Zero-energy space cancels the need for dark energy

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Mathematics, Physics and Philosophy in the Interpretations of Relativity Theory

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Latest PhysicsWeb Summaries 20.7.2007:

Dark-energy teams win cosmology prize (Jul 17)

http://physicsweb.org/article/news/11/7/15

Two independent teams of researchers who **discovered that the expansion of the universe is accelerating** have been awarded this year's Gruber Cosmology Prize. The prize, worth $500,000, has been given to the groups led by Saul Perlmutter and Brian Schmidt, who reported their discovery in 1998. Their work provided the first **convincing evidence for the existence of "dark energy"** -- a mysterious and so-far invisible entity that physicists believe works against gravity to boost the expansion of the universe.
Latest PhysicsWeb Summaries 20.7.2007:

Dark-energy teams win cosmology prize (Jul 17)

… an alternative way of wording the news:

Two independent teams of researchers who discovered that the magnitudes of high redshift supernovae do not follow the prediction of the standard cosmology model … have been awarded …
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Dark-energy teams win cosmology prize (Jul 17)

… an alternative way of wording the news:

Two independent teams of researchers who discovered that the magnitudes of high redshift supernovae do not follow the prediction of the standard cosmology model … have been awarded …

… a concept of dark energy working against gravitation between galaxies has been suggested to fix the problem.
Magnitude versus redshift: Supernova observations

Data:
A. G. Riess, et al.,
Magnitude versus redshift: Supernova observations

\[ \mu = 5 \log \frac{R_\mu}{10 \text{ pc}} \]

\[ +5 \log \left[ \frac{1}{\sqrt{(1+z)^2 (1 + \Omega_m z) - z (2 + z) \Omega_\Lambda}} \right] dz \]

Data:
A. G. Riess, et al.,
Magnitude versus redshift: Supernova observations

\[ \mu = 5 \log \frac{R_{\mu}}{10 \text{ pc}} + 5 \log \left( 1 + z \int_0^z \frac{1}{\sqrt{(1+z)^2 (1+ \Omega_m z) - z (2+z) \Omega_\Lambda}} \, dz \right) \]

Data:
A. G. Riess, et al.,

Suggested correction:
\[ \Omega_m = 0.3 \]
\[ \Omega_\Lambda = 0.7 \text{ (dark energy)} \]
Angular size of galaxies and quasars

Largest angular size (LAS),
Open circles: galaxies
Filled circles: quasars

Collection of data:
K. Nilsson et al.,
Angular size of galaxies and quasars

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(a) 

(b) 

(c) 

(d) 

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Suggested explanation:
high z galaxies are young;
sizes are still developing
(not supported by spectral data!)
… does the dark energy really solve the problem …

… or could the observations reflect a more fundamental problem in the Standard Cosmology Model or Relativity Theory?
Standard Cosmology

Solution of GR field equations by Friedman, Lemaître, Robertson, and Walker

assuming

- the cosmological principle
- space-time metrics and the assumptions of general relativity
  - Lorentz transformation
  - relativity principle
  - equivalence principle
  - constancy of the velocity of light
- local conservation of energy
  \(\Rightarrow\) galaxies conserve their dimension
Zero-energy space

Solution of zero-energy condition in spherically closed space

assuming

- minimum volume for closing 3-space
  ⇒ the surface of a 4-sphere
- conservation of total energy in all interactions in space
- homogeneity as the initial condition
  ⇒ cosmological principle
- absolute time and distance units
Zero-energy space

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- homogeneity as the initial condition
  ⇒ cosmological principle
- absolute time and distance units
Zero-energy balance of motion and gravitation

\[ E_m = c_0 |p| = c_0 mc_0 \]
\[ E_g = -\frac{GmM''}{R''} \]

\[ M'' = 0.776 M_\Sigma \]
Zero-energy balance of motion and gravitation

$$m = \text{mass}$$

$$M''$$

$$\text{Re}_{\delta}$$

$$\text{Im}_{\delta}$$

$$p_\phi = mc_\phi$$

$$E''_{g(\delta)}$$

$$E''_{g(0)}$$
Zero-energy balance of motion and gravitation

\[ E_{\text{rest}}(\delta) = c_0 |p_\delta| = c_0 m c_0 \cos \phi \]

\[ \cos \phi = \frac{E''_{g(\delta)}}{E''_{g(0)}} = 1 - \frac{GM}{r_0 c_0^2} = 1 - \delta \]

\[ \delta = \frac{GM}{r_0 c_0^2} \]
Zero-energy balance in tilted space

\[ E_{\text{rest}}(\delta) = E_{\text{rest}}(0) \left(1 - \delta\right) \]

\[ \delta = \frac{GM}{r_0 c_0^2} \]
Zero-energy balance in tilted space
Zero-energy balance in tilted space

\[ E_{\text{rest}(\delta, \beta)} = E_{\text{rest}(\delta)} \sqrt{1 - \beta^2} \]

\[ \beta = \frac{v}{c} \]
Zero-energy balance in tilted space

\[ E_{\text{rest}(\delta,\beta)} = E_{\text{rest}(\delta)} \sqrt{1 - \beta^2} \]

\[ E_{\text{rest}(\delta,\beta)} = E_{\text{rest}(0,0)} (1 - \delta) \sqrt{1 - \beta^2} \]
The system of nested energy frames

Hypothetical homogeneous space

… zero-energy space appears as a structured system of nested energy frames …

… where universal time and distance applies, …

… the local state of rest is an attribute of the local frame, …

… relativity is the measure of locally available share of total energy …

\[ E_{\text{rest}} = m_0 c_0^2 \prod_{i=1}^{n} (1 - \delta_i) \sqrt{1 - \beta_i^2} \]
The effect of reduced local energy on clock frequency

Zero-energy space:

$$f_{\delta, \beta(Z-E)} = f_{0,0} \prod_{i=1}^{n} (1 - \delta_i) \sqrt{1 - \beta_i^2}$$
The effect of reduced local energy on clock frequency

Zero-energy space:

\[ f_{\delta, \beta(Z-E)} = f_{0,0} \prod_{i=1}^{n} (1 - \delta_i) \sqrt{1 - \beta_i^2} \]

Standard model (Schwarzschild):

\[ f_{\delta, \beta(GR)} = f_{0,0} \sqrt{1 - 2\delta - \beta^2} \]
Physical distance of objects in zero-energy space

Optical distance of objects in zero-energy space

\[
D_{phys} = \alpha R_4
\]
Physical distance of objects in zero-energy space

Optical distance of objects in zero-energy space

\[ D_{\text{phys}} = \alpha R_4 \]

\[ D_{\text{opt}} = R_4 - R_{4(0)} = R_4 \left( 1 - e^{-\alpha} \right) = R_4 \frac{z}{1 + z} \]
Optical distance in zero energy space

Zero-energy space:

\[ D = R_4 \frac{z}{1 + z} \]
Angular size distance

Zero-energy space:

\[ D = R_4 \frac{z}{1+z} \]

Standard model:

\[ D = \frac{R_H}{1+z} \int_0^z \frac{1}{\sqrt{(1+z)^2 (1+\Omega_m z) - z (2+z) \Omega_\Lambda}} dz \]

\[ \Omega_m = 0.3 \quad \Omega_\Lambda = 0.7 \]

\[ \Omega_m = 1 \quad \Omega_\Lambda = 0 \]
Angular size of standard rod

Standard model:

\[ \begin{cases} 
\Omega_m = 1 \\
\Omega_\Lambda = 0 \\
\Omega_m = 0.3 \\
\Omega_\Lambda = 0.7 
\end{cases} \]

\[ \theta = \frac{r_s}{R_H} = \frac{r_s}{R_H} \frac{1+z}{R_H} \int_0^\infty \frac{1}{\sqrt{(1+z)^2 (1+\Omega_m z) - z (2+z) \Omega_\Lambda}} \, dz \]

Zero energy space, standard rod (solid objects):

\[ \theta = \frac{r_s}{D} = \frac{r_s}{R} \frac{1+z}{R} \frac{1}{z} \]
Angular size of standard rod & galaxies and quasars

**Standard model:**

\[
\left\{ \begin{array}{l}
\Omega_m = 1 \\
\Omega_\Lambda = 0
\end{array} \right. \quad \text{or} \quad \left\{ \begin{array}{l}
\Omega_m = 0.3 \\
\Omega_\Lambda = 0.7
\end{array} \right.
\]

\[
\theta = \frac{r_z}{D} = \frac{r_s}{R_H} \frac{1+z}{\int_0^z \frac{1}{\sqrt{(1+z)^3 (1+\Omega_m z) - z(2+z)\Omega_\Lambda}} dz}
\]

**Zero energy space, standard rod (solid objects):**

\[
\theta = \frac{r_z}{D} = \frac{r_s}{R_4} \frac{1+z}{z}
\]

**Zero energy space, expanding objects (e.g. galaxies, quasars):**

\[
\theta = \frac{r(z)}{D} = \frac{r_o}{(1+z)} \frac{1+z}{z} = \frac{r_o}{R_4} \frac{1}{z} = \text{Euclidean}
\]
**Angular size of galaxies and quasars**

Zero-energy space: complete agreement with observations

\[ \theta = \frac{r_0}{R_z z} \]

Largest angular size (LAS),
Open circles: galaxies
Filled circles: quasars

Collection of data:

Suggested explanation:
high z galaxies are young;
sizes are still developing
(not supported by spectral data!)
Observed energy flux

Standard model (for $k$-corrected observations):

$$\frac{F_D}{F_{d_0}} = \left( \frac{d_L(z=0)}{D_L} \right)^2$$
Observed energy flux

Standard model (for $k$-corrected observations):

$$\frac{F_{D}}{F_{d_0}} = \left( \frac{d_{L(z=0)}}{D_L} \right)^2 = \left( \frac{d_{A(z=0)}}{D_A (1+z)^2} \right)^2$$
Observed energy flux

Standard model (for $k$-corrected observations):

\[
\frac{F_D}{F_{d_0}} = \left( \frac{d_L(z=0)}{D_L} \right)^2 = \left( \frac{d_A(z=0)}{D_A (1+z)^2} \right)^2
= \frac{d_{(z=0)}^2}{R_{HI}^2} \cdot \frac{1}{\int_0^z \frac{1}{\sqrt{(1+z)^2 (1+\Omega_m z) - z (2+z) \Omega_k}} \, dz}\]

\[= \frac{d_{(z=0)}^2}{R_{HI}^2} \cdot \frac{1}{\int_0^z \frac{1}{\sqrt{(1+z)^2 (1+\Omega_m z) - z (2+z) \Omega_k}} \, dz}\]
Observed energy flux

Standard model (for $k$-corrected observations):

\[
\frac{F_D}{F_{d_0}} = \left( \frac{d_{L(z=0)}}{D_L} \right)^2 = \left( \frac{d_{A(z=0)}}{D_A (1+z)^2} \right)^2 = \frac{d_{(z=0)}^2}{R_H^2} \frac{1}{\left( 1+z \right)} \int_0^z \frac{1}{\sqrt{(1+z)^2 (1+\Omega_m z) - z (2+z) \Omega_k}} dz
\]

Zero energy space (bolometric):

\[
\frac{F_D}{F_{d_0}} = \left( \frac{d_{(z=0)}}{D} \right)^2 \frac{1}{1+z} = \frac{d_{(z=0)}^2}{R_H^2} \frac{(1+z)}{z^2}
\]
Observed energy flux

Standard model (for $k$-corrected observations):

$$
\frac{F_D}{F_{d_0}} = \left( \frac{d_L(z=0)}{D_L} \right)^2 = \left( \frac{d_A(z=0)}{D_A (1+z)^2} \right)^2 = \frac{d_{(z=0)}^2}{R_H^2} \frac{1}{\left(1+z\right) \int_0^z \frac{1}{\sqrt{(1+z)^2 (1+\Omega_m z) - z (2+z) \Omega_\Lambda}} d\zeta}
$$

Zero energy space (bolometric):

$$
\frac{F_D}{F_{d_0}} = \left( \frac{d_{(z=0)}}{D} \right)^2 \frac{1}{1+z} = \frac{d_{(z=0)}^2 (1+z)}{R_H^2 z^2}
$$

Zero energy space (for $k$-corrected observations in optimized multi-bandpass detection):

$$
\frac{F_D}{F_{d_0}} = \frac{d_{(z=0)}^2}{R_H^2} \frac{1}{z^2 (1+z)}
$$
Magnitude versus redshift: Supernova observations

\[ \mu = 5 \log \frac{R_i}{10 \text{ pc}} + 5 \log z + 2.5 \log (1 + z) \]
Magnitude versus redshift: Supernova observations

\[ \mu = 5 \log \frac{R_i}{10 \text{ pc}} + 5 \log z + 2.5 \log (1 + z) \]

Standard model with \( \Omega_m = 0.3, \Omega_\Lambda = 0.7 \)

Standard model with \( \Omega_m = 1, \Omega_\Lambda = 0 \)
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Magnitude versus redshift

\[ \Omega_m = 1 \]
\[ \Omega_\Lambda = 0 \]

Standard Model

Zero-energy space

Standard Model

Apparent magnitude (distance modulus)

\[ \mu = m - M \]
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Magnitude versus redshift

Apparent magnitude
(distance modulus)

\[ \mu = m - M \]

Zero-energy space

\[ \Omega_m = 0.3 \]
\[ \Omega_\Lambda = 0.7 \]

Observations

\[ \Omega_m = 1 \]
\[ \Omega_\Lambda = 0 \]

Standard Model

Magnitude versus redshift
Magnitude versus redshift

$$\Omega_m = 0.1$$
$$\Omega_\Lambda = 0.9$$

$$\Omega_m = 0.3$$
$$\Omega_\Lambda = 0.7$$

$$\Omega_m = 1$$
$$\Omega_\Lambda = 0$$

Standard Model
Local geometry of space

Schwarzschild space-time metric

Zero-energy space geometry
Space geometry at local singularity

Sgr A*: \[ r_{c(\text{Schwarzschild})} = \frac{2GM}{c^2} \approx 10^{10} \text{ [m]} \]

Sgr A*: \[ r_{c(Ze)} = \frac{GM}{c^2_0} = 5 \cdot 10^9 \text{ [m]} \]
Space geometry at local singularity

Sgr A*: \( r_{e(\text{Schwarzschild})} = \frac{2GM}{c^2} \approx 10^{10} \text{ m} \)

\[
Sgr \, A^*: \quad r_{e(\text{Ze})} = \frac{GM}{c_0^2} = 5 \cdot 10^9 \text{ m}
\]
Observed periodic emission at Sgr A*

Sgr A*: \[ r_{c(\text{Schwarzschild})} = \frac{2GM}{c^2} = 10^{10} \text{ [m]} \]

\[ \beta_{0\delta} = \frac{v_{\text{orb}}}{c_{0\delta}} \]

\[ v_{\text{orb}} = \frac{r}{r_c} \cdot 0.1 \cdot c \]

Sgr A*: \[ r_{c(\text{Ze})} = \frac{GM}{c^0} = 5 \cdot 10^9 \text{ [m]} \]

Observed periodic emission at Sgr A*

Sgr A*: $r_{(Schwarzschild)} = \frac{2GM}{c^2} \approx 10^{10} \text{ [m]}$

$\beta_{0\delta} = \frac{v_{orb}}{c_{0\delta}}$

17 min period*

Orbital velocity at circular orbit according to Standard Model

$\beta_{orb} = \frac{1}{\sqrt{\frac{2r}{r_{(Schwd)}}} - 3}$

Sgr A*: $r_{(Ze)} = \frac{GM}{c^2} = 5 \cdot 10^9 \text{ [m]}$

Observed periodic emission at Sgr A*

Sgr A*:

\[
r_{(Schwarzschild)} = \frac{2GM}{c^2} = 10^{10} \text{ [m]}
\]


Orbital velocity at circular orbit according to Standard Model

\[
\beta_{orb} = \frac{\sqrt{2r}}{r_{c(Schwd)}} - 3
\]

Proposed solution: spinning of black hole at 0.3 \( c \)

Sgr A*:

\[
r_{(Ze)} = \frac{GM}{c_0^2} = 5 \cdot 10^9 \text{ [m]}
\]
**Observed periodic emission at Sgr A***

\[
Sgr\ A^*: \quad r_{(\text{Schwarzschild})} = \frac{2GM}{c^2} \approx 10^{10} \text{ [m]}
\]

- **Orbital velocity at circular orbit according to Standard Model**

\[
\beta_{\text{orb}} = \frac{1}{\sqrt{\frac{2r}{r_{(\text{Schwd})}} - 3}}
\]

- **Orbits for black holes spinning at \( c \)**

\[
\beta_{\text{orb}(0,\delta)} = \sqrt{\frac{r_{c(\text{Ze})}}{r} \left(1 - \frac{r_{c(\text{Ze})}}{r}\right)^3}
\]

Conclusions …

There is a fundamental problem in the FLRW metrics – observed at the extremes: at large distances and at local singularities
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the problem is related to the local nature of general relativity and the missing linkage between the energy of local systems and the total energy in space …
Conclusions …

There is a fundamental problem in the FLRW metrics – observed at the extremes: at large distances and at local singularities

the problem is related to the local nature of general relativity and the missing linkage between the energy of local systems and the total energy in space …

… and the linear sum of $2\delta$ and $\beta^2$ terms in GR proper time – a consequence of the equivalence principle applied in space-time with time as the fourth dimension

$$
\tau = \frac{dt}{\sqrt{1 - 2\delta - \frac{dr^2}{c^2(1 - 2\delta)} - \frac{r^2 d\theta^2}{c^2} - \frac{r^2 \sin^2 \theta \cdot d\phi^2}{c^2} + \beta^2}}
$$
… conclusions

The zero-energy approach is a holistic analysis of zero-energy condition in spherically closed space


… conclusions

The zero-energy approach is a holistic analysis of zero-energy condition in spherically closed space

It shows the essence of relativity as the measure of locally available share of total energy,
… conclusions

The zero-energy approach is a holistic analysis of zero-energy condition in spherically closed space.

It shows the essence of relativity as the measure of locally available share of total energy,

… produces precise predictions to local and cosmological phenomena in closed mathematical forms,
… conclusions

The zero-energy approach is a holistic analysis of zero-energy condition in spherically closed space

It shows the essence of relativity as the measure of locally available share of total energy,

… produces precise predictions to local and cosmological phenomena in closed mathematical forms,

… and re-establishes the use of absolute coordinate quantities, time and distance, essential for human conception.

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