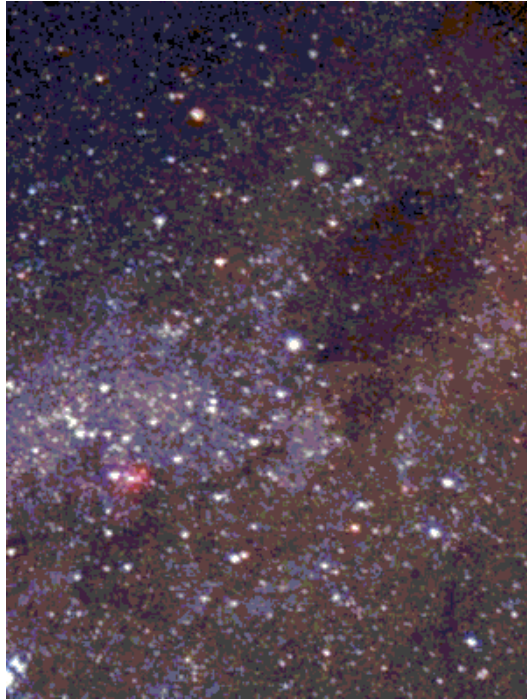


Astronomy Report

Southern Cross Constellation



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The Southern Cross

One of the constellations more easily seen during the whole year in the South Hemisphere is the Southern Cross (in Spanish “Cruz del Sur”). This is a group of stars readily observable (due to its simple shape) which has been object of veneration in diverse cultures, providing guidance and inspiration for a long time. One of the telescopes at Cerro Paranal [1] has been named after the Southern Cross using the mapudungún name for it, Melipal [2], which means “four tips” (as in the tips of arrows). (N.B.: Mapudungún is the language of the Mapuche, the native people living in central and southern Chile).

Our report includes the following aspects:

- The Southern Cross as lighthouse of literary inspiration.
- Knowing the Southern Cross astronomically.
- The Southern Cross in comparison to the Northern Cross.
- The Southern Cross and the mythology of the original cultures of the Andes.
- Classroom activity.

I. The Southern Cross as lighthouse of literary inspiration

Diverse authors have mentioned the Southern Cross in their works. Dante is one of them. In the Divine Comedy he writes in the first canto of the second part: “I turned right and, directing my attention to the other pole, I distinguished four stars only seen by the first humans. The sky seemed to rejoice in their shine...”. [3]

A Chilean author, the Literature Nobel Prize winner Pablo Neruda, wrote in his book “One hundred love sonets” (poem LXXXVI): “Oh Southern Cross, oh threefold of fragrant phosphorum / with four kisses today it penetrated your beauty / and went through the shadow and my hat: / the moon was round because of the chill. / Then with my love, oh diamonds / of blue frost, serenity of the sky, / mirror, you appeared and all was full of night / with your four depots trembling of wine.” [4]

These two examples make us think on how this constellation has inspired different poets which, from different latitudes and from different ways of viewing it, have found themselves captivated by this stellar cross; Dante, in the XIII c., observing from far away, and Neruda, in the XX c., from the austral Temuco [5], observing its whole grandeur.

II. Knowing the Southern Cross astronomically

This constellation is one of the 88 classified by the International Astronomical Union in 1930. Formerly it was part of Centaur after a classification by Ptolemy. Due to the precession of the Earth the Southern Cross became invisible from the North Hemisphere. It was split from Centaur by A. Royer in 1679. [6]

The shape of this constellation is that of a cross. It is formed by 4 outstanding stars and a dark nebula. It can be distinguished from other cross found in the same hemisphere (the False Cross) because it has a fifth star near its centre.

Its coordinates are A. R. 12.45 h and Dec. -59.97 degrees, visible between parallels 20 degrees N to 90 degrees S. Its area is 68 square degrees.



Image by astrophotographer Pedro Aguirre V. (<http://astrosurf.com/pedro>)

In Table 1 we show data for the 11 brightest stars of this constellation. We present data for position, magnitude and spectral class of each star.

Table 1 - Source: Catálogo de Brillos de Estrellas [7].

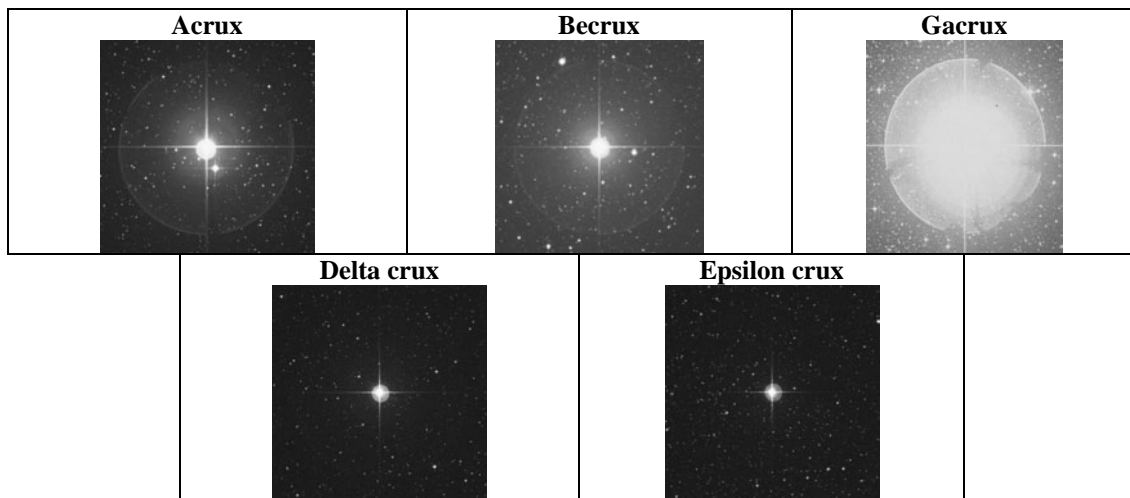
HR	Common Name	Bayer	VarID	RA J2000	DEC J2000	mag	MK Spectral Class	Multiple Count
4853	Becrux (Mimosa)	Beta	Bet Cru	12h 47m 43.2s	-59° 41' 19"	1.25	B0.5III	3
4730	Acrux	Alpha [7]		12h 26m 35.9s	-63° 5' 57"	1.33	B0.5IV	3
4763	Gacrux	Gamma	5672	12h 31m 9.9s	-57° 6' 48"	1.63	M3.5III	3
4731		Alpha [8]		12h 26m 36.5s	-63° 5' 58"	1.73	B1V	3
4656		Delta	Del Cru	12h 15m 8.7s	-58° 44' 56"	2.8	B2IV	
4700		Epsilon	5568	12h 21m 21.6s	-60° 24' 4"	3.59	K3-4III	
4898		Mu [7]		12h 54m 35.6s	-57° 10' 40"	4.03	B2IV-V	
4679		Zeta		12h 18m 26.1s	-64° 0' 11"	4.04	B2.5V	
4616		Nu		12h 6m 52.9s	-64° 36' 49"	4.15	F2III	
4599		Theta [7]		12h 3m 1.5s	-63° 18' 46"	4.33	Am	
4897		Lambda	Lam Cru	12h 54m 39.2s	-59° 8' 48"	4.62	B4Vne	

Acrux is one of the brightest stars in the sky, being the twelfth in bright. Other interesting Southern Cross data are the distances, temperatures, solar radii and absolute magnitudes, as obtained from the software Starry Night. [7]

Table 2 - Source: Software Starry Night, version 3.1.

HR	Bayer	Distance	Temperature	Solar Radius	Absolute Magnitude
4853	Beta	353	20.695	6,4	-3.92
4730	Alpha [7]	321	21.259	7,1	-4.22
4763	Gamma	88	3.276	269	-0.6
4731	Alpha [8]				
4656	Delta	364	16.569	4,7	-2.46
4700	Epsilon	226	3.738	129	-0.66
4898	Mu [7]	379	15.620	3	-1.33
4679	Zeta	362	14.819	3,1	
4616	Nu	64,3	7.144	2,3	
4599	Theta [7]	231	7.477	6,8	
4897	Lambda	360	13.904	2,7	

The following images were obtained from Simbad (astronomical database). [9]



Comparing the images with the spectral class of the stars (see Table 2), and using as a reference the classification by Morgan and Keenan, we see that:

Table 3

HR	Bayer	Absolute Magnitude	Class of star
4853	Beta	-3.92	Giant, white-blue, cepheid
4730	Alpha [7]	-4.22	Subgiant, white-blue
4763	Gamma	-0.6	Red giant
4731	Alpha [8]		Dwarf or from the main sequence
4656	Delta	-2.46	Subgiant
4700	Epsilon	-0.66	Giant
4898	Mu [7]	-1.33	Subgiant
4679	Zeta		Dwarf or from the main sequence
	Nu		
	Theta [7]		
	Lambda		

Another interesting information we are able to show about this constellation is the location of the stars in relation to the Milky Way.

Table 4 - Source: Catálogo de Brillos de Estrellas [7].

Acrux	Member of the Scorpio Centaur cluster.
Betacru	Probably a member of the cluster Sco-Cen; member of the association Sco-Cen; member of the Pleiades group.
Delta Cru	Probably a member of the Scorpio Centaur cluster.
Epsilon Cru	Hyades group.

Other objects we can distinguish in the Southern Cross are the following:

Table 5 - Source: Catálogo de Brillos de Estrellas [7].

Name	HR	Object	Magnitude
NGC	4755	Open cluster	4,2
NGC	4609	Open cluster	6,9
Ru	98	Open cluster	7
Harvard 5		Open cluster	7,1
NGC	4103	Open cluster	7,4
NGC	4349	Open cluster	7,4

NGC	4439	Open cluster	8,4
NGC	4052	Open cluster	8,8
NGC	4337	Open cluster	8,9
Ru	97	Open cluster	9,1
Hogg	14	Open cluster	9,5
Tr	20	Open cluster	10,1
Hogg	15	Open cluster	10,3
PK	298-0,1	Planetary nebula	11
PK	300-0,1	Planetary nebula	11,7
PK	298-1,2	Planetary nebula	12,4
PK	299+2,1	Planetary nebula	12,7
PK	300+0,1	Planetary nebula	12,9
PK	299-0,1	Planetary nebula	13,6
PK	300-1,1	Planetary nebula	13,8

The most interesting cluster in the Southern Cross is the Jewel Box (NGC 4755):



Image: Space Telescope Science Institute.

Image by astrophotographer Pedro Aguirre V. (<http://astrosurf.com/pedro>).

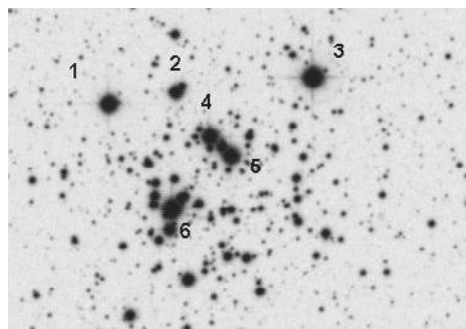


Image: <http://simbad.u-strasbg.fr/sim-fid.pl>

Some magnitudes in the Jewel Box:

Table 6 - Source: <http://www.seds.org/messier/xtra/ngc/n4755.html>

Right ascension	12h 53.6'
Declination	-60 degrees 20'
Distance	7600 light years
Visual bright	4,2 magnitude
Apparent size	10 arcmin

Nicolas Lacaille discovers and then mentions the Jewel Box in Coelum Australe Stelliferum in 1763. This is a young star cluster, approximately 7 million years old. [10]

NGC 4755 is made up of diverse stars from which we highlight the following:

Table 7 - Source: <http://simbad.u-strasbg.fr/Simbad>

	Name	Star type	B mag	V mag	Spectral class
1	HD 111990	Star in Double System	7.01	6.77	B1B2Ib
2	SAO 252075	Ellipsoidal variable Star	8.165	7.962	B0.5 Vn
3	HD 111904	Variable Star	6.09	5.80	B9Ia
4	SAO 252073	Variable Star of irregular type	9.82	7.66	M2Iab
5	HD 111934	Variable Star	7.15	6.91	B2Ib
6	HD 111973	Star in Cluster	6.10	5.9	B5Ia

The most remarkable dark nebula of the South, located in the Southern Cross, is the Coal Sack. This nebula is on the galactic plane, about 150 pc from the Sun [6]. It is known since prehistory in this hemisphere. It was observed in 1499 by Vicente Yáñez Pinzón [10].

Some data about this nebula:

Table8 - Source: <http://www.seds.org/messier/xtra/ngc/n4755.html>

Right ascension	12h 52'
Declination	-63 degrees 18'
Distance	2000 light years
Apparent size	420 by 240 arcmin

This nebula is composed of stellar dust that blocks the path of light. Here we see the Coal Sack (in Spanish: Saco de Carbón) in sheer splendour:







Image by astrophotographer Pedro Aguirre V. (<http://astrosurf.com/pedro>)

III. The Southern Cross in comparison to the Northern Cross.



Image: <http://faculty.rmwc.edu/tmichalik/mlkywayc.htm>

The image shows the two crosses: Cygnus to the left and Crux to the right. Both extend across the galactic equator. The following data illustrates similarities and differences between the crosses of both hemispheres.

	Southern Cross	Cygnus
Icon		
Image		
Apparent magnitude	Becrux 1.25	Deneb 1.25
Nebula	Coal Sack (dark nebula)	NGC 7000 (bright nebula)
Cluster	Jewel Box (NGC 4755) Open cluster, A-shaped.	M29 Open cluster; shaped as a spoon.
Name	Southern Cross	Northern Cross
Stars of apparent magnitude < 3	4	4
Visible in the range of latitudes...	20 to -90 degrees	90 to -40 degrees
Area	68 square degrees	804 square degrees

IV. The Southern Cross and the mythology of the original cultures of the Andes.

In a legend about the origin of the Mapuche the Southern Cross is mentioned. In the “Book of Mapuche tales”, compiled by Alicia Morel, we read:

“The children built a ruca (a Mapuche hut) and the Sun entered by the door facing East and left by the one facing West, following the ancient custom of the people of the land, respectful of the cardinal points and regarding the number four as sacred.

When at last the Maker of Rain was tired of riding over the clouds and returned to its hiding place behind the hills, water level began to descend and the rivers to follow their normal course. Then the coihue (a native tree) buried itself in the mud as a ship running aground, and when the wind dried the ground the Puma (a native feline), the Chilla (a native mouse) and the children jumped from the log and looked for a hidden valley to live.

The first thing they did, even before building another ruca or looking for a cave to inhabit, was to name their adoptive children. Magical names that would protect them forever. The son was named Manque, the condor that soars in the sky looking after the Earth. The daughter was named Melipal, like the Southern Cross.”

There are other known connections to the Southern Cross, which we mention now:

- The ancient indigenous farmers of the Andes observed the occurrence of astronomical phenomena in order to determine the epoch of their agricultural or

cattle raising activities. The Southern Cross dictates the calendar in the Andes; it says when it is time to harvest and when it is time to start sowing.

- The ancient inhabitants of the Andes organised their territory according to the laws of the stars. One of their most important constellations was the Southern Cross. Based on it they found the measures needed to organise their lands. They did it by bringing the constellation down to Earth using “water mirrors” (an amphora with water, which, when a star is on the zenith, reflects the starlight directly on the ground), and obtained the unit called Tupu (distance from end to end in the shortest arm), which corresponds to 20.4 meters.
- In the medicine wheel of the Quechua, the Mapuche and other native people, the four stars form a “square cross”, which is the axis of the wheel and which can be seen clearly depicted in the drawings of the kultrún, the drum used by the machis (Mapuche healers) during their healing ceremonies. In each of the four parts the kultrun results divided, they paint suns, moons or stars on it.
- For the old inhabitants of the zone of Esquel, province of Chubut (Argentina), the Southern Cross is represented as “the pawmarks of the Chokie or ñandú (a large bird) escaping from the bolas of the hunters”. This animal was sacred for them.
- For the Bororó (in Brazil), the Southern Cross was to be found in the paw of a large ñandú (Chokie).
- The legend of the Mocovies (Chaqueño Wood, between Paraguay and Río de la Plata) tells that the Southern Cross is part of the body of a ñandú. However, this ñandú was not completely free of danger: the stars Alpha and Beta Centauri, and several other stars, depicted two threatening dogs.
- For the Mapuche and the Tobas, two people far away from each other, the Coal Sack portrayed the body of the ñandú, laying on the ground, and the paw is formed by the four stars of the Southern Cross. There are cultures that saw the ñandú in nearly the whole Milky Way.
- Farther to the South, the tribes of the Andes tell the legend of Nemec. Nemec was the chief hunter and wanted to capture a choike (ñandú). When the bird was about to be captured he escaped flying to the stars. The chief then threw the bolas using his whole strength. They did not reach the bird but stayed in the sky, near the paw of the choike, as the stars we know as Alpha and Beta Centauri. They are also known as “the buoys of the Southern Cross” because they seem to point to the smaller mast of the cross.
- The cultures of the Ecuadorian seashore celebrate the feast of the crosses. This consist of adoration of a cross dressed as a woman and watched over during one night. Then the cross is escorted to the church where a priest blesses the “Holy Cross”. This feast is related with archeoastronomy because it is celebrated during the time in which the Southern Cross shines at its most over this zone (likely following a tradition from their ancestors).
- The Inca also regarded the Southern Cross as very important. There are many imperial buildings related to this constellation. As their stars pointed directly to the Celestial South Pole, they needed to know it in order to determine the different times of the year (seasons, time of sowing/harvest, solstices, equinoxes, etc).
- The Bolivian people celebrate on May 3 the Cross but, in this case, they talk specifically of the feast of the Southern Cross constellation. Their ancestors venerated this constellation with the name Achakana (Southern Cross). [11]

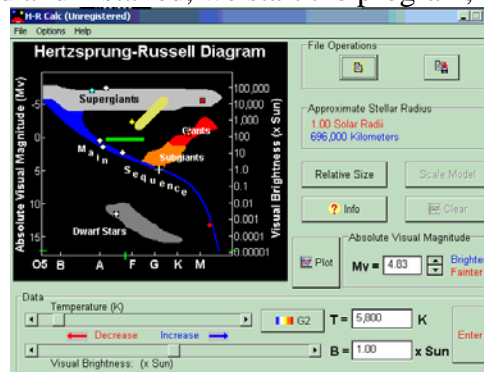
V. Classroom activity: Comparing stars.

How does the size of each star of the Southern Cross compare to the Sun? What happens if its spectral class or absolute magnitude changes? We can work these questions with the students in the classroom. In order to do this, we need a computer and the software H-R Calc6, about the Hertzsprung-Russell diagram.

With data taken from the tables presented in this report (absolute magnitude and spectral class) we can approximate the variety of star, size and temperature.

Steps:

- Download the software from the Internet. Locate it using a search engine with the terms “H-R Calc”.
- Once downloaded and installed, we start the program, obtaining this screen:



- Enter data for one of the stars of the Southern Cross. You will get:

Star Name	Greek / Alternate Designation	
<input type="text" value="acrux"/>	<input type="text" value="Alpha 1 crux"/>	
Absolute Visual Magnitude	Spectral Class	Luminosity Class
Mv = <input type="text" value="-4.22"/>	<input type="text" value="B0.5"/>	<input type="text" value="IV"/>
Remarks and Notes		
<input type="text"/>		
<input type="button" value="Update"/>		
<input type="button" value="Clear"/>		
<input type="button" value="Exit"/>		

- Obtain the position in the diagram and other information you require from the software:

