# Example 2

## Propagation of a Beam of Light in the z-direction with the speed of light: $c = \frac{1}{\sqrt{\epsilon 0\, \mu 0}}$ within a constant gravitational field, oriented in the z-direction, with accelleration g = G1, resulting in Gravitational Redshift.

In[ ]:=

Book : **Rising of the James Webb Space Telescope and its Fundamental Blindnes** : Page 46,

Equation (73)
Example of a Spherical Beam of Light ,
propagating in the radial – direction (r – direction)

with the speed of light $c = \frac{1}{\sqrt{\epsilon 0\, \mu 0}}$.

The input for the Electric Field Intensity {E (x, y, z,) = ev } and the Magnetic Field Intensity {H (x, y, z,) = mv} have been substituted in the Field Equation for the Electromagnetic Field within a constant gravitational field with accelleration g in the z – direction. (Book Equation 73, page 46).

$$-\frac{1}{c^2}\frac{\partial(\bar{E}\times\bar{H})}{\partial t}+\varepsilon_0\,\bar{E}\,(\nabla.\bar{E})-\varepsilon_0\,\bar{E}\times(\nabla\times\bar{E})+\mu_0\,\bar{H}\,(\nabla.\bar{H})-\mu_0\,\bar{H}\times(\nabla\times\bar{H})+\frac{1}{2}\left(\varepsilon^2\mu\left(\bar{E}.\bar{E}\right)+\varepsilon\,\mu^2\left(\bar{H}.\bar{H}\right)\right)\bar{g}=0$$

Equation (73)

Which can be written as :

$$\text{term1} = -\frac{1}{c^2}\,\frac{\partial(\bar{E}\times\bar{H})}{\partial t}$$

$$\text{term 2} = \varepsilon_0 \bar{E} (\nabla . \bar{E})$$

$$\text{term3} = -\varepsilon_0 \bar{E} \times (\nabla \times \bar{E})$$

$$\text{term4} = \mu_0 \bar{H} (\nabla . \bar{H})$$

$$\text{term5} = -\mu_0 \bar{H} \times (\nabla \times \bar{H})$$

$$\text{term6} = -\frac{1}{2}\left(\varepsilon^2 \mu \left(\bar{E} . \bar{E}\right) + \varepsilon \mu^2 \left(\bar{H} . \bar{H}\right)\right) \bar{g}$$

Equation (73) equals :

$$\text{term1} + \text{term2} + \text{term3} + \text{term4} + \text{term5} + \text{term6} = 0$$

```
In[∘]:= ϵ0 =.

In[∘]:= μ0 =.

In[∘]:= x =.

In[∘]:= y =.

In[∘]:= z =.

In[∘]:= t =.

In[∘]:= Get["VectorAnalysis`"]

  General: VectorAnalysis` is now obsolete. The legacy version being loaded may conflict with
     current functionality. See the Compatibility Guide for updating information.

In[∘]:= Get["Calculus`DSolve`"]

  Get: Cannot open Calculus`DSolve`.

Out[∘]= $Failed

In[∘]:= InverseFunctions → True

Out[∘]= InverseFunctions → True

In[∘]:= Needs["DifferentialEquations`NDSolveProblems`"]

In[∘]:= Needs["DifferentialEquations`NDSolveUtilities`"]

In[∘]:= Needs["DifferentialEquations`InterpolatingFunctionAnatomy`"]
```

In[ ]:= Get["Calculus`DSolveIntegrals`"]

Get: Cannot open Calculus`DSolveIntegrals`.

Out[ ]= $Failed

In[ ]:= SetCoordinates[Cartesian[x, y, z]]

Out[ ]= Cartesian[x, y, z]

In[ ]:= {Coordinates[Cartesian], CoordinateRanges[Cartesian]}

Out[ ]= $\{\{x, y, z\}, \{-\infty < x < \infty, -\infty < y < \infty, -\infty < z < \infty\}\}$

In[ ]:= G1 = .

In[ ]:= $ev = \left\{e^{-\frac{1}{2} G1\, z\, \epsilon0\, \mu0}\, g\left[e^{-G1\, \epsilon0\, \mu0}\left(t - z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right], 0, 0\right\}$

Out[ ]= $\left\{e^{-\frac{1}{2} G1\, z\, \epsilon0\, \mu0}\, g\left[e^{-G1\, \epsilon0\, \mu0}\left(t - z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right], 0, 0\right\}$

In[ ]:= $mv = (1/Sqrt[\mu0]) * Sqrt[\epsilon0] * \left\{0, e^{-\frac{1}{2} G1\, z\, \epsilon0\, \mu0}\, g\left[e^{-G1\, \epsilon0\, \mu0}\left(t - z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right], 0\right\}$

Out[ ]= $\left\{0, \frac{e^{-\frac{1}{2} G1\, z\, \epsilon0\, \mu0}\sqrt{\epsilon0}\, g\left[e^{-G1\, \epsilon0\, \mu0}\left(t - z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]}{\sqrt{\mu0}}, 0\right\}$

In[ ]:= gv = {0, 0, G1}

Out[ ]= {0, 0, G1}

In[ ]:= $Intensity = -\frac{1}{2}\left(\epsilon0\, (Dot[ev, ev]) + \mu0\, (Dot[mv, mv])\right)$

Out[ ]= $-\frac{1}{2} 1 \left(e^{-G1\, z\, \epsilon0\, \mu0}\, \epsilon0\, g\left[e^{-G1\, \epsilon0\, \mu0}\left(t - z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]^2 + e^{-G1\, z\, \epsilon0\, \mu0}\, g\left[e^{-G1\, \epsilon0\, \mu0}\left(t - z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]^2 \epsilon0\right)$

In[ ]:= FullSimplify[%]

Out[ ]= $-\frac{e^{-G1\, z\, \epsilon0\, \mu0}\, g\left[e^{-G1\, \epsilon0\, \mu0}\left(t - z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]^2 1 \left(\epsilon0 + \epsilon0\right)}{2}$

In[ ]:= Div[ev]

Out[ ]= 0

In[ ]:= Div[mv]

Out[ ]= 0

In[ ]:= FullSimplify[%]

Out[ ]= 0

In[ ]:= term1a = D[Cross[ev, mv], t]

Out[ ]= $\left\{0, 0, \frac{2\, e^{-G1 \epsilon 0 \mu 0 - G1 z \epsilon 0 \mu 0} \sqrt{\epsilon 0}\, g\left[e^{-G1 \epsilon 0 \mu 0}\left(t - z\sqrt{\epsilon 0}\sqrt{\mu 0}\right)\right] g'\left[e^{-G1 \epsilon 0 \mu 0}\left(t - z\sqrt{\epsilon 0}\sqrt{\mu 0}\right)\right]}{\sqrt{\mu 0}}\right\}$

In[ ]:=

$$\text{term1} = -\frac{1}{c^2}\frac{\partial(\bar{E} \times \bar{H})}{\partial t}.$$

In[ ]:= term1 = ((−ϵ0)∗μ0)∗D[Cross[ev, mv], t]

Out[ ]= $\left\{0, 0, -2\, e^{-G1 \epsilon 0 \mu 0 - G1 z \epsilon 0 \mu 0}\, \epsilon 0^{3/2} \sqrt{\mu 0}\; g\left[e^{-G1 \epsilon 0 \mu 0}\left(t - z\sqrt{\epsilon 0}\sqrt{\mu 0}\right)\right] g'\left[e^{-G1 \epsilon 0 \mu 0}\left(t - z\sqrt{\epsilon 0}\sqrt{\mu 0}\right)\right]\right\}$

In[ ]:=

$$\text{term2} = \varepsilon_0\, \bar{E}\, (\nabla . \bar{E}).$$

In[ ]:= term2 = ϵ0∗ev∗Div[ev]

Out[ ]= {0, 0, 0}

In[ ]:=

$$\text{term3} = -\varepsilon_0\, \bar{E} \times (\nabla \times \bar{E}).$$

In[ ]:= term3 = (−ϵ0)∗Cross[ev, Curl[ev]]

Out[ ]= $\left\{0, 0, -\epsilon 0\left(-\frac{1}{2} e^{-G1 z \epsilon 0 \mu 0}\, G1\, \epsilon 0\, \mu 0\, g\left[e^{-G1 \epsilon 0 \mu 0}\left(t - z\sqrt{\epsilon 0}\sqrt{\mu 0}\right)\right]^2 - e^{-G1 \epsilon 0 \mu 0 - G1 z \epsilon 0 \mu 0}\sqrt{\epsilon 0}\sqrt{\mu 0}\; g\left[e^{-G1 \epsilon 0 \mu 0}\left(t - z\sqrt{\epsilon 0}\sqrt{\mu 0}\right)\right] g'\left[e^{-G1 \epsilon 0 \mu 0}\left(t - z\sqrt{\epsilon 0}\sqrt{\mu 0}\right)\right]\right)\right\}$

In[ ]:=

$$\text{term4} = \mu_0\, \bar{H}\, (\nabla . \bar{H}).$$

In[ ]:= term4 = μ0∗mv∗Div[mv]

Out[ ]= {0, 0, 0}

In[ ]:=

$$\text{term5} = -\mu_0\, \bar{H} \times (\nabla \times \bar{H}).$$

In[ ]:= term5 = (−μ0)∗Cross[mv, Curl[mv]]

Out[ ]= $\left\{0, 0, -\mu 0\left(-\frac{1}{2} e^{-G1 z \epsilon 0 \mu 0}\, G1\, \epsilon 0^2\, g\left[e^{-G1 \epsilon 0 \mu 0}\left(t - z\sqrt{\epsilon 0}\sqrt{\mu 0}\right)\right]^2 - \frac{e^{-G1 \epsilon 0 \mu 0 - G1 z \epsilon 0 \mu 0}\, \epsilon 0^{3/2}\, g\left[e^{-G1 \epsilon 0 \mu 0}\left(t - z\sqrt{\epsilon 0}\sqrt{\mu 0}\right)\right] g'\left[e^{-G1 \epsilon 0 \mu 0}\left(t - z\sqrt{\epsilon 0}\sqrt{\mu 0}\right)\right]}{\sqrt{\mu 0}}\right)\right\}$

$$\text{term6} = -\frac{1}{2}\left(\varepsilon^2\,\mu\left(\overline{E}\,.\,\overline{E}\right) + \varepsilon\,\mu^2\left(\overline{H}\,.\,\overline{H}\right)\right)\overline{g}$$

In[ ]:= $\text{term6} = -\left(\frac{\epsilon0^2\,\mu0}{2}\,\text{Dot[ev, ev]} + \frac{\epsilon0\,\mu0^2}{2}\,\text{Dot[mv, mv]}\right)\text{gv}$

Out[ ]= $\left\{0, 0, -e^{-G1\,z\,\epsilon0\,\mu0}\,G1\,\epsilon0^2\,\mu0\,g\left[e^{-G1\,\epsilon0\,\mu0}\left(t - z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]^2\right\}$

In[ ]:= vergelijking = term1 + term2 + term3 + term4 + term5 + term6

Out[ ]= $$\Big\{0, 0, -e^{-G1\,z\,\epsilon0\,\mu0}\,G1\,\epsilon0^2\,\mu0\,g\left[e^{-G1\,\epsilon0\,\mu0}\left(t - z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]^2 - 2\,e^{-G1\,\epsilon0\,\mu0 - G1\,z\,\epsilon0\,\mu0}\,\epsilon0^{3/2}\sqrt{\mu0}\,g\left[e^{-G1\,\epsilon0\,\mu0}\left(t - z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]$$
$$g'\left[e^{-G1\,\epsilon0\,\mu0}\left(t - z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right] - \mu0\left(-\frac{1}{2}\,e^{-G1\,z\,\epsilon0\,\mu0}\,G1\,\epsilon0^2\,g\left[e^{-G1\,\epsilon0\,\mu0}\left(t - z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]^2 - \right.$$
$$\left.\frac{e^{-G1\,\epsilon0\,\mu0 - G1\,z\,\epsilon0\,\mu0}\,\epsilon0^{3/2}\,g\left[e^{-G1\,\epsilon0\,\mu0}\left(t - z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]\,g'\left[e^{-G1\,\epsilon0\,\mu0}\left(t - z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]}{\sqrt{\mu0}}\right) -$$
$$\epsilon0\left(-\frac{1}{2}\,e^{-G1\,z\,\epsilon0\,\mu0}\,G1\,\epsilon0\,\mu0\,g\left[e^{-G1\,\epsilon0\,\mu0}\left(t - z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]^2 - e^{-G1\,\epsilon0\,\mu0 - G1\,z\,\epsilon0\,\mu0}\right.$$
$$\left.\sqrt{\epsilon0}\sqrt{\mu0}\,g\left[e^{-G1\,\epsilon0\,\mu0}\left(t - z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]\,g'\left[e^{-G1\,\epsilon0\,\mu0}\left(t - z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]\right)\Big\}$$

In[ ]:=

# The electromagnetic force density in the x - direction equals :

In[ ]:= xvergelijking = term1[[1]] + term2[[1]] + term3[[1]] + term4[[1]] + term5[[1]] + term6[[1]]

Out[ ]= 0

In[ ]:= FullSimplify[%]

Out[ ]= 0

In[ ]:= xvergelijking1 = %

Out[ ]= 0

In[ ]:=

# The electromagnetic force density in the y - direction equals :

In[ ]:= yvergelijking = term1[[2]] + term2[[2]] + term3[[2]] + term4[[2]] + term5[[2]] + term6[[2]]

Out[ ]= 0

In[ ]:= FullSimplify[%]

Out[ ]= 0

In[ ]:= yvergelijking1 = %

Out[ ]= 0

In[∘]:=

The electromagnetic force density in the z - direction equals :

In[∘]:= zvergelijking = term1[[3]] + term2[[3]] + term3[[3]] + term4[[3]] + term5[[3]] + term6[[3]]

Out[∘]=
$$-e^{-G1\,z\,\epsilon0\,\mu0}\,G1\,\epsilon0^2\,\mu0\,g\left[e^{-G1\,\epsilon0\,\mu0}\left(t-z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]^2-2\,e^{-G1\,\epsilon0\,\mu0-G1\,z\,\epsilon0\,\mu0}\,\epsilon0^{3/2}\sqrt{\mu0}\,g\left[e^{-G1\,\epsilon0\,\mu0}\left(t-z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]g'\left[e^{-G1\,\epsilon0\,\mu0}\left(t-z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]-\mu0\left(-\frac{1}{2}e^{-G1\,z\,\epsilon0\,\mu0}\,G1\,\epsilon0^2\,g\left[e^{-G1\,\epsilon0\,\mu0}\left(t-z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]^2-\frac{e^{-G1\,\epsilon0\,\mu0-G1\,z\,\epsilon0\,\mu0}\,\epsilon0^{3/2}\,g\left[e^{-G1\,\epsilon0\,\mu0}\left(t-z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]g'\left[e^{-G1\,\epsilon0\,\mu0}\left(t-z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]}{\sqrt{\mu0}}\right)-\epsilon0\left(-\frac{1}{2}e^{-G1\,z\,\epsilon0\,\mu0}\,G1\,\epsilon0\,\mu0\,g\left[e^{-G1\,\epsilon0\,\mu0}\left(t-z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]^2-e^{-G1\,\epsilon0\,\mu0-G1\,z\,\epsilon0\,\mu0}\sqrt{\epsilon0}\sqrt{\mu0}\,g\left[e^{-G1\,\epsilon0\,\mu0}\left(t-z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]g'\left[e^{-G1\,\epsilon0\,\mu0}\left(t-z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]\right)$$

In[∘]:= FullSimplify[%]

Out[∘]= 0

In[∘]:= zvergelijking1 = %

Out[∘]= 0

Results force densities in resp x-direction, y-direction, z-direction

Results for the electromagnetic force densities in resp x-direction, y-direction, z-direction:

In[∘]:= xvergelijking1

Out[∘]= 0

In[∘]:= yvergelijking1

Out[∘]= 0

In[∘]:= zvergelijking1

Out[∘]= 0

According the force-density equations in the x-direction, y-direction and z-direction, the resulting electromagnetic force density equals **zero in every direction**. This represents the solution for equation (73) on page 46.
It follows from the mathematical solution for the electromagnetic field:

$$ev = e^{-\frac{1}{2}G1\,z\,\epsilon0\,\mu0}\,g\left[e^{-G1\,\epsilon0\,\mu0}\left(t-z\sqrt{\epsilon0}\sqrt{\mu0}\right)\right]$$

that the **intensity increases** with the value:

$$\text{Intensity} = -\frac{1}{2}\left(\epsilon0\,(\text{Dot}[\text{ev},\ \text{ev}]) + \mu0\,(\text{Dot}[\text{mv},\ \text{mv}])\right)$$

$$-\frac{1}{2}\,1\left(e^{-\frac{G1\,z\,\epsilon0\,\mu0}{2}}\ \epsilon0\ g\left[e^{-G1\,\epsilon0\,\mu0}\left(t - z\sqrt{\epsilon0}\ \sqrt{\mu0}\right)\right]^2 + e^{-\frac{G1\,z\,\epsilon0\,\mu0}{2}}\ g\left[e^{-G1\,\epsilon0\,\mu0}\left(t - z\sqrt{\epsilon0}\ \sqrt{\mu0}\right)\right]^2\ \epsilon0\right)$$

The Electromagnetic Energy Intensity is proportional to: $e^{-G1\,z\,\epsilon0\,\mu0}$ along the distance z in the direction **opposite** to the z-direction of the gravitational field.

The frequency is proportional to the energy density **(book: Equation 66 Page 42)** and the wavelength is inversely proportional to the energy. The speed of light remains **constant** in a gravitational field.

Within a Constant Gravitational Field G1 The observed Cosmological Redshift will be:

$$\omega_{NLGR} = \omega_0 \, e^{-g z \mu_0 \varepsilon_0} \sqrt{\frac{1+\frac{v}{c}}{1-\frac{v}{c}}}$$

The Relative Doppler Frequency Shift can be written as :

$$\frac{\Delta \omega_D}{\omega} = \sqrt{\frac{1+\frac{v}{c}}{1-\frac{v}{c}}}$$

The Relative Gravitational Frequency Shift can be written as :

$$\frac{\Delta \omega_G}{\omega} = e^{-g z \mu_0 \varepsilon_0}$$

According Taylor Series Expansions the exponential term:

$$\frac{\Delta \omega_G}{\omega} = e^{-g z \mu_0 \varepsilon_0} = 1 - \frac{(g z \mu_0 \epsilon_0)}{1!} + \frac{(g z \mu_0 \epsilon_0)^2}{2!} - \frac{(g z \mu_0 \epsilon_0)^3}{3!} + \ldots$$

The calculated Relative Gravitational Redshift in Quantum witl Light Theory (QLT) differs

from the calculations in General Relativity.,

startin in the **second term** $\frac{1}{2!}(-g z \mu_0 \varepsilon_0)^2$ , in **Taylors Series of the exponential function** compared to:

the Classical Gravitational Frequency Shift:

$\left(\frac{\Delta \omega}{\omega} = -g z \mu_0 \varepsilon_0\right)$ in **General Relativity** presented in

**An improved approach for testing Gravitational Redshift via**
**Satellite-Base three frequency links combination**