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LETTER

Does the Hubble redshift flip photons and gravitons?

Matthew R. Edwards

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Abstract Due to the Hubble redshift, photon energy, chiefly in the form of CMBR photons, is currently disappearing from the universe at the rate of nearly 10^{55} erg s^{-1}. An ongoing problem in cosmology concerns the fate of this energy. In one interpretation it is irretrievably lost, *i.e.*, energy is not conserved on the cosmic scale. Here we consider a different possibility which retains universal energy conservation. Treating gravitational potential energy conventionally as 'negative', it has earlier been proposed that the Hubble shift flips positive energy (photons) to negative energy (gravitons) and *vice versa*. The lost photon energy would thus be directed *towards* gravitation, making gravitational energy wells more negative. Conversely, within astrophysical bodies, the flipping of gravitons to photons would give rise to a 'Hubble luminosity' of magnitude $-UH_0$, where U is the internal gravitational potential energy of the object. Preliminary evidence of such an energy release is presented in bodies ranging from planets, white dwarfs and neutron stars to supermassive black holes and the visible universe.

Keywords Cosmological redshift · Graviton decay · Hubble luminosity · Supermassive Black Hole · Neutron star · White dwarf · Cosmic recycling

1 Introduction

As the universe expands in the standard cosmology, the number density of photons within each expanding volume of space remains constant. The wavelength of each photon at the same time is increased and so there is a net loss of photon energy in the universe. The largest pool of photon energy is the cosmic microwave background radiation (CMBR) and the loss of energy from this pool due to the redshift is readily estimated at about 10^{55} erg s^{-1}. This is roughly equal in magnitude to the total luminosity of all the stars in the visible universe. Not surprisingly, an important question in cosmology concerns the fate of this energy. Harrison (1995) observed that the energy does not apparently go into perturbations of the spacetime metric, since those disturbances, as they propagate, would also lose energy because of the cosmic redshift. The question would then become where did the gravitational energy go? With respect to the lost photon energy Harrison thus concluded: "Does the energy totally vanish, or does it reappear, perhaps in some global dynamic form? The tentative answer based on standard relativistic equations is that the vanished energy does not reappear in any other form, and therefore it seems that on the cosmic scale energy is not conserved."

Returning to Harrison's abandoned idea that the lost photon energy could reappear within the spacetime metric, let us consider the role of gravitational potential energy. Gravitational potential energy is an enigmatic concept in both Newtonian and relativistic physics. In the former it cannot be localized to any specific part of the system, while in the latter the whole concept of potential energy is lacking definition. Yet, if gravitational potential energy takes the form of discrete waves within the metric, then it can easily be shown that the universe's stock of it would suffer an almost equal energy rate of loss $\sim 10^{55}$ erg s^{-1}. There would then be not one but two pools of energy steadily dissipating at the same enormous rate. If these processes were unconnected, it would be a remarkable coincidence.

Treating gravitational potential energy conventionally as negative energy, it has been proposed by the author that

M.R. Edwards (✉)
Gerstein Science Information Centre, University of Toronto, Toronto, Ontario, Canada, M5S 3K3
e-mail: matt.edwards@utoronto.ca