November 17, 2010

Reading: Chapter 12

Astronomy in the News?

Baby Black Hole? Supernova 1979C emitting constant X-rays for 30 years; not magnetar? not interaction with circumstellar matter? maybe an accreting black hole? I'm skeptical. Why constant, why not CSM?

NYT cover story – controversial Alpha Magnetic Spectrometer to search for Dark Matter, to be launched on extra, last shuttle flight to International Space Station, Feb 2011.

Alan Sandage, giant of 20th century cosmology, dies at 84. How stars work, how galaxies form, Big Bang versus Steady State, age, deceleration of the Universe.

Pic of the Day – Betelgeuse has not yet blown up.

Goal:

To understand what the Dark Energy implies for the shape and fate of the Universe.

Other arguments, especially careful study of the small irregularities of the temperature of the cosmic background radiation left over from the Big Bang, confirm the evidence from supernovae

=> Accelerating Universe - confirmed by all tests applied so far.

⇒ Universe is filled with an even more mysterious ***Dark Energy***,

The dark energy seems to be some sort of force field (like a magnetic field, only different), that permeates the vacuum, empty space, and that that *pushes*, ***anti-gravitates!***

As space expands there is just more vacuum filled with this force field, so the effect is not diluted by the expansion.

Dark Energy Anti-gravitates: cannot be any particle, "normal" (p, n, e) or Dark Matter, that gravitates.

Dark Energy force field is not accounted for by any currently known physics.

A major challenge to fundamental physics!

Add up all the normal matter (not much, about 4%), Dark Matter (about 23%) and the mass equivalent of the Dark Energy ($E = mc^2$, about 73%) and find the Universe has just the very special density to be flat!

The Universe is Flat (in 3D) on average

Still have individual stars, neutron stars, black holes, galaxies, that curve the space around them causing the small scale, local effects of gravity.

Just as a table top is composed of atoms and molecules on small scales, but is flat for all practical purposes when we sit down to eat.

The best current guess is that our real 3D Universe is essentially 3D flat - but accelerating!

One Minute Exam

The type of supernova used to discover the acceleration of the Universe was

 Type Ia

 Type Ib

 Type Ic

 Type II

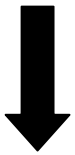
One Minute Exam

Dark Matter is responsible for

 The acceleration of the Universe

 The dark space between stars and galaxies

 The clumping of matter to form stars and galaxies

 The Dark Ages after the initial Big Bang

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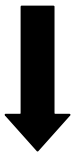 The Dark Ages after the initial Big Bang

Nature of Dark Energy

Energy of vacuum - quantum fluctuations, particle/anti-particle (recall role in Hawking radiation) predict an acceleration that is too large by a factor x 10^{120}

"Worst prediction ever in physics,"
Steven Weinberg (UT Nobel Laureate)

Related phase early in Big Bang, when the Universe was a fraction of a second old,

A huge "inflation" by anti-gravitating vacuum force blows the Universe so big that it is essentially flat (like the surface of the Earth appears to us, only moreso!)

Anti-gravitating energy went away - has come back gently in the last 5 billion years. ***What is it???***

"Space-time diagrams" illustrate how the Big Bang led to inflation, then deceleration, and now acceleration