

Journey to the Frontier of Physics

Splash!

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- Frontiers of Knowledge
 - Definitions
 - A little philosophy of science
 - A few fun frontiers
 - Cosmology
 - Particle Physics
 - ...
- Frontiers of YOUR Knowledge
 - What is Research
 - Your Scientific Career

Background Check!

- Physics classes?
- Exponential notation, e.g. $10^6 = 1,000,000$
- Logarithmic Scales?

Frontiers of Knowledge

- What is a frontier?
- Working definition:
 - A frontier of knowledge is an unambiguous question to which the answer is unknown.
 - Examples (suggestions?):
 - Do human beings have free will?
 - What happens to the conscious mind when we die?
 - Counterexamples (suggestions?):
 - What is on FOX Tuesday at 8pm?
 - What is the best rock and roll band of all time?
- Are these examples *scientific* frontiers?

Scientific Questions

- *Scientific* frontier => *Scientific* question
- What is a *Scientific* question?
 - Question with a verifiable answer
 - Question about a physical object (not abstract concept)
 - Examples/Counterexamples (suggestions?):
 - What happens to the conscious mind when we die?
 - What is the charge of the electron?
 - What is life?
 - What is $2+2$?
- How do we answer questions?
 - Hypothesis

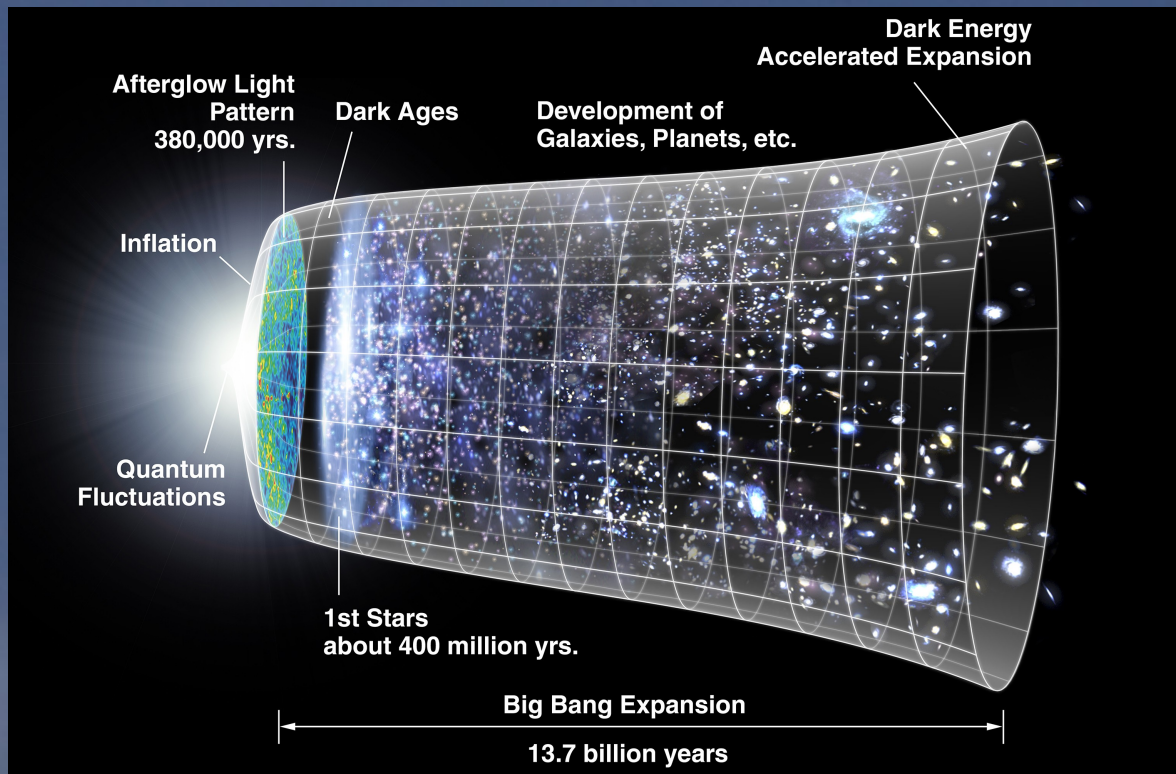
- What is a hypothesis?
 - Predicts the answer to many questions
 - Assume valid until proven wrong
 - Check where it seems like it will fail
- Often many competing hypotheses
- Examples
 - Repeatability, predictability
 - Galileo (Video)

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- What makes a scientific question *Physics*?
 - Questions in physics are answered by hypotheses about the *fundamental* components of objects and systems.
 - Examples
 - What is the rate at which H_2O dissociates under given conditions (temperature, current, etc.)?
 - *Chemistry*: Measure, develop empirical laws
 - *Physics*: Model the relevant components of H and O (nuclei and electrons), predict from the hypothesized behavior of these components.

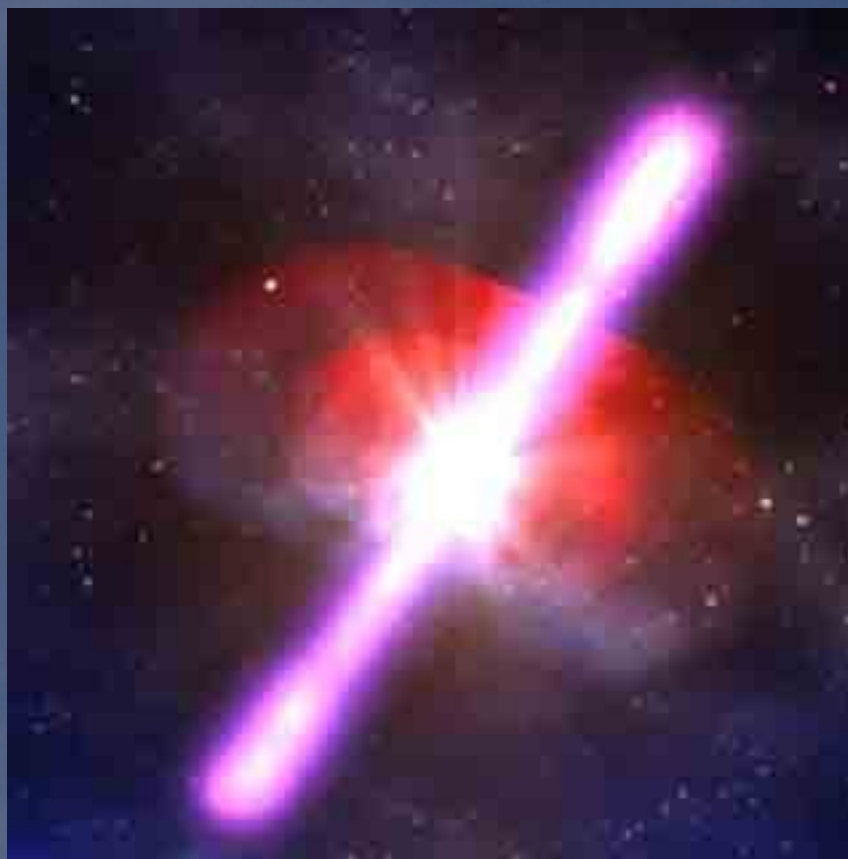
Cosmology and the CMB

- Hypothesis: Big Bang Cosmology
 - Universe started 13.6 Billion (10^9) years ago.
 - How do we know?



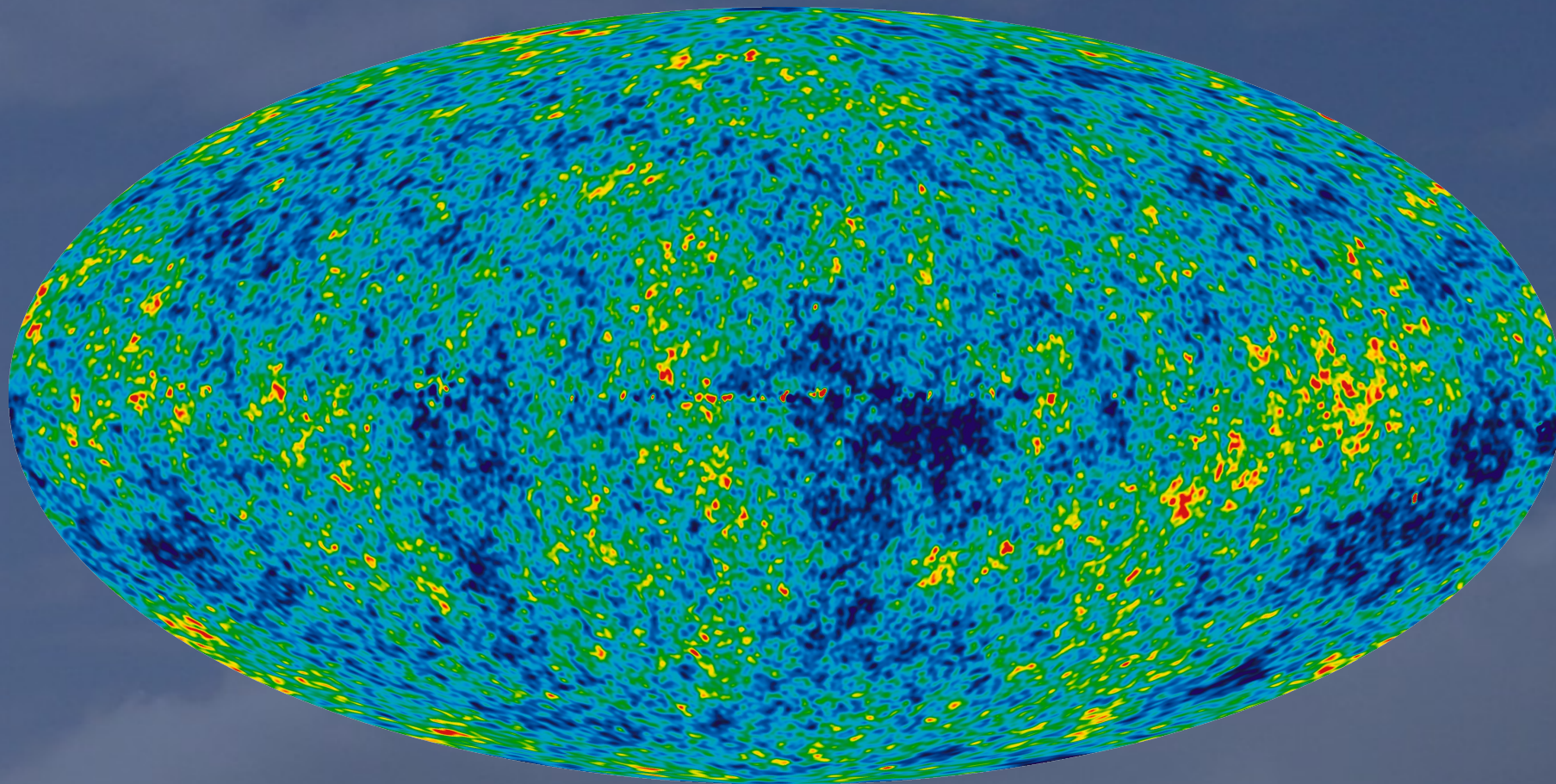
Cosmology and the CMB - Supernovae

- Supernovae



Cosmology and the CMB - CMB

- Cosmic Microwave Background

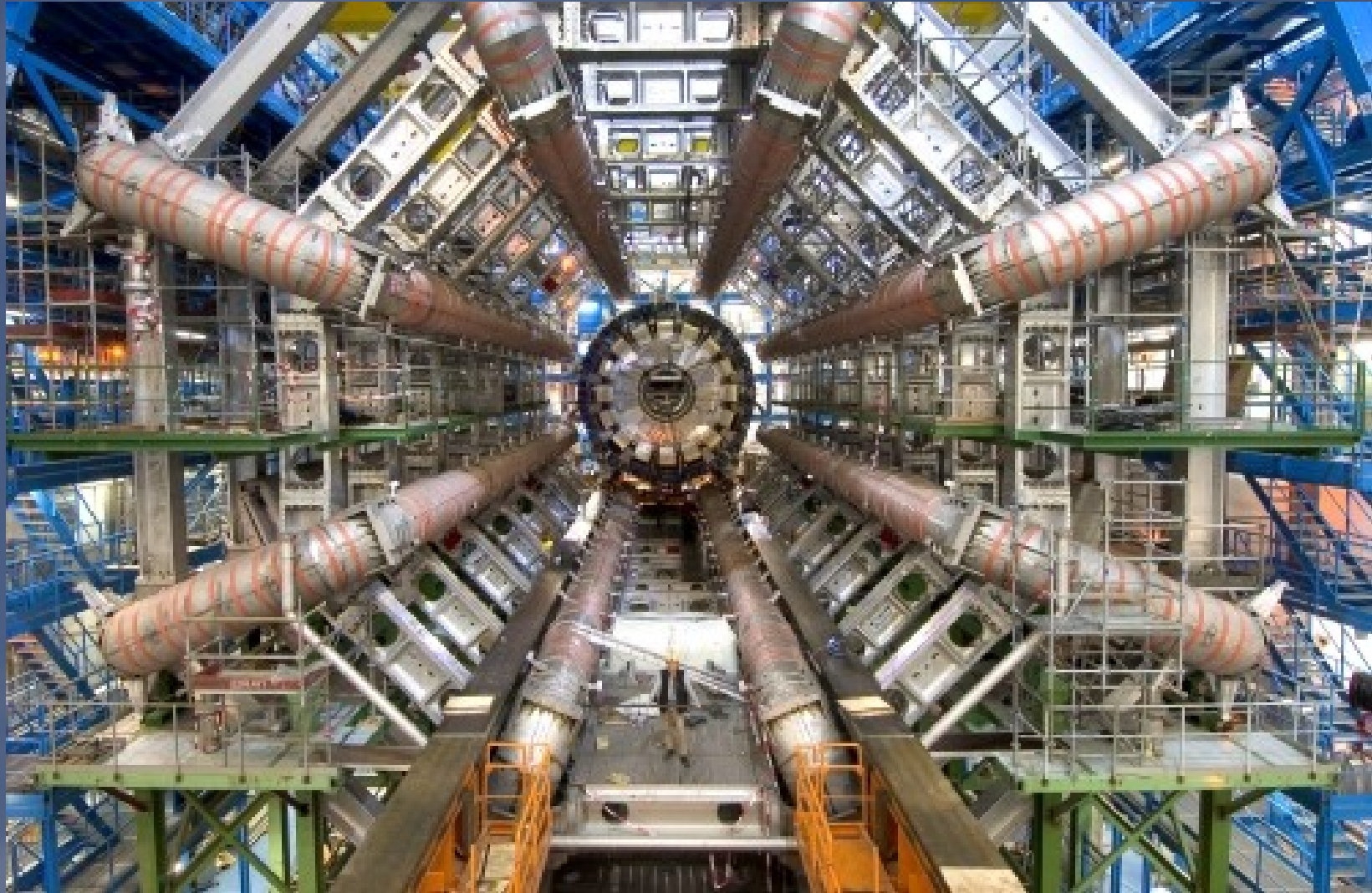


LHC – Particle Physics

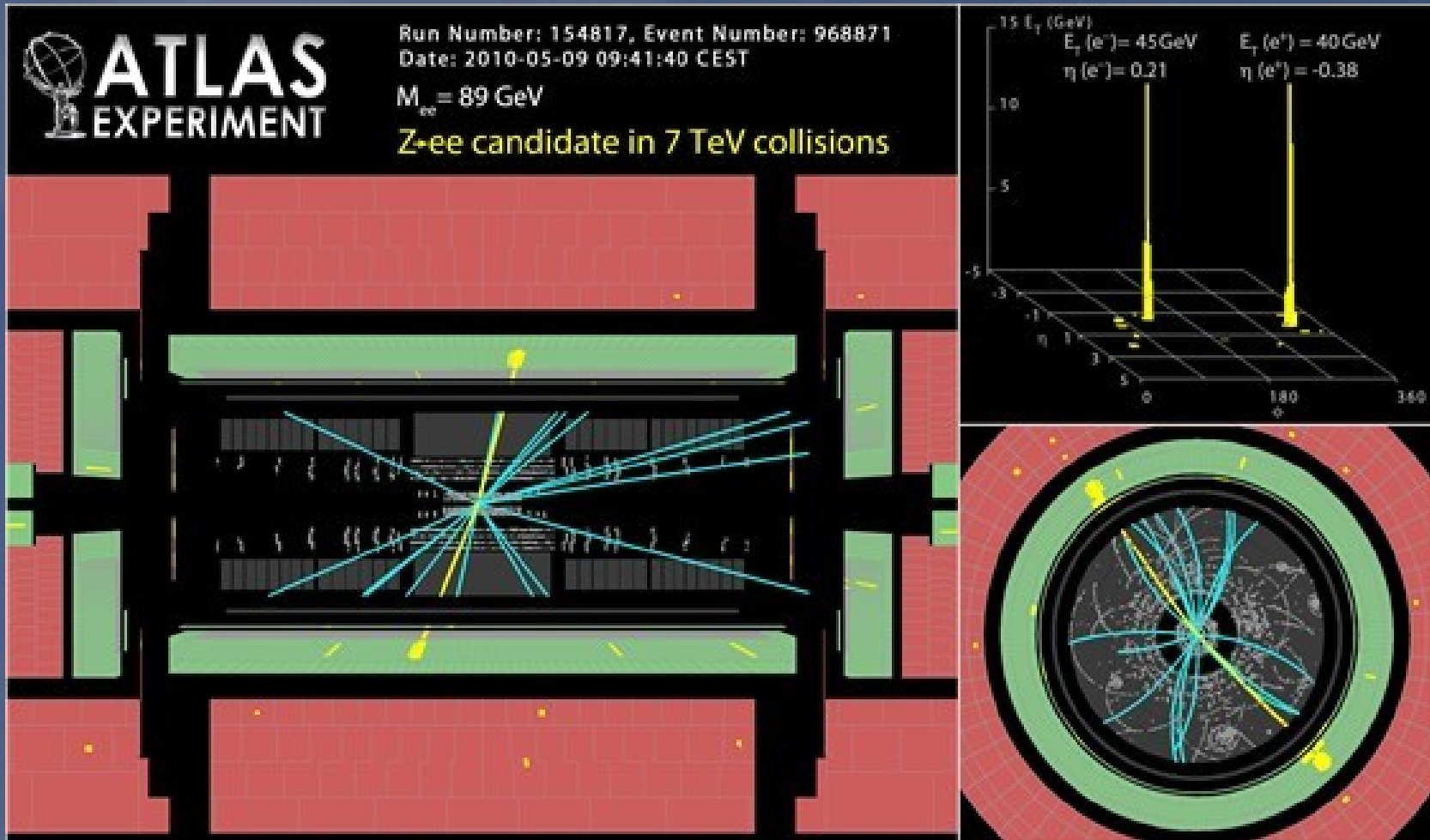
- Hypothesis:
 - All physical phenomenon can be understood by the properties of particles
 - The properties of particles can be measured by colliders



LHC – Particle Physics



Particle Physics - Frontiers



- Limitations of the Hypothesis (The Standard Model)
 - Planck Scale
 - Unification Scale
 - Hierarchy Problem