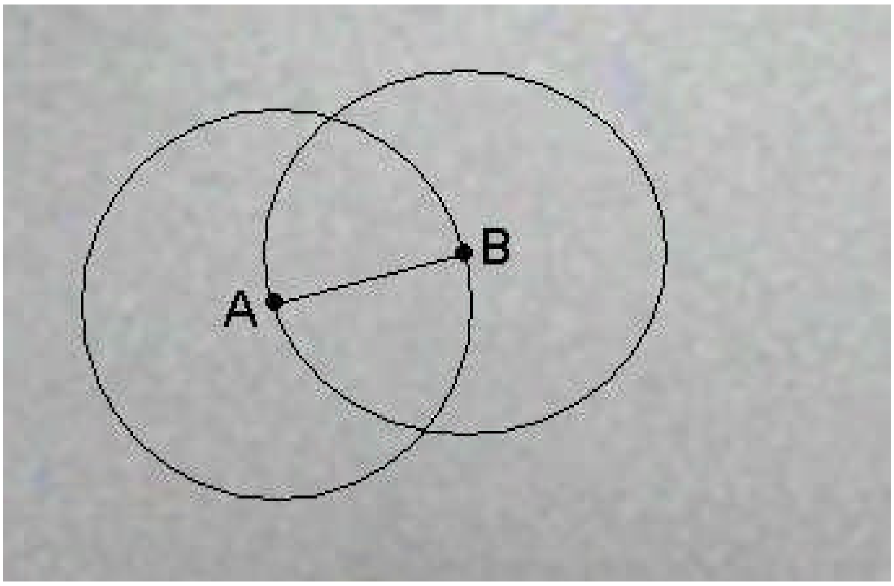

Relativistic Time Inflation

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In physics we are often pushing the boundaries of what the human mind can conceive.

How do we conceive more than 3 dimensions? The answer is that we cannot. However we can construct a mathematical 3D space through coordinate geometry and linear algebra which matches our intuitive understanding and then extend it using the same logical rules. This allows us to calculate what will happen in a space of any number of dimensions even though we cannot conceive it intuitively.

We can also proceed by analogy. How can we conceive parallel universes? For two universes to be “parallel” they would have to exist within a super-universe with higher dimensionality which we cannot conceive but we can imagine two sheets of paper lying on top of one another in a 3 dimensional universe and ask ourselves how 2D objects belonging to one sheet of paper could get across the 3D gap to the neighbouring 2D universe. This is called a “thought experiment”.

Theoretical physics works best when the mathematical approach and the thought experiment approach compliment one another.

Einstein first conceived the relativity theory by performing thought experiments, e.g. “If I could travel at the speed of light what would I see?” Einstein was a very good thought experimenter and the special theory is based on his thought experiments with some rather unsophisticated mathematical support. The General Theory started off this way too. It was Minkowsky who introduced Einstein to tensor calculus which is possibly the most powerful tool ever devised for the mathematical expression of physics.

However tensor calculus is difficult to grasp at an intuitive level. The deeper one goes into tensor calculus the more difficult it becomes to devise thought experiments with which to gain an intuitive grasp on what is really going on. In the end one just gives up on intuition and believes the tensors.

Possibly Einstein's greatest contribution to physics was his insight that space and time are not absolutes (hence "Relativity" – a much abused title). Space and time are what are measured by measuring rods and clocks respectively. That is all. It is a concept which is hard to grasp for a beginner with a Newtonian "fish-tank" universe in mind but it is truly fundamental.

Special Relativity assumes that clocks go slower and measuring rods become shorter when they are moving. That is necessary for the velocity of light to remain constant in every inertial reference system ("inertial" means moving in a straight line at constant speed).

General Relativity extends this concept to all the laws of physics and to reference frames which may be rotating and/or accelerating. Tensor calculus allows us to manipulate physical quantities in this mind-bogglingly difficult circumstance. Tensors are like "super-vectors" and obey strict transformation laws. They are invariant under transformation. The Relativity Theory should have been called "The Theory of Invariants".

However there is one fundamental physical quantity which does not transform as a proper tensor. That is the energy-momentum pseudotensor. There is no energy-momentum tensor.

In General Relativity, one cannot describe the energy and momentum of the gravitational field by an energy-momentum tensor. Instead, one introduces objects that behave as tensors only with respect to restricted coordinate transformations. Strictly speaking, such objects are not tensors at all.

This is a very serious shortcoming of the general theory because it has real physical consequences. However it has been known about for so long that physicists have learned to live with it and don't let it bother them any more.

Now let's do a thought experiment.

When an object travels up a potential gradient it loses energy and momentum . For example a ball loses kinetic energy and momentum when it is thrown upwards. The loss of energy of a photon is manifested by a decrease in its frequency. This is a consequence of relativity that has been verified experimentally by the famous Pound-Rebka experiment that was carried out in the Harvard clock-tower in 1959, see http://en.wikipedia.org/wiki/Pound%E2%80%93Rebka_experiment.

This effect is known as the gravitational red-shift and is well understood at planetary scales. However there is problem with it at cosmological scales.

The diagram at the top of the page depicts an idealized region of space in which matter is uniformly distributed. A and B are two galaxies which are relatively stationary so that there is no Doppler shift. The circles depict two spheres with centres at A and B respectively

Now consider a photon emitted from Galaxy A and observed from Galaxy B. A is at he centre of a sphere and B is on the sphere's surface. In Newtonian terms there will be a gravitational potential difference between A and B. By Gauss's theorem, all of the mass within the sphere can be considered as concentrated at its centre, A, so that B will have a higher gravitational potential than A and the photon will experience a gravitational red-shift as it *ascends* from A to B.

However there is no reason to chose A rather than B as the centre. If B is chosen as the centre of a sphere for the purpose of Gauss's theorem then A will have a greater potential than B and the photon will experience a gravitation blue-shift as it *descends* from A to B.

This is a true dilemma. There is an ambiguity which leads to conflicting predictions of how a photon will behave. Could it be that this dilemma underlies the "pseudo" nature of the Energy-Momentum pseudotensor?

Any proper physical theory must give an unambiguous prediction of what will be observed when the photon arrives at B.

Now we make an assumption similar to the assumptions about clocks and measuring rods on which the Special Theory is based.

The assumption is that all clocks are accelerating. Call it "relativistic time inflation", RTI.

Two clocks right next to one another will keep in step of course. However if an observer observes a clock on a distant galaxy it will be seen to be going slower because of the time that elapsed as light from the distant clock traveled to the observer.

This solves the dilemma. In the reference frame in which A is chosen as the centre, the photon is slowed down by the gravitational red shift. In the reference frame in which B is chosen as the centre there will be a red-shift because of the time elapsed as it journeyed from A to B which over-rides the blue shift due to the decrease in gravitational potential. Observer B will say "Yes, the photon didn't show the expected blue-shift, but that is because clocks at A were going slower when it started out."

RTI is only postulated here as a thought experiment and as such is over-simplified of course. It needs to be couched in terms of tensor calculus and this is beyond the skill of the author. The acid test is whether an Energy-Momentum pseudotensor can exist as a true tensor under the RTI assumption.

If this proposal can be confirmed in tensor calculus terms, think of the consequences: RTI would account for the observed red shift of distant galaxies rather than the Doppler Effect. Hence we need to postulate neither an expanding universe, nor a big bang nor any mysterious dark matter to hold it all together.

Apart from resolving the inconsistency concerning the energy momentum pseudotensor, is there any experiment that can be done to decide this issue?

The answer is Yes. Not only that, an experiment has already been done! By accident.

The Pioneer 10 and Pioneer 11 spacecraft were robotic space probes launched by NASA in 1972 and 1973 to study Jupiter, Saturn and eventually interstellar space. Radio-metric Doppler tracking data received from these spacecraft from heliocentric distances of 20-70 AU has consistently indicated the presence of a small, anomalous, blue-shifted frequency drift uniformly changing with a rate of ~6 x 10^{-9} Hz/s. The drift can be interpreted as a constant sunward deceleration of each particular spacecraft at the level of a_P = (8.74 +/- 1.33) x 10^{-10} m/s^2. This apparent violation of the Newton's gravitational inverse-square law has become known as the Pioneer anomaly; the nature of this anomaly remains unexplained. See http://en.wikipedia.org/wiki/Pioneer_anomaly.

The magnitude of the Pioneer effect a_p is numerically quite close to the product of the speed of light c and the Hubble constant H_0, hinting at a cosmological connection, but the significance of this, if any, is unknown.

Both theory and observation indicate that there is something seriously wrong with cosmology and the General Theory of Relativity which underpins it.

There is a Nobel Prize here for some bright young physicist with the skill to handle tensor calculus and the guts to challenge the Big Bang orthodoxy.