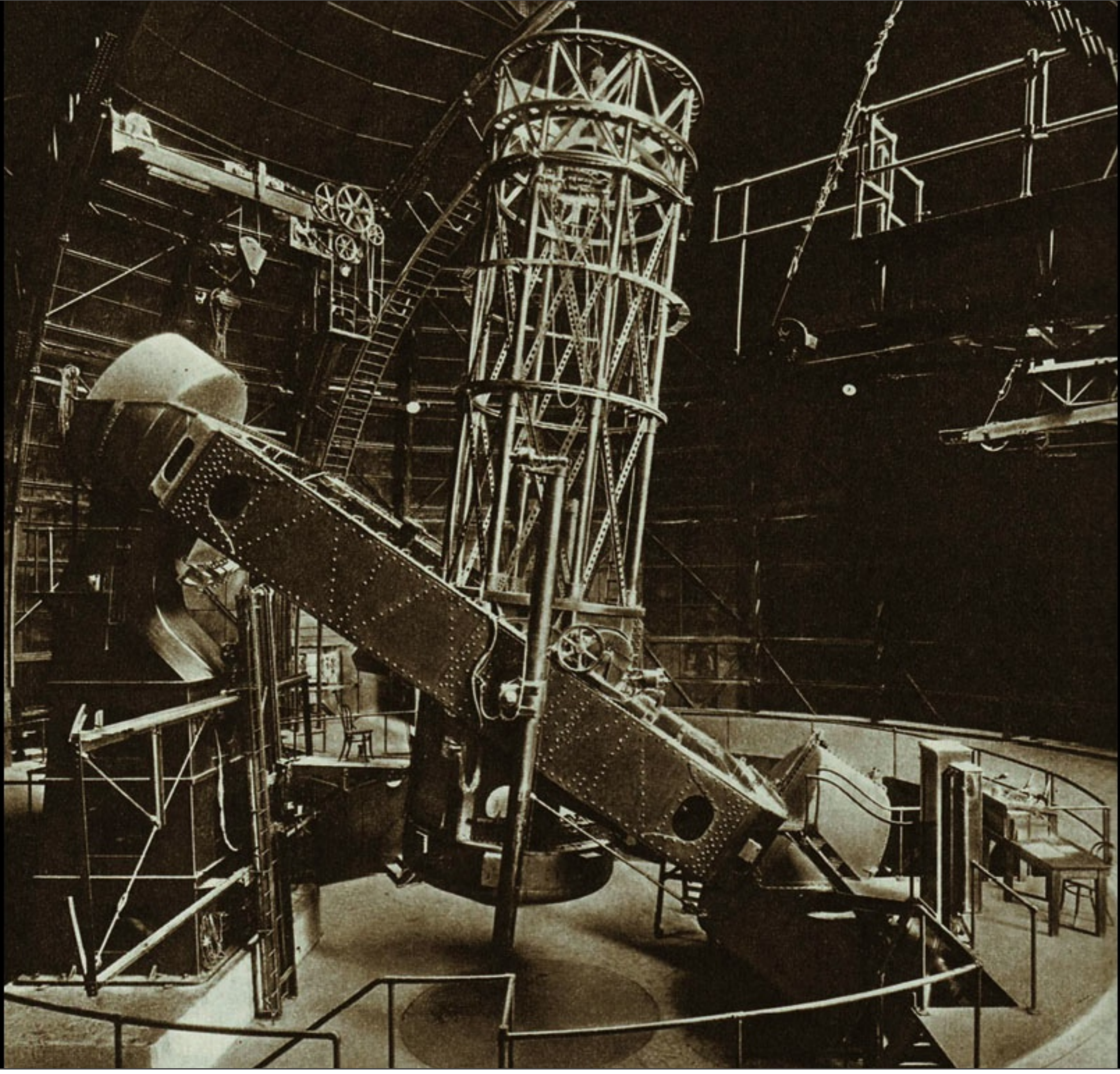
"Dark Energy" and "Dark Matter" in Friedmann Universes

Understanding modern puzzles
with physics from the 1920's

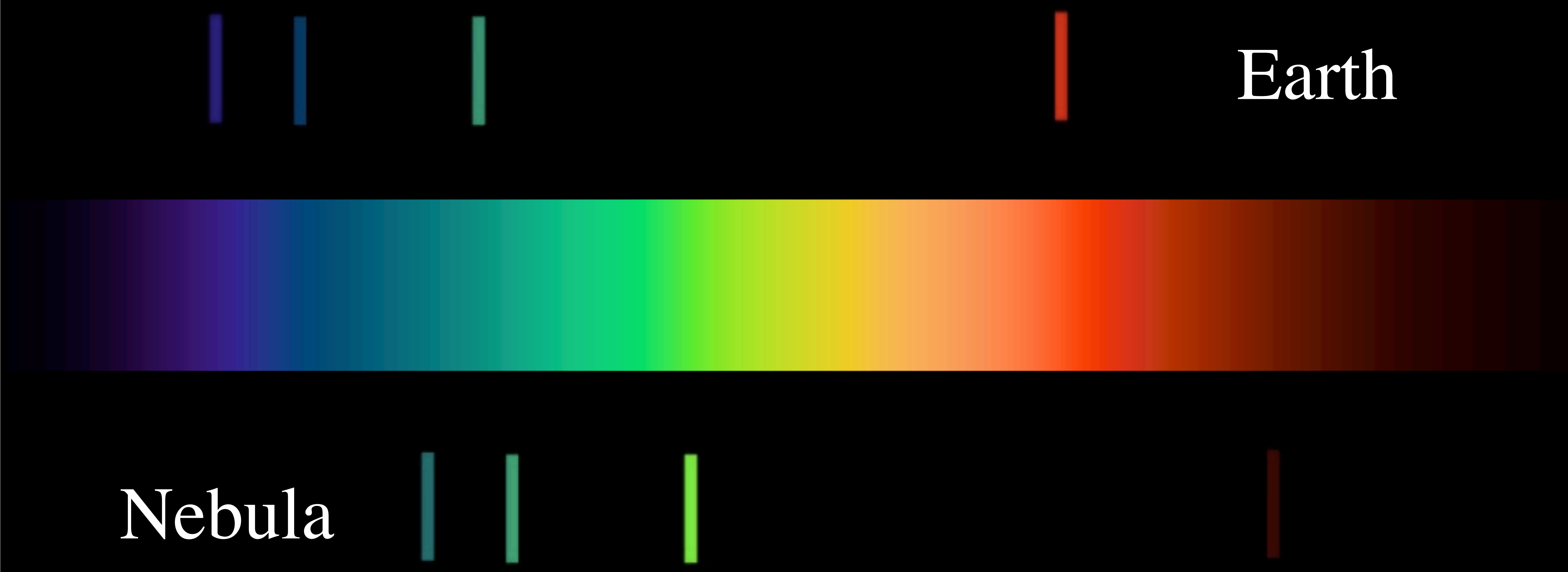
William Q. Sumner

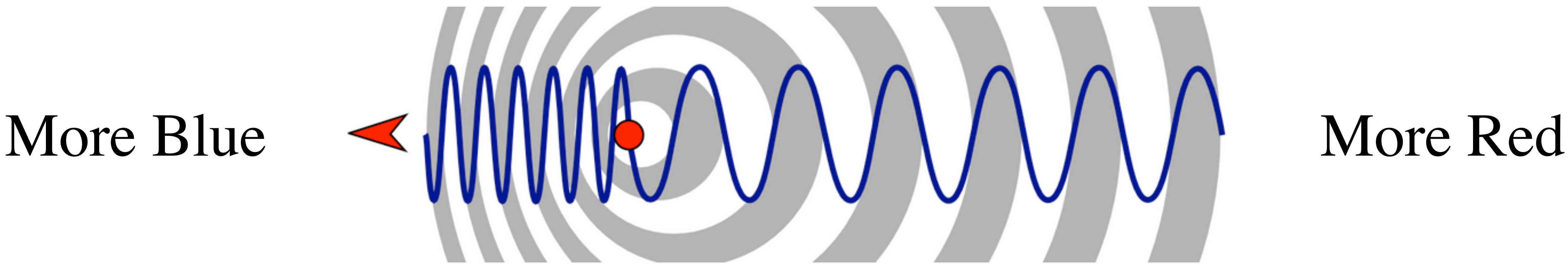
January 16, 2012

St. Petersburg, Russia




Edwin
Hubble


Earth
Nebula



Hubble redshifts were explained as Doppler shifts caused by nebular velocities away from the earth.

A RELATION BETWEEN DISTANCE AND RADIAL VELOCITY AMONG EXTRA-GALACTIC NEBULAE

BY EDWIN HUBBLE

MOUNT WILSON OBSERVATORY, CARNEGIE INSTITUTION OF WASHINGTON

Communicated January 17, 1929

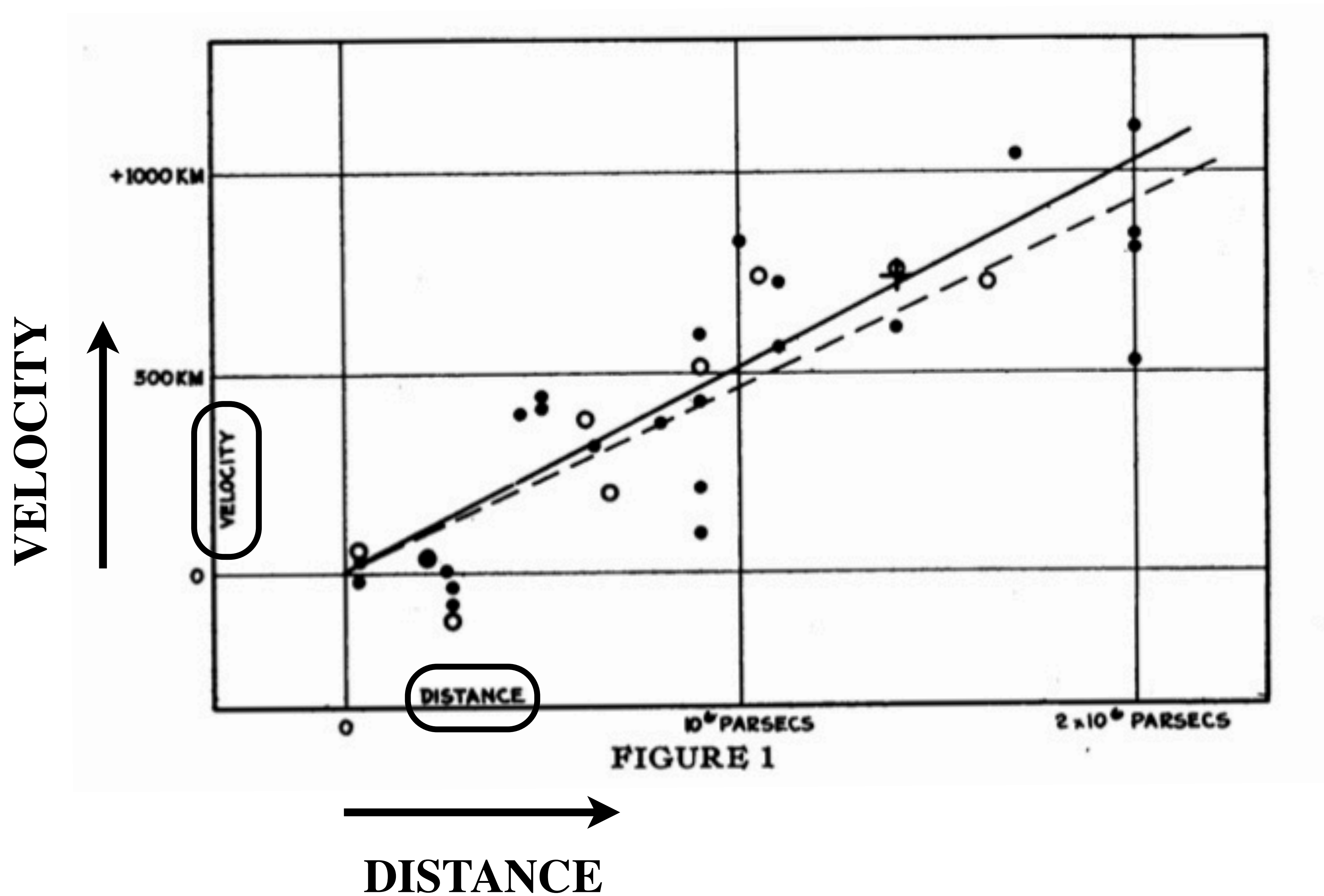
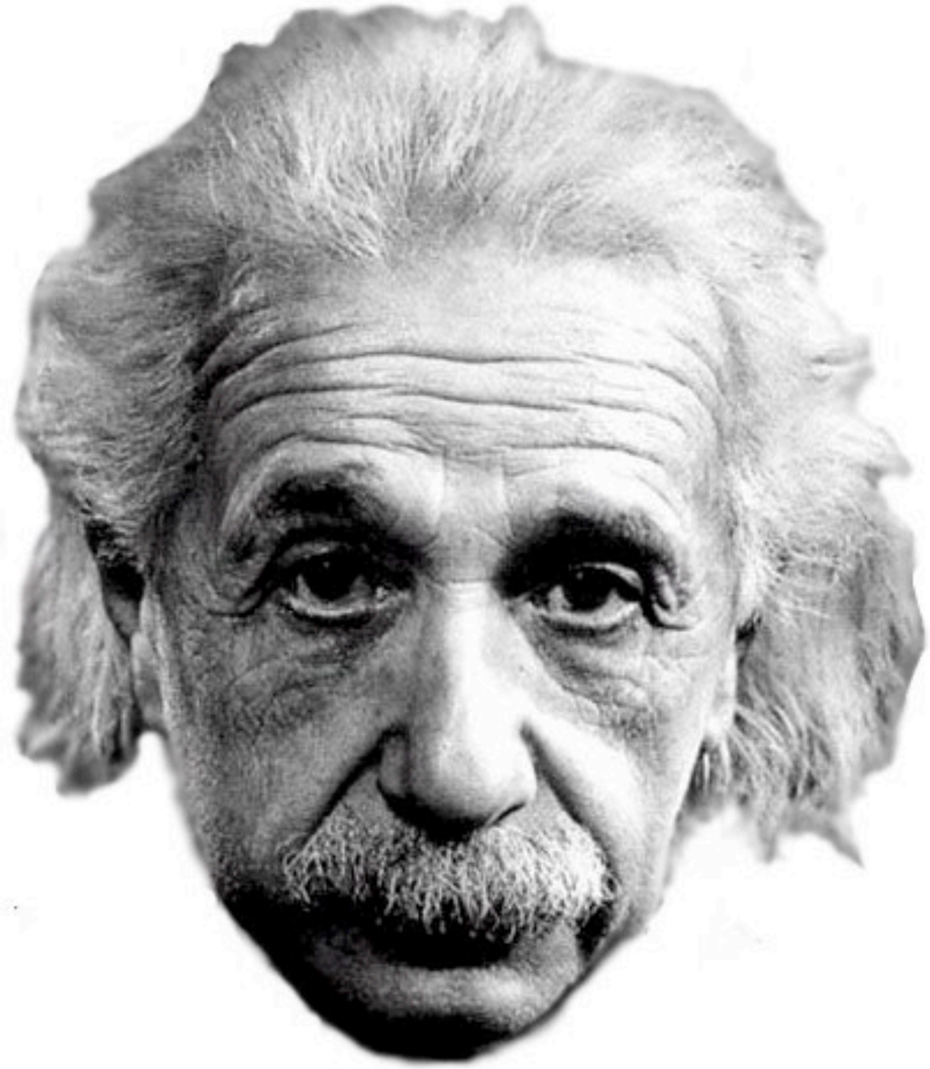


FIGURE 1



Albert Einstein

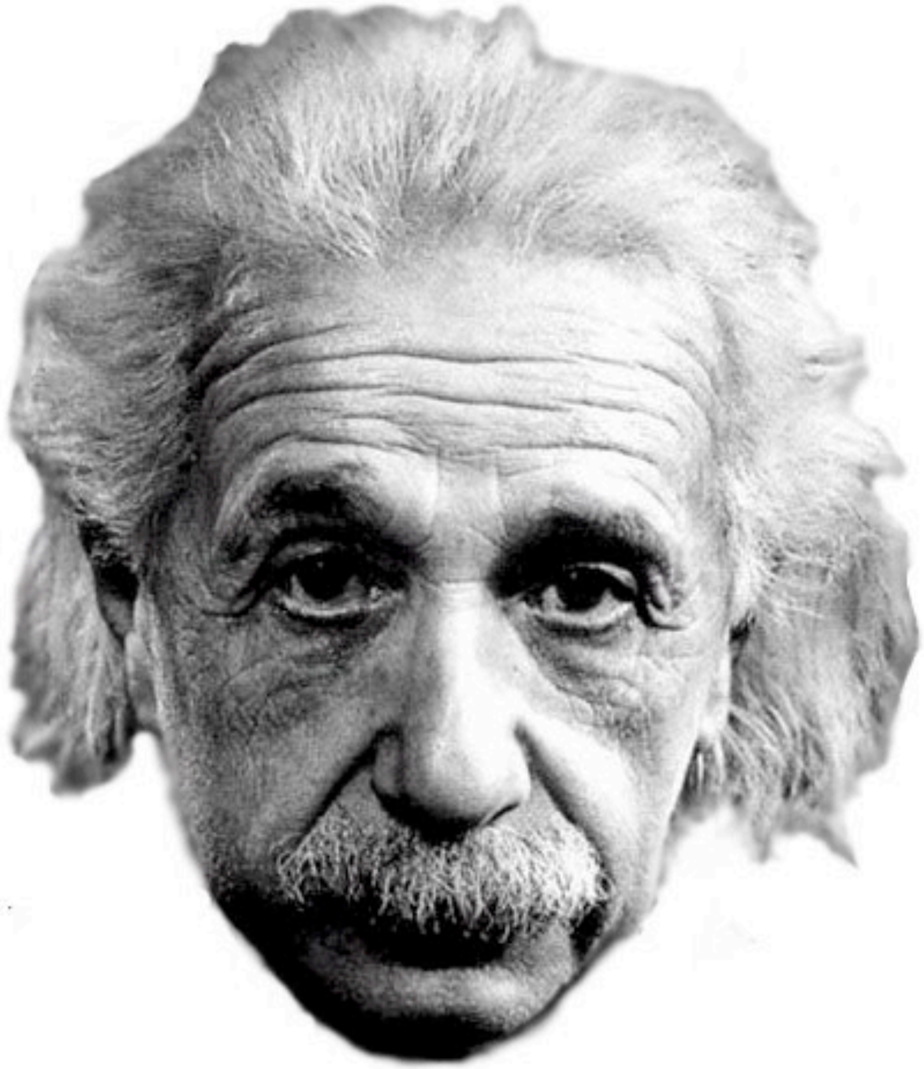
1916. №7.

ANNALEN DER PHYSIK.

VIERTE FOLGE. BAND 49.

1. *Die Grundlage der allgemeinen Relativitätstheorie;*

von A. Einstein.



$$G^{\alpha\beta} = 8\pi \, T^{\alpha\beta}$$

Alexandr Friedmann

Über die Krümmung des Raumes.

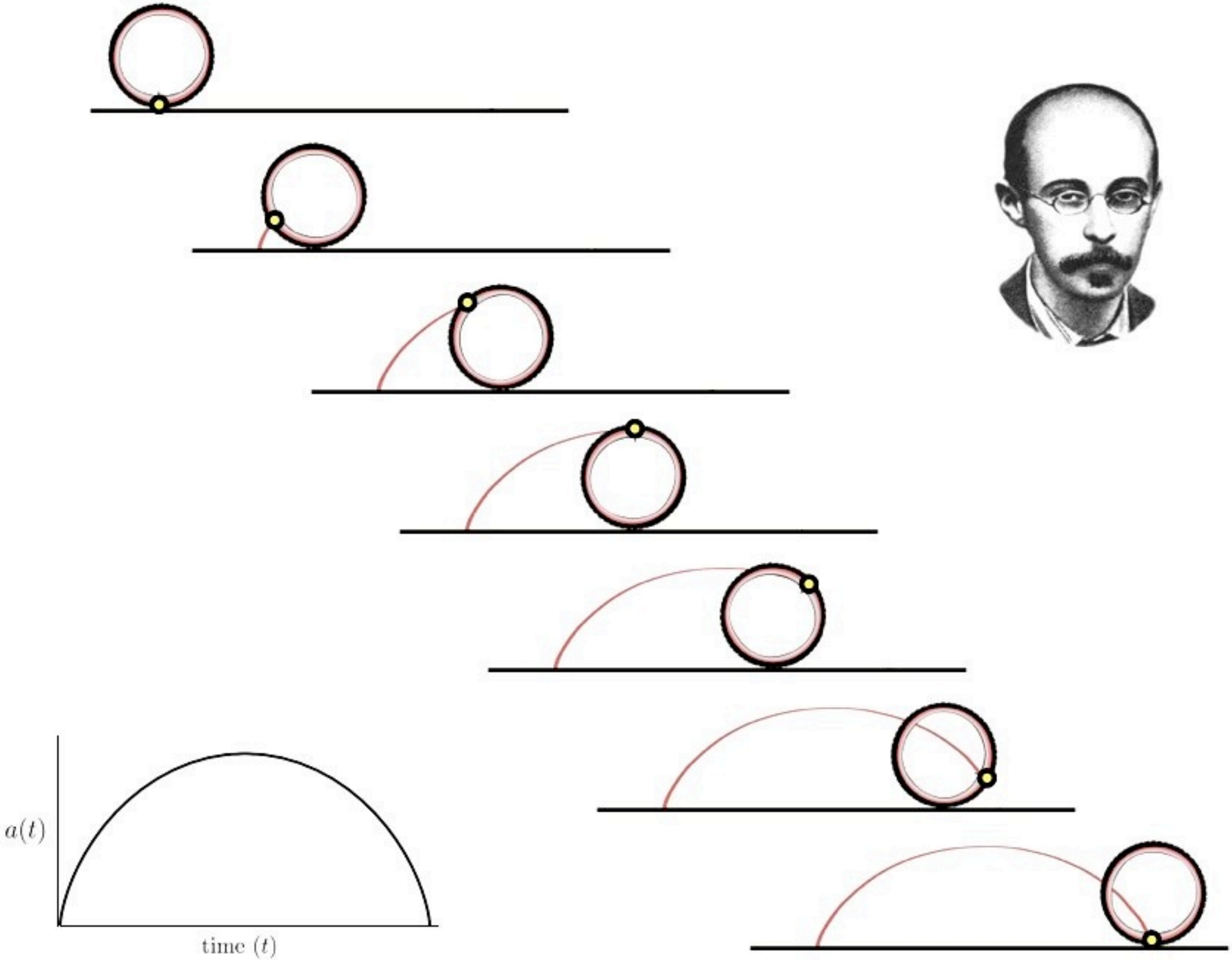
Von **A. Friedman** in Petersburg.

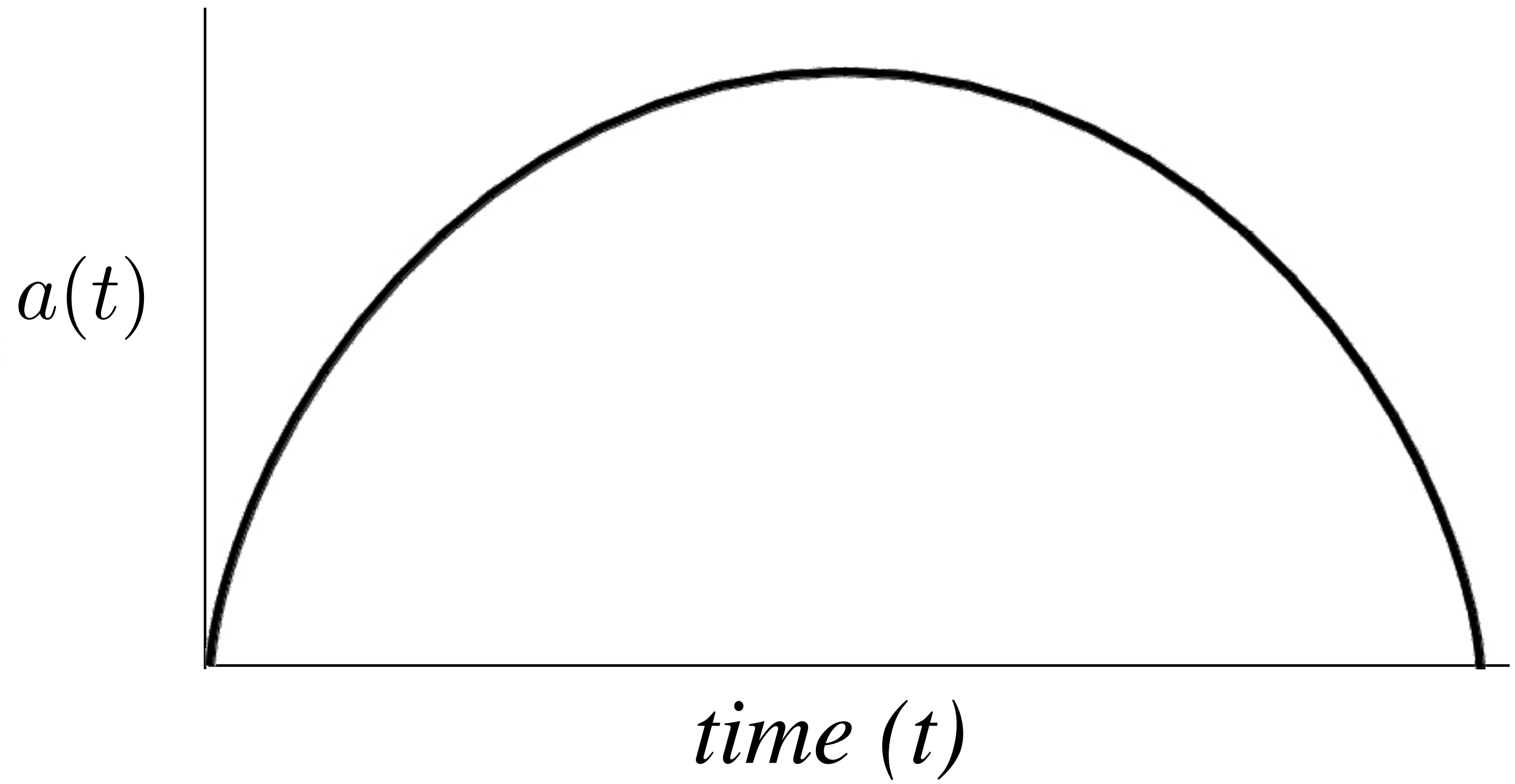
Mit einer Abbildung. (Eingegangen am 29. Juni 1922.)

$$G^{\alpha\beta} = 8\pi\, T^{\alpha\beta}$$

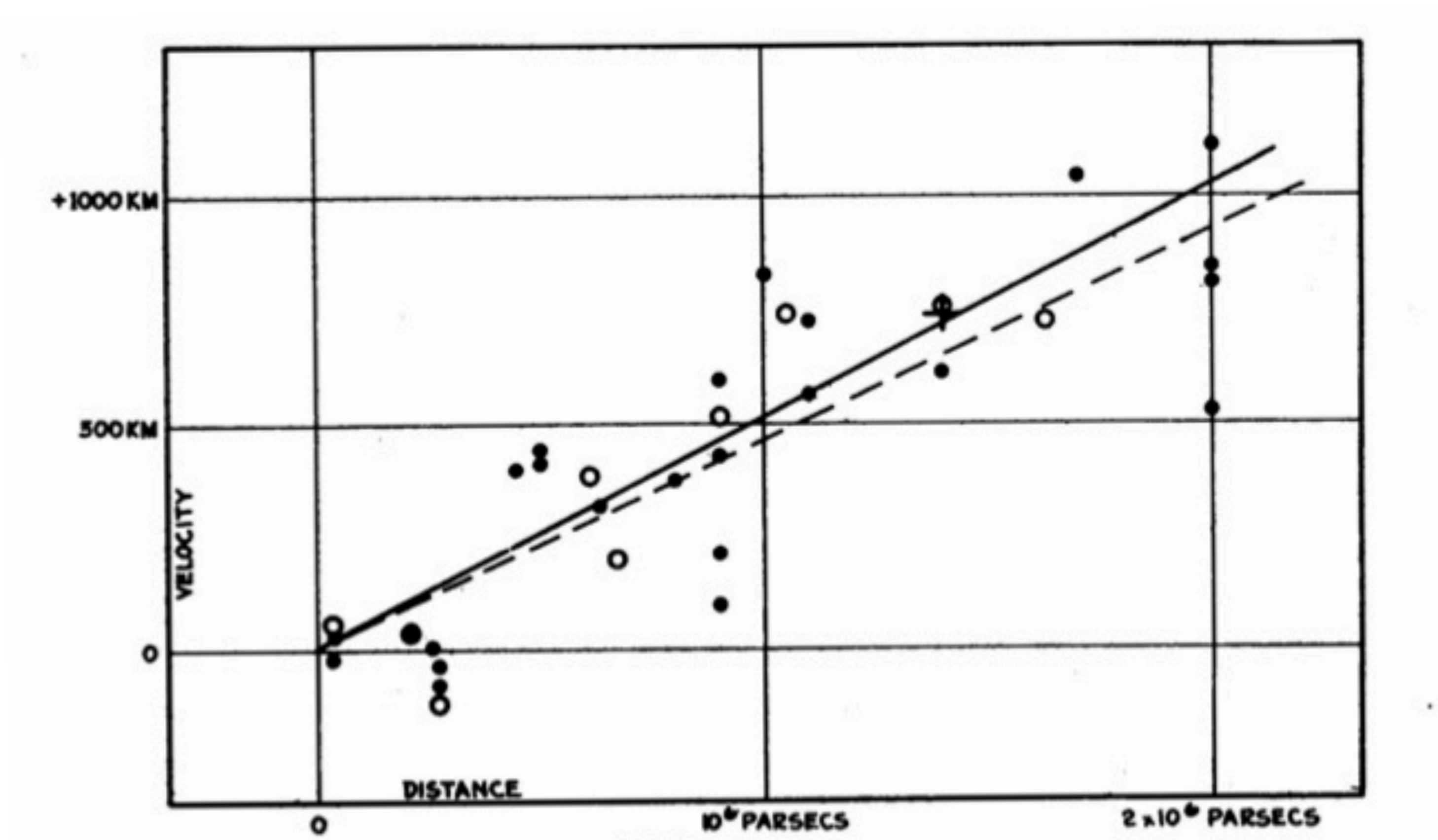
Isotropic & homogeneous
"dust"

$$ds^2 \;=\; c^2dt^2 \;-\; a^2(t)\left[\frac{dr^2}{(1-r^2)} + r^2\left(d\vartheta^2 \;+\; sin^2\vartheta\, d\varphi^2\right)\right]$$


$a(t)$
time (t)

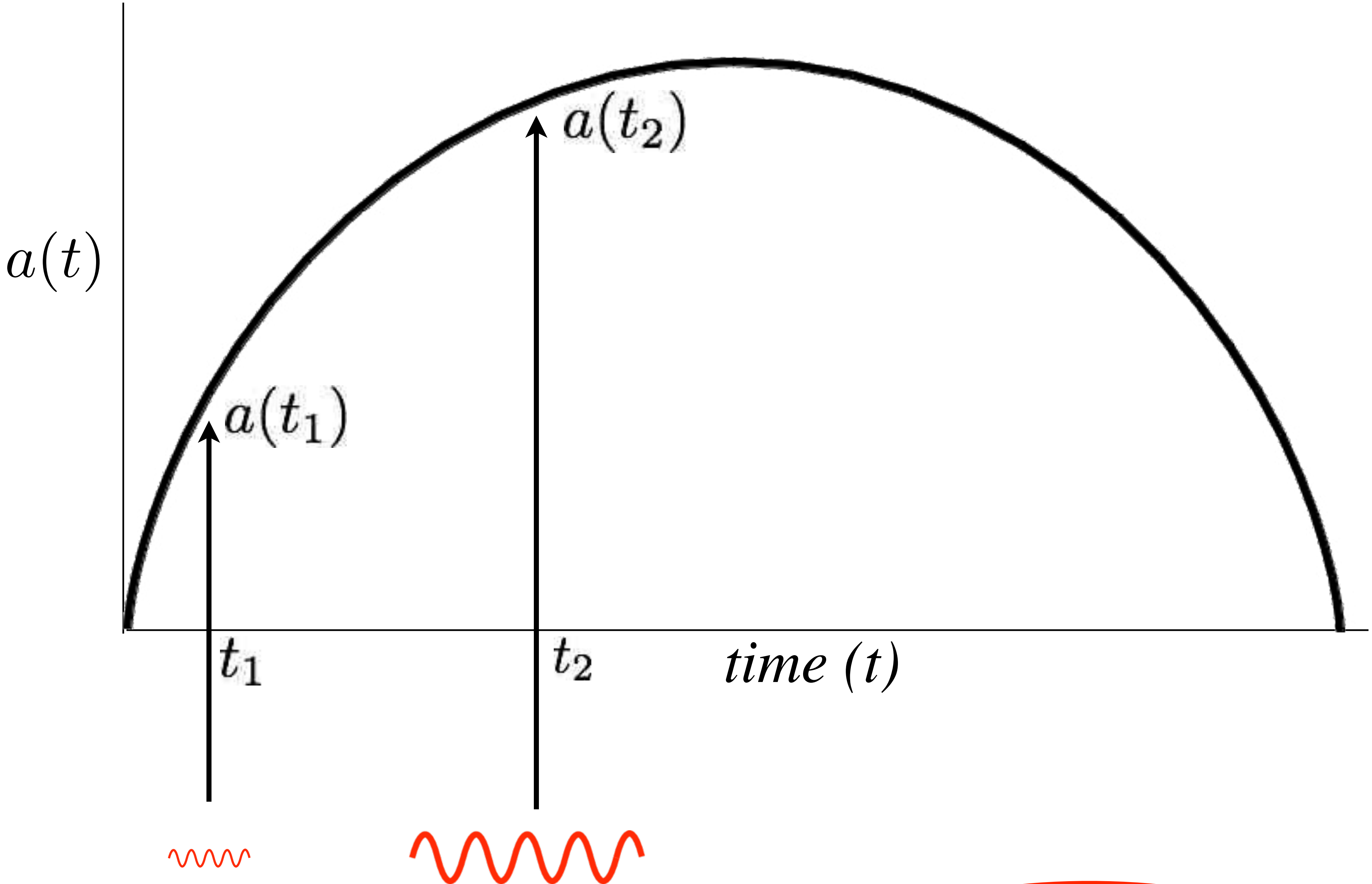


$a(t)$
time (t)

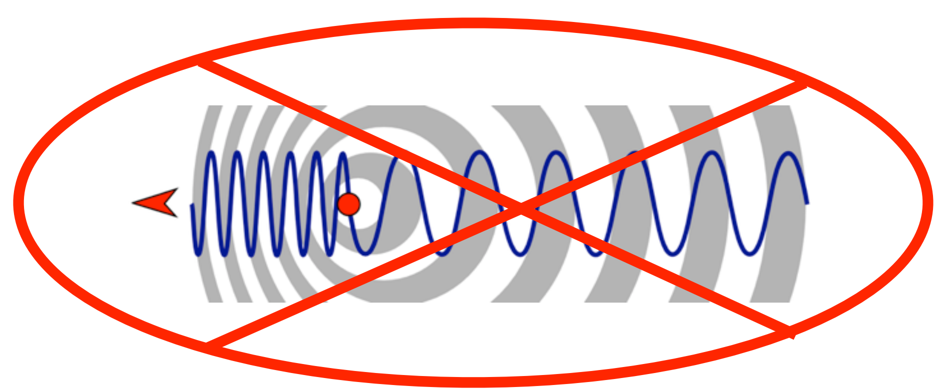


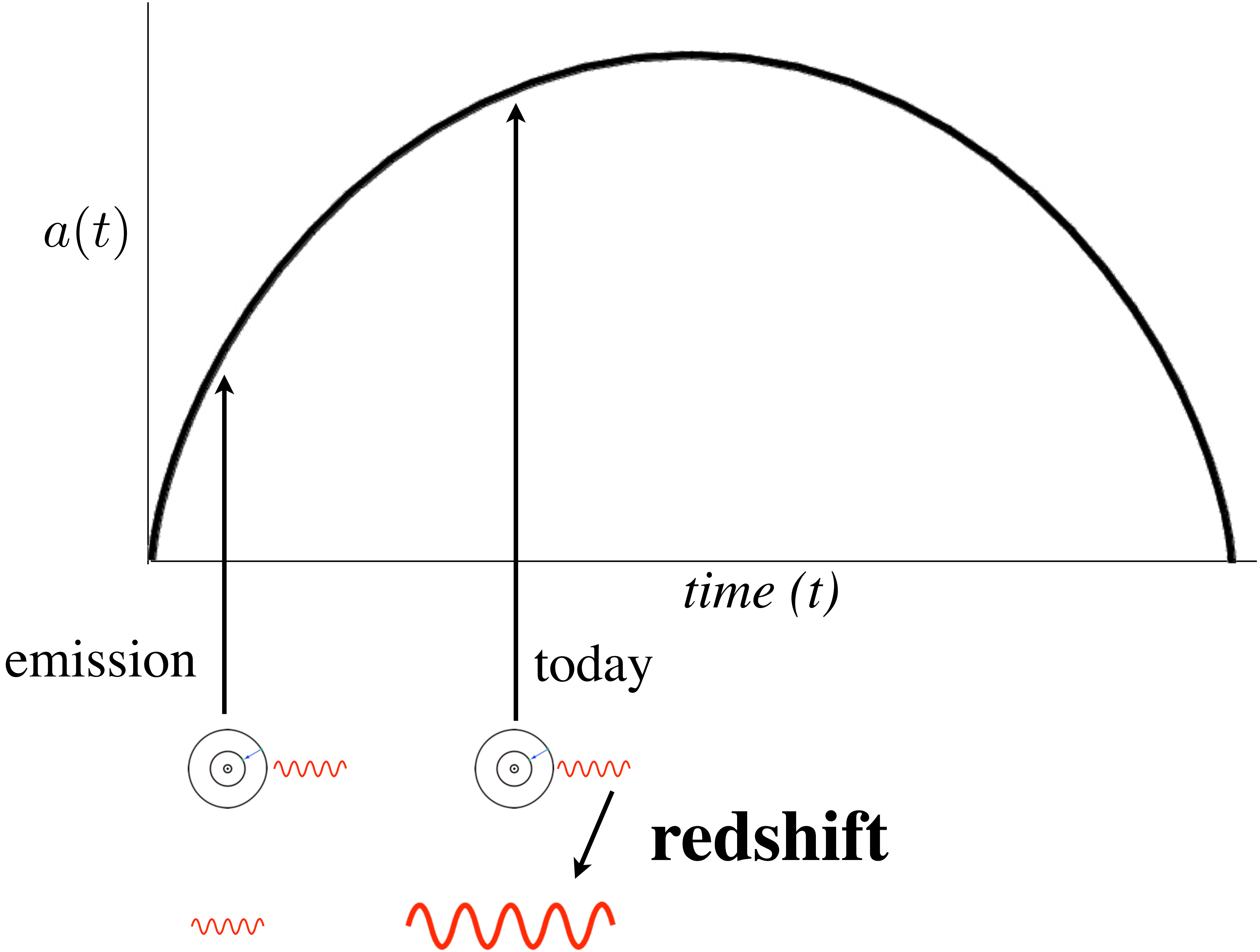
+1000 KM
500 KM
0
VELOCITY
DISTANCE
0
10⁶ PARSECS
2 x 10⁶ PARSECS

FIGURE 1



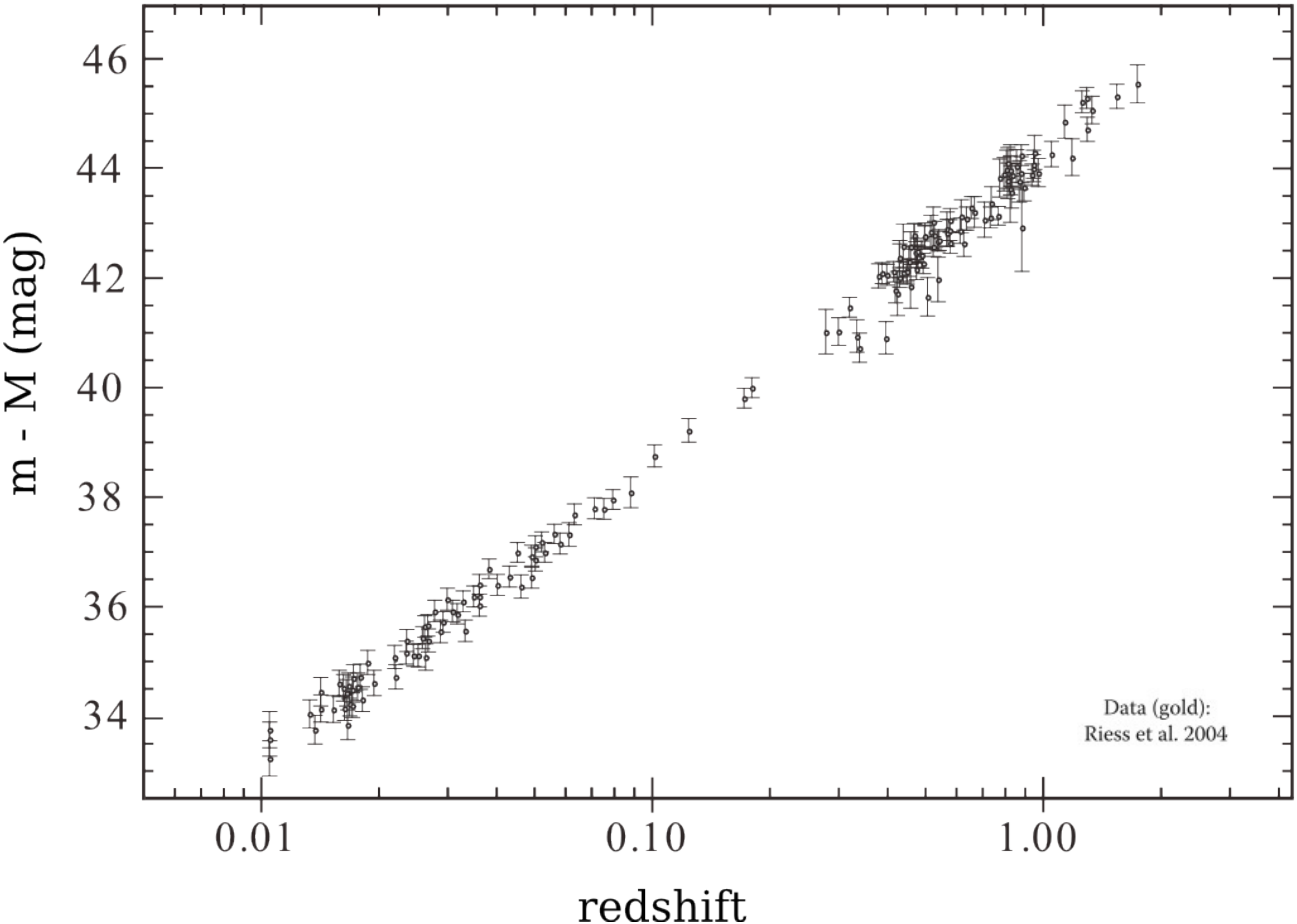
$$\frac{\lambda(t_1)}{\lambda(t_2)} = \frac{a(t_1)}{a(t_2)}$$



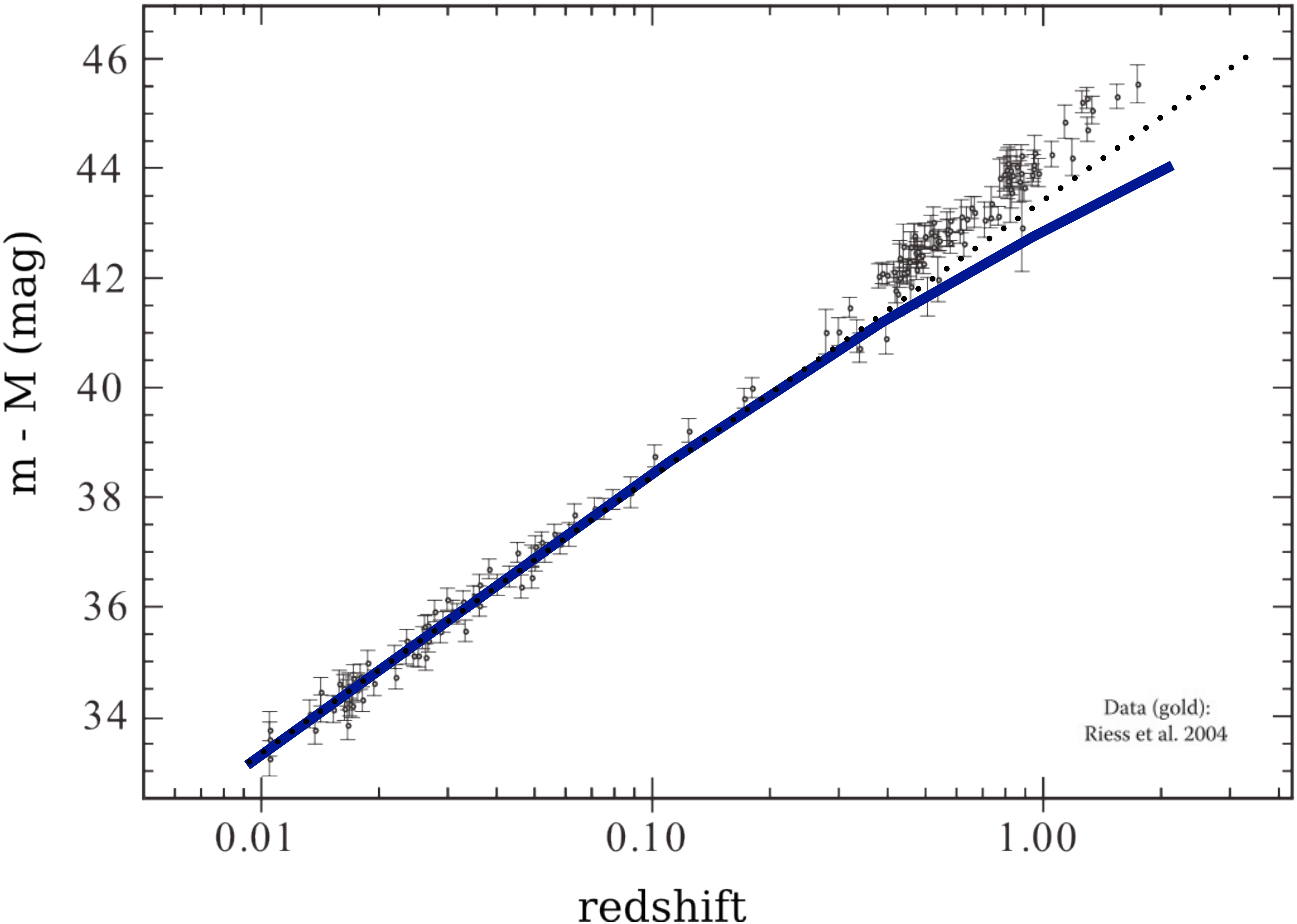


$a(t)$
time (t)
emission
today
redshift


SN 2011dh



46
44
42
40
38
36
34
m - M (mag)
0.01
0.10
1.00
redshift
Data (gold):
Riess et al. 2004



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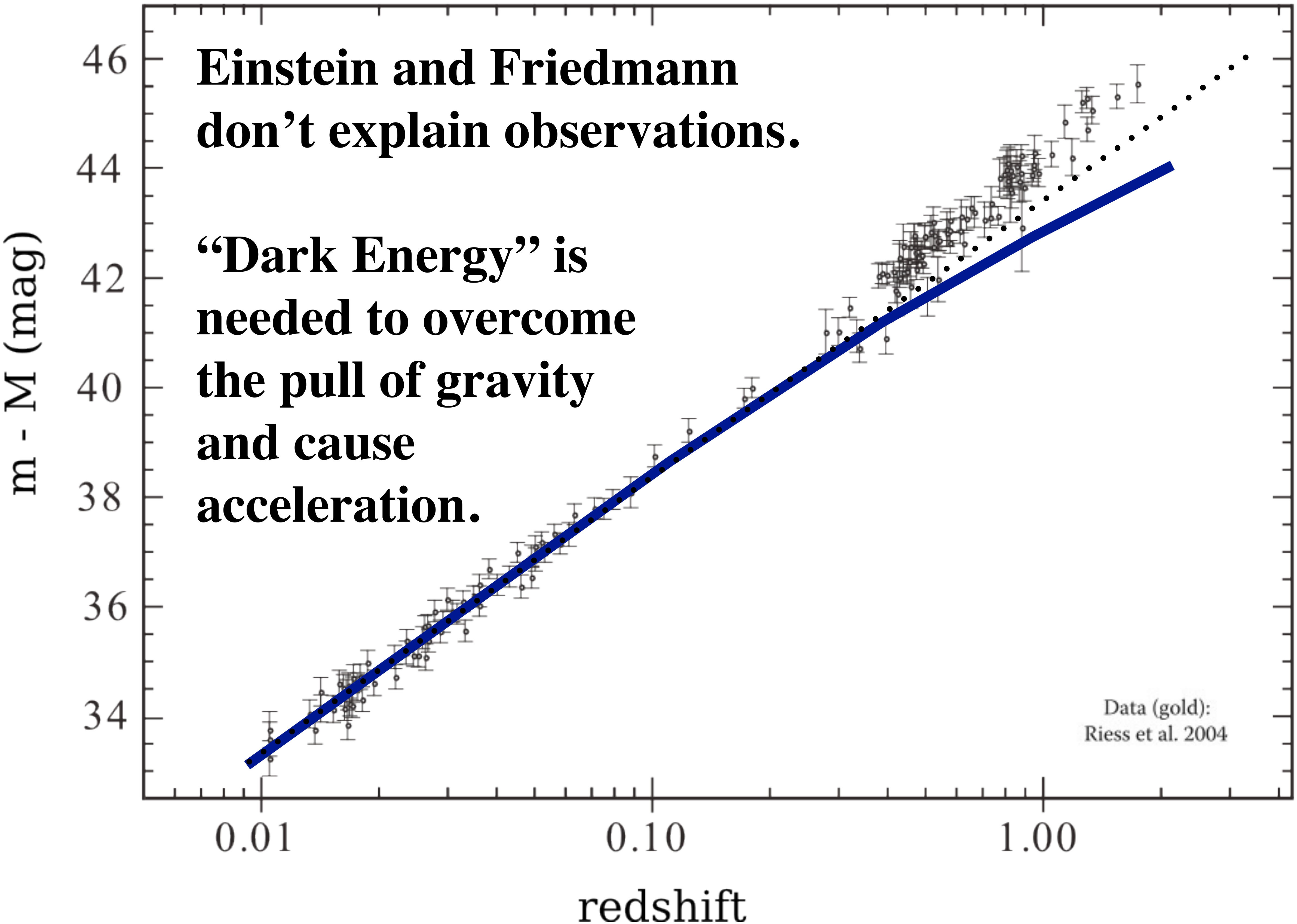


Einstein and Friedmann
don't explain observations.
"Dark Energy" is
needed to overcome
the pull of gravity
and cause
acceleration.
m - M (mag)
46
44
42
40
38
36
34
0.01
0.10
1.00
redshift
Data (gold):
Riess et al. 2004

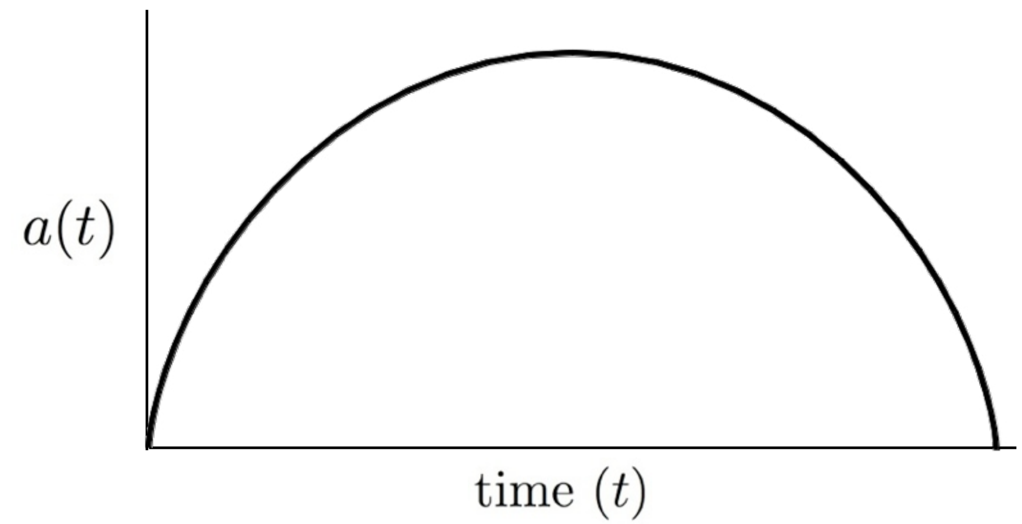
Erwin Schrödinger

THE PROPER VIBRATIONS
OF THE EXPANDING UNIVERSE

by ERWIN SCHRÖDINGER

Schrödinger, E. 1939, Physica, 6, 899

$$G^{\alpha\beta} = 8\pi\, T^{\alpha\beta}$$



Vladimir Fock

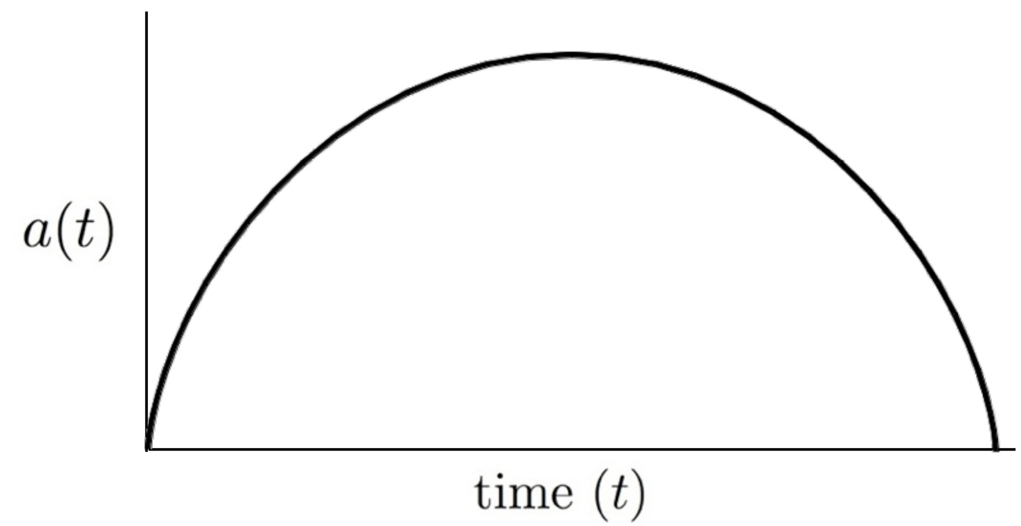
Zur Schrödingerschen Wellenmechanik.

Von **V. Fock** in Leningrad.

(Eingegangen am 11. Juni 1926.)

$$\frac{1}{\sqrt{-g}}\frac{\partial}{\partial x^\alpha}\left[\sqrt{-g}\,g^{\alpha\beta}\frac{\partial\psi}{\partial x^\beta}\right]+\mu^2\psi=0$$

$$G^{\alpha\beta} = 8\pi\, T^{\alpha\beta}$$



$$\frac{1}{\sqrt{-g}}\frac{\partial}{\partial x^\alpha}\left[\sqrt{-g}\, g^{\alpha\beta}\frac{\partial\psi}{\partial x^\beta}\right] + \mu^2\psi = 0$$

What are the basis functions for ψ?

THE PROPER VIBRATIONS OF THE EXPANDING UNIVERSE

by ERWIN SCHRÖDINGER

§ 1. *Introduction and summary*. Wave mechanics imposes an a priori reason for assuming space to be closed; for then and only then are its proper modes discontinuous and provide an adequate description of the observed atomicity of matter and light.

• • •

For *light*: when referred to the customary *co-moving* coordinates, an *arbitrary* wave process exhibits essentially the same succession of states as without expansion. Briefly, the wave function shares the general dilatation. Hence all *wave lengths* increase proportionally to the radius of curvature. — The *time rate* of events is slowed down.

• • •

For the *material particle* the broad results are these: a strictly monochromatic process (i.e. a proper vibration) again shares the

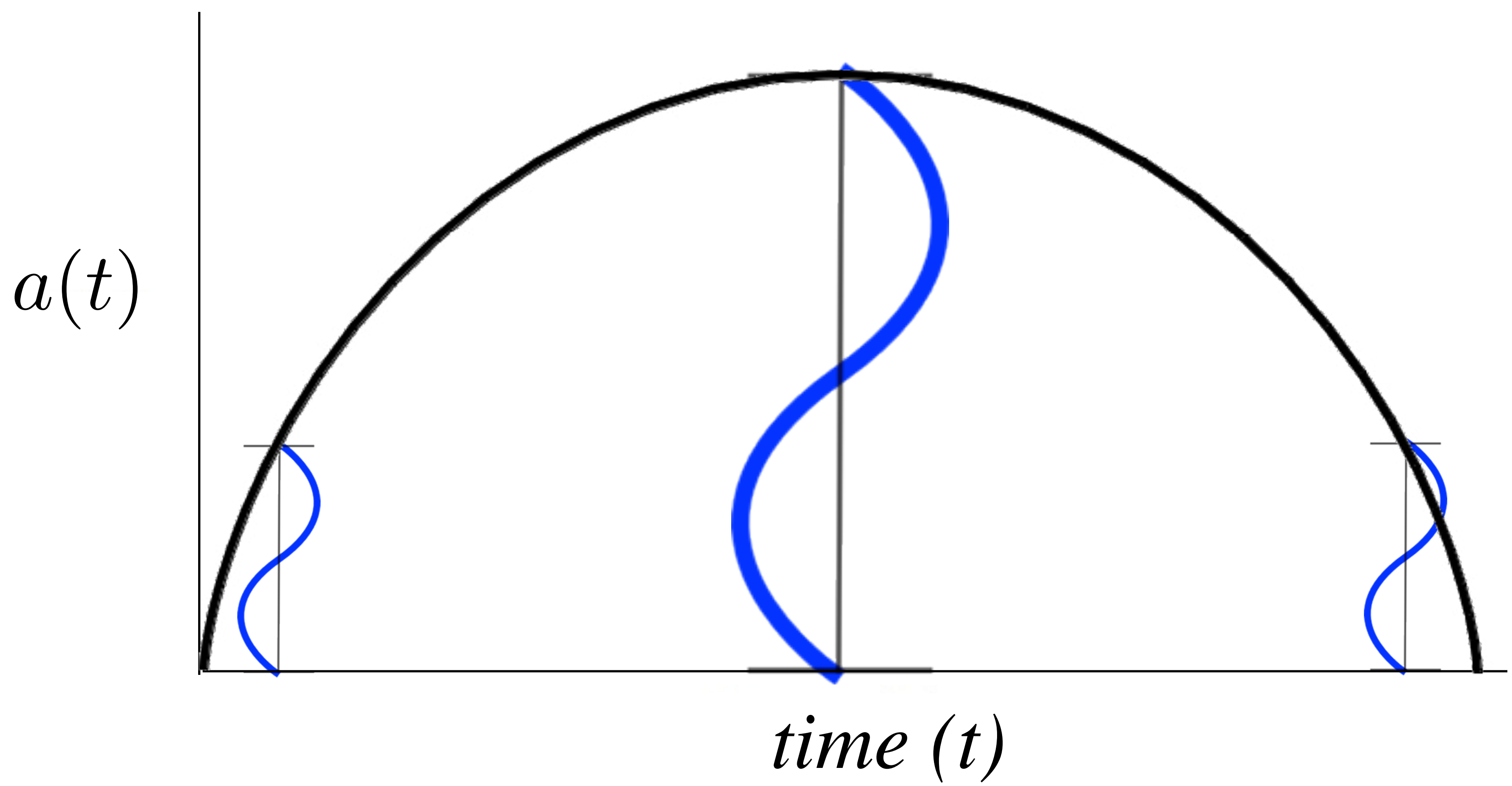
— 899 —

common dilatation, so that its wave length λ is proportional to R, as before.

Schrödinger, E. 1939, Physica, 6, 899

"In an expanding space all momenta decrease . . . This simple law has an even simpler interpretation in wave mechanics: all wavelengths, being inversely proportional to the momenta, simply expand with space."

Erwin Schrödinger



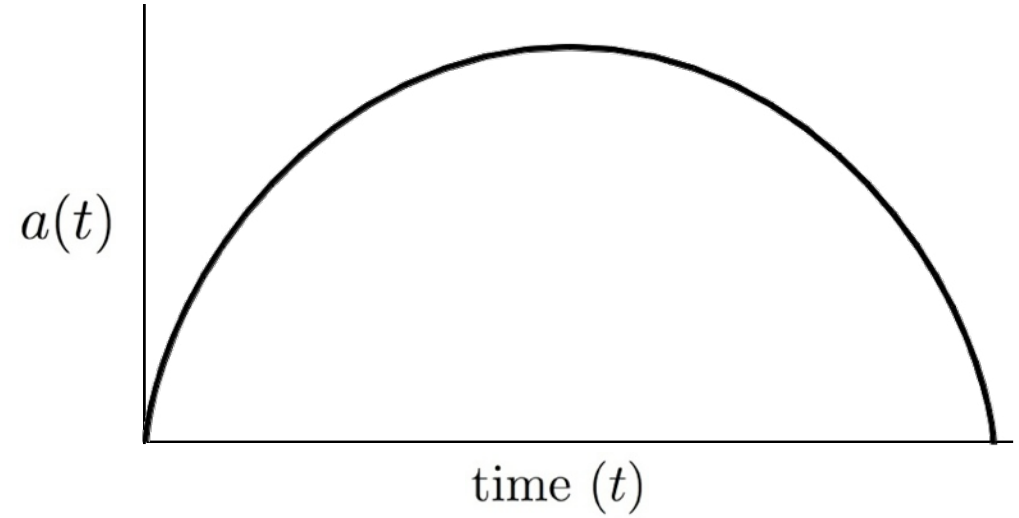
ON THE VARIATION OF VACUUM PERMITTIVITY IN FRIEDMANN UNIVERSES

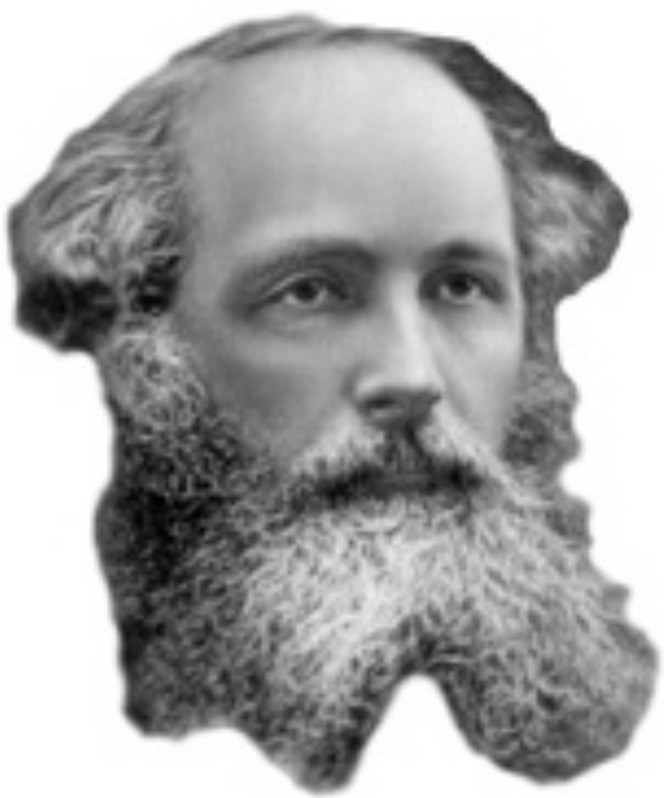
WILLIAM Q. SUMNER
Box 588, Kittitas, WA 98934
Received 1993 March 31; accepted 1994 January 14

THE ASTROPHYSICAL JOURNAL, 429:491–498, 1994 July 10

William Sumner

$$G^{\alpha\beta} = 8\pi\, T^{\alpha\beta}$$





$$T^{\mu\nu} = \varepsilon_0 \left(-g^{\nu\beta} F^{\mu\alpha} F_{\beta\alpha} + \frac{1}{4}\, g^{\mu\nu} F^{\alpha\beta} F_{\alpha\beta} \right)$$

$$\left(\varepsilon_o F^{\alpha\beta}\right)_{;\beta} = J^{\alpha}$$

$$\vec{F} = \frac{1}{4\pi\varepsilon_o} \frac{q_1 q_2 \hat{r}}{r^2}$$

James Clerk Maxwell

THE ASTROPHYSICAL JOURNAL, 429:491–498, 1994 July 10

ON THE VARIATION OF VACUUM PERMITTIVITY IN FRIEDMANN UNIVERSES

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ABSTRACT

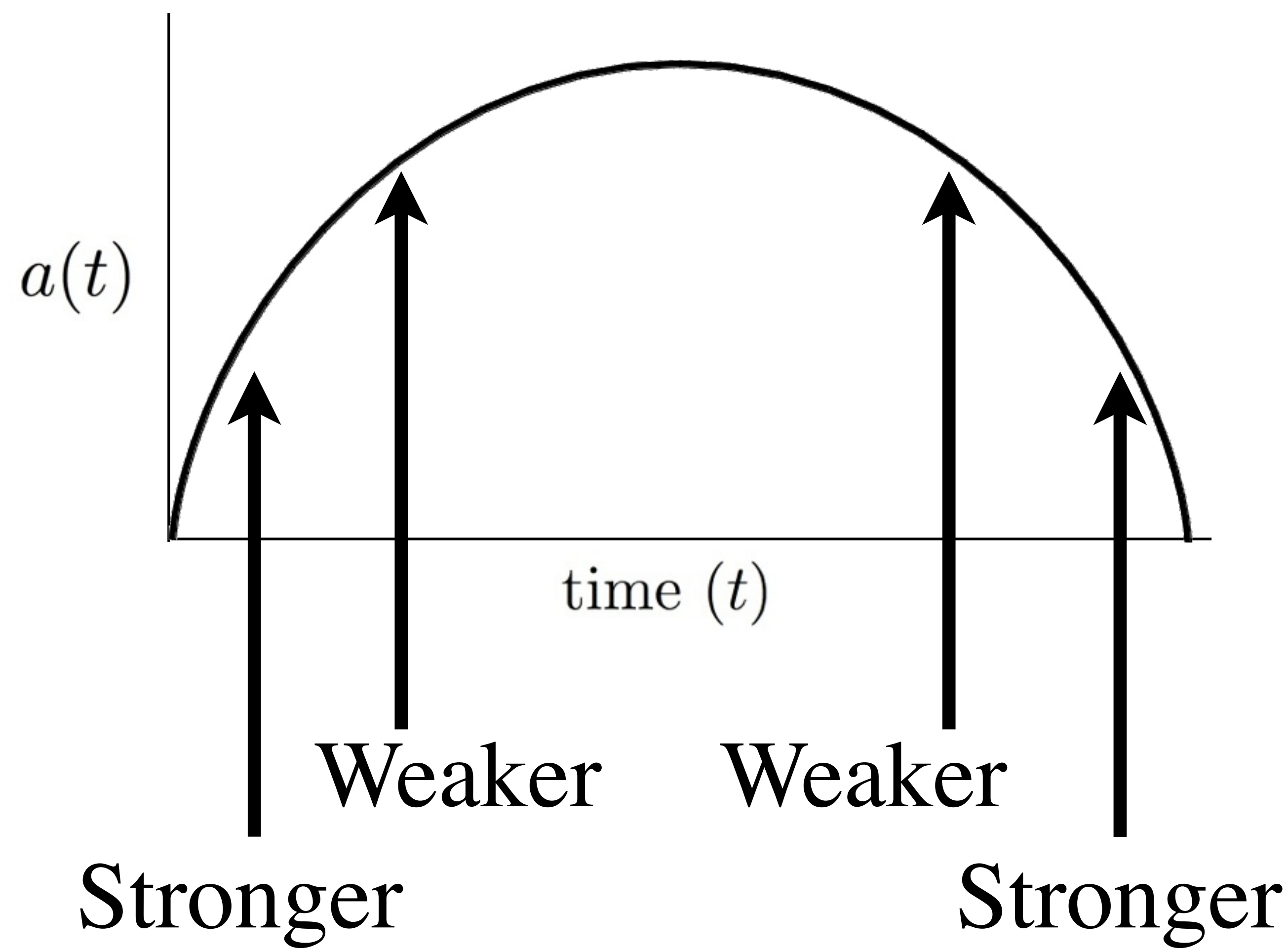
Vacuum permittivity, the measure of strength of electric fields in a vacuum, is a function of the spacetime geometry of Einstein's general relativity. This dependence on geometry was noted over 40 years ago by C. Møller (1952) and has remarkable consequences. Variation in vacuum permittivity breaks the equivalence of physical measurements and mathematical coordinates postulated by Einstein. Physical lengths, as measured by a rigid rod, and physical times, as measured by an atomic clock, are not equivalent to the mathematical lengths and times of general relativity. This changes some concepts of space and time, invalidates stronger interpretations of the principle of equivalence, and requires that care be exercised in interpreting the speed of light. The laws of physics must be carefully used to understand the essential relationships between mathematical spacetime and physical measurements.

For Friedmann universes, vacuum permittivity is directly proportional to the Friedmann radius and is therefore a function of time. As the size of the universe evolves, the changing strength of the electrical force between charges shifts atomic energy levels, changing the wavelengths of emitted light. This shift in photon emission due to the evolution of electrical attraction in the atom is twice as large as evolutionary photon shift. Considered together, atomic and photon evolution reverse the interpretation of Hubble redshift to imply that the Friedmann universe is presently collapsing.

Subject headings: cosmology: theory

Vacuum permittivity is proportional to the Friedmann radius $\varepsilon_0(t)\,\alpha\,a(t)$

$$\vec{F} = \frac{1}{4\pi\varepsilon_o}\frac{q_1 q_2 \hat{r}}{r^2}$$



Atomic Sizes Change

Bohr radius $$a_o(t) = \frac{\varepsilon_0(t)h^2}{\pi m_e\, e^2}$$

And $$\varepsilon_0(t)\,\alpha\,a(t)$$

$$\frac{a_o\,(t_1)}{a_o\,(t_2)} = \frac{a\,(t_1)}{a\,(t_2)}$$

Atomic Energy Levels Change

$$\lambda_e = \frac{h}{\Delta E} = \frac{8\varepsilon_0^2 h^3}{me^4}\left(\frac{n_1^2 n_2^2}{n_1^2 - n_2^2}\right)$$

$$\frac{\lambda_e(t_1)}{\lambda_e(t_2)} = \frac{a^2(t_1)}{a^2(t_2)}$$

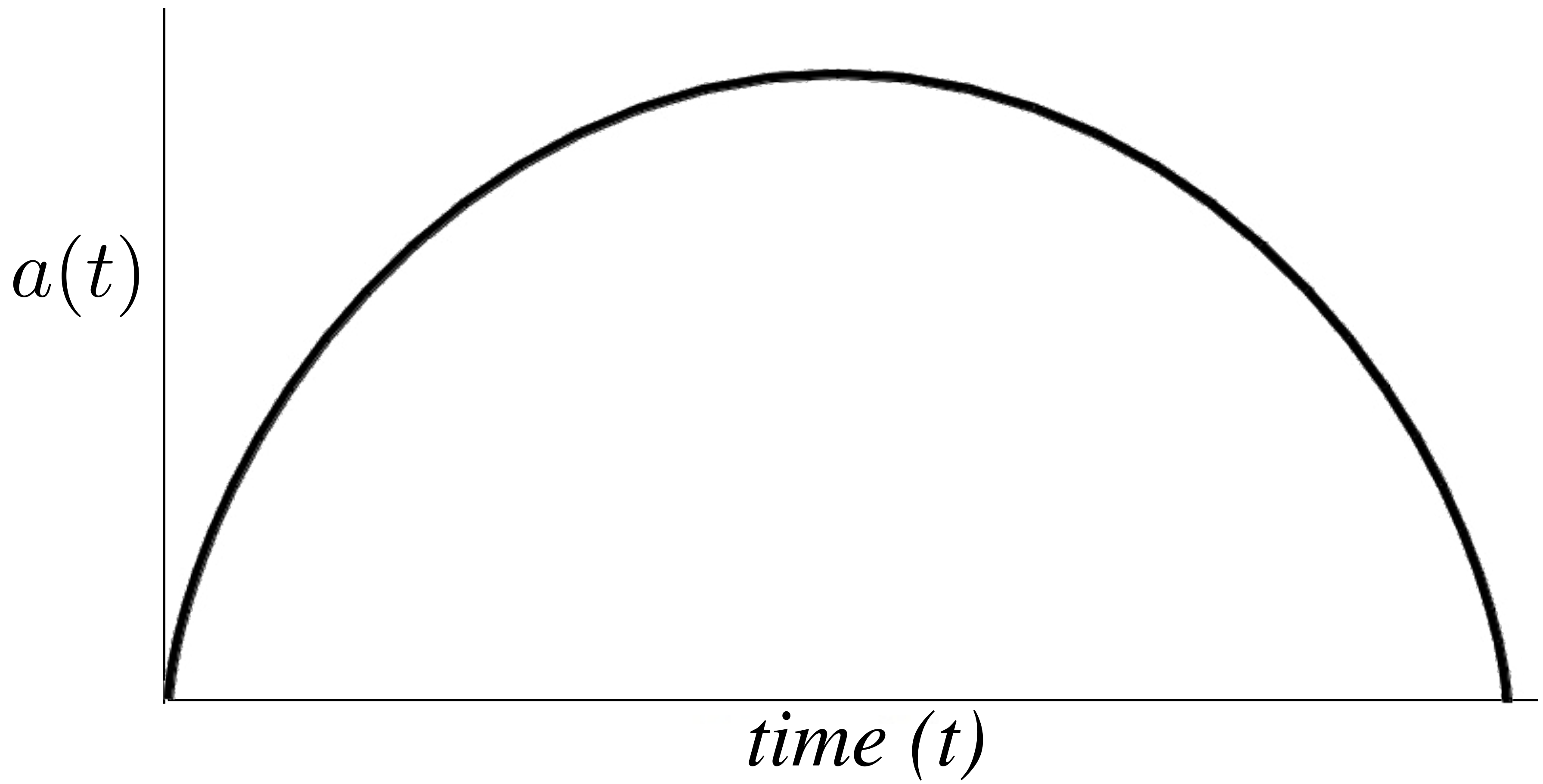
Photons change

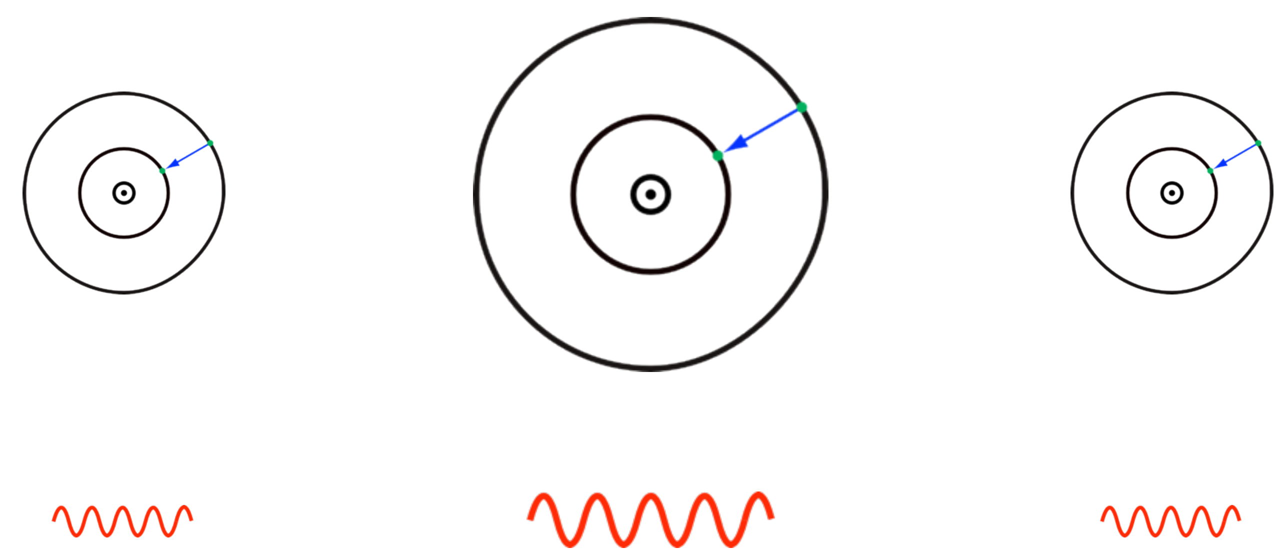
$$\frac{\lambda(t_1)}{\lambda(t_2)} = \frac{a(t_1)}{a(t_2)}$$

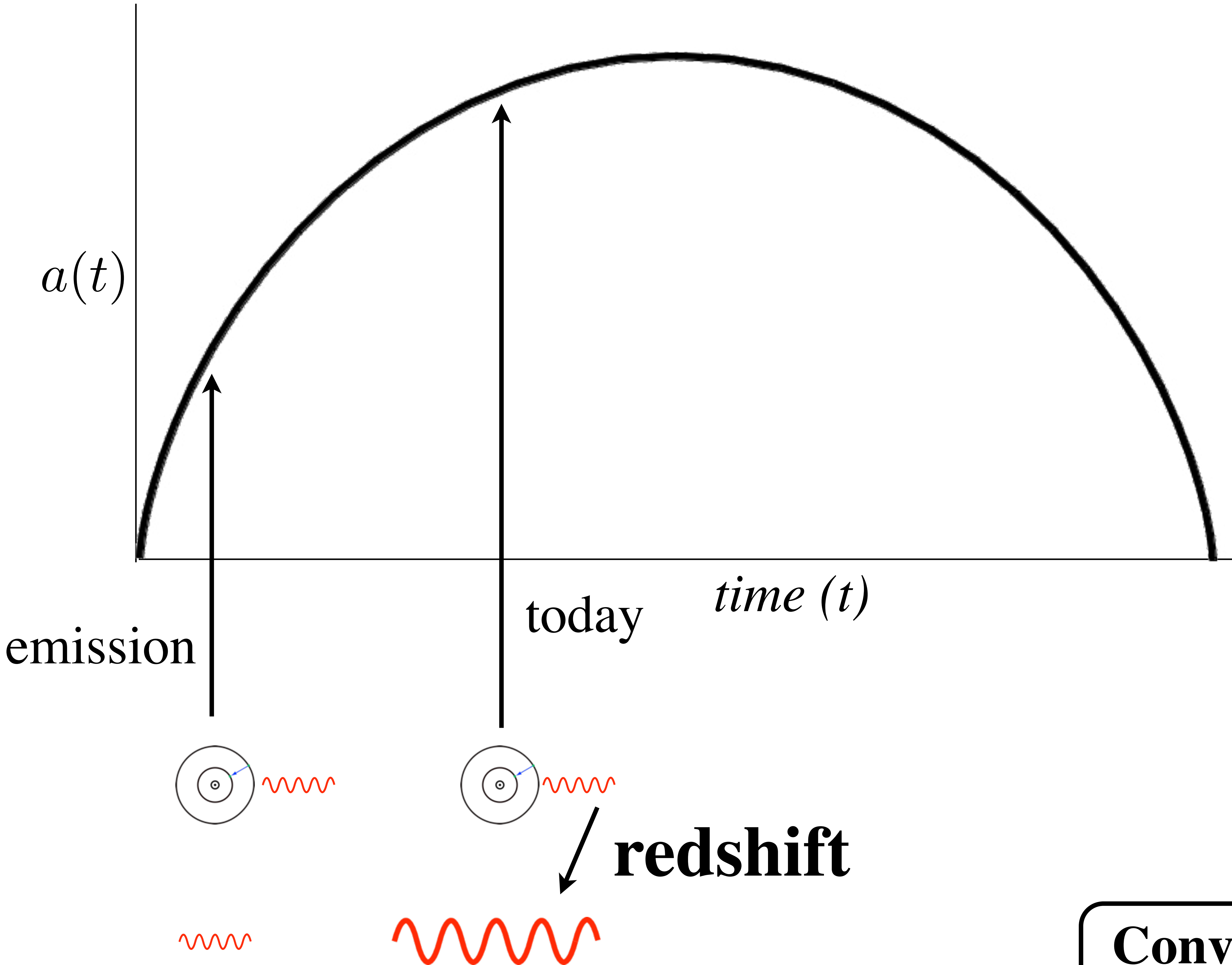
!!

Atomic emissions change more

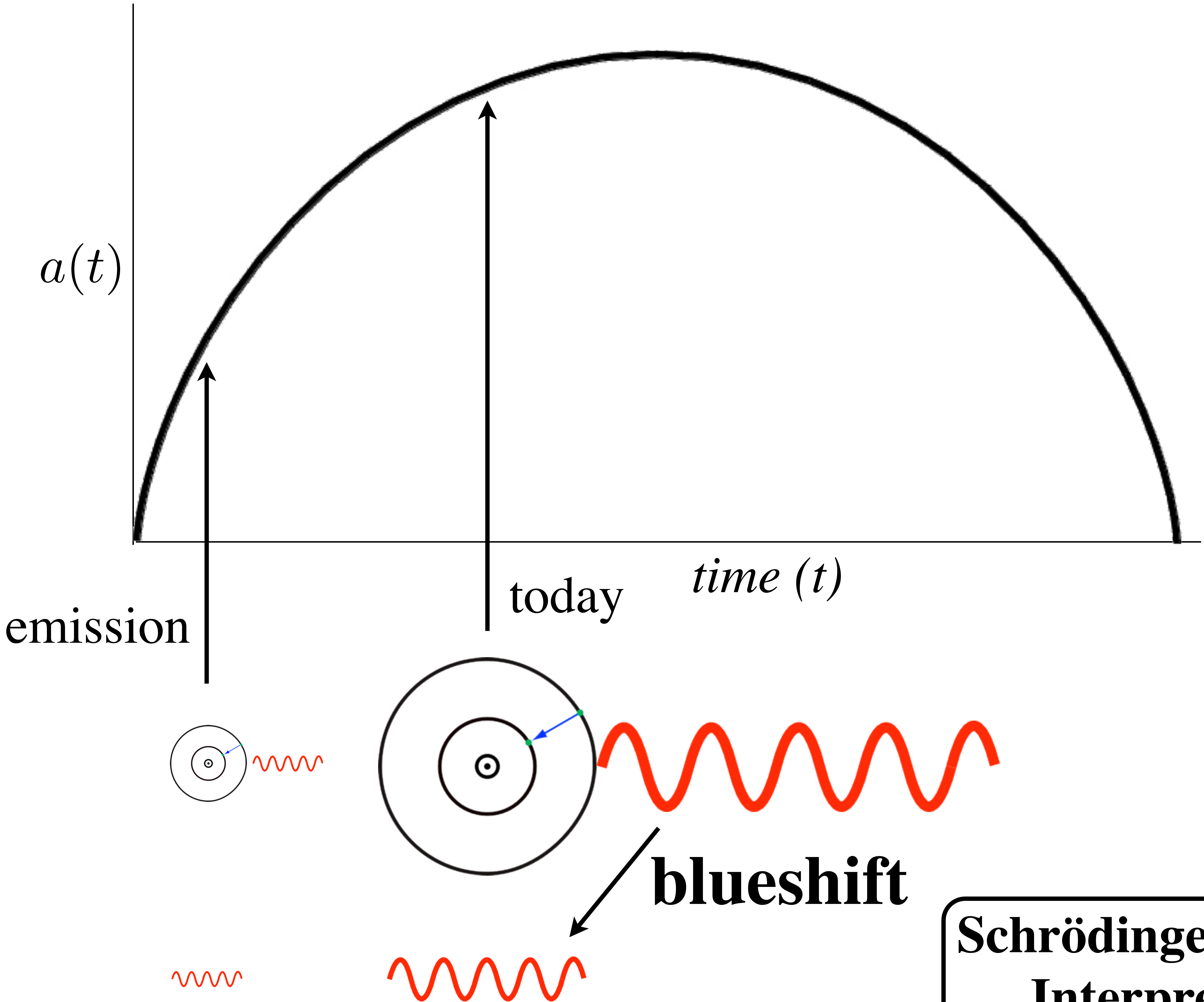
$$\frac{\lambda_e\left(t_1\right)}{\lambda_e\left(t_2\right)} = \frac{a^2\left(t_1\right)}{a^2\left(t_2\right)}$$


$a(t)$
time (t)

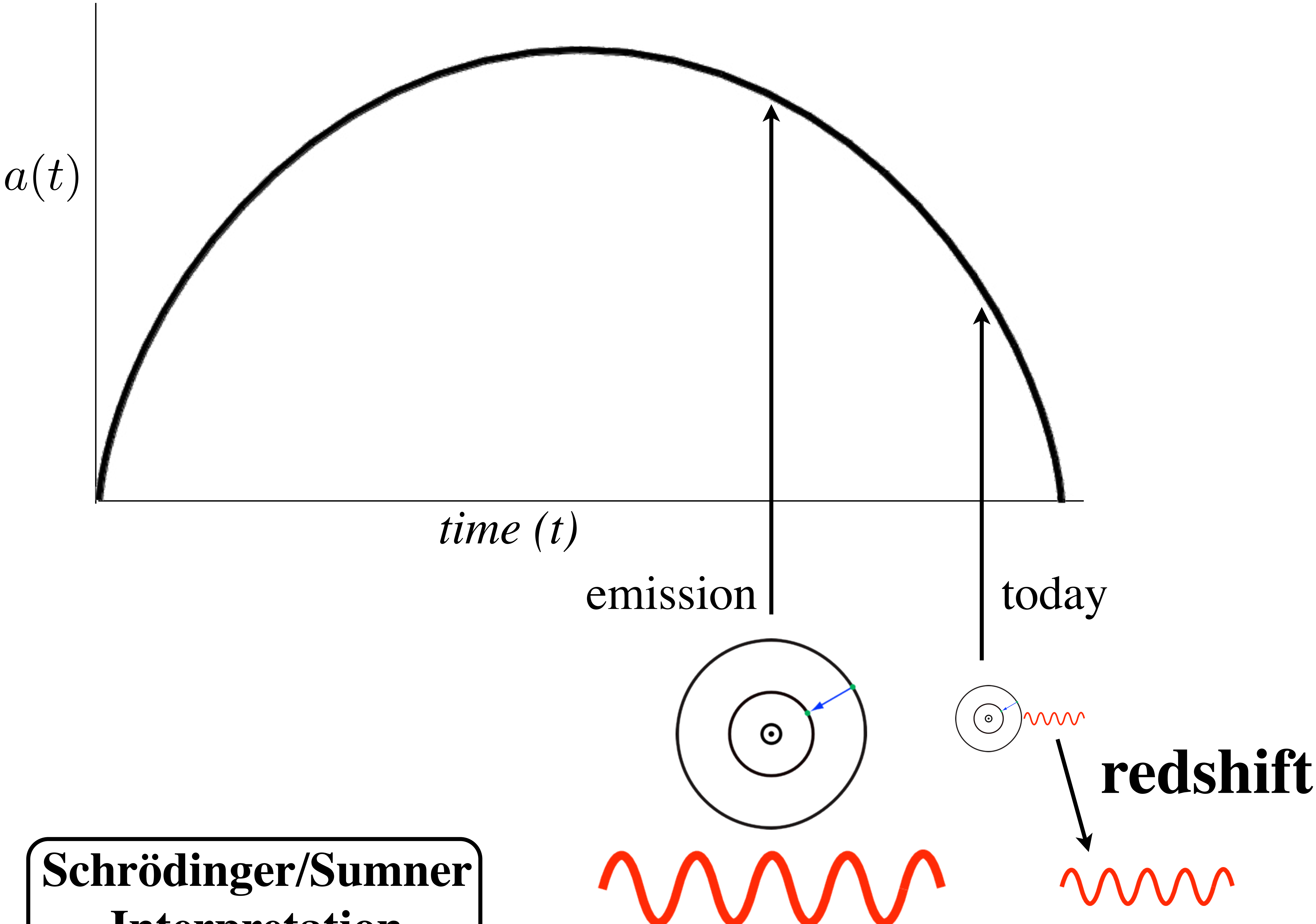




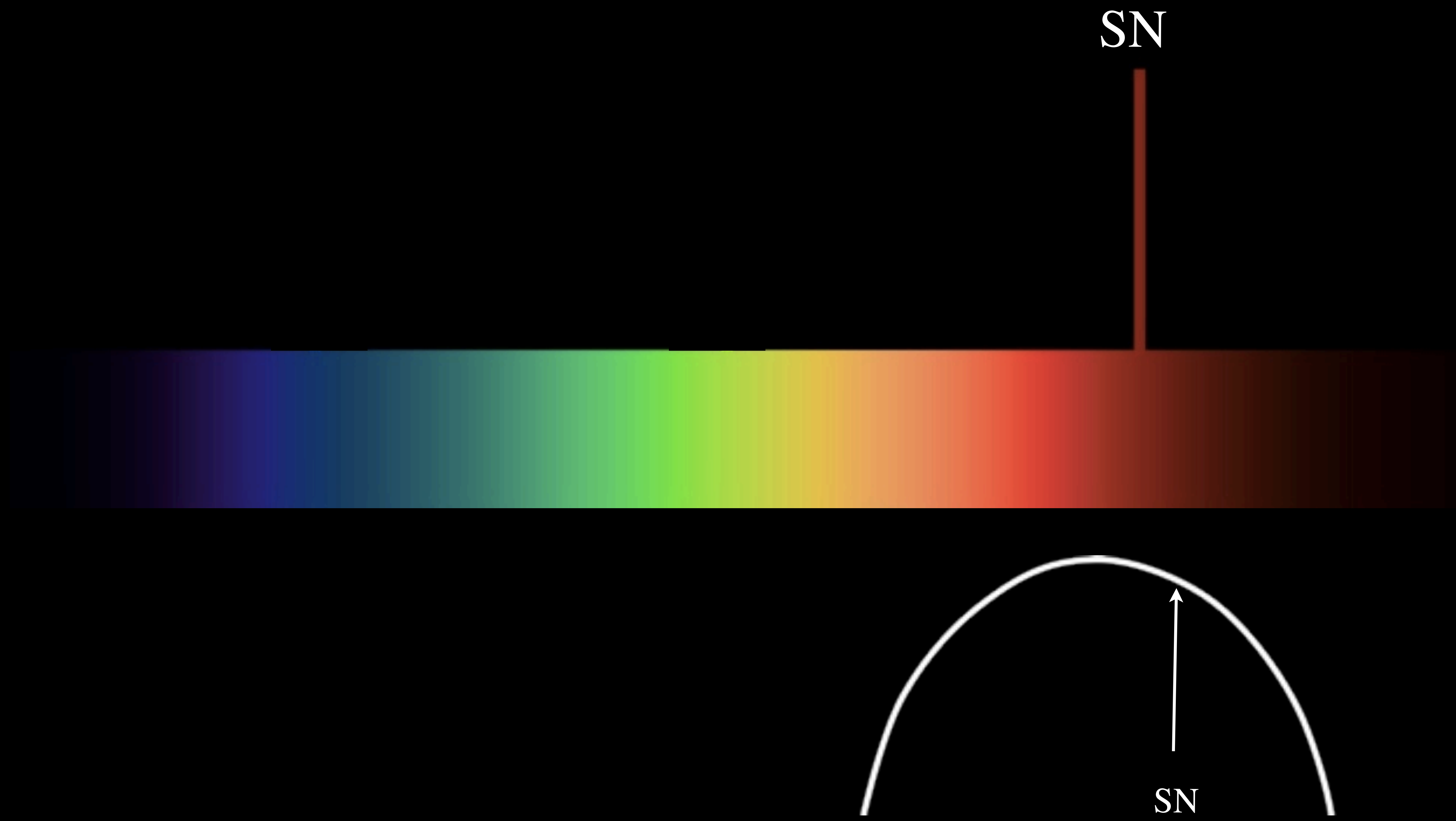
Conventional Interpretation



Schrödinger/Sumner Interpretation



Schrödinger/Sumner Interpretation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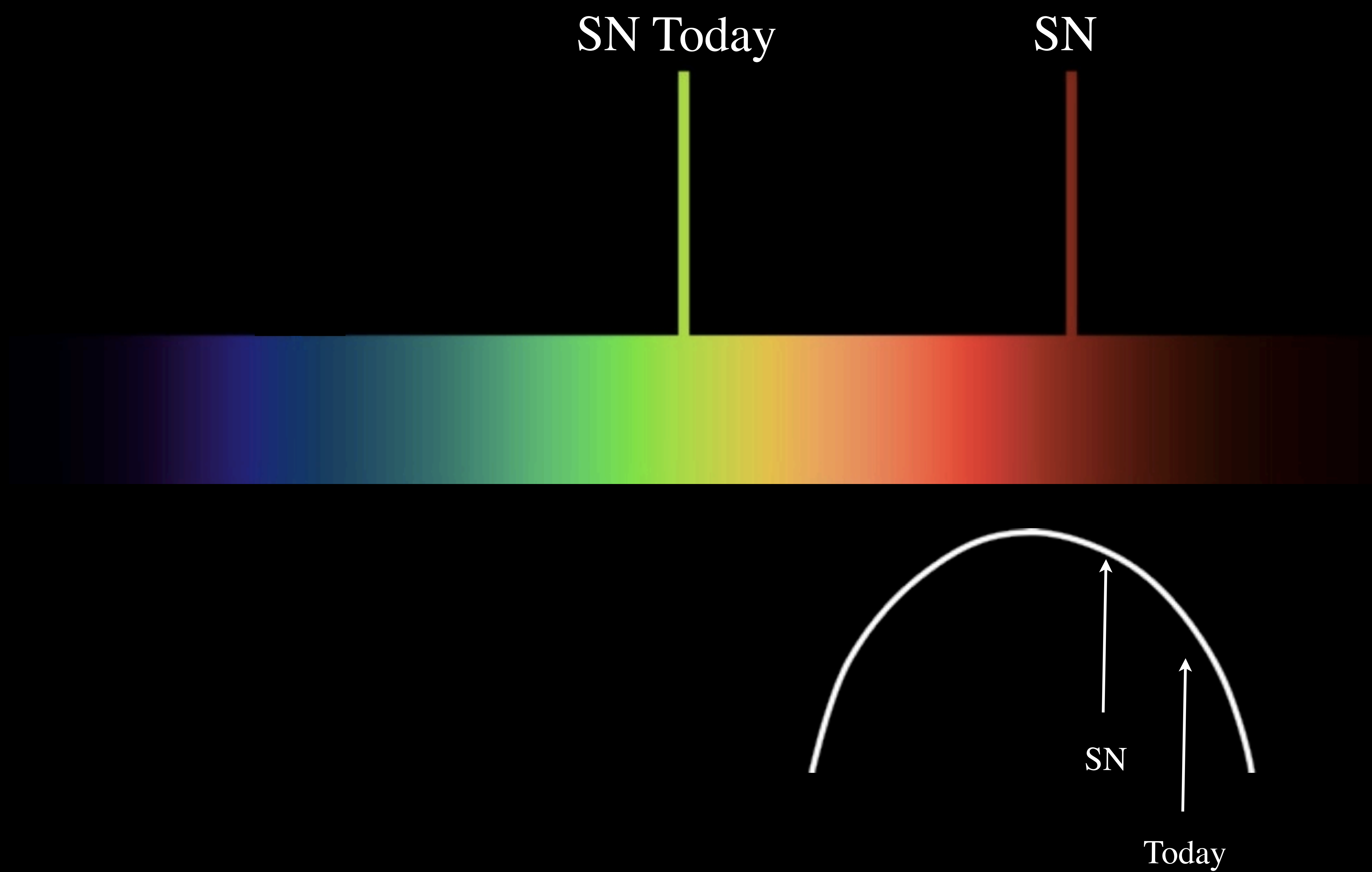
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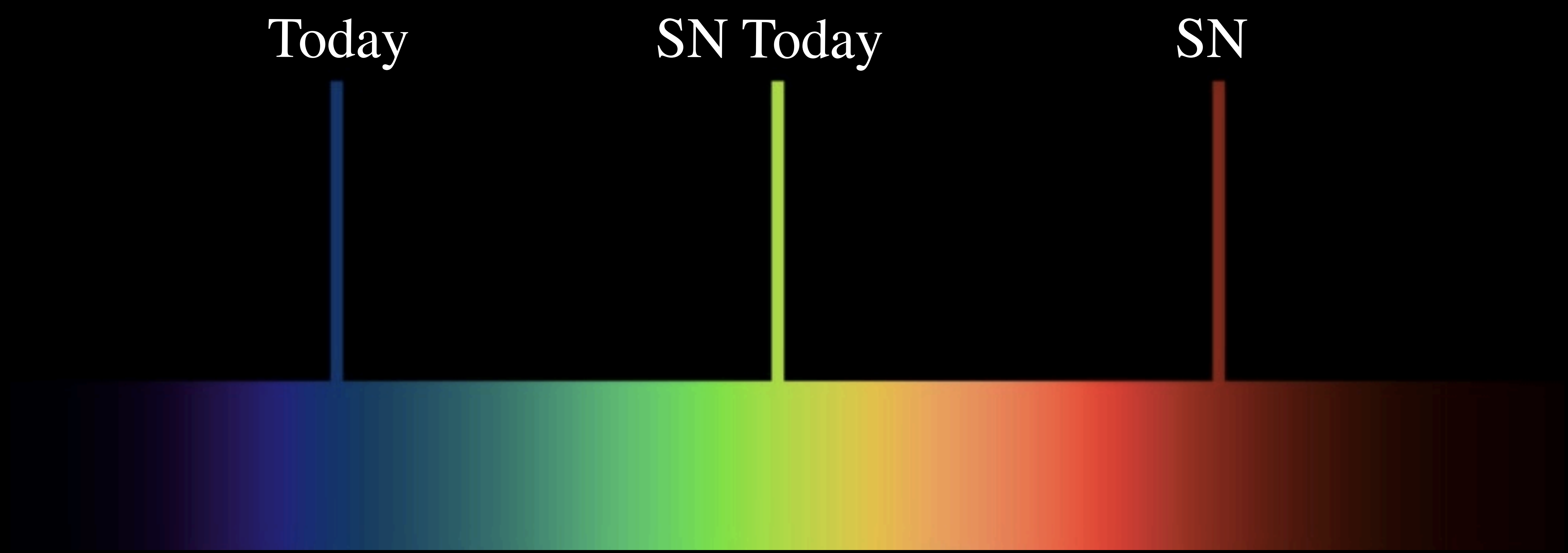
Today
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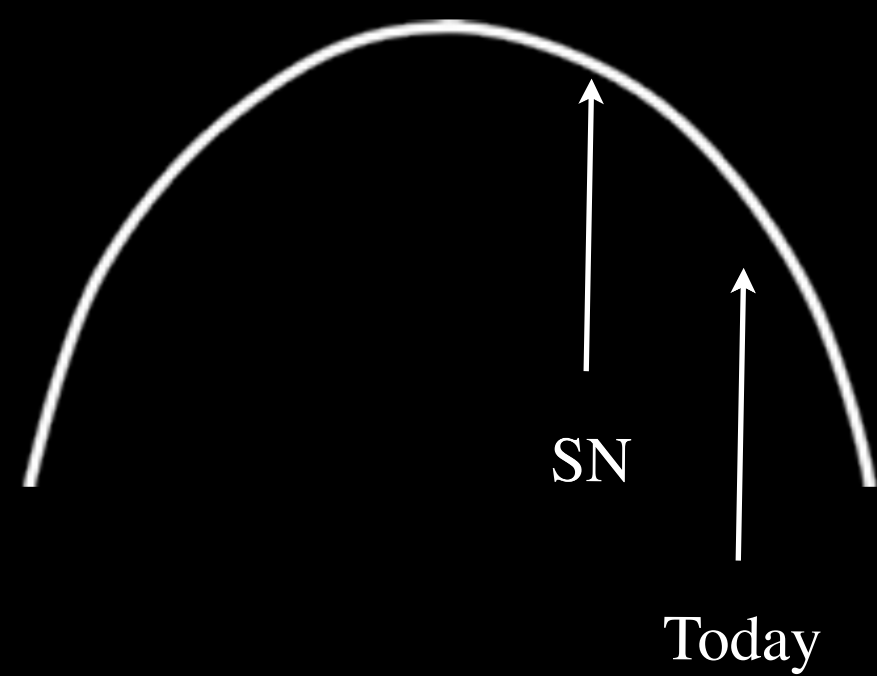
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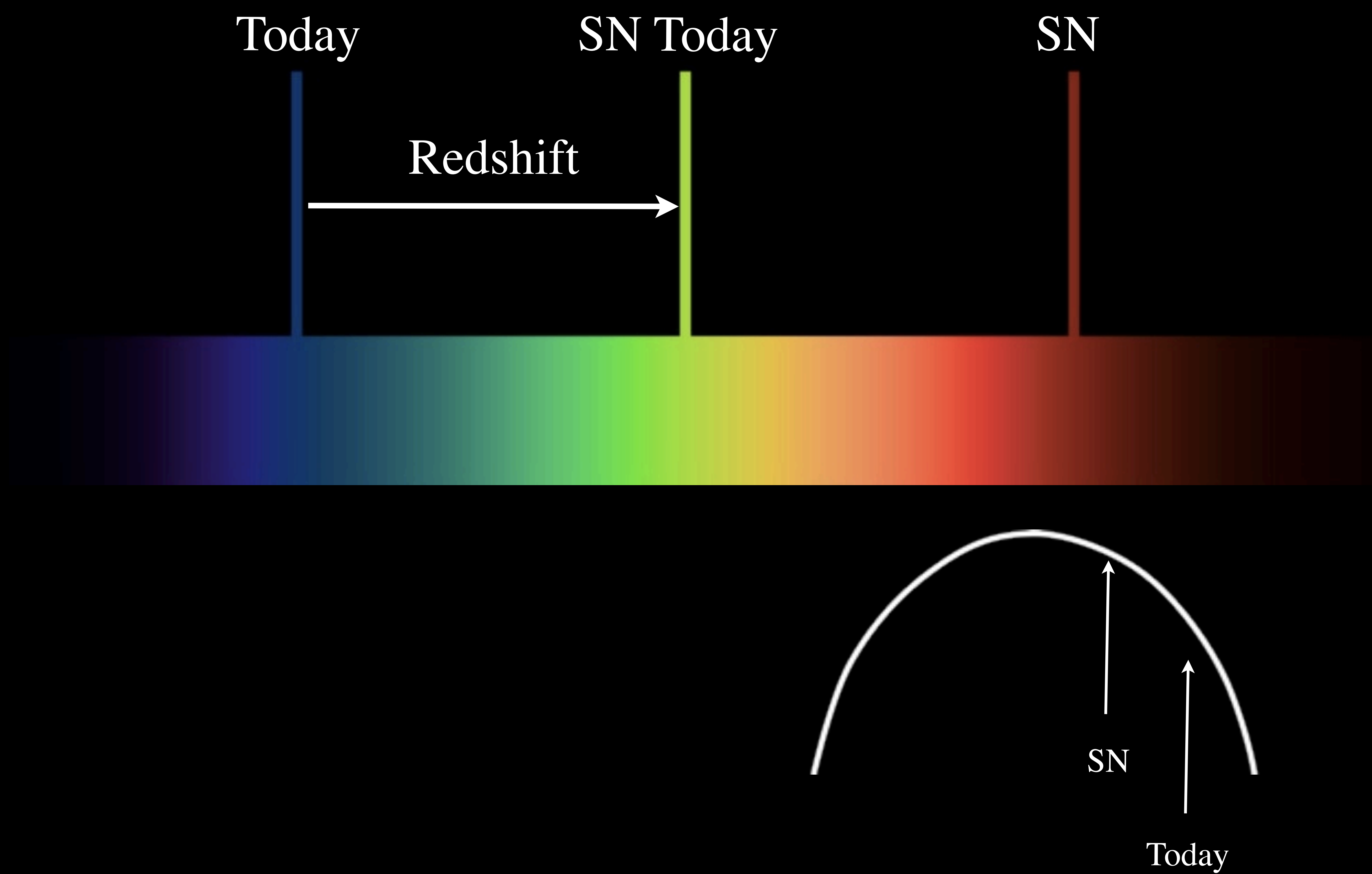
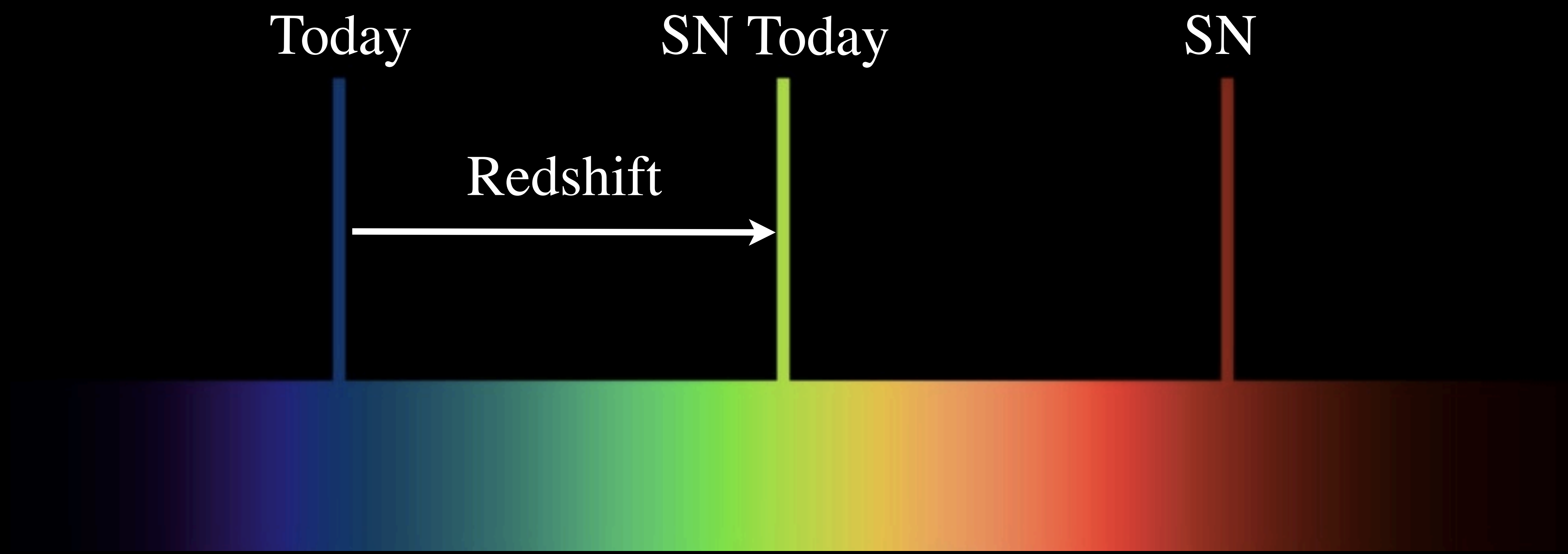
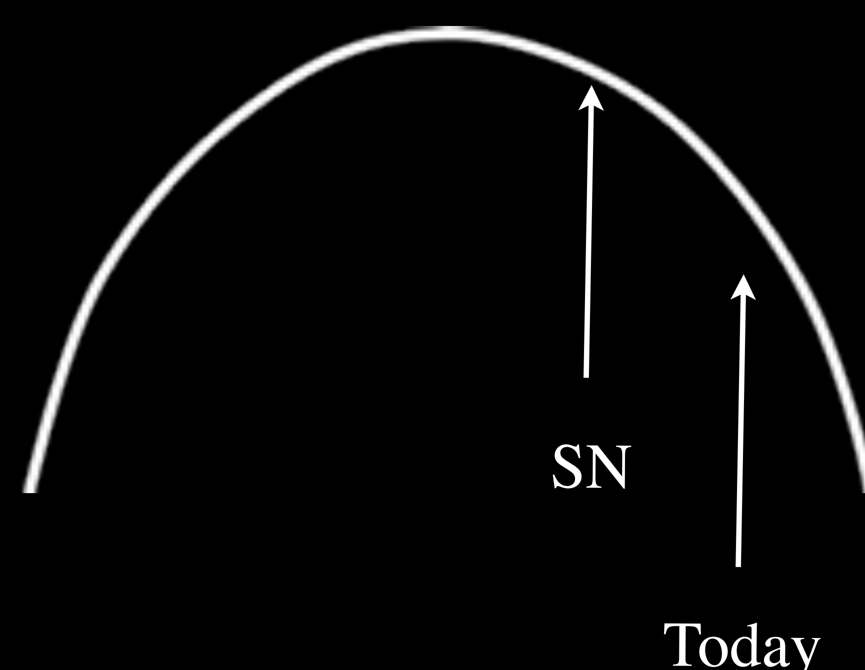
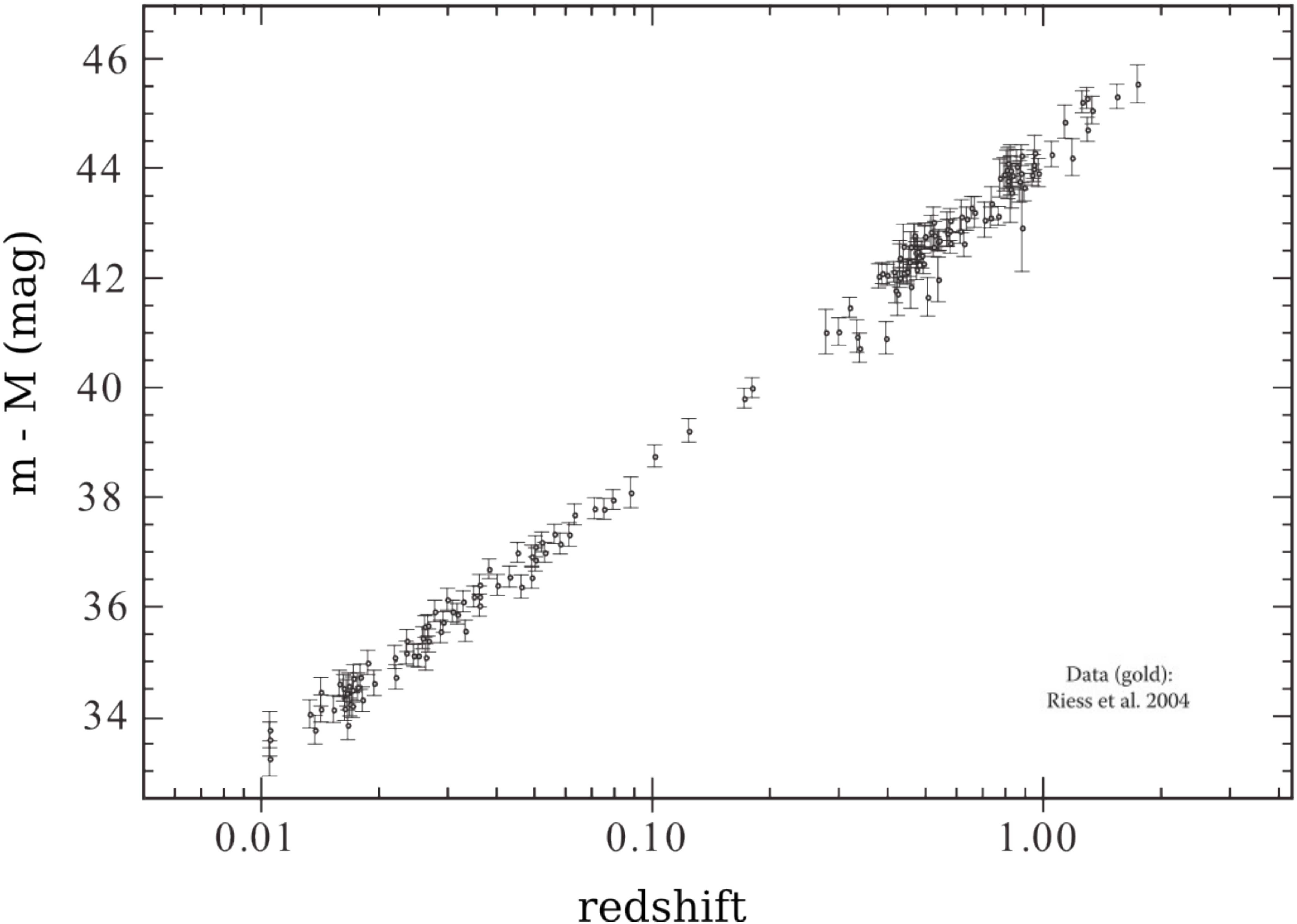
Today


Today
SN Today
SN
Redshift
SN
Today

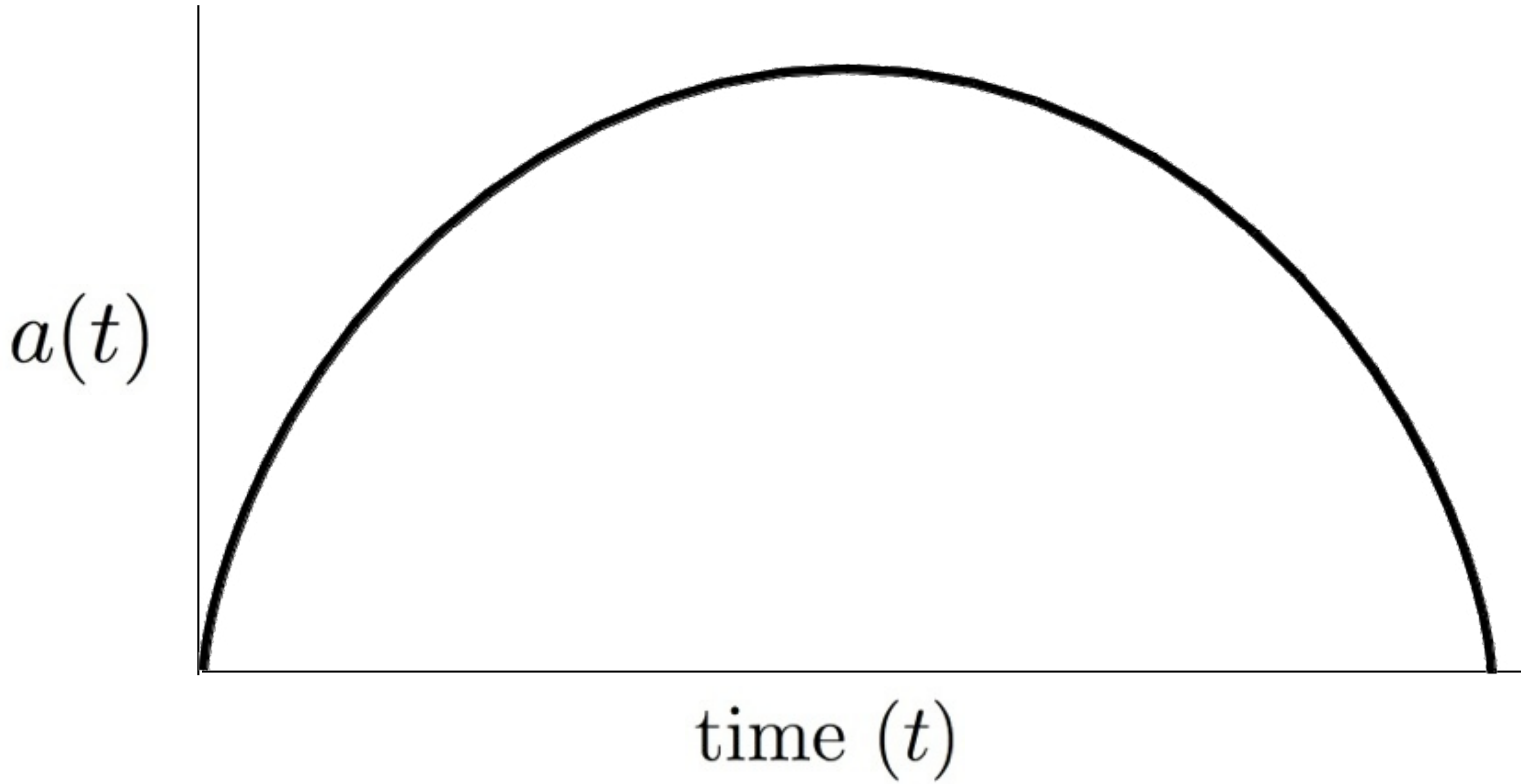


Redshift means collapse




46
44
42
40
38
36
34
m - M (mag)
0.01
0.10
1.00
redshift
Data (gold):
Riess et al. 2004

Calculate Redshift for a Collapsing Friedmann Universe



• Define redshift $k = \frac{\lambda_{obs}(t_0) - \lambda_e(t_0)}{\lambda_e(t_0)}, \quad k = \frac{a(t_1)}{a(t_0)} - 1$

• Characterize the Friedmann curve using the Hubble constant, H_o, and the deceleration parameter, q_o.

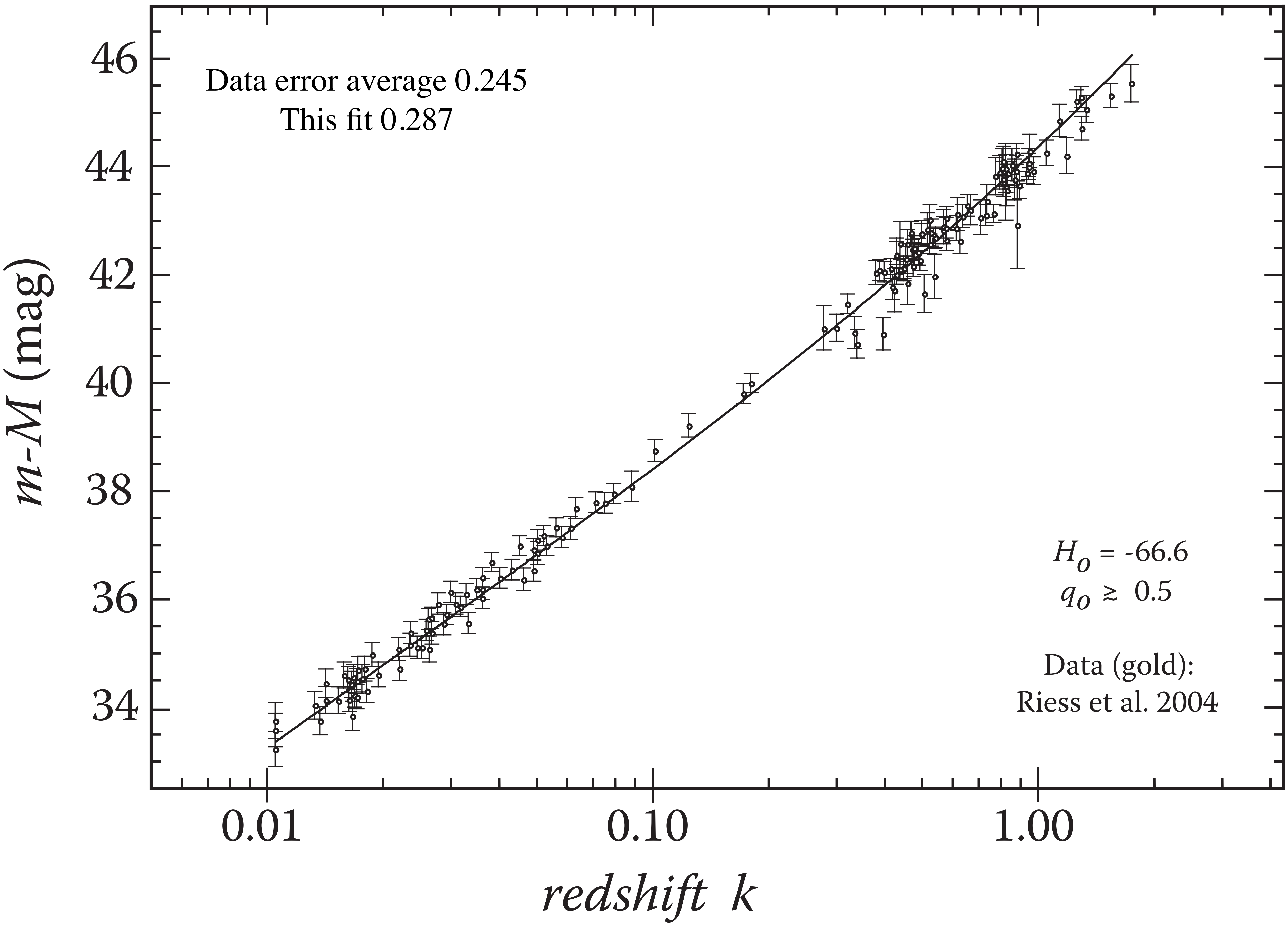
• Derive from Friedmann solution

$$D_L = \left(\frac{-c}{H_0}\right)\frac{(1+k)}{q_0}\left\{\begin{aligned}&\left[k - \frac{(1+k)(1-q_0)}{q_0}\right] \\ &+\frac{(1-q_0)}{(2q_0-1)^{1/2}}\left\{1-\left[k-\frac{(1+k)(1-q_0)}{q_0}\right]^2\right\}^{1/2}\end{aligned}\right\}.$$

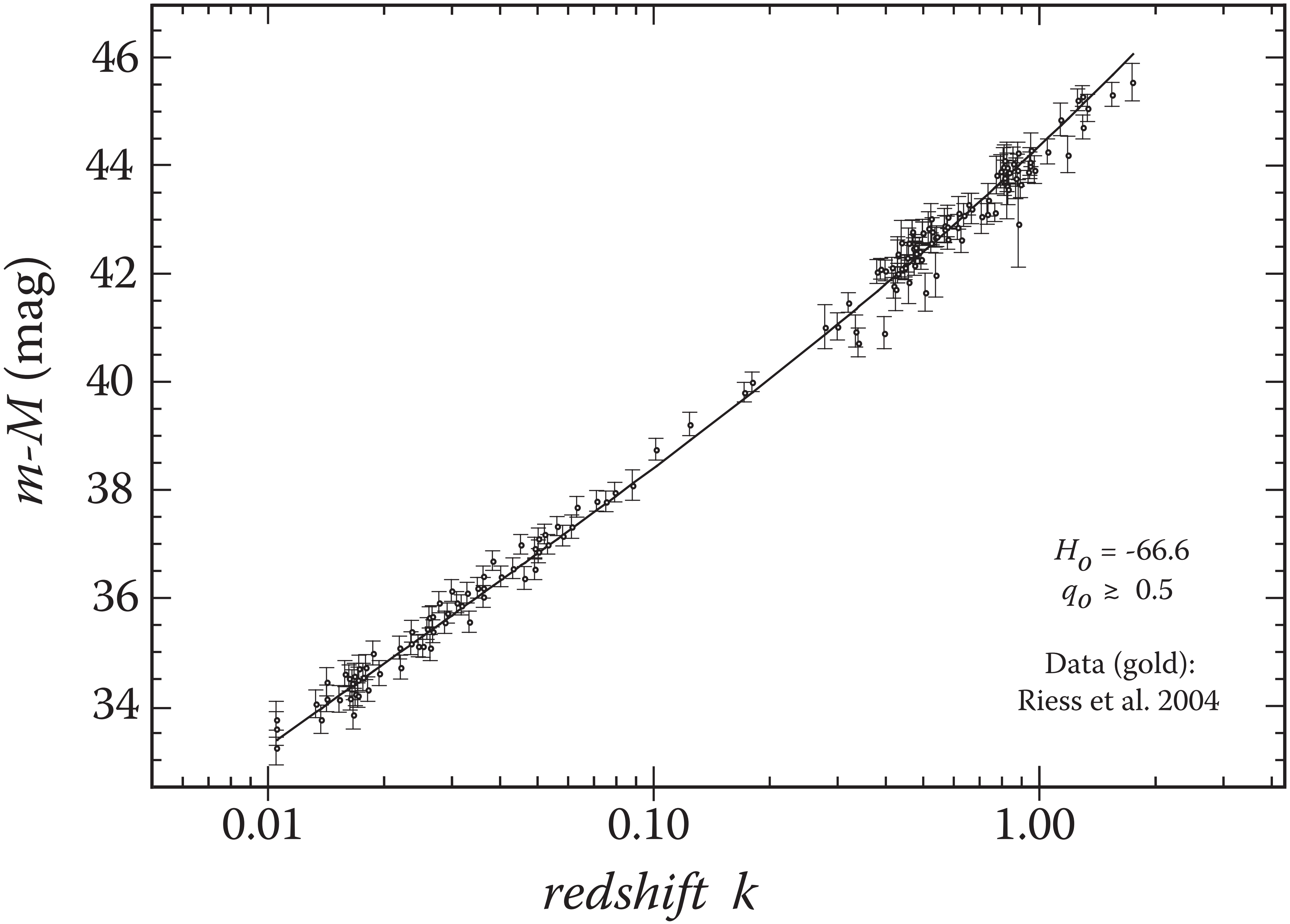
• Vary H_o and q_o for best fit for supernova brightness, m - M, and redshifts, k, using

$$m - M = 5\log_{10}\left(\frac{D_L}{10\text{ parsecs}}\right).$$

Details: arXiv:astro-ph/0008386v1

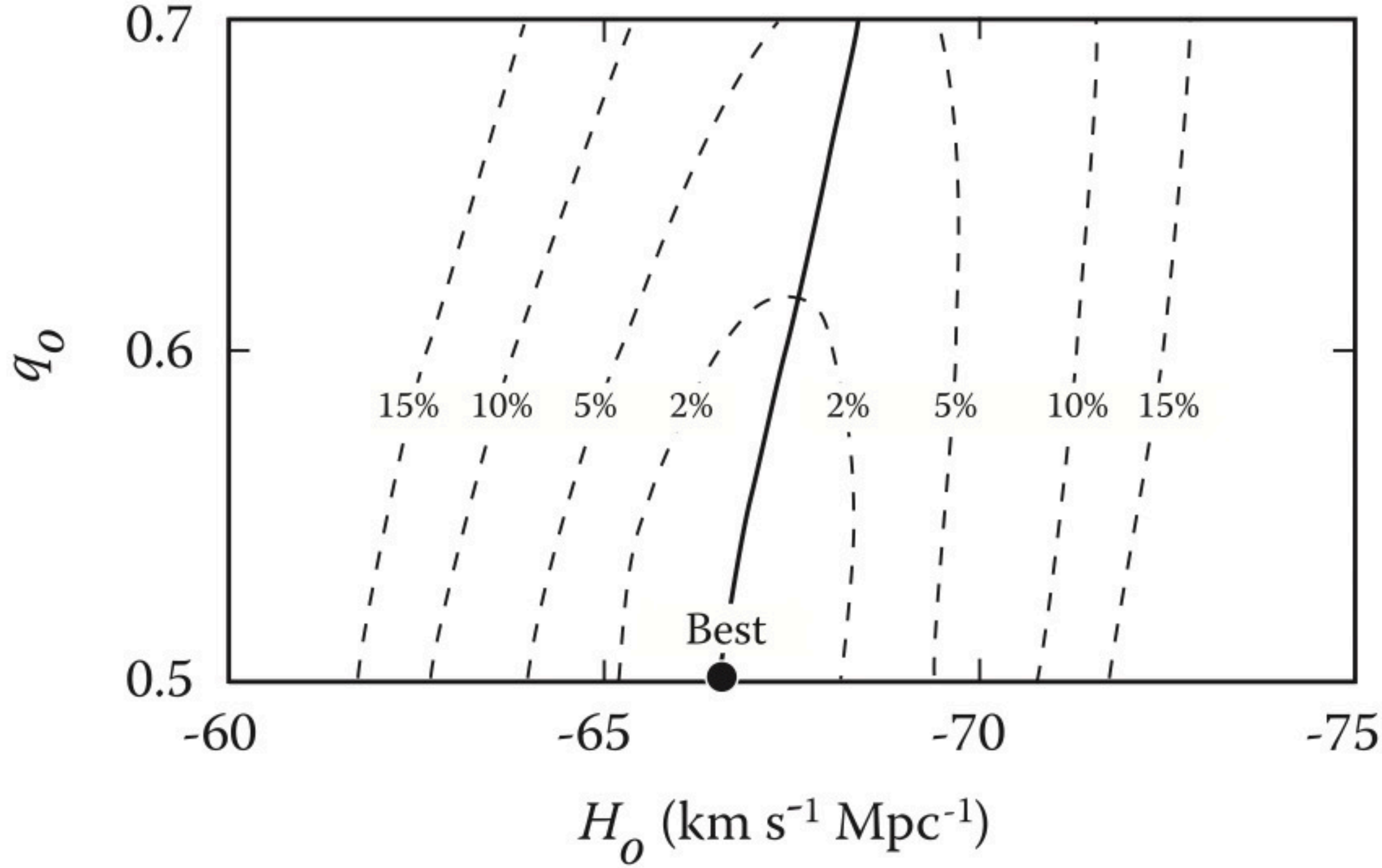


Details: arXiv:astro-ph/0503161v1

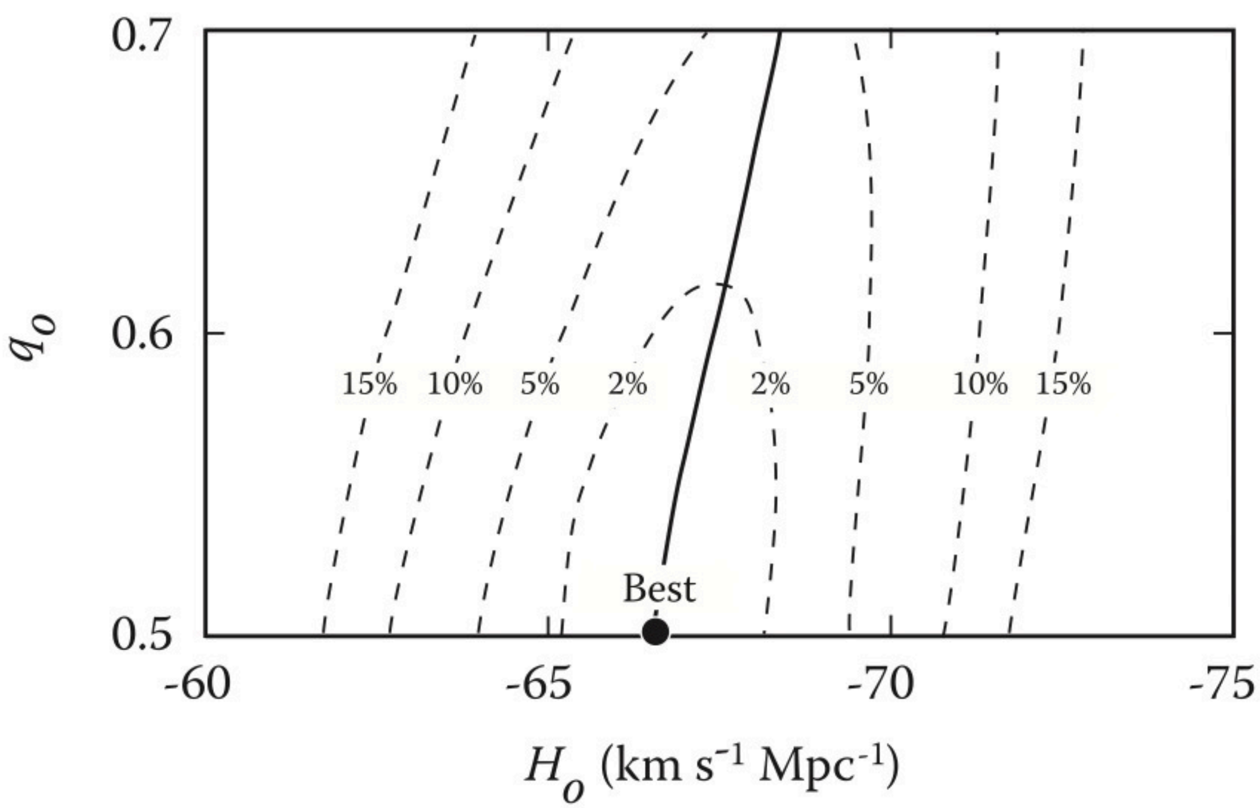


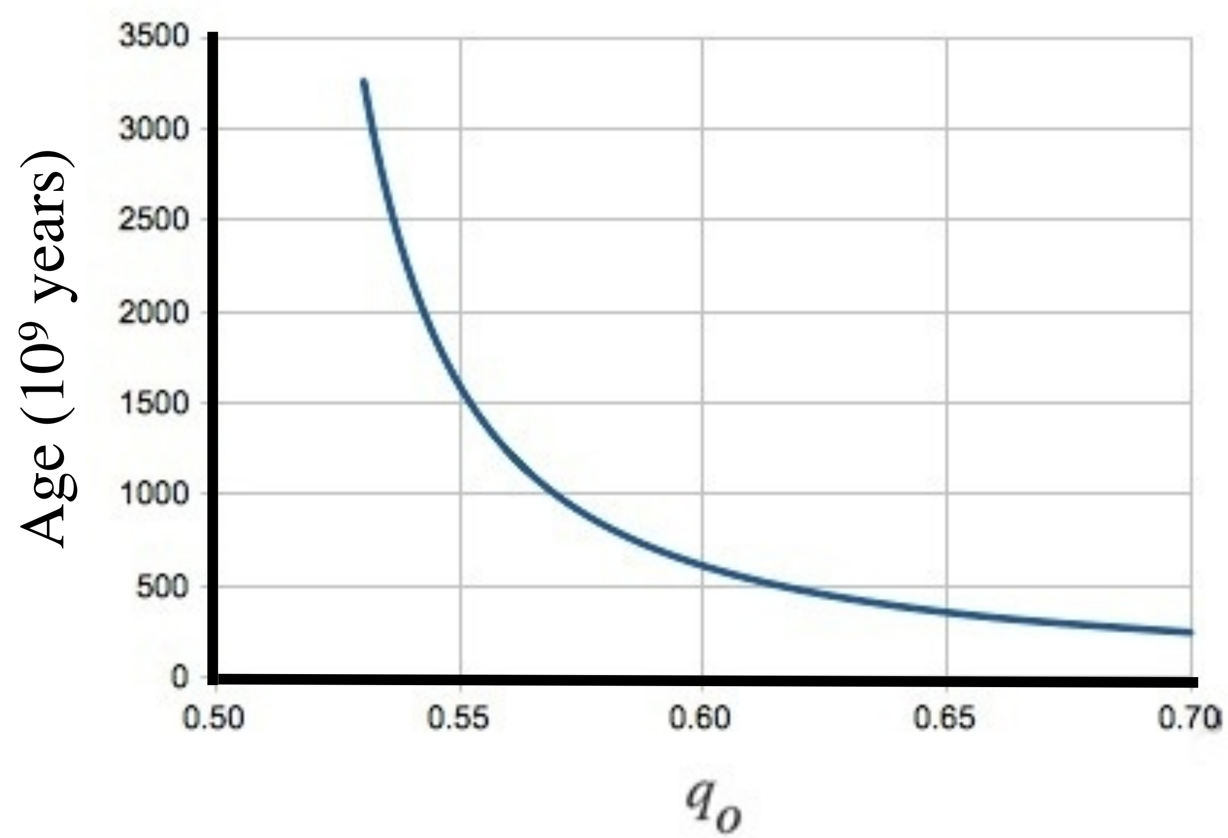
The Friedmann solution explains accelerating redshift. No "Dark Energy" is needed.

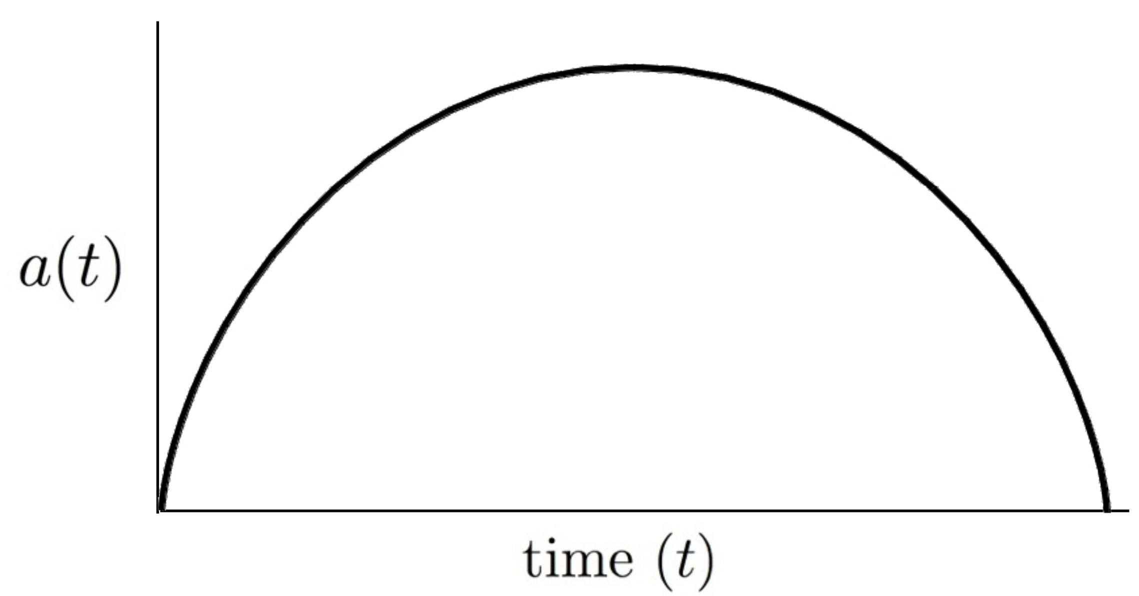
The Universe Is Nearly Flat ($q_o \sim 1/2$)



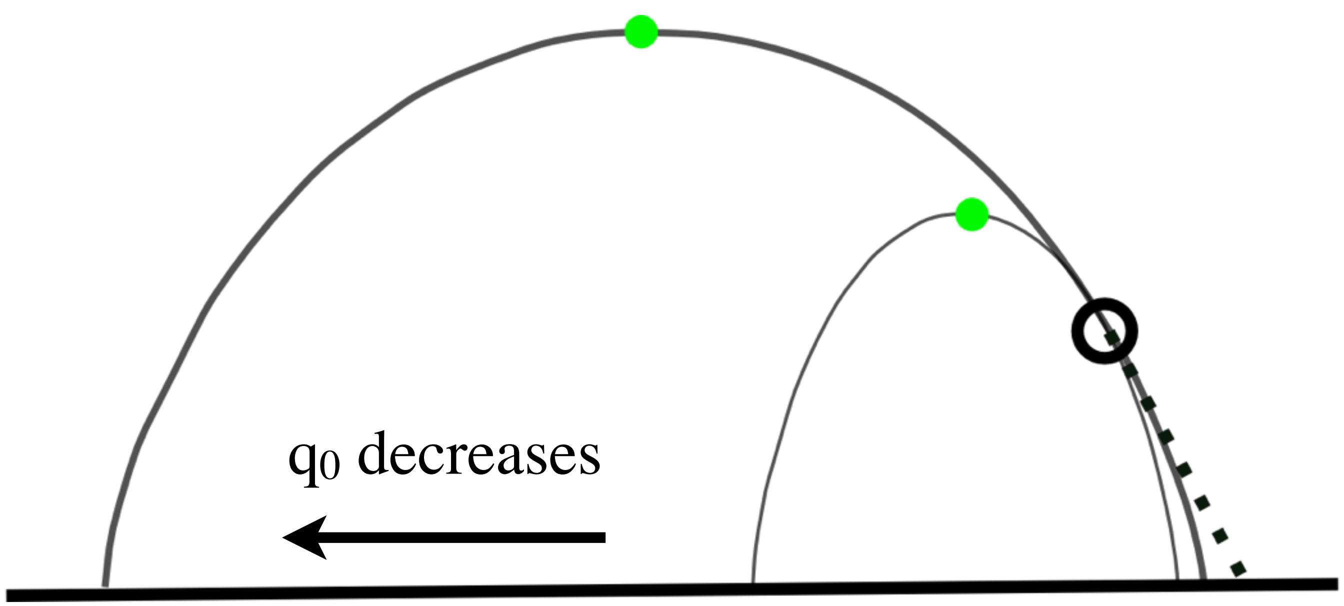
Estimating the Age of the Universe

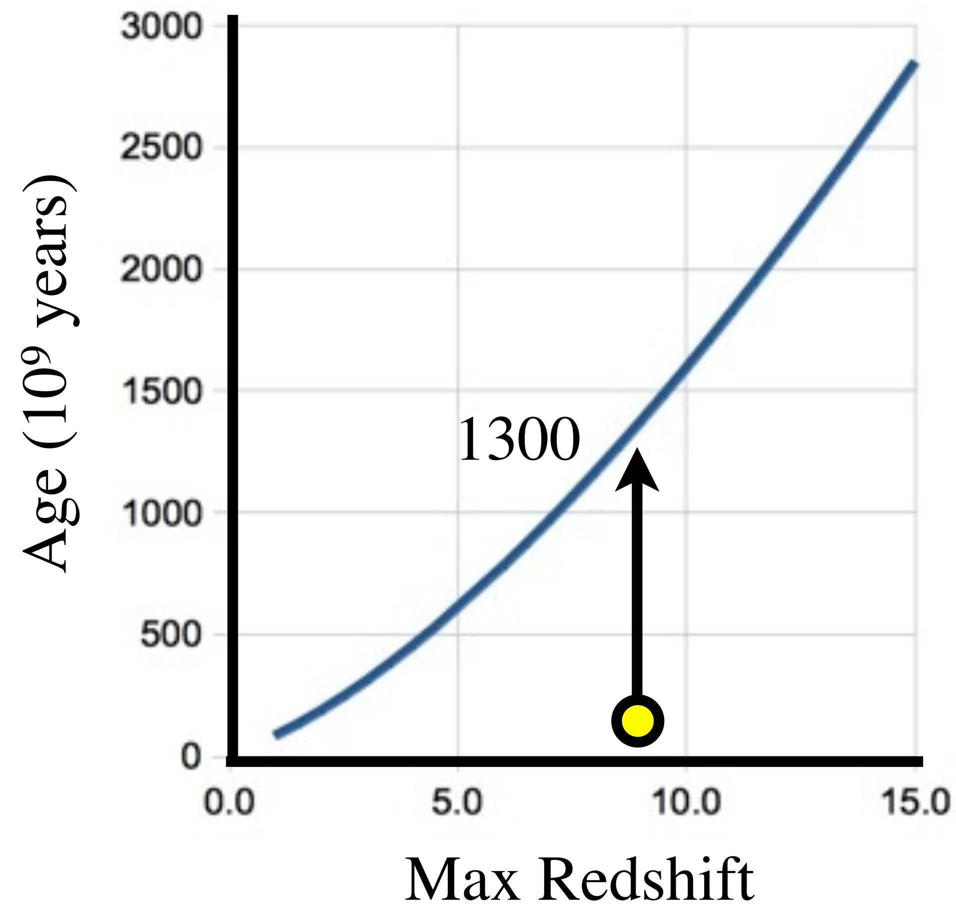






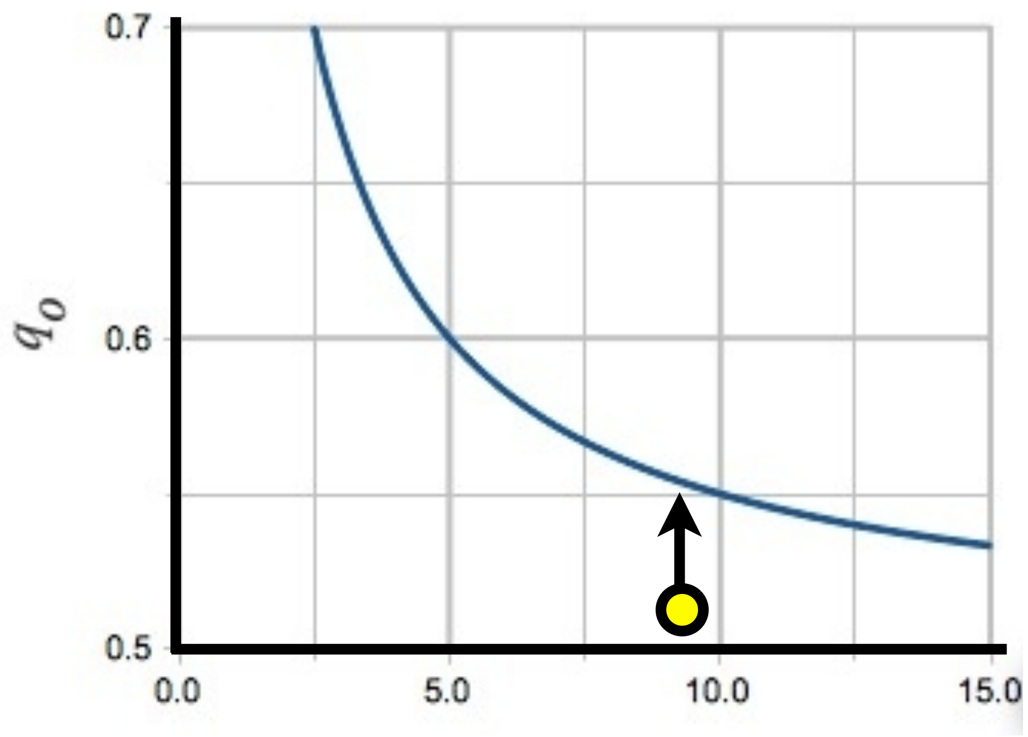
Estimating <u>minimum</u> <u>age</u> by using the maximum observed redshift



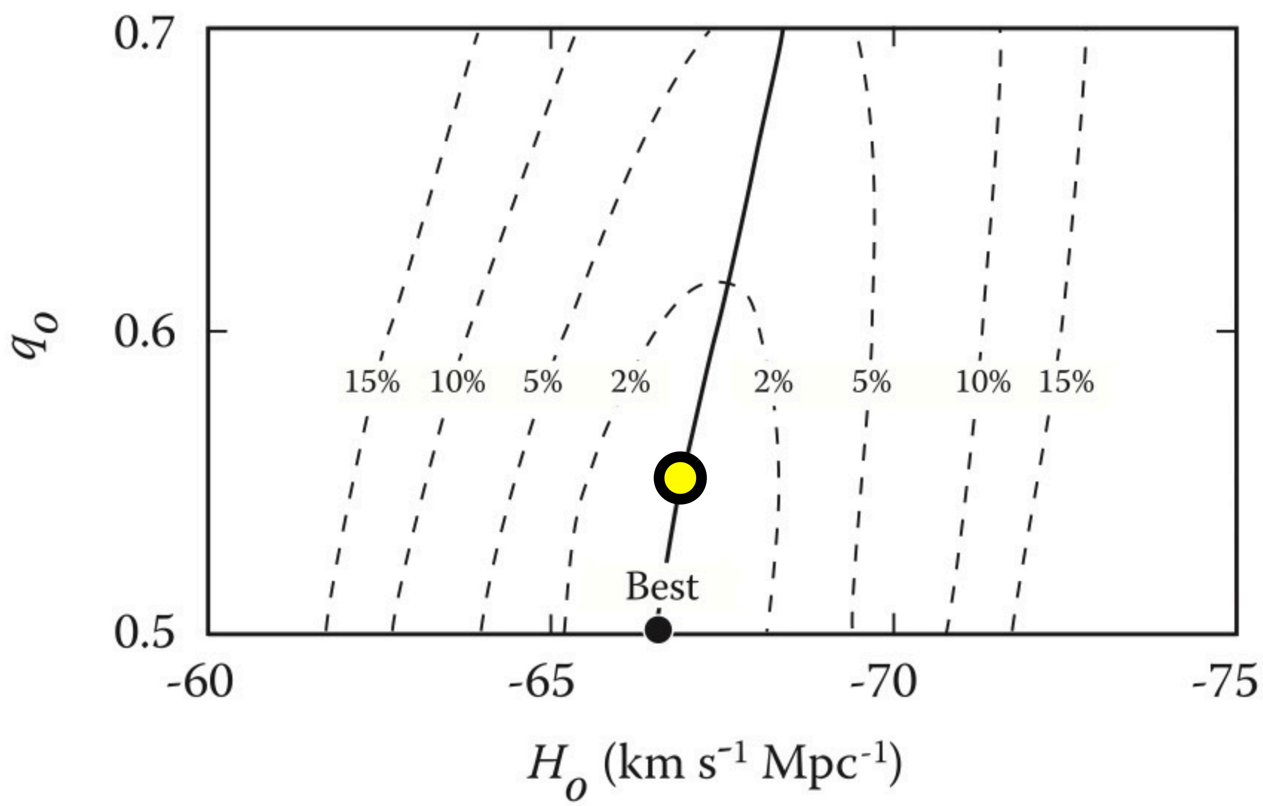


Details: arXiv:astro-ph/0403012 v1

8.6 maximum redshift



Max Redshift

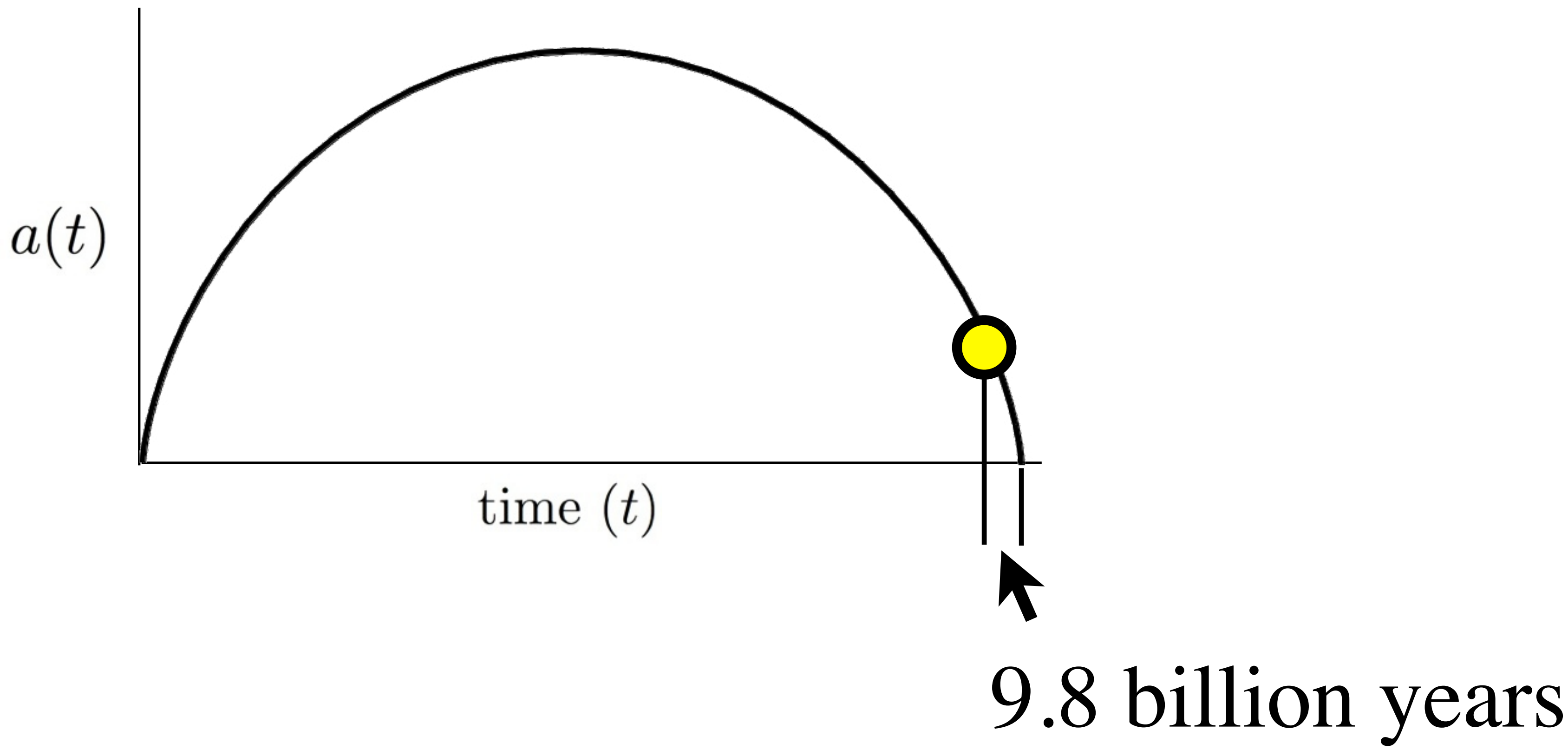


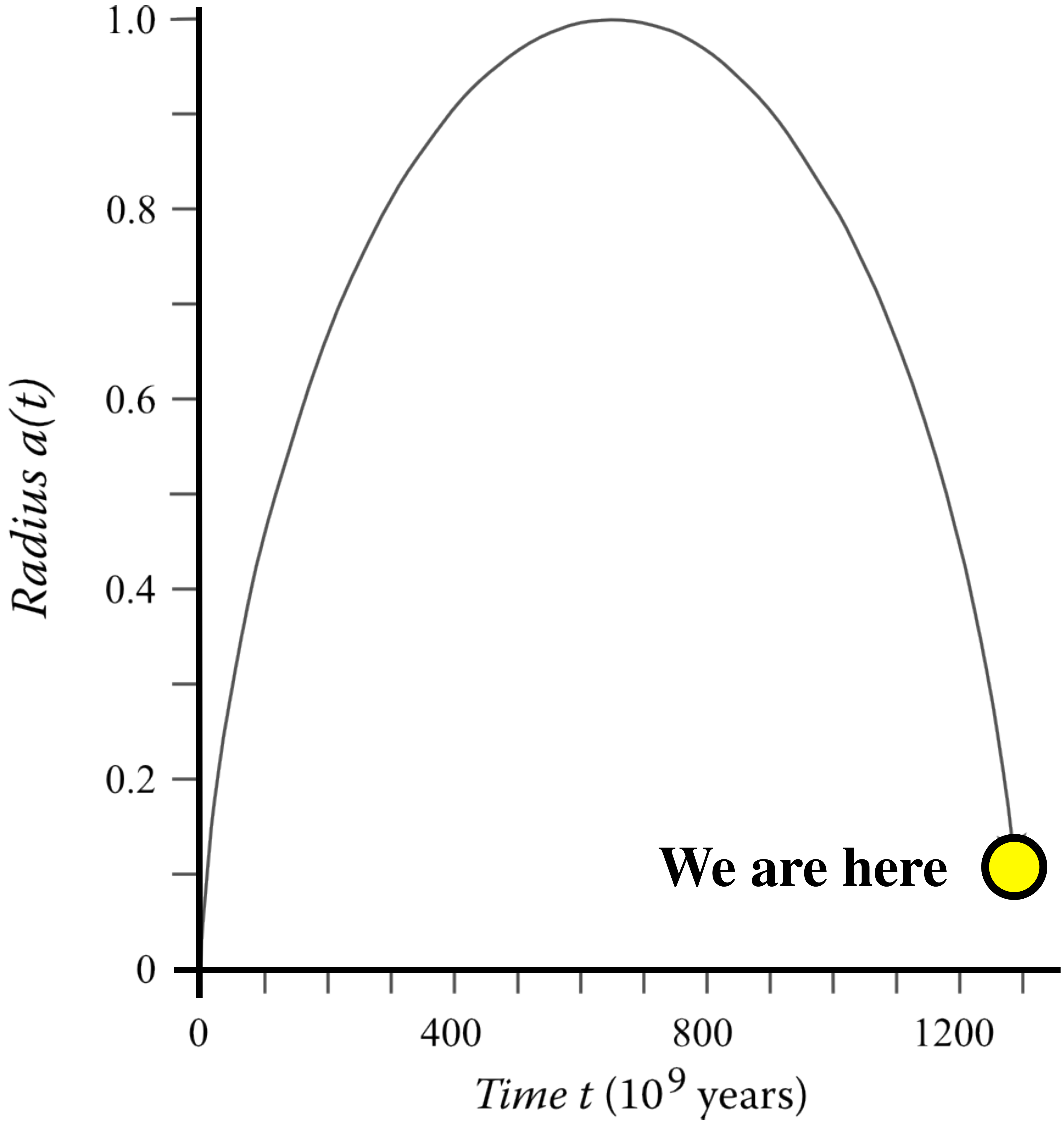
Details: arXiv:astro-ph/0403012 v1

● 8.6 maximum redshift

Time Until Collapse

For the time until collapse, $2/3 \times |H_o|^{-1}$ is a good estimate when q_o is near 0.5. For $H_o = -66.6\ km\ s^{-1}\ Mpc^{-1}$, this is 9.8 billion years.




1.0
0.8
0.6
0.4
0.2
0
Radius $a(t)$
We are here
0
400
800
1200
Time t (10^9 years)

“Dark Matter”

is mass that neither emits
nor scatters electromagnetic radiation.

It cannot be directly detected
by optical or radio astronomy.

There is “Dark Matter”

- The closed Friedmann Universe requires much more matter than has been directly observed.

There is "Dark Matter"

- The closed Friedmann Universe requires much more matter than has been directly observed.

- Many astronomical studies indicate there is much more matter than has been directly observed.

There is "Dark Matter"

- The closed Friedmann Universe requires much more matter than has been directly observed.

- Many astronomical studies indicate there is much more matter than has been directly observed.

    - Motions of clusters of galaxies.

    - Rotational speeds of galaxies.

    - Gravitational lensing.

    - Temperature distributions of hot gases.

A Simple Explanation for "Dark Matter"

- The universe is at least 1300 billion years old.

- The lifetime of our sun, an average star, is estimated to be of the order of 10 billion years.

- Stars began forming soon after the Big Bang. Those and most stars from the following 1300 billion years have gone dark.

- This leads to the hypothesis that

- Most "Dark Matter" likely consists of burned-out stars.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