The redshift inside a sphere

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Consider a transparent but uniformly dense sphere of radius R, mass M.

Consider an atom emitting a photon of energy E(0) at a distance r from the centre of the sphere, but which is observed from the centre.

The photon will be redshifted by the the fact that it is emitted in a gravitational field due to the mass of the sphere below it. The redshifted energy of this photon as observed at the centre, E(r), will depend on the mass of the sphere below it M(r) according to

$$E(r)/E(0) = 1 - G.M(r)/(r.c^2)$$

where

c = velocity of light
G = gravitational constant

As the sphere has a uniform density:

$$M(r) = M.r^3/R^3$$

so that

$$E(r)/E(0) = 1 - G.M.r^3/(R^3.r.c^2) = 1 - G.M.r^2/(R^3.c^2)$$

If we then choose

$$G.M = R.c^2$$

then

$$E(r)/E(0) = 1 - r^2/R^2$$

or using the redshift parameter z:

$$z = 1/(1 - r^2/R^2)$$

which produces an accelerating redshift as r increases.

Note that the condition

$$G.M = R.c^2$$

implies that the sphere is inside a black hole.
Thus an observed accelerating redshift can be interpreted as that we are living inside a black hole.

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