Proposal to the standardization of a method to imagine the Observed Universe proportionately in sizes and distances.

Method of four fixed-sized maps and its new units of distance measurement

Method "The Universe on four maps"

INTRODUCTION

Human beings have been observing the universe for about 2 million years now. However, it has been only a few hundred years since human beings observe the universe trying to understand and imagine the size of its celestial bodies and the distances to them.

Nowadays we are fortunate to have access to the data needed to achieve this exciting act of imagination.

Science provides society with all these data, as well as thousands of pictures of a large variety of celestial objects that are spread throughout the Universe.
But Science has not proposed yet a method with which been able to imagine the Universe proportionately in size and distance, with no need for recalling complex figures.
In this paper I propose this method and I request the International Astronomical Union its standardization or, at least, to recommend it as suitable to be taught in schools, colleges and universities.
If we human beings concur on doing this, our children and future generations will grow up imagining the Universe as distinctly as their home.

MOTIVATION

Everybody knows which is the right map when told about a non-astronomical distance. We all pick a map of our neighbourhood in order to pinpoint a restaurant 800 metres from our home. We all pick a map of our country in order to pinpoint a hotel 200 km away. We all can use the world map to pinpoint an island 8,000 km away from our country. Which map would you use in order to pinpoint an object 50,000 million km away? Which one to pinpoint an object 4,600 million light years away? Are you able to imagine a 180 million light years sized structure?

It is undeniable that the society can not pick a map when the distance refers to something located outside our planet. The society can not picture astronomical distances and sizes. This is the reality, a sad reality. We are lucky enough as to have been born at a time when we can finally picture our universe, yet we do not do it because the right method has not been standardized. As a matter of fact, the society does not even know there is a method. It not even know that it is able to

picture the universe. (Humanity does not even know that it actually is able to...)
Any person who knows what the universe contains (planets, stars, nebulae, star clusters, galaxies, galaxy clusters, super-clusters of galaxies and huge empty spaces), is able to imagine the universe and its content proportionately in sizes and distances.
I believe that humanity should know that it is able to do so. In this sense, I am convinced that Science is in debt with society.

THE METHOD

There are four fixed-sized maps to be used by everybody and we should think of them whenever we wanted to picture distances or sizes in the universe.

They are maps that have a scale "reality--- map" that is very easy to remember and apply. They are maps that all of us see in our ordinary life. When we get used to handle them, we will be able to apply four new units of measuring distance in those maps. In this paper I also propose the use of these new units to avoid the need for remembering and applying that proportion.
With these new four units of measurement we don´t have to do any maths in order to be able to picture the distance or size of a given object.
The term I have chosen for each of these new units of measurement is composed of a prefix that refers to the map in which it is applied followed by the distance to be pictured on that map. This distance is expressed in millimetres, centimetres or metres, and it is applied to the map to which the prefix refers. Some examples are provided below.
The choice of a particular map is made unconsciously, by the association of this map with its "natural distance". By "natural distance" I mean the order of magnitude of a map that makes the user to choose it and not another one. For instance, tens or hundreds of metres are the "natural distance" in a neighbour map, as hundreds of kilometres are in a country map and thousands of kilometres are in a world map. We are not taught more natural distances at schools. We learn some figures related to the Earth-Moon System, the Solar System, our galaxy or the Universe, but we are not shown how each of these four scenarios has its own "natural distance".

The *natural distances* for the four maps proposed in this paper are as follows:

Map	Natural distance
Earth-Moon	**Thousands of Km** (or hundreds of thousands of Km)
Solar System	**Millions of Km** (and thousands of millions of Km)
Galaxy	**Ligtht Years** (and hundreds and thousands of Light Years)
Hubble Sphere ($V_{recession} < c$) **≈ 1/3 the size of the observable Universe**	**Millions of light years** (and hundreds and thousands of millions of light years)

Tabla 1.- *Natural Distances* of the four maps proposed in the *Method "The Universe in Four Maps"*

As we are not used to chosing these maps when told an astronomical figures, we should learn this table. There is two ways of learning the table: one is by heart and the other one is by using it. I strongly recommend the latter.

Once we know how to choose the right map, we must apply a particular size to this map. The specific size I propose is based on the choice of a everyday life object in which easily apply the "reality → map" proportion.
We only had to memorise any size or distance of any astronomical element (astronomical body) in the map and from this point we can picture everything. The following table is a summary of all the above.

Map	Element of everyday life and its size	Element to memorize	Reality – map proportion
Earth-Moon	Bicycle wheel of radius 40 cm 	The Earth is like a blue marbel, of about 13 mm in diameter at the wheel axle. The Moon, on the edge of the wheel, is like a little white pearl of about 3.5 mm in diameter.	1,000 Km in the reality = 1 mm on the wheel.
Solar System	Roundabout of radius 6 meters (to Pluto) 	The Sun, at the roundabout centre, is like a little red ball, 1.4 mm size. Pluto's orbit (the roundabout edge) is 6 m average from the Sun. Uranus is half that distance, 3 m from the Sun.	1 million (10^6) Km in the reality = 1 mm on the roundabout. 1,000 millions (10^9) Km in the reality = 1 m on the roundabout.
Galaxy	Football (soccer) field 100 metres long. 	Stars are microscopic. Our Sun and Earth are in the central defender position, at about 30 m from the centre of the field, and 20 m from the nearest goal. Proxima Centauri is 4.2 mm from the Sun.	1 light year in the reality = 1 mm on the soccer field. 1,000 light years in the reality = 1 m on the soccer field.
Hubble Sphere (v < c)	A sphere enclosing Eiffel Tower (300 m high). This sphere is 150 m radius 	The sphere enclosing Eiffel Tower represents 1/3 of the observable universe. Our galaxy, the Milky Way is at the centre, 1 mm on the map -as big as a tiny grain of sand. Our Local Group -our family consisting of just over thirty galaxies- is like a golf ball in size. Our Local Super-cluster -or Virgo Super-cluster, consisting of a hundred of galaxy clusters, is like a small city car, a Smart. There are thousands of cars in the universe, all different in size, that is, there are thousands of super-clusters.	1 million (10^6) light year in the reality = 1 cm on the Eiffel Tower map. ***NB:*** This scale strictly applies to a Universe model in which c/H_0 =15,000 millions (15x10^9) of light years. Maybe a skyscraper 280 m high would be more accurate for the standard model of the universe, but I have chosen Eiffel Tower (300 m, counting the lookout level) as it is an iconic worldwide recognised building.

Table 2.- Proposed maps for the standardization of *"The Universe in Four Maps" Method*

Applying the "*reality → map*" scale. Instances below.

Map	Element of everyday life and its size	Instance: reality	Instance: map
Earth-Moon	Bicycle wheel of radius 40 cm	Geostationary satellites orbit 36,000 km above the Earth.	Geostationary satellites orbit 36 mm above the blue marble on the wheel.
Solar System	Roundabout of radius 6 meters	Saturn orbits 1,500 million (15x10^8) Km from the Sun.	Saturn orbits, on the roundabout, 1.5 m from the central yellow ball -the Sun.
Galaxy	Football (soccer) field 100 metres long.	The globular cluster M13, consisting of about 400,000 stars, is 25,000 light years away and it is about 145 light years across in diameter. There are some 180 known globular clusters in our Galaxy.	The globular cluster M13, consisting of about 400,000 stars, is 25 m away on the field, and is 14.5 cm across -just less than a handball ball. There are some 180 known globular clusters in our Galaxy.
Hubble Sphere (v < c) ≈ 1/3 of the observable universe	A sphere enclosing Eiffel Tower (300 m high). This sphere is 150 m radius	M87, elliptical galaxy inside the Virgo cluster, is 60 million light years away. The Virgo cluster, comprising approximately two thousand galaxies, is 10 million light years across	M87, elliptical galaxy inside the Virgo cluster, is 60 cm away in the Eiffel Tower. The Virgo cluster, consisting of more than two thousand galaxies, is about the same size of a grapefruit in the Eiffel Tower map, some 10 cm across.

Table 3.- Examples of the application of the "reality → map" scale

Let us look at some examples of how to apply the "*reality → map*" scale by using the new measurement units as proposed in this paper.

Map	New Unit of Measurement for Distance	Example: reality	Example: map using the new Measurement Units for Distance
Earth-Moon	Whe-millimetres Whe-centimetres Whe-metres	Geostationary satellites orbit 36,000 km above the Earth.	Geostationary satellites orbit 3.6 **Whe-centimetres**
Solar System	Rou-millimetres Rou-centimetres Rou-metres	Saturn orbits 1,500 million (15x10^8) Km from the Sun.	Saturn orbits 1.5 **Rou-metres**
Galaxy	Foo-millimetres Foo-centimetres Foo-metres	The globular cluster M13, consisting of about 400,000 stars, is 25,000 light years away and it is about 145 light years across in diameter.	The globular cluster M13, consisting of about 400,000 stars, is 25 **Foo-metres** away and it is 14.5 **Foo-centimetres** across in diameter.
Hubble Sphere (v < c) ≈ 1/3 of the Observable Universe	Tow-millimetres Tow-centimetres Tow-metres	M87, elliptical galaxy inside the Virgo cluster, is 60 million light years away. The Virgo cluster, comprising approximately two thousand galaxies, is 10 million light years across	M87, elliptical galaxy inside the Virgo cluster, is 60 **Tow-centimetres** away. The Virgo cluster, comprising approximately two thousand galaxies, is 10 **Tow-centimetres** across

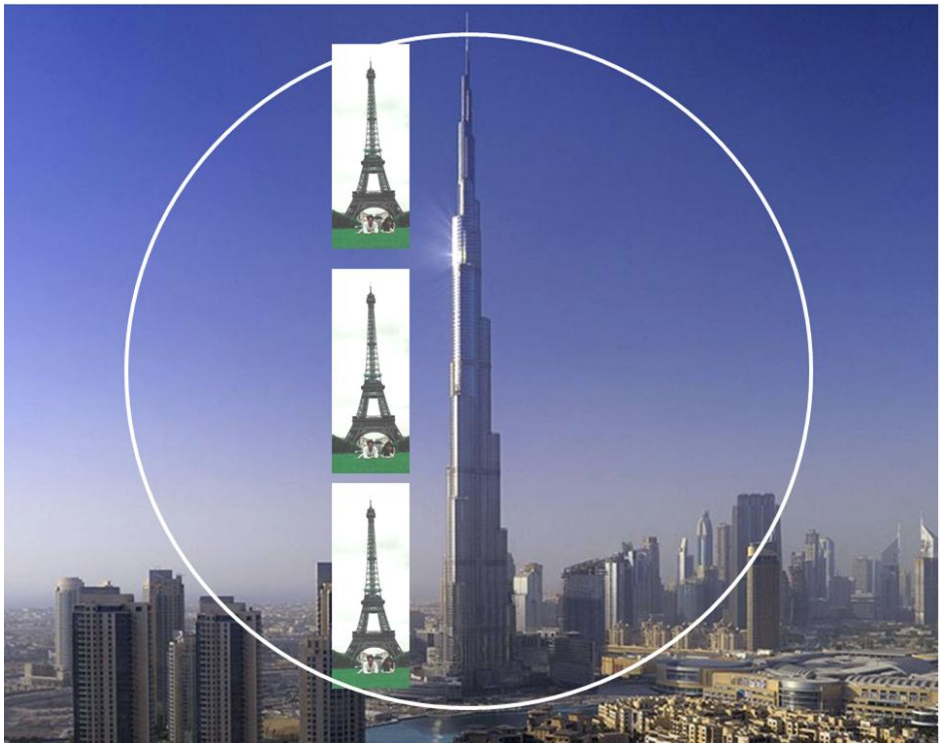
Table 4.- Examples of the application of the "reality → map" scale by using the four new measurement units proposed in this paper

The "*observable universe*" (≈ 3 times Hubble Sphere) = Burj Khalifa Tower (Dubai)

In most articles and books on Cosmology there are many graphics in which distance scales are often expressed in multiples or divisors of the Hubble Sphere radius (4th map). That is, in multiples or divisors of c/H_0, where H_0 is the current Hubble Constant. For instance, if we see in a graphic that a X super-cluster is 0.5* (c/H0), we will immediately picture that it is half the radius of Eiffel Tower, -we are at the centre of that map. We picture straightforward in proportion to the size of the Observable Universe (3 times the Eiffel Tower) how far that X super-cluster is.

The *Observable Universe* is roughly 3 times the Hubble Sphere. Therefore, if in a graphic we see the distance 1.7* (c/H0), we will picture 1.7 times the Eiffel Tower radius to imagine that distance proportionately, (in proportion to the size of the Observable Universe and in proportion to the size of our galaxy, the Milky Way (1 mm in the Eiffel Tower map).

We might use a new unit of measurement for distances called BURJ-metres, or BURJ-centimetres or BURJ-milimetres. For instance, our galaxy is 1 BURJ-mm in size. The Virgo cluster is 60 BURJ-cm away. The "*Visible Universe*" limit (last scattering sphere) is ≈ 440 BURJ-m away. These maps are approximate, of course. For Humanity, accuracy is not as important as the ability of proportionaly picture sizes and distances.



Map of the Observable Universe: Burj Khalifa Tower (Dubai). Radius ≈ 450 m
(1 million light years → 1 cm) = (1 Mpc = 3.26 m)

Direction of celestial objects

The ability of picture distances and sizes is a great achievement of human intelligence. Imagining directions is another major accomplishment.

When considering the direction of a specific celestial object, we always have into account the framework of that object. This framework is an agreement that we human beings have reached. It is called "reference system". In a particular framework, we agreed to stablish an origin and to define a coordinate system that make it possible to identify position and direction of any point of this framework.

It is not my intention to propose any new system of celestial coordinates. My proposal is that in primary schools and high schools, we should teach the standard celestial coordinates applied over the four maps proposed in this paper.

It is not my aim in this paper to show the system of coordinates used in the Earth-Moon system or Solar System. Nevertheless, there is a great enthusiasm for observation with telescopes and people are fond of observing celestial objects in our galaxy, the Milky Way, and even looking for other galaxies. That is why I am proposing in this paper the use of the Galactic Coordinate System as a way to know the direction of any celestial object in our galaxy or in any other galaxy.

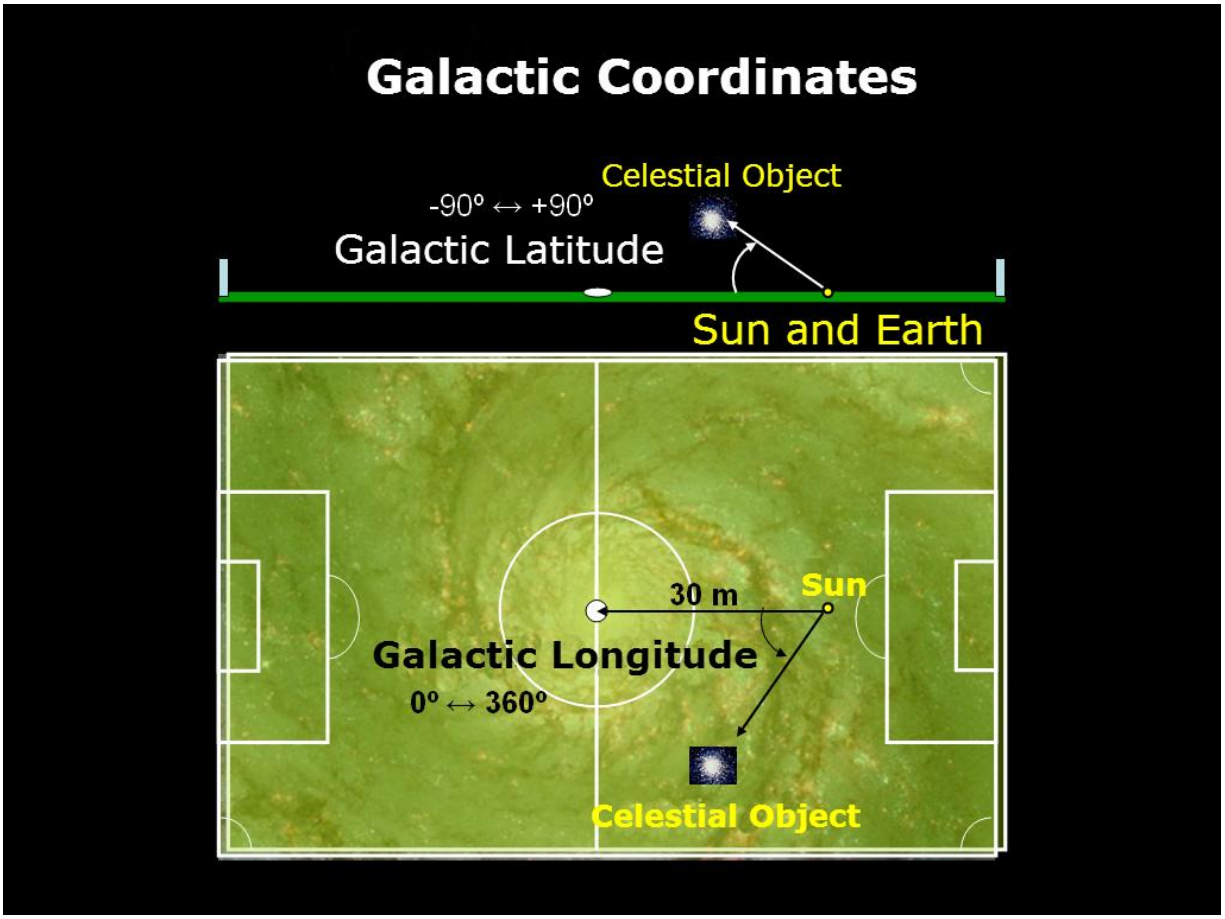
Therefore, I am proposing to use these coordinates, but applied on the football field map, not as they are always represented in Astronomy books or on the Internet, with drawings of spheres with many great circles, spherical trigonometry and strange-named angles, which, for most people, are very difficult to picture and understand. On the football field (the map of the Milky Way galaxy) everybody can apply the galactic coordinates to imagine the direction of any celestial object.

Observing any celestial object through a telescope while imagining at the same time its distance and direction, is far more rewarding than watching the object without picturing anything.

To locate the direction of any celestial object in our galaxy, we have agreed to place ourselves on the football field (in our galaxy), at our present position (central defender) and, looking at the centre of the field, we start counting degrees (an angle) to the left until we meet the the celestial object projection on the grass. This angle is called "Galactic Longitude". It is pitiful that it was not named "Galactic Angle to the Left"- by this name everybody would know what it is.

Naturally, this Angle to the Left ranges between 0° and 360°. Then we have agreed to count degrees (un angle) up or down until meet the celestial object in question. This angle is called "Galactic Latitude". It is pitiful that they were not named "Galactic Up Angle"or "Galactic Down Angle"- by these names

everybody would know the meaning. The "Up Angle" ranges between 0° and +90°. The "Down Angle" ranges between 0° and -90°. Therefore, the Galactic Latitude ranges between -90° and +90°.



Galactic Coordinates according to the method *"The Universe in Four Maps"*

The most observed objects by amateur astronomers are the ones in the Messier Catalogue. The following table enables the user to picture the distance and direction of all of them.

Messier number	**Constellation**	**Object Type**	**Galactic Longitude degrees (°)** **Angle to the left** on the football field map	**Galactic Latitude degrees (°)** **Up / Down Angle** on the football field map	**Distance (thousands of light years)** **Distance** on the football field map (metres)
M1	Taurus	SNR (Supernova Remnant)	184.62	-5.78	6.3
M2	Aquarius	Globular Cluster	55.12	-34.87	36
M3	Canes Venatici	Globular Cluster	42.29	78.70	31
M4	Scorpius	Globular Cluster	351.04	15.96	7
M5	Serpens	Globular Cluster	3.94	46.78	23
M6	Scorpius	Open Cluster	356.66	-0.73	2
M7	Scorpius	Open Cluster	355.92	-4.53	1
M8	Sagittarius	Nebula with Cluster	6.05	-1.21	7
M9	Ophiuchus	Globular Cluster	5.62	10.69	26
M10	Ophiuchus	Globular Cluster	15.20	23.08	13
M11	Scutum	Open Cluster	27.38	-2.79	6
M12	Ophiuchus	Globular Cluster	15.78	26.31	18
M13	Hercules	Globular Cluster	59.08	40.91	25
M14	Ophiuchus	Globular Cluster	21.39	14.79	27
M15	Pegasus	Globular Cluster	65.09	-27.32	33
M16	Serpens	H II Region Cluster	17.05	0.79	7
M17	Sagittarius	H II Region Cluster	15.16	-0.76	5
M18	Sagittarius	Open Cluster	14.22	-1.02	6
M19	Ophiuchus	Globular Cluster	356.94	9.38	27
M20	Sagittarius	H II Region Clusterr	7.09	-0.31	2
M21	Sagittarius	Open Cluster	7.78	-0.45	3
M22	Sagittarius	Globular Cluster	9.97	-7.56	10
M23	Sagittarius	Open Cluster	9.91	2.86	4.5
M24	Sagittarius	Star Cluster	12.69	-1.03	10
M25	Sagittarius	Open Cluster	13.64	-4.47	2
M26	Scutum	Open Cluster	23.93	-2.91	5
M27	Vulpecula	Planetary Nebula	60.90	-3.70	1.25
M28	Sagittarius	Globular Cluster	7.87	-5.58	18
M29	Cygnus	Open Cluster	76.99	0.61	7.2
M30	Capricornus	Globular Cluster	27.25	-46.85	25
M31	Andromeda	Spiral Galaxy	121.24	-21.57	2300
M32	Andromeda	Dwarf Elliptical Galaxy	121.23	-21.97	26000
M33	Triangulum	Spiral Galaxy	133.70	-31.33	2590
M34	Perseus	Open Cluster	143.71	-15.59	1.4
M35	Gemini	Open Cluster	186.66	2.20	2.8
M36	Auriga	Open Cluster	174.59	1.04	4.1
M37	Auriga	Open Cluster	177.72	3.12	4.6
M38	Auriga	Open Cluster	172.30	0.65	4.2

M39	Cygnus	Open Cluster	92.52	-2.29	0.3
M40	Ursa Major	Double Star WNC4	130.36	58.63	0.5
M41	Canis Major	Open Cluster	231.17	-10.22	2.4
M42	Orion	H II Region	209.15	-19.37	1.5
M43	Orion	H II Region	209.00	-19.25	1.5
M44	Cancer	Open Cluster	205.61	32.54	0.5
M45	Taurus	Open Cluster	166.64	-23.51	0.4
M46	Puppis	Open Cluster	231.94	4.07	5.4
M47	Puppis	Open Cluster	231.05	3.13	1.6
M48	Hydra	Open Cluster	228.00	15.39	1.5
M49	Virgo	Elliptical Galaxy	287.04	70.19	60000
M50	Monoceros	Open Cluster	221.76	-1.19	3
M51	Canes Venatici	Spiral Galaxy	104.90	68.56	37000
M52	Cassiopeia	Open Cluster	112.82	0.45	7
M53	Coma Berenices	Globular Cluster	333.03	79.76	56
M54	Sagittarius	Globular Cluster	5.68	-14.11	83
M55	Sagittarius	Globular Cluster	8.86	-23.28	17
M56	Lyra	Globular Cluster	62.73	8.33	32
M57	Lyra	Planetary Nebula	63.25	13.97	2
M58	Virgo	Barred Spiral Galaxy	290.48	74.35	60000
M59	Virgo	Elliptical Galaxy	294.43	74.36	60000
M60	Virgo	Elliptical Galaxy	296.01	74.31	60000
M61	Virgo	Spiral Galaxy	284.46	66.27	60000
M62	Ophiuchus	Globular Cluster	353.64	7.31	22
M63	Canes Venatici	Spiral Galaxy	106.05	74.29	37000
M64	Coma Berenices	Spiral Galaxy	315.76	84.42	12000
M65	Leo	Barred Spiral Galaxy	241.43	64.22	35000
M66	Leo	Barred Spiral Galaxy	242.05	64.41	35000
M67	Cancer	Open Cluster	215.65	31.71	2.25
M68	Hydra	Globular Cluster	299.71	36.04	32
M69	Sagittarius	Globular Cluster	1.79	-10.28	25
M70	Sagittarius	Globular Cluster	2.92	-12.52	28
M71	Sagitta	Globular Cluster	56.83	-4.57	12
M72	Aquarius	Globular Cluster	35.25	-32.70	53
M73	Aquarius	Four-star Asterism	35.79	-33.94	-
M74	Pisces	Spiral Galaxy	138.70	-45.70	35000
M75	Sagittarius	Globular Cluster	20.38	-25.76	58
M76	Perseus	Planetary Nebula	131.02	-10.50	3.4
M77	Cetus	Spiral Galaxy	171.99	-51.79	60000
M78	Orion	Nebula Diffuse	205.42	-14.33	2
M79	Lepus	Globular Cluster	227.35	-29.28	40
M80	Scorpius	Globular Cluster	352.73	19.46	27
M81	Ursa Major	Spiral Galaxy	142.15	40.91	11000
M82	Ursa Major	Barred Spiral Galaxy	141.48	40.57	11000
M83	Hydra	Barred Spiral Galaxy	314.66	31.97	10000
M84	Virgo	Lenticular Galaxy	278.35	74.48	60000
M85	Coma Berenices	Lenticular Galaxy	267.86	79.23	60000
M86	Virgo	Lenticular Galaxy	279.19	74.64	60000
M87	Virgo	Elliptical Galaxy	283.85	74.50	60000
M88	Coma Berenices	Spiral Galaxy	282.46	76.50	60000
M89	Virgo	Elliptical Galaxy	288.08	74.96	60000
M90	Virgo	Spiral Galaxy	288.54	75.62	60000
M91	Coma Berenices	Barred Spiral Galaxy	285.76	76.83	60000

M92	Hercules	Globular Cluster	68.40	34.86	26
M93	Puppis	Open Cluster	240.11	0.11	4.5
M94	Canes Venatici	Spiral Galaxy	123.39	76.02	14500
M95	Leo	Spiral Galaxy	234.05	56.38	38000
M96	Leo	Spiral Galaxy	234.53	57.02	38000
M97	Ursa Major	Planetary Nebula	148.56	57.06	2.6
M98	Coma Berenices	Spiral Galaxy	265.54	74.96	60000
M99	Coma Berenices	Spiral Galaxy	270.52	75.19	60000
M100	Coma Berenices	Spiral Galaxy	255.69	74.04	60000
M101	Ursa Major	Spiral Galaxy	102.10	59.77	24000
M102	Inconclusive Current Identification		92.10	52.49	-
M103	Cassiopeia	Open Cluster	128.09	-1.75	8
M104	Virgo	Spiral Galaxy	298.55	51.15	50000
M105	Leo	Elliptical Galaxy	233.57	57.63	38000
M106	Canes Venatici	Spiral Galaxy	138.36	68.86	25000
M107	Ophiuchus	Globular Cluster	3.44	23.01	20
M108	Ursa Major	Spiral Galaxy	148.39	56.26	45000
M109	Ursa Major	Barred Spiral Galaxy	140.14	61.92	55000
M110	Andromeda	Dwarf Elliptical Galaxy	120.80	-21.14	2200

Conclusions

It is my understanding that it is necessary for the population to have a method with which being able to imagine proportionately sizes and distances within the Universe, and feel that we belong here, that we know where we are. I think that this is a pending challenge of the International Astronomical Union and the institution should standardize a method, the one I propose in this paper or another method.

I firmly believe that our society is entitled to imagine its Observable Universe, especially now, when we know the data needed to do it, and there is a method.

Should the International Astronomical Union propose a method (any method), the 21st century will be remembered as the century when, for the first time in humankind History, human beings actually pictured the Observable Universe.

From my opinion, it is a good think to show the society that the scientific authorities are not oblivious to "its curiosity" and its "thirst for knowledge". For this reason I believe that these authorities -and not the divulgative ones, must undertake the task of standardization and divulgation, or at least the proposal of a *Method* (anyone). Society as a whole -that all in all funds these institutions, will be eternally grateful.