Physics 102 – Spring 2011 – Recitation module 9

What scientific evidence supports the big bang theory?

Water has a chemical formula H_2O. Where did the hydrogen in water on the Earth most likely originate? Where did the oxygen in the water on the Earth most likely originate? Why do these two sources differ?

According to big bang cosmology, nucleosynthesis occurred at roughly 100 seconds after the start of the big bang. What is meant by big bang nucleosynthesis? Why did it not happen earlier, say at 10^{-6} seconds after the start of the big bang?

The next time you meet someone who thinks they are at the center of the universe, you can tell them that according to big bang cosmology they are most definitely not at the center of the universe. Discuss and explain this.

If you had little boxes containing matter from different times during the early universe, what particles would you expect to find in boxes labeled 10^{-20} seconds, 300 seconds, 200,000 years, 500,000 years – all times with respect to the start of the big bang.

Is the size of the observable universe changing with time? Why? How big is it (roughly)?

What is the cosmic microwave background?

Some exam practice questions to think about and discuss

Why is it that the spectrum of light emitted by an atom is often said to be a "fingerprint" for that atom?

If there are only approximately 100 different atomic elements (types of atoms) in our world, how is it that you can identify many, many more than 100 different types of substances in the world around you?

Suppose we find a rock and geologists tell us that when that rock was formed in a volcano it would have contained an equal amount of Iridium-192 (Z=77, symbol = Ir) and Bismuth-209 (Z=83, symbol = Bi). Suppose that Iridium-192 and Bismuth-209 are both naturally radioactive. Also, suppose that Iridium-192 decays with a half-life of 500,000 years and Bismuth-209 decays with a half-life of 1 million years. If the rock is two million years old and you measure the amount of Iridium-192 and Bismuth-209 in the rock, what ratio for the amount of Iridium-192 to Bismuth-209 would you expect to measure?

The strong force is mediated by gluons in the same way the electromagnetic force is mediated by

a) electrons.
b) neutrinos.
c) Z particles.
d) protons.
e) photons.

A nucleus X decays into a nucleus Y and emits some form of radiation as shown by the reaction below.

$$^{50}_{21}X \rightarrow ^{50}_{20}Y + ?$$

The particle that is emitted (symbolized above as "?") is

a) an alpha particle.
b) a negative beta particle (electron)
c) a positive beta particle (positron).
d) a photon.
e) a neutron.

By each description on the left, put the letter of the answer on the right that best fits. There may be more than one answer on the right that works, in which case any of the correct answers is sufficient.

___ One type of quark found in neutrons

___ Force carrier (gauge boson) for electromagnetic interaction

___ Force carrier (gauge boson) for strong interaction

___ Only undiscovered particle predicted by the Standard Model of particle physics

___ Particle that can pass through light years of lead without interacting

___ One of the particles mediating the weak interaction (force carrier for weak interaction)

___ A particle made up of three quarks

___ An example of a meson

___ An example of a lepton

a. electron

b. muon neutrino

c. proton

d. pion

e. charm (c) quark

f. W

g. gluon

h. higgs

j. top (t) quark

k. muon

l. photon

m. up (u) quark

A quantum state is

a) a term that refers to atoms that are able to emit photons.
b) a state that is smaller than most other states – for example, Rhode Island.
c) a phrase describing the frame of mind of a physicist who is contemplating the complicated aspects of matter.
d) a reference to the potential spatial regions and energies allowed for particles according to quantum mechanics.
e) the place where a particle is seen to be located.

Quarks interact with other particles in nature via

a) the strong nuclear force.
b) the weak nuclear force.
c) the electromagnetic force.
d) gravitation.
e) all of the above.

The source of energy for the creation of most gold atoms (a gold atom is heavier than an iron atom) used in jewelry is

a) the gravitational collapse of a star.
b) a goldsmith's smelter.
c) The fission of a heavier element such as radium or hafnium.
d) the shock wave of a supernova explosion at the end of the stellar life cycle for a large star.
e) the heat at the center of the earth.