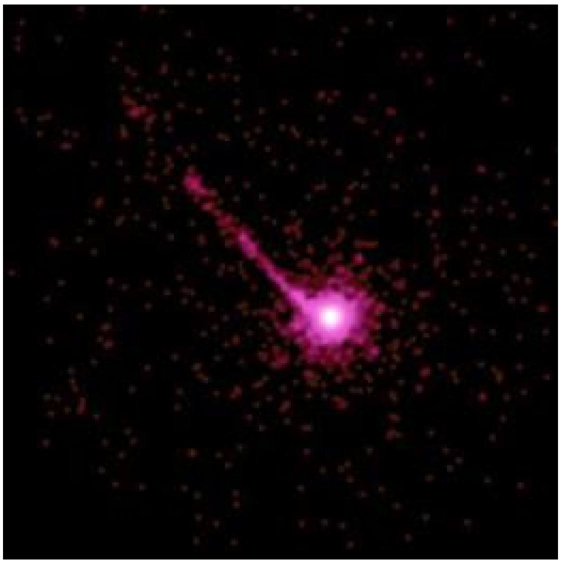
Discovery that quasars don't show time dilation mystifies astronomers

9 April 2010, by Lisa Zyga



This X-ray image shows the quasar PKS 1127-145, a highly luminous source of X-rays and visible light located about 10 billion light years from Earth. Its X-ray jet extends at least a million light years from the quasar. Credit: NASA.

(PhysOrg.com) -- The phenomenon of time dilation is a strange yet experimentally confirmed effect of relativity theory. One of its implications is that events occurring in distant parts of the universe should appear to occur more slowly than events located closer to us. For example, when observing supernovae, scientists have found that distant explosions seem to fade more slowly than the quickly-fading nearby supernovae.

The effect can be explained because (1) the speed of light is a constant (independent of how fast a light source is moving toward or away from an observer) and (2) the universe is expanding at an accelerating rate, which causes light from distant objects to redshift (i.e. the wavelengths to become longer) in relation to how far away the objects are from observers on Earth. In other words, as space expands, the interval between light pulses also lengthens. Since expansion occurs throughout the universe, it seems that time dilation should be a property of the universe that holds true everywhere, regardless of the specific object or event being observed. However, a new study has found that this doesn't seem to be the case - quasars, it seems, give off light pulses at the same rate no matter their distance from the Earth, without a hint of time dilation.

Astronomer Mike Hawkins from the Royal Observatory in Edinburgh came to this conclusion after looking at nearly 900 quasars over periods of up to 28 years. When comparing the light patterns of quasars located about 6 billion light years from us and those located 10 billion light years away, he was surprised to find that the light signatures of the two samples were exactly the same. If these quasars were like the previously observed supernovae, an observer would expect to see longer, “stretched” timescales for the distant, “stretched” high-redshift quasars. But even though the distant quasars were more strongly redshifted than the closer quasars, there was no difference in the time it took the light to reach Earth.

This quasar conundrum doesn’t seem to have an obvious explanation, although Hawkins has a few ideas. For some background, quasars are extreme objects in many ways: they are the most luminous and energetic objects known in the universe, and also one of the most distant (and thus, oldest) known objects. Officially called “quasi-stellar radio sources,” quasars are dense regions surrounding the central supermassive black holes in the centers of massive galaxies. They feed off an accretion disc that surrounds each black hole, which powers the quasars’ extreme luminosity and makes them visible to Earth.

One of Hawkins’ possible explanations for quasars’ lack of time dilation is that light from the quasars is being bent by black holes scattered throughout the universe. These black holes, which may have formed shortly after the big bang, would have a gravitational distortion that affects the time dilation of distant quasars. However, this idea of “gravitational microlensing” is a controversial suggestion, as it requires that there be enough black holes to account for all of the universe’s dark matter. As Hawkins explains, most physicists predict that dark matter consists of undiscovered subatomic particles rather than primordial black holes.

There’s also a possibility that the explanation could be even more far-reaching, such as that the universe is not expanding and that the big bang theory is wrong. Or, quasars may not be located at the distances indicated by their redshifts, although this suggestion has previously been discredited. Although these explanations are controversial, Hawkins plans to continue investigating the quasar mystery, and maybe solve a few other problems along the way.

Hawkins’ paper will be published in an upcoming issue of the *Monthly Notices of the Royal Astronomical Society*.

More information: * On time dilation in quasar light curves, M. R. S. Hawkins, DOI:10.1111/j.1365-2966.2010.16581.x
Via: New Scientist