

The Big Bang or the Conductivity of the Interstellar Space

Abstract

Based on the non-zero conductivity hypothesis of the interstellar space, an alternative cosmological model called "Knowledge spherocone" is formulated. Its significant feature is the ultimate size of a scientifically recognizable universe. It also formulated the hypothesis of ageing light in interstellar space, and calculated the approximate value of skin depth of light in interstellar space.

Part of the article is a discussion of the consistency of the formulated cosmological model with experimentally verified physical laws.

The text is complemented by analyses of the Big Bang theory conflict with experimentally verified physical laws and internal inconsistencies of Big Bang theory.

Keywords

Big Bang Theory, Cosmology, Red Shift, Cosmic microwave background radiation, Conductivity of Universe, Ageing light, Heating interstellar material

1 Introduction

There are currently two widely accepted cosmological theory or hypothesis. Static and the Big Bang Theory (BBT). This text is devoted to that which the majorities currently believe **i.e.** BBT [1].

Cosmology deals with the remote past of the distant universe. However, scientific experiments **cannot** be carried out in the past. Nowadays, humanity does not have the means to carry out scientific experiments elsewhere than on Earth or in its very near vicinity (measured by the dimensions that cosmology deals with).

The main arguments for the BBT are the results of measurements made from the Earth or its immediate vicinity at present, respectively in a very near past. This is the effect of red shift and microwave radiation.

The basic methodology of scientific knowledge is the verification of hypotheses and theories by the experiment. Directly or indirectly, using previously authenticated natural laws.

To refute the hypothesis or theory, a single disagreement with the experiment or known, experimentally verified law is sufficient.

Another question is an explanation of the measured values, which can be interpreted differently.

The text formulates a hypothesis that makes it possible to explain the measured results in accordance with known physics laws differently than BBT.

The non-zero conductivity of interstellar space and ageing light hypotheses are used.

The relevant analyses are enclosed.

2 Conductivity of the Universe

Let us work with the hypothesis of **the non-zero conductivity of interstellar space**. This means that we will work with the interstellar space in exactly the same way as with other

42 material, we will not make an exception for interstellar space. We will respect that
 43 experimentally validated Maxwell equations [30] also apply in interstellar space, and this is
 44 characterized by all three non-zero material constants i.e. permittivity, permeability and
 45 conductivity.

46 That is, we will not consider that the interstellar space is filled with the abstract phenomenon
 47 of vacuum, a space without any mass, but we will respect that the distance between the
 48 particles in the interstellar space is final, and that these particles make material analogous to
 49 other materials known from Earth and its surroundings.

50 The hypothesis can also be formulated differently. Vacuum does not exist. It is a physically
 51 unrealistic abstraction. Everywhere in the universe there are particles of matter. Therefore,
 52 the interstellar space also has non-zero conductivity and is no exception.

53 2.1 Ageing Light

54 According to Maxwell's equations, the plane electromagnetic wave is attenuated, depending
 55 on the conductivity of the material in which it propagates, the energy expressed by the
 56 Poynting vector [2] decreases depending on the distance $P(D) = P(0) \cdot e^{-2\alpha D}$, where

57 $\alpha = \frac{\sigma}{2} \sqrt{\frac{\mu}{\epsilon}}$, where σ is conductivity, μ is permeability and ϵ is permittivity of the material.

58 Compare this property of electromagnetic radiation with the experimental results described
 59 by the Hubble equation, from which we remove the hypothesis of the interpretation of the
 60 cause of wavelength change $\frac{\Delta\lambda}{\lambda} = z = \frac{H_0}{c} \cdot D$.

61 How the wavelength (or frequency) of light is related to energy? The Planck-Einstein
 62 relationship is the answer to this question [3, 4] $E = hf = \frac{hc}{\lambda}$.

63 So far, it has not been experimentally verified that the energy and thus the photon
 64 wavelength and frequency of the photon would change with long-term light propagation and
 65 there is no evidence to the contrary. We can formulate the second part of the hypothesis:
 66 **The Planck-Einstein relation remains valid also in the case of loss of photon energy**
 67 **when light propagates in conductive material.**

68
 69 Based on the hypothesis we can describe the dependence of wavelength on the distance

$$E(D) = \frac{hc}{\lambda(D)} = hf(D)$$

$$\lambda(D) = \frac{hc}{E(D)} \equiv \frac{hc}{P(D)} = \frac{hc}{P(0) \cdot e^{-2\alpha D}} = \frac{hc}{P(0)} \cdot e^{2\alpha D}$$

70
 71 We calculate the average conductivity of the universe from the measured linear
 72 approximation of the red shift and distance described by the Hubble relationship using the
 73 formulated hypothesis.

74
 75 According to Hubble law [5] use approximate calculation for small z : $z = \frac{\lambda_o}{\lambda_e} - 1 \approx \frac{H_0 \cdot D}{c}$. We
 76 will use a previously derived relationship to which we mark the indexing used above $\lambda(D) \equiv$

77 $\frac{hc}{P(0)} \cdot e^{2\alpha D} = \frac{hc}{P(e)} \cdot e^{2\alpha D}$, we will get $z = \frac{\lambda_o}{\lambda_e} - 1 = \frac{\frac{hc}{P(e)} \cdot e^{2\alpha D_o}}{\frac{hc}{P(e)} \cdot e^{2\alpha D_e}} - 1 = \frac{e^{2\alpha D_o}}{e^{2\alpha D_e}} - 1$.

78 Because in the description of the electromagnetic wave attenuation the distance from the
 79 source is measured, and in the Hubble relationship from the observer, we get $D_o = D_a$
 80 $D_e = 0$ and

$$z = \frac{\lambda_o}{\lambda_e} - 1 = \frac{e^{2\alpha D_o}}{e^{2\alpha D_e}} - 1 = \frac{e^{2\alpha D}}{1} - 1 = e^{2\alpha D} - 1$$

81 To calculate the conductivity, we use a first-order approximation (for small D) $e^{kD} \approx 1 + kD$,
82 we get

$$83 \quad z = e^{2\alpha D} - 1 \approx 1 + 2\alpha D - 1 = 2\alpha D. \text{ Compare with } z \approx \frac{H_0 \cdot D}{c} \text{ and get } 2\alpha D = \frac{H_0 \cdot D}{c} \rightarrow \alpha = \frac{H_0}{2c}.$$

84

85 Relations between the material constants, the speed of light propagation and attenuation of
86 electromagnetic waves are known [6, 7] $\alpha = \frac{\sigma}{2} \sqrt{\frac{\mu}{\epsilon}}$ and $c = \frac{1}{\sqrt{\epsilon\mu}}$, we can calculate the
87 conductivity

$$\sigma = 2\alpha \sqrt{\frac{\epsilon}{\mu}} = 2 \frac{H_0}{2c} \sqrt{\frac{\epsilon}{\mu}} = \frac{H_0}{c} \sqrt{\frac{\epsilon}{\mu}} = H_0 \sqrt{\epsilon\mu} \sqrt{\frac{\epsilon}{\mu}} = H_0 \epsilon$$

88

89 We will count for $H_0 = 2.28 \cdot 10^{-18} [s^{-1}]$ and $\epsilon = 8.8 \cdot 10^{-12} [Fm^{-1}]$, we get $\sigma = 2.0 \cdot$
90 $10^{-29} [Sm^{-1}]$.

91

92 The accuracy of the value is determined by the accuracy of the constants used, namely the
93 Hubble constant and permittivity.

94

95 It is known that permittivity is a property of the material, and conductivity is also a property of
96 the material.

97

98 Sometimes inverse value is used – Resistivity $\rho = \zeta = \frac{1}{\sigma}$, we quantify $\rho = 5.0 \cdot 10^{28} [\Omega m]$.

99

100 From the above-defined hypothesis and the derived relation between the Hubble constant
101 and the attenuation of electromagnetic waves, it is possible to describe the dependence of
102 the red shift in a homogeneous environment with a constant conductivity $z = e^{2\alpha D} - 1 =$
103 $e^{2\frac{H_0 D}{2c}} - 1 = e^{\frac{H_0 D}{c}} - 1$.

104 **Alternatively**, other expressions using material constants used in Maxwell's equations

$$105 \quad z = e^{2\alpha D} - 1 = e^{2\frac{\sigma}{2} \sqrt{\frac{\mu}{\epsilon}} D} - 1 = e^{\sigma \sqrt{\frac{\mu}{\epsilon}} D} - 1.$$

106 Note:

107 If the conductivity in the vicinity of the Earth is greater than in the distant universe (the
108 conductivity is greater within the Milky Way than in the intergalactic space because the
109 average particle distance is smaller inside the galactic space than between the galaxies), the
110 redshift of nearby sources will be relatively larger than distant.

111 The same is true of the directional dependence of the conductivity and the resulting redshift.

112 Deviations of the red **shift from** the red shift of the homogeneous environment can be used to
113 investigate the physical properties of the space in which the light diffuses.

114 2.2 The Half-life of Light

115 Physical phenomena with exponential dependencies are characterized in practice by a useful
116 parameter associated with a value of $1/e$ or $\ln(2)$. For example, Skin depth [8] or Half-life [9].

117

118 By analogy, we calculate the half-life of light and the skin depth of light in the universe.

119

120 Half-life of light - The time at which the energy of the plane wave (photon) is reduced to half,

121 i.e. the time at which the frequency is reduced to one half $T_{1/2} = \frac{\ln(2)}{\frac{\sigma}{\epsilon}} = \ln(2) \frac{\epsilon}{\sigma} = \ln(2) \epsilon \rho =$

122 $\frac{\ln(2)}{H_0}$.

123 Enumeration $T_{1/2} = 3.04 \cdot 10^{17} [s] = 9.64 \cdot 10^9 [year]$.

124 Over a period equal to the half-life the light spread into the distance $D = T_{1/2} \cdot c = 9.64 \cdot$

125 $10^9 [ly]$.

126 Thus, the skin depth of light in the interstellar space is about 10 billion light-years.

127 Note – this is not a decrease in brightness due to the geometry of the spherical wave.

128 2.3 Heating Interstellar Material

129 Because the energy lost as a result of the non-zero conductivity of the universe and the red
130 shift has been transformed into heat, the interstellar space is heated by this energy and
131 therefore radiates electromagnetic radiation according to Planck's law [10]. This means that
132 the measured Cosmic microwave background radiation (CMB) [35] can be interpreted as the
133 radiation of a black body radiated by the material of the universe, and this material has a
134 measured temperature of approximately 2.7K.

135

136 The largest proportion of CMB measured from Earth is radiation emitted near Earth. The
137 measured inhomogeneity of CMB can be interpreted as a result of non-homogeneity of
138 material in the Earth's vicinity, manifested as non-homogeneity of conductivity.

139 The amount of energy converted to heat is dependent on conductivity, a known
140 experimentally verified phenomenon.

141 Therefore, it is expected that the red shift of the source in the direction of the high CMB
142 temperature will be greater than the red shift of the source in the direction of the low CMB
143 temperature.

144 2.4 Microwave Pollution

145 According to the hypothesis of the conductivity of the universe, the microwave radiation
146 radiates the surroundings of the observer anywhere in the universe, which is the result of
147 heating the interstellar material due to non-zero conductivity.

148 At the same time, due to the ageing of light, the wavelength of distant sources is extended.

149 With the increasing distance of the source, the size of the Fresnel zone[27] increases. This is
150 due both to the distance itself and also to the wavelength increase.

151 The ability to distinguish the direction of the source of electromagnetic radiation deteriorates
152 with the increasing wavelength.

153 Increasing distance also reduces radiation energy captured by the observer due to geometry
154 and also the ageing of light, the loss of energy by spreading in the conductive material.

155 At the same time, increasing the distance assuming a homogeneous distribution of resources
156 increases the number of sources in a constant angle segment.

157 This means that with increasing distance, the possibilities of recognizing radiation from
158 different sources and the differentiation of resources are getting worse.

159 Closer resources overshadow remote sources. Far more remote sources overshadow even
160 more remote sources. The larger the wavelength, the larger the shadow range.

161 When the wavelength is prolonged enough to approach the CMB wavelength, it is overshoot
162 by near CMB radiation, making observation impossible. There will be an analogy that
163 astronomers know well from the surface of the Earth and is called light pollution or light smog
164 [11].

165 The local CMB thus creates a barrier to possible research of distant sources of
166 electromagnetic waves.

167 **3 Cosmological Model**

168 The alternative cosmological model is based on the hypothesis of the universe with non-zero
169 conductivity.

170
171 The universe is filled with material characterized by three electromagnetic material constants
172 (permittivity, permeability, conductivity). The material also has other material properties
173 analogous to materials on Earth and its surroundings.

174 The material is not completely homogeneous. The extent, properties and causes of
175 inhomogeneity are not yet known.

176 Vacuum does not exist. It is a physically unrealistic abstraction.

177 The light spreads in space in accordance with Maxwell's equations, so the speed of light is
178 not constant. It is given by an experimentally verified relationship $c = \frac{1}{\sqrt{\epsilon \cdot \mu}}$.

179 The speed of light is related to the material in which it is spreading.

180 It is not excluded that the speed of light in some parts of the universe is greater than the
181 speed of light around the Earth. This may be due to the fact that the mean distance between
182 the atoms is greater than the average distance between the atoms in the vicinity of the Earth
183 and therefore the permeability and / or permeability is smaller.

184 Light from distant sources ages and part of energy is absorbed by the material of the
185 universe.

186 This heated material emits energy in the form of microwave radiation (high wavelength).

187 Geometric properties, along with ageing light and microwave backgrounds, limit the ability to
188 discover distant areas of the universe.

189 This creates the ultimate spherocone of knowledge.

190 **3.1 Knowledge Spherocone**

191 The observer has the ability to explore the universe using electromagnetic waves (light,
192 microwaves, ...). It can only evaluate the waves it captured at the time of observation at the
193 observation site.

194 This means that it only captures the radiation that was radiated at the right time from the right
195 place. The correct time and place is relative to the observer in the sense that it must be in a
196 time and space just so that the radiation is captured by the observer.

197 For clarity - when we plot this dependence into a 3D graph with two spatial coordinates and
198 the third coordinate is time, a cone image is created. Cone angle corresponds to the velocity
199 of the radiation.

200 So the observer can only observe what is happening on the cone shell. All that is inside is
201 the past; the radiation went to the observation point before the observation began.

202 Everything outside is the future, the radiation will go to the observation point after the end of
203 the observation.

204 The real space has three dimensions and the observer can capture the radiation from any
205 direction, creating a sphere.

206 Because we live on Earth and nowadays and we have the ability to conduct observations
207 only in relatively near Earth and in a relatively short period of time compared to spatial and
208 temporal scales of the universe, the center-point of our spherocone is located on Earth at
209 present.

210 In other words, our Earth is the center of a recognizable universe. This does not mean that
211 Earth is the center of the universe, but it is the center of human knowledge of the universe.

212

213 Since the effect of microwave pollution, together with the ageing of the light, limits the
214 distance from which it is possible to observe and evaluate information from the received
215 radiation, the spherocone has the final dimension. However, the end is not clearly defined,
216 there is no recognizable boundary between the recognizable and unrecognizable part of the
217 universe. The knowledge and technological possibilities of mankind can increase the size of
218 the spherocone of knowledge.

219 **3.2 The Origin of the Universe**

220 The fundamental part of cosmology is the question of the origin or non-appearance of the
221 universe and its evolution over time.

222
223 The answer to this question, according to the cosmological model described, has two
224 variants:

225 The universe is so small or so young that the origin or edge of the universe is within our
226 spherocone of knowledge.

227 The universe is larger and older than our spherocone of knowledge.

228

229 By roughly estimating the magnitude of our spherocone of knowledge for 100 billion years of
230 time and 100 billion light-years of radius, we have the hope of obtaining a science-based
231 answer to the question of the age or size of the universe only if the universe arose later than
232 100 billion years ago or the Earth is closer than 100 billion light-years to the edge of the
233 universe (and if such a margin exists).

234 Otherwise, if the universe is older and larger, we will not know whether the universe
235 originated, when it originated and how it originated.

236 There is not yet any experimentally proven evidence that would derail the possibility that the
237 universe is much older and larger than our spherocone of knowledge.

238 Until we have evidence that the creation of the universe or the edge of the universe is in our
239 spherocone of knowledge, we can only humble ourselves that this question remains
240 unanswered or irresponsible.

241 It only means that we will be reconciled to the fact that space and time are large enough for
242 the question of the origin of the universe not to be troubled.

243 **3.3 The Ultimate Dimension of Knowledge Spherocone**

244 How the knowledge spherocone can have the final dimension and not have borders? What's
245 next? What happens when someone gets to the border?

246 The situation can be imagined, as we stand on the freshly snow-covered meadow in thick
247 fog. Everywhere is white. There is no known where the snow passes in the fog. All sides are
248 the same white. We see our own hand and things in the immediate vicinity.

249 Only when we go to the forest (if we are lucky and choose the right direction) then after some
250 time something darker will appear in the fog. And what we will be closer to the forest, the
251 more clearly we will see the border of the forest and then the individual trees.

252 In the case of the knowledge spherocone it is analogous, except that we have no chance to
253 move in either space or time.

254 More specifically, human possibilities are negligible compared to the dimensions of space,
255 both in terms of distance and time.

256 How is the spherocone big?

257 According to the hypothesis of light ageing and measured data, the Skin depth of light in the
258 interstellar space is about 10 billion light-years.

259 Sunlight-like light (around 6000°K) is overshadowed by the CMB due to the wavelength
260 change, that is, when the energy drops to roughly a thousandth. This occurs at about ten
261 times the Skin depth. The cone-ball dimension, according to today's measured data, is
262 estimated at about 100 billion light-years and 100 billion years old.

263

264 Compare this dimension with human possibilities.

265 Human civilization is about 10,000 years old. Even if civilized humanity survived on Earth a
266 million years, it will be 10^{-5} of spherocone time.

267

268 Nowadays, people have moved to the Moon, using automatic probes to the boundary of the
269 Solar System. The closest star (Proxima Centauri) is at distance 4.2 ly. The closest galaxy
270 (Great Magellanic Cloud) is at a distance of 70,000. ly. The distance of 70,000 ly is less than
271 10^{-6} of knowledge spherocone radius.

272 That means, after making such enormous effort that the expedition to the neighboring galaxy
273 would certainly require, the knowledge of humankind would change in the same way as
274 when we observe something at a distance of 1 km and shifted by 1 mm.

275 4 Discussion

276 4.1 The Existence of a Vacuum

277 There is experimental evidence that interstellar space is not empty. Let's say, for example, a
278 hydrogen cloud between our galaxy (Milky Way) and the two closest galaxies. [12] -
279 "Streams of neutral hydrogen connect them to the Milky Way and to each other"
280 Or the NASA results [13] - "Plasmas are the most common phase of matter. Some estimates
281 suggest that up to 99% of the entire visible universe is plasma ". [14] and also solar wind [15]
282 and cosmic dust [16].

283 Light and heat radiation can also be added if we recognize the validity of the principle of
284 equivalence of matter and energy [17].

285

286 The idea of vacuum is a well-known abstraction in the professional public, so let's put the
287 following argument. Let us use a reversed look: ordinary material (hydrogen, sulfur, carbon,
288 copper, ...) can be considered a vacuum or a special case of vacuum because most of the
289 space inside the atoms and between the atoms is empty. "Exceptions" can be neglected.
290 This is the same "logical" approach as in interstellar space, only values differ.

291 4.2 The Speed of Light

292 It is experimentally verified that light propagates in different materials at different speeds
293 $c = \frac{1}{\sqrt{\epsilon \cdot \mu}}$. that is why glasses, cameras, binoculars, etc. work.

294 Present physics recognizes one exceptional speed of light as a universal constant. This
295 exceptional feature has a special environment that is called a vacuum.

296 The formulated hypothesis says that there is no such extraordinary environment or material
297 in the universe that it is merely a human idea.

298 Thus, the speed of light (in vacuum) used in a number of physical theories is not a real
299 picture of true nature.

300 It can be argued that the speed of light in the vacuum was measured. Its size is known. This
301 is only partially true. The speed of light was measured, but it was not measured in the actual
302 vacuum, but only in the material declared under vacuum. In fact, there was mass inside the
303 Fresnel Zone [27].

304 For reliable measurement of the velocity of light in a vacuum, it would be necessary to
 305 perform measurements in a space without any mass or energy and which would have a
 306 dimension allowing the measurement of propagation time with sufficient precision. So if it
 307 were enough to carry out the 1s measurement, there would have to be a space of 300,000
 308 kilometers without a single atom, another photon or other particle of matter in the Fresnel
 309 zone. This is roughly the distance of the Earth - the Moon.

310 4.3 Brightness Attenuation Analysis

311 From the conductive universe model, the brightness of the remote light source will decrease
 312 not only due to the geometric change in energy density, but will also decrease with the
 313 attenuation (as much as the frequency drops).

314
 315 If the attenuation is not included in the calculation of the distance from the measured
 316 brightness, the distance will be greater than the actual distance.

317
 318 Let us start from the relationship between energy and the wavelength of the light quantum

$$319 E = \frac{h}{\lambda}.$$

320 Let us suppose that the light quantum energy is dependent on the distance from the source
 321 according to the general function $E = E_0 \cdot f(r)$, where r is the distance from the source and E_0
 322 is the energy emitted by the source.

323 We calculate the light intensity of the omnidirectional source depending on the distance for
 324 two variants:

325 1 - no energy dependency of light quantum on distance (zero conductivity of environment) - i_1
 326 2- with the dependence of the light quantum energy on the distance (non-zero conductivity of
 327 the environment) - i_2

$$328 i_1 = P \frac{1}{4\pi r^2}, i_2 = P \frac{f(r)}{4\pi r^2}$$

329
 330 Depending on the energy of the light quantum we express the red shift z

$$331 E = E_0 \cdot f(r) = \frac{h}{\lambda(r)}, \text{ then } \lambda(r) = \frac{h}{E_0 \cdot f(r)} = \frac{\lambda_0}{f(r)} \text{ and } z(r) = \frac{\lambda(r) - \lambda_0}{\lambda_0} = \frac{1}{f(r)} - 1, f(r) = \frac{1}{z(r) + 1}$$

332
 333 Calculate the distance ratio of variants 1 and 2 for the same light intensity

$$334 i_1 = P \frac{1}{4\pi r_1^2} = i_2 = P \frac{f(r_2)}{4\pi r_2^2}, \text{ then } \frac{1}{r_1^2} = \frac{f(r_2)}{r_2^2} \text{ and } \frac{r_2^2}{r_1^2} = f(r_2), \text{ we get } \frac{r_2}{r_1} = \sqrt{f(r_2)}.$$

335
 336 The ratio of distances with energy dependence and without energy dependency is expressed
 337 by the red shift $z \frac{r_2}{r_1} = \sqrt{f(r_2)} = \sqrt{\frac{1}{z(r_2) + 1}}$.

338 We can see that the distance r_2 calculated by including the general energy attenuation that is
 339 directly proportional to the red shift z is always smaller than the distance r_1 without counting
 340 the attenuation. The ratio increases with the increasing red shift.

341 4.4 Comparison of the Conductivity Hypothesis with the 342 Measurement Results and Applicable Laws

343 Compare the hypothesis of conductivity of the universe with experimentally verified laws and
 344 measurement results.

345 The hypothesis works with constant distances as well as classical physical laws. There is no
346 problem with the wavelength, frequency and propagation velocity of electromagnetic waves,
347 there is no problem with Kepler's laws, with the kinetic energy of the planets, changes in
348 planetary distances. There is no need to consider the time dependencies of physical
349 constants or even the time dependency of the length unit.

350 There is no need to predict the effects of an unknown gravitational force or other source of
351 exponential or other acceleration growth of all bodies in space.

352 The measured red shift is not due to the movement of light sources or the expansion of the
353 light wavelength. It is caused by the conductivity of the universe; it is the manifestation of
354 ageing of light, which is in accordance with known and experimentally verified laws of
355 thermodynamics. It is no hidden Perpetuum.

356 There is no need for an exception applied to interstellar space; it is possible to work with a
357 complete set of Maxwell's equations in interstellar space as well.

358 CMB can be interpreted directly as radiation of heated interstellar material.

359

360 The second hypothesis used is the light ageing hypothesis, which is based on the
361 assumption of the validity of the experimentally verified Planck-Einstein relation even in the
362 case of loss of photon energy due to the conductivity of the material.

363 This hypothesis has not yet been experimentally refuted. If we do not take into account the
364 experiments below, it goes from a methodological point of view to a hypothesis analogous to
365 the Scale factor wavelength expansion hypothesis, or a hypothesis explaining the red shift as
366 a consequence of the Doppler effect of the receding source.

367 It can be argued that the Doppler effect is experimentally verified.

368 The Planck-Einstein relationship is also verified.

369

370 There are experiments that can be interpreted as experimental verification of this hypothesis.

371 4.4.1 Gravitational Redshift of Light

372 It has been experimentally verified that the wavelength of light changes in the Pound-Rebka
373 experiment [18].

374 Changing the wavelength in this experiment cannot be interpreted as Doppler effect because
375 the source and the light detector do not move each other. Changing the wavelength cannot
376 be interpreted either as a result of the space expansion effect.

377

378 The result can be interpreted as changing the part of the photon energy to potential
379 gravitational energy and the red shift as a result of diminishing photon energy.

380

381 According to [19] is $\frac{\Delta\lambda}{\lambda} \approx \frac{g\Delta y}{c^2}$ where Δy is height difference.

382 According to [20] $\Delta\nu_h = \nu_h - \nu_0 = \nu_0 gh/c^2 (1 + h/R)$ where h is the height relative to the
383 Earth's surface, R is the radius of the Earth, ν_h the frequency measured at the height h and
384 ν_0 the frequency measured at the Earth's surface.

385 The results of the experiment [21] are in line with the theory - $(\Delta\nu)_{exp}/(\Delta\nu)_{theor} = +1.05 \pm$
386 0.10.

387

388 For comparison, we calculate the change in photon frequency caused by photon energy
389 change equal to potential photon energy in the gravitational field.

390 We express the effective mass of the photon $E = m \cdot c^2$ then $m = \frac{E}{c^2}$. Potential gravitational
391 energy in the near field of Earth $E = m \cdot g \cdot h$. Planck-Einstein relationship [3, 4] is $E = hf =$
392 $\frac{hc}{\lambda}$, for better comprehensibility, we label Plack's constant to k $E = kf = \frac{kc}{\lambda}$, then $f = \frac{E}{k}$.

393 We calculate the change of frequency from the energy change $\Delta f_h = f_h - f_0 = \frac{E_h}{k} - \frac{E_0}{k} =$
394 $-\frac{\Delta E}{k} = -\frac{m \cdot g \cdot \Delta h}{k} = -\frac{E}{c^2} \cdot \frac{g \cdot \Delta h}{k} = -\frac{E}{k} \cdot \frac{g \cdot \Delta h}{c^2} = -f_0 \cdot \frac{g \cdot \Delta h}{c^2}$ then $\frac{\Delta f_h}{f_0} = -\frac{g \cdot \Delta h}{c^2}$.

395 Because for small frequency changes $\frac{\Delta f}{f} \approx -\frac{\Delta \lambda}{\lambda}$, we get a relationship that was
396 experimentally verified for $h \ll R$.

397 The result of R. V. Pound and G. A. Rebka, Jr experiment can be interpreted as confirming
398 the hypothesis of changing the frequency and the wavelength of light depending on the
399 photon energy change.

400 **4.4.2 Santilly Isoresdshift**

401 Changing the wavelength of the light depending on the environment through which the light
402 passes has been experimentally verified by R. M. Santilli experiments [22].

403 **4.4.3 Spectrum of red sky**

404 The red shift effect, depending on the light passing through the non-zero conductivity
405 material, can be observed by the naked eye at sunset and at sunrise.

406 If the spectral filtration in the air had a dominant influence, it would change the color of
407 Sunlight at sunset and at sunrise to blue or blue-green. Not red as observed.

408 The air consists of nitrogen, oxygen and argon (99.97% in total) [23]. Only oxygen has
409 interesting Fraunhofer lines (y - 898nm, Z - 822nm, A - 759nm, B - 686nm and a - 627nm)
410 [24]. These absorption wavelengths are only in the red and infrared sections of the Sun
411 spectrum.

412

413 The red shift effect can be verified by a simple experiment. It is enough to measure the shift
414 of the sunlight spectrum of the red sky, the difference between daylight when the light passes
415 through a relatively short path through the dense layers of atmosphere and red sky, when
416 the light passes a much longer distance through the dense air – see Fig. 1.

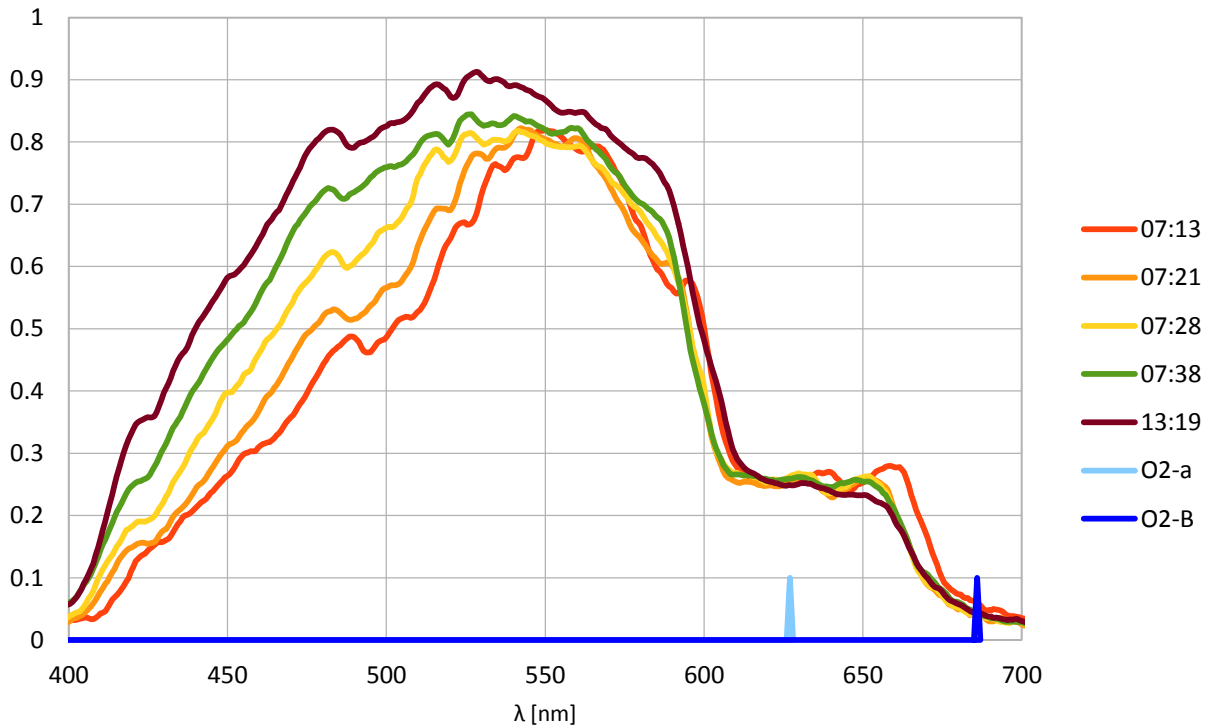


Fig 1 - The result of measuring the time dependence of the Sun's spectrum at sunrise. Measured with a simple spectrometer with a conventional color USB camera (containing an infrared filter). O2-a, O2-B – Oxygen Fraunhofer lines.

417

418 4.5 Dark Matter

419 BBT works with the hypothesis of the existence of dark matter [25]. This has not yet been
 420 confirmed experimentally. In the case of a conducting space hypothesis, interstellar matter
 421 shines; it can be observed and examined by CMB, but only in the near vicinity of Earth.

422 4.6 Dark Energy

423 New red shift measurements on remote sources are interpreted as a red shift dependency on
 424 source age, showing a deviation from the original Hubble hypothesis of linear dependence
 425 that is the basis of the BBT. BBT explains this internal inconsistency with the new hypothesis
 426 of the existence of dark energy.

427 Measured results are interpreted as acceleration of space expansion. The measured
 428 average unit red shift (the measured red shift divided by the distance of the source)
 429 decreases with the increasing distance of the source.

430 Because of the BBT hypothesis, the red shift is proportional to the expansion of the universe
 431 and the measured dependence can be interpreted as a dependence on the time of radiation
 432 of the measured light, the measured data is interpreted so that today the universe expands
 433 faster than it used to be in the past.

434

435 The hypothesis of the conducting universe allows a different interpretation of the measured
 436 data.

437

438 According to the results of the measured large red shifts [26] „Adam Riess *et al.* found that
439 "the distances of the high-redshift SNe Ia were, on average, 10% to 15% farther than
440 expected in a low mass density $\Omega_M = 0.2$ universe without a cosmological constant". This
441 means that the measured high-redshift distances were too large, compared to nearby ones,
442 for a decelerating universe.“

443

444 Compare the measured data with the above Brightness attenuation analysis. First of all, it
445 should be noted that distance measurement was based on the measurement of light source
446 brightness. Only the brightness reduction effect of geometry and not the effect of attenuation
447 of the conductive environment were included in the calculation of the distance in [26].

448 We quantify the conductive environment attenuation effect for $z = 0.5$ $\frac{r_2}{r_1} = \sqrt{\frac{1}{z+1}} = \sqrt{\frac{1}{1.5}} =$
449 0.816.

450

451 In the case of calculating the decrease of the energy of the light quantum for $z = 0.5$, the
452 distance of the source is 18.4% smaller than when the energy loss is not counted.
453 Thus, if the dimming effect is included in the distance calculation, proportional to the red shift,
454 i.e., the attenuation corresponding to the hypothesis of the conducting universe, the distance
455 corresponding to the red shift is obtained, and the acceleration effect does not occur. So
456 there is no need to correct the measurement results using speculation about the existence of
457 dark energy.

458 **5 Analysis 1 - Spreading Electromagnetic Waves,** 459 **Perpetuum and Forgotten Maxwell Equation**

460 **5.1 Fresnel Zone**

461 Common idea of propagation of light is that light propagates in a straight line, that the
462 thickness of the light beam is negligible.

463 Such an idea is simplified and simplification is only justified sometimes.

464

465 It is experimentally verified that electromagnetic waves do not extend only through a direct
466 line between two points (from the transmitter to the receiver), but also around the line.
467 Designers of microwave communication routes know this from practice.

468 The Fresnel Zone is used to calculate the magnitude and shape of the area with the
469 dominant influence on the transmission of electromagnetic waves [27].

470

471 Let's make an engineering estimate of the size of the Fresnel Zone in astronomical
472 conditions.

473 Calculate the volume of the Fresnel zone for a light beam with a mean wavelength of the
474 visible spectrum, i.e. a wavelength of 500 nm, spread from a distance of 1 billion light-years.

475

476 Fresnel zone volume is calculated as the volume of an ellipsoid of revolution $V = 4/3 \pi abc$
477 a, b, c – semi-axes [28].

478

479 $F_1 = \frac{1}{2} \sqrt{\lambda D}$, where F_1 - maximum radius of Fresnel zone 1, λ - wavelength, D - distance
480 between source and detector.

481 For the mean wavelength of visible light 500 nm - $5 \cdot 10^{-7}$ m and $D = 1 \cdot 10^9$ ly (light years) we
482 get $F_1 = 2.17 \cdot 10^9$ m = 14.6 AU and the volume of the zone is $V = 9.33 \cdot 10^{43}$ m³.

483 The Fresnel zone has a radius of about 15 AU at its widest point. This is about half the radius
484 of the solar system measured by Neptune's orbit. Volume of Fresnel zone corresponds to the
485 volume of a sphere of a radius of 10^{14} m, i.e. 10^3 AU, which corresponds to a sphere of
486 radius about 30 times greater than the radius of the solar system.

487 This means that it is not possible without further analysis neglect the volume of space in
488 which the light beam propagates from the remote space. According to experimentally verified
489 physical laws, all matter in the Fresnel zone has an effect on the propagation of
490 electromagnetic waves and thus on the propagation of light.

491 The open question remains what the material is, what are the electromagnetic properties and
492 how it affects the light beam.

493 **5.2 Perpetuum and the Forgotten Maxwell Equation**

494 The engineer normally struggles with heat losses, with efficiency. He knows there is no old
495 dream called Perpetual motion machine or **Perpetuum** Mobile, a lossless system [29].

496

497 The light beam propagating from the distant universe should not be an exception. There is no
498 experimental evidence that the light beam preserves all of its energy for a long time traveling
499 from the distant universe.

500 At the same time, it is known and experimentally verified that electromagnetic waves do not
501 propagate without energy loss in any environment on the surface and around the Earth.

502

503 Currently, simplified Maxwell equations are used. Normally, there are 4 equations with two
504 material-dependent constants. Typically, the material constants of the vacuum are given.
505 These equations only work with two material constants with **permittivity** and permeability.
506 They do not include any energy losses; they describe the electromagnetic Perpetual motion
507 machine [30].

508

509 It is true that the solution of these simplified equations is simpler and more elegant. Missing
510 members describe the attenuation in the material.

511

512 **Electro technical** engineers know from practice, i.e. from experimentally verified physical
513 laws, that there is no material with zero or infinite conductivity, always non-zero resistance or
514 conductivity, always creating energy losses of the electromagnetic field.
515 Maxwell knew that, so he included Ohm's law into the published system of equations [31].

516

517 Thus, the original and experimentally widely validated system of Maxwell equations is
518 parameterized by **three** material-dependent coefficients (**permittivity**, permeability and
519 conductivity / resistivity).

520

521 Only by incorporating the conductivity losses thus it becomes credible application of
522 Maxwell's equations. Without conductivity, it is an unrealistic abstraction that **cannot**
523 **approximate** the real world. **It is** a modern **Perpetuum**.

524 **5.3 Plain Wave Attenuation in Conductive Material**

525 If the electromagnetic waves propagate in a material having non-zero conductivity, the
526 solution of the wave equation for the plane wave propagating in the z direction is $E_x(z, t) =$

527 $Ae^{-\alpha z} \cos(\omega t - \beta z)$, where $k = \beta - j\alpha$, is the root of the quadratic equation $k^2 = \omega^2 \mu (\epsilon -$
528 $j \frac{\gamma}{\omega})$.

529 For small losses (conductivity) it can be simplified $\alpha = \frac{\sigma}{2} \sqrt{\frac{\mu}{\epsilon}}$, where σ - conductivity, μ -
530 permeability, ϵ - permittivity.

531
532 Plane wave performance attenuation can be expressed using the Poynting vector [2]
533 depending on the distance on the z axis $P(z) = P(0) \cdot e^{-2\alpha z}$ and dependence on time
534 $P(t) = P(0) \cdot e^{-2\alpha ct}$.

535
536 We see that the rate of energy reduction of planar electromagnetic waves is directly
537 proportional to the conductivity of the material through which the wave propagates. This
538 attenuation is not due to the propagation geometry but to the conductivity of the material.
539 Therefore, electromagnetic waves are dampened more quickly, for example, in sea water
540 compared to air.

541 5.4 Photon Energy

542 Quantum mechanics based on many experimental evidence (photo effect, black body
543 radiation, semiconductors, LEDs) represents the photon energy as indivisible and
544 unchangeable quantum of energy $E = hf$ or $E = \frac{hc}{\lambda}$ [4]. The photon energy is uniquely bound
545 to frequency and wavelength, that is, to the color of light. It is not possible to change the
546 photon wavelength without changing the photon energy.

547 5.5 Summary 1

548 At the Earth's surface and in its vicinity, it is experimentally proven that electromagnetic
549 waves do not extend only along the line between the transmitter and the receiver but that the
550 propagation is influenced by the atoms that are near the propagation path in the Fresnel
551 zone. The volume of such a Fresnel zone of beam spreading from a distant universe is
552 astronomical.

553 The original Maxwell equations describe an experimentally verified effect of energy loss of
554 electromagnetic radiation by means of a third material constant called conductivity or
555 resistance.

556 Electromagnetic wave loses energy when spreads material with a non-zero conductivity.
557 It is experimentally confirmed that the photon energy is inversely proportional to the
558 wavelength, so the wavelength extension corresponds to the photon energy reduction.

559 6 Analysis 2 - BBT and Well-known Physical Laws

560 Well-known and experimentally verified laws are verified on Earth, so apply the BBT to Earth
561 and the Solar System and compare the results with known laws.

562 6.1 Expansion of the Solar System

563 Calculate by BBT parameters of the Earth and the Sun during the formation of the Earth.
564 Calculate the orbit parameters and other physical parameters on Earth, assuming the
565 universe expanded according to BBT in the Solar system.

566
567 Earth's age is 4.54 billion years. BBT's cornerstone is the dependence of the red shift z on
568 the source distance called the Hubble Law [5]. The measured dependence of the red shift on
569 the time the beam was radiated can be described $v_{s1} = H_0 \cdot D_{e1} = 70.4 [km s^{-1} / Mpc] \cdot \frac{1}{3.26} \times$

570 $10^{-6}[Mpc/ly] \cdot 9.26 \times 10^9[ly] = 200 \times 10^3[kms^{-1}]$, where t_0 – reference time and t_e – emit
571 time.

572

573 The Hubble constant H_0 has a magnitude $H_0 = 22.6 \cdot 10^{-19}[s^{-1}] = 2.26 \cdot 10^{-18}[s^{-1}]$ then
574 $H_0 \cdot \Delta T = 2.26 \cdot 10^{-18} \cdot 4.54 \cdot 10^9 \cdot 3.15 \cdot 10^7 = 0.32$, for the Earth at the time of its creation
575 we have $z \approx 0.32$.

576 Definition of $z = \frac{\lambda_0}{\lambda_e} - 1$ can be overwritten to $\lambda_e = \frac{\lambda_0}{1+z} = k_e \cdot \lambda_0$, where k_e is the wavelength
577 expansion coefficient.

578 Since, according to BBT, wavelength expands as much as space, it is possible to calculate
579 how the universe expanded in the Solar system since the formation of the Earth. We get
580 $k_e = 0.757$.

581 Thus, assuming the validity of the BBT, the Earth orbited the orbit of about 0.75 Au, roughly
582 in the same orbit as Venus is currently circulating.

583 6.2 Expansion on Earth

584 As the BBT is expanding everywhere, it also expands within the Earth. Therefore, the Earth's
585 diameter was 0.75 times smaller and therefore the gravity on the surface was 1.74 times
586 larger, assuming that Earth's weight or Newton's gravitational law (experimentally verified) or
587 gravitational constant did not changed.

588 Because the space is expanding everywhere, all the objects on the Earth's surface are
589 expanding, so the water on Earth is expanding. Therefore, at the time of the Earth's origin,
590 the water had a specific weight of 40N / liter (less water volume times greater gravitational
591 acceleration due to a smaller Earth radius). This is almost twice the actual concrete specific
592 weight or roughly half of today's specific weight of iron.

593 Are there any experimental proofs of such effects?

594 6.3 Planetary Orbit Expansion

595 Relationships between the parameters of the orbital bodies are known and verified
596 experimentally (Kepler's laws[32]). Is the hypothesis of expanding the orbit of the Earth or
597 other planets according to the BBT in accordance with these validated laws?

598 Third Kepler law [32] gives $\frac{P^2}{r^3} = constant$ where P – period of circulation, r – mean radius
599 (radius for circle).

600 For simplicity of calculation, we work with a circular path. Circular speed is $v = \frac{2\pi r}{P}$. Apply
601 third Kepler's law on expanding universe according BBT where R (t) is Scale Factor [33]. We
602 shall use the designation R according Hubble law [5] to avoid confusion with the
603 acceleration.

604 $\frac{P_0^2}{r_0^3} = constant = \frac{P(t)^2}{r(t)^3} = \frac{P(t)^2}{(R(t) \cdot r_0)^3}$, this means that when the radius of the circular path

605 changes, the circulation time must also change: $P(t) = P_0 \cdot \sqrt{R(t)^3}$

606 Calculate the velocity of the planet, depending on the expansion space by BBT respecting

607 Kepler's third law: $v(t) = \frac{2\pi r(t)}{P(t)} = \frac{2\pi a(t)r_0}{P_0 \cdot \sqrt{a(t)^3}} = \frac{v_0}{\sqrt{R(t)}}$

608 Thus upon expansion the space, according to the third Kepler's law should decrease the
609 speed of each planet to the square root of the scale factor of R. This is a time-dependent
610 value.

611

612 Changing speeds is not possible without acceleration and speed up the experimentally
613 verified by Newton's law of motion requires an applied force.

614 Because BBT space is constantly expanding at every moment, this braking force should still
615 be applied. So today.

616 Since the direction of the circulation speed changes at every moment, this braking force
617 should change its direction exactly in line with the direction of the velocity of circulation.
618 This is not a known physical phenomenon.

619

620 Changing the speed also means a change in kinetic energy. Decreasing speed means a loss
621 of kinetic energy [34] $E_k = \frac{1}{2} \cdot mv^2$, then $E_k(t) = \frac{1}{2} \cdot mv(t)^2 = \frac{1}{2} \cdot m \frac{v_0^2}{R(t)} = \frac{E_{k0}}{R(t)}$.

622

623 According to known experimentally validated laws of energy **cannot** be lost "without a trace".
624 According to BBT, the energy of the planets should be diminished in proportion to the
625 expansion of the universe.

626 What is the result of changes in kinetic energy of the planets during the expansion of the
627 universe by BBT?

628

629 The previous analysis worked with what BBT describes, **i.e.** the expansion of space, that is,
630 space in time.

631 It is also possible to work with the hypothesis of expanding space and time so that there is no
632 change in speed and therefore there is no problem with the acceleration of the planets.

633 It means $v(t) = v_0$. From velocity definition $v(t) = \frac{d(t)}{t(t)}$ we get $v(t) = \frac{d(t)}{t(t)} = \frac{R(t) \cdot d_0}{t(t)} = \frac{d_0}{t_0} = v_0$,
634 ie. $t(t) = R(t) \cdot t_0$.

635 If time expands as fast as the distance, the speed will not change and the kinetic energy will
636 remain.

637 Because the speed remains constant and the radius of the track changes, the Kepler's law,
638 which is experimentally verified, will be violated. That hypothesis must be rejected.

639 6.4 Expansion of Wavelength

640 According to BBT, space is expanding in time. There is an interpretation that the reason for
641 the measured red shift is the expansion of the wavelength in accordance with the expansion
642 of the space. Thus, the cause of the **red shift** is not the Doppler effect but the space
643 expansion itself.

644 Recall that there is a clear physical relationship between the wavelength, the velocity of
645 propagation and frequency $c = \lambda \cdot \nu = \lambda \cdot f$ thus $\lambda = \frac{f}{c}$.

646

647 In the case of the Doppler effect, the source emits wavelengths with different wavelengths
648 and corresponding to other frequencies. The wavelength and frequency do not change over
649 time.

650

651 The interpretation of the measured red shift using BBT, where the wavelength extension is
652 explained as a consequence of expanding space, has its physical reasons.

653 If the wavelength change **were** interpreted as the Doppler effect, the radiation would have to
654 be emitted with the changed wavelength by the source, with a red shift proportional to the
655 distance from the observer a billion years ago. This would be against the principle of
656 causality and the source would have to "know" when and where the emitted light will be
657 measured.

658 The other option is that there are other physical patterns that ensure that the relationship
659 between the red shift and the distance between the radiation source and the observer is
660 maintained. See chap. „Doppler effect“.

661
662 Let us return to the wavelength extension hypothesis in line with the Scale Factor [33], that
663 is, the change in wavelength during the time of light propagation.
664 The question remains if the wavelength changes depending on the expansion of the space,
665 what else changes so that the relationship between the propagation velocity, the frequency
666 and the wavelength $\lambda = \frac{f}{c}$ remains preserved. Moreover, that at any moment.
667 Increases speed of light or decreasing frequency, or both?
668 Expands the speed of light, or extends the time?
669
670 There is an experimentally verified Planck's law [10] which has two equivalent forms, both for
671 wavelength and for the black body radiation frequency.
672
673 In that case, it should be noted that if the wavelength is changed as a result of the expansion
674 of the space, the frequency of the radiation must also be changed, inversely proportional to
675 the expansion of the space. In such a theory, the speed of light can be constant, unchanging
676 in time.
677 The consequence is that hypotheses based on the space expansion hypothesis should allow
678 for the same time extension to maintain the ratio between wavelength and frequency at any
679 given time.
680 The BBT effect of expanding or compressing time does not include. This has resulted in
681 inconsistencies with Planck's law
682
683 There is also an experimentally verified relationship between photon energy and wavelength
684 [3]. According to it, the photon energy is inversely proportional to the wavelength and at the
685 same time proportional to the frequency.
686
687 According BBT photon wavelength increases due to the expansion space. Therefore, the
688 effect of expanding the wavelength is to reduce the energy of the photon. Asked what
689 happened to the lost energy, BBT has no answer.
690 And there is an analogous problem with the photon frequency. Does photon frequency
691 change to maintain the relationship between frequency and energy at wavelength extension?

692 **6.5 Expansion of Physical Constants**

693 Relationships between different physical quantities contain physical constants.
694 The series of constants have their magnitude dependent on the distance unit. Then the value
695 of the constant varies according to the unit of distance so that the physical effect remained.
696 According to the BBT, the distance is not constant but changes over time.
697 Are BBT physical constants that depend on the distance unit time-constant? So they still
698 have the same numerical value or the same physical effect?
699 For example.
700 Varies gravitational force between two objects or the value of the gravitational constant when
701 expanding space and thus expanding the distance?
702 Changes to photon energy, or the value of Planck's constant during the space expansion and
703 hence wavelength expansion of the photon?
704 Does the photon frequency change or propagation velocity of light change when space is
705 expanding, and thus expanding the photon wavelength?
706
707 Important constants that could change according to BBT depending on the expansion of the
708 universe:
709 Boltzmann constant [J.K⁻¹] [m².kg.s⁻².K⁻¹]

- 710 Gravity Constant [$m^3.kg^{-1}.s^{-2}$]
711 Permeability of vacuum [$N.A^{-2}$] [$m.kg.s^{-2}.a^{-2}$]
712 Permittivity of vacuum [$F.m^{-1}$] [$m^{-3}.kg^{-1}.s^4.A^2$]
713 Planck constant [$J.s$] [$m^2.kg.s^{-1}$]
714 Speed of light [$m.s^{-1}$]

715 6.6 Expansion of the Atom

- 716 According to BBT, space is expanding. There is no reason why the BBT should not expand
717 the space within the atom.
718 Changing the dimensions of the atom can change its physical properties. We know only
719 atoms of today's dimensions.
720 The BBT is based on the assumption that the atoms that emit the analyzed photons with a
721 measured red shift are the same as today's atoms, **i.e.** they emit photons with the same
722 properties as today's atoms.
723 It is not experimentally verified that an atom of another dimension has the same properties or
724 that an atom of another dimension exists.

725 6.7 Expansion of the Distance Unit

- 726 BBT describes the expansion of the universe by relationship (using R and D writing) [33])
727 $D(t) = R(t) \cdot D_0$, where D is the distance and R is the Scale Factor.
728 This is a mathematical record interpreted as a description of the expansion of the universe in
729 all directions, depending on time. The result of the calculation is not the distance but the
730 number. Intuitively, a larger number is interpreted as a larger distance.
731 Let's recall that physics uses defined physical units and the physical value of the respective
732 magnitude is quantitated in multiples of the respective physical unit.
733 The question is: what is the time dependency of the length unit if the universe expands
734 according to the BBT?
735 Does the distance unit depending on the same dependency or otherwise? By what?
736
737 Can we measure very distant events in the deep past with our current local distance unit size
738 if the unit changes over time and event information is spreading at the ultimate rate?
739 It is known that the length unit has been defined differently in history. Consider therefore
740 metric system meter. The meter was defined by the Earth Quadrant, the distance of the
741 markings on the standard, the wavelength, and the speed of light and time.
742 As discussed earlier, BBT expansion refers to or may concern all physical phenomena used
743 to define the distance unit.
744 We get into a complicated situation. Is the physical unit length according to BBT time-
745 dependent or independent?
746 If the base unit expands $D(t) = R(t) \cdot D_0$, how can a different number occur when calculating
747 the distance when the distance extends as much as the distance unit?
748 Does the distance extend differently than the distance unit?
749 If the distance expands equally as a distance unit, the distance expressed in numbers will be
750 unchanged.
751 If the unit of distance is defined physically, how is it possible for the unit of distance not to be
752 covered by the general law of expansion applicable by BBT universally?
753 Does BBT deny itself?

754 6.8 Summary 2

- 755 This analysis shows that it is not physically possible to apply BBT in general. That the
756 application of space expansion hypothesis to physically verifiable phenomena conflicts with
757 experimentally verified physical laws, or it brings significant uncertainties into the system of
758 verified physical laws such as the time dependence of physical constants, physical units, or

759 the questioning of assumptions used in the interpretation of measured data.
760 The hypothesis may be applied only to such phenomena and objects where experimental
761 verification is missing.

762 **7 Analysis 3 - Experimental BBT Verification**

763 Analyze the measured physical phenomena interpreted as experimental evidence of BBT's
764 compliance with the real world.

765 **7.1 Cosmic Microwave Background Radiation**

766 Cosmic microwave background radiation (CMB) is interpreted as BBT experimental
767 verification so that measured microwave radiation is a relic of early stages of the universe
768 (relic radiation).

769 This is, however, an interpretation of measured data. The radiation that corresponds to the
770 radiance of a black body of about 2.7K was measured.

771
772 The question is why the measured elm. radiation that corresponds to black body radiation
773 according to the experimentally verified Planck's law [10] is interpreted otherwise than under
774 this law?

775 Why is not the measured radiation interpreted as radiation of a black body with a
776 temperature of about 2.7K surrounding Earth?

777

778 It is true that according to Planck's law, the radiance of the black body B_1 at the temperature
779 T_1 from the radiation of the black body B_2 at temperature $T_2 = z \cdot T_1$ **cannot** be distinguished
780 when the radiance of the body B_2 is modified by the red shift z .

781

782 Experimental results can be interpreted with at least two different hypotheses:

783 A - Hypothesis of the local source, i.e. the radiation emitted by the black body surrounding
784 the Earth without a red shift ($z = 0$)

785 B - Hypothesis of the remote source, i.e. radiation with a red shift of $z = 1100$, as is
786 interpreted as evidence of BBT [35].

787

788 Let us look at hypothesis B - a hypothesis of a remote CMB source. We will not address the
789 issue of the direction of radiation. The analysis deals with the source in any **direction**.

790 **According** to the [35], the measured temperature of CMB $T_r = 2.726$ K. This is according to
791 hypothesis B to correspond to the original black body radiation of about 3000 K and a red
792 shift of about 1100.

793 **7.2 Yesterday's Storm**

794 There is nothing surprising in the fact that today you **cannot** shoot lightning from yesterday's
795 storm. Let alone the same opportunity to shoot lightning today and tomorrow at the same
796 place.

797 It is possible to speculate that today it is possible to photograph the lightning of the day
798 yesterday from the distance of one **light day**, where the light has just arrived, but it is certain
799 that tomorrow the light will be two **light days** away.

800

801 Analyze analogous situation with CMB according to hypothesis B.

802 We know that microwave radiation has been measured many times in different periods. So
803 we have a certainty that the radiation from the emission site has arrived on Earth. According
804 to BBT, we can determine when the radiation was emitted, so we can calculate how far from

805 Earth radiation was emitted so that it could be measured from Earth at present [1,36].
806 The BBT recombination period occurred at t_{e0} before the present
807 $t_{e0} = 13.8 \times 10^9 - 378 \times 10^3 [\text{Year}] \approx 13.8 \times 10^9 [\text{Year}]$. We get a distance $D_{e0} = 13.8 \times$
808 $10^9 [\text{ly}]$.

809

810 How did it before, for example at the time of the creation of the Earth?

811 We can assume that the position of the Earth and the moment of Earth's creation are not
812 physically significant, and therefore there is no reason for CMB to affect the Earth's surface
813 at the time of Earth's creation, or at any time in the past between the time of Earth's creation
814 and the present.

815 Let us analyze cautiously both possible variants, **i.e.** variant B1, that CMB was on Earth at
816 the time of Earth's creation, and variant B2 that CMB did not exist on Earth at that time.

817

818 In the case of B1, we can similarly calculate the distance CMB resources from Earth at the
819 time of formation of the Earth $t_{e1} = 13.8 \times 10^9 - 378 \times 10^3 - 4.54 \times 10^9 [\text{Year}] \approx 9.26 \times$
820 $10^9 [\text{Year}]$. We get $D_{e1} = 9.26 \times 10^9 [\text{ly}]$.

821 From the difference of distances and times we can calculate the average velocity of
822 movement of the CMB source with respect to the Earth or the Earth relative to the CMB
823 source (the duration of the recombination time is negligible).

$$v_{sA} = \frac{D_{e0} - D_{e1}}{t_{earth}} = \frac{13.8 \times 10^9 - 9.26 \times 10^9}{4.54 \times 10^9} = 1 [\text{ly}/\text{Year}]$$

824 Thus, in the case of B1, the CMB source must move at an average speed of 1 light year per
825 year relative to Earth, that is, the speed of light.

826

827 In the case of B2, we know that today CMB falls on Earth and that the evolution of the
828 universe is monotone according to BBT (no oscillations). Therefore, we can rule out the
829 situation that CMB existed at Earth's place before the Earth originated and then ceased to fall
830 (and then began again). In the case of B2, we also know that the distance of CMB source
831 from Earth was greater than D_{e1} and therefore CMB began to fall on Earth only later.

832

833 We can calculate the smallest possible average speed of CMB resource from the moment of
834 the Big Bang to the moment of the Earth creation $v_{sB} > \frac{D_{e1}}{t_{e1}} = \frac{9.26 \times 10^9}{9.26 \times 10^9} = 1 [\text{ly}/\text{Year}]$.

835

836 Thus, for variant B2, the CMB source had to move at least at an average speed greater than
837 the light velocity over the entire period from Big Bang to the moment Earth was created.

838

839 Therefore, from the fact that we are able to measure CMB interpreted as the radiation of a
840 remote source according to hypothesis B, CMB source has to move at the average speed of
841 light with respect to the Earth, all the time from the time of recombination until today. At the
842 same time, the CMB source had to be at a distance $D_{e0} = 13.8 \times 10^9 [\text{ly}]$ from Earth.

843 The CMB is measured in all directions from Earth. According to BBT, the CMB source is a
844 point source when compared to the current size of the universe.

845 It follows that, according to BBT, the Earth moves at the speed of light in all directions at the
846 same time, that is, it moves simultaneously in two opposite directions (**i.e.** the same direction
847 with the opposite orientation) to the same source at the speed of light.

848

849 We have an interesting paradox. At the time of CMB radiation, **i.e.** about 378,000 years after
850 the Big Bang [36], the CMB source was $D_{e0} = 13.8 \times 10^9 [\text{ly}]$ away from the Earth (in order to

851 receive its radiation nowadays), yet the dimension of the whole universe had to be such that
 852 recombination may occur. So it had to be significantly smaller than $D_{e0} = 13.8 \times 10^9 [ly]$.
 853 At the same time, the same CMB source had to be far $D_{e1} = 9.26 \times 10^9 [ly]$ from the same
 854 Earth in order to be able to accept CMB on Earth at the time of Earth's creation. So, the CMB
 855 Source and the Earth had to move away at the speed of light. According to theory of relativity
 856 [37], it is not possible if the CMB source has a nonzero rest mass.

857 7.2.1 Cross Check

858 Check the internal consistency BBT different ways to calculate and compare the results.
 859 Calculate the CMB source velocity according to Hubble law, CMB source distance and CMB
 860 source temperature.

861 7.2.1.1 Source Speed Based on Distance

862 According to BBT - **Hubble** law [5], we calculate the current CMB source speed (index 0) and
 863 speed at the time of formation of the Earth (index 1) by distance (calculated from the CMB
 864 propagation time and velocity).

$$v = H_0 \cdot D$$

$$v_{s0} = H_0 \cdot D_{e0} = 70.4 [km s^{-1}/Mpc] \cdot \frac{1}{3.26} \times 10^{-6} [Mpc/ly] \cdot 13.8 \times 10^9 [ly]$$

$$= 298 \times 10^3 [kms^{-1}]$$

$$v_{s1} = H_0 \cdot D_{e1} = 70.4 [km s^{-1}/Mpc] \cdot \frac{1}{3.26} \times 10^{-6} [Mpc/ly] \cdot 9.26 \times 10^9 [ly]$$

$$= 200 \times 10^3 [kms^{-1}]$$

865

866 In the first case, the speed roughly corresponds to the previous calculation, **i.e.** the speed of
 867 light, in the latter case the deviation is very high (33 and 50% respectively).

868 Since Hubble's constant is time-dependent according to BBT, **let us** try to calculate the
 869 constant size to get the correct speed, the same speed as in the first case $H_1 = H_0 \frac{v_{s0}}{v_{s1}} =$

$$870 104.9 [km s^{-1}/Mpc].$$

871 This suggests that the rate of expansion of the universe should be significantly greater at the
 872 time of Earth's creation than at present. This is in contradiction with new measurements that
 873 are interpreted to the contrary, that is, the rate of expansion is increasing [26].

874 7.2.1.2 Source Distance According to Red Shift

875 Relict radiation corresponds to the black body radiation temperature of $T_r = 2.726 K$.

876 According to the BBT, this corresponds to the original radiation of the black body of about
 877 3000 K and the red shift of about 1100.

878 According to Hubble law [5] **recessional** velocity $cz \approx v_r$, which only applies to small red
 879 shifts.

880 For big red shifts, the BBT does not offer a clear answer – see [38].

881

882 According to published theories for $z = 1100$ velocity needed to achieve such a shift either
 883 1100c (thousand times the speed of light) for the linear dependence or about 3 times the
 884 speed of light for general relativity or near the speed of light (special relativity).

885

886 Distance calculation resources by Hubble law by the red-shift determined by Planck's law i.e.
 887 $z = 1100$ system.

888 According to Hubble law can calculate the distance to the source with known red shift

889
$$D \approx \frac{cz}{H_0} = \frac{300 \times 10^3 [kms^{-1}] \cdot 1100 [1]}{70.4 [kms^{-1}/Mpc]} = 4.7 \times 10^6 [Mpc] = 15.3 \times 10^{12} [ly].$$

890 Thus, according to the red shift could be the source of more than a thousand times more
891 distanced than traveled by light from the Big Bang.

892
893 Thus, light with the red shift corresponding to the CMB-measured temperature and BBT-
894 calculated temperature, would have to reach 15.3 Ty on the Earth according to the Hubble
895 Law. Age universe by BBT is 13.8 Gy, therefore more than 1000 times smaller. This means
896 that if the BBT is used strictly, the radiation from the CMB source should not be measurable
897 or its redshift is different from that reported and therefore inconsistent with the BBT.

898 7.2.1.3 CMB Source Temperature

899 Calculate the red shift and the source temperature of the measured CMB, provided the light
900 was emitted at BBT recombination time, **i.e.** at a distance $D_{e0} = 13.8 \times 10^9 [ly]$

901
$$z \approx \frac{H_0 \cdot D}{c} = \frac{70.4 [kms^{-1}/Mpc] \cdot \frac{1}{3.26} \times 10^{-6} [Mpc/ly] \cdot 13.8 \times 10^9 [ly]}{300 \times 10^3 [kms^{-1}]} = 0.99$$

$$\frac{\lambda_0}{\lambda_e} = z + 1 = 1.99$$

902 This means that the source of the measured CMB has a temperature of $T_s = 5.43$ K and not
903 3000K as reported by BBT. This is more than 500 times lower.

904 This means that according to the **Hubble's** equation and according to Planck's law, the
905 source of the measured CMB has a temperature of $T_s = 5.43$ K and not 3000K as reported by
906 BBT.

907 7.2.1.4 Largest Red Shifts

908 According to [39], the maximum measured red shifts are $z = 11.1$, corresponding to 400
909 million years after the Big Bang.

910 In addition, "The cosmic microwave background has a redshift of $z = 1089$, corresponding to
911 an age of approximately 379,000 years after the Big Bang and a **commoving** distance of
912 more than 46 billion light years."

913 Because light travels at the speed of light travels a distance of 1 ly per year. CMB rays from
914 a distance of 46 billion light-years spread 46 billion years. Because according to BBT CMB
915 was emitted 13.8 billion years ago, rays CMB may arrive at Earth until after 32 billion years.
916 **This means that the measured CMB cannot be explained by BBT.**

917 7.3 Red Shift, Speed and Expansion

918 The basic experimental BBT argument is the measured dependence of the red shift on the
919 distance of the source, which can be approximated by linear dependence in the first
920 approximation.

921 This led to the quantification of the Hubble constant and the formulation of Hubble law [5] the
922 Hubble constant, **i.e.** the approximation of the measured results, gradually changed with the
923 improvement of the measurement technology (in a ratio greater than 1: 7). This results from
924 the problem of the accuracy of measuring the distance of very distant light sources in space.
925 The first interpretation of the measurement results indicates the speed of the light source as
926 a result of the measurement, although the distance was measured very inaccurately and the
927 speed is defined as the time change of the distance.

928 How was the radiation source velocity measured? Was it measured? How was the speed
929 detected?

930 In deeper study of this question, we find that speed was never measured, the change in
931 wavelength of spectral lines in the spectrum of distant sources, called the red shift, was
932 measured.

933 The speed was calculated based on the interpretation of Vesko Slipher [40] by using the

934 Doppler effect in 1921. Hubble then used this interpretation [41]. It was not experimentally
 935 verified that the measured red shift is due to the Doppler effect. This means that the speed of
 936 the light source has never been scientifically verified. So whether it is a speed calculated
 937 according to the Hubble equation or zero speed or negligible velocity or other. Only the
 938 difference in the range of remote sources and the dependence on the source distance were
 939 measured.

940 There are currently two hypotheses in the BBT on the interpretation of the measured red
 941 shift: "At the time of the discovery and development of Hubble's law, it was acceptable to
 942 explain the redshift phenomenon as a Doppler shift in the context of special relativity, and
 943 use the Doppler formula to associate redshift z with velocity. Today, the velocity-distance
 944 relationship of Hubble's law is viewed as a theoretical result with a velocity to be associated
 945 with the observed redshift not by the Doppler effect, but by a cosmological model correlating
 946 the recessional velocity to the expansion of the Universe. Even for small, the velocity
 947 entering Hubble law is no longer interpreted as a Doppler effect, although at a small velocity-
 948 redshift relation for both interpretations is the same." - [5].

949
 950 Before we analyze the physical properties of both hypotheses **i.e.**:

951 A - **Red** shift is due to the Doppler effect

952 B - The red shift is a result of expansion of the wavelength ("**r**ecessional velocity")

953 **We** analyze the general relationship between distance, velocity, and space expansion.

954 7.3.1 Time Dependence

955 BBT Scale Factor Definition: $D(t) = R(t) \cdot D_0$.

956 Physical definition of speed $v(t) = \dot{D}(t)$ - speed is the time change of distance. From the
 957 Scale factor definition we get $v(t) = \dot{R}(t) \cdot D_0$ (if we consider the reference distance D_0 as
 958 constant).

959 We calculate the general relation for the velocity and distance ratio from the Scale factor:

960
$$\frac{v(t)}{D(t)} = \frac{\dot{R}(t) \cdot D_0}{R(t) \cdot D_0} = \frac{\dot{R}(t)}{R(t)}$$

961 7.3.2 Spatial Dependence

962 Take two bodies B_1 and B_2 at the distance D_1 and D_2 from the observer where $D_1 \neq D_2$.

963 Expansion is described by the Scale factor definition $D(t) = R(t) \cdot D_0$.

964 Calculate the time dependence of the distance of both bodies (at the same time):

965
$$D_1(t) = R(t) \cdot D_{10} \quad D_2(t) = R(t) \cdot D_{20}$$

966 Speed is calculated as the time derivative of the distance: $v_1(t) = \dot{R}(t) \cdot D_{10}$, $v_2(t) = \dot{R}(t) \cdot$
 967 D_{20} .

968 Acceleration as the second time derivative of the distance: $a_1(t) = \dot{R}(t) \cdot D_{10}$, $a_2(t) = \dot{R}(t) \cdot$
 969 D_{20} .

970 If the Scale Factor time derivative is different from zero and the reference distance is

971 different from zero, we can calculate the ratio of velocities $\frac{v_2(t)}{v_1(t)} = \frac{\dot{R}(t) \cdot D_{20}}{\dot{R}(t) \cdot D_{10}} = \frac{D_{20}}{D_{10}}$ $v_2(t) = \frac{D_{20}}{D_{10}} \cdot$

972 $v_1(t)$.

973 The ratio of the speeds caused by the expansion of the space is equal to the distance ratio.

974 This ratio is time independent. The speeds expand as well as the distance (for any non-zero
 975 Scale factor time derivative).

976 If the second time derivative of Scale factor is different from zero and the reference distance

977 is different from zero, we can calculate the acceleration ratio $\frac{a_2(t)}{a_1(t)} = \frac{\dot{R}(t) \cdot D_{20}}{\dot{R}(t) \cdot D_{10}} = \frac{D_{20}}{D_{10}}$ $a_2(t) = \frac{D_{20}}{D_{10}} \cdot$

978 $a_1(t)$.

979 The acceleration ratio due to expansion of space is equal to the distance ratio. Acceleration
 980 expands as well as distances (for any non-zero time derivative Scale factor and at any time).

981 Distance, velocity, and acceleration are thus expanded at the same time-constant ratio

982
$$\frac{a_2(t)}{a_1(t)} = \frac{v_2(t)}{v_1(t)} = \frac{D_2(t)}{D_1(t)} = \frac{D_{20}}{D_{10}}.$$

983 We have three theoretical options:

984 $\dot{R}(t) = 0$ and $\ddot{R}(t) = 0$

985 $\dot{R}(t) \neq 0$ and $\ddot{R}(t) = 0$

986 $\dot{R}(t) \neq 0$ and $\ddot{R}(t) \neq 0$

987 After these general analyzes of the properties of the expanding space, we analyze two basic
988 physical hypotheses of the experimentally verified red shift.

989 7.3.3 Doppler Effect

990 Hypothesis A: The original Hubble's law applies; the ratio between speed and distance is
991 constant. Thus the red shift is due to an experimentally verified Doppler effect.

992 The general relationship between velocity and distance $\frac{v(t)}{D(t)} = \frac{\dot{R}(t) \cdot D_0}{R(t) \cdot D_0} = \frac{\dot{R}(t)}{R(t)}$ can be rewritten

993 into the form of the ordinary differential equation $\frac{v(t)}{D(t)} \cdot R(t) - \dot{R}(t) = 0$. According to the

994 hypothesis, the ratio of velocity and distance is constant and is equal to Hubble constant

995 $\frac{v(t)}{D(t)} = H$, we reach the equation $H \cdot R(t) - \dot{R}(t) = 0$.

996 This equation has a known solution $R(t) = e^{Ht} + R_0$. From the Scale factor definition, we get
997 the value of the integration constant R_0 . $D(t) = R(t) \cdot D_0$ for $t = 0$ $D(0) = R(0) \cdot D_0 = D_0$ then
998 $R(0) = 1$. Therefore $R_0 = 0$.

999

1000 Let us summarize. From the constant ratio of velocity to distance hypothesis, the only
1001 possible solution of the Scale factor time dependence $R(t) = e^{Ht}$ is obtained.

1002 Since speed and acceleration directly derive from the Scale factor definition, we find:

1003 $v(t) = \dot{R}(t) \cdot D_0 = H \cdot D_0 \cdot e^{Ht}$ and $a(t) = \ddot{R}(t) \cdot D_0 = H^2 \cdot D_0 \cdot e^{Ht}$.

1004

1005 Distance, velocity and acceleration increase exponentially with time.

1006 Because in this case the terms $\dot{R}(t) \neq 0$ and $\ddot{R}(t) \neq 0$ of option III of the spatial dependency

1007 analysis are applicable and the spatial dependency $\frac{a_2(t)}{a_1(t)} = \frac{v_2(t)}{v_1(t)} = \frac{D_{20}}{D_{10}}$ also applies. This

1008 means that speed and acceleration increases linearly with increasing distance. Thus, time
1009 dependence is exponential and spatial is directly proportional to distance.

1010 7.3.3.1 Physical Consequences

1011 According to Newton's laws, the force of acceleration of the material body is a necessary
1012 condition. The acceleration is inversely dependent on the mass of the body. Because the
1013 expansion of space is independent of the mass of bodies and therefore the acceleration does
1014 not depend on the mass of bodies, the hypothetical force must be dependent on the body
1015 mass.

1016 As the acceleration increases linearly with the increasing distance between the bodies, the
1017 force must increase linearly with the increasing distance.

1018 Since the acceleration must be positive, it must have the force direction repelling bodies
1019 among themselves.

1020 Because acceleration increases exponentially over time, the force must grow exponentially
1021 over time.

1022 Physics knows the only force that is dependent on the mass of the body and that is the
1023 gravitational force.

1024 However, it has an inverse dependence on the distance and the opposite direction of force,
1025 rather than the force required to move the body during expansion.

1026

1027 A necessary condition of expansion according to hypothesis A is the existence of an
1028 unknown kind of gravitational force, which has the following characteristics:

- 1029 • is directly proportional to the weight of the body
1030 • grows linearly with increasing distance between bodies and exponentially over time
1031 • causes repulsion of bodies

1032 therefore, the further the bodies are, the greater the repulsive force between them, the later
1033 the greater the force.

1034

1035 Such a physical phenomenon has not yet been experimentally verified.

1036 On the other hand, wavelength variation, depending on the velocity between the observer
1037 and the source of the waves, is a known and experimentally verified Doppler effect.

1038 7.3.4 Expansion of Wavelength

1039 Hypothesis B: The wavelength of the light expands in the same way as the space; the ratio
1040 between the distance and the wavelength expansion is constant. Thus the red shift is caused
1041 by the unverified physical effect that is the subject of the hypothesis.

1042

1043 The wavelength extends as much as space. By applying the Scale factor definition $D(t) =$
1044 $R(t) \cdot D_0$ to wavelength we get $\lambda(t) = R(t) \cdot \lambda_0$.

1045 The linear dependence of the wavelength growth on the distances is expressed by the
1046 relationship $\frac{\Delta\lambda}{\lambda_0} = k_A \cdot D$.

1047 Because $\Delta\lambda = \lambda - \lambda_0$ we are adjusting $\frac{\Delta\lambda}{\lambda_0} = k_A \cdot D$ for $\Delta\lambda = k_A \cdot D \cdot \lambda_0 = \lambda - \lambda_0$ that $\lambda = k_A \cdot$
1048 $D \cdot \lambda_0 + \lambda_0$ we use $\lambda(t) = R(t) \cdot \lambda_0$ and get $R(t) \cdot \lambda_0 = k_A \cdot D \cdot \lambda_0 + \lambda_0$ therefore $R(t) = k_A \cdot$
1049 $D + 1$.

1050 As light propagates from the distance D at time t where $D = c \cdot t$ we recalculate $R(t) = k_A \cdot$
1051 $D + 1 = k_A \cdot c \cdot t + 1 = v_R \cdot t + 1$ where the constant v_R denotes the velocity of expansion of
1052 the Scale Factor.

1053 This result can be interpreted as the time dependency of the Scale Factor.

1054

1055 Calculate the time dependence of the rate of expansion and distance using the same
1056 procedure as in Variant A.

1057
$$\frac{v(t)}{D(t)} = \frac{\dot{R}(t)}{R(t)} = \frac{v_R}{v_R \cdot t + 1} = \frac{1}{t + 1/v_R} = H(t).$$

1058

1059 In this hypothesis, the expansion acceleration is zero, i.e., the body is moving away due to a
1060 constant expansion velocity.

1061 This hypothesis corresponds to Option II. of spatial analysis where $\dot{R}(t) \neq 0$ and $\ddot{R}(t) = 0$. In
1062 this case, the limited spatial dependency $\frac{v_2(t)}{v_1(t)} = \frac{D_{20}}{D_{10}}$ applies, ie the velocity of the body

1063 increases with increasing distance. This is due to the speed versus distance dependence.

1064 The velocity of expansion is constant over time.

1065 The ratio between velocity and distance decreases inversely in proportion to time as the
1066 bodies move away from each other at a constant speed.

1067

1068 Now compare the size of the red shift of the hypothesis formed by the expansion space with
1069 the size of the **red shift** arising from the Doppler effect for distancing source.

1070 For Doppler's light effect, for example, see [5] $z = \frac{\Delta\lambda}{\lambda_0} \approx \frac{v}{c}$. The speed of the source and the
1071 observer is given by $v(t) = \dot{R}(t) \cdot D_0 = v_R \cdot D_0$. Therefore, there is another red shift according

1072 to the Doppler effect $z_D \approx \frac{v}{c} = \frac{v_R \cdot D_0}{c}$.

1073 The red shift according to the wavelength expansion hypothesis is $\lambda(t) = R(t) \cdot \lambda_0$ where
1074 $R(t) = k_A \cdot D + 1$.

1075 We will adjust $z_E = \frac{\Delta\lambda}{\lambda_0} = \frac{\lambda - \lambda_0}{\lambda_0} = \frac{R(t) \cdot \lambda_0 - \lambda_0}{\lambda_0} = R(t) - 1 = k_A \cdot D$. The relationship between
1076 constants is $k_A \cdot c = v_R$.

1077 We calculate the red shift ratio $\frac{z_D}{z_E} = \frac{\frac{v_R \cdot D_0}{c}}{k_A \cdot D} = \frac{k_A \cdot D_0}{k_A \cdot D} = \frac{D_0}{D} = \frac{D_0}{R(t) \cdot D_0} = \frac{1}{R(t)} = \frac{1}{z_E + 1}$.

1078

1079 Thus, the red shift caused by the Doppler effect is approximately the same as the red shift
1080 resulting from the wavelength expansion hypothesis for small red shifts.

1081 The total red shift is the sum of both shifts $z = z_D + z_E = \frac{z_E}{z_E + 1} + z_E = \frac{z_E + (z_E + 1)z_E}{z_E + 1} = \frac{2z_E + z_E^2}{1 + z_E}$.

1082 For small red shifts, the total red shift is nearly twice the red shift according to the wavelength
1083 expansion hypothesis.

1084 7.3.4.1 Physical Consequences

1085 In this variant, there is apparently no problem with unknown gravitational force as in variant
1086 A.

1087 Instead, the variant is built on the wavelength expansion hypothesis just as the expansion of
1088 space. Such a phenomenon has not yet been experimentally verified in any other way.

1089 According to the hypothesis, the speed increases with increasing distance, and the ratio
1090 between speed and distance decreases inversely in proportion to time.

1091

1092 At the same time, this variant does not include the influence of wavelength variation due to
1093 the nonzero velocity of the radiation source relative to the observer. It should exhibit an
1094 experimentally verified Doppler effect with the appropriate properties. Thus, for small red
1095 shifts, the measured red shifts should be doubled, and a red shift dependence corresponding
1096 to the dependence of red shift ratios should be shown. If such a phenomenon is not analyzed
1097 in the measured results, it is inconsistent with physical laws. It is not experimentally verified
1098 that the Doppler effect could be turned off or otherwise removed.

1099 7.3.4.2 Reference Time and Reference Distance

1100 The Scale factor definition is described $D(t) = R(t) \cdot D_0$. Physically, the reference time $t = 0$
1101 or the reference distance D_0 is unambiguously determined. It is not clear whether or not the
1102 reference time is shifting as is common in reproducible experiments, so it is not clear whether
1103 the hypothesis is verifiable by reproducible experiments.

1104 This is equally true of the reference distance. It's a certain distance fixed in the history of the
1105 evolution of the universe or the distance at any moment. Is it a distance relative to the history
1106 or future of the radiation source and its long-term existence, or is the distance at any given
1107 moment, **e.g.** the moment of the radiation of the observed photon or the distance at the
1108 moment of observation?

1109

1110 How to calculate the BBT speed correctly?

1111 When computed according to the Scale factor definition, the speed of motion is not included
1112 as a result of the speed-to-distance ratio. Let's show it on an example with a constant rate of
1113 expansion

1114 $R(t) = v_R \cdot t + 1$ where v_R is time-invariant constant.

1115

1116 At time t_1 the body is at a distance D_1 from the observer and it moves at a speed v_1 $v_1(t_1) =$
1117 $\dot{R}(t_1) \cdot D_0 = v_R \cdot D_0$. We use the distance D_1 as the reference distance to calculate the

1118 velocity v_2 at time t_2 . Since the time derivative of Scale factor is constant, we need not
1119 address the issues of the time shift, therefore $v_2(t_2) = \dot{R}(t_2) \cdot D_1 = v_R \cdot D_1$.

1120 Calculate D_1 $D_1(t_1) = R(t_1) \cdot D_0 = (v_R \cdot t_1 + 1) \cdot D_0 = D_0 + D_0 \cdot v_R \cdot t_1$ and substitute $v_2(t_2) =$
1121 $v_R \cdot D_1 = v_R \cdot (D_0 + D_0 \cdot v_R \cdot t_1) = v_R \cdot D_0 + D_0 \cdot v_R^2 \cdot t_1 = v_1(t_1) + v_1(t_1) \cdot v_R \cdot t_1$.

1122 This is a surprising result. Although the rate of expansion is unchanged over time, the body
1123 velocity varies due to the change in the distance of the body and the speed dependence on
1124 the distance.

1125 **Speed is changing;** there must be acceleration and therefore force. Therefore, even in this
1126 case, an unknown gravitational force with the opposite direction of force and the opposite
1127 distance dependence is needed than Newton's gravity.

1128 7.3.5 Summary 3

1129 BBT uses two different physical interpretations of the measured red-shift dependence on the
1130 distance of the radiation source. These interpretations have significantly different physical
1131 properties.

1132 The direct consequence of the interpretation based on the experimentally verified Doppler
1133 **effect** (hypothesis A) is exponential growth of velocity and acceleration of space expansion
1134 over time. Otherwise, the physical conditions necessary for the validity of this hypothesis
1135 could not be met.

1136 The consequence of such a hypothesis is the exponential growth of the red shift over time.

1137 The direct consequence of the hypothesis B, **i.e.** the interpretation of the red shift as a
1138 consequence of recessional velocity, is the necessity of a constant velocity expansion and
1139 thus the independence of the space expansion velocity over time and distance. This
1140 hypothesis is in direct conflict with Hubble's law, which is considered to be the BBT pillar.

1141 Experimental results of the measured red shift are roughly twice lower than would be
1142 expected for hypothesis B (for small z).

1143 In both cases, an unknown gravitational force with properties relevant to the given hypothesis
1144 is needed to expand the space and movement of the mass bodies in such an expanding
1145 space.

1146 No hypothesis can be demonstrated by the use of only known and experimentally verified
1147 physical laws.

1148 The actual expansion velocity of light sources and hence the rate of expansion of space has
1149 not yet been directly verified experimentally.

1150

1151 8 Conclusions

1152 **Based on analyzes** performed, significant physical shortcomings of the BBT cosmological
1153 model have been identified.

1154 The formulated alternative cosmological model does not have these shortcomings.

1155 It is left to the reader to make his / her own opinion.

1156

1157 **COMPETING INTERESTS DISCLAIMER:**

1158 **Authors have declared that no competing interests exist. The products used for this**
1159 **research are commonly and predominantly use products in our area of research and**
1160 **country. There is absolutely no conflict of interest between the authors and producers**
1161 **of the products because we do not intend to use these products as an avenue for any**
1162 **litigation but for the advancement of knowledge. Also, the research was not funded by**
1163 **the producing company rather it was funded by personal efforts of the authors.**

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