ACOUSTIC PLANETARIUM FOR BLIND PERSONS OR WITH AMBLYOPIA DISORDER

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ABSTRACT

One of the most important aspects of a person's development is the relation with the environment. This proposal suggests the possibility of teaching astronomy to blind persons or those with amblyopia disorder by means of sounds. This is an adaptation of the magnitude system of Hiparcus of Nicea, through the application of its concepts to the emission of a sound, which is useful to obtain a "mental map" of the sky that would have the best possible correspondence with reality.

AN ACOUSTIC PLANETARIUM

One of the most important aspects of a person's development is the relation with the environment. The knowledge of the environment becomes the origin of all the questions and future curiosities, a motivator for learning, and it will supply the necessary confidence for exploration.

Astronomy is, according to many, the mother of all natural sciences, because in the celestial phenomena are reflected the most diverse disciplines of the human knowledge. It also creates an ambivalent sentiment: on one side, the desire to penetrate the mysterious and, on the other hand, the notion of immensity that it represents, contributes to the idea that Astronomy is something meant for a few people only, and it is often considered an elitist type of knowledge, of difficult access to common people.

For those of us who are in charge of this idea, knowledge is an asset that anyone can have, and it is the responsibility of those who can speak of it to adapt the messages to all the levels of interest. With our project of teaching astronomy to blind people or with amblyopia disorder, we believe the only barrier to be overthrown is prejudice, and once some simple adaptations are made, our target public will be able to truly "see the sky", and will plunge into its mysteries as rigorously in truth as any other amateur to this science.

Concepts from Observational Astronomy

One of the most important astronomers of early times was Hiparcus of Nicea (190-120 BC), a greek astronomer born in the city of Nicea, Bitinia (today, Iznik in Turkey). His studies survived to this day thanks to Ptolemy, who in the year 90 BC wrote a book which became essential to any person of culture, until the Renaissance. This book was called the Almagest, a collection of all the knowledge known to man at the time, added to Ptolemy's studies and other works such as Hiparcus' star catalogue that contained a celestial map (that is how it is called) the position of 1,000 stars divided, according to their brightness, into 6 magnitudes, from 1 to

6. Magnitude 6 stars are those that the naked eye can barely see, and magnitude 1 stars would be the brightest objects in the sky.

It was the first time that stars were described with a difference of brightness. Of course in times of Hiparcus, there were no such thing as big cities covered with a halo of light that prevent star observation nor was there the contamination that we have today. Today, in Mar del Plata for example, we can observe stars up to 4.5 magnitude; to see more we would need a telescope.

What's interesting about this is that Hiparcus used the only thing he had at hand to study the sky, which were his own organs, with no instrumental aid to improve or increase his observational capacity. We can easily extend these concepts to a sound emission that would help to obtain a "mental map" of the sky, with the highest possible correlation to reality. The magnitudes of this guy from Nicea increased 2.5 times the brightness of the previous magnitude. A magnitude 3 star was 2.5 times brighter than a magnitude 4 star. But our eye cannot easily distinguish those differences and, on the other hand, taking these concepts to audio would be erroneous because those stars that we can observe with our eyes effortlessly would become, in this new scale, strange noises which would confuse the reality we are studying.

If Hiparcus would have taken this idea, he would have surely considered a magnitude 6 star to be heard at 10 dB, more or less what we consider the threshold of human audition. Magnitude 5 stars we will relate to a 20 dB sound, similar to the sound of tree leaves, magnitude 4 would be around 30 dB, and so on and so forth. The 10 dB leap corresponds approximately to a 3-scale sound increase, quite similar to the visual correspondence used in the conventional astronomical scale.

This same scale can also be taken to objects invisible to the naked eye, such as those "corrections" that scientists had to perform for objects with negative magnitudes.

We will assimilate to 40 dB the magnitude 3 stars that are easily observable by anyone that has good eyesight; this is a low-sound observation; magnitude 2 stars would correspond to 50 dB, which is the equivalent to a radio that plays soft music. Hiparcus arrived to the conclusion that the brightest stars are those of magnitude 1, and we will consider 60 dB for them, which is the sound level that has an ordinary conversation (and one where no bad words are used too).

What we have not said is that current scientists corrected this greek man because by "listening" better to the sky they discovered that some stars and planets were below magnitude 1. So they called them magnitude 0 objects; we will give 70 dB to those. There were still fainter objects out there, so scientists had to add -1 magnitude, which would be 80 dB, which is something like the sound of a street with heavy traffic; magnitude -2 (90 dB), magnitude -3 (100 dB) and magnitude -4 (such as the brightness of Venus), we will assimilate to 110 dB. That sound will be like rock drill. In this way, we will have an idea of how different these sounds are in relation to the sound of paper that is described by the first magnitudes objects. This important difference is the same that characterizes the brightness of the stars in the sky.

Stars also have different colors:

Not all stars will have the same color. That is why we will assume red to be a deep sound, while blue would be a higher-pitched emission, yellow would be somewhere in the middle and white light, which is actually a saturation of all colors would be represented by a sound made up by all the rest. The same principal applied to the light's wavelength is used in this "new language" to show the color of the stars.

Some useful considerations:

At this time, our knowledge of the sky is pretty good, and we can mingle into it rather comfortably, almost as if we knew it all our life, almost as if we could touch it. In order to improve what we know, we must mention other objects that we find in the night sky, and for this we must study more about Astronomy.

Our galaxy, the Milky Way, is a spiral shaped galaxy an in one of its outer arms is the Sun, and revolving around it is the Earth, along with other planets, asteroids, comets and smaller objects of the Solar System. The galactic arm located right next to ours is viewed as a cloudy fringe. This "cloudy thing" we will call it "noise or interference", because it stands for the same thing. Beyond this interference, we cannot see anything else, in the same way that a frying pan sound makes it difficult to have a phone conversation. We will assign 20 dB to this concept.

In this way, we shaped the map of the sky. We have set stars into it, and with the same magnitude methodology explained previously we can include the planets, which can be heard without any instrument to amplify them. These are: Mercury, Venus, Mars, Jupiter and Saturn. The planets will be perceived differently than the stars because the latter have an intermittent sound, since they are a sound source, whereas the planets make the sounds bounce off the stars (in more adequate terms, they reflect the starlight) . This is why planets, even if they are opaque objects, they can be seen and in our particular case, heard.

Teaching blind people to look at the sky is taking the only part of their surrounding which is denied to the touch. This proposal also becomes a social inclusion tool, which teaches persons with no apparent disabilities, something apparently difficult by using a language created for a minority (usually discriminated).

A challenge for amateur science: taking science….to everyone.