# On Cosmological Redshift Energy Loss Due to Universe Expansion

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## Abstract

The cosmological redshift energy loss due to the expansion of the universe is stored in the dark matter energy tensor D(4,0) related to the Riemann curvature. The Cosmic Microwave Background energy loss has been stored in the dark matter energy tensor D(4,0)

Dark matter gravity is generated by D(4,0) energy related directly to the S(4,0) tensor, however this gravity is attributed to exotic particles never detected, galaxies in our universe are rotating with such speed that the gravity generated by their observable matter could not possibly hold them together

Total Energy T(4,0) and energy tensors are defined to complete the General Relativity field equations. The Ricci decomposition is a way of breaking up the Riemann curvature tensor into three orthogonal tensors, Z(4,0), Weyl tensor C(4,0) and S(4,0)

## Cosmological redshift energy loss due to the expansion of the universe

In an expanding closed universe, regardless our universe is closed or open, the final wave length of the photon when the closed universe reaches its maximum radius is [4]

$$\frac{\lambda_{now}}{r_{now}} = \frac{\lambda_f}{r_f}$$

$$\frac{\nu_f}{r_{now}} = \frac{\nu_{now}}{r_f}$$

$$E_l = h\nu_{now} - h\nu_f$$

where h is the Planck constant and $E_l$ is the energy loss, in a closed universe after reaching its maximum expansion the universe comes backwards and will reach $r_{now}$ again restoring the loss of energy to the photon, so this $E_l$ has been stored and was not definitely lost

The cosmological redshift energy loss due to the expansion of the universe is stored in the dark matter energy tensor D(4,0) related directly to the S(4,0) tensor, however this gravity is attributed to exotic particles never detected

The Cosmic Microwave Background energy loss has been stored in the dark matter energy tensor D(4,0), gravitational waves and other fields are subject to the same redshift phenomena

# Conformal energy U defined as a combination of C and the Hodge dual of C, dark matter energy D defined as a combination of S and the Hodge dual of S, similar definitions for V/Z and T/R

The Ricci decomposition is a way of breaking up the Riemann curvature tensor into three orthogonal tensors, $\mathbf{Z}$ , Weyl tensor $\mathbf{C}$ and $\mathbf{S}$, $\mathbf{S}$ tensor generates the dark matter gravity

$$R_{ijkl} = Z_{ijkl} + C_{ijkl} + S_{ijkl}$$

$$S_{ijkl} = \frac{1}{12} R \left( g_{il} g_{jk} - g_{ik} g_{jl} \right)$$

$$Y_{jk} = R_{jk} - \frac{1}{4} R g_{jk}, \; Z_{ijkl} = \tfrac{1}{2} \left( Y_{il} g_{jk} - Y_{jl} g_{ik} - Y_{ik} g_{jl} + Y_{jk} g_{il} \right)$$

where $R_{abcd}$ is the Riemann tensor, $R_{ab}$ is the Ricci tensor, $R$ is the Ricci scalar (the scalar curvature)

The conformal energy tensor $\mathbf{U}$ can be defined as a combination of $\mathbf{C}$ and the Hodge dual of $\mathbf{C}$ [1]

$$U_{abcd} = 1/8\pi (C_{amcd} C^m_{bcd} + {*}C_{amcd}{*}C^m_{bcd} + C_{abcn} C^n_{abd} + {*}C_{abcn}{*}C^n_{abd})$$

The new dark matter energy tensor $\mathbf{D}$ can be defined as a combination of $\mathbf{S}$ and the Hodge dual of $\mathbf{S}$

$$D_{abcd} = 1/8\pi (S_{amcd} S^m_{bcd} + {*}S_{amcd}{*}S^m_{bcd} + S_{abcn} S^n_{abd} + {*}S_{abcn}{*}S^n_{abd})$$

The new energy tensor $\mathbf{V}$ can be defined as a combination of $\mathbf{Z}$ and the Hodge dual of $\mathbf{Z}$

$$V_{abcd} = 1/8\pi (Z_{amcd} Z^m_{bcd} + {*}Z_{amcd}{*}Z^m_{bcd} + Z_{abcn} Z^n_{abd} + {*}Z_{abcn}{*}Z^n_{abd})$$

The new Total Energy tensor $\mathbf{T}$ can be defined as a combination of the Riemann tensor $\mathbf{R}$ and the Hodge dual of $\mathbf{R}$

$$T_{abcd} = 1/8\pi (R_{amcd} R^m_{bcd} + {*}R_{amcd}{*}R^m_{bcd} + R_{abcn} R^n_{abd} + {*}R_{abcn}{*}R^n_{abd})$$

## Hodge dual definitions

The Hodge dual definition for Electromagnetic tensor and Weyl tensor [2]

$*F_{ab} = \frac{1}{2}\varepsilon_{abln}F^{ln}$

$*C_{abcd} = \frac{1}{2}\varepsilon_{abln}C^{ln}_{\phantom{ln}cd}$

The Hodge dual definition for dark matter S tensor, Z and R tensors

$*S_{abcd} = \frac{1}{2}\varepsilon_{abln}S^{ln}_{\phantom{ln}cd}$ , $*Z_{abcd} = \frac{1}{2}\varepsilon_{abln}Z^{ln}_{\phantom{ln}cd}$ , $*R_{abcd} = \frac{1}{2}\varepsilon_{abln}R^{ln}_{\phantom{ln}cd}$

Weyl tensor C(4,0) is related to the new Conformal Energy tensor U(4,0). Dark matter tensor S(4,0) is related to the new dark matter energy tensor D(4,0). Z(4,0) tensor is related to the new energy tensor V(4,0). Riemann tensor R(4,0) is related to the new Total Energy tensor T(4,0)

## Complete General Relativity field equations

The complete field equations are described by a new T(4,0) tensor for Total Energy, the new conformal energy tensor U(4,0), the new energy tensor V(4,0) and the new dark matter energy tensor D(4,0)

$Z_{ab} - \frac{1}{2}Zg_{ab} + \Lambda_z g_{ab} = -k_z V_{ab}$

$C_{ab} - \frac{1}{2}Cg_{ab} + \Lambda_c g_{ab} = -k_c U_{ab}$

$S_{ab} - \frac{1}{2}Sg_{ab} + \Lambda_s g_{ab} = -k_s D_{ab}$

$R = Z + C + S$

$\kappa T = k_z V + k_c U + k_s D$

$\Lambda = \Lambda_z + \Lambda_c + \Lambda_s$

$\kappa T_{abcd} = k_z V_{abcd} + k_c U_{abcd} + k_s D_{abcd}$

In the general theory of relativity the Einstein field equations relate the geometry of spacetime to the distribution of matter. [3]

$R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} + \Lambda g_{\mu\nu} = -\kappa T_{\mu\nu}$

# References

[1] Jesus Delso Lapuerta, https://vixra.org/abs/2012.0093, "On the conformal energy tensor defined as a combination of Weyl tensor and the Hodge dual of Weyl tensor"

[2] See Chapter 32, 32.2 in: Roger Penrose, "The Road to Reality", Jonathan Cape, London 2004

[3] See Page 175 in: Albert Einstein, "El significado de la relatividad" / "The meaning of relativity" , Planeta - De Agostini, Barcelona 1985

[4] See Page 572 in: Frank J. Tipler, "The Physics of Immortality", Doubleday, New York,1994