Measurement problem of structural-parametric identification on supernovae type SN Ia for cosmological distances scale of red shift based

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By data, on which basis within the limits of model Friedman–Robertson–Walker the conclusion has been drawn on the beginning of «accelerated expansion of Universe» about 6 billion years ago, the problem of calibration for interpolation models of distances scale with form parameter is solved. According to results of identification at them Doppler interpretations in «Universe expansion» about 2.64–3.18 billion years ago there was pause. The pause was replaced by accelerated expansion which by modern epoch has degenerated in Hubble's stream. On similar data of Sternberg Institute the interpolation model gives practically linear dependence of red shift on photometric distance.

Keywords: cosmological distances scale, interpolation model with form parameter, structurally-parametrical identification, «magnitude standard» of supernovae type SN Ia.

DOI: 10.18698/2309-7604-2015-1-299-310

Introduction

The major metrological designs in astronomy and cosmology are scales of distances *D*. All of them are based on method of indirect measurement [1]. The equation of method of indirect measurement of distance or the equation of distances scale can be based on known geometrical parities, physical laws or on likelihood models of stochastic dependences between distance to observable object and the measured physical sizes connected with it.

Presence in radiation spectra of the majority of extragalactic objects of red shift *z* has generated on this basis a number of cosmological distances scales. Red shift is accessible to measurement at identification issue or absorptive lines as part of spectrum by comparison with set of spectral lines in terrestrial conditions.

The physical nature of red shift is connected with gravitational shift z_g at the expense of difference of gravitational potentials in radiation and reception points and Doppler shift z_v at the expense of movement of source of radiation concerning point of reception [2].

Besides, by analogy to «dark matter» and «dark energy» it is possible to assume existence of one more mechanism of red shift – «dark attenuation». From this point of view to cosmological red shift $z_к$ we will carry its component not identified on a source.

Distances scales $D_Z(z)$ on the basis of red shift are the kind equations

$$D_Z(z) = (c / H_0) \cdot z\,, \tag{1}$$

$$D_Z(z) = (c / H_0) \cdot [(1+z)^2 - 1] / [(1+z)^2 + 1], \tag{2}$$

$$D_Z(z) = (R_0 / q_0^2) \cdot [q_0 z + (q_0 - 1) \cdot (\sqrt{2q_0 z + 1} - 1)], \tag{3}$$

$$D_Z(z) = (2K)^{-1} \cdot [\sqrt{H_0^2 + 4K \cdot c \cdot z} - H_0], \tag{4}$$

$$D_Z(z) = (c / H_0) \cdot [z / (1+z)], \tag{5}$$

$$D_z(z) = (R_0 / k) \cdot [(1+z)^k - 1] \text{ or } (D_z / R_0)^k + k \cdot (D_z / R_0) \cdot z^k = z^k, \tag{6}$$

$$D_Z = \frac{c \cdot (1+z)}{H_0 \cdot |\Omega_k|^{1/2}} \cdot \mathrm{Six}\left\{ |\Omega_k|^{1/2} \int_0^z [(1+z)^2 (1 + \Omega_M \cdot z) - z(2+z) \cdot \Omega_\Lambda]^{-1/2} dz \right\},$$

$$\mathrm{Six}\{\cdot\} = \begin{cases} \mathrm{sh}\{\cdot\}, \Omega_k \geq 0 \\ \sin\{\cdot\}, \Omega_k \leq 0 \end{cases}, \tag{7}$$

where c – fundamental constant of light velocity, H_0 – Hubble's constant, $R_0 = c/H_0$ – Hubble's radius, q_0 – delay/acceleration parameter, K – Hoyle's parameter, k – form parameter, Ω_M – density of weights, Ω_Λ – density of «dark energy», $\Omega_k = 1 - \Omega_M - \Omega_\Lambda$.

Hubble's scale (1) [3], it Doppler variant (2) and scale on the basis of kinematical model (5) [4] actually contain one parameter $R_0 = c/H_0$, and accuracy of these scales is defined by accuracy of estimation of Hubble's constant. Mattig's scale (3) [5], Hoyle's scale (4) [6] and interpolation scales (6) [4] have on one additional parameter, and scale in model Friedman–Robertson-Walker (7) [7] – two additional parameters. Also there is natural question, whether gives this circumstance and additional possibilities on increase in accuracy of these scales at the expense of calibration on these parameters?

Problems of calibration of scales cosmological distances on red shift

Structurally-parametrical identification of mathematical models of measurements objects within the limits of method of collateral measurements [1] is spent by criterion of minimum accepted functional inadequacy errors, for example, the average module of casual component. Before introduction [1] problem here was that an inadequacy error named an approximation error of model for measurements data.

This mess at number increase n model parameters conducted to reduction of an error of approximation, and at equality of number of parameters of model to volume of sample of the given measurements the approximation error appeared equal to zero. But at increase in sample at unit without recalculation of parameters at the expense of inadequacy of model this readout, as a rule, turned to «allocated result» or «rough error».

The minimum of inadequacy error of model of physical object is reached at equality of structural and parametrical components, and its position on an axis of structure codes of models depends on dimensional component [1]. To more difficult models there correspond more exact measurements. This minimum corresponds to terminological phrase – «in the ideal image in the qualitative and quantitative relation».

Calibration of scale (7) on reference points of photometric distances scale D_L with standard $M_{\text{st SN Ia}} = -19{,}37^m$ absolute magnitude of supernovae type SN Ia has allowed to receive fundamental result to Big Bang theory [8, 9]: «Universe expansion occurs to acceleration».

Actually it means recognition of method for definition cosmological distances under standard $M_{\text{st SN Ia}}$ as the fundamental. To this circumstance it is necessary to add necessarily the result established during experiment WMAP [10]: global geometry of astronomical Universe practically «flat» (Euclidian) with parameter of spatial curvature $\Omega_k = -\,0{,}0027\ ^{+0{,}0039}/_{-0{,}0038}$.

Standard $M_{\text{st SN Ia}}$ is based that in double system the white dwarf, reaching on weight of Chandrasekhar limit [11] for the account accretion substances of the companion, becomes supernovae (SN) from almost constant luminosity in maximum in absolute magnitude. Distance modules of reference points for this scale $\mu_0 = m^{\text{peak}} - M_{\text{st SN Ia}} = 5\cdot \lg D_L + 25$ establish method of collateral measurements under Hubble's diagram, under forms or templates of curves of luminosity introduction of amendments for current observable magnitude for luminosity maximum m^{peak}.

For «flat» cosmology the best approximation by the form of curve luminosity method has given (Ω_M = 0,24; Ω_Λ = 0,76), template method – (Ω_M = 0,20; Ω_Λ = 0,80) [8] and method of the Hubble's diagram – (Ω_M = 0,28; Ω_Λ = 0,72) [9], that corresponds Ω_k = 0.

Calibration of such scales of distances has number of the problem moments.

First, shift in spectra can contain little making and depending on their parity can be red or violet: $z=(1+z_g)(1+z_v)(1+z_\kappa)-1$. For gravitational component $z_g=\sqrt{(1-2\varphi_0/c^2)/(1-2\varphi_e/c^2)}-1$, where φ_e and φ_0 – gravitational potentials in points accordingly radiations and measurements, usually neglect, as gravitational red shift of white dwarfs makes $z_g \le 10^{-3}$. And though by the flash moment gravitational red shift of the white dwarf increases more than 10 times, it masks Doppler violet shift at the expense of extending at explosion towards the observer of cover of the white dwarf with speed of an order $3\cdot10^4$ km·s^{-1}. Doppler component of red shift $z_v=(1-V_r/c)/\sqrt{1-(V_r^2+V_{tg}^2)/c^2}-1$, where V_r and V_{tg} – radial and tangential component of movement speed of object concerning the observer. But in cosmological models «Universe expansions» divide it on peculiar and cosmological components. The first of them at big red shift neglect, and last believe Doppler and connect with «dark energy».

Alternative to «dark» factors is «dark attenuation».

As result red shift into components do not divide, and for SN accept red shift of host galaxies, as took place in [8, 9].

Secondly, calibration for distances scale assumes presence of quantity of reference points which characteristics are known with accuracy, obviously not below demanded accuracy of calibration. Such characteristic is mathematical model of dependence on observable sizes of estimations for red shift not so much actually SN, how many red shift of their host galaxies:

$$z \Leftrightarrow D_L = 10^{-5+0,2(m^{peak}-M_{stSNIa})} = 10^{-5+0,2\mu_0},$$

where standard deviations of estimations for red shift make $\sigma_z \sim 10^{-3}$ [9].

In [8] set of reference points sample from 27 SN forms at $z < 0,13$ and 10 SN at $0,30 \le z \le 0,97$, and in [9] – sample from 42 SN with red shift $0,354 \le z \le 0,828$. The standard of absolute luminosity $M_{\text{st SN Ia}}$ =–19,37^m is accepted on SN 1992bs (z = 0,063; m_B^{peak} = 18,24; μ_0 = 37,6^m) and SN 1997ap (z = 0,830; m_B^{peak} = 24,30; μ_0 = 43,67^m) in filter B. For others SN in [8] deviations from standard $M_{\text{st SN Ia}}$ = –19,37^m are limited by an interval [–0,52^m; +0,40^m], and in [9] residual deviations of effective observable star sizes on Hubble's diagram are limited by interval [–0,7^m; +1,3^m]. However, in [9] SN 1992bs in sample has not entered; it is mentioned in review [12].

In [9] transition from delay to «accelerated expansion of Universe» it is dated by flash SN 1997G (m_B^{peak} = 24,49^m; z = 0,763) ~ $6\cdot10^9$ years back.

To this moment in «flat» cosmology corresponds $D_L \approx 1842$ Mpc, but thus $M_{\text{st SN Ia}} = -16{,}84^m$.

The deviation from the standard of absolute luminosity $2{,}53^m$ leaves far beyond the specified deviations. However, dating in [9] is connected with scale of photometric distances of type «Hubble-constant-free», in detail enough quantitatively not described.

However among so-called «unexpected coincidence» [13] maximum of acceleration equivalent on Doppler effect «Universe expansions» on scale (5) $w_{\text{макс}} = 9{,}59 \cdot 10^{-10}$ m·s^{-2} are necessary on $z = 0{,}732$ and $D_L \approx 1667{,}2$ Mpc = 5,4 billion light years, and to scale zero-point strictly there corresponds acceleration $w(0) = c \cdot H_0 = 7{,}21 \cdot 10^{-10}$ m·s^{-2} [11]. This estimation coincides with an abnormal component of acceleration Pioneer-10 on 23rd year of flight. However problem of other scales that at similar Doppler interpretations for them w(0) = 0 and, the most important thing, «anomaly of Pioneers» corresponds not red, but to violet shift.

Thirdly, the decision of considered problem of calibration by method of collateral measurements demands the account of inadequacy errors of interpreting model [1] in common with statistical variability of measurements data, i.e. not only kind of probabilities distribution, and compositions of distributions within the limits of this model. The best fitting for «flat» cosmology is reached at $\Omega_M = 0{,}24$ and $\Omega_\Lambda = 0{,}76$ in [8] and at $\Omega_M = 0{,}28$ and $\Omega_\Lambda = 0{,}72$ in [9].

In these cases $\Omega_M + \Omega_\Lambda = 1$ or $\Omega_k = 0$, also becomes record of the formula appreciable carelessness (7) in [8] at $\Omega_k = 0$. In [8] for peculiar making beam speed at dispersion of estimations in limits 100 km·s^{-1} $\leq \sigma_v \leq$ 400 km·s^{-1} standard uncertainty or mean square deviation $\sigma_v \sim 200$ km·s^{-1}, and in [9] – $\sigma_v \sim 300$ km·s^{-1} or $\sim 10^{-3}$ in units z has been accepted. At the same time received in [8, 9] results were limited to consideration of this problem moment of calibration only concerning so-called «normal law» or Gauss distribution. Check according to [15] on number of distributions, including truncated, has shown, that is essential probability maximum of the consent to approximation errors of model in [8] truncated Laplace distribution is. In border of the maximum likelihood method in [8] used an estimation of dispersion parameter for this distribution is not mean square deviation, and the average absolute deviation [16].

Fourthly, thanks to that for Hoyle's scale $K \approx c \cdot (H_0/c)^2$, in [4] has been shown that for the description of red shift can be involved as physical, so and interpolation models.

Calibration for interpolation cosmological distances scales

Let's consider measuring problem of calibration for cosmological distances scale (6) according to [9] about red displacement *z* and effective star sizes 42 supernovae SN Ia on maximum of shine m_B^{eff} (Table 3) for model of red shift [4]

$$z_k = (D_L / R_0)(1 - kD_L / R_0)^{-1/k}. \tag{8}$$

For comparison data [17] (Table 1) in which beam speed is defined as $V_r = c \cdot z$, and photographic magnitude *m* are used specified with color index.

Table 1. Reference points for interpolation scales at H_0 = 74,2 km·c^{-1}·Mpc^{-1} and $M_{\text{st SN Ia}} = -16{,}84^m$

SN	Data [9]		Data [17]		SN	Data [9]		Data [17]		SN	Data 9]		Data [17]	
	m_B^{eff}	z_n	m	V_r, km·c^{-1}		m_B^{eff}	z_n	z_n	V_r, km·c^{-1}		m_B^{eff}	z_n	z_n	V_r, km·c^{-1}
1992bi	23,11	0,458	>R 22	137305	1995az	22,51	0,450	>R 24	134907	1997K	24,42	0,592	> 23,6	176878
1994F	22,38	0,354	>R 22	106126	1995ba	22,65	0,388	>R 22,6	116319	1997L	23,51	0,550	> 23,1	164886
1994G	22,13	0,425	>I 21,8	127411	1996cf	23,27	0,570	>R 22,7	170882	1997N	20,43	0,180	> 21,2	53963
1994H	21,72	0,374	>R 21,9	112122	1996cg	23,10	0,490	>R 22,5	146898	1997O	23,52	0,374	> 23,7	110923
1994al	22,55	0,420	> 22,6	125913	1996ci	22,83	0,495	>R 22,3	148397	**1997P**	23,11	0,472	> 23	140902
1994am	22,26	0,372	> 21,7	111523	1996ck	23,57	0,656	>R 23	196664	**1997Q**	22,57	0,430	> 22,5	131909
1994an	22,58	0,378	> 22,3	113322	1996cl	24,65	0,828	>I 23,5	248228	1997R	23,83	0,657	> 24,4	194865
1995aq	23,17	0,453	>R 22,4	135805	1996cm	23,17	0,450	>R 22,7	134907	1997S	23,69	0,612	> 23,6	182873
1995ar	23,33	0,465	>R 23,1	139403	1996cn	23,13	0,430	>R 22,6	128911	1997ac	21,86	0,320	> 23,1	95934
1995as	23,71	0,498	>R 23,3	149296	1997F	23,46	0,580	> 23,9	173880	1997af	23,48	0,579	> 22,3	173580
1995at	23,27	0,655	>R 22,7	196364	1997G	24,47	0,763	> 23,7	228741	1997ai	22,83	0,450	> 22,3	134907
1995aw	22,36	0,400	>R 22,5	119917	1997H	23,15	0,526	> 22,8	158890	1997aj	23,09	0,581	> 23,8	174179
1995ax	23,19	0,615	>R 22,6	184372	1997I	20,17	0,172	> 20,9	53963	1997am	22,57	0,416	> 22,9	124714
1995ay	22,96	0,480	>R 22,7	143900	1997J	23,80	0,619	> 23,4	185571	1997ap	24,32	0,830	> 24,2	248828

Model (8) has been checked up on parameterization correctness by substitution of distances module and decision of equations system concerning of form parameter (Table 2)

$$z_{\kappa} = (R_0^{-1} 10^{-5+0,2(m_{B,n}^{eff} - M_{stSNIa})})(1 - k_n R_0^{-1} 10^{-5+0,2(m_{B,n}^{eff} - M_{stSNIa})})^{-1/k_n}, \; n = \overline{1,42}. \tag{9}$$

Table 2. Form parameter of cosmological distances scale

SN	Data [9]		Data [17]		SN	Data [9]		Data [17]	
	D_L, Mpc	k_n	D_L, Mpc	k_n		D_L, Mpc	k_n	D_L, Mpc	k_n
1992bi	977,237	3,75948	586,138	6,89063	1996cm	1004,616	3,52480	809,096	4,89906
1994F	698,232	5,68859	586,138	6,87822	1996cn	986,279	3,54651	772,681	5,14829
1994G	622,300	6,48357	534,564	7,55705	1997F	1148,154	3,14605	1406,048	1,61280
1994H	515,229	7,84012	559,758	7,21240	1997G	1828,100	0,56511	1282,331	2,90409
1994al	755,092	5,27614	772,681	5,13709	1997H	995,405	3,83811	847,227	4,70829
1994am	660,693	6,07376	510,505	7,91284	1997I	–	–	353,183	11,43680
1994an	765,597	5,12401	672,977	5,95819	1997J	1342,765	2,28041	1116,863	3,38049
1995aq	1004,616	3,54100	704,693	5,70879	1997K	–	–2,67464	1224,616	2,78208
1995ar	1081,434	3,03856	972,747	3,81676	1997L	1174,898	2,89569	972,747	2,78208
1995as	1288,250	1,59878	1066,596	3,33059	1997N	–	–	405,509	9,93353
1995at	1051,962	3,71616	809,096	4,97998	1997O	–	–1,32145	1282,331	–8,55733
1995aw	691,831	5,79737	737,904	5,39574	**1997P**	**977,237**	3,81094	928,966	4,12079
1995ax	1013,911	3,85961	772,681	5,21718	**1997Q**	**762,079**	5,23052	737,904	5,42915
1995ay	912,011	4,25083	809,096	4,92632	1997R	1361,445	2,34952	1770,109	–0,52256
1995az	741,310	5,40765	1472,313	–4,78147	1997S	1276,439	2,59689	1224,616	2,84963
1995ba	790,678	4,93565	772,681	5,08582	1997ac	549,541	7,33840	972,747	1,20870
1996cf	1051,962	3,61461	809,096	4,96594	1997af	1158,777	3,08849	672,977	6,00027
1996cg	972,747	3,89216	737,904	5,45015	1997ai	859,014	4,54806	672,977	5,98805
1996ci	859,014	4,60767	672,977	5,99491	1997aj	968,278	4,05794	1342,765	2,05331
1996ck	1207,814	3,03789	928,966	4,30142	1997am	762,079	5,21609	887,156	4,25366
1996cl	1986,095	0,22836	1169,499	3,35289	1997ap	1706,082	1,52087	1614,359	1,86046

In system (9) positive roots of the equations were considered only, and the received results have found out presence of dependences which according to report of calculations with allocation of meaning categories are presented by models in the form of position characteristics with instructions of an average absolute deviation (fig. 1):

$$k_{[9]}(\lg D_L) = \mathbf{41{,}152}7664 - \mathbf{12{,}450}01197 \cdot \lg D_L \pm \mathbf{0{,}157}4237748, \quad (10)$$

$$k_{[17]}(\lg D_L) = \mathbf{45{,}442}5535 - \mathbf{13{,}873}8728 \cdot \lg D_L \pm \mathbf{0{,}256}4187429.$$

Thereby for cosmological distances scale the general analytical expression of settlement value for red shift take on form (fig. 1)

$$z_{\text{к}} = (D_L / R_0) \cdot [1 - (\mathrm{A} + \mathrm{B} \cdot \lg D_L) \cdot D_L / R_0]^{-1/(\mathrm{A}+\mathrm{B}\cdot\lg D_L)}. \quad (11)$$

For data [17] dependence (11) is practically linear and corresponds to fixed Hubble's constant H_0 = 73,9 km·c^{-1}·Mpc^{-1}. For data [9] dependence (11) in return time corresponds to change of Hubble's constant with 77,9 to 449,7 km·c^{-1}·Mpc^{-1} with smooth transition in present period to 76,4 km·c^{-1}·Mpc^{-1} (fig. 2).

To last case there corresponds an distances interval between local extreme of dependence (11) – [809,06; 897,84] Mpc. The nearest to it SN 1997Q and SN 1997P according to scale on the basis of parity (10) according to [9] will be accordingly on distances 2,64 and 3,18 billion light years. Further Hubble's constant is practically fixed.

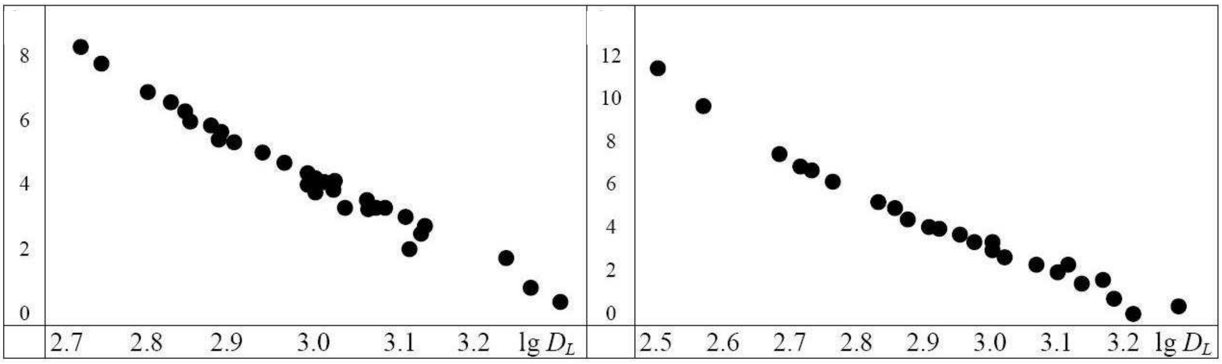

Fig. 1. Dependence of form parameter on photometric distance

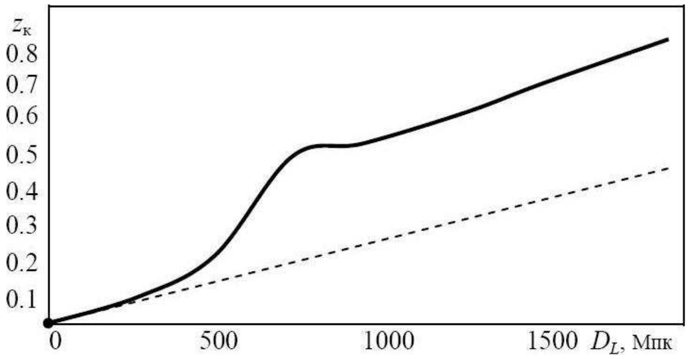

Fig. 2. Dependence of red shift on photometric distance for interpolation models (11)

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Parametrical identification of components of substance with various constants of condition in model Friedman–Robertson–Walker on the basis of the photometric distances scale which reference points are supernovae type SN Ia in luminosity maximum, has been carried out in 1998–1999 by two ways. The group of researchers «High-Z SN Search Team» [8] used scale adjustment cosmological distances on the basis of red displacement under modules of distances of supernovae type SN Ia within the limits of Hubble's diagram, and group of researchers Supernova Cosmology Project [9] – adjustment of modeling dependence for maxima of luminosity supernovae under given measurements. Thus estimations of free parameters have appeared compatible, as it was necessary in a conclusion basis about «acceleration of expansion of the Universe».

In these works the cosmological distances scale by results of calibration on reference points of photometric distances scale is not constructed. An problem essence that estimations of distance modules received thus, not speaking already about known extragalactic objects at $1 < z < 10$, for $z \sim 0.97$ at $M_{\text{st SN Ia}} = -19.5^m$ give the photometric distances exceeding Hubble radius. This circumstance has also purely metrological interpretation in terms of measuring problems theory [1].

The matter is that in cosmology it is considered not only a scale of photometric distances, and also scales of «angular distance», «accompanying distance» and «aberrational distance» which are connected with «Universe expansion». On distances of an order of 2 billion light years they practically coincide, and further – disperse.

For photometric distances scale, unlike other scales, the fundamental experimental fact is global Euclidean geometry for astronomical Universe. It allows considering as physical reality the «observable» distances which are not demanding for the interpretation cosmological models «extending Universe». As various modeling versions «Universe expansion» do not give the answer to type questions «and that was before», «why there was Big Bang», etc.

Developed in cosmology it is possible to compare situation to problem of gravitational waves when interpretation of century reduction for orbital period of double pulsar PSR 1913+16 within the limits of General relativity theory as consequences of gravitational waves radiation is considered in [18] as «the first experimental acknowledgement of their existence». However attempts of gravitational detection by method of direct measurement in projects LIGO (USA), «Virgo» (France, Italy), GEO-600 (Germany, Great Britain), TAMA-300 (Japan), LISA (international satellite project), «Nautilus» (Italy) and «Explorer» (Switzerland) while are unsuccessful [19].

In a considered problem used by the mentioned groups of researchers of model have the free parameters which physical sense has no experimental basis. On the same data the same problem has been solved with the help interpolation models cosmological red shift with form parameter. Dependence of parameter of the form on distance, and the beginning of «the accelerated expansion of Universe» was thus found out was displaced to red shift $z \approx 0{,}51$ or to the moment when «have blown up SN 1997P and SN 1997Q», i.e. about 3 billion years ago.

In basis interpolation models of red shift (8), unlike model Friedman–Robertson–Walker for an extending ideal homogeneous and isotropic liquid, mutual removal with initial speeds $0 \le v \le c$ dot sources of electromagnetic radiation concentrated during the initial moment of time in small area some enough lays. For the observer in the centre of this area distribution of sources speeds on distance in «flat Universe» at expense of delay submits to the law $v \sim D \cdot (1/H_0 - D/c)^{-1}$, where D – observable distance, $T_0 = 1/H_0$ – time from the movement beginning moment [4]. For observable distances $D << c/H_0$ the law of speeds distribution becomes linear, further there is square-law amendment Hoyle [6], and on Hubble's radius the model has rupture of 2nd sort.

Possible deviations from linear distribution of removal speeds of at Doppler interpretations for interpolation models are considered by form parameter. Check of correctness's has shown to parameterization, that this parameter is function of photometric distance, that essentially raises accuracy of interpreting model of red shift and, accordingly, calibrated in such a way cosmological distances scales on the basis of red shift. Certainly, anything surprising is not present that on the same data various models yield various results. Therefore received for interpolation models with form parameter results should be considered only as an illustration of calibration technique of cosmological distances scale for which more reliable data are necessary. After 4 objects that it is possible to consider as sign of statistical heterogeneity of data or their sign unequal accuracy have dropped out of sample in volume 42 SN Ia.

Moreover, interpolation model of red shift according to Supernova Cosmology Project [9] has in a qualitative sense confirmed nonlinearity presence in dependence of red shift on distance, that at Doppler interpretation does not contradict a hypothesis about «acceleration of expansion of Universe». But for data from catalogue [17] for the same objects the same interpolation model has yielded negative result. From the point of view of Eljasberg–Hampel paradox [20, 21, 13], connected by that «statistical criteria cannot prove any hypothesis: they can specify only in «absence of a refutation»» [22], in the mathematical statistics negative results has greater weight.

However from the point of view of the theory of measuring problems [1] data Supernova Cosmology Project and [17] differ by data about effective star sizes on one category, i.e. by default, errors of data Supernova Cosmology Project 10 times less. And to it there should correspond more difficult model.

Conclusion

Thus, the phenomenon of change of dependence of red shift in spectra of extragalactic sources from observable distance is qualitative proves to be true. However questions on real accuracy of estimations of «accelerated expansion of Universe» at Doppler interpretation of red shift demand additional research and the comparative analysis of alternative models taking into account an inadequacy error.

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