Optical gravity model could transform geophysics, astrophysics and cosmology

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Figure 1. Optical gravity and the Hubble force. Gravitons from remote parts of the universe lose momentum to the graviton spacetime envelopes fixed to two local masses. The masses are then pushed together in gravity. In dense objects gravity is diminished by the Hubble force. Credit: Matthew R. Edwards

A longstanding goal in physics has been to link general relativity with quantum theory and so unify the forces of nature. Theories of quantum gravity, however, are plagued by the weak theoretical foundations of quantum physics. This has allowed questionable hypotheses, such as the many-worlds interpretation, to gain more respectability than perhaps deserved. The huge gap between gravity and quantum physics cannot have left other fields unaffected. The Standard (Big Bang) model from its beginning has required one corrective patch after another, while in geophysics and astrophysics, important problems like the ultimate causes of plate tectonics and the internal structure of black holes remain unsolved.

Optical gravity

I propose that the solution to these issues comes from general relativity—or, more precisely, an optical analog of it. It has long been known that the relativistic deflection of light as it passes by a mass is mathematically equivalent to the refraction of light in an optical medium with a density gradient. This correlation is so precise that it has been used to explore phenomena such as gravitational lensing or, in microchip models, the photospheres of black holes. This has led to suggestions that the analog optical medium of spacetime is in fact a real, physical medium and that it could account for gravity.

How could an optical spacetime stitch general relativity, quantum physics and cosmology into a coherent whole? In quantum gravity, the hypothetical particle exchanged between masses is the graviton. Supposing that gravitons exist, the streams of gravitons being exchanged between the masses of the visible universe would immediately constitute a cosmic medium. To make this an optical medium simply requires that gravitons share at least some properties with photons or virtual photons. Gravitons could then serve as both the medium and the message in gravity and quantum physics.

Particles would essentially be reprocessing centers for gravitons, combining multiple streams of gravitons from remote sources into coherently arranged outgoing streams. Gravitons would carry information about the particles they originated from, such as their velocity, polarization and spin. To mesh with general relativity, the energy within the graviton stream connecting two particles must be equal to the particles' mutual gravitational potential energy.

The stage is now set for optical gravity. All waves, including photons and other gravitons, are refracted in this graviton spacetime. Applying the Abraham interpretation of optical momentum, photons and gravitons then transfer energy and momentum to the envelopes of spacetime linked to every mass of the visible universe. The cosmic index of refraction of spacetime can be calculated using the optical-mechanical analogy and then used to find the loss rate. It turns out that all waves, including gravitons, fractionally lose energy and momentum at the rate specified by the Hubble constant, H_0, or about 2×10^{-18} sec^{-1}. This allows us to estimate the absorption coefficient of matter to gravitons. From that, the Newtonian force and a correct value for the gravitational constant G can then be derived.

The basic process is shown in Figure 1. Two gravitons g_1 and g_2 from remote sources (blue arrows) pass by two local particles A and B (red spheres), each surrounded by density gradients of spacetime (yellow circles). Graviton g_1 passes A first and transmits momentum to the envelope of spacetime around A, causing A to be pushed towards B. It is therefore weaker when it passes B and so will transfer less momentum to B than it did to A. Graviton g_2 conversely transfers more momentum to B than to A. The net result is that A and B are pushed together in gravity (large white arrows).

The Hubble force

Optical gravity could profoundly alter geophysics and astrophysics. In Figure 1, gravitons are also being exchanged between A and B directly (gray bar). If A and B are relatively close to each other, however, these gravitons are coherently superimposed on the local spacetime structure incorporating A and B and so do not cause a repulsive force. Like all waves, however, they would lose energy by refraction in the cosmic medium. This gives rise to a small Hubble force of repulsion, F_H (small white arrows). For two atoms, this force is negligible in comparison to the impulses received from the countless remote gravitons and so gravity easily wins out.

In dense objects like planets, stars and black holes, however, the Hubble forces become significant, as such bodies have significant internal gravitational potential energy, U. They thus have an intrinsic Hubble luminosity, given by $L_H = -UH_0$. I have proposed that deep mantle plumes driven by this energy carry high density material from the core-mantle boundary to the upper mantle, where it recrystallizes at lower densities. This could induce expansion of the upper mantle, mountain building and a small annual increase in the Earth's radius, as has been reported by Chinese geophysicists.

In ultra-dense stars, such as white dwarfs and neutron stars, the Hubble luminosities appear to closely match their bolometric luminosities and so would replace the diverse and arcane heating mechanisms that have been proposed for these objects. As for black holes, my preliminary work indicates that these function essentially as separate micro-universes with their own Hubble constant, which is many orders of magnitude greater than H_0. The energy released inside black holes by the Hubble luminosity appears to be exactly enough to prevent them from collapsing into a singularity.

Spacetime expands but the universe does not

In cosmology, linking the Hubble constant with optical gravity would replace the notion of a universe exploding out of a primordial particle. Instead, the continuous reprocessing of older, redshifted photons and gravitons by particles into newer, more energetic ones allows for a perpetuum mobile universe, in which all physical entities are continuously recycled.

But wait. Doesn't the time dilation seen in Type 1A supernovae *prove* that spacetime is expanding? Indeed it does, but in optical gravity, this happens because the gravitons comprising an individual packet of spacetime are themselves steadily redshifted to longer wavelengths. The spacetime packet will accordingly expand and an array of photons embedded within it will thus expand also, inducing the time dilation observed.

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