

Ricky's Afterthought:

What is Gravity?

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Well before indulging in questions that we cannot answer let us consider the obvious manifestations of gravity. All objects exert gravity on other objects. The larger the objects are and the shorter the distance between them the stronger the pull on each other.

The four forces that are inherent in the Standard Model of the Universe are the strong and weak nuclear forces, the electromagnetic force and gravity. It is well known that Einstein in his relativity papers postulated that space is inherent to gravity as it curves around large objects. Although gravity is weak compared to the other three forces, unlike the other three it is only positive and therefore cumulative and cannot be cancelled out by positive or negative parts as in the other three.

Newtonian gravity, such as in the solar system has been measured and is well understood, however, we know that the expansion of the universe is accelerating so somehow we must study gravitational forces over large distances. Is gravity weaker at interstellar distances or is the accelerated expansion driven by an unknown energy, termed dark energy? One idea is that quasars may hold the answer and scientists are looking at multiple images of the brightness of these quasars to see if it's constant, and subsequently measure the length of time the light takes to get to Earth. One estimate is that one needs to observe over many quasars to get sufficient information but only a handful of these are found to date.

Another major project currently under way is the Illustris cosmological simulation project, which is an ongoing series of astrophysical simulations run by an international collaboration of scientists. The aim is to study the processes of galaxy formation including dark energy and dark matter and combine

it with a comprehensive physical model of the Universe.

How about the notion that black holes and dark matter are linked? Black holes are massive and as such exhibit a strong gravitational force.

Another study to unravel the mysteries of gravity is to consider the Cosmic Microwave Background (CMB) radiation which is the residual electromagnetic background of the Big Bang which engulfs the entire Universe (see Afterword article AMPERE Newsletter March 2012 Issue 72). In 1964 two engineers, Arnold Penzias and Robert Wilson at New Jersey USA, set out using their Holmdel Horn Antenna to observe the galaxy through the invisible light that emanated from it. However from the very start they realised that they were picking up some background interference which masked what they were trying to measure. Having checked the entire equipment over and over again they could not get rid what they thought was simply a troublesome "noise" signal. The only explanation left was the very unlikely event of this radiation coming from outside our galaxy. Eventually physicists realised that this was the remnant of radiation originated immediately after the Big Bang some 13.75 billion years ago. Today data from Planck's CMB are used to understand the amount of dark matter there is in the Universe and specifically whether the amount changes over time. Planck is a European Space Agency space-based observatory observing the Universe at wavelengths between 0.3 mm and 11.1 mm (corresponding to frequencies between 27 GHz and 1 THz), broadly covering the far-infrared, microwave, and high frequency radio domains.

Finally, the remarkable fact is that after hundred years since Einstein developed his theory of

relativity stating, that gravity arises from the curvature of space and time, the data fit that theory. Cosmologists are holding their breath at the thought that in the future data may reveal the need to modify Einstein's theory. However, bear in mind that even if that happens does not prove that Einstein was wrong- after all the moon landings were based on Newtonian mechanics not relativity. We simply have to adapt our existing theories to fit the new findings.

Does this explain what gravity is? The emphatic answer is No!

The above was extracted from the following article:
https://www.alumni.cam.ac.uk/news/a-force-to-be-reckoned-with?utm_medium=email&utm_source=EN1117
