



Results of Hubble's Law using the ROR Methodology

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Abstract

There are a large number of natural and even social phenomena in nature, whose occurrence, evolution and final result depend on several independent variables. Even though all these variables intervene in the phenomenon, some are more important than others and even the interrelation between them plays a very important role. Hubble's Law is a law that has great importance in astronomy. The data for the study were taken as own elaboration of an internet database. In this new application we will see how Hubble's law can be obtained using the ROR methodology. Cristosols are used for its calculation. The best estimate of the Hubble constant is $i = 1/0$, a Cristosol, classically i is approximately $1000 \text{ Mpc}^{-1}\text{km/sec}$ assuming that we are approaching the zero moment of the explosion or BIG BANG. Hubble's Law is estimated with Classical Regression as $V = 1000 * D$ and more exactly with Regressive Objective Regression as $X^2 = H = i$. The ROR Regression measures the Hubble constant more accurately using the Cristosols.

Keywords: Hubble's Law; ROR methodology; Classical regression; Cristosoles

Introduction

There are a large number of natural and even social phenomena in nature, whose occurrence, evolution and final result depend on several independent variables. Even though all these variables intervene in the phenomenon, some are more important than others and even the interrelation between them plays a very important role. The intervention of several independent variables makes the prediction of the occurrence of a natural phenomenon difficult to quantify. Predictive techniques have been developed both in the study of natural phenomena and in social phenomena, each with its scope and limitations.

Currently there are several methods to predict the occurrence of some phenomenon or result, which are included in the predictive analysis (Espino, 2017 [1]). Predictive analytics is a subdiscipline of data analysis that uses statistical techniques, such as machine learning or data "mining," to develop models that predict future events or behaviors. These predictive models allow you to take advantage of behavior patterns found in current and historical data to identify risks. This type of analysis is based on the identification of relationships between variables in past events, in order to later exploit these relationships and predict possible results in future situations. Doing this is not easy since it must be taken into account

that the precision of the results obtained depends a lot on how the data analysis has been carried out, as well as on the quality of the assumptions.

On the trivial level, it might seem that predictive analytics is the same as forecasting (which makes predictions at a macroscopic level), but no, it's something else entirely. In a crude example, while a forecast can predict how many hurricanes may form in a year, predictive analytics can indicate what intensity and what time of year they are most likely to form, and even where. Therefore, to carry out predictive analysis it is essential to have a large amount of data, both current and past, in order to establish behavior patterns and thus induce knowledge. In the example above, there is more probability of prediction if you also consider variations in regional and global temperature, wind direction, changes and sources of change in pressures etc. This process is done thanks to computational learning. Computers can "learn" autonomously and thus develop new knowledge and capabilities, for this it is necessary to have large databases and predictive analysis tools.

There are currently several techniques applicable to predictive analysis;

- i) regression, which includes linear, non-linear, and multivariable adaptive regression; support vectors,
 - ii) computational learning, which includes neural networks, Naïve Bayes and K-nearest neighbors. One of these tools is the Regressive Objective Regression method that we will explain briefly later. Various applications are included in the bibliography, and the idea is to extend this type of analysis to phenomena in the context of the Zacatecas region. In this new application we will see how Hubble's law can be obtained using the ROR methodology.
- e. forecast of meteorological disturbances (cold fronts, and hurricanes, latitude prediction and length of earthquakes (Osés, et al. 2018 [8]) search for information in white noises (Osés, et al. 2017 [9]) modeling of the Equivalent Effective Temperature (TEE) (Osés et al, 2016 [10]) and Atmospheric Pressure (PA),
 - f. up to the electricity consumption of a municipality), and more recently in the COVID-19 pandemic (Fimia, et al. 2022 [11], Osés, et al. 2022 [12]).

Materials and Methods

The data for the study were taken from Topic 5,

https://webs.ucm.es/info/Astrof/POPIA/asignaturas/ana_dat_est/temario.html and own elaboration since it is impossible to copy the pdf database.

Regression analysis is the most widely used statistical technique to investigate or estimate the relationship between dependent variables and a set of independent explanatory variables. In our environment, the ROR methodology has allowed mathematical modeling

- a. the larval densities of mosquitoes (Osés, et al. 2018 [2], Fimia, et al. 2018 [3], Osés, et al. 2014 [4]),
- b. the population dynamics of mollusks,
- c. the modeling of infectious entities of different etiologies, such as HIV/AIDS, Cholera, Influenza, Acute Respiratory Infections (ARI), Covid-19, Acute Bronchial Asthma Crisis (CAAB), Fasciolosis, Angiostromyolysis and even,
- d. in the estimation of the longitude and area of the universe, (Osés, et al. 2015 [5], Osés R 2022 [6]) monthly forecast of precipitations and extreme temperatures (Osés, et al. 2018

Results and Discussion

Using Classical Regression, Hubble's Law can be obtained in two ways:

1st.... $V = H \cdot D$, where V is the speed of the Galaxies and D, the distance between them, therefore H is the Hubble constant that is measured in $\text{Mpc}^{-1}\text{km/sec}$, or

2nd... $D = 1/H \cdot V$, in this article this second option will be used and there will be an approximation of the Law according to the Classical Regression and another using the Regressive Objective Regression, ROR.

Next, Hubble's law for Classical Regression, according to the second formula.

In Table 1, you can see the calculation of Hubble's Law by the traditional method, the corrected R square is 0.878 with a typical error of 0.3893096, the Durbin Watson is close to 1, so more variables can be added in the model.

The Analysis of Variance (Table 2) shows a Fisher's F of 173.458 significant at 100%.

In Table 3 the traditional model of Hubble's Law of $D=1/H \cdot V$.

Table 1: Summary of the Model^{c,d}.

Model	R	R square ^b	Corrected R Square	Typ. Error of the Estimate	Durbin-Watson
1	0.940 ^a	0.883	0.878	0.3893096	1.093

a. Predictor variables: Vkm/s

b. For regression through the origin (the model with no intercept term), R-squared measures the proportion of the variability in the dependent variable explained by regression through the origin. CANNOT compare the above with the R-squared for models that include an intersection.

c. Dependent variable: D (Mpc)

d. Linear regression through the origin

Table 2: ANOVA^{c,d}.

Model	Sum of squares	gl	Root Mean Square	F	Sig.	
1	Regression	26.290	1	26.290	173.458	0.000 ^a
	Residual	3.486	23	0.152		
	Total	29.776 ^b	24			

a. Predictor variables: Vkm/s

b. This total sum of squares has not been corrected for the constant because the constant is zero for regression through the origin.

c. Dependent variable: D (Mpc)

d. Linear regression through the origin

Table 3: Coefficients^{a,b}.

Model	Unstandardized coefficients		standardized coefficients	t	Sig.
	B	Error típ.	Beta		
0.1 V kms	0.001	0.000	0.940	13.170	0.000

a. Dependent variable: D (Mpc)

b. Linear regression through the origin

Since $D = 0.001 V$, therefore clearing we obtain the classic Hubble's Law, that is: $V = 1000 D$, so classically the Hubble constant is estimated as $1000 \text{ Mpc}^{-1}\text{km/sec}$, according to the second form.

0.24 and a standard deviation of 0.970.

Figure 2 shows the expected cumulative probability vs. Observed cumulative probability.

Figure 1 shows the Histogram of the residuals with a mean of

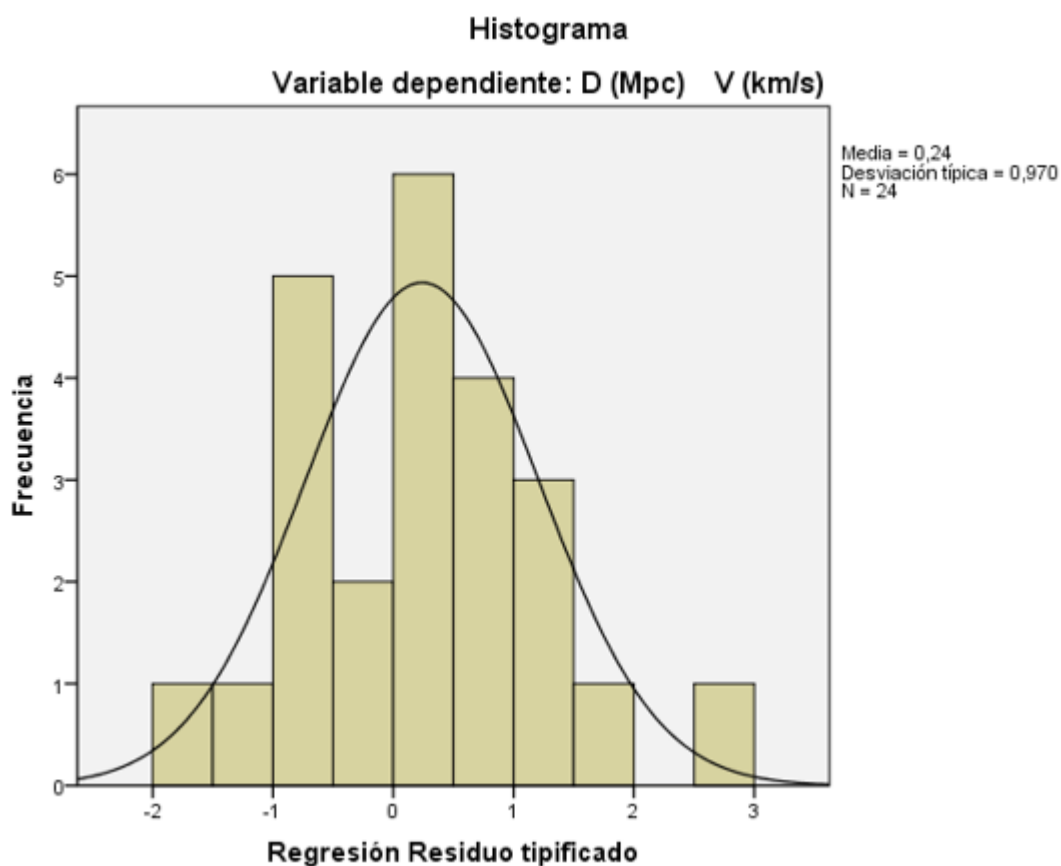


Figure 1: Histogram of the residues.

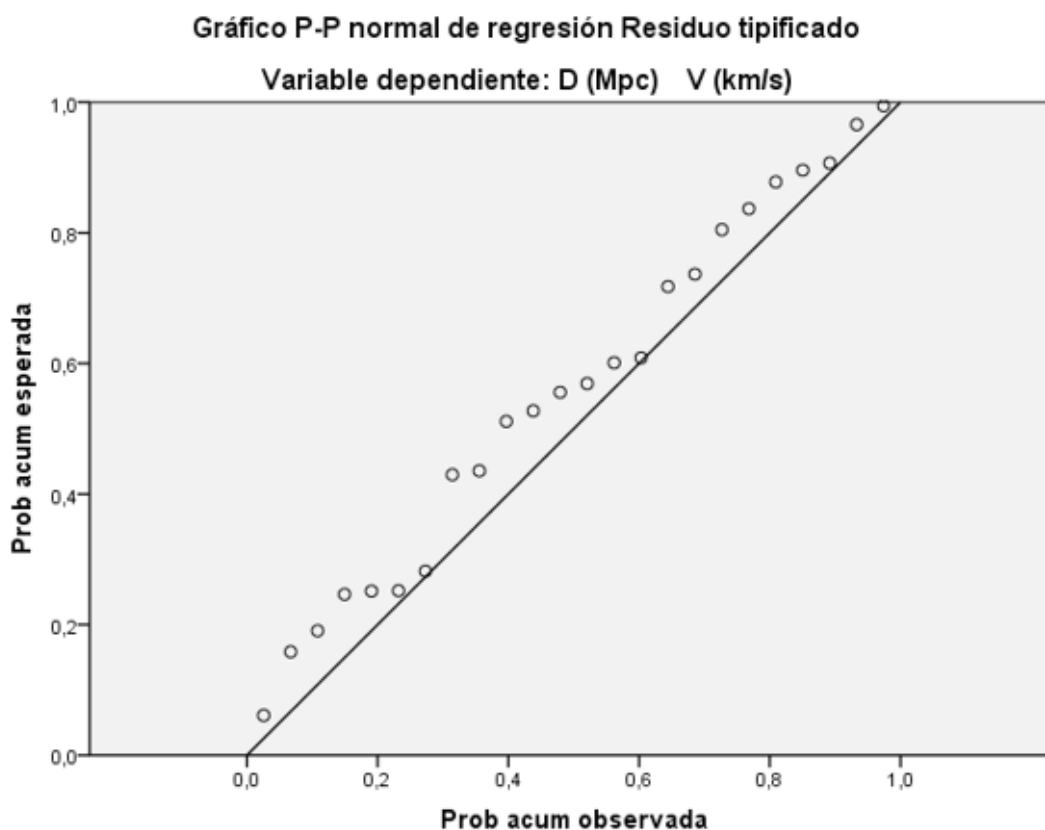


Figure 2: Shows the expected cumulative probability vs. Observed cumulative probability.

Next, the result of the residuals. Table 4.

In the case of the ROR methodology (Table 5), a corrected R of 0.996 is obtained with an error of 0.0805881, and this time the Durbin Watson statistic is close to 2, so there is no correlation in the residuals. It can be seen that the standard error of the estimation is smaller than in the classical case (Table 1).

The Analysis of Variance has a Fisher's F (Table 6) of 759.202 much higher than the classic F (Table 2), so we can state that the

ROR model for Hubble's Law is more probable than the classic one.

The ROR model in question can be seen in Table 7. DS is a sawtooth variable and DI is an inverted sawtooth variable, although they are not significant they provide variance to the model, NoC represents the trend of the process which is significant to the increase, the Galaxies are moving away, Lag1 and Lag2 are the distances returned in 1 and two steps and lag4VKms, is the speed returned in 4 steps, which is 90% significant despite the fact that the coefficient is zero.

Table 4: Statistics on residues b^{a,b}.

	Minimum	Maximum	Media	Typical deviation	N
Predicted value	0.193401	2.089.064	0.817787	0.6672154	24
Residual	0.6019214	0.9883740	0.0930462	0.3775287	24
Predicted value typ.	1.516	1.905	0.000	1.000	24
Residuo tip.	1.546	2.539	0.239	0.970	24

a. Dependent variable: D (Mpc) V (km/s)

b. Linear regression through the origin

Table 5: Summary of the Model^{c,d}.

Model	R	R squared	R Corrected Square	typ. error of the estimate	Durbin-Watson
1	0.998 ^a	0.997	0.996	0.0805881	2.055

a. Predictor variables: Lag4Vkms, DS, DI, Lag2, NoC, Lag1

b. For regression through the origin (the model with no intercept term), R-squared measures the proportion of the variability in the dependent variable explained by regression through the origin. CANNOT compare the above with the R-squared for models that include an intersection.

c. Dependent variable: D (Mpc) V (km/s)

d. Linear regression through the origin

Table 6: ANOVA^{c,d}.

Model		Sum of Squares	gl	Root Mean Square	F	Sig.
1	Regresión	29.584	6	4.931	759.202	0.000 ^a
	Residual	0.091	14	0.006		
	Total	29.675 ^b	20			

a. Predictor variables: Lag4Vkms, DS, DI, Lag2, NoC, Lag1

b. This total sum of squares has not been corrected for the constant because the constant is zero for regression through the origin.

c. Dependent variable: D (Mpc) V (km/s)

d. Linear regression through the origin

Table 7: Coefficients^{a,b}.

Model	B	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		Error típ.	Beta			
1	DS	0.041	0.075	0.024	0.542	0.596
	DI	0.093	0.077	0.054	1.204	0.248
	NoC	0.029	0.012	0.366	2.368	0.033
	Lag1	1.147	0.201	1.067	5.709	0.000
	Lag2	0.536	0.197	0.458	2.721	0.017
	Lag4Vkms	0.000	0.000	0.080	1.911	0.077

a. Dependent variable: D (Mpc)

b. Linear regression through the origin

The NoC trend, which is the trend of the process, was positive and equal to 0.029, so the distance between the Galaxies is increasing, therefore, clearing V from Table 7, it remains:

$$V_{.4} = (0,041/0)*DS + (0,093/0)*DI - (0,029/0)*NoC - (1,147/0)*D-1 + (0,536/0)*D-2 + D/0.....(1)$$

Then, substituting 1/0 for i (See 6), a better formula is obtained to measure the speed of Galaxies as a function of Cristosols and an approximation of the Hubble constant as the coefficient of D, that is, H= i = 1/ 0 and is approximately 1000 or better using the Xiomara constant G [6], in such a way that X² = H= i, since X=√(i), where H is the Hubble constant taken as equal to i so the formula could be:

$$V_{.4} = (0,04*X^2)*DS + (0,093* X^2)*DI - (0,029* X^2)*NoC - (1,147* X^2)*D-1 + (0,536 X^2)*D-2 + X^2.....(2)$$

D-1, D-2, D are the distances returned in 1 step, two steps and the distance between the Galaxies

V_{.4} is the velocity of the Galaxies returned in 4 steps, whose coefficient is zero (Table 7) and for this reason in the formula that we have just written above (1) all the parameters are divided by zero.

In Table 8, the statistics of the residuals, it can be seen that the mean of the residuals is zero and the standard deviation is 0.0691764, in addition the maximum and minimum of the residuals are smaller than those of the Classical regression (Table 4)

In Figure 3 the Histogram of the residuals with ROR. The mean is 2.33 *10⁻¹⁵, and a standard deviation of 0.858, smaller than in the classical model.

Table 8: Statistics on residuals^{a,b}.

	Minimum	Maximum	Media	Typical deviation	N
Predicted value	0.254115	2.048.033	1.067.500	0.5979110	20
Residual	0.1234722	0.1387321	0.0000000	0.0691764	20
Predicted value typ.	1.360	1.640	0.000	1.000	20
Residuo tip.	1.532	1.721	0.000	0.858	20

a. Variable dependiente: D (Mpc) V (km/s)

b. Regresión lineal a través del origen

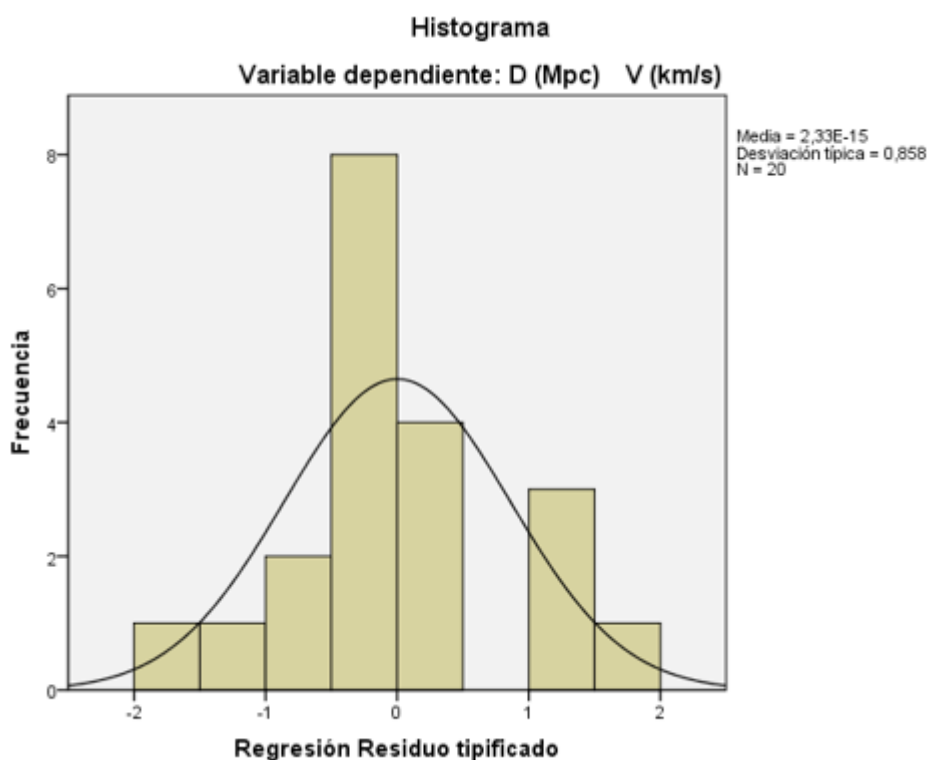
**Figure 3:** Histogram of the residuals by ROR.

Figure 4 shows the expected cumulative probability vs. Observed cumulative probability according to ROR.

Below (Figure 5) is a plot of the real value against the forecast with its Errors for the classical model and the ROR for the calculation of D.

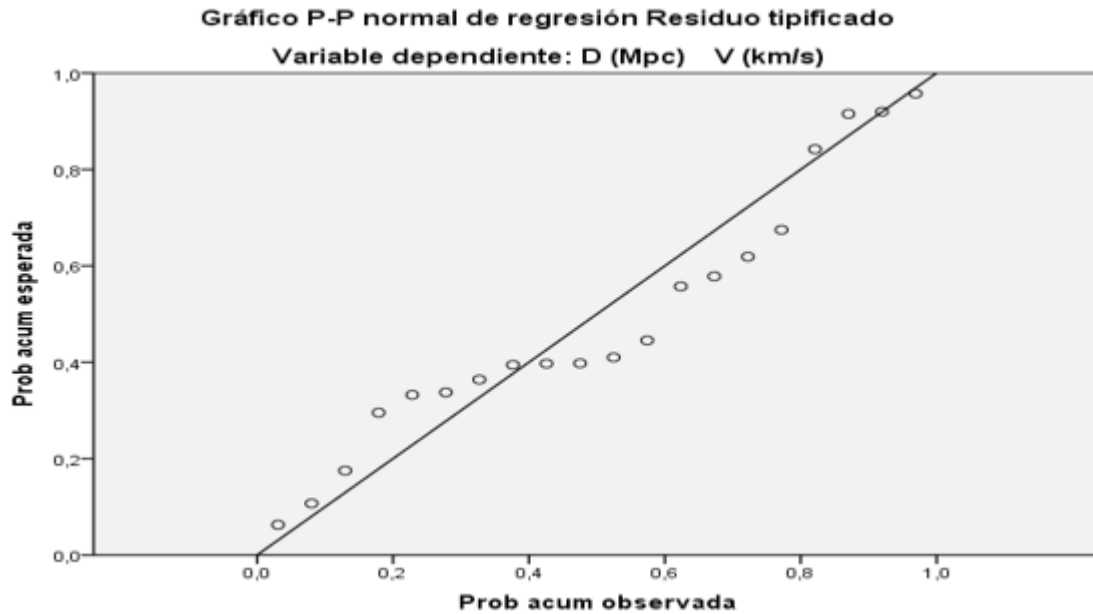


Figure 4: Expected cumulative probability vs. Observed cumulative probability according to ROR.

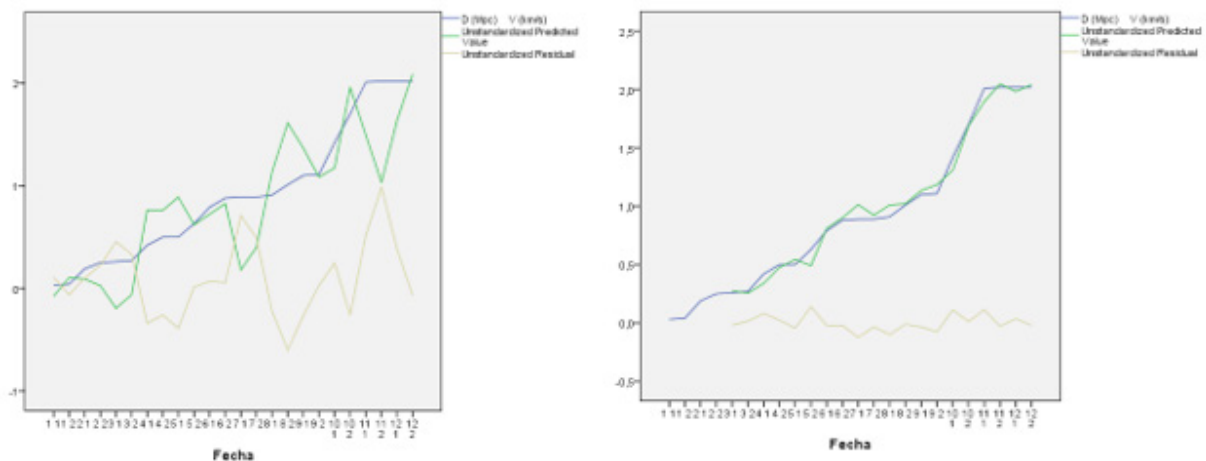


Figure 5: a) Classic Model.

b) ROR model.

Conclusion

The best estimate of the Hubble constant is $H = 1/0$, a Cristosol, classically H is approximately $1000 \text{ Mpc}^{-1}\text{km/sec}$ assuming that we are approaching the zero moment of the explosion or BIG BANG.

Hubble's Law is estimated with the Classical Regression as $V=1000 \cdot D$ and more exactly with the Regressive Objective Regression as $X^2 = H = i$.

ROR Regression measures the Hubble constant more precisely.

Acknowledgment

None.

Conflicts of Interest

No conflict of interest.

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