Randall, *Dark Matter and the Dinosaurs,* ix-33
Wesley Advocates 10 December 2017

Definitions

Cosmology: study of the origin, evolution, eventual fate of the universe

Astronomy: science of celestial objects, space, and the physical universe as a whole

Astrophysics: a branch of astronomy concerned with the physical nature of stars and other celestial bodies and the application of laws and theories of physics to interpret astronomical observations

Metaphysics: branch of philosophy that deals with the first principles of things including abstract concepts such as being, knowing, substance, cause, identity, time, and space

Introduction

What is dark matter, and where do we find it?

Randall and others believe what connection exists between dark matter and the fifth extinction occurring about 66 million years ago?

What is the mid-plane of the Milky Way? How does the sun interact with that plane?

How did the heavier elements (such as uranium) reach Earth?

About how old is our Universe? Our solar system? What is the Standard Model?

According to Randall, dark matter constitutes how much of our Universe? How do we know dark matter exists if we cannot see it? How does dark matter affect the motions of stars and other objects?

The Clandestine Dark Matter Society

Describe ordinary matter. What are the properties of matter most of us know and understand? Why can we see matter, but cannot see dark matter? Of the matter existing in the Universe, dark matter constitutes about how much? How is it that dark matter particles pass through us constantly without our knowing?

If not ordinary atoms, then dark matter comprises what?

What does Randall mean when she says dark matter aggregates or clumps? Describe the relations between dark matter and gravity, between dark matter and the Universe's expansion.

What does Randall mean by this statement: "Without dark matter there wouldn't have been enough time to form the structure that we now observe. Clumps of dark matter seeded the Milky Way galaxy. . . ."

Whence came electromagnetic radiation?

What happens when light shines on dark matter? Why might "transparent" matter have proved a better, more precise name?

What is dark energy?

How do black holes differ from dark matter?

What is the cosmological constant? What do we learn from Einstein's theory about the absolute amount of energy?

The Discovery of Dark Matter

Why is gravity a particularly weak force?

What did we learn from Fritz Zwicky about the velocities of galaxies? What did we learn from Jan Oort about the velocities of stars?

Who was Vera Rubin, and why was she especially important? What did Rubin and Ford's observations about galaxies teach us about dark matter?

How do spiral galaxies and elliptical galaxies differ? What are velocity dispersions?

What is gravitational lensing of light? How does it contribute to our knowledge of dark matter?

What does the Bullet Cluster reveal about dark matter?

When did atoms first form, and why? What is a recombination temperature? What are photons?

For how long after the Big Bang did the Universe remain "homogeneous and isotropic"? Why?

When and why did the Universe begin to oscillate? What is acoustic oscillation? Why does it matter?

Please study the pie graph on p. 20: what does it reveal?

What are white dwarfs? What is the type IA supernova? What do we mean when we say that astronomers can measure both the speed at which a galaxy recedes and its luminosity and, therefore, can measure the expansion rate of the Universe?

What is a redshift? Why does it help us know about the Universe's rate of expansion?

The Big Questions

Does anyone other than Randall care about the etymological relationship between *cosmologist* and *cosmetologist*? Does anyone other than me care about her annoying propensity for split infinitives?

How does Randall distinguish science and philosophy? Anything new here?

What is the cosmic horizon? How does it limit science?

According to Randall, why is there something rather than nothing? How does matter differ from antimatter? What accounts for the asymmetry between matter and antimatter? Why does that matter?

What happened during and immediately after the Big Bang?

What is a multiverse? And how likely is it that a multiverse, rather than a Universe, exists, according to Randall?

What is a braneworld?

Why can we not rely on anthropic reasoning when considering a multiverse?