Inclusive Astronomy

Colour-Temperature Relationship
Temperature of the stars: Scorpio Thermal Constellation
2019 version

Alexis Mancilla[1], Beatriz García[1]

1. Instituto de Tecnologías en Detección y Astropartículas, CNEA, CONICET, UNSAM

1. Introduction

Over the years different modules have been developed for education and he dissemination of Astronomy. Among others, it is worth mentioning the planetarium for the blind, that consists of a dome covered with LEDs , which represent the stars with different sizes (magnituds) and colors (temperature). This kind of proposal, is accessible for blind, because the people can touch the stars and recognize the different paterns (asterisms, constellations) and sized and understand abut the magnitude meaning and also the resource is attractve for people without visual disabilities, the lights can be seeing and you add to the magnitude the color, and then the surface temperature of the stars topic.

Beyound the complete installation, we also developed some tactile constellation also with LEDs, which are portable and permits to develope a lesson in a clasroom (see Figure 1).

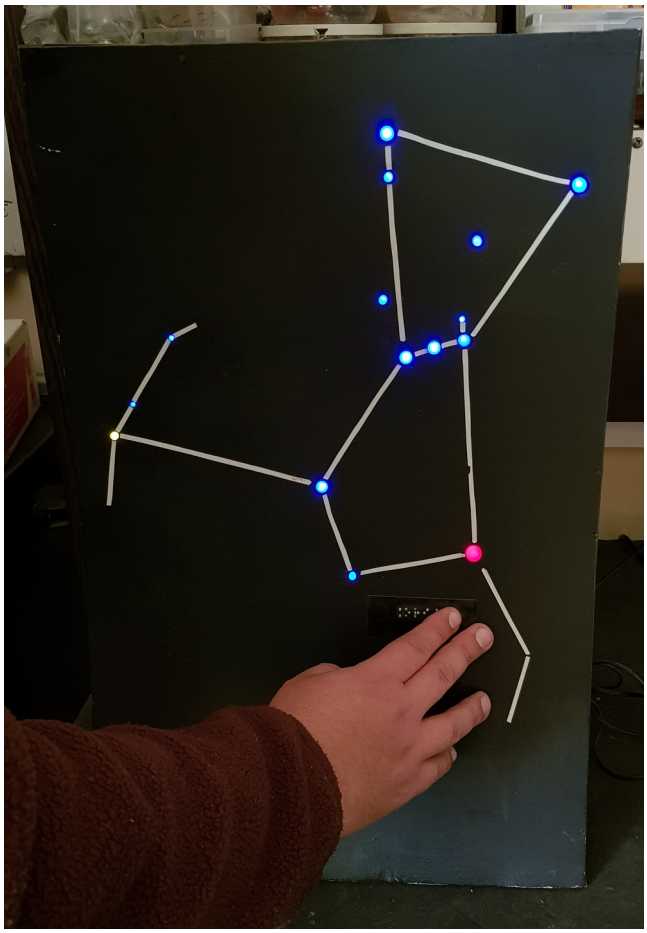


Figure 1. LED Constellation: Orion.

A challenge of this development was to include in the model the magnitude **and** colour characteristics of the stars for blind, and for this, an adaptation in which the temperature can be perceives was the *core* of the project

The present report describes the design, supplies and construction of a constellation made with bulbs, which represent stars with different temperatures, without forgetting the magnitude topic.

2. Design and supplies

Because of its relative simplicity, the Scorpio Constellation was chosen to prepare a model prototype. Figure 2 shows the constellation, the distribution of stars, with the identification and the color of each object, and Table 1 details the magnitude and spectral type/colour of each one, in order to determine the surface temperature.

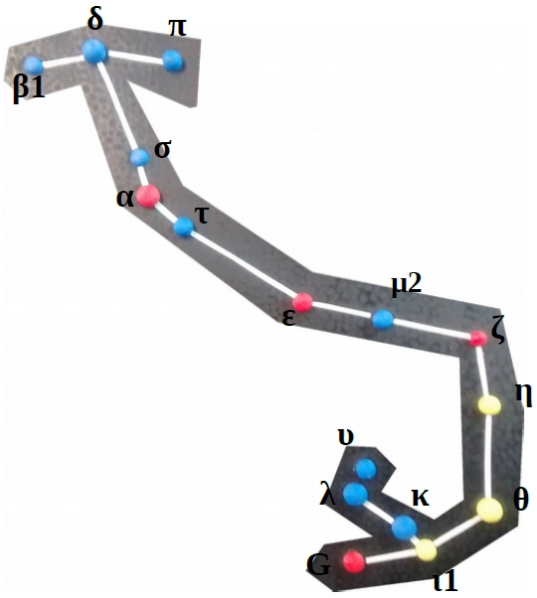


Figure 2: Scorpio Constellation design

Table 1: Assignment of star size and colour

α	1,06/10mm	K/Roja
λ	1,62/8mm	B/azul
θ	1,86/8mm	A/amarilla
δ	2,29/8mm	B/azul
ε	2,29/8mm	K/rojo
κ	2,39/10mm	B/azul
β1	2,56/5mm	B/azul
υ	2,7/5mm	B/azul
τ	2,82/5mm	B/azul
π	2,89/5mm	B/azul
σ	2,9/5mm	B/azul
ι1	2,99/5mm	A/amarilla
η	3,32/5mm	/amarilla
μ2	3,56/5mm	B/azul
ζ2	3,62/5mm	K/rojo
G	8mm	rojo

To achieve different temperatures, incandescent lamps of car boards were used. These lamps are (in general) of 12V-12W and of 5mm of diameter (Figure 3). These allow to lower the supply voltage to obtain a lower temperature than outside.

Figure 3: Lamp T5 of car board 12V,12W

2.1 **Design of Caps of different colours and sizes**

To represent the stars and cover the lamps, specially designed 3D caps were printed, they were designed taking into account three different measures : 8mm, 10mm and 12mm(Figure 4), using 3 different colours: red, blue and yellow. Each cap is 15mm high, which permits to use the same lamp for all the star magnitudes involved.

It is important to note that ABS material was used for the lamp caps that has a melting temperature higher than 200C, which prevents melting of the plastic when the lamp reaches 55C, the maximum temperature programmed for the model (see section 2.2).

Figure 4:. Lam caps: 8mm, 10mm and 12mm, from left to right.

2.2 Electronics and temperature

To simplify the model, three possible temperatures were considered to represent the surface condition of the stars: 27C, 35C and 45C, which were measured on the top of the plastic coating (lamp cap) with the thermocouple of the Tester Fluke 179 (sn 24300581), these temperatures were achieved by varying the supply voltage of each lamp .

To achieve that each lamp has the different ones are supplied with different voltages, was used the LM317 regulator adjusted to 3.5V for 27C, 5.5V for 35C and 12V for 45C, this

regulator was used according to the circuit proposed by the manufacturer in the data sheet (Figure 5).

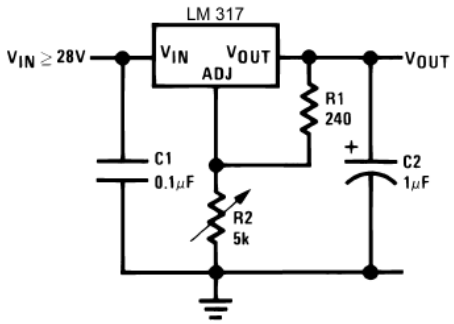


Figure 5. Basic scheme of the LM317

It is worth mentioning that a voltage regulator was used for the 3.5V, and one for the 5.5V, respecting the configuration proposed by the manufacturer.

The wire coming from the regulators are welded to the lamps and the regulators are powered by a 12V, 2A power supply.

2.3 Box and structure

To supporting the stars that make up the constellation, a box with 3mm MDF was assembled, painted with satin black paint, according the design in Figure 6.

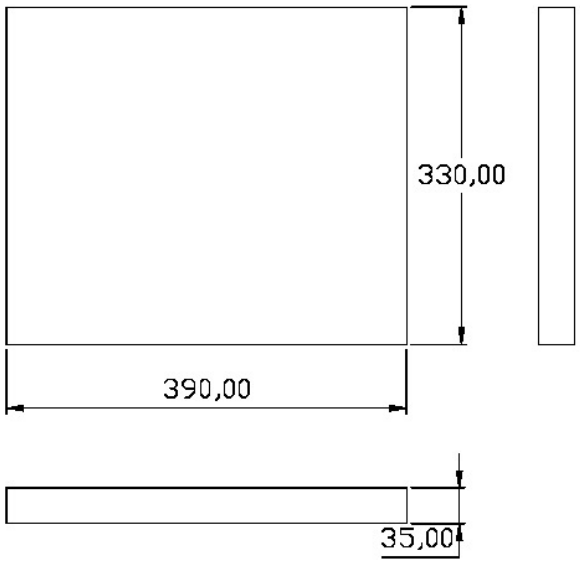


Figure 6. Constellation box (dimensions expressed in mm).

The final model is presnted in Figure 7, where different sizes (magnitude) and colors (suface temperature) represent the constellation of Scorpio in this case.

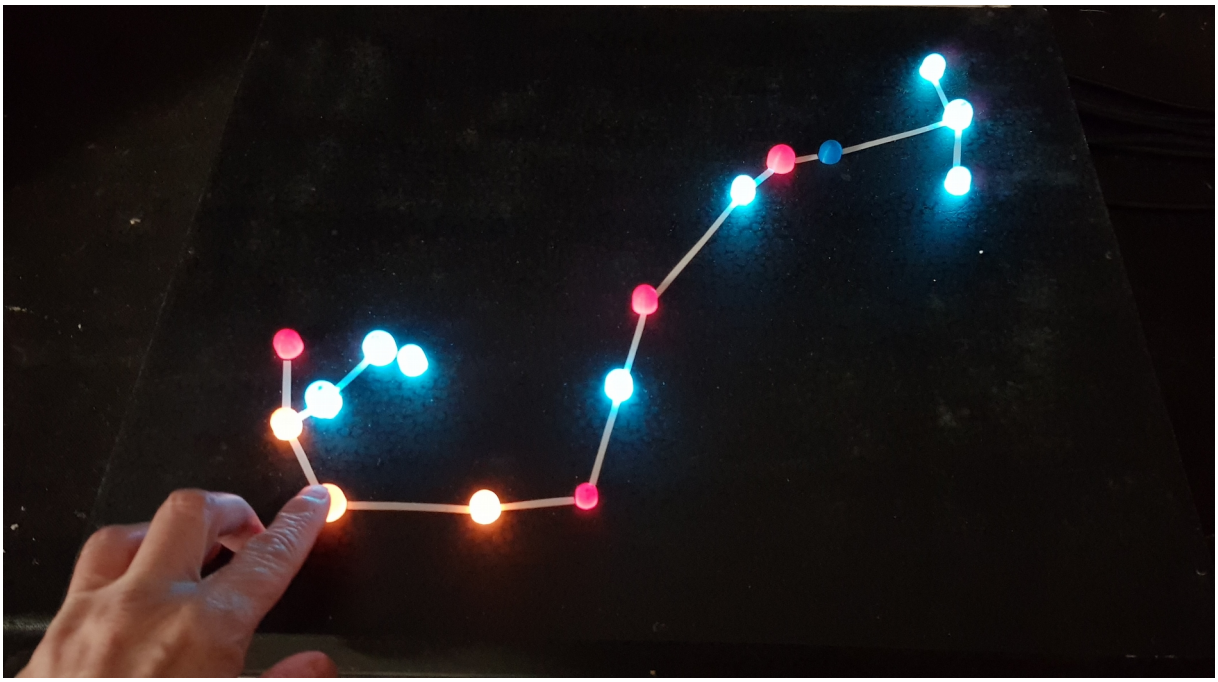


Figure 7. Scorpio Constellation Thermal model

3. Comments and Conclusions

Several tests were performed to evaluate the thermal variation and thermal perception by real users.

It was shown in some testing sessions with blind people, that in general the result was positive in the perception of the temperature difference.

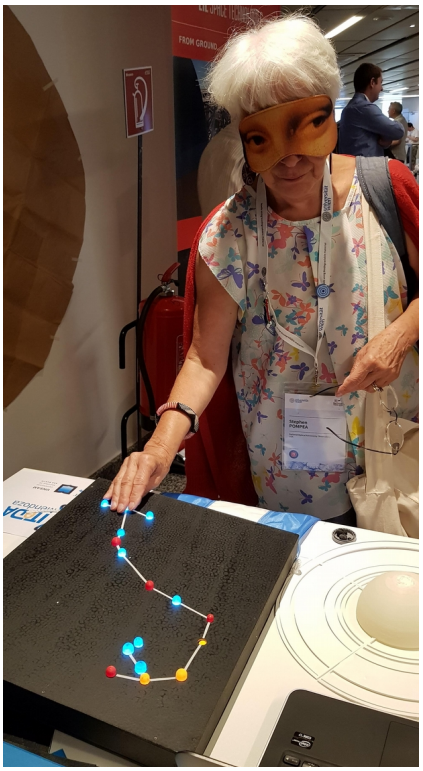
At the time of testing the model after transporting it, there were problems with the lamp connectors since the tin did not adhere well, for the improvement of this model it is advisable to use a lamp holder and not direct welding.

The model was uses in several exhibition with a good impact (see Figures 6 and 7), it is of interest not only for the blind people, also for colour blinds and person not visually disabled, in order to understand the concepts associated to the colour-temperature relationship.

Figure 8 reflects the exhibition and use of the model at The invisible Factory, an exhibition for blind at the Legislature in Mendoza, on July 2018, and Figure 9 shows visitor at the XXXa

IAU-GA Assembly in Vienna, in August of 2019, during the first exhibition of IAU-Inspiring Stars.

Figure 8. *The invisible Factory*, exhibition for blind at the Legislature in Mendoza, Argentina, July 2018



Fiigure 9. Visitor at the XXX IAU-General Assembly in Vienna, August of 2019, during the first exhibition of IAU-Inspiring Stars