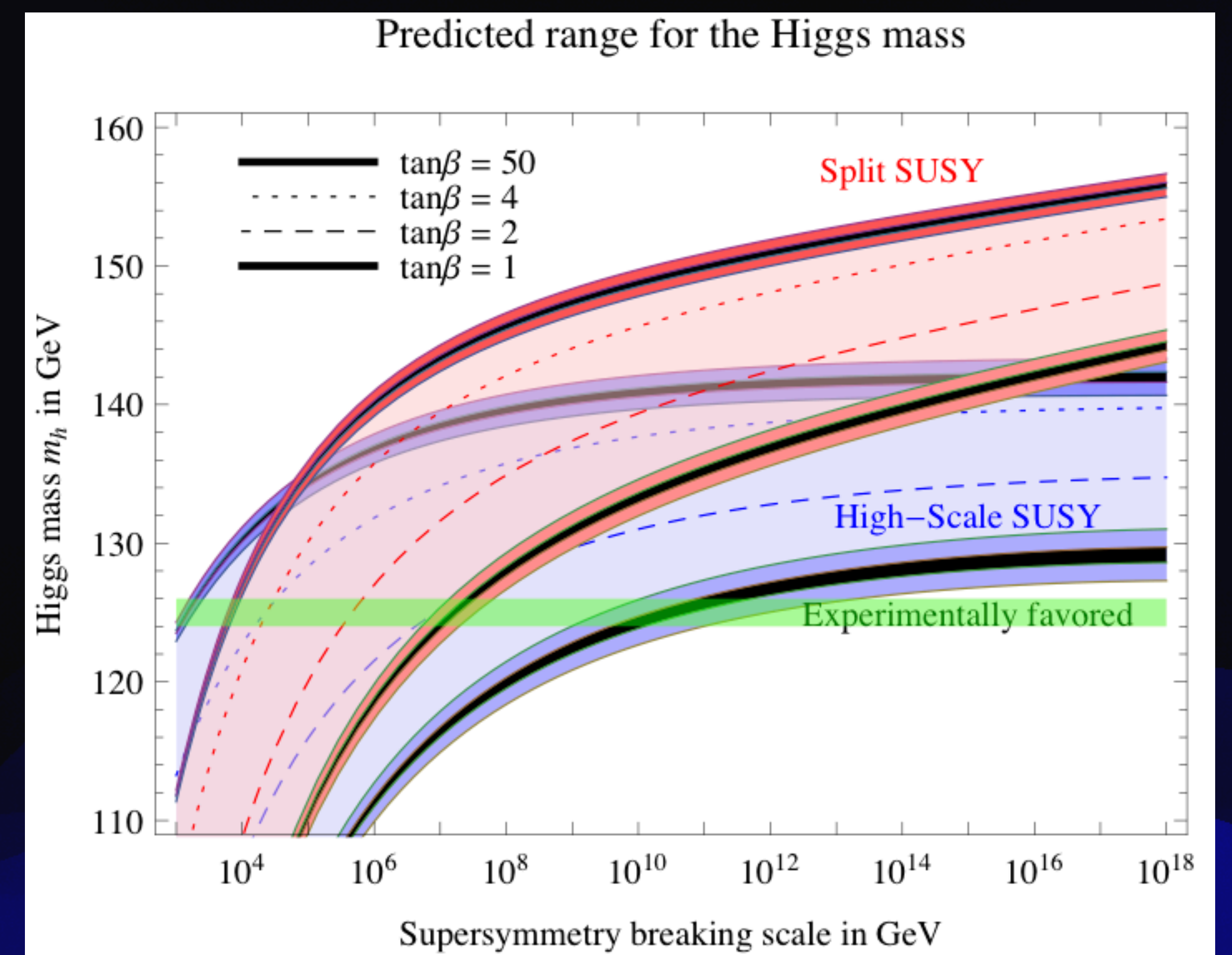


The point of it all

(Learn from past mistakes)

- Don't focus on:

- Promoting your favorite (probably your own) ideas
- Promising extensive spinoff technology capabilities
- Promoting an unsubstantiated, speculative theory
- Promising you'll find the next great breakthrough
 - New particles? Dark matter? SUSY? Exotics?



The point of it all

(For real)

- To increase the scope of what we know about reality
 - Not to think or suspect, but to know for certain
- This is the one and only Universe we have access to
 - We only learn about how nature works by interrogating it
 - We are compelled to interrogate it intelligently and comprehensively
- Be a cheerleader for the endeavor as a whole
 - What we're doing and why we're doing it is valuable, in and of itself
- Irresponsible communication can tank opportunity for future generations!

