

Re: Dark Energy

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>> My understanding is that the Universe is expanding and that
>> this expansion is speeding up. What is fuelling this expansion
>> rate increase that is working against the force of gravity?
>>
>> The answer seems to be Dark Energy.

Correct.

> Whatever that is!

Dark energy may be modelled by adding a constant to Einstein's equations; hence the term "cosmological constant".

>> The question in my mind is where does this energy come from
>> and it would seem that more and more of it is needed in order
>> to increase the expansion rate.

Correct. The energy comes from the expansion (a form of gravitational or geometric energy) which is negative. As the universe expands the positive energy locked as dark energy increases (density is constant, but volume increases); this is offset by the negative energy in the Hubble expansion which decreases (becomes more negative).

In the case of dark energy this process can continue for ever; it's a slow form of inflation.

>
> It doesn't have to come from anywhere. The Friedmann-Lemaître
> equations allow for such a term, and apparently it has been observed.
> Note that there is not a problem with energy conservation, since
> energy isn't conserved in general relativity anyway.

That is not true. Energy is conserved in GR, with the obvious caveat that we have to adopt a sensible definition of energy.
http://www.physics.adelaide.edu.au/~dkoks/Faq/Relativity/GR/energy_gr.html

> (Imagine a universe consisting only of radiation. It expands.
> The number of photons remains the same, but the energy of each

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> decreases due to the redshift. No, this lost energy does not do
> the work of expanding the universe.)

Then why does a radiant-filled universe decelerate faster than a matter-filled universe? Because the energy lost in the redshift cancels some of the negative energy tied up in the Hubble expansion.

Cheers,
Michael C Price

<http://mcp.longevity-report.com>
<http://www.hedweb.com/manworld.htm>

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