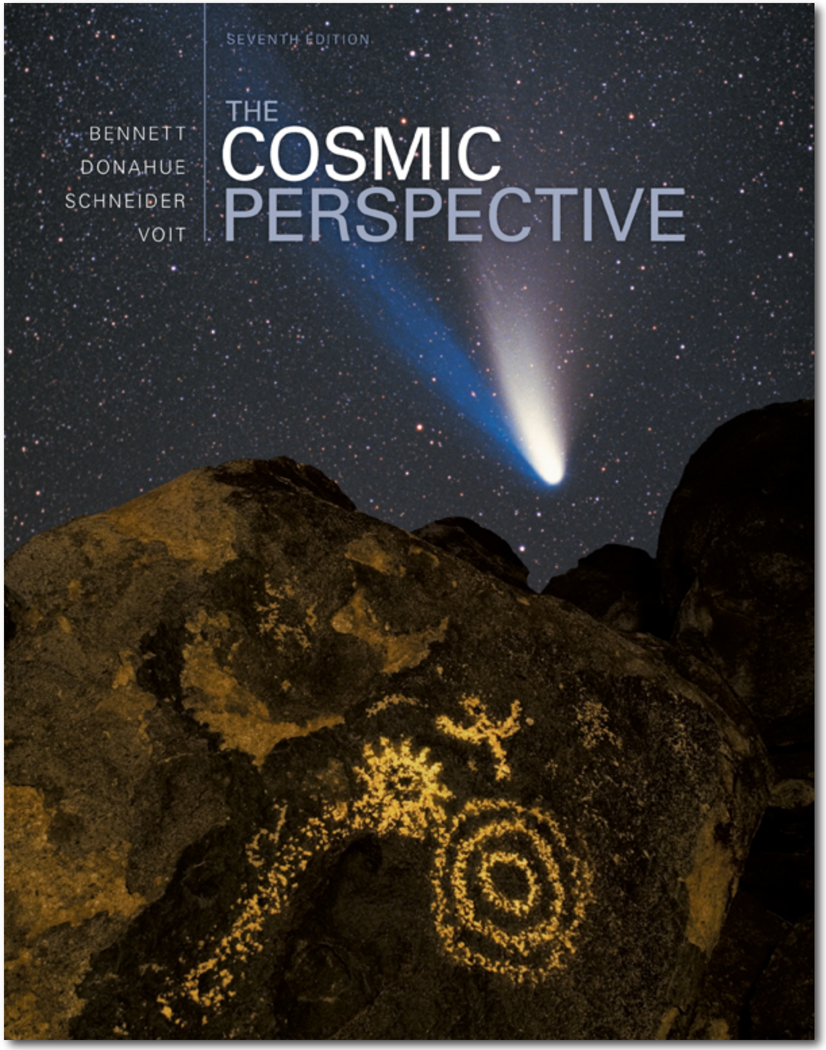
# The Cosmic Perspective

Seventh Edition




## The Birth of the Universe

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b) It was billions of years ago.
c) It was extremely hot and dense.
d) A and C
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What <u>observed</u> feature of the universe motivated scientists to propose the *big bang theory*?

a) There is lots of debris in space, as would be expected from an explosion.
b) The universe is expanding, and the expansion must trace back to a specific point and time of origin in the past.
c) Everything has a beginning, middle, and end.

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What does the big bang theory *predict* can be seen today if there really was a big bang?

a) Radiation from the big bang might be detected. It was gamma rays 14 billion years ago, but today it is cooler and would look like weak microwaves coming from all of space.
b) The Big Bang produced three elements, which might be seen in the oldest stars: 75% hydrogen, 25% helium, 1 part in a billion lithium.
c) The universe must be finite in mass and dimension.
d) all of the above
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Which of the two main predictions of the big bang theory turned out to be true?

a) Radiation has been found coming from all of space, just as predicted.
b) The oldest stars are made of hydrogen, helium, and lithium, in the proportions predicted.
c) both A and B
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How do scientists test the idea that the four fundamental forces are aspects of a more general force that became separate ("froze out") during the big bang?

a) It can't be tested.
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c) Particle accelerators like Fermilab and the Large Hadron Collider have tested predictions that the weak and electromagnetic forces are related.

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The cosmic background radiation from the big bang has been mapped in detail. What does it look like?

a) It is all over the sky.
b) It is seen even where there is no matter.
c) It is very uniform in overall distribution.
d) If you look *very* closely, there are slight fluctuations from place to place.
e) all of the above

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True or False?: When we look at the cosmic background radiation, we are looking farther into space–further back in time–then when we look at the farthest galaxies.

a) true
b) false

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a) **true**
b) false

What are the slight fluctuations seen in maps of the cosmic background radiation?

a) uncertainties in the map
b) variations in the instrument's sensitivity
c) the beginning of the formation of galaxies and clusters of galaxies
d) dark matter
e) none of the above

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Grand unified theories of physics (GUTs) predict that the very early universe ($10^{-32}$ seconds after the big bang) may have had a phase transition, releasing energy and causing

a) a period of rapid expansion (inflation).
b) tiny fluctuations predicted by quantum mechanics to expand large enough to contribute to the fluctuations we see in the cosmic background radiation.
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a) true
b) false-matter isn't moving through space, *space itself* is expanding

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Models of the universe that include inflation and match the details of the cosmic background radiation say the universe is about

a) 4.6 billion years old.
b) 10 billion years old.
c) 13.7 billion years old.
d) Infinitely old.

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If the expansion of the galaxies is traced backwards in time, it indicates the universe began about

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The best current estimate for what the universe is made of is

a) about 4% ordinary visible matter.
b) about 23% dark matter.
c) about 73% dark energy.
d) All of the above

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What is *Olbers' paradox*?

a) If the universe was infinite, any direction you looked you would eventually see a star.
b) If the universe was infinitely old, the starlight would have time to get here.
c) The sky should look bright at night because all areas of the sky should have a star, and time for the starlight to reach us.
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Since the sky is dark at night, what's wrong with Olbers' paradox?

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b) There's not an infinite number of stars.
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Why should it not be surprising that some galaxies contain a little more than 25% helium, but it would be very surprising if some galaxies contained less.

a) A star converts about 25% of its hydrogen into helium before it dies, so galaxies with multiple generations of star formation can have a higher percentage of helium.
b) The big bang fused 25% of normal matter in the universe into helium, and stellar nucleosynthesis can increase, but not decrease, this amount.
c) The helium fraction decreases with age, so younger galaxies have more than 25%, but galaxies with less helium would be older than the estimated age of the universe.
d) Helium is more massive than hydrogen so it cannot readily escape the gravitational field of a galaxy. A percentage lower than 25% would indicate that the galaxy had no dark matter.

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True or False? Although the universe today appears to be made mostly of matter and not antimatter, the big bang theory suggests that the early universe had nearly equal amounts of matter and antimatter.

a) True, the Big Bang theory predicts that high temperatures in the early universe generated matter-antimatter pairs, and the amounts of each were therefore virtually equal.
b) True, the Big Bang was started by the mutual annihilation of virtually equal numbers of matter and antimatter particles.
c) False, the amount of matter and antimatter in the early universe should be exactly the same as it is today.
d) False, the amount of matter and antimatter in the early universe should be in the same proportion as it is today.

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True or False?: The theory of inflation suggests that the structure of the universe may have originated as tiny quantum fluctuations.

a) True, tiny quantum fluctuations were stretched to enormous sizes by inflation and became large enough to grow into galaxies and galaxy clusters.
b) True, quantum uncertainty meant that some regions of the universe expanded more slowly than other regions and these slower moving regions eventually became galaxies and galaxy clusters.
c) False, the theory of inflation suggests that the structure of the universe arose when radiation decoupled from matter.
d) False, quantum fluctuations are on an atomic scale and the structure of the universe is on the scale of galaxies.

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True or False?: The fact that the night sky is dark tells us that the universe cannot be infinite, unchanging, and the same everywhere.

a) True, the dark night sky shows that the Big Bang theory must be modified by allowing for an initial period of inflation.
b) True, if the universe were infinite, unchanging, and the same everywhere, the night sky would be as bright as the surface as the Sun.
c) False, the night sky is dark at optical wavelengths but is blazing at microwave wavelengths.
d) False, the night sky is dark simply because the Sun is on the opposite side of Earth!

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