U09a1 universe review

Finance

Define dark matter and dark energy, and clearly distinguish between them. What types of observations have led scientists to propose the existenceof each of these unseen influences? Dark energy is a hypothetical form of energy that permeates space and exerts a negative pressure, which would have gravitational effects to account for the differences between the theoretical and observational results of gravitational effects on visible matter. Dark energy is not directly observed, but rather inferred from observations of gravitational interactions between astronomical objects, along with dark matter. Dark matter must exist to account for the gravity that holds galaxies together. Dark matter is also responsible for amplifying small fluctuations in the cosmic microwave background back in the early universe to create the large scale structure we observe in the universe today. Dark energy, which also goes by the names of the cosmological constant or quintessence, must exist due to the rate of expansion we observe for our universe. Not only is the universe expanding, but this expansion is also accelerating so the unknown 'anti-gravity' force at work is termed 'dark energy'. Some researchers are searching for an explanation that encompasses both dark matter and dark energy. One example of such a theory uses a form of energy called a scalar field (it is a field because it has magnitude, energy and pressure, but it is scalar so it has no direction). Things would certainly be easier if we didn't need to have separate theories to explain dark matter and dark energy. However, other researchers look at dark matter and dark energy as two separate problems. For example, many string theories use super symmetric particles to explain dark matter and make no connection to dark energy at all. It is now over a decade later, and the existence of dark energy is still so puzzling that some cosmologists are revisiting the fundamental postulates that led them to deduce its existence in the first place. One of these is the product of that earlier revolution: the Copernican principle that Earth is not in a central or otherwise special position in the universe. If we discard this basic principle, a surprisingly different picture of what could account for the observations emerges. 2. How do we construct rotation curves for other spiral galaxies? What do they tell us about the galaxy masses and dark matter? Spiral galaxies are disks of stars and gas which rotate around their center due to the force of gravity holding them together. Without gravity, the disks would fly apart due to their large circular velocities. By measuring the speed at which the stars and gas move, we can calculate the amount of mass necessary to hold them on circular orbits, in essence measuring the mass of the galaxy. To measure the rotation speed of a spiral galaxy, we take a spectrum of the galaxy and measure the Doppler shift of the emission lines. From these observations we can construct the observed line of sight velocity of different parts of the galaxy. In the simplest sense, we can tell a galaxy is rotating when one side of the galaxy is moving towards us and the other is moving away. A rotation curve is a plot of the velocities of stars or gas in a galaxy versus distance from the center. It can be used to find the mass of spiral galaxies, including the Milky Way. The mass can be found by applying Kepler's and Newton's laws. Note however that the mass that one determines by measuring the velocity of a gas cloud or a star in the disk of a spiral galaxy is the mass contained within the circle made by the orbit of that object. To find the total mass of a galaxy one has to measure the velocity of a gas cloud or star at the edge of the disk of the galaxy. Very often it is much more convenient to measure the velocity of the gas rather than the stars, especially in the case of the Milky Way. In the Milky Way one has to resort to measuring the velocity of the gas because distant stars are obscured by dust in the Galactic plane. The flat rotation curves indicate that there is a great deal of unseen matter beyond the visible edge of the Milky Way and of spiral galaxies in general, which we call dark matter. The dark matter in the Milky Way has about twice as much mass as the visible matter. 3. What is gravitational lensing? Why does it occur? How can we use it to estimate the masses of lensing objects? Gravitational Lensing occurs when light from a distant bright object is literally bent due the gravitational field of another large object between the bright object and the observer. If a massive galaxy is blocking the direct view to the quasar, the light will be bent by the gravitational field around the galaxy. This is called " gravitational lensing," since the gravity of the intervening galaxy acts like a lens to redirect the light rays. In general relativity, the presence of matter can curve space time, and the path of a light ray will be deflected as a result. This process is called gravitational lensing. Gravitational Lensing can be used to help astronomers. Since gravitational lenses can make objects brighter, it is possible to detect objects farther away than we normally would have. In fact the most distant galaxy known to man was found using gravitational lensing. 4. The primary evidence for an accelerating universe comes from observations of young stars in the Milky Way. No, it doesn't. While evidence for expansion exists everywhere, cohesion dominates within the galaxy. In order to measure accelerating expansion, we need to measure the distances of objects billions of light-years away. 5. Strong evidence for the existence of dark matter comes from observations of (a) our solar system. (b) the center of the Milky Way. (c) clusters of galaxies. Ans: Clusters of galaxies " Dark Energy" is the term used to describe a hypothetical form of energy that permeates all of space and comprises about 70% of the total mass-energy of the universe. The strongest evidence for the existence of dark energy comes from the discovery that the expansion rate of the universe appears to be accelerating. The evidence for this acceleration comes from observations of nearby and distant type Ia supernovae. Dark energy also addresses another puzzling problem, which is that observations of the microwave background indicate that the density of the universe is close to the " critical density", but the total amount of matter identified so far, including " dark matter", falls far short. The nature of dark energy is unknown and presents a fundamental challenge to both cosmology and particle physics. 6. What are the four forces that operate in the universe today? Why do we think there were fewer forces operating in the early universe? Strong Nuclear Force:- Operates on extremely small scales, responsible for keeping the quarks in protons and neutrons together. Electromagnetism:- Responsible for polarization of particles and objects as well as electricity and certain interactions between particles. Is highly unique because it operates on both the extremely small and large scales. Weak Nuclear Force:- Responsible for radioactive decay in particles, as well as certain interactions between particles. Only apparent on the small 'nuclear' scale. Gravitational Force:- Only apparent on extremely large scales. it is what we think of that keeps us on the ground, and the earth orbiting the sun. Relative to the other forces, it is extremely weak. Although the above discussion indicates that the fundamental forces in our present Universe are distinct and have very different characteristics, the current thinking in theoretical physics is that this was not always so. There is a rather strong belief that in the very early Universe when temperatures were very high compared with today, the weak, electromagnetic, and strong forces were unified into a single force. Only when the temperature dropped did these forces separate from each other, with the strong force separating first and then at a still lower temperature the electromagnetic and weak forces separating to leave us with the 4 distinct forces that we see in our present Universe. The process of the forces separating from each other is called spontaneous symmetry breaking. There is further speculation, which is even less firm than that above, that at even higher temperatures all four forces were unified into a single force. It is often said that orginally there was one force and that then through symmetry-breaking this separated into two forces, then three forces, the electroweak, strong, and gravity, and then finally all four forces, the electromagnetic, weak, strong, and gravity. Thus in the early universe, and also at short distances, there were fewer forces than we experience. 7. When we observe the cosmic microwave background, at what age are we seeing the universe? How long have these microwave photons been traveling through space? Explain. This cosmic microwave background is 13. 7 billion years old it originates in the Big Bang. But it should be noted that the CMBR is not something that is visible from the time of the Big Bang. Perhaps the most conclusive piece of evidence for the Big Bang is the existence of an isotropic radiation bath that permeates the entire Universe known as the " cosmic microwave background" (CMB). The word " isotropic" means the same in all directions; the degree of anisotropy of the CMB is about one part in a thousand. In 1965, two young radio astronomers, Arno Penzias and Robert Wilson, almost accidentally discovered the CMB using a small, well-calibrated horn antenna. It was soon determined that the radiation was diffuse, emanated unifromly from all directions in the sky, and had a temperature of approximately 2. 7 Kelvin (ie 2. 7 degrees above absolute zero). Initially, they could find no satisfactory explanation for their observations, and considered the possibility that their signal may have been due to some undetermined systematic noise. This background of microwaves was in fact the cooled remnant of the primeval fireball - an echo of the Big Bang. 16. What is Olbers’ paradox, and how is it resolved by the Big Bang theory? In an infinite, static, universe, if we look along any line of sight, we will eventually hit a star or some source of light. So, in an infinite, static universe, the whole sky should be covered with packed stars: the farther away you go, the less light from the stars, but the more stars there are. The sky is in fact dark: which means that the universe is not both static and infinite. The Big Bang theory states that the Universe had a birth: it has not existed forever. The universe may or may not be spatially infinite, but it is most definitely not static. In the Big Bang picture, some of the stars in the universe are beyond our cosmological horizon due to the universe's expansion. If the universe is truly infinite in every respect, then every line of sight should end on the surface of a star and the night sky should be everywhere as bright as the surface of the sun. Clearly that is not the case. The only resolution of this paradox is that some property of the universe must be finite. Olbers' paradox The apparent contradiction between the simple observation that the night sky is dark and the theoretical expectation that an infinite, static Universe, filled more or less uniformly with stars and galaxies, should be as bright as the surface of a star. The first correct discussion of this paradox was published in 1744 by the Swiss astronomer (Jean) Philippe Loys de Cheseaux (1718–51); H. W. M. Olbers published his discussion of it in 1826. The paradox can be resolved by identifying its incorrect assumptions. Most important of these is that, as shown by the Big Bang theory, the Universe is not infinite, having come into being around 15 billion years ago. An additional, less important, effect is that the expansion of the Universe weakens the light from distant galaxies, but this on its own cannot fully explain the paradox. 8. The main reason that the night sky is dark is that stars are generally so far away. The planets don't really " shine" they just reflect light from the sun. But with regards to other stars, they are many astronomical units from the earth, and the light that they do emit is not enough compared to the vastness of space. There would have to be a lot more stars for the night to be lighter than what it is, but gravity probably would not allow for so many stars to be so close together. Scientists have observed that if the universe was infinitely large, and contained an infinite number of stars, then the night sky should actually be as bright and as hot as the surface of the Sun. But this obviously is not the case. This little brain teaser has come to be known as Olber’s paradox, named after the German astronomer who tried to solve the problem in 1823. The most likely explanation is that the universe is simply not old enough and the observable part of the universe contains too few stars to fill the sky with light. Thus, the night sky is dark. 9. Which of the following does inflation help to explain? (a) the origin of hydrogen (b) the origin of galaxies (c) the origin of atomic nuclei Ans: Orgin of galaxies. As I understand it, inflation explains the size of the universe and its large scale structure. So I guess the most likely of your answers is that it helps explain galaxies One of its great virtues, cosmologists say, is that inflation explains the origin of galaxies, the main citizens of the cosmos. The answer comes from the paradoxical-sounding quantum rules that govern subatomic affairs. On the smallest scales, according to quantum theory, nature is lumpy, emitting even energy in little bits and subject to an irreducible randomness. As a result, so-called quantum fluctuations would leave faint lumps in the early universe. These would serve as the gravitational seeds for future galaxies and other cosmic structures.

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