ABSTRACT

1743 data calculated for 249 High-z SCP Union supernovae are analysed according to the expansion center model (ECM). The analysis in Hubble units begins with 13 listed normal points corresponding to 13 z-bin samples at as many Hubble depths. The novel finding is a clear drop in the average scattering of the SNe Ia Hubble Magnitude $M$ with the Hubble depth $D$, after using the average trend $\langle M \rangle$ computed in paper IX. Other correlations of the $M$ scattering with the position in the sky are proposed. Consequently, 13 ECM dipole tests on the 13 z-bin samples were carried out both with unweighted and weighted fittings. A further check was made with Hubble depths $D$ obtained by assuming $M \equiv \langle M \rangle$ according to paper IX and XV. In conclusion the analysis of 249 SCPU SNe confirms once again the ECM at any Hubble depth, including a strengthening $\Delta M$ perturbation effect at decreasing $z \lesssim 0.5$. A new successful dipole test introduces the absolute magnitude analysis of 398 SCPU supernovae. After testing 14 high-z normal points $\langle M_0 \rangle$ from paper IX Table 2, a trend analysis of another 15 and 30 normal points of the Hubble Magnitude $M$ and a new absolute magnitude $M^*$, at increasing $\langle z \rangle \equiv z_0$ corresponding to a different series of z bins, leads to the discovery of the magnitude anomaly of the low $\langle z \rangle$ points. When the low $\langle z \rangle$ points are excluded, the best fittings make it possible to extrapolate the SNe Ia absolute magnitude $M_0$ at a central redshift $z_0 \rightarrow 0$, with $M_0 = -17.9 \pm 0.1$ and a few final ECM solutions of the SNe Ia $\langle M \rangle$ and $\langle M^* \rangle$. The magnitude anomaly is here interpreted as due to a deficiency in the magnitude formulas used; these produce a maximum peak of deviation, with a systematic $\Delta M \approx 1$ in the range $0.04 \lesssim \langle z \rangle \lesssim 0.08$. That is a proof of the Universe rotation within the expansion center model.
1. Introduction

The present work, which results to be a fusion of paper XI with paper XIII presented at EWASS 2012, is to all intents a further and necessary supplement to complete the parallel paper XV, which represents the final crucial proof of the expansion center Universe. In that paper, the model independent dipole test was limited to $z$ bins centred on $\langle z \rangle = 1$. Here the aim is the ECM dipole analysis of 13 $z$ bins at different Hubble depths, using 249 supernovae lying within the range $0.2 < z < 1.4$ from the selected 307 SNe Ia of the SCP Union compilation (SCP U: Kowalski et. al. 2008), in order to show how the wedge-shaped Hubble diagram of paper IX is affected by both the ECM dipole anisotropy and a $\Delta M$ effect that appears to be more perturbative at decreasing $z \lesssim 0.5$. Indeed, having confirmed the expansion center model (ECM), here the ECM is used to check and explore more thoroughly the SNe Ia behaviour at varying Hubble depths and positions in the sky. Hence the analysis of the SNe Ia absolute magnitude bases itself on the data of the whole SCP Union sample, which reports redshifts and blue apparent magnitudes of 398 SNe Ia. Owing to the cited strengthening perturbation effect of the scattering of the Hubble Magnitude $M$ at decreasing $z < 0.5$, new $\langle M \rangle$ fittings limited to normal points with $\langle z \rangle > 0.55$ from paper IX Table 2 have been explored. After the successful check, 30 new normal points from the data of all the 398 SCPU SNe have been constructed, in order to better analyse the SN magnitude trend at different Hubble depths. The main construction and analysis of the magnitude normal points does not involve the expansion center model. In other words the main experimental results obtained, the SNe absolute magnitude value $M_0$ and the trend of the Hubble Magnitude $M$, can be considered both model independent and able to confirm once again the ECM. In particular the new findings provide astronomical evidence for cosmic rotation around the expansion center, in accordance with the limits of the ECM itself, which formally, as one must recall, implies a rigid rotation of the very nearby Universe (cf. paper VII).

All the plots and graphical fittings of this analysis appear in the Appendix ”Atlas of the ECM paper XVI figures”. Moreover, as we deal only with blue magnitudes, the pedicel $B$ becomes superfluous; thus the convention $M_B \equiv M$ is adopted within this paper XVI as in paper XV.

The cited papers I-II-III-IV-VI-VII-VIII-IX-XI-XII-XIII-XV are those referenced as Lorenzi 1999a→2012d, while S&T is for Sandage & Tammann 1975a, B&S for Bahcall & Soneira 1982, P99 for Perlmutter et al. 1999, K03 for Knop et al. 2003.
2. ECM values from the observed \((z, m, \gamma)\)

2.1 ECM standard values

The ECM Hubble law in Hubble units (cf. papers V-VI-IX),

\[
cz = \left[H_0 - a_0 X\right] \cdot D = H_X \cdot D \quad \text{with} \quad H_X = H_0 - a_0 X
\]

where

\[
X = \cos \gamma \cdot (1 - x) \frac{x}{1 + x} \quad D = \frac{xc}{3H_0} \left(\frac{1 + x}{1 - x}\right) \quad r = \frac{xc}{3H_0}
\]

and after introducing the ECM standard values (based on data by S&T)

\[
H_0 \equiv 70 \text{ km s}^{-1} \text{Mpc}^{-1} \quad a_0 \equiv 12.7 \text{ km s}^{-1} \text{Mpc}^{-1}
\]

allows us to give each supernova at \((\alpha, \delta)\) the ECM light space \(r_z\), Hubble depth \(D_z\) and Hubble Magnitude \(M_z = M(D_z)\), being \(D_L \equiv D_C\) assumed (cf. papers V-VI-IX-XV) and \(z, m = m_B^{\text{max}}\) available from literature together with the computed value of \(\cos \gamma = \sin \delta_{VC} \sin \delta + \cos \delta_{VC} \cos \delta\) \(\cos(\alpha - \alpha_{VC})\) with \(\alpha_{VC} \approx 9^h\) and \(\delta_{VC} \approx +30^0\) (B&S), as follows:

\[
[z, \cos \gamma] \Rightarrow x = x(z, \cos \gamma) \Rightarrow r = r_z; \quad D = D_z; \quad X = X_z \Rightarrow cz \equiv H_X \cdot D_z \Rightarrow
\]

\[
[m = m_B^{\text{max}}] \Rightarrow D_C = D_z \cdot (1 + z) = \frac{xc}{3H_0} \left(\frac{1 + x}{1 - x}\right) (1 + z) \Rightarrow M_z = m - 5 \log D_C - 25
\]

2.2 Computation of the \(M\) scattering

The ECM Hubble Magnitude \(M_z\) needs to be compared with the model independent value \(\langle M \rangle\), which comes from the \(M(D)\) average trend computed in paper IX, whose eq. (22) gives the fitting curve of 30 normal points from 398 SNe listed in Table 11 of the SCPU compilation (Kowalski et al. 2008). Here the computation of \(\langle M \rangle\), then the scattering \(\Delta M = M_z - \langle M \rangle\), utilizes the ECM Hubble depth \(D_z\) with the same parameters \(d_0 d_1 d_2\), according to the following expressions:

\[
\cos \gamma = 0 \Rightarrow z = z_0 \Rightarrow D = \frac{c z_0}{H_0} \quad \text{and} \quad \cos \gamma \neq 0 \Rightarrow D = \frac{c z}{H_X} = D_z \Rightarrow
\]

\[
M(z_0) = A_0 + A_1 z_0 + A_2 z_0^2 = d_0 + d_1 D_z + d_2 D_z^2 = \langle M \rangle
\]

\[
d_0 = A_0 \cong -18.77; \quad d_1 \cong -1.421 \cdot H_0/c; \quad d_2 \cong +0.3589 \cdot H_0^2/c^2
\]

\[
\Delta M = M_z - \langle M \rangle
\]
2.3 Computation of the Hubble depth $D_{\langle M \rangle}$

On the basis of the previous formulations, one can finally calculate the Hubble depth $D_{\langle M \rangle}$ corresponding to the Hubble Magnitude equal to its average value $\langle M \rangle$ of eq. (7). To this end consider some sequential steps:

$$\langle M \rangle = M_z - \Delta M = m - 5 \log D_C - 25 - \Delta M$$  \hspace{1cm} (10)

$$\log [D_z(1+z)] = 0.2(m - \langle M \rangle - \Delta M) - 5$$  \hspace{1cm} (11)

$$D_z = 10^{0.2(m-\langle M \rangle-\Delta M)-5/(1+z)}$$  \hspace{1cm} (12)

$$D_{\langle M \rangle} = 10^{0.2(m-\langle M \rangle)-5/(1+z)}$$  \hspace{1cm} (13)

$$D_{\langle M \rangle} = D_z \cdot 10^{0.2\Delta M}$$  \hspace{1cm} (14)

$$\Delta M \rightarrow 0 \Rightarrow M_z \rightarrow \langle M \rangle \Rightarrow D_{\langle M \rangle} \rightarrow D_z$$  \hspace{1cm} (15)

2.4 Weighted ECM Hubble law

It is clear that only the Hubble depth $D_{\langle M \rangle}$ can be obtained, if we exclude the ECM value of $D_z$. So the check of $a_0$ in eq. (1), after introducing $D = D_{\langle M \rangle}$ from eq. (13), should take into account the $\Delta M$ perturbation. That may be done through an ECM Hubble law weighted by $w_i$ with $i = 0, 1, 2$, as follows:

$$cz = (H_0 - a_0 X_z) \cdot D_{\langle M \rangle} \Rightarrow Y = \frac{cz}{D_{\langle M \rangle}} - H_0 \rightarrow -X_z \Rightarrow a_0 \quad \text{with} \quad w_i \propto |\Delta M|^{-i}$$  \hspace{1cm} (16)

3. ECM dipole analysis of 249 High-$z$ SCP Union SNe Ia

The ECM values for each of the 249 SNe Ia (those of Table 3 in Appendix of paper IX and cited in the papers X-XV as pilot sample XVI) are listed in the corresponding Table 3 of section 4.

3.1 Construction of 13 normal points

Table 0 below lists a set of normal points referring to the pilot sample XVI and to 12 derived samples. In particular the 10 columns of Table 0 present the following data for each SNe sample, in order: Sample ordinal number; number $N$ of the sample SNe; sample $z$ bin; mean $\langle z \rangle$ of the $z$ bin; unweighted mathematical mean $\langle m_B^{\mathrm{max}} \rangle$ of the corresponding SNe magnitudes; mean $\langle \cos \gamma \rangle$ of the SNe $\cos \gamma$; relative scattering of the average Hubble depth of the sample SNe, as $\frac{\Delta D}{D}$ where
\[ \Delta D = \langle D_z \rangle - D \] and \[ D = \frac{\Delta(z)}{H_0} \] with \( \langle z \rangle \equiv z_0 \) assumed; average Hubble depth of the sample SNe, as \( \langle D_z \rangle \), whose individual \( D_z \) come from the ECM solution (4); average Hubble Magnitude \( \langle M_z \rangle \) of the sample SNe whose individual \( M_z \) follow from eq. (5); average scattering in modulus of the sample SNe Hubble Magnitudes, as \( \langle |\Delta M| \rangle \) whose individual \( |\Delta M| = |M_z - \langle M \rangle| \) follow from the \( M_z \) eq. (5) and the average trend \( \langle M \rangle = d_0 + d_1D_z + d_2D_z^2 \) according to eqs. (7)(8).

**Table 0**

| Sample | N  | \( z \) bin | \( \langle z \rangle \) | \( \langle m \rangle \) | \( \langle \cos \gamma \rangle \) | \( \Delta\langle\rangle \) | \( \langle D_z \rangle \) | \( \langle M_z \rangle \) | \( \langle |\Delta M| \rangle \) |
|--------|----|-------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| XVI_{11} | 50 | 0.2 < \( z \) < 0.4 | 0.322 | 22.123 | -0.00 | 0.03 | 1425 | -19.146 | 0.342 |
| XVI_{12} | 101 | 0.2 < \( z \) < 0.5 | 0.387 | 22.534 | +0.06 | 0.04 | 1716 | -19.235 | 0.330 |
| XVI_{13} | 142 | 0.2 < \( z \) < 0.6 | 0.434 | 22.762 | +0.03 | 0.02 | 1893 | -19.304 | 0.302 |
| XVI_{14} | 174 | 0.2 < \( z \) < 0.7 | 0.472 | 22.928 | +0.00 | 0.01 | 2037 | -19.357 | 0.289 |
| XVI_{15} | 192 | 0.2 < \( z \) < 0.8 | 0.499 | 23.040 | +0.03 | 0.01 | 2152 | -19.389 | 0.279 |
| XVI_{16} | 215 | 0.2 < \( z \) < 0.9 | 0.535 | 23.195 | +0.05 | 0.02 | 2332 | -19.417 | 0.271 |
| XVI | 249 | 0.2 < \( z \) < 1.4 | 0.607 | 23.440 | +0.08 | 0.02 | 2651 | -19.482 | 0.250 |
| XVI_{17} | 200 | 0.4 < \( z \) < 1.4 | 0.677 | 23.763 | +0.10 | 0.02 | 2951 | -19.567 | 0.239 |
| XVI_{18} | 149 | 0.5 < \( z \) < 1.4 | 0.756 | 24.052 | +0.10 | 0.01 | 3282 | -19.650 | 0.210 |
| XVI_{19} | 107 | 0.6 < \( z \) < 1.4 | 0.837 | 24.339 | +0.15 | 0.02 | 3658 | -19.719 | 0.202 |
| XVI_{20} | 75 | 0.7 < \( z \) < 1.4 | 0.919 | 24.627 | +0.28 | 0.03 | 4075 | -19.773 | 0.188 |
| XVI_{21} | 58 | 0.8 < \( z \) < 1.4 | 0.969 | 24.784 | +0.26 | 0.04 | 4323 | -19.789 | 0.193 |
| **XVI** | **48** | **0.83 < \( z \) < 1.4** | **1.001** | **24.836** | **+0.29** | **0.03** | **4409** | **-19.852** | **0.175** |

By an unweighted fitting of the 13 normal points of Table 0, plotting the listed \( \langle |\Delta M| \rangle \) values versus the corresponding \( \langle D_z \rangle \) as shown in Appendix Figure 1, one can draw an important relationship, according to the following two formulations:

\[ \langle |\Delta M| \rangle = 0.40(\pm0.01) - 0.000053(\pm0.000004) \cdot \langle D_z \rangle \]  
(17)

\[ \langle |\Delta M| \rangle = 1.42(\pm0.05) - 0.15(\pm0.01) \cdot \ln(\langle D_z \rangle) \]  
(18)

which are well confirmed by the corresponding two unweighted fittings of the 249 \( |\Delta M| \) from Table 3abcdefg, as follows:

\[ \langle |\Delta M| \rangle = 0.40(\pm0.04) - 0.000052(\pm0.000013) \cdot D_z \]  
(19)

\[ \langle |\Delta M| \rangle = 1.45(\pm0.26) - 0.15(\pm0.04) \cdot \ln(D_z) \]  
(20)
Both the previous correlations, (19) and (20), are shown in Appendix Figure 2, as fitting lines which run very near to each other at all the 249 SNe Hubble depths. At the same time, plotting the $\langle M_z \rangle$ values versus the corresponding $\langle D_z \rangle$ for the 13 normal points of Table 0, as shown in Appendix Figure 3, allows a quick check of the fitting curve II (2nd order), whose ECM equation

$$\langle M_z \rangle \simeq -18.62 \times 10^0 - 4 \times 10^{-4} \langle D_z \rangle + 3 \times 10^{-8} \langle D_z \rangle^2$$

results to agree with the paper IX eq. (22), that based on 30 (practically model independent) normal points, including all the 398 SNe Ia with $z$ and $m_{B}^{\text{max}}$ listed in Table 11 of the SCPU compilation (Kowalski et al. 2008). Let us recall the paper IX values $d_0 = -18.77 \times 10^0$, $d_1 = -3.318 \times 10^{-4}$, $d_2 = 1.957 \times 10^{-8}$, also used in paper XV and in the present dipole analysis, according to eqs. (7)(8)(9). Other two fitting curves, III and IV (of 3rd and 4th order respectively), are represented in Appendix Figures 4 and 5, where the relative equations show the peculiarity of a systematic reduction in modulus of the zero order coefficient, according to the corresponding values: $-18.77, -18.62, -18.51, -18.36$.

Appendix Figure 6 shows the plot and cubic fitting of the 249 SNe $M_z$ listed in Table 3abcdefghi against the corresponding $D_z$. It is important to remark that here the zero order coefficient, as $-18.15$, has a value in modulus smaller than the previous ones.

From the 249 $\Delta M$ values of Table 3abcdefghi, even a few rough correlations of $|\Delta M|$ with $\cos \gamma$ seem to come out; these are:

$$\langle |\Delta M| \rangle \approx 0.26 - 0.05 \cdot \cos \gamma \quad \text{at} \quad 0.2 < z < 1.4$$

(22)

$$\langle |\Delta M| \rangle \approx 0.34 - 0.10 \cdot \cos \gamma \quad \text{at} \quad 0.2 < z \leq 0.5 \quad \text{(see Appendix Figure 7)}$$

(23)

$$\langle |\Delta M| \rangle \approx 0.21 - 0.00 \cdot \cos \gamma \quad \text{at} \quad 0.5 < z < 1.4$$

(24)

A further remark about the data of Table 0 regards the 7th column, where the small positive values of $\Delta D$ may indicate a systematic scattering of $\langle z \rangle$ from $z_0$. Furthermore $\Delta D$ has here the same behaviour as in Table 1b of the parallel paper XV. For instance the sample XVI of Table 0, whose $\langle D_z \rangle = cz_0/H_0$, gives $z_0 = 1.029$ and $\langle z \rangle - z_0 = -0.028$ or $|\Delta z| \simeq 0.03$. At the same time the dipole tests A1 and B1 of paper XV, with $\langle D \rangle = cz_0/H_0$, give $z_0 = 1.032$ and $z_0 = 1.045$, that is the corresponding $\langle z \rangle - z_0 = -0.031$ and $\langle z \rangle - z_0 = -0.044$, or $|\Delta z| \simeq 0.03$ and 0.04, respectively.
3.2 ECM dipole tests weighted by $w_i \propto |\Delta M|^{-i}$

The results of the dipole test based on the weighted ECM Hubble law (16), applied to each supernova of Table 3abcdefghi with weight $w_i \propto |\Delta M|^{-i}$, are listed in Table 1. Here the 9 columns present three ECM dipole solutions for each SNe sample, with $i = 0, 1, 2$ respectively, as follows: Test identification name (TID); sample ordinal number; number N of the sample SNe; the fitting standard deviation $s(w_0)$ in H.u. of the unweighted ECM dipole test carried out on the line sample and the resulting angular coefficient $a_0$ of eq. (16) with its standard deviation, in H.u., corresponding to the weight applied $w_0 = 1$ to each sample SNe; the standard deviation $s(w_1)$ in H.u. of the fitting with $w_1 = |\Delta M|^{-1}$ together with the resulting $a_0$ in H.u.; the standard deviation $s(w_2)$ in H.u. of the fitting with $w_2 = |\Delta M|^{-2}$ together with the resulting $a_0$ in H.u..

### Table 1

| TID | Sample | N  | $s(w_0)$ | $a_0$   | $s(w_1)$ | $a_0$   | $s(w_2)$ | $a_0$   |
|-----|--------|----|----------|---------|----------|---------|----------|---------|
| W11 | XVI11  | 50 | 12.52    | −1.2 ± 5.1 | 4.40   | 11.3   | 0.45 | 12.7 |
| W12 | XVI12  | 101 | 11.62    | −2.9 ± 3.7 | 4.63   | 11.0   | 0.57 | 12.8 |
| W13 | XVI13  | 142 | 10.95    | −1.4 ± 3.0 | 4.09   | 11.0   | 0.57 | 12.7 |
| W14 | XVI14  | 174 | 10.92    | 1.8 ± 2.8 | 4.20   | 11.3   | 0.62 | 12.7 |
| W15 | XVI15  | 192 | 10.62    | 2.3 ± 2.6 | 4.18   | 11.3   | 0.65 | 12.7 |
| W16 | XVI16  | 215 | 10.42    | 3.1 ± 2.4 | 3.73   | 11.3   | 0.45 | 12.7 |
| W0  | XVI    | 249 | 10.11    | 4.3 ± 2.2 | 3.75   | 11.6   | 0.48 | 12.75 |
| W17 | XVI17  | 200 | 9.409    | 6.6 ± 2.4 | 3.60   | 11.9   | 0.49 | 12.8 |
| W18 | XVI18  | 149 | 8.547    | 10.8 ± 2.6 | 3.22   | 12.4   | 0.44 | 12.7 |
| W19 | XVI19  | 107 | 8.254    | 14.1 ± 3.0 | 3.26   | 13.5   | 0.40 | 13.3 |
| W20 | XVI20  | 75  | 7.618    | 11.8 ± 3.3 | 2.82   | 12.9   | 0.33 | 13.3 |
| W21 | XVI21  | 58  | 7.794    | 12.7 ± 3.9 | 2.65   | 13.5   | 0.29 | 13.3 |
| W1  | XVI4   | 48  | 7.109    | 14.4 ± 3.9 | 2.39   | 14.1   | 0.26 | 13.4 |

At first sight the results in Table 1 seem to suggest that only the high values of $\langle |\Delta M| \rangle$ in the 10th column of Table 0, corresponding to $z \lesssim 0.5$, are significantly affecting the unweighted ECM Hubble law (4th and 5th columns of Table 1) with $D = D_{\langle M \rangle}$. On the other hand only the weights $w_2 = |\Delta M|^{-2}$ give $a_0$ the exact ECM standard value 12.7 at $z \lesssim 0.5$; this means the ECM agrees with the adopted $\langle M \rangle = d_0 + d_1 D_z + d_2 D_z^2$ at that $z$ range. In other words the solutions in Table 1 represent a further successful check of the expansion center model at any Hubble depth of the
supernovae Ia. As an illustration, the dipole diagram of the unweighted test W18 is reported in Appendix Figure 8. This ECM dipole test, referring to the SNe of Table 3abcdefghi with \( z \geq 0.5 \), is graphically represented by the fitted plot of 149 values of \( Y_{W18} = \frac{cz}{D(M)} - H_0 \) against each corresponding value of \(-X_z\) (cf. section 4). Appendix Figure 9 represents the same diagram of 3 normal points \( \langle Y \rangle \) versus the corresponding \( \langle -X_z \rangle \), which include: 74 SNe at the range \(-X_z < 0\); 52 SNe at \( 0 < -X_z < 0.25 \) and 23 SNe at \(-X_z > 0.25\).

### 3.3 ECM dipole test based on \( \Delta M \equiv 0 \)

Within the previous dipole test, when one assumes \( M \equiv \langle M \rangle \) or \( \Delta M \equiv 0 \), eq. (14) immediately leads to the identity \( D(M) \equiv D_z \), that is a Hubble depth \( D \) which should agree with both the ECM Hubble law (1) and the Hubble Magnitude formulation of eq. (10). This is the case of the 1st type dipole test in paper XV, according to the paper IX procedure, here integrated by the ECM formulae and summarized as follows:

\[
M - \langle M \rangle = \Delta M \rightarrow 0 \Rightarrow M \equiv \langle M \rangle = d_2D^2 + d_1D + d_0 = m - 5\log D_C - 25
\]  
(25)

\[
D_C = D \cdot (1 + z) \Rightarrow d_2D^2 + d_1D + d_0 + 5\log D = m - 5\log(1 + z) - 25
\]  
(26)

\[
\left[ z, m, d_0, d_1, d_2 \Rightarrow D \right]
\]  
(27)

\[
D = \frac{xc}{3H_0} \left( \frac{1 + x}{1 - x} \right) \Rightarrow X = X(D) \Rightarrow X = X(x, \cos\gamma) = X(D, \cos\gamma)
\]  
(28)

\[
cz = (H_0 - a_0X) \cdot D \Rightarrow Y = \left( \frac{cz}{D} - H_0 \right) \Rightarrow Y \rightarrow -X \Rightarrow a_0
\]  
(29)

Eq. (29) has been checked again on the pilot sample XVI, using all the \( cz \) and \( D \) values listed in Table 3abcdefghi in the paper IX appendix. The \( \cos\gamma \) introduction allows a further ECM dipole test on the same 13 \( z \) bins in Table 0. The resulting angular coefficient \( a_0 \) of each unweighted dipole test and the corresponding standard deviation \( s \), in H.u., are reported in the last two columns of Table 2; here the first column is the TID names, as the continuation of the A series in paper XV. Also this ECM dipole test based on \( \Delta M \equiv 0 \), as the results of Table 2 show when compared with those of Table 1, gives evidence for the perturbative \( \Delta M \) effect at \( z \lesssim 0.5 \).

As in the previous section, Appendix Figure 10 presents the dipole diagram of the test A18, as a plot of \( Y_{A18} \) versus \(-X\). Appendix Figure 11 represents the same diagram of 3 normal points \( \langle Y \rangle \) versus the corresponding \( \langle -X \rangle \), which include: 74 SNe at the range \(-X < 0\); 52 SNe at \( 0 < -X < 0.25 \) and 23 SNe at \(-X > 0.25\).
Table 2

| TID | Sample | N  | $z$ bin | $s$   | $a_0$ |
|-----|--------|----|---------|-------|-------|
| A11 | XVI_{11} | 50 | $0.2 < z \leq 0.4$ | 14.89 | $-2 \pm 6$ |
| A12 | XVI_{12} | 101 | $0.2 < z \leq 0.5$ | 14.35 | $-5 \pm 5$ |
| A13 | XVI_{13} | 142 | $0.2 < z \leq 0.6$ | 13.78 | $-4 \pm 4$ |
| A14 | XVI_{14} | 174 | $0.2 < z \leq 0.7$ | 13.93 | $0 \pm 4$ |
| A15 | XVI_{15} | 192 | $0.2 < z \leq 0.8$ | 13.62 | $1 \pm 4$ |
| A16 | XVI_{16} | 215 | $0.2 < z \leq 0.9$ | 13.43 | $1 \pm 4$ |
| A0  | XVI    | 249 | $0.2 < z < 1.4$   | 13.15 | $3 \pm 3$ |
| A17 | XVI_{17} | 200 | $0.4 \leq z < 1.4$ | 12.73 | $4 \pm 4$ |
| A18 | XVI_{18} | 149 | $0.5 \leq z < 1.4$ | 11.94 | $9.5 \pm 3.6$ |
| A19 | XVI_{19} | 107 | $0.6 \leq z < 1.4$ | 11.72 | $13.8 \pm 4.2$ |
| A20 | XVI_{20} | 75  | $0.7 \leq z < 1.4$ | 11.01 | $9.6 \pm 4.8$ |
| A21 | XVI_{21} | 58  | $0.8 \leq z < 1.4$ | 11.24 | $11.1 \pm 5.6$ |
| A1  | XVI_{1} | 48  | $0.83 \leq z < 1.4$ | 10.50 | $12.6 \pm 5.8$ |

3.4 The SNe $\Delta M$ effect

All the previous dipole tests seem to give $\Delta M$ a crucial and macroscopic perturbation role, within the adopted expansion center model. What might be the nature of such a $\Delta M$? Here, at least two origins have to be taken into account, intrinsic or statistical. While the first has to do with the physics and gravitation of the supernova itself, the latter may be due both to selection effects and limits in the model, which is formally correct when applied to the very nearby Universe with a rigid rotation (cf. paper VII and section 7.4 of paper I). In fact the ECM dipoles were well confirmed in the nearby Universe (cf. papers I-II and also Lorenzi 1991-93), without using supernovae; further confirmation came only from the far Abell clusters, the 66 of Richness 3, at $z \lesssim 0.3$ and $\langle z \rangle \approx 0.2$ (cf. paper V and also Lorenzi 1994). A first successful dipole test on SNe Ia was carried out through two historic and accurate SCP samples, by P99 and K03, at the average redshift $\langle z \rangle = 0.5$ (cf. paper VI). The latest ECM confirmation refers to the Deep Universe, at $0.2 < z \lesssim 1.4$, as shown in this work and in the parallel paper XV. Consequently, the present disagreement of the unweighted SNe dipoles at $z \lesssim 0.5$ is very likely due to the perturbation effect of the SNe $\Delta M$, producing both an intrinsic and statistical interference.
4. ECM values from 249 High-z SCP Union SNe Ia

This section is devoted to presenting 1743 data in Hubble units, calculated for 249 High-z SCP Union supernovae, according to the expansion center model. In particular the first three columns of Table 3 list below in order: Supernova name as reported in the 2008 SCP Union paper (SCP Union: Kowalski et al. 2008); redshift $z_{SCP}$ of supernova or host galaxy as listed in SCP Union, but rounded off to the third decimal place as the CMB reference affects the value for about 0.001 on average (cf. paper IX); supernova magnitude $m_{SCP}$ as $m_B^{max}$ value listed in SCP Union, without standard deviation. The fourth column holds the calculated value of $-\cos \gamma$, according to eq. (16) of paper XV, after introducing the SNe R.A. $\alpha$ and Decl. $\delta$, those listed in paper XV Table 5abc or in the SCP Union reference papers (cf. Harvard-IAU, Riess et al. 2007, Astier et al. 2006, Riess et al. 2004, Miknaitis et al. 2007). The following four columns are all dedicated to as many ECM values, here called $r_z$, $D_z$, $M_z$, $-X_z$ in that directly coming from eq. (1) with the ECM standard values $H_0 = 70$ H.u. and $a_0 = 12.7$ H.u. applied. Lastly, the 9th column reports the integer value of the Hubble ratio $c\frac{r_z}{D_z}$, with $D_{\langle M \rangle}$ calculated through eq. (13), while column 10 lists the crucial value of $\Delta M = M_z - \langle M \rangle$, which represents the ECM scattering of the SN Hubble Magnitude with respect the average value $\langle M \rangle$ of eq. (7).

4.1 Evidence for intrinsic SNe $\Delta M$

Concerning Table 3 below, one can attempt to search for the possible intrinsic nature of some large $\Delta M$. First of all one’s attention must fall on those SNe which present very high $\Delta M$, for example $\Delta M \geq +1.0$, as in the case of the following SNe: 03D4au with $\Delta M = +1.03$; g055 with $\Delta M = +1.39$; g142 with $\Delta M = +0.98$; k485 with $\Delta M = +1.26$. Another simple and more powerful procedure is based on the comparison of only a few pairs of supernovae which, with almost the same redshift and position on the celestial sphere, show very different $\Delta M$. To this end we also need to check the SNe coordinates, as the same ECM $\cos \gamma$ refers to the same hemisphere, not necessarily to the same position in the sky. In Table 3 we can find a few of such SNe couples with at least one $\Delta M > 0.5$ and $\Delta (\Delta M) > 0.5$ (as an example we cite the couple 05Zwi-2002hr). The aforementioned evidence for a possible intrinsic origin of many SNe $\Delta M$ is very important, in that it appears to represent a crucial proof, in accordance with the expansion center model, against the common assumption of using the supernovae SNe Ia as good standard candles. In particular, at present it results that the individual SNe Ia are not usable standard candles.
| Name  | $z_{SCP}$ | $m_{SCP}$ | $-\cos \gamma$ | $r_z$ | $D_z$ | $-X_z$ | $\frac{cz}{D_{145}}$ | $\Delta M$ |
|-------|----------|----------|----------------|-----|------|-------|-----------------|--------|
| 1996h | 0.620    | 23.50    | -0.5301        | 794 | 2784 | -19.77 | -0.260          | 74     | -0.23          |
| 1996i | 0.570    | 23.40    | -0.6082        | 771 | 2582 | -19.64 | -0.305          | 71     | -0.14          |
| 1996j | 0.300    | 22.03    | -0.6961        | 583 | 1388 | -19.25 | -0.415          | 67     | -0.06          |
| 1996k | 0.380    | 22.64    | -0.8527        | 658 | 1783 | -19.32 | -0.475          | 64     | -0.02          |
| 1996u | 0.430    | 22.61    | -0.7171        | 690 | 1981 | -19.65 | -0.388          | 75     | -0.30          |
| 1995ao| 0.240    | 21.60    | +0.0241        | 496 | 1024 | -18.92 | +0.016          | 65     | +0.17          |
| 1995ap| 0.300    | 21.53    | -0.0533        | 562 | 1292 | -19.60 | -0.032          | 85     | -0.43          |
| 1996t | 0.240    | 20.99    | -0.7591        | 522 | 1124 | -19.73 | -0.478          | 85     | -0.61          |
| 1997ce| 0.440    | 22.80    | -0.0179        | 675 | 1886 | -19.37 | -0.010          | 71     | -0.04          |
| 1997cj| 0.500    | 23.14    | -0.6772        | 734 | 2288 | -19.54 | -0.352          | 69     | -0.11          |
| 1997ck| 0.970    | 24.72    | -0.0482        | 914 | 4167 | -19.85 | -0.021          | 71     | -0.04          |
| 1995k | 0.479    | 22.72    | -0.6764        | 721 | 2192 | -19.83 | -0.356          | 80     | -0.43          |
| 1997ap| 0.830    | 24.34    | -0.2912        | 875 | 3646 | -19.78 | -0.132          | 70     | -0.06          |
| 1997am| 0.416    | 22.46    | -0.7253        | 680 | 1917 | -19.71 | -0.396          | 77     | -0.37          |
| 1997aj| 0.581    | 23.16    | -0.7211        | 780 | 2659 | -19.96 | -0.358          | 80     | -0.44          |
| 1997ai| 0.450    | 22.92    | -0.7745        | 705 | 2081 | -19.48 | -0.413          | 68     | -0.10          |
| 1997af| 0.579    | 23.57    | -0.8892        | 784 | 2694 | -19.57 | -0.440          | 66     | -0.05          |
| 1997ac| 0.320    | 21.89    | -0.8896        | 609 | 1515 | -19.62 | -0.518          | 76     | -0.39          |
| 1997r | 0.657    | 23.92    | -0.7191        | 817 | 3003 | -19.56 | -0.345          | 65     | +0.03          |
| 1997p | 0.472    | 23.13    | -0.7214        | 718 | 2171 | -19.39 | -0.380          | 65     | +0.01          |
| 1997o | 0.374    | 23.32    | -0.8892        | 654 | 1760 | -18.60 | -0.497          | 46     | +0.70          |
| 1997h | 0.526    | 23.18    | -0.4034        | 741 | 2340 | -19.58 | -0.208          | 72     | -0.14          |
| 1997g | 0.763    | 24.37    | -0.3989        | 853 | 3386 | -19.51 | -0.184          | 63     | +0.16          |
| 1997f | 0.580    | 23.41    | -0.3639        | 770 | 2573 | -19.64 | -0.183          | 72     | -0.14          |
| 1996cn| 0.430    | 23.22    | -0.2871        | 677 | 1898 | -18.95 | -0.157          | 57     | +0.38          |
| 1996cm| 0.450    | 23.25    | +0.0616        | 680 | 1917 | -18.97 | +0.034          | 60     | +0.36          |
| 1996cl| 0.828    | 24.55    | -0.7224        | 885 | 3772 | -19.64 | -0.323          | 63     | +0.10          |
| 1996ck| 0.656    | 23.77    | -0.4630        | 809 | 2925 | -19.66 | -0.224          | 70     | -0.08          |
| 1996ci| 0.495    | 22.82    | -0.2963        | 720 | 2185 | -19.75 | -0.156          | 80     | -0.35          |
| 1996cg| 0.490    | 23.07    | -0.8838        | 734 | 2288 | -19.59 | -0.459          | 69     | -0.17          |
| Name  | \(z_{SCP}\) | \(m_{SCP}\) | \(-\cos\gamma\) | \(r_x\) | \(D_x\) | \(M_x\) | \(-X_x\) | \(\frac{c^2}{D_{min}}\) | \(\Delta M\) |
|-------|---------|---------|--------------|--------|-------|--------|--------|----------------|-------|
| 1996cf | 0.570   | 23.31   | -0.7708      | 776    | 2624  | -19.76 | -0.384 | 73   -0.26    |
| 1995ba | 0.388   | 22.55   | -0.9117      | 666    | 1831  | -19.48 | -0.504 | 68   -0.16    |
| 1995az | 0.450   | 22.61   | -0.3184      | 691    | 1987  | -19.69 | -0.172 | 79   -0.34    |
| 1995ay | 0.480   | 23.06   | -0.0072      | 702    | 2060  | -19.36 | -0.004 | 70   +0.01    |
| 1995ax | 0.615   | 23.22   | +0.1194      | 774    | 2607  | -19.90 | +0.060 | 85   -0.40    |
| 1995aw | 0.400   | 22.18   | +0.1244      | 642    | 1691  | -19.69 | +0.070 | 86   -0.42    |
| 1995at | 0.655   | 23.22   | +0.3761      | 786    | 2712  | -20.04 | +0.186 | 92   -0.51    |
| 1995as | 0.498   | 23.66   | +0.3878      | 701    | 1987  | -18.78 | +0.208 | 55   +0.59    |
| 1995ar | 0.465   | 23.37   | +0.3899      | 680    | 1917  | -18.87 | +0.213 | 59   +0.46    |
| 1995aq | 0.453   | 23.20   | +0.4566      | 670    | 1855  | -18.95 | +0.252 | 62   +0.37    |
| 1994g  | 0.425   | 22.34   | -0.9019      | 692    | 1994  | -19.93 | -0.487 | 83   -0.57    |
| 1999fw | 0.278   | 21.72   | +0.6812      | 517    | 1104  | -19.03 | +0.430 | 73   +0.08    |
| 1999fn | 0.477   | 22.72   | -0.3119      | 709    | 2108  | -19.75 | -0.166 | 80   -0.36    |
| 1999fm | 0.950   | 24.30   | +0.1006      | 905    | 4040  | -20.18 | +0.044 | 84   -0.39    |
| 1999fk | 1.057   | 24.77   | +0.1061      | 935    | 4485  | -20.05 | +0.045 | 77   -0.19    |
| 1999fj | 0.816   | 24.22   | +0.1134      | 860    | 3466  | -19.77 | +0.052 | 74   -0.09    |
| 1999ff | 0.455   | 23.21   | +0.0036      | 682    | 1930  | -19.03 | +0.051 | 61   +0.31    |
| 2002ad | 0.514   | 23.06   | -0.8341      | 747    | 2387  | -19.73 | -0.428 | 73   -0.28    |
| 2002ab | 0.423   | 22.60   | -0.8996      | 691    | 1987  | -19.66 | -0.486 | 73   -0.31    |
| 2002aa | 0.946   | 24.60   | -0.9007      | 927    | 4360  | -20.04 | -0.385 | 71   -0.20    |
| 2002x  | 0.859   | 24.73   | -0.9684      | 901    | 3984  | -19.62 | -0.426 | 60   +0.16    |
| 2002w  | 1.031   | 24.47   | -0.9684      | 952    | 4763  | -20.46 | -0.403 | 84   -0.55    |
| 2001kd | 0.936   | 24.96   | -0.9029      | 924    | 4315  | -19.65 | -0.387 | 60   +0.19    |
| 2001jp | 0.528   | 22.89   | -0.6266      | 749    | 2402  | -19.93 | -0.321 | 82   -0.48    |
| 2001jn | 0.645   | 24.55   | -0.3552      | 801    | 2849  | -18.80 | -0.173 | 48   +0.75    |
| 2001jm | 0.978   | 24.50   | -0.3511      | 923    | 4300  | -20.15 | -0.151 | 79   -0.31    |
| 2001jh | 0.885   | 24.31   | +0.1137      | 884    | 3759  | -19.94 | +0.051 | 77   -0.20    |
| 2001jf | 0.815   | 25.19   | +0.1162      | 859    | 3455  | -18.80 | +0.053 | 47   +0.89    |
| 2001iy | 0.568   | 23.07   | -0.8336      | 777    | 2633  | -20.01 | -0.415 | 81   -0.50    |
| 2001ix | 0.711   | 23.80   | -0.8348      | 843    | 3274  | -19.94 | -0.390 | 75   -0.30    |
| Name   | $z_{SCP}$ | $m_{SCP}$ | $-\cos \gamma$ | $r_z$ | $D_z$ | $M_z$ | $-X_z$ | $\frac{cz}{D_{z(2)}}$ | $\Delta M$ |
|--------|----------|-----------|-----------------|-------|-------|-------|-------|------------------|----------|
| 2001iw | 0.340    | 22.10     | -0.3503         | 608   | 1510  | -19.43| -0.204| 74               | -0.20    |
| 2001iv | 0.396    | 22.47     | -0.9022         | 671   | 1861  | -19.60| -0.497| 73               | -0.28    |
| 2001hy | 0.812    | 24.95     | -0.9686         | 885   | 3772  | -19.22| -0.433| 51               | +0.52    |
| 2001hx | 0.799    | 24.78     | -0.9695         | 881   | 3721  | -19.35| -0.435| 54               | +0.39    |
| 2001hu | 0.882    | 24.91     | -0.9007         | 907   | 4067  | -19.51| -0.393| 57               | +0.29    |
| 2001hs | 0.833    | 24.26     | -0.3503         | 877   | 3671  | -19.88| -0.158| 73               | -0.16    |
| 2001fs | 0.874    | 25.12     | -0.3514         | 891   | 3850  | -19.17| -0.156| 52               | +0.59    |
| 2000fr | 0.543    | 23.03     | -0.3497         | 749   | 2402  | -19.82| -0.179| 80               | -0.36    |
| 1998bi | 0.750    | 23.91     | -0.2890         | 845   | 3296  | -19.90| -0.135| 76               | -0.24    |
| 1998be | 0.640    | 23.80     | -0.2914         | 797   | 2812  | -19.52| -0.142| 67               | +0.03    |
| 1998ba | 0.430    | 22.87     | -0.3035         | 677   | 1898  | -19.30| -0.166| 67               | +0.03    |
| 1998ay | 0.640    | 23.72     | -0.7253         | 809   | 2925  | -19.68| -0.350| 69               | -0.11    |
| 1998ax | 0.497    | 23.15     | -0.7224         | 734   | 2288  | -19.52| -0.375| 68               | -0.12    |
| 1998aw | 0.440    | 23.20     | -0.7178         | 698   | 2027  | -19.39| -0.386| 58               | +0.23    |
| 1998as | 0.355    | 22.67     | -0.7279         | 633   | 1642  | -19.07| -0.415| 59               | +0.20    |
| 1997ez | 0.780    | 24.26     | -0.8822         | 871   | 3597  | -19.77| -0.400| 67               | -0.06    |
| 1997eq | 0.540    | 23.16     | -0.3936         | 749   | 2402  | -19.68| -0.201| 75               | -0.23    |
| 1997ek | 0.860    | 24.48     | -0.3875         | 887   | 3798  | -19.77| -0.173| 68               | -0.02    |
| 04Eag  | 1.020    | 24.97     | -0.6777         | 943   | 4613  | -19.88| -0.285| 66               | +0.01    |
| 04Gre  | 1.140    | 24.73     | +0.1253         | 956   | 4832  | -20.34| +0.052| 86               | -0.43    |
| 04Man  | 0.854    | 24.53     | -0.6786         | 892   | 3863  | -19.75| -0.301| 66               | +0.01    |
| 04Mcg  | 1.370    | 25.73     | +0.1263         | 1006  | 5807  | -19.96| +0.049| 68               | +0.07    |
| 04Omb  | 0.975    | 24.88     | +0.1248         | 912   | 4163  | -19.68| +0.054| 67               | +0.13    |
| 04Pat  | 0.970    | 25.02     | -0.6762         | 929   | 4391  | -19.67| -0.288| 61               | +0.18    |
| 04Rak  | 0.740    | 23.84     | +0.1250         | 830   | 3136  | -19.84| +0.059| 79               | -0.23    |
| 04Sas  | 1.390    | 25.82     | -0.6786         | 1025  | 6244  | -20.05| -0.259| 66               | +0.03    |
| 04Yow  | 0.460    | 23.59     | -0.6789         | 709   | 2108  | -18.85| -0.361| 51               | +0.53    |
| 05Fer  | 1.020    | 24.83     | -0.6789         | 943   | 4613  | -20.02| -0.285| 70               | -0.13    |
| 05Gab  | 1.120    | 25.07     | -0.6794         | 968   | 5046  | -20.08| -0.277| 71               | -0.13    |
Table 3d

| Name | $z_{SCP}$ | $m_{SCP,U}$ | $-\cos\gamma$ | $r_z$ | $D_z$ | $M_z$ | $-X_z$ | $\frac{cz}{D_{(M)}}$ | $\Delta M$ |
|------|---------|------------|---------------|-------|------|------|-------|-------------------|--------|
| 05Lan | 1.230   | 26.02      | -0.6783       | 993   | 5531 | -19.44 | -0.269 | 51 +0.57          |
| 05Red | 1.190   | 25.76      | -0.6782       | 985   | 5369 | -19.59 | -0.272 | 55 +0.40          |
| 05Spo | 0.839   | 24.20      | -0.6779       | 887   | 3798 | -20.02 | -0.302 | 75 -0.27          |
| 05Str | 1.010   | 25.03      | -0.6793       | 940   | 4564 | -19.78 | -0.286 | 64 +0.09          |
| 05Zwi | 0.521   | 23.07      | +0.1235       | 723   | 2207 | -19.56 | +0.065 | 76 -0.15          |
| 2002dc| 0.475   | 23.09      | -0.6785       | 719   | 2178 | -19.44 | -0.357 | 67 -0.04          |
| 2002dd| 0.950   | 24.66      | -0.6784       | 923   | 4300 | -19.96 | -0.291 | 70 -0.12          |
| 2002fw| 1.300   | 25.65      | +0.1244       | 992   | 5510 | -19.86 | +0.049 | 66 +0.14          |
| 2002hp| 1.305   | 25.41      | +0.1250       | 993   | 5521 | -19.92 | +0.050 | 74 -0.11          |
| 2002hr| 0.526   | 24.04      | +0.1244       | 726   | 2229 | -18.62 | +0.065 | 49 +0.79          |
| 2002kd| 0.735   | 24.02      | +0.1247       | 828   | 3115 | -19.64 | +0.059 | 72 -0.03          |
| 2002ki| 1.140   | 25.35      | -0.6770       | 973   | 5138 | -19.86 | -0.275 | 63 +0.10          |
| 2003az| 1.265   | 25.68      | -0.6774       | 1001  | 5699 | -19.87 | -0.266 | 62 +0.15          |
| 2003dy| 1.340   | 25.77      | -0.6780       | 1016  | 6032 | -19.98 | -0.262 | 64 +0.08          |
| 2003eq| 0.840   | 24.35      | -0.6770       | 888   | 3811 | -19.88 | -0.302 | 70 -0.13          |
| 03D4au| 0.468   | 23.86      | +0.9334       | 666   | 1831 | -18.29 | +0.516 | 48 +1.03          |
| 04D4bk| 0.840   | 24.31      | +0.9345       | 848   | 3329 | -19.63 | +0.434 | 75 +0.03          |
| 04D3nr| 0.960   | 24.54      | -0.4827       | 921   | 4270 | -20.07 | -0.208 | 75 -0.24          |
| 04D3lu| 0.822   | 24.34      | -0.4872       | 877   | 3671 | -19.79 | -0.220 | 69 -0.06          |
| 04D3ki| 0.930   | 24.87      | -0.4885       | 912   | 4138 | -19.64 | -0.212 | 62 +0.17          |
| 04D3gt| 0.451   | 23.23      | -0.4829       | 697   | 2027 | -19.11 | -0.260 | 59 +0.25          |
| 04D3do| 0.610   | 23.57      | -0.4926       | 788   | 2730 | -19.64 | -0.243 | 71 -0.11          |
| 04D3cp| 0.830   | 24.24      | -0.4884       | 880   | 3708 | -19.92 | -0.220 | 73 -0.19          |
| 04D2gp| 0.707   | 24.15      | -0.8582       | 842   | 3263 | -19.58 | -0.401 | 63 +0.06          |
| 04D2fp| 0.415   | 22.53      | -0.8566       | 684   | 1942 | -19.67 | -0.466 | 74 -0.32          |
| 04D1ag| 0.557   | 23.00      | +0.1699       | 742   | 2348 | -19.82 | +0.088 | 84 -0.37          |
| 03D4fd| 0.791   | 24.21      | +0.9306       | 830   | 3136 | -19.54 | +0.440 | 73 +0.08          |
| 03D4cz| 0.695   | 24.03      | +0.9322       | 790   | 2748 | -19.31 | +0.459 | 68 +0.22          |
| 03D4at| 0.633   | 23.74      | +0.9343       | 761   | 2499 | -19.31 | +0.473 | 70 +0.16          |
| 03D3bh| 0.249   | 21.13      | -0.4847       | 523   | 1128 | -19.61 | -0.305 | 83 -0.49          |
| Name   | $z_{SCP}$ | $m_{SCP}$ | $-\cos \gamma$ | $r_z$ | $D_z$ | $M_z$ | $-X_z$ | $\frac{c}{D_{z}(U)}$ | $\Delta M$ |
|--------|----------|----------|----------------|------|------|------|-------|----------------|-----------|
| 03D3af | 0.532    | 23.49    | -0.4855        | 747  | 2387 | -19.33| -0.249 | 63              | +0.13     |
| 03D1fc | 0.331    | 21.80    | +0.1648        | 584  | 1393 | -19.54| +0.098 | 84              | -0.35     |
| 03D1bp | 0.346    | 22.45    | +0.1674        | 597  | 1455 | -19.01| +0.099 | 65              | +0.20     |
| 04D4dw | 0.961    | 24.57    | +0.9317        | 889  | 3824 | -19.80| +0.415 | 77              | -0.05     |
| 04D4an | 0.613    | 24.02    | +0.9321        | 751  | 2418 | -18.94| +0.476 | 60              | +0.52     |
| 04D3nh | 0.340    | 22.14    | -0.4821        | 613  | 1536 | -19.43| -0.280 | 73              | -0.19     |
| 04D3lp | 0.983    | 24.93    | -0.4866        | 928  | 4376 | -19.76| -0.209 | 65              | +0.09     |
| 04D3is | 0.710    | 24.26    | -0.4963        | 834  | 3178 | -19.42| -0.234 | 61              | +0.21     |
| 04D3fj | 0.730    | 24.13    | -0.4947        | 842  | 3263 | -19.63| -0.231 | 67              | +0.02     |
| 04D3df | 0.470    | 23.47    | -0.4917        | 710  | 2115 | -18.99| -0.261 | 56              | +0.39     |
| 04D3co | 0.620    | 23.78    | -0.4946        | 793  | 2775 | -19.48| -0.243 | 65              | +0.06     |
| 04D2gc | 0.521    | 23.32    | -0.8509        | 752  | 2426 | -19.52| -0.434 | 66              | -0.06     |
| 04D2cf | 0.369    | 22.34    | -0.8505        | 649  | 1731 | -19.53| -0.478 | 72              | -0.25     |
| 03D4gl | 0.571    | 23.26    | +0.9329        | 729  | 2250 | -19.48| +0.487 | 78              | -0.06     |
| 03D4dy | 0.604    | 23.32    | +0.9344        | 746  | 2379 | -19.59| +0.480 | 81              | -0.14     |
| 03D4cy | 0.927    | 24.72    | +0.9347        | 878  | 3683 | -19.54| +0.421 | 69              | +0.19     |
| 03D4ag | 0.285    | 21.21    | +0.9337        | 517  | 1104 | -19.55| +0.590 | 95              | -0.44     |
| 03D3ba | 0.291    | 22.05    | -0.4955        | 568  | 1319 | -19.11| -0.299 | 64              | +0.07     |
| 03D1gt | 0.548    | 24.12    | +0.1676        | 737  | 2310 | -18.65| +0.087 | 50              | +0.79     |
| 03D1ew | 0.868    | 24.37    | +0.1748        | 876  | 3659 | -19.80| +0.079 | 74              | -0.08     |
| 03D1ax | 0.496    | 22.96    | +0.1747        | 706  | 2088 | -19.51| +0.093 | 76              | -0.14     |
| 04D4dm | 0.811    | 24.39    | +0.9309        | 838  | 3220 | -19.44| +0.437 | 69              | -0.20     |
| 04D3oe | 0.756    | 24.08    | -0.4892        | 852  | 3374 | -19.78| -0.226 | 71              | -0.12     |
| 04D3nc | 0.817    | 24.27    | -0.4959        | 875  | 3646 | -19.84| -0.224 | 71              | -0.12     |
| 04D3ks | 0.752    | 23.88    | -0.4814        | 850  | 3352 | -19.96| -0.223 | 77              | -0.30     |
| 04D3ln | 0.552    | 23.47    | -0.4825        | 758  | 2474 | -19.45| -0.245 | 66              | +0.02     |
| 04D3fj | 0.358    | 22.53    | -0.4919        | 628  | 1614 | -19.17| -0.282 | 64              | +0.08     |
| 04D3dd | 1.010    | 25.12    | -0.4931        | 936  | 4500 | -19.66| -0.209 | 61              | +0.20     |
| 04D2ja | 0.741    | 24.10    | -0.8527        | 856  | 3420 | -19.77| -0.393 | 68              | -0.10     |
| 04D2gb | 0.430    | 22.80    | -0.8502        | 694  | 2007 | -19.49| -0.458 | 68              | -0.13     |
| Name       | $z_{SCP}$ | $m_{SCP}$ | $-\cos\gamma$ | $r_z$ | $D_z$ | $M_z$ | $-X_z$ | $\frac{cz}{D_{(z)}}$ | $\Delta M$ |
|------------|----------|----------|----------------|-------|-------|-------|--------|-------------------|-----------|
| 04D1ak     | 0.526    | 23.63    | +0.1596        | 725   | 2221  | -19.02| +0.084 | 59                | +0.39     |
| 03D4gg     | 0.592    | 23.40    | +0.9331        | 740   | 2333  | -19.45| +0.482 | 76                | -0.01     |
| 03D4di     | 0.905    | 24.29    | +0.9334        | 871   | 3597  | -19.89| +0.423 | 82                | -0.18     |
| 03D4cx     | 0.949    | 24.50    | +0.9333        | 885   | 3772  | -19.83| +0.417 | 79                | -0.09     |
| 03D3cd     | 0.461    | 22.56    | -0.4916        | 704   | 2074  | -19.85| -0.263 | 83                | -0.47     |
| 03D3ay     | 0.371    | 22.20    | -0.4928        | 639   | 1675  | -19.60| -0.279 | 77                | -0.33     |
| 03D1fq     | 0.800    | 24.52    | +0.1617        | 853   | 3386  | -19.40| +0.075 | 63                | +0.26     |
| 03D1co     | 0.679    | 24.10    | +0.1696        | 803   | 2868  | -19.31| +0.082 | 63                | +0.25     |
| 03D1aw     | 0.582    | 23.59    | +0.1735        | 755   | 2450  | -19.35| +0.088 | 68                | +0.11     |
| 04D4bq     | 0.550    | 23.36    | +0.9345        | 717   | 2164  | -19.27| +0.493 | 72                | +0.13     |
| 04D3ny     | 0.810    | 24.27    | -0.4896        | 872   | 3609  | -19.81| -0.222 | 70                | -0.09     |
| 04D3ml     | 0.950    | 24.55    | -0.4976        | 919   | 4240  | -20.04| -0.215 | 74                | -0.21     |
| 04D3kr     | 0.337    | 21.97    | -0.4959        | 611   | 1525  | -19.58| -0.288 | 78                | -0.35     |
| 04D3gx     | 0.910    | 24.71    | -0.4870        | 906   | 4053  | -19.73| -0.213 | 65                | +0.06     |
| 04D3ez     | 0.263    | 21.68    | -0.4920        | 539   | 1193  | -19.21| -0.305 | 68                | -0.07     |
| 04D3cy     | 0.643    | 23.80    | -0.4928        | 804   | 2877  | -19.57| -0.239 | 67                | -0.01     |
| 04D2iu     | 0.691    | 24.26    | -0.8556        | 835   | 3188  | -19.40| -0.403 | 58                | +0.23     |
| 04D2fs     | 0.357    | 22.42    | -0.8512        | 639   | 1675  | -19.36| -0.482 | 67                | -0.09     |
| 04D1aj     | 0.721    | 23.90    | +0.1714        | 821   | 3043  | -19.70| +0.082 | 74                | -0.10     |
| 03D4gf     | 0.581    | 23.35    | +0.9341        | 734   | 2288  | -19.44| +0.485 | 77                | -0.01     |
| 03D4dh     | 0.627    | 23.39    | +0.9300        | 758   | 2474  | -19.63| +0.472 | 82                | -0.16     |
| 03D4cn     | 0.818    | 24.65    | +0.9297        | 840   | 3242  | -19.20| +0.435 | 62                | +0.44     |
| 03D3aw     | 0.449    | 22.55    | -0.4865        | 696   | 2020  | -19.78| -0.262 | 81                | -0.42     |
| 03D1fl     | 0.688    | 23.63    | +0.1638        | 807   | 2906  | -19.82| +0.079 | 80                | -0.25     |
| 03D1cm     | 0.870    | 24.46    | +0.1699        | 877   | 3671  | -19.72| +0.077 | 71                | -0.01     |
| 03D1au     | 0.504    | 22.98    | +0.1697        | 711   | 2122  | -19.54| +0.090 | 76                | -0.15     |
| b010       | 0.591    | 23.40    | +0.1807        | 760   | 2490  | -19.59| +0.092 | 75                | -0.11     |
| b013       | 0.426    | 22.68    | +0.1816        | 659   | 1789  | -19.35| +0.101 | 73                | -0.05     |
| b016       | 0.329    | 22.50    | +0.7603        | 564   | 1301  | -18.69| +0.461 | 61                | +0.48     |
| d033       | 0.531    | 23.23    | +0.7700        | 710   | 2115  | -19.32| +0.409 | 73                | +0.06     |
| Name | $z_{SCP}$ | $m_{SCP}$ | $-\cos \gamma$ | $r_z$ | $D_z$ | $M_z$ | $-X_z$ | $\frac{\sigma}{\langle D_z \rangle}$ | $\Delta M$ |
|------|----------|----------|----------------|------|------|------|-------|-----------------|--------|
| d058 | 0.583    | 23.59    | +0.4062        | 749  | 2402 | -19.31| +0.208 | 68              | +0.14  |
| d084 | 0.519    | 23.64    | +0.1955        | 720  | 2185 | -18.97| +0.103 | 58              | +0.44  |
| d085 | 0.401    | 22.48    | +0.7611        | 624  | 1593 | -19.26| +0.437 | 76              | -0.01  |
| d087 | 0.340    | 21.91    | +0.3942        | 585  | 1397 | -19.45| +0.235 | 82              | -0.26  |
| d089 | 0.436    | 22.50    | +0.1884        | 666  | 1831 | -19.60| +0.104 | 81              | -0.29  |
| d093 | 0.363    | 21.89    | +0.1865        | 611  | 1525 | -19.70| +0.108 | 89              | -0.47  |
| d097 | 0.436    | 22.50    | +0.1794        | 667  | 1837 | -19.61| +0.099 | 81              | -0.29  |
| d117 | 0.309    | 22.36    | +0.1837        | 563  | 1296 | -18.79| +0.111 | 60              | +0.38  |
| d149 | 0.342    | 22.19    | +0.2222        | 592  | 1431 | -19.23| +0.131 | 72              | -0.02  |
| e029 | 0.332    | 22.52    | +0.3917        | 578  | 1364 | -18.78| +0.235 | 60              | +0.41  |
| e108 | 0.469    | 22.55    | +0.1904        | 689  | 1974 | -19.76| +0.103 | 86              | -0.41  |
| e132 | 0.239    | 21.70    | +0.2211        | 489  | 999  | -18.76| +0.143 | 62              | +0.32  |
| e136 | 0.352    | 22.80    | +0.2161        | 601  | 1475 | -18.70| +0.127 | 56              | +0.52  |
| e138 | 0.612    | 24.05    | +0.1726        | 771  | 2582 | -19.05| +0.087 | 58              | +0.45  |
| e140 | 0.631    | 23.39    | +0.1791        | 780  | 2659 | -19.80| +0.089 | 81              | -0.28  |
| e147 | 0.645    | 23.38    | +0.1832        | 787  | 2721 | -19.87| +0.090 | 83              | -0.35  |
| e148 | 0.429    | 22.65    | +0.1816        | 662  | 1807 | -19.41| +0.101 | 75              | -0.10  |
| e149 | 0.497    | 22.90    | +0.1808        | 707  | 2094 | -19.58| +0.096 | 78              | -0.20  |
| f011 | 0.539    | 23.29    | +0.2290        | 730  | 2258 | -19.41| +0.119 | 71              | +0.005 |
| f041 | 0.561    | 23.09    | +0.4021        | 738  | 2318 | -19.70| +0.208 | 82              | -0.27  |
| f076 | 0.410    | 22.37    | +0.4102        | 641  | 1686 | -19.51| +0.232 | 81              | -0.24  |
| f096 | 0.412    | 23.06    | +0.7677        | 632  | 1636 | -18.76| +0.438 | 60              | +0.50  |
| f216 | 0.599    | 23.75    | +0.1613        | 765  | 2531 | -19.29| +0.081 | 65              | +0.20  |
| Name | $z_{SCP}$ | $m_{SCP}$ | $-\cos \gamma$ | $r_z$ | $D_z$ | $M_z$ | $-X_z$ | $\frac{cz}{D_{(z)}}$ | $\Delta M$ |
|------|---------|---------|----------------|-------|------|------|-------|----------------|--------|
| f231 | 0.619   | 23.45   | +0.7531        | 759   | 2482 | -19.57 | +0.382 | 78              | -0.10  |
| f235 | 0.422   | 22.45   | +0.3897        | 650   | 1737 | -19.51 | +0.219 | 81              | -0.23  |
| f244 | 0.540   | 23.30   | +0.1861        | 732   | 2273 | -19.42 | +0.097 | 71              | +0.003 |
| f308 | 0.401   | 23.07   | +0.1891        | 641   | 1686 | -18.80 | +0.107 | 57              | +0.48  |
| g005 | 0.218   | 21.32   | +0.7577        | 447   | 855  | -18.77 | +0.509 | 67              | +0.27  |
| g050 | 0.633   | 23.18   | +0.7625        | 765   | 2531 | -19.90 | +0.384 | 91              | -0.42  |
| g052 | 0.383   | 22.33   | +0.7678        | 609   | 1515 | -19.28 | +0.447 | 77              | -0.05  |
| g055 | 0.302   | 23.28   | +0.3891        | 550   | 1239 | -17.76 | +0.239 | 38              | +1.39  |
| g097 | 0.340   | 22.27   | +0.7661        | 574   | 1346 | -19.01 | +0.460 | 70              | +0.17  |
| g120 | 0.510   | 22.79   | +0.3830        | 709   | 2108 | -19.72 | +0.204 | 85              | -0.34  |
| g133 | 0.421   | 23.17   | +0.2240        | 655   | 1766 | -18.83 | +0.125 | 58              | +0.47  |
| g142 | 0.399   | 23.46   | +0.7582        | 622   | 1583 | -18.27 | +0.436 | 48              | +0.98  |
| g160 | 0.493   | 22.92   | +0.1835        | 704   | 2074 | -19.53 | +0.098 | 77              | -0.16  |
| g240 | 0.687   | 23.40   | +0.7523        | 791   | 2757 | -19.94 | +0.370 | 90              | -0.40  |
| h283 | 0.502   | 23.45   | +0.2496        | 708   | 2101 | -19.05 | +0.133 | 61              | +0.34  |
| h300 | 0.687   | 23.52   | +0.1821        | 806   | 2896 | -19.92 | +0.088 | 84              | -0.36  |
| h319 | 0.495   | 22.90   | +0.2300        | 704   | 2074 | -19.56 | +0.123 | 78              | -0.18  |
| h323 | 0.603   | 23.48   | +0.1851        | 766   | 2540 | -19.57 | +0.093 | 74              | -0.08  |
| h342 | 0.421   | 22.44   | +0.1800        | 656   | 1771 | -19.56 | +0.100 | 81              | -0.27  |
| h359 | 0.348   | 22.65   | +0.2364        | 597   | 1455 | -18.81 | +0.139 | 60              | +0.40  |
| h363 | 0.213   | 22.01   | +0.2404        | 457   | 887  | -18.15 | +0.160 | 48              | +0.90  |
| h364 | 0.344   | 21.71   | +0.1887        | 595   | 1445 | -19.73 | +0.111 | 91              | -0.52  |
| k396 | 0.271   | 21.84   | +0.7610        | 507   | 1065 | -18.82 | +0.485 | 67              | +0.28  |
| Name   | $z_{SCP}$ | $m_{SCP_U}$ | $-\cos\gamma$ | $r_z$ | $D_z$ | $M_z$ | $-X_z$ | $\frac{cz}{D_{(cz)}}$ | $\Delta M$ |
|--------|-----------|-------------|----------------|------|------|------|-------|----------------------|---------|
| k411   | 0.564     | 22.89       | +0.7643        | 729  | 2250 | -19.84 | +0.399 | 91                   | -0.42   |
| k425   | 0.274     | 21.94       | +0.3917        | 522  | 1124 | -18.84 | +0.246 | 64                   | +0.28   |
| k430   | 0.582     | 23.81       | +0.3826        | 750  | 2410 | -19.10 | +0.196 | 61                   | +0.36   |
| k441   | 0.680     | 23.73       | +0.2204        | 802  | 2858 | -19.68 | +0.107 | 75                   | -0.12   |
| k448   | 0.401     | 23.34       | +0.4038        | 634  | 1647 | -18.48 | +0.230 | 51                   | +0.79   |
| k485   | 0.416     | 23.93       | +0.2254        | 651  | 1742 | -18.03 | +0.126 | 40                   | +1.26   |
| m027   | 0.286     | 22.52       | +0.4012        | 534  | 1172 | -18.37 | +0.250 | 52                   | +0.76   |
| m062   | 0.314     | 21.99       | +0.3950        | 561  | 1287 | -19.15 | +0.240 | 73                   | +0.01   |
| m138   | 0.581     | 23.28       | +0.2077        | 749  | 2402 | -19.02 | +0.140 | 72                   | +0.16   |
| m158   | 0.463     | 23.09       | +0.7727        | 668  | 1843 | -19.06 | +0.427 | 67                   | +0.25   |
| m193   | 0.341     | 21.66       | +0.1832        | 592  | 1431 | -19.65 | +0.108 | 92                   | -0.55   |
| m226   | 0.671     | 23.64       | +0.2419        | 797  | 2812 | -19.72 | +0.118 | 77                   | -0.17   |
| n256   | 0.631     | 23.41       | +0.1867        | 780  | 2659 | -19.78 | +0.093 | 80                   | -0.26   |
| n258   | 0.522     | 23.29       | +0.2372        | 720  | 2185 | -19.32 | +0.125 | 69                   | +0.08   |
| n263   | 0.368     | 22.04       | +0.2473        | 613  | 1536 | -19.57 | +0.143 | 84                   | -0.34   |
| n278   | 0.309     | 21.87       | +0.7633        | 545  | 1218 | -19.14 | +0.471 | 76                   | +0.002  |
| n285   | 0.528     | 23.27       | +0.7664        | 709  | 2108 | -19.27 | +0.407 | 71                   | +0.11   |
| n326   | 0.268     | 22.11       | +0.7561        | 504  | 1054 | -18.52 | +0.483 | 58                   | +0.58   |
| p454   | 0.695     | 23.93       | +0.2235        | 808  | 2915 | -19.54 | +0.108 | 70                   | +0.03   |
| p455   | 0.284     | 21.66       | +0.2195        | 538  | 1189 | -19.26 | +0.136 | 76                   | -0.12   |
| p524   | 0.508     | 22.91       | +0.1883        | 713  | 2136 | -19.63 | +0.100 | 80                   | -0.24   |
| p528   | 0.781     | 24.12       | +0.2281        | 844  | 3285 | -19.72 | +0.106 | 74                   | -0.07   |
| p534   | 0.613     | 23.40       | +0.2389        | 770  | 2573 | -19.69 | +0.120 | 78                   | -0.20   |
5. A new ECM dipole test

All the ECM papers, V, VI, IX, XV, and the previous sections of paper XVI, have been developed by assuming the identity \( D_C = D(1 + z) \equiv D_L \). As the Hubble depth \( D \) represents an apparent distance at the present epoch \( t_0 \) (cf. paper XV), so the related \( D_L \) should be a fictitious luminous distance \( D_{FL} \), according to the arguments in paper V. Consequently the resulting successful \( M \), called Hubble Magnitude in paper X and XV, may be different from the true absolute magnitude, though the formula

\[
M = m - 5 \log D_L - 25 \tag{30}
\]

might make the necessary adjustment between the apparent magnitude \( m \) and the apparent distance \( D_L \) in order to produce the correct value of the absolute magnitude \( M \). This is the problem: what luminosity distance \( D_L \) is able to produce, not just a useful but likely fictitious value of \( M \), but the true \( M \)? The present section proposes the ECM exploration of the following \( D_L^* \) formula:

\[
D_L^* = r \cdot (1 + z)^2 \tag{31}
\]

The previous \( D_L^* \) equation differs from relativistic cosmology in that, here, the light-space \( r = -c\Delta t \) is a physical distance, representing the space run by light during the past travel time \( \Delta t = t - t_0 \), in place of the relativistic proper distance \( r_{pr} \) at the emission epoch \( t \) (cf. section 2 of papers VIII, IX, XV). However \( r \) in light-time also represents a measure of the past epoch \( t \); in other words \( r \) may be considered to all intents and purposes the light-space distance of the source at time \( t \). That \( r \), as \( r_z \), is the light space fitting the ECM Hubble law (1). In this case the proposed experimental formulation of the luminosity distance is eq. (31), here explored and tested on 249 High-z SCP Union supernovae, both to check the behaviour of the SNe Ia absolute magnitude according to the expansion center model, where now the High-z SNe Ia show low and slowly increasing average absolute magnitudes \( \langle M^* \rangle \), and to reconfirm the expansion dipole of the ECM Universe - with \( \langle M^* \rangle \equiv -18.01 \) from all 249 SNe - \( \langle M^* \rangle \equiv -18.02 \) from 200 SNe at \( z \geq 0.4 \)- \( \langle M^* \rangle \equiv -18.03 \) from 149 SNe at \( z \geq 0.5 \).

The ECM test of eq. (31) is based on the 13 ECM normal points of the corresponding samples in Table 0, here partially reproduced in Table 4, with two new columns, \( \langle r_z \rangle \) and the \( \langle M^* \rangle \) resulting from the data of Table 3abcdefghi, as the sequence (32) reported below shows:

\[
\text{ECM : } r = r_z \Rightarrow D_L^* \equiv r_z(1 + z)^2 \Rightarrow \langle M^* \rangle = \langle m_{B_{\text{max}}} \rangle - 5\langle \log D_L^* \rangle - 25 \tag{32}
\]
The linear fitting of the 13 normal \( \langle M^* \rangle \) values of Table 4 versus the corresponding \( \langle z \rangle \) listed in column 4\(^{th}\) gives the resulting relationship (33):

\[
\langle M^* \rangle = -17.83( \pm 0.01 ) - 0.15( \pm 0.02 ) \cdot \langle z \rangle
\]  

(33)

Hence a 2\(^{nd}\) type dipole test (cf. section 3.2 of paper XV) based on eq. (31) has been carried out through the following sequential steps:

\[
M^* = m - 5 \log \left[ r \cdot (1 + z)^2 \right] - 25 \Rightarrow r = 10^{0.2(m - M^*) - 5} / (1 + z)^2
\]  

(34)

**ECM:**

\[
x = \frac{3H_0 r}{c} \Rightarrow D = r \cdot \left( \frac{1 + x}{1 - x} \right) \Rightarrow Y = \frac{cz}{D} - H_0 = -\cos \gamma \cdot a^* (x)
\]  

(35)

\[
[\gamma, z, m, M^* (s_{Min})] \Rightarrow r = 10^{0.2[m - M^* (s_{Min})] - 5} / (1 + z)^2 \Rightarrow Y \rightarrow -\cos \gamma \Rightarrow a^*
\]  

(36)

\[
a^* (x) = a_0 \cdot (1 - x)^{\frac{1}{3}} / (1 + x) \Rightarrow X = \cos \gamma \cdot (1 - x)^{\frac{1}{3}} / (1 + x) \Rightarrow Y \rightarrow -X \Rightarrow a_0
\]  

(37)

The least square procedure has been applied to all the 13 samples of Table 4. The obtained solutions of the unweighted fittings (36) and (37) are listed in Table 5, for each new double dipole test R whose TID number refers to the sample index of Table 4 column 1. The corresponding rows present the resulting angular coefficients \( a^* (x) \) and \( a_0 \), preceded by the minimum value of the fitting standard deviations \( s_{Min} \) and the related values \( M^* (s_{Min}) \), following the same order as in Table 3 of paper V. In particular the expected value \( a^*_{ECM} \) in column 2 derives from the \( a^* (x) \) formula of (37) with \( x = 3H_0 (r) / c \), \( H_0 = 70 \) and \( a_0 = 12.7 \) H.u. (cf. section 2.1), being \( (r) \) the computed mean light distance of the sample according to (36). The results of this new dipole test are important, though the **standard deviations** \( s_{Min} \) **have here more than doubled**. The test gives a further ECM confirmation. Three large sets of High-z SNe Ia of Table 5, the samples called **XVI - XVI\(_{17}\) - XVI\(_{18}\)**, produce angular coefficients in accordance with those expected. Moreover the mathematical means of all the 13 \( a^* \) and \( a_0 \) values listed in Table 5 become \( \langle a^* (x) \rangle = +6.1 \pm 2.2 \) and \( \langle a_0 \rangle = +11.6 \pm 3.8 \), respectively, being \( \langle a^*_{ECM} \rangle = +6.1 \pm 0.2 \) H.u.. Thus the present test, when compared with the previous ones based on \( D_L = D \cdot (1 + z) \) (cf. also the papers V-VI-IX-XV), clearly shows the ECM dipole check as being independent from the inferred value of \( M \), within the limits of consistent formulations of the luminosity distance \( D_L \). As in the section 3.2 and 3.3, Appendix Figure 12 presents the dipole diagram of the test \( R_{18} \), as a plot of \( Y_{R_{18}} \) versus \( -X \). Appendix Figure 13 represents the same diagram of 3 normal points \( \langle Y \rangle \) versus the corresponding \( \langle -X \rangle \), which include: 74 SNe at the range \( -X < 0 \); 52 SNe at \( 0 < -X < 0.25 \) and 23 SNe at \( -X > 0.25 \).
Table 4

| Sample | N    | $z$ bin | $\langle z \rangle$ | $\langle m \rangle$ | $\langle D_z \rangle$ | $\langle r_z \rangle$ | $\langle M^* \rangle$ |
|--------|------|---------|---------------------|---------------------|---------------------|---------------------|---------------------|
| XVI_{11} | 50   | $0.2 < z \leq 0.4$ | 0.322              | 22.123              | 1425                | 577.6               | -17.883            |
| XVI_{12} | 101  | $0.2 < z \leq 0.5$ | 0.387              | 22.534              | 1716                | 632.1               | -17.869            |
| XVI_{13} | 142  | $0.2 < z \leq 0.6$ | 0.434              | 22.762              | 1893                | 663.5               | -17.885            |
| XVI_{14} | 174  | $0.2 < z \leq 0.7$ | 0.472              | 22.928              | 2037                | 686.3               | -17.902            |
| XVI_{15} | 192  | $0.2 < z \leq 0.8$ | 0.499              | 23.040              | 2152                | 701.3               | -17.907            |
| XVI_{16} | 215  | $0.2 < z \leq 0.9$ | 0.535              | 23.195              | 2332                | 720.1               | -17.902            |
| XVI    | 249  | $0.2 < z < 1.4$   | 0.607              | 23.440              | 2651                | 750.4               | -17.918            |
| XVI_{17} | 200  | $0.4 \leq z < 1.4$ | 0.677              | 23.763              | 2951                | 793.0               | -17.928            |
| XVI_{18} | 149  | $0.5 \leq z < 1.4$ | 0.756              | 24.052              | 3282                | 830.4               | -17.951            |
| XVI_{19} | 107  | $0.6 \leq z < 1.4$ | 0.837              | 24.339              | 3658                | 865.6               | -17.961            |
| XVI_{20} | 75   | $0.7 \leq z < 1.4$ | 0.919              | 24.627              | 4075                | 898.9               | -17.954            |
| XVI_{21} | 58   | $0.8 \leq z < 1.4$ | 0.969              | 24.784              | 4323                | 914.4               | -17.948            |
| XVI_{1}  | 48   | $0.83 \leq z < 1.4$| 1.001              | 24.836              | 4409                | 924.9               | -17.993            |

Table 5

| TID | $a_E^{ECM}$ | $s_{Min}$ | $M^*(s_{Min})$ | $a^*(x)$ | $s_{Min}$ | $M^*(s_{Min})$ | $a_0$ |
|-----|-------------|-----------|----------------|---------|-----------|----------------|-------|
| R11 | +7.3        | 23.190    | -18.02         | -2 ± 6  | 23.209    | -18.01         | -2 ± 10|
| R12 | +6.9        | 23.157    | -17.98         | -4 ± 5  | 23.202    | -17.98         | -5 ± 8 |
| R13 | +6.8        | 22.313    | -17.99         | -3 ± 4  | 22.346    | -17.99         | -4 ± 7 |
| R14 | +6.6        | 22.662    | -18.01         | +1 ± 3  | 22.654    | -18.01         | +2 ± 6 |
| R15 | +6.5        | 22.372    | -18.01         | +1.7 ± 2.9 | 22.368  | -18.01         | +3.7 ± 5.6|
| R16 | +6.4        | 22.551    | -17.99         | +2.8 ± 2.8 | 22.562  | -17.99         | +4.9 ± 5.4|
| R0  | +6.2        | 22.908    | -18.01         | +4.6 ± 2.6 | 22.964  | -18.01         | +7.3 ± 5.2|
| R17 | +6.0        | 22.794    | -18.02         | +6.6 ± 2.9 | 22.887  | -18.01         | +11.1 ± 6.1|
| R18 | +5.8        | 22.134    | -18.03         | +10.0 ± 3.1 | 22.345  | -18.02         | +18.2 ± 6.9|
| R19 | +5.5        | 22.440    | -18.04         | +14 ± 4  | 22.823    | -18.04         | +29 ± 9 |
| R20 | +5.3        | 22.697    | -18.05         | +15 ± 5  | 23.298    | -18.03         | +25 ± 11|
| R21 | +5.2        | 24.072    | -18.04         | +14 ± 6  | 24.644    | -18.03         | +25 ± 13|
| R1  | +5.2        | 21.701    | -18.08         | +19 ± 6  | 22.746    | -18.07         | +35 ± 14|
6. Absolute magnitude analysis of the SCP Union supernovae

After the preliminary magnitude analysis on the SCP Union data set in paper IX, here a further more precise analysis is carried out so as to distinguish the normal luminosity behavior of the supernovae Ia of the deep Universe from the SNe magnitude trend of the nearby Universe.

6.1 Fitting 14 High-\(z\) SNe \(M\) normal points

In the above sections we found evidence for a clear perturbation effect of the SNe \(\Delta M\) at \(z \lesssim 0.5\). In order to avoid possible interference effects, here a new model independent analysis of the normal points in paper IX Table 2 is undertaken and limited to 14 high-\(z\) mean Hubble Magnitudes \(\langle M \rangle\), those with \(z\)-bin normal redshifts \(\langle z \rangle > 0.55\). If a first, second and third degree polynomial is applied to the fitting of the \(\langle M \rangle\) plot versus \(\langle z \rangle\), the statistical coefficients of determination \(R^2\) are 0.9720, 0.9967, 0.9974, respectively. The best fitting is clearly the cubic one. Therefore, after adopting the identity between the \(z\)-bin normal redshift and the central redshift \(z_0\), that is

\[
\langle z \rangle \equiv z_0
\]  

and the normal equation of the Hubble Magnitude

\[
\langle M \rangle = (m_B^{\text{max}}) - 5\langle \log [cz(1 + z)] \rangle + 5 \log H_0 - 25 
\]  

the line equation of the normal Hubble Magnitude \(\langle M \rangle\) as a function of the central redshift \(z_0\) becomes

\[
\langle M \rangle = A_0 + A_1 z_0 + A_2 z_0^2 + A_3 z_0^3 
\]

with

\[
A_0 = -17.96 \quad A_1 = -4.117 \quad A_2 = +3.197 \quad A_3 = -0.9463 
\]

from the automatic cubic fitting (cf. Appendix Figure 14) whose coefficient of determination \(R^2 = 0.9974\).

Note that the previous eq. (2) of the normal points \(\langle M \rangle\) is the same normal \(M\) equation (21) of paper IX, while the Hubble Magnitude \(M\) of an individual source with redshift \(z\) and apparent magnitude \(m\) is by definition

\[
M = m - 5 \log [D \cdot (1 + z)] - 25 
\]

where \(D = cz/H_X = cz_0/H_0\) is the Hubble depth according to the expansion center Universe (cf. the ECM papers V-VI-IX-XV).
Together with the successful cubic fitting (3) of 14 high-
\[ z \] normal Hubble Magnitudes \( \langle M \rangle \) versus the normal redshift \( \langle z \rangle \), it is possible to carry out a successful linear fitting of the same 14 \( \langle M \rangle \) points versus the corresponding central light space values \( r = r(z_0) \) listed in column 8 of paper IX Table 2. In this case the normal Hubble Magnitude \( \langle M \rangle \) is represented by the equation
\[
\langle M \rangle = C_0 + C_1 r
\] (43)
with
\[
C_0 = -17.80 \quad C_1 = -0.002200
\] (44)
from the automatic linear fitting (cf. Appendix Figure 2) whose coefficient of determination \( R^2 = 0.9951 \).

The result of the two fittings can be summarized as follows:
\[
M_0 \approx \langle M \rangle(z_0 \to 0) = A_0 \approx \langle M \rangle(r \to 0) = C_0
\] (45)

Of course \( M_0 \) represents the absolute magnitude of a hypothetical supernova Ia with a central redshift \( z_0 \to 0 \). As the Hubble Magnitude \( M \) is clearly an apparent absolute magnitude at increasing Hubble depths, so its standard value for \( D \to 0 \) must necessarily coincide with the true intrinsic absolute magnitude, that is \( M_\alpha \) (cf. paper XV).

The conclusion of the preliminary analysis of the SNe Ia absolute magnitudes, based on the high-
\[ z \] normal points with \( \langle z \rangle > 0.55 \) of the paper IX Table 2, leads to the new result
\[
M_0 = \langle M_\alpha \rangle(z_0 \to 0) \approx -17.9
\] (46)

The previous \( M_0 \) value agrees with the new absolute magnitudes \( \langle M^* \rangle \) of section 5, those listed in Table 4, that is with the contents in the ADDENDUM NOTE - October 2011 - of paper XI.

### 6.2 Construction of 30 new normal points from 398 SCPU SNe data

The normal points of paper IX Table 2 refer to excessively large \( z \)-ranges to be able to represent accurately the SNe Hubble Magnitude trend at the low redshifts of the nearby Universe. Therefore, in order to improve the analysis, we need smaller \( z \) bins. The following Table 6 and Table 7, referring to the nearby and deep Universe respectively, collect 30 new normal points, based on 398 SCPU supernovae. These two tables were constructed according to the same procedure as paper IX Table 2. In particular the first 5 columns both of Table 6 and Table 7 contain numerical values derived from the observed \( z \) and \( m_{B,\text{max}} \) listed within the SCPU compilation (Kowalski et al.
2008); the values referring to each $z$ bin are in the order: $z$ range; number $N$ of the SNe included in the normal point; unweighted mathematical mean $\langle m \rangle$ of the corresponding SNe magnitudes $m_{B,\text{max}}$; mean Hubble Magnitude $\langle M \rangle$ resulting from the normal eq. (2) applied to the bin, with $H_0 = 70$ assumed; mathematical mean of the observed redshifts of the $z$ bin, according to the position $\langle z \rangle \equiv z_0$ of eq. (1). The 6th column holds the value of the Hubble Magnitude of a supernova Ia, with $z = \langle z \rangle \equiv z_0$ and $m = \langle m \rangle \equiv m_0$ assumed (cf. paper XV), according to the paper IX formula (19) (also called ECM $M(z_0)$ equation):

$$M(z_0) = m_0 - 5 \log [c z_0 \cdot (1 + z_0)] + 5 \log H_0 - 25 \quad (47)$$

Fitting the points $M(z_0)$ plotted versus $z_0$ or $r(z_0)$ leads to the line equation, $M(z_0)$ or $M(r)$, representing the central Hubble Magnitude of the supernovae Ia.

The last two columns, 7th and 8th, include two other central quantities, the light space $r(z_0)$ and the new absolute magnitude $M^*(z_0)$, corresponding to the assumed central redshift $z_0 \equiv \langle z \rangle$ and the central magnitude $m_0 \equiv \langle m \rangle$. Let us recall the ECM calculation procedure of $r(z_0)$, that applied in section 2.1 of paper IX and section 4 of paper XV:

$$z_0 = \frac{x}{3} \left( \frac{1 + x}{1 - x} \right) \Rightarrow x = x(z_0) = \frac{3 H_0 r(z_0)}{c} \Rightarrow r(z_0) = \frac{c x(z_0)}{3 H_0} \quad (48)$$

According to eq. (31), the previous $r(z_0)$, whose values are listed in column 7th of Table 6 and 7, allow the introduction of a new central luminosity distance, that is

$$D_L^* (z_0) = r(z_0) \cdot (1 + z_0)^2 \quad (49)$$

together with the new absolute magnitude of a supernova Ia, always with $z = \langle z \rangle \equiv z_0$ and $m = \langle m \rangle \equiv m_0$ assumed, as follows:

$$M^*(z_0) = m_0 - 5 \log [r(z_0) \cdot (1 + z_0)^2] - 25 \quad (50)$$

Fitting the points $M^*(z_0)$ plotted versus $z_0$ or $r(z_0)$ leads to the line equation, $M^*(z_0)$ or $M^*(r)$, representing the new central absolute magnitude of the supernovae Ia.
| z range       | N  | $\langle m \rangle$ | $\langle M \rangle$ | $\langle z \rangle \equiv z_0$ | $M(z_0)$ | $r(z_0)$ | $M^*(z_0)$ |
|--------------|----|---------------------|---------------------|--------------------------|---------|---------|----------|
| $0 < z \leq 0.010$ | 16  | 14.24               | $-18.14 \pm 0.36$  | 0.007                    | -18.24  | 29      | -18.09   |
| $0 < z \leq 0.015$ | 33  | 14.60               | $-18.44 \pm 0.21$  | 0.010                    | -18.58  | 40      | -18.48   |
| $0.005 \leq z \leq 0.020$ | 50  | 14.99               | $-18.63 \pm 0.11$  | 0.013                    | -18.75  | 52      | -18.64   |
| $0.010 \leq z \leq 0.025$ | 45  | 15.46               | $-18.75 \pm 0.11$  | 0.016                    | -18.81  | 63      | -18.60   |
| $0.015 \leq z \leq 0.030$ | 40  | 15.90               | $-18.86 \pm 0.10$  | 0.021                    | -18.92  | 80      | -18.72   |
| $0.020 \leq z \leq 0.050$ | 39  | 16.63               | $-19.07 \pm 0.06$  | 0.032                    | -19.14  | 116     | -18.84   |
| $0.025 \leq z \leq 0.100$ | 42  | 17.19               | $-19.14 \pm 0.05$  | 0.044                    | -19.28  | 152     | -18.91   |
| $0.030 \leq z \leq 0.150$ | 37  | 17.77               | $-19.15 \pm 0.05$  | 0.059                    | -19.38  | 193     | -18.90   |
| $0.035 \leq z \leq 0.200$ | 39  | 18.42               | $-19.16 \pm 0.05$  | 0.083                    | -19.51  | 250     | -18.91   |
| $0.040 \leq z \leq 0.250$ | 42  | 19.50               | $-19.09 \pm 0.06$  | 0.129                    | -19.48  | 340     | -18.68   |
| $0.045 \leq z \leq 0.300$ | 52  | 20.04               | $-19.09 \pm 0.06$  | 0.163                    | -19.51  | 395     | -18.60   |
| $0.050 \leq z \leq 0.350$ | 66  | 20.81               | $-19.15 \pm 0.06$  | 0.220                    | -19.49  | 473     | -18.43   |
| $0.10 \leq z \leq 0.40$ | 74  | 21.80               | $-19.13 \pm 0.06$  | 0.291                    | -19.24  | 552     | -18.02   |
| $0.15 \leq z \leq 0.45$ | 100 | 22.20               | $-19.18 \pm 0.05$  | 0.341                    | -19.26  | 598     | -17.96   |
| $0.20 \leq z \leq 0.50$ | 120 | 22.51               | $-19.21 \pm 0.05$  | 0.382                    | -19.26  | 632     | -17.90   |
Table 7

| $z$ range | N  | ⟨$m$⟩ | ⟨$M$⟩ | ⟨$z$⟩ ≡ $z_0$ | $M(z_0)$ | $r(z_0)$ | $M^*(z_0)$ |
|-----------|----|--------|--------|----------------|----------|----------|------------|
| $0.25 \leq z \leq 0.55$ | 131 | 22.72  | −19.26 ± 0.04 | 0.419 | −19.31 | 660 | −17.90 |
| $0.30 \leq z \leq 0.60$ | 142 | 22.87  | −19.32 ± 0.04 | 0.450 | −19.36 | 682 | −17.91 |
| $0.35 \leq z \leq 0.65$ | 143 | 23.10  | −19.37 ± 0.04 | 0.495 | −19.40 | 711 | −17.90 |
| $0.40 \leq z \leq 0.70$ | 138 | 23.25  | −19.44 ± 0.04 | 0.533 | −19.47 | 733 | −17.93 |
| $0.45 \leq z \leq 0.75$ | 118 | 23.43  | −19.48 ± 0.04 | 0.574 | −19.51 | 756 | −17.93 |
| $0.50 \leq z \leq 0.80$ | 98  | 23.61  | −19.55 ± 0.04 | 0.623 | −19.57 | 781 | −17.96 |
| $0.55 \leq z \leq 0.85$ | 91  | 23.82  | −19.60 ± 0.04 | 0.680 | −19.62 | 808 | −17.97 |
| $0.60 \leq z \leq 0.90$ | 79  | 24.03  | −19.62 ± 0.04 | 0.730 | −19.64 | 829 | −17.94 |
| $0.65 \leq z \leq 0.95$ | 68  | 24.25  | −19.68 ± 0.04 | 0.797 | −19.69 | 855 | −17.96 |
| $0.70 \leq z \leq 1.00$ | 62  | 24.42  | −19.71 ± 0.04 | 0.851 | −19.72 | 875 | −17.96 |
| $0.75 \leq z \leq 1.10$ | 60  | 24.52  | −19.74 ± 0.04 | 0.885 | −19.75 | 886 | −17.97 |
| $0.80 \leq z \leq 1.20$ | 56  | 24.62  | −19.79 ± 0.05 | 0.927 | −19.80 | 900 | −18.00 |
| $0.85 \leq z \leq 1.30$ | 44  | 24.77  | −19.86 ± 0.06 | 0.996 | −19.88 | 921 | −18.05 |
| $z \geq 0.9$       | 43  | 25.01  | −19.88 ± 0.06 | 1.082 | −19.91 | 944 | −18.05 |
| $z \geq 0.95$      | 34  | 25.13  | −19.89 ± 0.07 | 1.123 | −19.92 | 955 | −18.04 |

Formally eq. (50) of $M^*(z_0)$ (whose high-$z$ values are listed in column 8th of the above Table 7) is different from eq. (32) of $⟨M^*⟩$ (whose high-$z$ values are listed in column 8th of Table 4), that is the normal equation of the new absolute magnitude, here rewritten in eq. (51),

$$⟨M^*⟩ = ⟨m⟩ - 5(\log [r_z(1 + z)^2]) - 25$$

(51)

where $r_z$ is the light space resulting from the ECM × equation (cf. eq. (4) of paper IX).

Fitting the normal points $⟨M^*⟩$ plotted versus $z_0$ or $⟨r_z⟩$ leads to the line equation, $⟨M^*⟩(z_0)$ or $⟨M^*⟩(⟨r_z⟩)$, representing the new normal absolute magnitude of the supernovae Ia.

Numerically, we find a small difference between $⟨M^*⟩$ and $M^*(z_0)$, about 0.03 magnitudes on average at high $z$, that is

$$⟨M^*⟩(z_0) - M^*(z_0) ≈ 0.03$$

(52)

Thus the usefulness of the new central absolute magnitude $M^*(z_0)$ is confirmed.
6.3 Plotting 30 values of SNe $\langle M \rangle$, $M(z_0)$, $M^*(z_0)$ versus $z_0$ and $r(z_0)$

The 30 values of $\langle M \rangle$, $M(z_0)$, $M^*(z_0)$ in Table 6 and 7 from SCPU data of 398 SNe allow the construction of the corresponding 6 plots, versus $z_0 \equiv \langle z \rangle$ and $r(z_0)$ respectively. These diagrams appear in the Appendix "Atlas of the ECM paper XVI figures". In particular Appendix Figure 16 presents the plot of 30 SNe Ia normal Hubble Magnitudes $\langle M \rangle$ versus the mean redshift $\langle z \rangle$, Appendix Figure 17 the plot of 30 SNe Ia normal Hubble Magnitudes $\langle M \rangle$ versus the ECM $r(z_0)$, Appendix Figure 18 the plot of 30 SNe Ia central Hubble Magnitudes $M(z_0)$ versus $z_0$, Appendix Figure 19 the plot of 30 SNe Ia central Hubble Magnitudes $M(z_0)$ versus the ECM $r(z_0)$, Appendix Figure 20 the plot of 30 SNe Ia central absolute magnitudes $M^*(z_0)$ versus $z_0$, Appendix Figure 21 the plot of 30 SNe Ia central absolute magnitudes $M^*(z_0)$ versus the ECM $r(z_0)$.

6.4 The magnitude anomaly of the SNe Ia at low $\langle z \rangle$

Even at first sight the plots of the Appendix Figures 16-17-18-19-20-21 highlight the magnitude anomaly of the low $\langle z \rangle$ points. In other words these six diagrams give clear empirical evidence for the normal luminosity behaviour of the supernovae Ia of the deep Universe in comparison with the SNe magnitude trend of the nearby Universe. Such a distinction has been emphasized through the separation of the 30 normal points into two groups of 15 points each. Table 6 collects 15 normalized-central supernovae Ia, which appear to be affected by the magnitude anomaly, with individual redshifts $z \leq 0.5$, while Table 7 collects other 15 normalized-central supernovae Ia based on individual redshifts $z \geq 0.25$. In particular it is remarkable to see in Appendix Figure 20 a significant linear trend (almost constant) of the central absolute magnitudes $M^*(z_0)$ after high normal redshifts, with $\langle z \rangle \gtrsim 0.4$. Thus a preliminary cut-off redshift limit between the nearby Universe affected by the magnitude anomaly and the unperturbed deep Universe is here fixed at $z = 0.25$ and corresponding $\langle z \rangle > 0.4$. But the discovered variation of the SNe Ia luminosity may be only apparent, because there is no astrophysical explanation able to reproduce intrinsically the observed maximum peak in the depth range $0.04 \lesssim \langle z \rangle \lesssim 0.08$, with a resulting $\Delta M \approx 1$ (cf. Appendix Figures 16-18-20).

6.5 Astronomical evidence for cosmic rotation

An interpretation of the observed magnitude anomaly can be found in paper VII "Cosmic mechanics of the nearby Universe within the expansion center model with angular momentum conserved".
In other words the negative collapse of the SNe $M$ at $\langle z \rangle \approx 0.06$ and $\langle z \rangle \equiv z_0 \lesssim 0.4$ is here considered to be a proof of cosmic rotation, which not even the ECM Hubble law (cf. section 2.1 and papers V-VI-IX) includes. Consequently the related magnitude formula, owing to the inclusion of distorted Hubble depths $D = cz_0/H_0 = cz/H_X$ or light spaces $r$ as inferred from the ECM Hubble law, should also give distorted values of SNe $\langle M \rangle$, $M(z_0)$, $M^*(z_0)$ to a wide Galaxy entourage, including the Huge Void (Bahcall & Soneira 1982) and the expansion center at $R_0 \approx 260\text{ Mpc}$ from the Local Group (cf. papers I-II and author 1991). Indeed, only the very nearby Universe, at $z_0 \lesssim 0.007$ or $D \lesssim 30\text{ Mpc}$, should be somewhat independent from the cosmic rotation, owing to the Galilean relativity effect within the ECM rigid rotation; on the other hand also the normal or central points of the deep Universe, at $\langle z \rangle \equiv z_0 \gtrsim 0.4$ or $D \gtrsim 1000\text{ Mpc}$, result to be negligibly affected by the cosmic rotation, probably thanks to a better statistical merging of the individual $z$ points. Here we must remark that, according to the rotating Universe calculated in paper VII, the transversal velocity of the Galaxy, $R_0 \dot{\theta}_0 \approx 6 \times 10^9 cm/s$, is more than three times the radial velocity, $\dot{R}_0 \approx 1.8 \times 10^9 cm/s$. Therefore the observed redshift $z$ from the Milky Way must also be linked to a relative motion of differential rotation, which however is inconsistent with the ECM rigid rotation. In conclusion the magnitude anomaly of the SNe Ia at low $\langle z \rangle$ may be technically interpreted as due to a deficiency in the used magnitude formulas, which produce a maximum peak of deviation, with a resulting systematic $\Delta M \approx 1$ at $0.04 \lesssim \langle z \rangle \lesssim 0.08$, that is in the Hubble depth range $170\text{ Mpc} \lesssim D \lesssim 350\text{ Mpc}$.

### 6.6 Fitting 15 values of High-$z$ SNe $\langle M \rangle$, $M(z_0)$, $M^*(z_0)$ versus $z_0$ and $r$

As a consequence of the previous results, a correct analysis of the SNe Ia absolute magnitudes (cf. eqs. 39-42-47-50) must necessarily be limited to the data of Table 7, that of a deep Universe whose magnitude anomaly seems to be negligible within the limits of the present astronomical measurements.

Fitting the 15 points $\langle M \rangle$ (cf. Table 7) plotted versus $z_0$ and $r(z_0)$ leads to the line equations, $\langle M \rangle(z_0)$ and $\langle M \rangle(r)$, representing the normal Hubble Magnitude of the supernovae Ia, as a function of the central redshift $z_0$ and light space $r(z_0)$. The solutions from the following automatic cubic and linear fittings (cf. Appendix Figures 22-23)

$$\langle M \rangle(z_0) = A_0 + A_1 z_0 + A_2 z_0^2 + A_3 z_0^3$$  \hspace{1cm} (53)

$$\langle M \rangle(r) = C_0 + C_1 r(z_0)$$  \hspace{1cm} (54)
, whose corresponding coefficients of determination $R^2 = 0.9948$ and $R^2 = 0.9950$ respectively, give the values:

$$A_0 = -18.26 \quad A_1 = -3.351 \quad A_2 = +2.636 \quad A_3 = -0.8485$$

(55)

$$C_0 = -17.86 \quad C_1 = -0.002138$$

(56)

Fitting the 15 points $M(z_0)$, (cf. Table 7) plotted versus $z_0$ and $r(z_0)$ leads to the line equations, $M(z_0)$ and $M(r)$, representing the central Hubble Magnitude of the supernovae Ia, as a function of the central redshift $z_0$ and light space $r(z_0)$. The solutions from the following automatic cubic and linear fittings (cf. Appendix Figures 24-25)

$$M(z_0) = A_0 + A_1 z_0 + A_2 z_0^2 + A_3 z_0^3$$

(57)

$$M(r) = C_0 + C_1 r(z_0)$$

(58)

, whose corresponding coefficients of determination $R^2 = 0.9939$ and $R^2 = 0.9923$ respectively, give the values:

$$A_0 = -18.38 \quad A_1 = -3.188 \quad A_2 = +2.681 \quad A_3 = -0.9603$$

(59)

$$C_0 = -17.95 \quad C_1 = -0.002061$$

(60)

Fitting the 15 points $M^*(z_0)$ (cf. Table 7) plotted versus $z_0$ and $r(z_0)$ leads to the line equations, one of $M^*(z_0)$ and two of $M^*(r)$, representing the new central absolute magnitude of the supernovae Ia, as a function of the central redshift $z_0$ and light space $r(z_0)$. The solutions from one quadratic and two linear automatic fittings (cf. Appendix Figures 26-27-28)

$$M^*(z_0) = A_0 + A_1 z_0 + A_2 z_0^2$$

(61)

$$M^*(z_0) = A_0 + A_1 z_0$$

(62)

$$M^*(r) = C_0 + C_1 r(z_0)$$

(63)

, whose corresponding coefficients of determination $R^2 = 0.8883$, $R^2 = 0.8772$ and $R^2 = 0.8353$, respectively, give the values:

$$A_0 = -17.87 \quad A_1 = -0.02420 \quad A_2 = -0.1199$$

(64)

$$A_0 = -17.81 \quad A_1 = -0.2071$$

(65)

$$C_0 = -17.57 \quad C_1 = -4.831E - 04$$

(66)
6.7 A final solution for the SNe Ia $\langle M \rangle$ and $\langle M^* \rangle$

Each solution in the previous sections has given an extrapolated value of the absolute magnitude $\langle M \rangle(z \to 0)$ as $M_0 = A_0$ or $M_0 = C_0$. Thus the solution here adopted for the absolute magnitude $M_0$ of the supernovae Ia, from the mathematical mean of the 9 values listed above, is the following:

$$M_0 = -17.9 \pm 0.1$$  \hspace{1cm} (67)

Once the starting point has been fixed at this $M_0 = -17.9$, a solution of the SNe Ia $\langle M \rangle$ and $\langle M^* \rangle$ can be found taking into account only the best normal points, that is the core of the available data, those based on $z$ bins with individual $z \geq 0.4$ and a number $N \geq 60$ as a minimum limit for the SNe included in the normal point. In particular the choice for $\langle M \rangle$ includes 9 normal points from paper IX Table 2 and the 4 ECM normal points here listed as $\langle M_z \rangle$ in Table 8, while that for $\langle M^* \rangle$ includes only the 4 ECM normal points of Table 8.

Fitting the plot of the 9 core points $\langle M \rangle$ from paper IX Table 2 and the starting point $M_0 = -17.9$, both versus $\langle z \rangle \equiv z_0$ and $r(z_0)$, leads to the line equations, $\langle M \rangle(z_0)$ and $\langle M \rangle(r)$, representing the normal Hubble Magnitude of the supernovae Ia, as a function of the central redshift $z_0$ and light space $r(z_0)$. The solutions of the following automatic cubic and linear fittings (cf. Appendix Figures 29-31)

$$\langle M \rangle(z_0) = A_0 + A_1 z_0 + A_2 z_0^2 + A_3 z_0^3$$  \hspace{1cm} (68)

$$\langle M \rangle(r) = C_0 + C_1 r(z_0)$$  \hspace{1cm} (69)

, whose corresponding coefficients of determination $R^2 = 0.99992$ and $R^2 = 0.9996$ respectively, give the values:

$$A_0 = -17.900 \quad A_1 = -4.2618 \quad A_2 = +3.2507 \quad A_3 = -0.90878$$  \hspace{1cm} (70)

$$C_0 = -17.90 \quad C_1 = -0.002091$$  \hspace{1cm} (71)

The parallel check solutions based only on the 9 points $\langle M \rangle$ without $M_0 = -17.9$ (cf. Appendix Figures 30-32) give $R^2 = 0.9974$ and $R^2 = 0.9943$, with $A_0 = -18.11$ and $C_0 = -17.75$, respectively.

An alternative solution is based on the 4 ECM normal points of Table 8, which was constructed by combining the core points from Table 0 of section 3.1 with those from Table 4 of section 5.
| N  | z bin | ⟨z⟩ | ⟨m⟩ | ⟨rz⟩ | ⟨Mz⟩ | ⟨M*⟩ |
|----|------|-----|-----|------|------|------|
| 200| 0.4 ≤ z < 1.4 | 0.677 | 23.763 | 793.0 | −19.567 | −17.928 |
| 149| 0.5 ≤ z < 1.4 | 0.756 | 24.052 | 830.4 | −19.650 | −17.951 |
| 107| 0.6 ≤ z < 1.4 | 0.837 | 24.339 | 865.6 | −19.719 | −17.961 |
| 75 | 0.7 ≤ z < 1.4 | 0.919 | 24.627 | 898.9 | −19.773 | −17.954 |

Fitting the plot of the 4 ECM points ⟨Mz⟩ of Table 8 and the starting point $M_0 = -17.9$, both versus ⟨z⟩ ≡ $z_0$ and ⟨rz⟩, leads to the line equations, ⟨Mz⟩($z_0$) and ⟨Mz⟩(⟨rz⟩), representing the ECM normal Hubble Magnitude of the supernovae Ia, as a function of the central redshift $z_0$ and light space ⟨rz⟩. The solutions of the following automatic cubic and linear fittings (cf. Appendix Figures 33-35)

\[
\langle M_z \rangle (z_0) = A_0 + A_1 z_0 + A_2 z_0^2 + A_3 z_0^3 \tag{72}
\]

\[
\langle M_z \rangle (\langle r_z \rangle) = C_0 + C_1 \langle r_z \rangle \tag{73}
\]

, whose corresponding coefficients of determination $R^2 = 1.0000$ and $R^2 = 0.99990$ respectively, give the values:

\[
A_0 = -17.900 \quad A_1 = -4.0675 \quad A_2 = +2.8270 \quad A_3 = -0.67334 \tag{74}
\]

\[
C_0 = -17.901 \quad C_1 = -0.0020968 \tag{75}
\]

The parallel check solutions based only on the 4 points ⟨Mz⟩ without $M_0 = -17.9$ (cf. Appendix Figures 34-36) give $R^2 = 0.9999$ and $R^2 = 0.9954$, with $A_0 = -18.12$ and $C_0 = -18.03$, respectively.

Indeed, the high reliability of the 4 ECM normal points of Table 8 is clearly shown by the very precise solutions above listed, which are very near to those derived from the previous 9 points ⟨M⟩ from paper IX Table 2. Consequently these 4 ECM normal points are here considered pilot points also for finding a better trend of the new absolute magnitude $M^*$ of the supernovae Ia.

Fitting only the plot of the 4 core points ⟨M*⟩ listed in Table 8 (excluding the starting point $M_0 = -17.9$), both versus ⟨z⟩ ≡ $z_0$ and ⟨rz⟩, leads to the line equations, ⟨M*⟩($z_0$) and ⟨M*⟩(⟨rz⟩), representing the new normal absolute magnitude of the supernovae Ia, as a function of the central redshift $z_0$ and light space ⟨rz⟩, with ⟨M*⟩($z_0$) ≡ ⟨M*⟩(⟨rz⟩) ≡ ⟨Mα⟩($z_0$) assumed.
The solutions from both the automatic linear fittings (cf. Appendix Figures 37-38), that is

\[ \langle M^* \rangle(z_0) = A_0 + A_1 z_0 \] (76)

and

\[ \langle M^* \rangle(\langle r_z \rangle) = C_0 + C_1 \langle r_z \rangle \] (77)

, whose corresponding coefficients of determination \( R^2 = 0.6237 \) and \( R^2 = 0.6564 \) respectively, give the values:

\[ A_0 = -17.86 \quad A_1 = -0.1084 \] (78)

\[ C_0 = -17.73 \quad C_1 = -0.0002541 \] (79)

The 6 previous fittings carried out without the starting point \( M_0 = -17.9 \) give again an extrapolated absolute magnitude \( \langle M_\alpha \rangle(z_0 \rightarrow 0) \) as \( M_0 = A_0 \) or \( M_0 = C_0 \). Hence the computed solution for the absolute magnitude \( M_0 \) of the supernovae Ia, from the mathematical mean of the 6 values listed above, is here confirmed to be the following:

\[ M_0 = -17.93 \pm 0.08 \] (80)

Finally, the solutions here proposed for the SNe \( \langle M \rangle \) and \( \langle M^* \rangle \) permit the computation of both the total \( M \) spread and the absolute magnitude \( M_\alpha \) when \( M_\alpha \equiv M^* \) is assumed, according to paper XV and paper X Appendix. Table 9 lists 5 spread values (in second, fourth and sixth column) following the 3 solutions (70)(74)(78), calculated at the 5 different \( \langle z \rangle \equiv z_0 \) of the first column. In addition Table 9 also reports the relativistic value of the deceleration parameter which results by applying the total spread of the extrapolated Hubble Magnitudes \( \langle M \rangle(z_0) \) and \( \langle M_z \rangle(z_0) \) at \( z_0 = 0.001 \) into the \( q_0 \) formula (59) of the parallel paper XV (or A19 of paper X).

| \( z_0 \) | \( \langle M \rangle(z_0) - M_0 \) | \( q_0 \) | \( \langle M_z \rangle(z_0) - M_0 \) | \( q_0 \) | \( \langle M^* \rangle(z_0) - A_0 \) |
|----------------|----------------|---------|----------------|---------|----------------|
| 0.001 | -0.004259 | +2.92 | -0.004065 | +2.74 | -0.000109 |
| 0.01  | -0.04229  |        | -0.04039  |        | -0.00108   |
| 0.1   | -0.3946   |        | -0.3792   |        | -0.0108    |
| 0.5   | -1.432    |        | -1.411    |        | -0.0542    |
| 1     | -1.920    |        | -1.914    |        | -0.1084    |

Table 9
6.8 The new absolute magnitude $M^*$

At the end of this magnitude analysis, the coincidence between the intrinsic absolute magnitude $M_\alpha$ with the new absolute magnitude $M^*$ (cf. paper XV, paper XI Addendum Note, paper X Appendix) must also be shown theoretically, summed up in the identity

$$M_\alpha \equiv M^* = m - 5 \log D_L - 25$$

(81)

with

$$D_L = r \cdot (1 + z)^2 = r_0 \cdot (1 + z)$$

(82)

as a new formulation of the luminosity distance $D_L$, which differs from relativistic cosmology in that, here, the light space $r = -c\Delta t$ is a physical distance, representing the space run by light during the past travel time $\Delta t = t - t_0$, in place of the relativistic proper distance $r_{pr}$ at the emission epoch $t$ (cf. section 2 of paper VIII, IX, XV).

Mathematically, such light-space $r$ in eq. (82) is the same $r$ we find in Milne’s cosmology (Rowan-Robinson 1996) as the distance at the emission epoch; however the "cosmic medium" (CM), with respect to which light moves at constant speed $c = \lambda/T$, is expanding as does the whole Universe. Consequently, also $\lambda$ and $T$ increase, because of the CM expansion with the constancy of $c$. As a result, the light-space $r$ is larger than the distance at the emission epoch, although its value in light-time represents a measure of that past epoch $t$.

The same, $r_0 = r \cdot (1 + z)$ in eq. (82) seems to substitute the relativistic proper distance at the present epoch $t_0$, while its meaning has yet to be found within expansion center cosmology.

In conclusion the physical demonstration of eq. (82) is possible, but such a task must belong rigorously to the theoreticians.
7. Conclusions

The present paper, after the parallel paper XV, is the latest in a series of ECM papers, containing important new results, based on the fundamental SCP Union data, in addition to the further reconfirmation of the expansion center model.

A few remarks and concluding statements on the topic may be summarized as follows:

0) The preliminary empirical model of the expansion center Universe (Lorenzi 1989) led to a confirmed dipole equation of the Hubble ratio (Lorenzi 1991-93); after the discovery of a high rate of variation of the Hubble constant in the nearby Universe (Lorenzi 1994), a more rigorous formulation of the new Hubble law was developed and studied in terms of possible outcomes. The expansion center model (ECM) is the proposed solution in the 1999 papers I and II;

1) The adjective ”model independent”, first of all means the exclusion of the ECM formalism of paper II, as specified in the ”Introduction” of paper XV. In this sense papers V, VI, IX, XV may be considered model independent papers;

2) The formulation for the wedge-shape of the new Hubble law, or new Hubble D law, implies a clear Hubble ratio dipole, as 
\[ \frac{cz}{D} = H_0 - a^*(D) \cos \gamma, \]
where the Hubble depth 
\[ D = \frac{D_C}{1 + z} \]
can be calculated through the \( M \) value which produces the identity 
\[ D_C \equiv D_L = 10^{0.2(m-5)} - 5; \]

3) The relation (22) in paper IX, expressing the average trend of the SNe Hubble Magnitude 
\[ M(z_0) = d_0 + d_1D + d_2D^2 \equiv \langle M \rangle, \]
was constructed by using the normal ECM \( M \) equation (21) from paper IX, with \( H_0 = 70 \) H.u. assumed and without including the ECM dipole terms of 398 SCPU supernovae. In practice that means the adoption of an ECM-independent procedure;

4) Without doubt, paper XV has produced two significant results, that is a model independent confirmation both of the Hubble ratio dipole and of the angular coefficient \( a^* = 5.5 \) H.u. predicted by the ECM at the central redshift \( z_0 \equiv \langle z \rangle = 1.0 \) or Hubble depth \( D \approx 4283 \) Mpc;

5) Unlike in paper XV, the dipole analysis of this paper XVI was based on the adoption of the ECM, to make possible the check test of the ECM standard value, \( a_0 = 12.7 \) H.u.. A similar procedure was applied also in paper VI and in its integral version;

6) A new finding from paper XVI is a clear macroscopic discovery of large \( \Delta M \) in SNe Ia, which consequently, at the present time, are not usable standard candles when taken individually;

7) A secondary result from paper XVI is the resulting drop in the scattering \( \Delta M \) with the Hubble depth \( D \), more likely according to the relationship 
\[ \langle |\Delta M| \rangle \approx 1.4 - 0.15 \ln(D); \]

8) In addition to the previous relationship, the available data set of Table 3 seems to suggest
the preliminatory correlation $\langle |\Delta M| \rangle \approx 0.34 - 0.10 \cdot \cos \gamma$, only at redshifts $z \lesssim 0.5$ (cf. Appendix Figure 7);

9) Another important outcome of the present "Dipole analysis..." is the evidence for a clear perturbation effect on ECM of the SNe $\Delta M$ at $z \lesssim 0.5$;

10) The above cited perturbation effect of $\Delta M$, after introducing the weights $w_i \propto |\Delta M|^{-i}$, allows both a further reconfirmation of the expansion center model at any Hubble depth $D$ and, at the same time, the demonstration of the adopted $\langle M \rangle = d_0 + d_1 D_z + d_2 D_z^2$ being able to accurately reproduce the predicted Hubble ratio dipole when $\Delta M \to 0$;

11) The unweighted dipole tests, that is with $w_0 = 1$, directly confirm the ECM at $z \gtrsim 0.5$, since the mathematical mean of all the 10 $a_0$ values, those resulting from W18-W19-W20-W21-W22 of Table 1 and A18-A19-A20-A21-A22 of Table 2, becomes $\langle a_0 \rangle = 12.0 \pm 0.6$ H.u., while the above best 5 fittings in Table 1 give $\langle a_0 \rangle = 12.8 \pm 0.7$ H.u.. Once again these average values agree very well with the ECM, being 12.7 H.u the standard value of $a_0$;

12) A further result here reported is some astronomical evidence for intrinsic SNe Ia $\Delta M$;

13) The magnitude anomaly of the SCPU supernovae at low redshifts, with an observed maximum peak of $\Delta M \approx 1$ in the range $0.04 \lesssim \langle z \rangle \lesssim 0.08$ (cf. Appendix Figures 16-18-20), is the most important finding in paper XIII, which has been rolled out in paper XVI;

14) The negative collapse of the SNe $M$ at $\langle z \rangle \approx 0.06$ in a range $0.007 \lesssim \langle z \rangle \lesssim 0.4$ is here considered to be structural and due to the cosmic rotation, which should affect significantly the usual magnitude formulas for a wide Galaxy entourage, including the Huge Void (Bahcall & Soneira 1982) and the expansion center at $R_0 \approx 260 Mpc$ (cf. ECM papers I-II and author 1991);

15) Once the perturbation zone on the SNe $M$ is removed, the luminosity analysis of high $z$ SNe Ia has allowed the extrapolation of the corresponding absolute magnitude $M_0$ value at a central redshift $z_0 \to 0$. The final result is $M_0 = -17.93 \pm 0.08$;

16) The extrapolated trend of the normal Hubble Magnitude $\langle M \rangle$ of the supernovae Ia at low central redshifts $z_0 \equiv \langle z \rangle \ll 1$, according to $\langle M \rangle = \langle m \rangle - 5[\log D(1 + z)] - 25$ with $D = cz/H_X \equiv cz_0/H_0$, presents a sharp negative increase with $z_0$, which clearly contrasts with the almost constant trend due to a relativistic $q_0 \approx -1$ (cf. paper XV and paper X Appendix);

17) The new ECM absolute magnitude of the supernovae Ia, that $M^*$ based on a luminosity distance $D_L = r_z \cdot (1 + z)^2$ where $r_z = -c(t - t_0)$ is the light space resulting from the ECM $z$ equation as space run by light at constant speed $c$ into the expanding "cosmic medium" or Hubble flow, shows here a slowly increasing negative trend, that is: $\langle M^* \rangle = -17.9 - 0.1 \times z_0$, with
$z_0 \equiv \langle z \rangle$ assumed;

18) Two precise values of the determination coefficient, that is $R^2 = 0.99992$ and $R^2 = 1.0000$, from the final cubic fittings of $\langle M \rangle(z_0)$ and $\langle M_z \rangle(z_0)$ respectively, give the corresponding total $M$ spread in Table 9 a high accuracy. As a consequence, the more reliable value of the relativistic deceleration parameter $q_0$ here is about $+3$;

19) The intrinsic absolute magnitude $M_\alpha$ is found to coincide with the new absolute magnitude $M^*$, that is $M_\alpha \equiv M^*$, based both on empirical and theoretical results;

20) After the strong experimental evidence for the expansion center and some mechanical investigations about the Universe as a whole, according to the ECM papers series, this paper XVI presents a noteworthy observational proof of the cosmic rotation, that is the magnitude anomaly of the nearby supernovae Ia. Thus Gamow (1946) was right to propose a "Rotating Universe?" to Einstein, however unsuccessfully (cf. Kragh 1996). Actually there are other important astronomical proofs on the topic (cf. Longo 2011). The conclusion might be in favour of a Big Bang as a Big Crush, when the ECM cosmic mechanics with angular momentum conserved (cf. paper VII and VIII) is applied even to Lemaître primitive atom (1946).
8. Acknowledgements

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9. References

Astier, P. et al. 2006, A&A 447, 31
Bahcall, N.A. & Soneira, R.M. 1982, ApJ 262, 419 (B&S)
EWASS 2012, http://www.ifsi-roma.inaf.it/ewass2012/
Gamow, G. 1946, "Rotating Universe?", Nature, 158, 549
Harvard-IAU 2003, http://cfa-www.harvard.edu/iau/lists/Supernovae.html
Knop, R.A. et al. 2003, ApJ 598, 102 (K03)
Kowalski, M. et al. 2008, arXiv:0804.4142v1 [astro-ph] 25 Apr 2008 →ApJ 686, 749
Kragh, H. 1996, "Cosmology and Controversy", Princeton University Press
Lemaître, G. 1946, "L'Hypothese de l'atom primitif", Neuchatel, Griffon
Longo, M.J. 2011, arXiv:1104.2815v1 [astro-ph.CO] 14 Apr 2011
Lorenzi, L. 1989, 1991, Contributi N. 0,1, Centro Studi Astronomia - Mondovì, Italy
1993, in 1995 MemSAIt, 66, 1, 249
1994, in 1996 Astro. Lett. & Comm., 33, 143
1999a, astro-ph/9906299 17 Jun 1999,
in 2000 MemSAIt, 71, 1163 (paper I: reprinted in 2003, MemSAIt, 74)
1999b, astro-ph/9906292 17 Jun 1999,
in 2000 MemSAIt, 71, 1183 (paper II: reprinted in 2003, MemSAIt, 74)
2003b, MemSAIt Suppl. 3,
http://sait.oat.ts.astro.it/MSAIS/3/POST/Lorenzi_poster.pdf (paper V)
2004, MemSAIt Suppl. 5, 347 (paper VI: partial and integral version)
2008, http://terri1.os-teramo.inaf.it/sait08/slides/1/ecmem9b.pdf (paper VII)
2009, http://astro.df.unipi.it/sait09/presentazioni/AulaMagna/08AM/Lorenzi.pdf (paper VIII)
2010, arXiv: 1006.2112v3 [physics.gen-ph] 17 Jun 2010 (paper IX)
2011a, http://www.astropa.unipa.it/SAITT2011/Proceedings/Lorenzi1.pdf (paper X)
2011b, http://www.astropa.unipa.it/SAITT2011/Proceedings/Lorenzi2.pdf (paper XI)
2012a, poster paper presented at EWASS 2012 (paper XII)
2012b, parallel poster paper presented at EWASS 2012 (paper XIII)
2012d (paper XV: parallel paper)
Miknaitis, G. 2007, ApJ 666, 674

Perlmutter, S., et al. 1999, ApJ 517, 565 (P99)

Riess, A.G. et al. 2004, ApJ 607, 665

Riess, A.G. et al. 2007, ApJ 659, 98

Rowan-Robinson, M. 1996, "Cosmology" Clarendon Press - Oxford

Sandage, A., Tammann G. A. 1975a, ApJ 196, 313 (S&T: Paper V)

Wikipedia 2011, [http://en.m.wikipedia.org/wiki/Allan_Sandage](http://en.m.wikipedia.org/wiki/Allan_Sandage)
10. **APPENDIX: Atlas of the ECM paper XVI figures**

All the plots and graphical fittings of this "Dipole and absolute magnitude analysis of the SCP Union supernovae ..." appear in the following check atlas of 38 figures and their corresponding legends.

The atlas uses Hubble units; therefore the abscissae as Hubble depth $D_z$ or the mean $\langle D_z \rangle$, light space $r(z_0)$ or $\langle r_z \rangle$ are in Megaparsecs, while $\langle z \rangle \equiv z_0$ is normal redshift; the abscissae as $\cos \gamma$, $-X$ or the mean $\langle -X \rangle$ are dimensionless; the ordinates as $|\Delta M|$, $\langle |\Delta M| \rangle$, $M_z$, $\langle M_z \rangle$, $\langle M \rangle$, $M(z_0)$, $M^*(z_0)$, $\langle M^* \rangle$ are magnitudes; the ordinates as $Y$ are in km $s^{-1} Mpc^{-1}$.

In the cartesian plane $(x, y)$ of Figures 3-4-5-6-8-9-10-11-12-13-14-15-22-23-24-25-26-27-28-29-30-31-32-33-34-35-36-37-38 the resulting fitting equations, as $y = f(x)$, are included, together with the coefficient of determination $R^2$.

The diagrams of Figures 16-17-18-19-20-21 highlight the magnitude anomaly of the low $\langle z \rangle$ points. In particular **Figure 20**, that presents the plot of 30 SNe new central absolute magnitudes $M^*(z_0)$ versus $\langle z \rangle = z_0$ from SCP Union data of 398 supernovae Ia, gives clear empirical evidence for the normal luminosity behaviour of the supernovae Ia of the deep Universe in comparison with the SNe Ia magnitude trend of the nearby Universe, where we can see a maximum peak of $M^*$ deviation, with a resulting systematic $\Delta M^* \approx 1$ at $0.04 \lesssim \langle z \rangle \lesssim 0.08$, that is in the Hubble depth range $170 \, Mpc \lesssim D \lesssim 350 \, Mpc$. Note that the distance of the expansion center from the Local Group at the present epoch $t_0$ results to be $R_0 \approx 260 \, Mpc$, according to the ECM.

Lastly, the high reliability of the core points in Table 8 is clearly shown by the plots and precise fittings of Figures 33-34-35-36. Thus these 4 **ECM normal points** become **pilot points** also in Figures 37-38, to represent two linear trends of the new normal absolute magnitude $\langle M^* \rangle$ of the supernovae Ia.
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