

# Zero-energy space cancels the need for dark energy

Tuomo Suntola, [www.sci.fi/~suntola/](http://www.sci.fi/~suntola/), Finland



*Mathematics, Physics and Philosophy  
in the Interpretations of Relativity Theory*

*Budapest, 7-9. September 2007*



## **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:**

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... 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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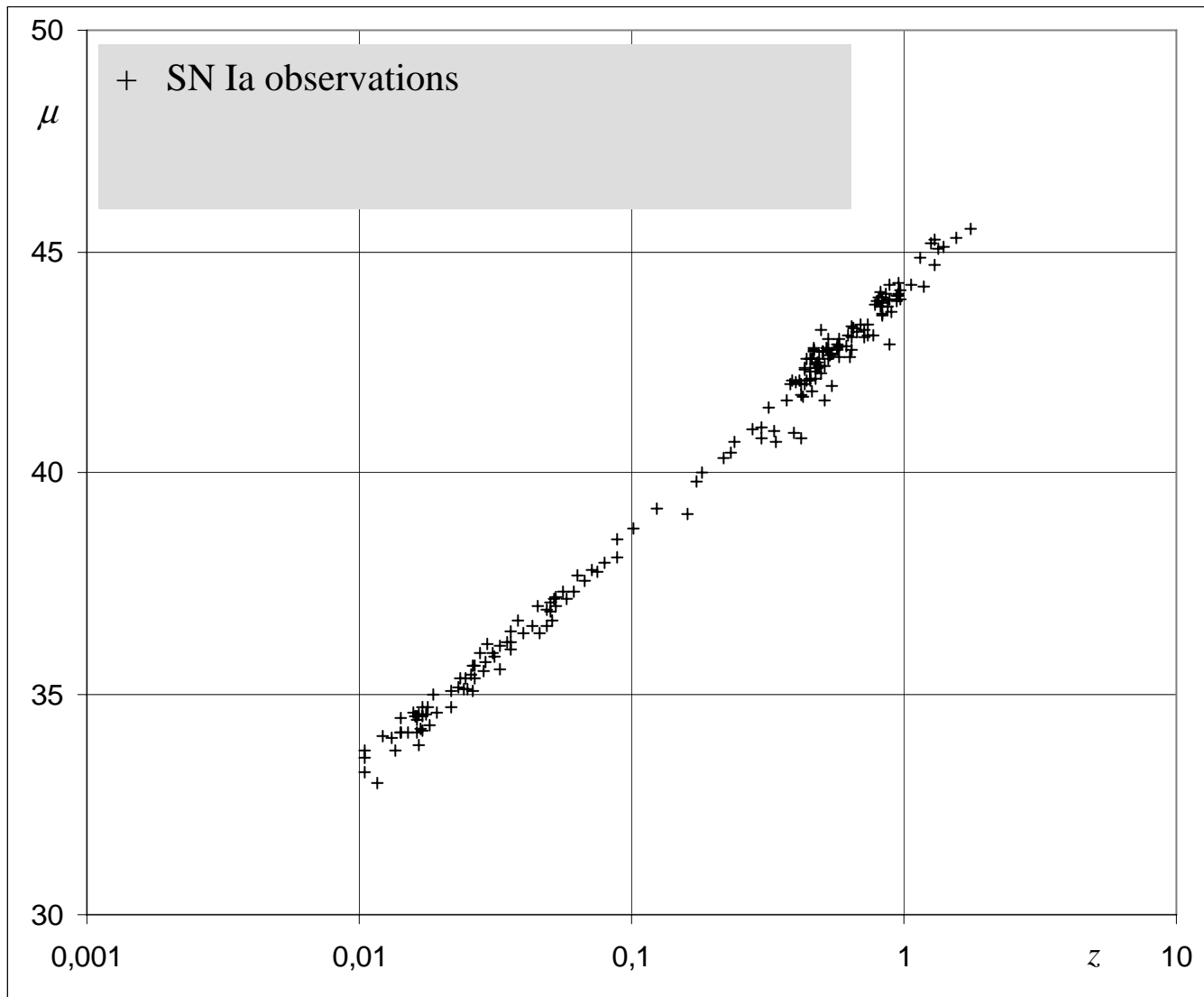
... an alternative way of wording the news:

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.



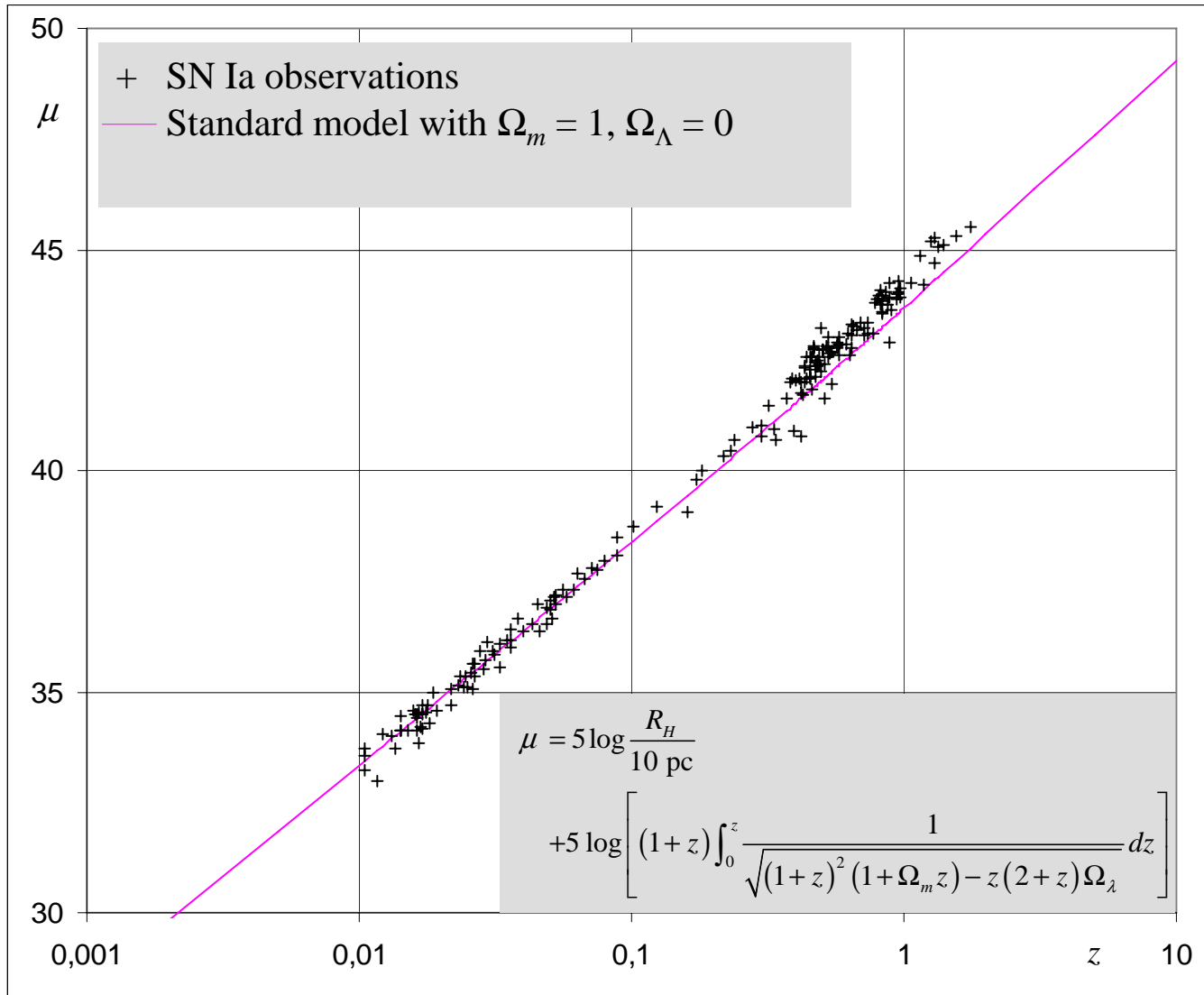
# Magnitude versus redshift: Supernova observations



Data:  
A. G. Riess, *et al.*,  
*Astrophys. J.*, 607, 665  
(2004)



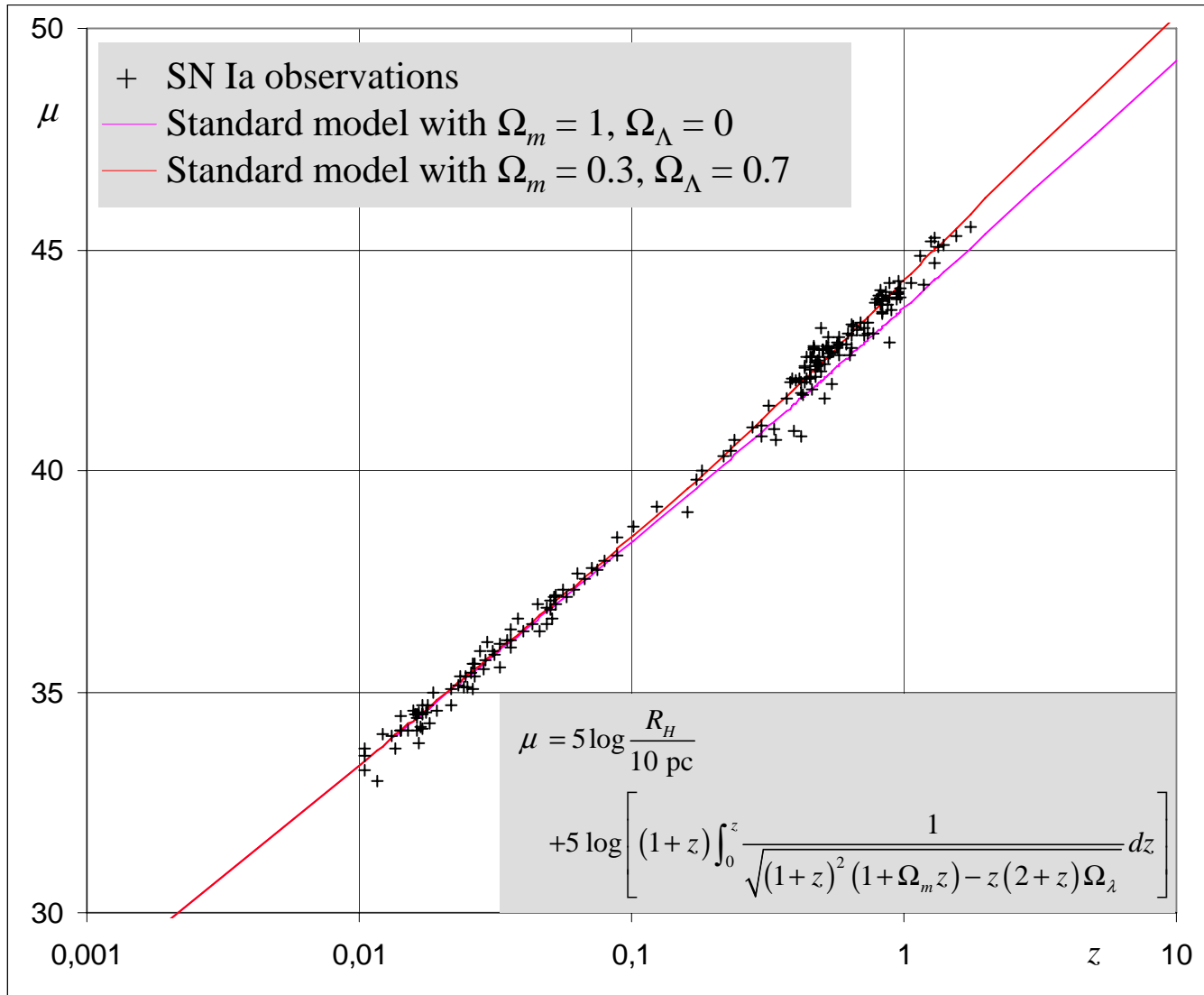
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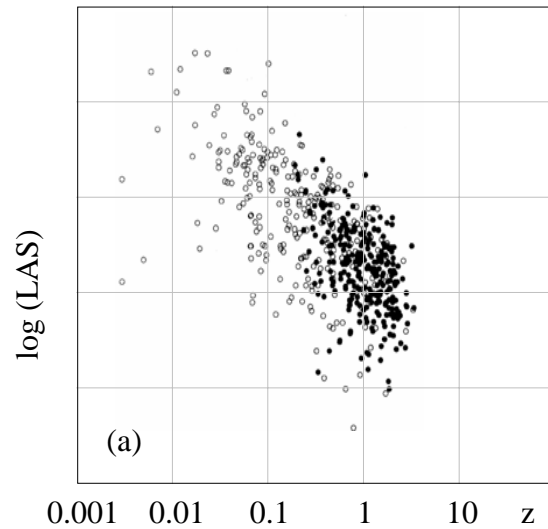


Data:  
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Suggested correction:  
 $\Omega_m = 0.3$   
 $\Omega_\Lambda = 0.7$  (dark energy)



# Angular size of galaxies and quasars

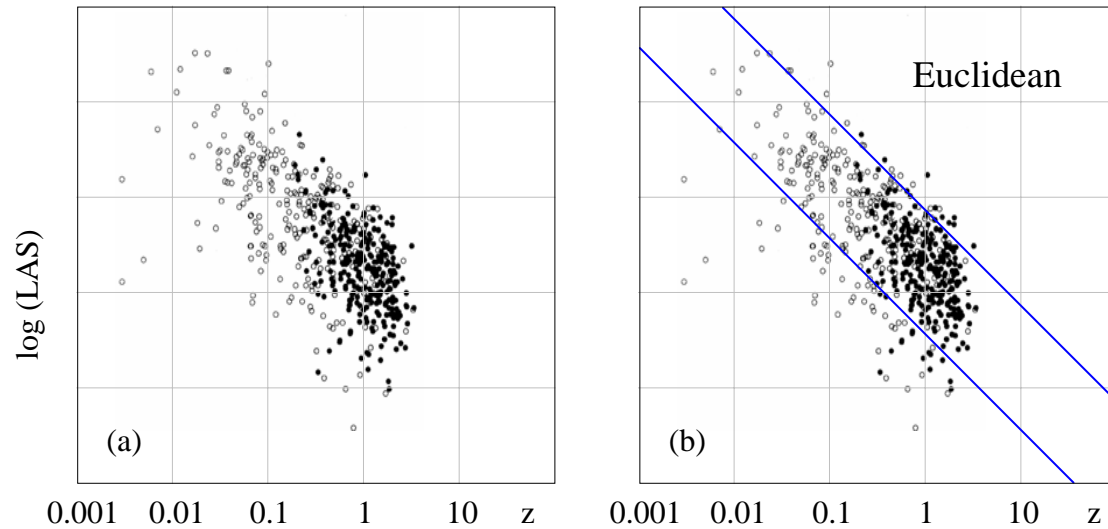


Largest angular size (LAS),  
Open circles: galaxies  
Filled circles: quasars

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## Angular size of galaxies and quasars

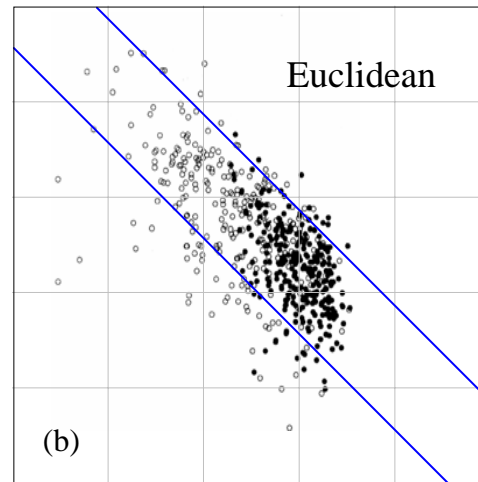
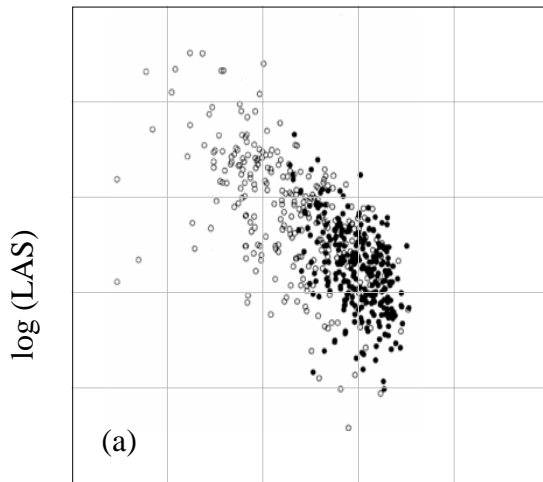


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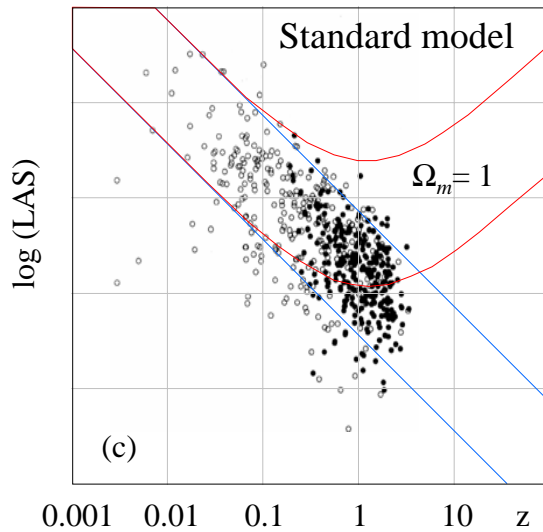


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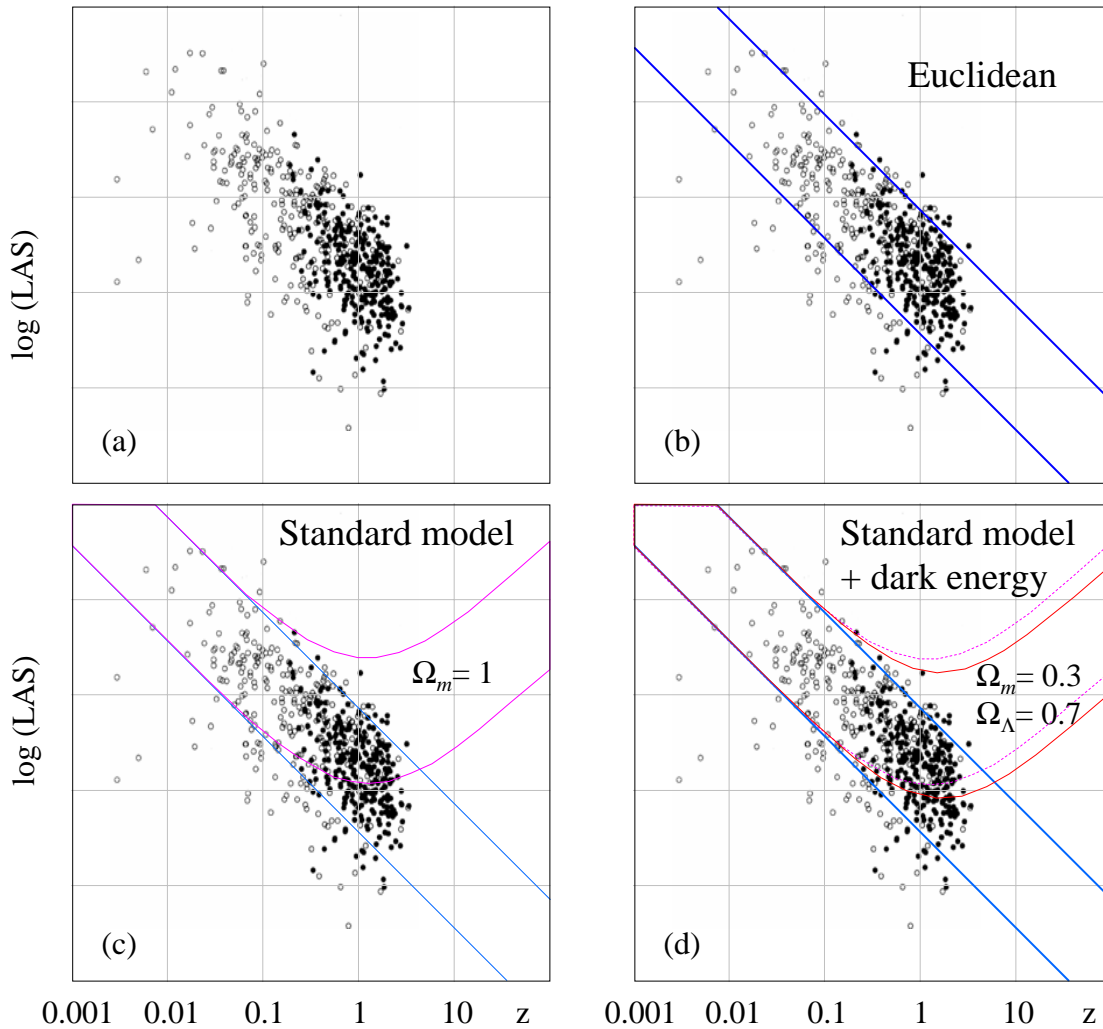
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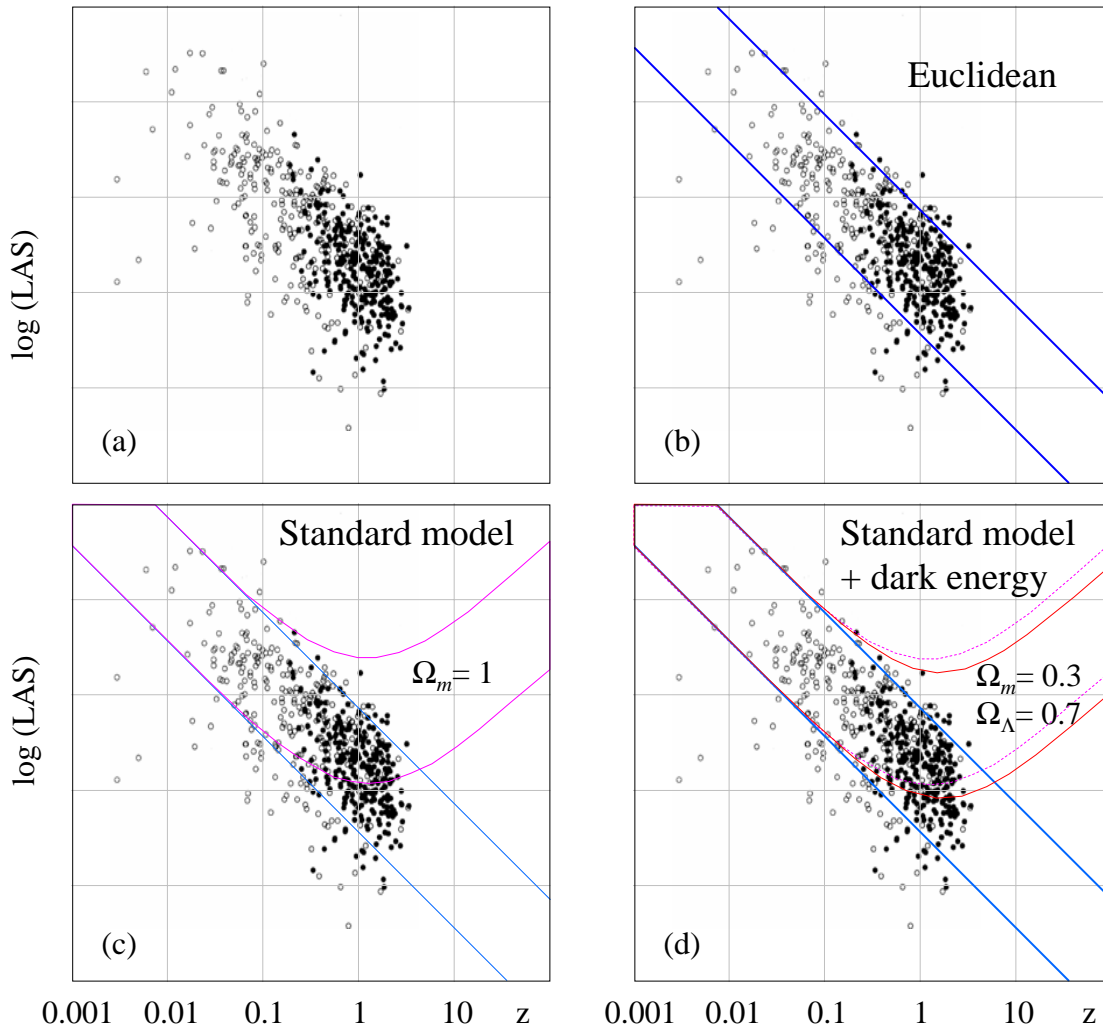


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**Suggested explanation:**  
high z galaxies are young;  
sizes are still developing  
(not supported by spectral data!)



**... 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**
  - ⇒ 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**

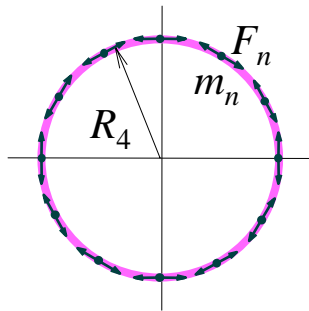


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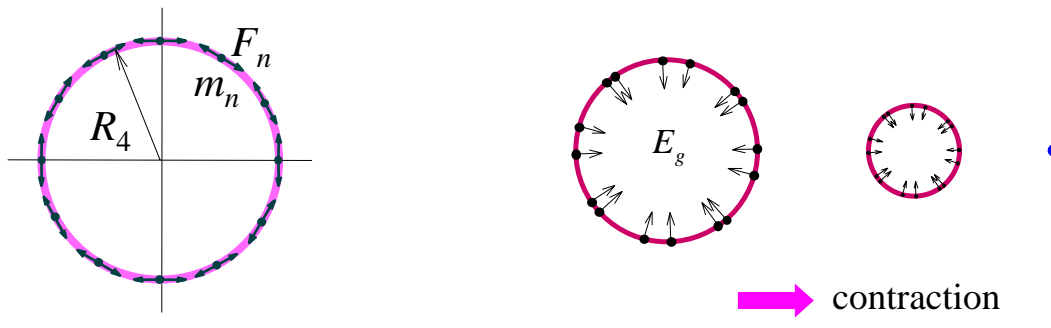


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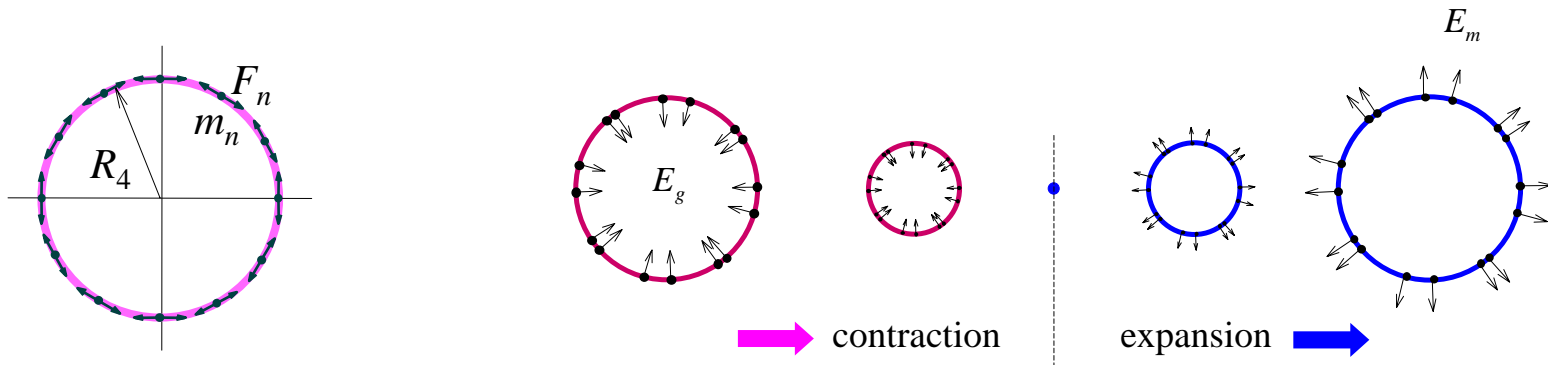


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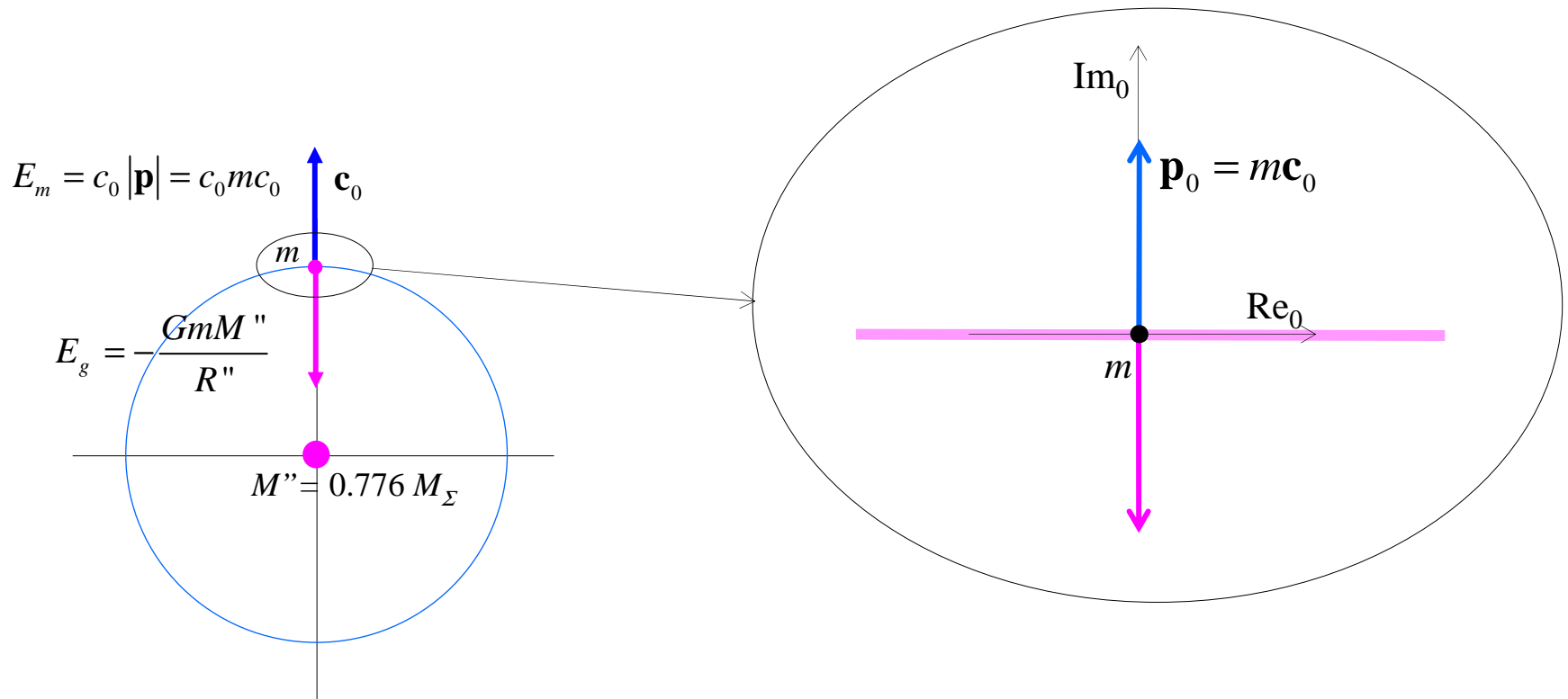
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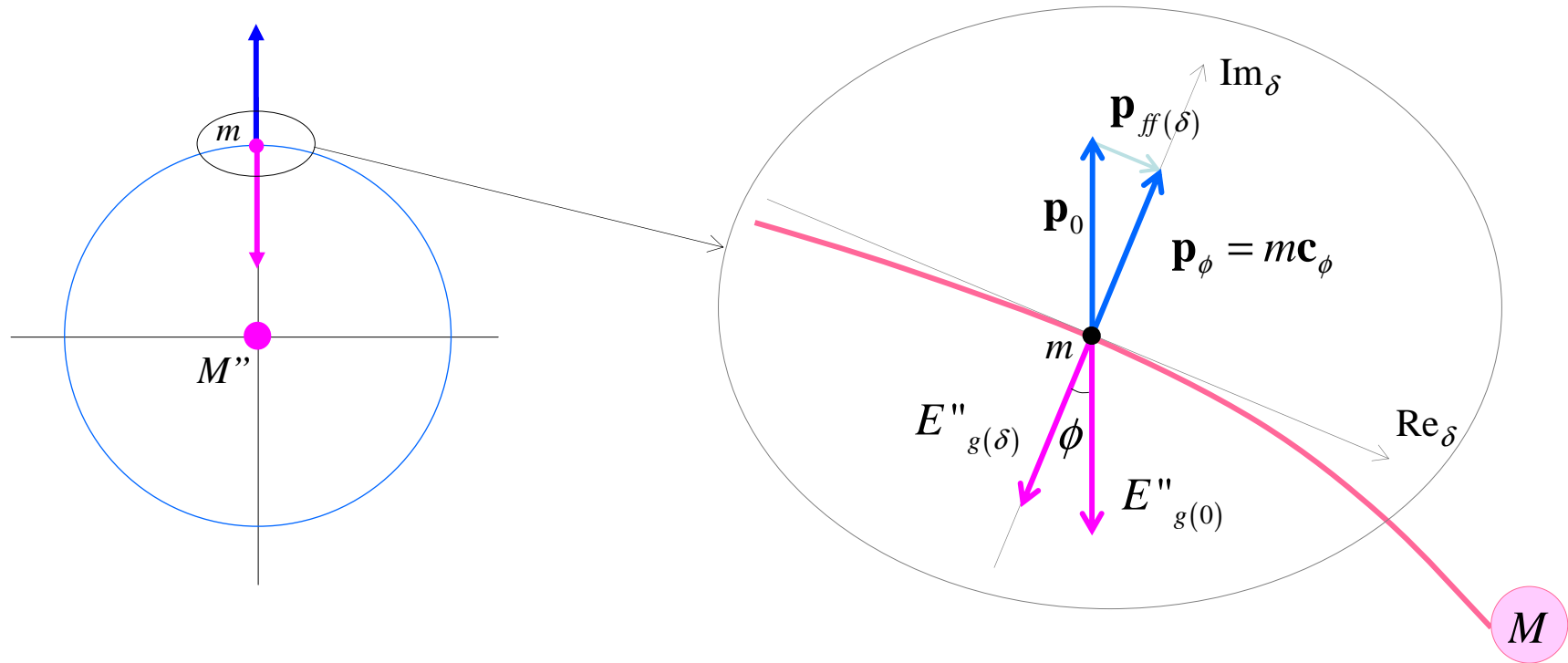


## Zero-energy balance of motion and gravitation





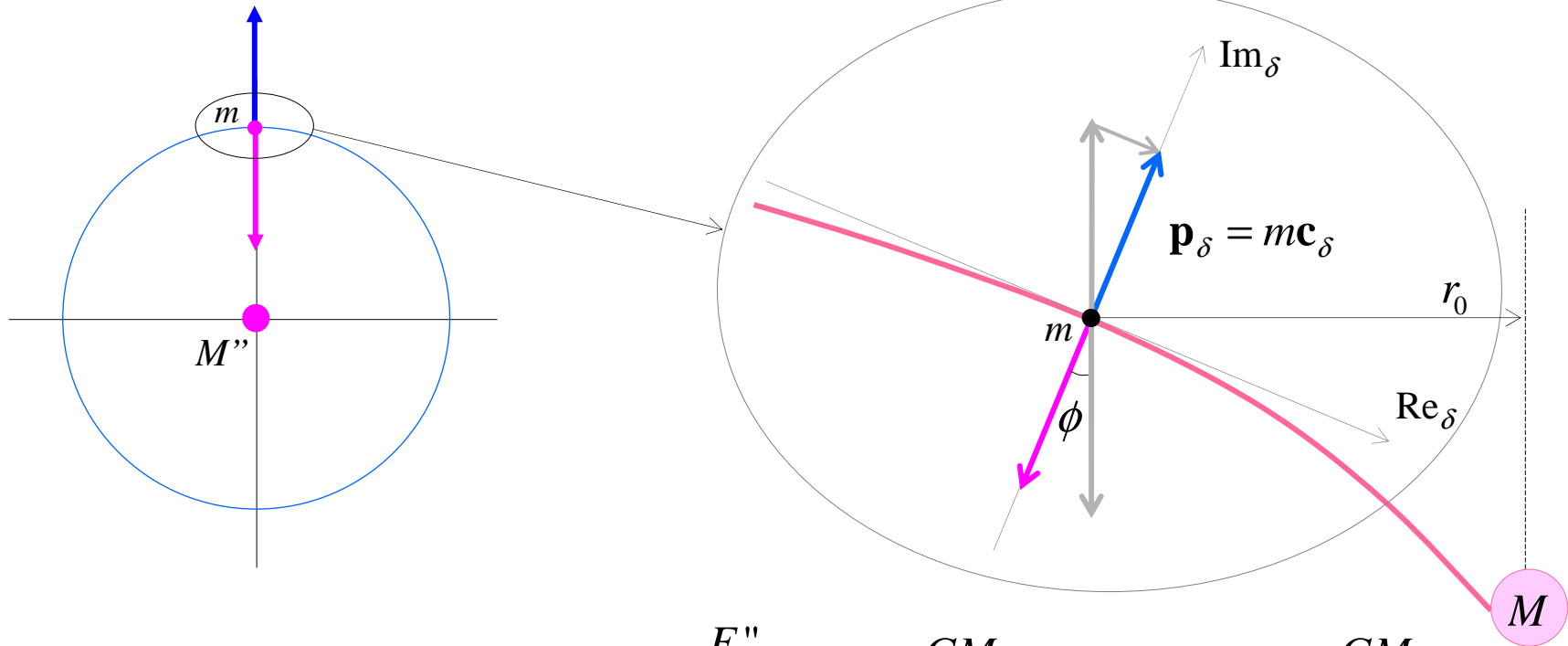
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## Zero-energy balance of motion and gravitation

$$E_{rest(\delta)} = c_0 |\mathbf{p}_\delta| = c_0 m c_0 \cos \phi$$



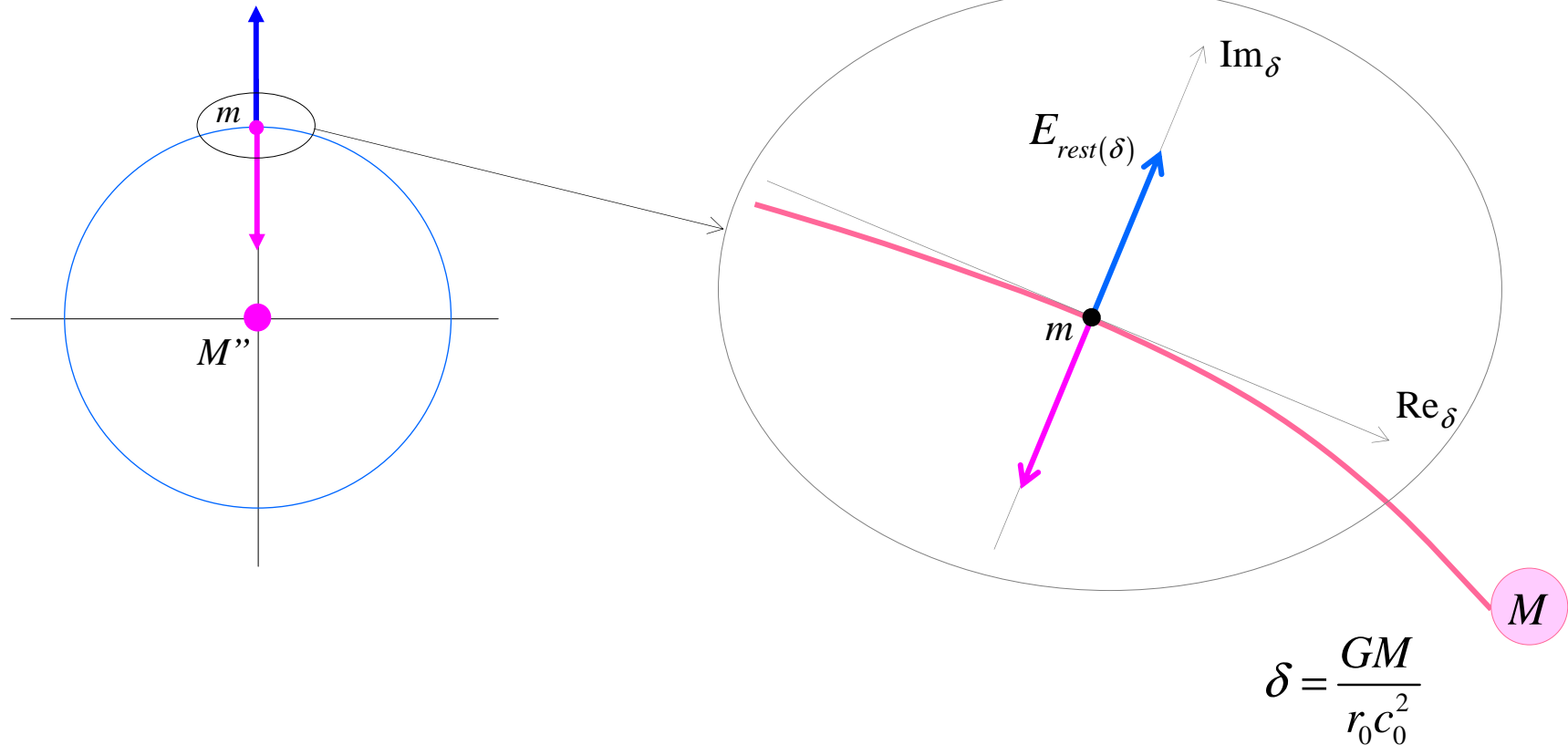
$$\cos \phi = \frac{E''_{g(\delta)}}{E''_{g(0)}} = 1 - \frac{GM}{r_0 c_0^2} = 1 - \delta$$

$$\delta = \frac{GM}{r_0 c_0^2}$$



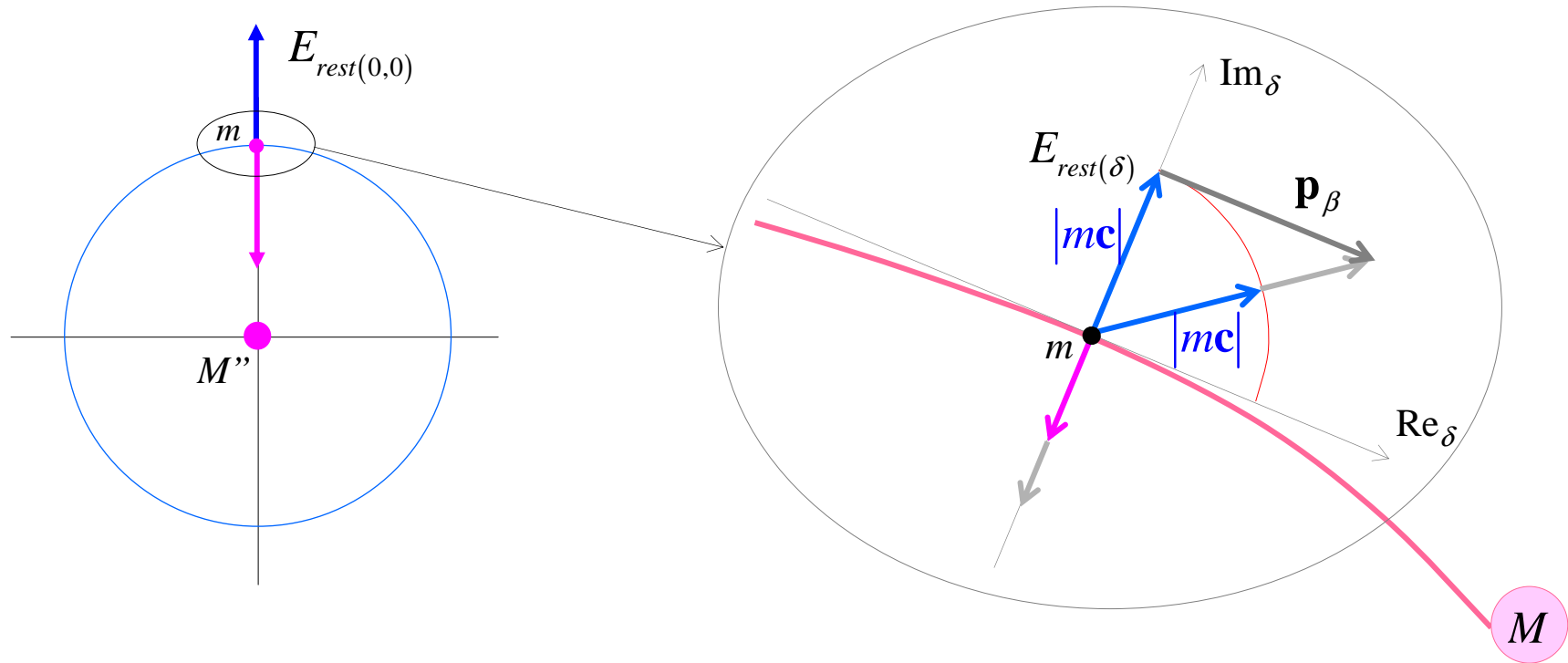
## Zero-energy balance in tilted space

$$E_{rest(\delta)} = E_{rest(0)} (1 - \delta)$$





## Zero-energy balance in tilted space

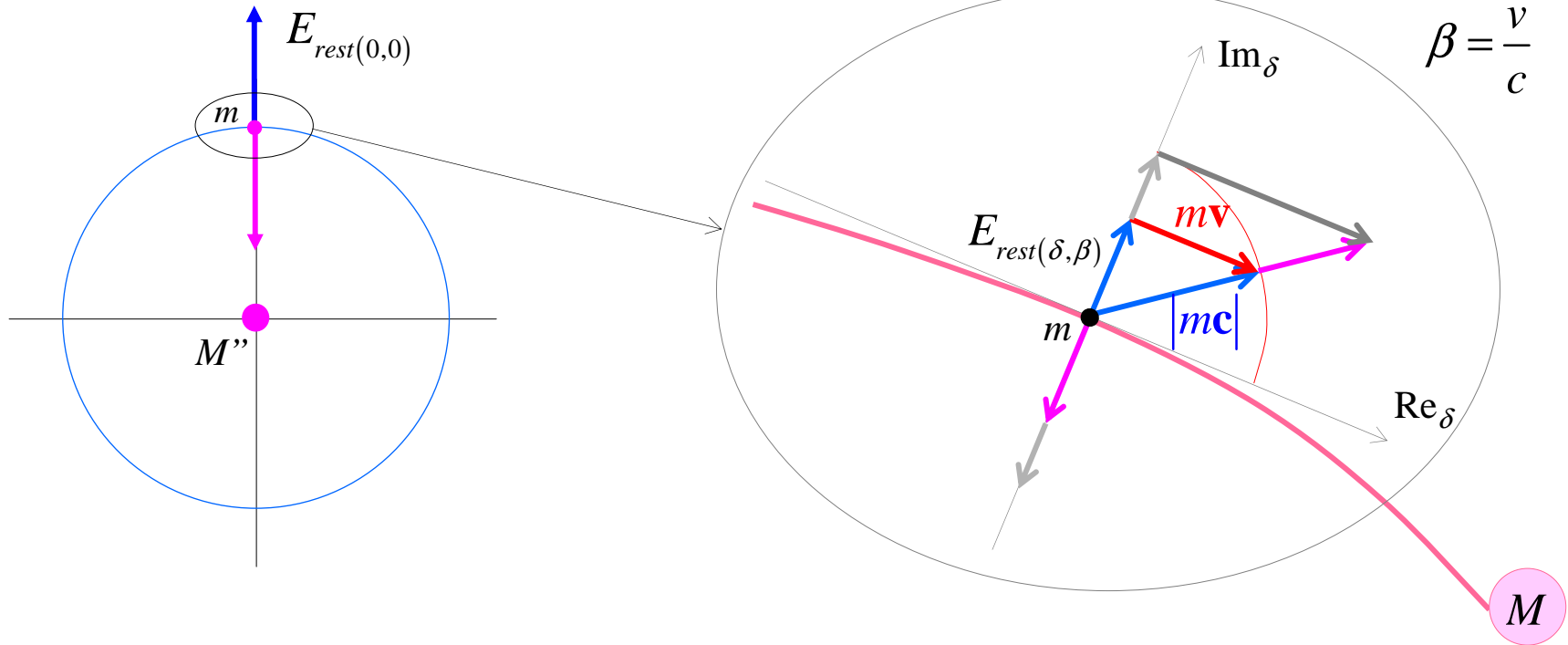




# Zero-energy balance in tilted space

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

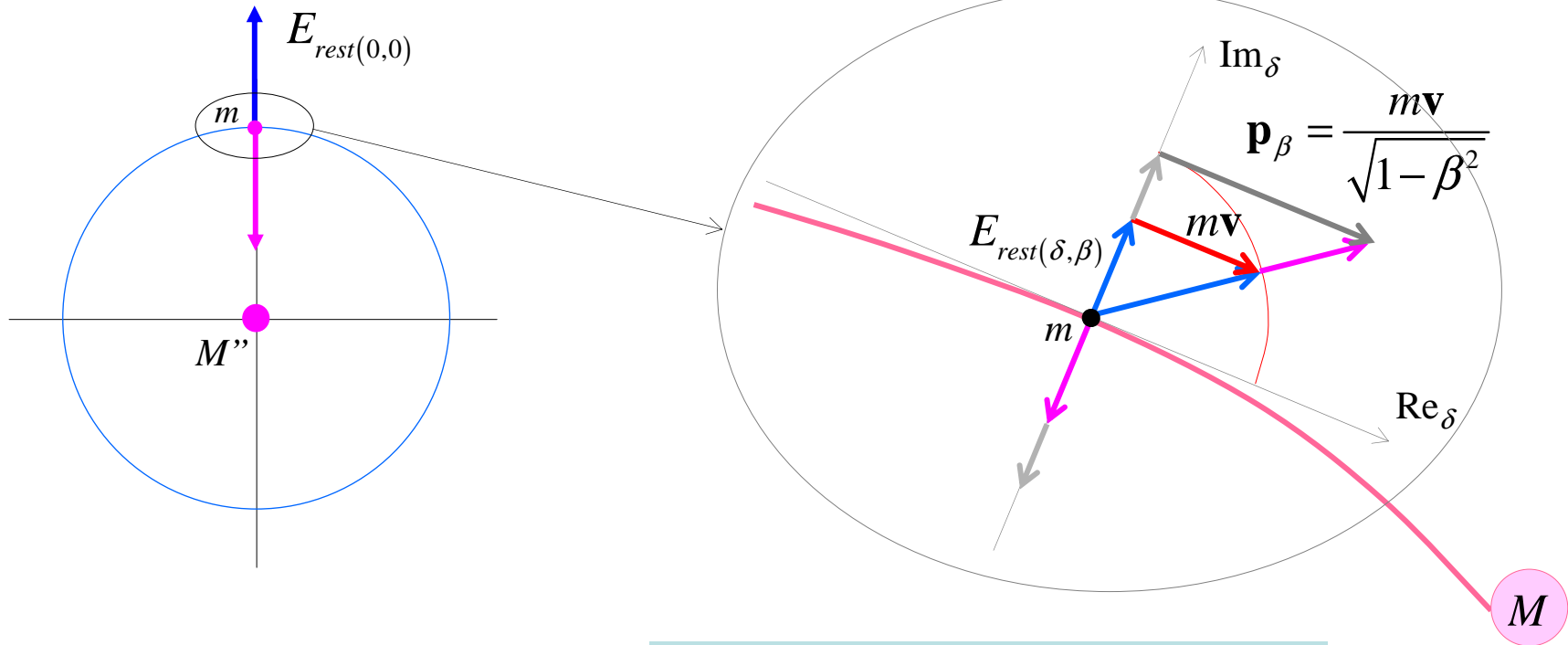
$$\beta = \frac{v}{c}$$





## Zero-energy balance in tilted space

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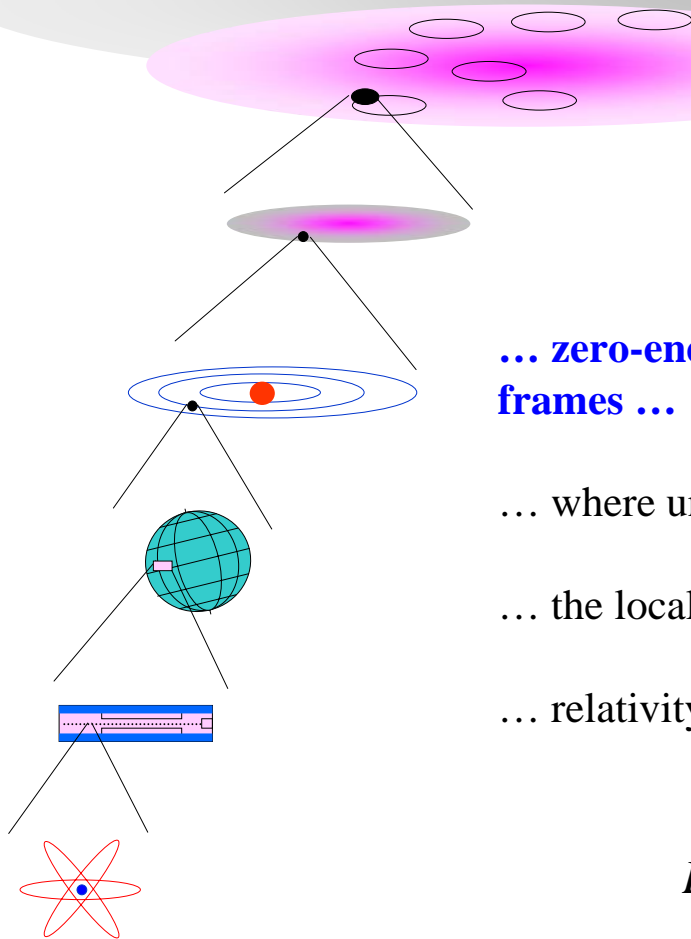


$$E_{rest(\delta,\beta)} = E_{rest(0,0)} (1-\delta) \sqrt{1-\beta^2}$$



## 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 ...

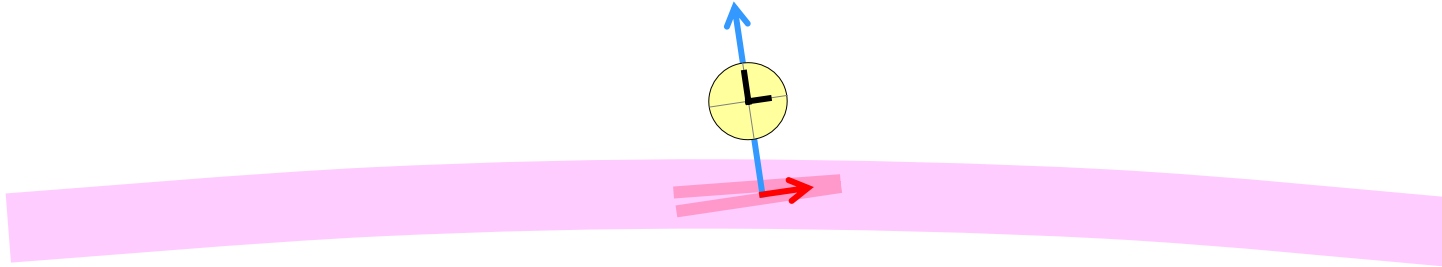
$$E_{rest} = m_0 c_0^2 \prod_{i=1}^n (1 - \delta_i) \sqrt{1 - \beta_i^2}$$



# The effect of reduced local energy on clock frequency

Zero-energy space:

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

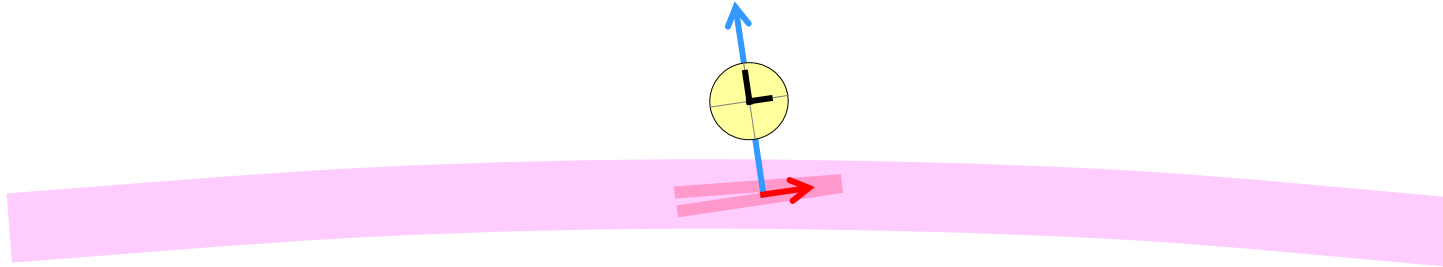




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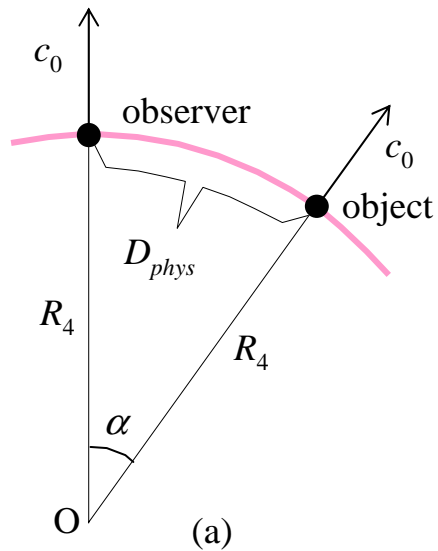
Standard model (Schwarzschild):

$$f_{\delta,\beta(GR)} = f_{0,0} \sqrt{1 - 2\delta - \beta^2}$$



## Physical distance of objects in zero-energy space

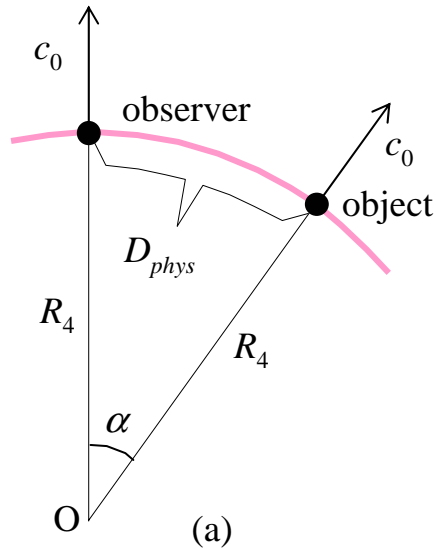
## Optical distance of objects in zero-energy space



$$D_{phys} = \alpha R_4$$

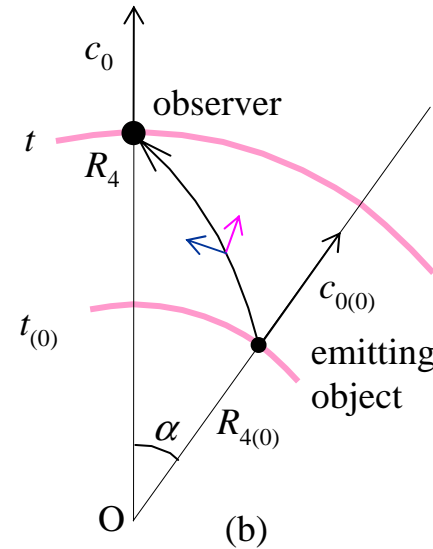


## Physical distance of objects in zero-energy space



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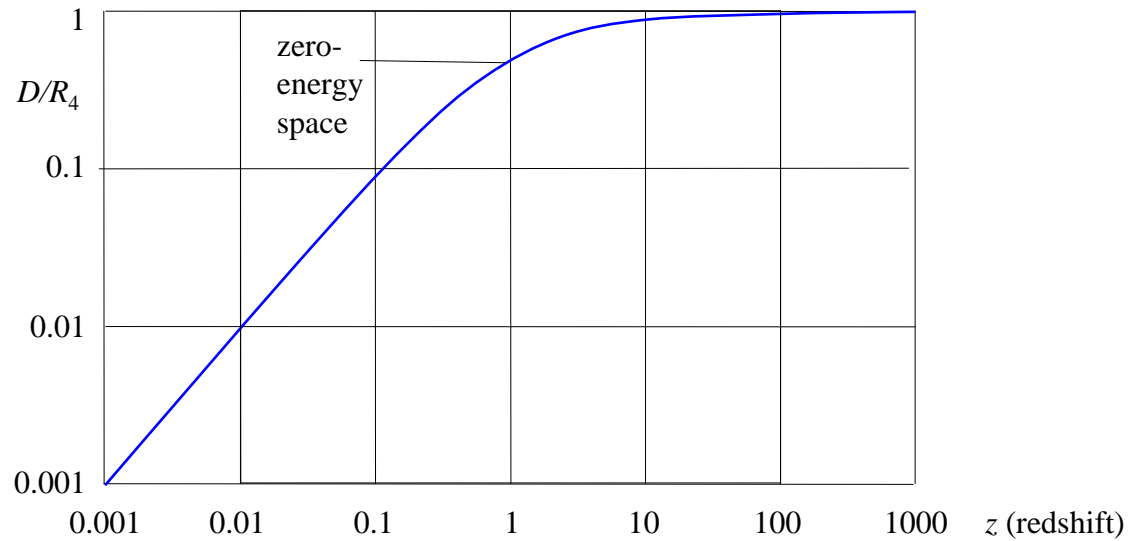
## Optical distance of objects in zero-energy space



$$D_{opt} = R_4 - R_{4(0)} = R_4 (1 - e^{-\alpha}) = R_4 \frac{z}{1+z}$$



## Optical distance in zero energy space

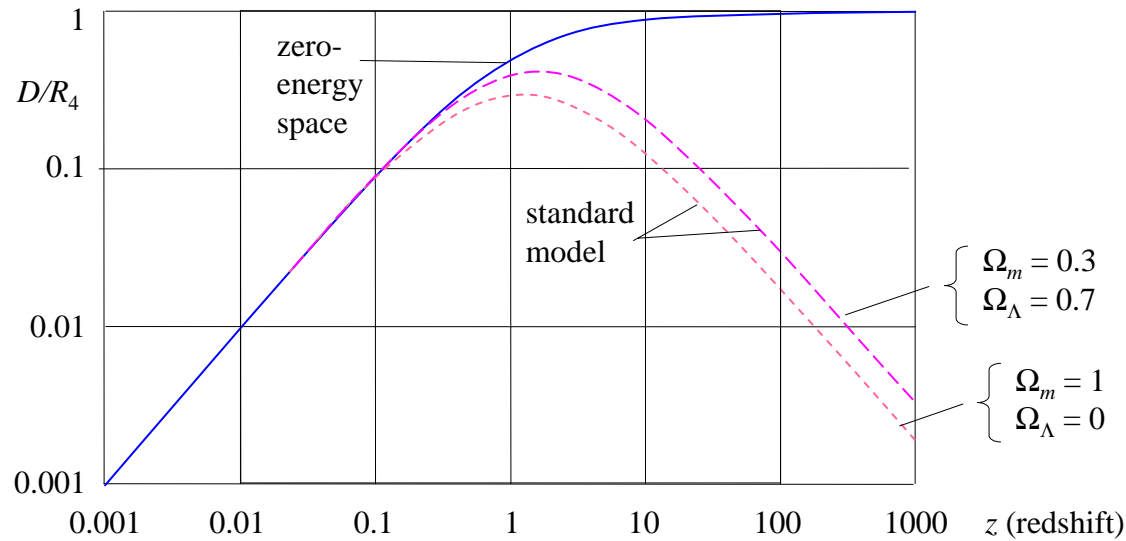


Zero-energy space:

$$D = R_4 \frac{z}{1+z}$$



## Angular size distance



Zero-energy space:

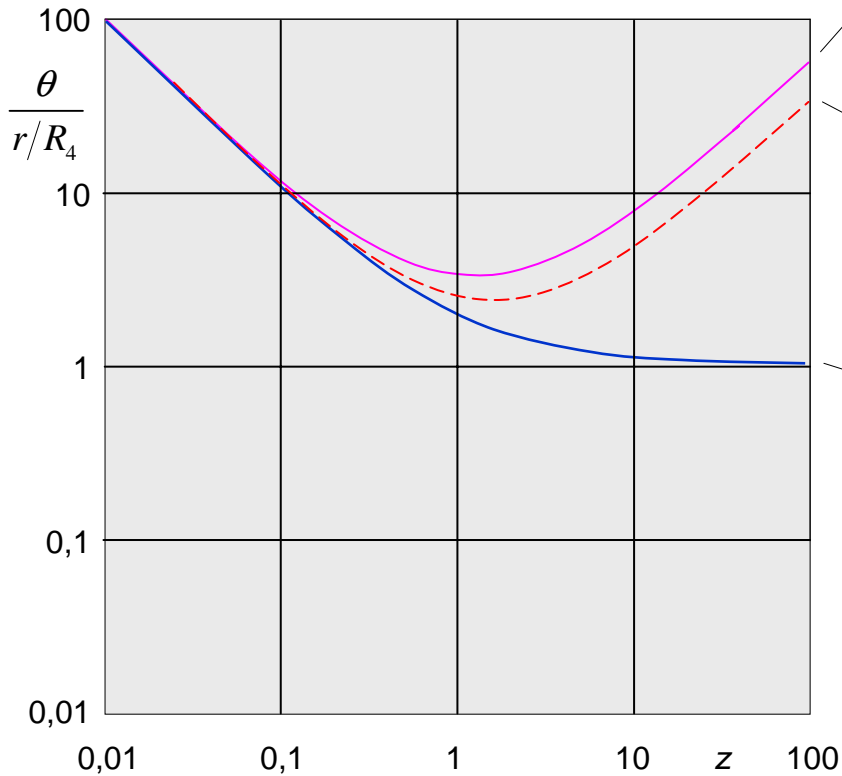
$$D = R_4 \frac{z}{1+z}$$

Standard model:

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



## Angular size of standard rod



**Standard model:**

$$\begin{cases} \Omega_m = 1 \\ \Omega_\Lambda = 0 \end{cases}$$

$$\begin{cases} \Omega_m = 0.3 \\ \Omega_\Lambda = 0.7 \end{cases}$$

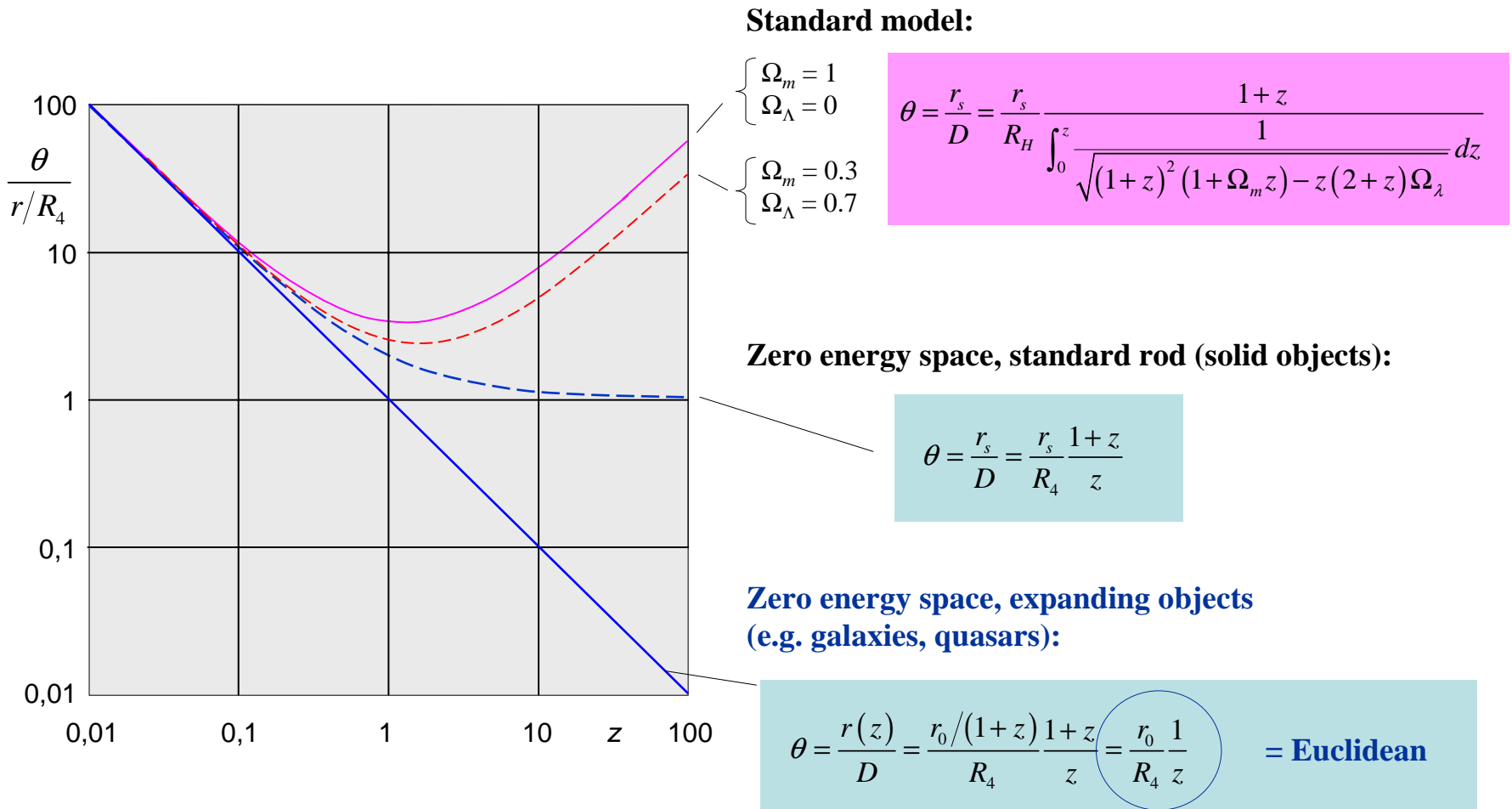
$$\theta = \frac{r_s}{D} = \frac{r_s}{R_H} \frac{1+z}{\int_0^z \frac{1}{\sqrt{(1+z)^2 (1+\Omega_m z) - z(2+z)\Omega_\Lambda}} dz}$$

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

$$\theta = \frac{r_s}{D} = \frac{r_s}{R_4} \frac{1+z}{z}$$

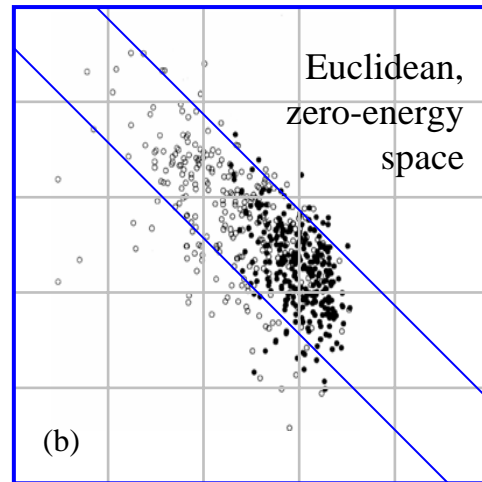
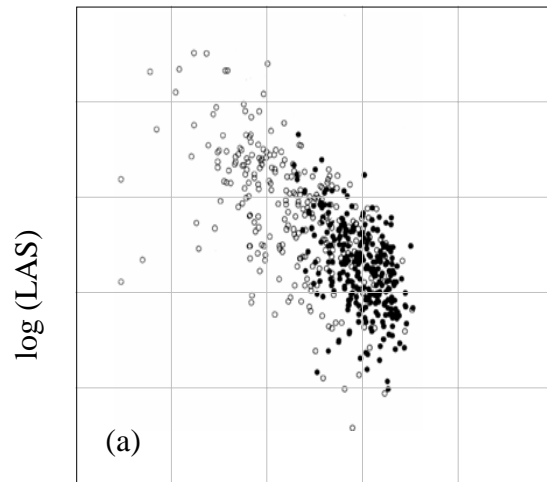


## Angular size of standard rod & galaxies and quasars





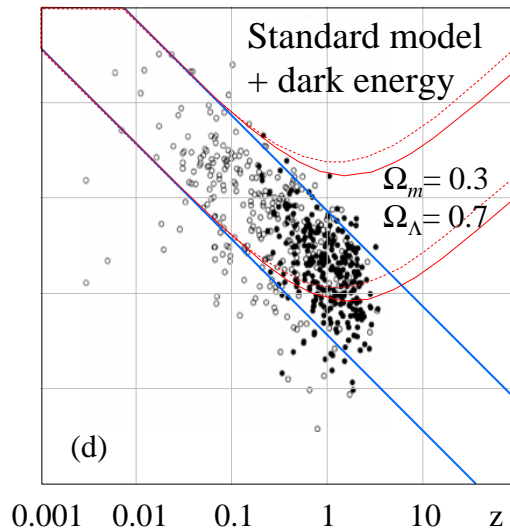
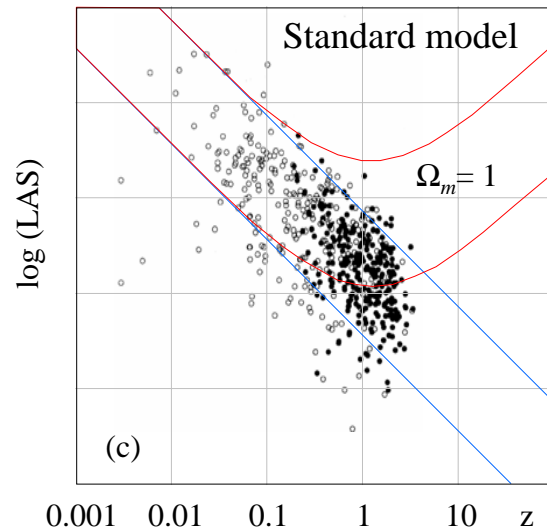
# Angular size of galaxies and quasars



Zero-energy space:  
complete agreement with  
observations

$$\theta = \frac{r_0}{R_4} \frac{1}{z}$$

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



Collection of data:  
K. Nilsson *et al.*,  
*Astrophys. J.*, **413**, 453 (1993)

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):

$$\frac{F_D}{F_{d_0}} = \left( \frac{d_{L(z=0)}}{D_L} \right)^2$$



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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):

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

Zero energy space (bolometric):

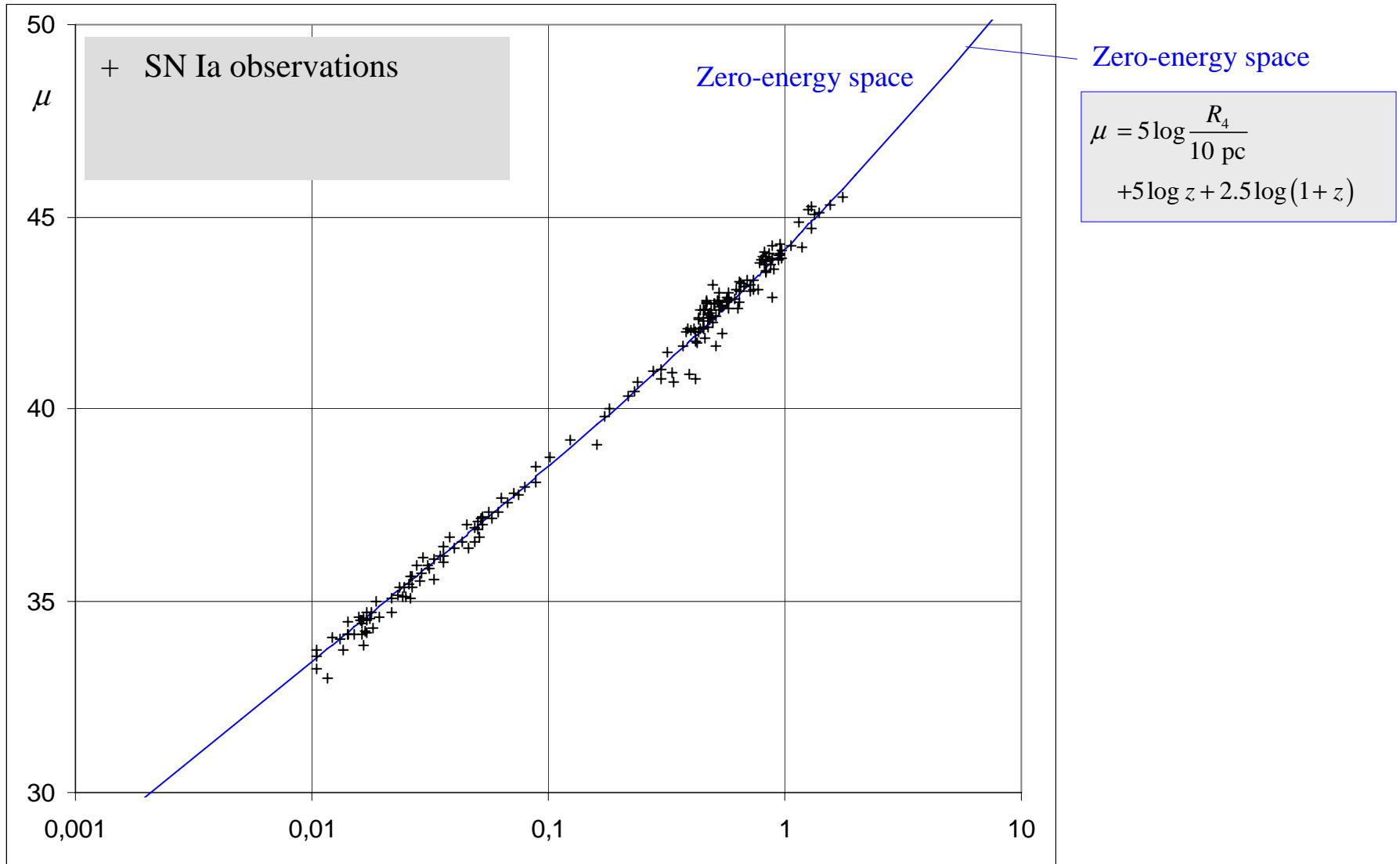
$$\frac{F_D}{F_{d_0}} = \left( \frac{d_{(z \approx 0)}}{D} \right)^2 \frac{1}{1+z} = \frac{d_{(z \approx 0)}^2}{R_H^2} \frac{(1+z)}{z^2}$$

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

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

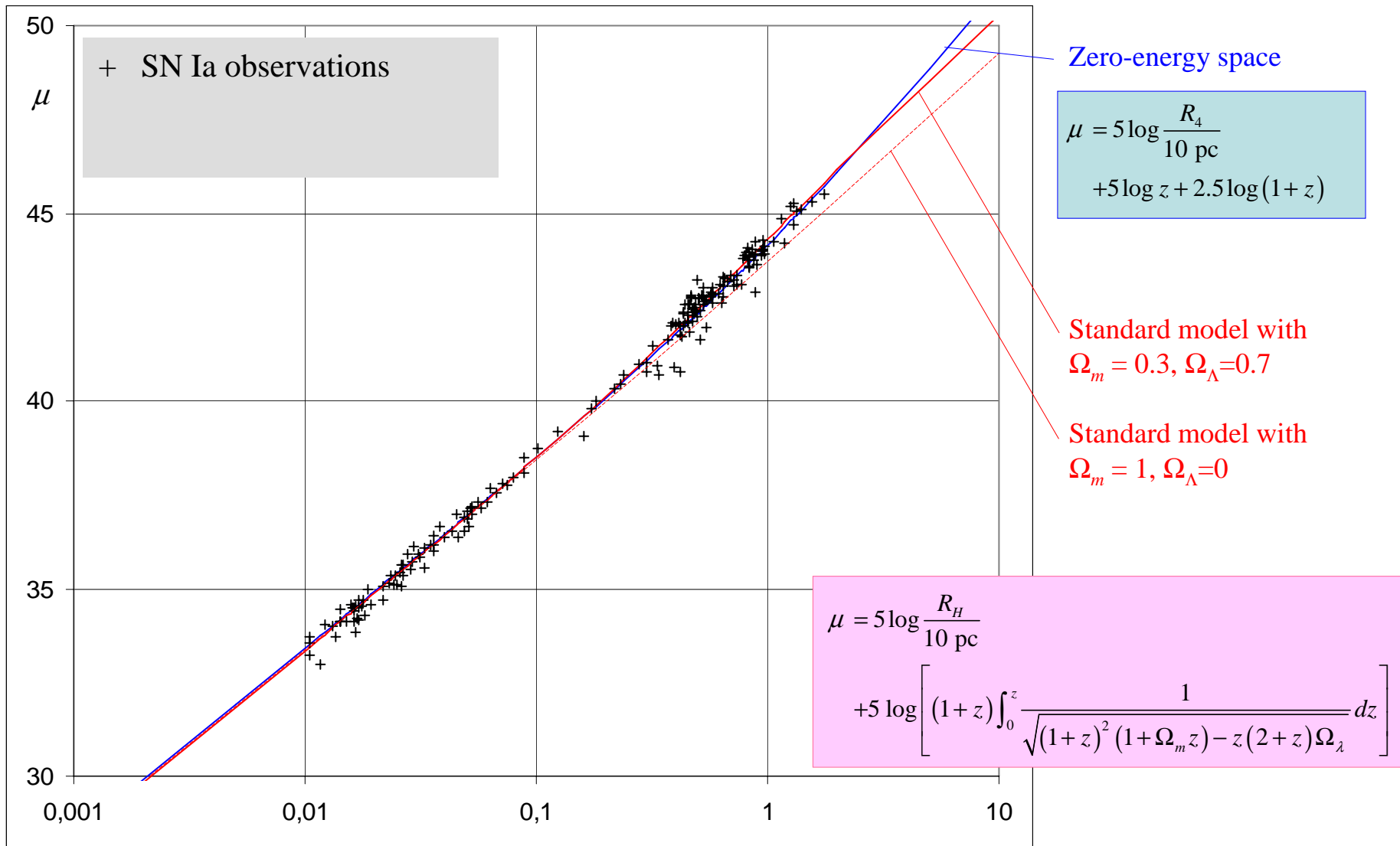


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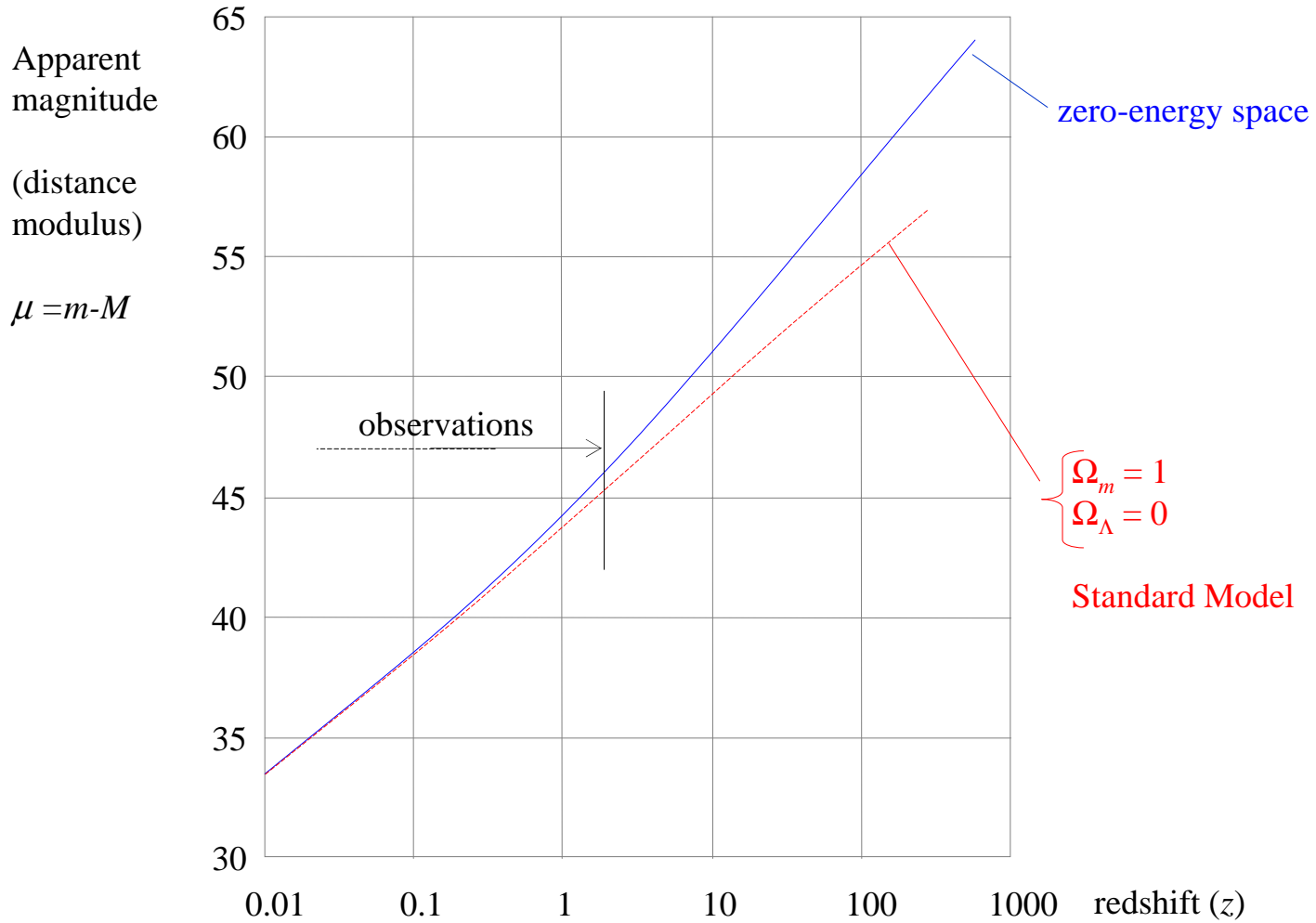


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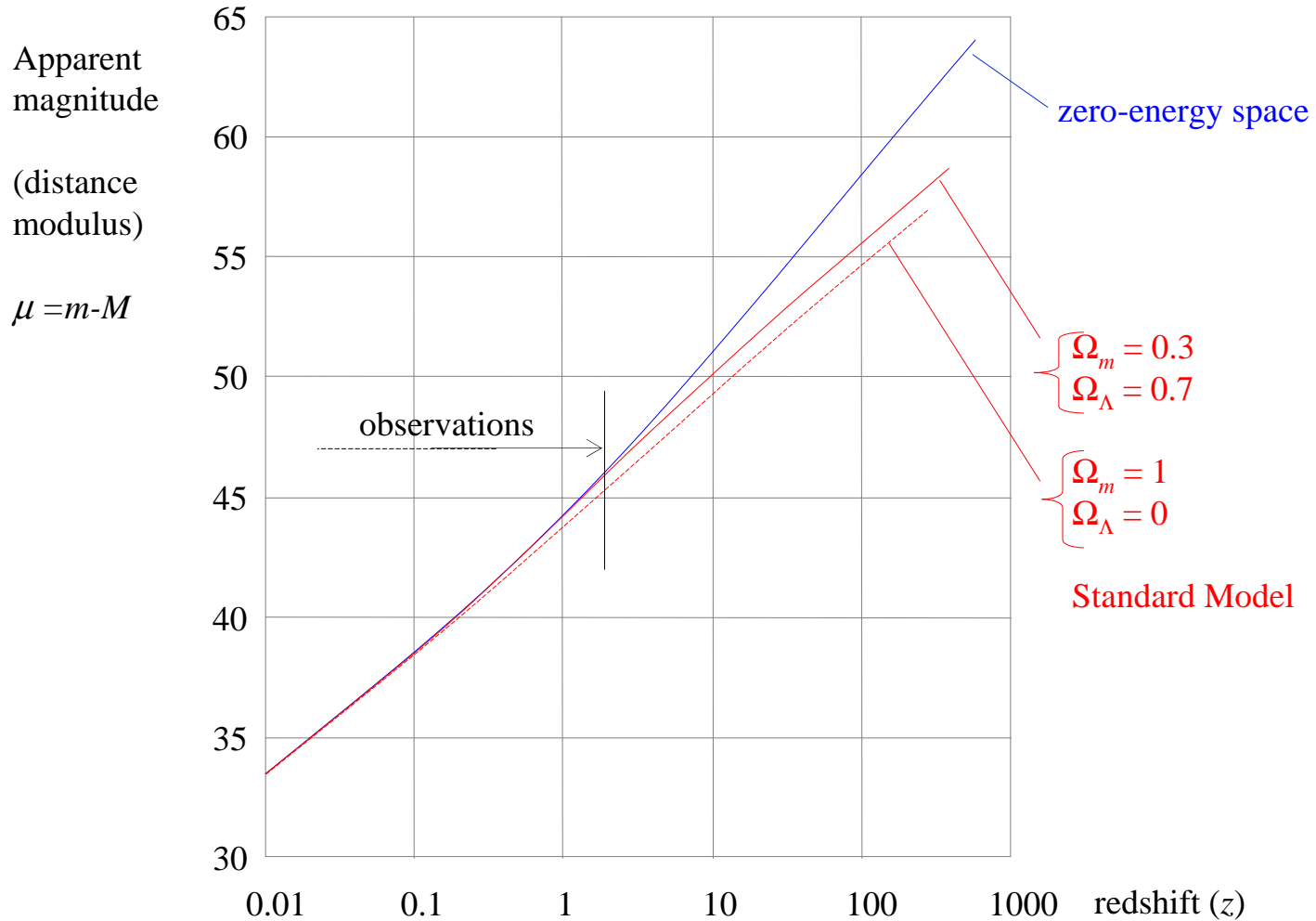


# Magnitude versus redshift



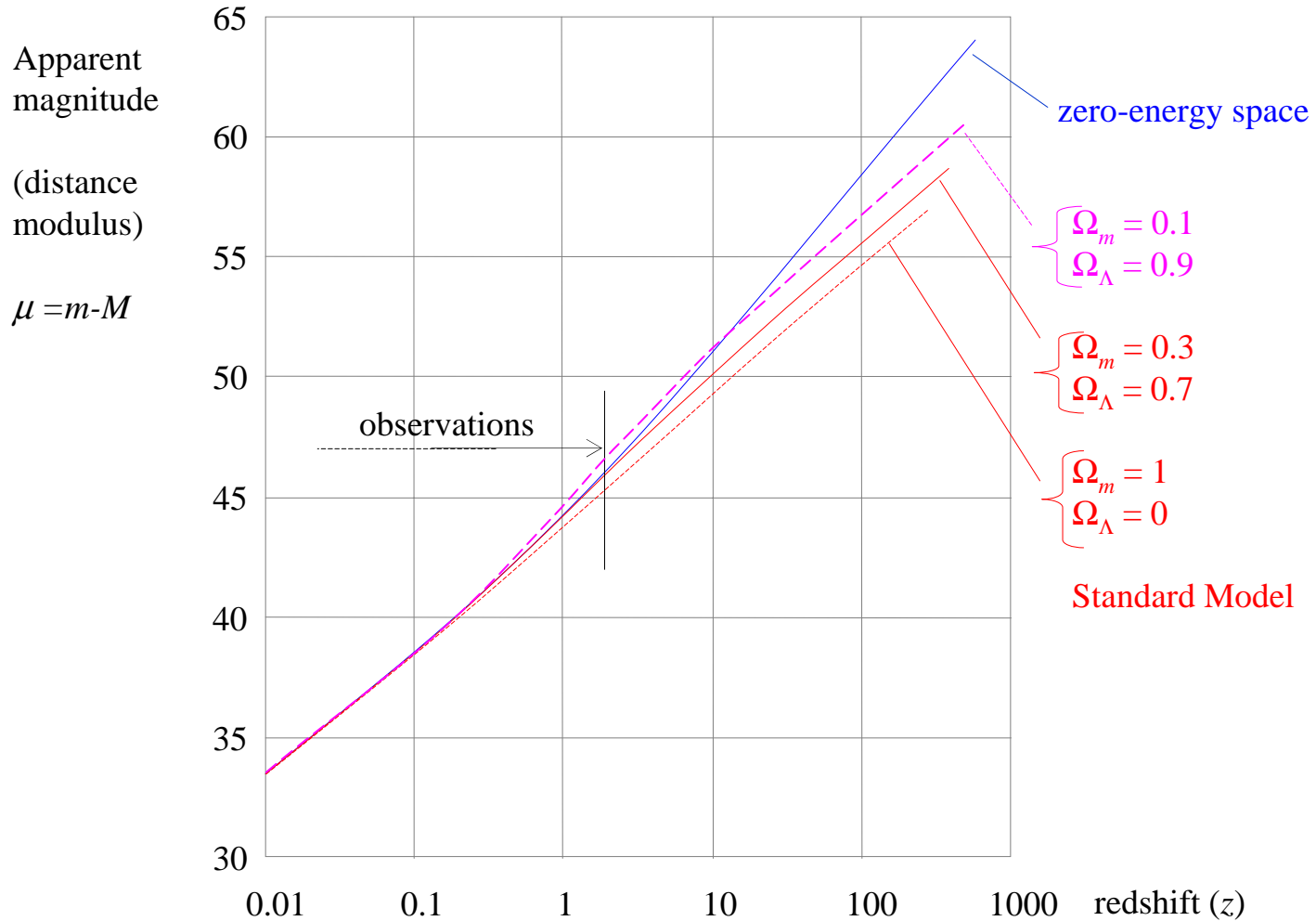


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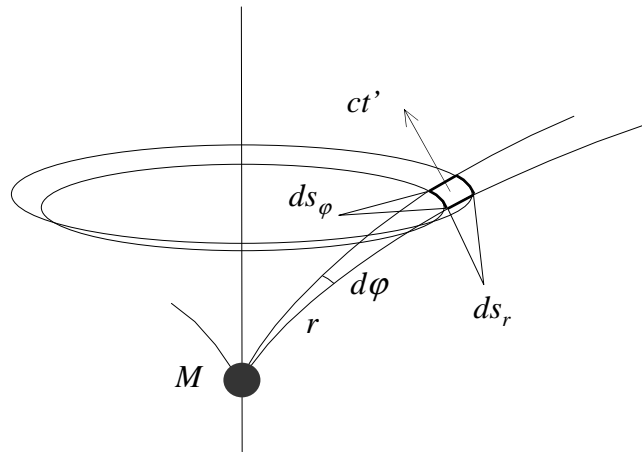


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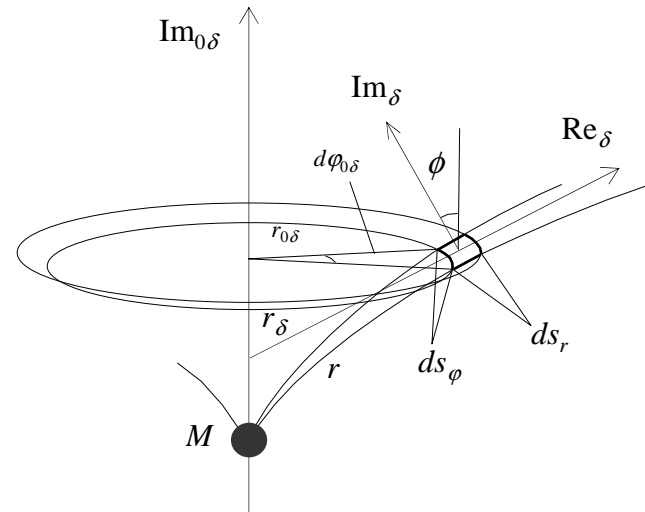




# Local geometry of space



**Schwarzschild  
space-time metric**

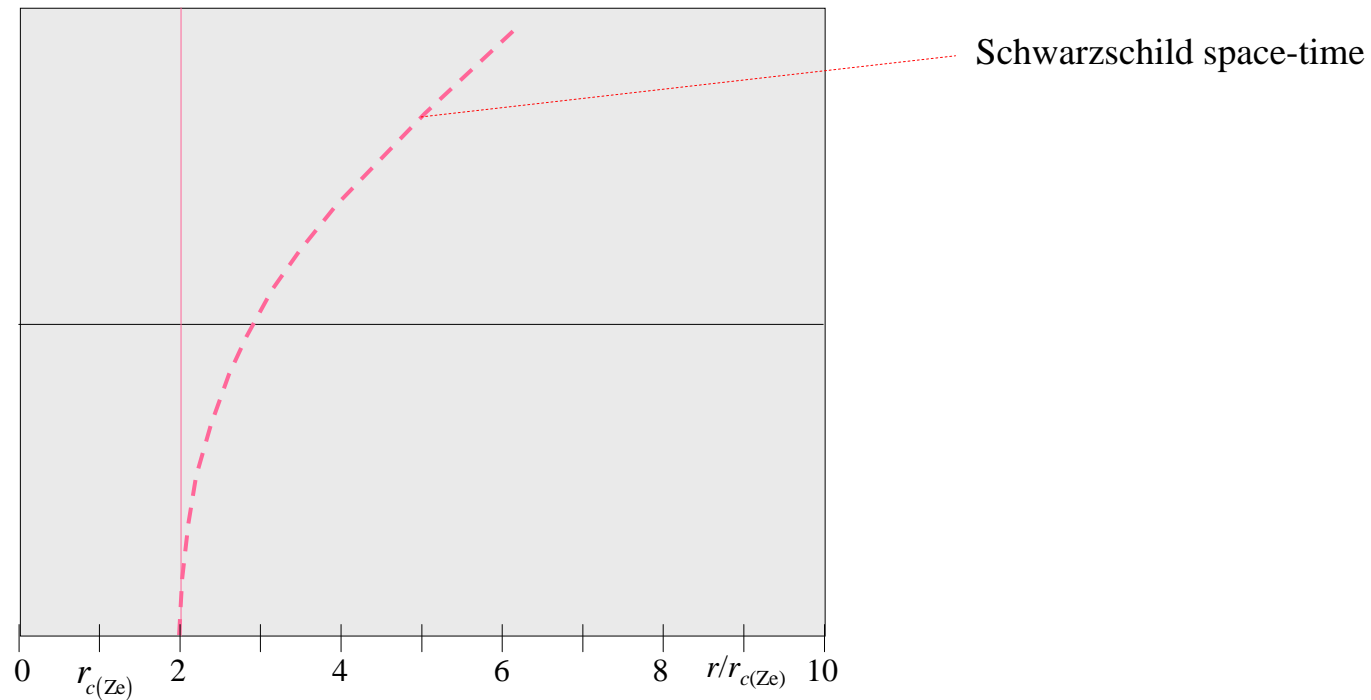


**Zero-energy  
space geometry**



## Space geometry at local singularity

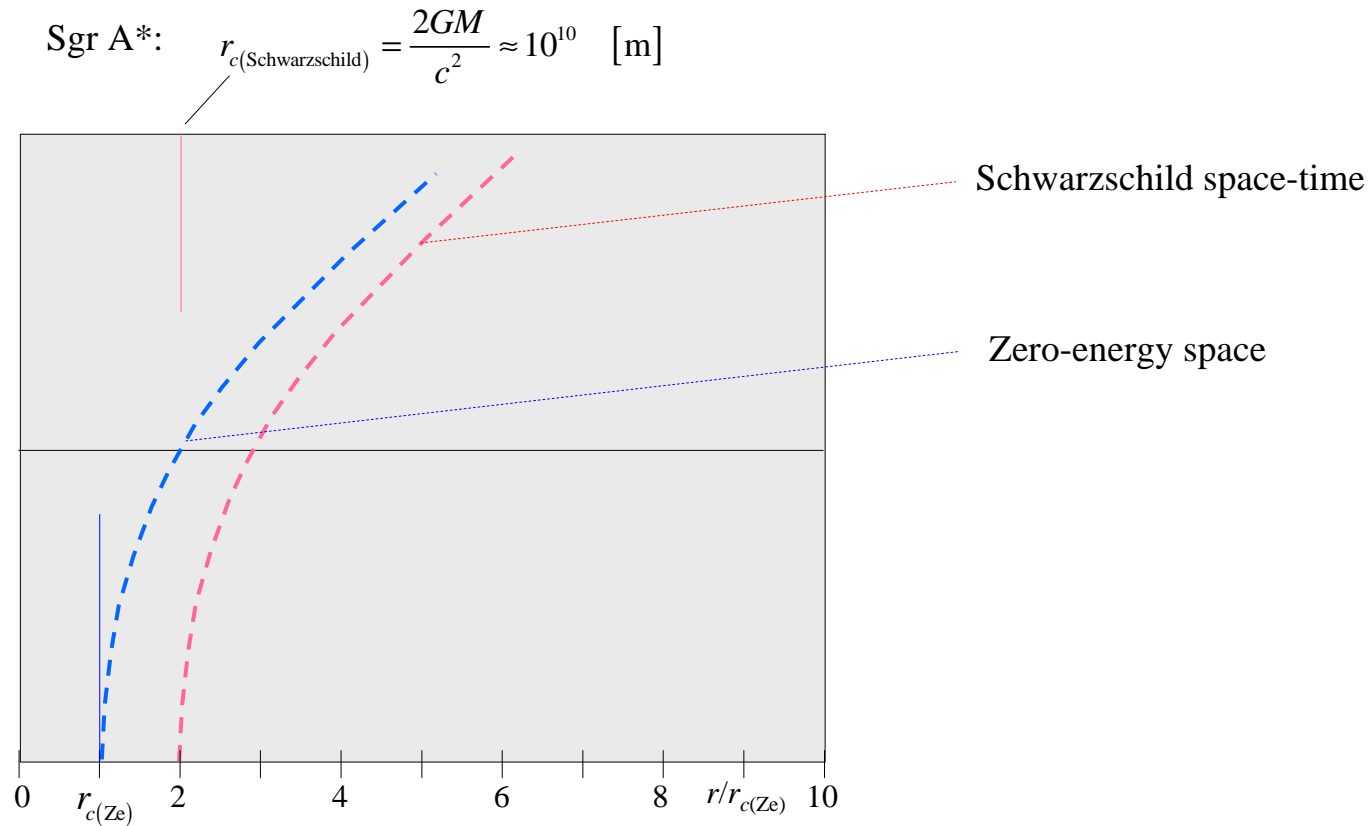
Sgr A\*:  
 $r_{c(\text{Schwarzschild})} = \frac{2GM}{c^2} \approx 10^{10} \text{ [m]}$



Sgr A\*:  
 $r_{c(Ze)} = \frac{GM}{c_0^2} = 5 \cdot 10^9 \text{ [m]}$



## Space geometry at local singularity



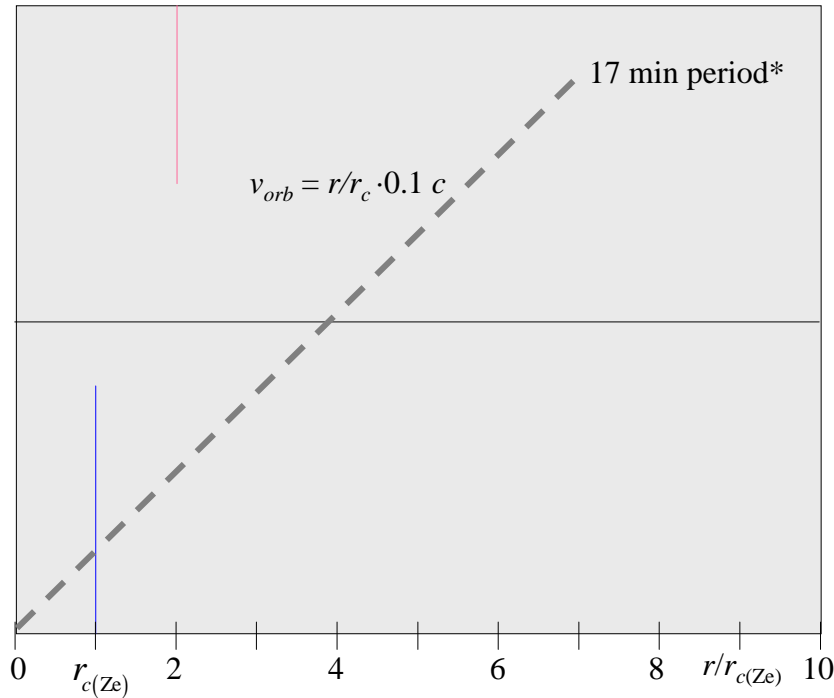
Sgr A\*:  
 $r_{c(\text{Ze})} = \frac{GM}{c_0^2} = 5 \cdot 10^9 \text{ [m]}$



# Observed periodic emission at Sgr A\*

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

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

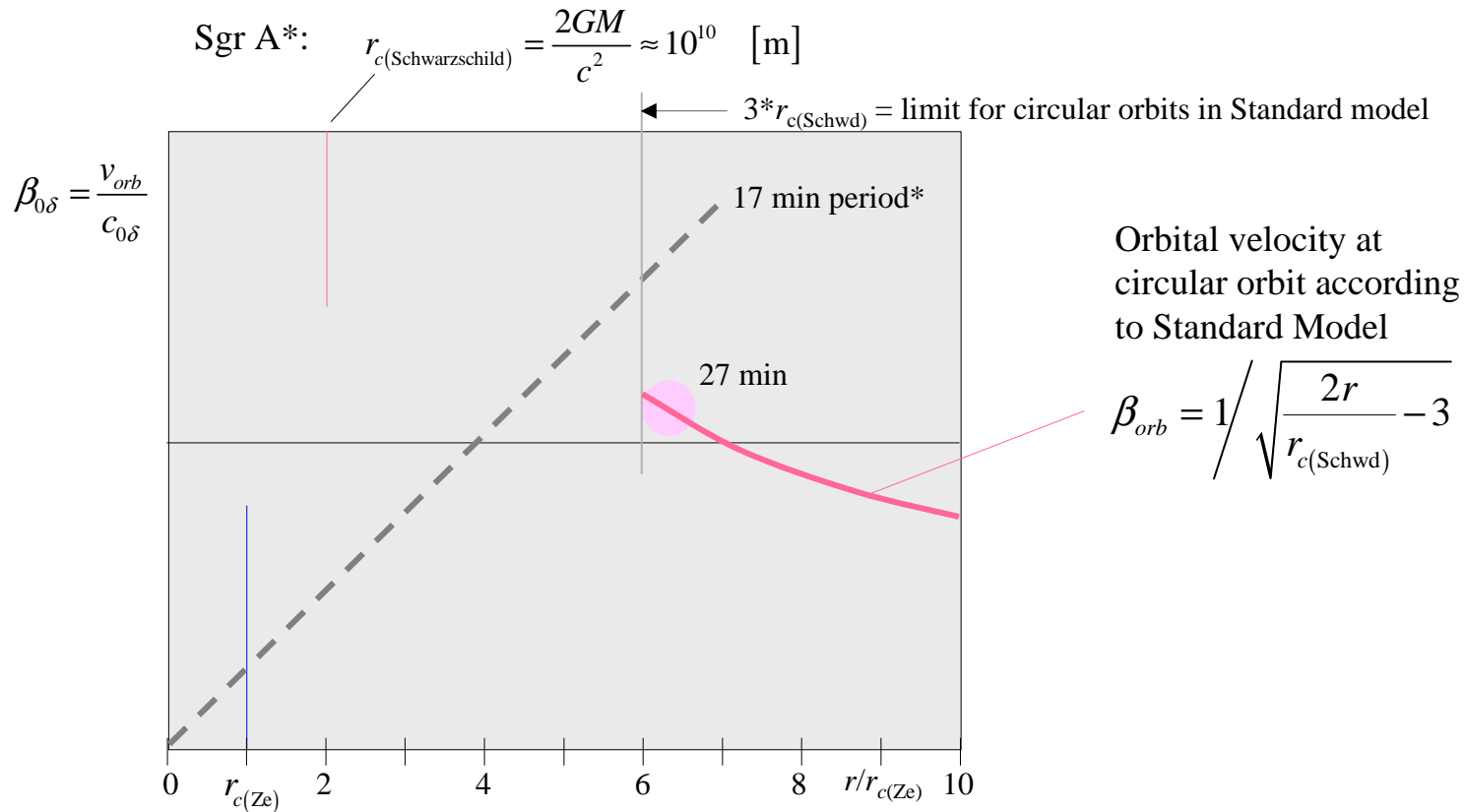


Sgr A\*:  $r_{c(Ze)} = \frac{GM}{c_0^2} = 5 \cdot 10^9 \text{ [m]}$

\*Observed 17 min rotation period at Milky Way Center, Sgr A\* [R. Genzel, *et al.*, Nature 425, 934 (2003) ]



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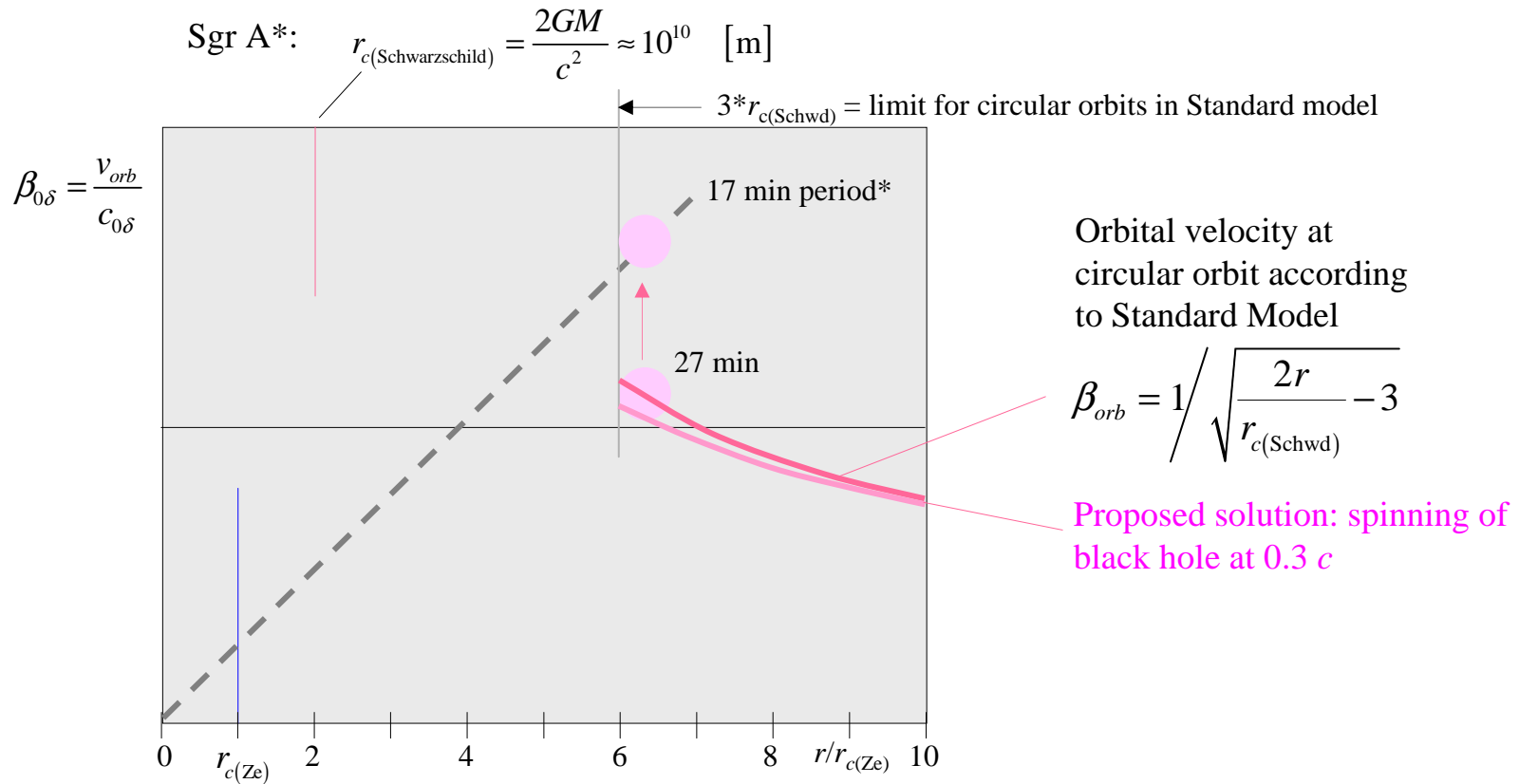


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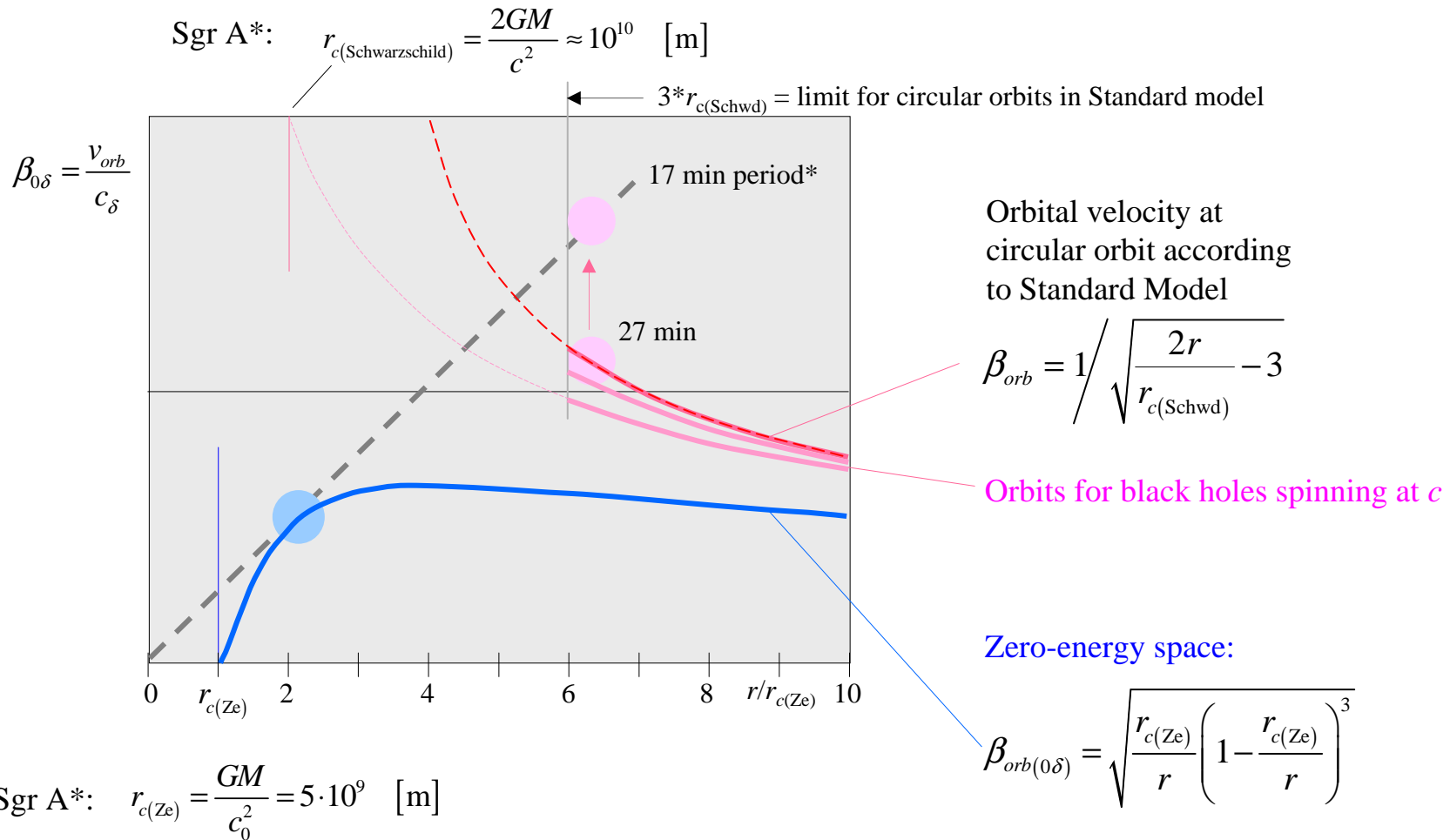
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\*Observed 17 min rotation period at Milky Way Center, Sgr A\* [R. Genzel, *et al.*, Nature 425, 934 (2003) ]



## Conclusions ...

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**... 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**

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



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**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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