

## **Astronomy Report**

### Southern Cross



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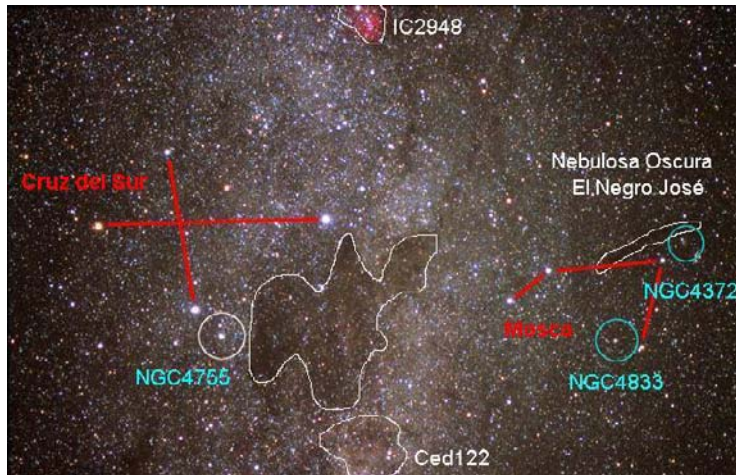
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#### **Acknowledgements**

The authors acknowledge the support provided by the Chilean Astronomy Network (RChA, Red Chilena de Astronomía, <http://www.rcha.cl>) during the production of this work. The Spanish version of this report has been freed to the public domain under the terms of the License RChA.

**2003**



Object: areas of the Southern Cross and the Fly.

Exposure: 30 minutes.

Instrument: SMC Pentax-M lens 100 mm. F/2.8.

Mount: CG-5

Camera: Pentax K-1000

Film: Kodak Ektachrome 200.

Place: La Totorita camping, Mamalluca hill, IV region, Chile.

Date: Sunday 10<sup>th</sup> February 2002, 02:38 h.

Processing: Photoshop 5.0.

## I. Introduction

Name: Southern Cross.

Astronomical name: Crux.

GENITIVE: Crucis.

Common name: Southern Cross.

This circumpolar constellation (always situated above the horizon) of the South Hemisphere, is located between the Centauri and the Fly constellations, just above the Polar Antarctic Circle and it is crossed by the Milky Way. The Crux is visible the whole year between 25 N and 90 S degrees of latitude, especially at early night from middle autumn and during the whole winter. This is why the Crux is not totally visible to all countries, and among those where it has the best visibility are: Chile, Argentina, Perú, Madagascar, Bolivia, Uruguay, etc.

The Southern Cross is the smallest constellation, filling only 68 square degrees in the firmament and covering only the 5% of the biggest one, the Hidra. In despite of being the smallest, the Crux is composed of approximately 54 stars; It was named thanks to its four principal stars which are Alpha Crucis or Acrux, Beta Crucis or Mimosa or Becrus, Gacrux or Gamma Crucis and Delta Crucis; all of them are represented using Greek letters and give this constellation the shape of a perfect cross.

The stellar figure of the Cruz is one of the most famous and easiest to recognize due to its location in a bright region of the Milky Way and also because of other stars not necessarily related to this constellation but that help to find it as Alpha and Beta Centauri, better known as “the buoys of the Cross”. These two beautiful stars seem to point to its higher mast. When finding the Crux we will notice that its main axis, the longest, points to the Southern Celestial Pole. This is the reason why the Crux is used in orientation during the night. Knowing where is the South we are able to find the North, the West and the East. This system of reference has

been used for centuries by seamen that sailed across the world's seas, more specifically the Southern Seas.



Photograph taken from Darien, Cauca Valley, Colombia, using a Zenit II of 58 mm.  
Film: Kodak 400 ASA.  
Exposure: 35 seconds approximately.

## **II. The Cross through time and its past .**

As many of us know, most of the existent constellations had influence in the past of human beings, which after thousands of years of evolution sought more knowledge using the Universe, its stars and its mysteries.

During centuries humanity was looking for an answer to many phenomena that today seem very simple to explain. In Antiquity people used fantastic stories that helped to explain the origin of all the surrounding phenomena, and in so doing many civilizations mentioned the Southern Cross in their myths and legends. Many of them explain us about the ancient location of the constellation.

The Babylonians (5th century B.C.) identified the 12 zodiacal signs and also the Crux, which was glanced from Alexandria, Athens and Rome too. The Egyptians, that knew the stars from a long time, classified them in 1022 (the person in charge of this classification was Ptolemy) and in their classification system Acrux was already present. This binary star was visible 5 degrees above the southern horizon and even when Crux was not yet distinguished as an independent constellation (but was part of Centauri together with Lupus) was important for the civilization according to the Alberto Martos' Theory (stories of the constellations). Marto's Theory argues that ANKH (an ancient kind of cross) means life and the living could not be indifferent to a such and advanced civilization.

Source: <http://www.cielosur.com>

In the other corner of the world (Peru) the Inca culture used the Southern Cross to determinate the best dates for planting and harvesting and solstices and equinoxes.

Source: Carlos Andrade's INTI project.

Also in Chile, the Mapuche people associated the Cross with the footprint of the Choike or ñandú. On the other hand the Aymara in Peru considered the Crux as a square cross in whose centre Mother Quilla was situated (the Moon). This way, the fame of the Cross spread all over South America. Also in Bolivia (with the Tiawanako petroglyphs, Paracas cloaks and Chavin

ceramic) it is demonstrated that this constellation was important for people's life and even today their pilgrimage (on March 3<sup>rd</sup>) is the continuity of the veneration towards the Southern Cross in the antiquity.

In India there existed a constellation called SULA (Beam of Crucifixion). It was confirmed that they were talking about the Cross due to its characteristics and general descriptions. In the Centre of Australia it was called "the eagle's leg" and, coincidentally, among some Brazilian tribes it was called "The Suri's leg".

In 1500 Joao of Lisbon and Pero Anes used this constellation as a reference to find the South. For the first time in 1505 Hernando de Magallanes names it as "Cruz do Sul" (Southern Cross), and some time later, in 1515, Andres de Corsalli called it "Marvellous Cross".

Just 164 years later Bayer incorporates this constellation in his work, but it is in 1679 when finally Royer separates it from Centauri giving birth to the constellation number 63. In his drawings Royer puts the constellation vertically.

It is thought that Marco Polo was able to see the Cross from Java and Madagascar, when Prieto de Albano describes Marco Polo's sky in his "book of wonders". This way Dante knew of its existence and could mention it in his work "The Divine Comedy"



Image: NASA photograph, from above the Maula Loa.

The Southern Cross has not been visible from the Northern Hemisphere for 20 centuries but it has been well observable from the South for many centuries, as it has been demonstrated through ancient cultures that worshiped this constellation.

### **III. Today's sky.**

If Ptolemy lived at this time, he would not be able to observe this constellation because currently from Alexandria it is only possible to see Gamma Crucis at 1.5 degrees above the horizon.

Nevertheless, in South America we have the possibility of seeing the Cross and people even today remember their ancestors' traditions such as the celebration of the 3<sup>rd</sup> May (which represents day zero in Aymara calendar). In Mexico, Bolivia and Peru there are many Andean festivities such as:

Mexico: the day of the bricklayer is commemorated, in which people pay homage to the "Saint Cross", wrapping a cross with a special paper to decorate buildings.

Bolivia and Peru: Considering their geography, the cultures of these two countries are linked by ancient Inca life. Currently people from both countries celebrate especially the Southern Cross better known for them as chakana (which on the 3<sup>rd</sup> May acquires the shape of a perfect cross). In this feast people give thanks to the cross for the protection of the crops as May is the month for harvesting.

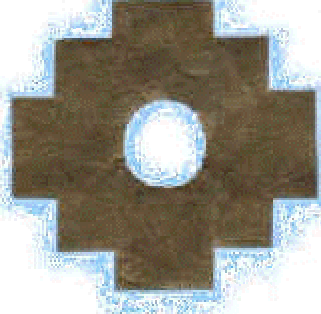


Image: Chakana Cross.

Currently the Southern Cross is present in many national flags and flags of groups, such as the one of MERCOSUR, a commercial treaty among some South American countries. The Cross is also present in the flags of Australia and Brazil. To illustrate it we present the following table with Brazilian cities and the star represented by it:

Brazilian City	Star of the Southern Cross
Sao Paulo	Alpha Crucis
Río de Janeiro	Beta Crucis
Bahía	Gamma Crucis
Minas Gerais	Delta Crucis
Espírito Santo	Crucis Elipson



Image: MERCOSUR's Flag.

#### IV. Possible future of the cross

In a far away future the Southern Cross will change its shape due to the proper motion of stars through space. This means that it will look no longer like a cross so its name will likely change as well. This change can also occur if one of the stars making up this constellation disappears. The life of a star depends on the speed with which it performs thermonuclear reactions (consuming hydrogen) and also on what stage of its vital cycle we find it. Thus we can predict:

- Gamma is a red giant (last stage of a star's life) that could disappear earlier, exploding as a nova or supernova, and then evolving to be a white dwarf or a neutron star, eventually becoming a pulsar. On the other hand, we must take notice of the fact that neutron star has an inferior size limit, so it could become a black hole (region of the space with such a high density that no radiation can escape from it).

- Other part of the constellation that could change substantially is the Jewel Box cluster. Although it is just a few million years old, its red stars already show signs of premature ageing. This happens because the more massive stars have already exhausted their supplies of nuclear hydrogen (converting it to helium via nuclear fusion), and so starting an accelerated agony. Surely some other stars will also change colours as millions of years go by, and thus our descendants will find that this box contains more rubies but less diamonds.



Image: Transit of spacecraft “ECO 1” in front of Centaurus and Crux, photographed by Ángel Meynet (Santa Fe) el 28/06/1979. The picture was obtained during the last days before re-entry of the spacecraft into the atmosphere. A teleobjective of 100mm was used. Exposure of 15 seconds.



Image: Picture of the Jewel Box, NASA.

## V. Southern Cross, legends and stories.

Antonio Fernández, a specialist in Mapuche language, conducted a research about the experiences of the Mapuche ancestors. He found out that the Southern Cross is represented as the pawmark of a choike o ñandú (a native bird). Also, the anthropologist Roberto Lehmann-Nitsche points out that in Patagonia, in the XVIII c. the Milky Way was imagined as a field for ñandú hunting. This legend tells that Nemec, a chief hunter, tried to capture an enormous choke, but the bird escaped unharmed to the sky and stayed there.

Source: Departamento de Física Universidad Nacional de la Patagonia.

In the following table we list the representations of the constellation by some local cultures:

People	Name or description of the constellation
Aymara, quechua	Chakana

(Andean high plateaus)	
Carabuco (Titikaka lake, Bolivia)	Square cross
Bororó (Brasil)	Paw of a large ñandú
Mocovies	Choike
Mapuche (Patagonia)	Choike
Yirkala (Australia)	Paw of an eagle

Sources:

<http://www.indigenas.bioetica.org>

“El cielo en la mitología”, F. Molina-Telles. Buenos Aires, Argentina.

“Anales de instituto popular de conferencias”, Lehmann-Nitsche. Buenos Aires, Argentina.

“The patterns in the sky”, McDonald and Woodward.

We cannot be sure about the origin of legends. Time has altered the stories so that new tales have emerged, occasionally producing radically different stories. Historians, archaeologists and anthropologists are the scientists in charge of recovering the past and discover fascinating data about it. Their method is to search for information by studying oral stories, iconographic materials, written materials, etc.

In old books there are tales about ancient travellers and scientists. Thus is how, in theory, Dante heard of the constellation Crux, by the writings of P. Albano, who tells the story of Marco Polo.

Past will not be ever recovered completely because no science is completely precise.

## **VI. Chemical composition of a star**

All stars have nearly the same chemical composition; in fact, lots of stars must be analysed in order to find noticeable differences. The composition of a star is basically hydrogen (H) and helium (He). The latter is produced in thermonuclear reactions inside the star.

The spectral analysis of the majority of the stars reveals that they are composed of 92.4% of hydrogen, 7.4% of Helium and the resting 0.2% of other chemical elements such as Lithium, (Li), Beryllium (Be), Boron (B), Sodium, Carbon, Nitrogen, etc. The spectral analysis only shows us the composition of the more superficial layers of the stars, so we have to use more sophisticated methods in order to find out its internal composition. The evidences about the internal composition of the stars comes from the finding of Technetium (Tc) in their atmosphere. Technetium is radioactive and it disintegrates quickly and has been detected in some giant stars, in whose centre it is theorized to be produced.

## **VII. The stars making up the cross**

The stars composing the Southern Cross are approximately 54. The most important stars are the four ones that give the Cross its peculiar shape: Alpha, Beta, Gamma and Delta. There are also some other important stars in this constellation, such as E-Crucis which is variable and is located just in the middle of the imaginary line that links Delta and Alpha. In addition Crux includes an open cluster, one of the most beautiful, known as the cluster of the Jewel Box.

**Acrux or Alpha Crucis:** is one of the prettiest double stars in the sky, having magnitudes 1.7 and 2.1 it is situated in 21<sup>st</sup> place in a ranking of all the stars ordered by magnitude. These stars of a white-bluish colour, are located at a distance of approximately 296 light years and its temperature is between 10,000 and 30,000 degrees Celsius. The luminosity of these stars in relation to our Sun (Sun:1) is of 3.200/2.000. Currently its orbital period is unknown.

**Mimosa or Beta Crucis:** this star is at the West end of the cross. It is roughly 500 light years from the Sun. This white-bluish giant has a magnitude 1.3 and a luminosity of 6,000 with respect to the Sun. Its apparent size varies 5 times a day, but increasing by less than 1/10 of magnitude, so this change is not detectable to the unaided eye. Its temperature is between 7,000 and 20,000 Celsius degrees.



Exposure: 20 minutes.  
Film: kodak gold 400.  
Lens: 50mm. f/2.8.  
Location: MT. Kaputar, near Narrabri.



Film: Fujicolor Super G ACE800.  
Lens: 50mm f/ 2.0.

**Gacrux or Gamma crucis:** is the star at the top of the cross. It is a red giant of magnitude 1.6. It is a visual double, having a very bright orange star of magnitude 6.4 two minutes away from it. Gacrux is roughly 200 light years from the Sun. Its temperature is between 2,500 and 4,500 Celsius degrees. It is believed that this star will be the first in dying, because it is at the end of its life cycle (red giant on the way of becoming a nebula).

**Delta Crucis:** it is on the right of the cross, pointing to the West. It is one of the faintest stars, with magnitude 2.79. It is 570 light years away from the Sun.

**NGC4755 or Jewel Box:** this open cluster is nearly 1 degree south of Mimosa. It contains over 100 stars of several colours and magnitudes from 10 to 6. These stars use an area equivalent to one third of the apparent size of the Full Moon. Although in fact this cluster is farther than any of the already mentioned stars (7,600 light years, so the light we see was emitted before Egypt's pyramids were built), it can be distinguished very well by using binoculars and it is impressive when looking at it through a telescope. Most of the stars in this

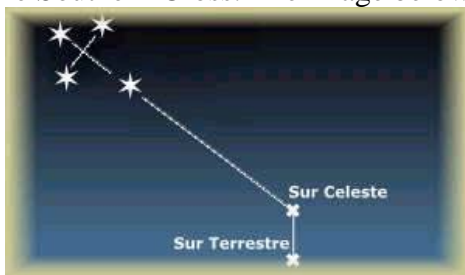
cluster are white-bluish supergiant, with temperatures ranging from 10,000 to 30,000 Celsius degrees. In the centre of this cluster there is a super giant of magnitude 8; many blue stars surround it, one of them being Kappa Crucis, a white-bluish giant of magnitude 5.9. This cluster owes its name to the rich colour contrast between its stars, which make it look like a jewel box. These stars will probably change their aspect in many more millions of years.

### VIII. Activity: How to locate the Southern Cross?

Not having an instrument (e.g. a telescope) it is not a problem to observe this wonderful constellation. It can be observed with the unaided eye from latitude 25 degrees N to 90 degrees S. What you must do is the following:

- Wait for a clear night, and for feeling like observing the constellation!
- Stand on a place from where you can observe most of the sky (free of buildings blocking the view).
- Look to the South.
- Raise your eyes from the horizon and you will find the Celestial South Pole.
- Look diagonal from it and you will find the “pointer” of this constellation (Alpha).
- Then look to both sides and above the pointer.

In this way you will locate the four stars whose positions imitate the shape of a cross. This is the Southern Cross. The image below should make easier to locate the cross:



But beware, there is a false cross too! There are three ways of telling the false cross from the true one:

- The true cross has an extra star on one side, which is absent in the false one.
- At the feet of the true cross there are four fainter but fairly visible stars. They make up the constellation of the Fly.
- The true cross is followed in its path by two bright stars: Alpha and Beta Centauri.

### IX. Comparison between the constellations Cygnus and Crux

Feature	Southern Cross	Northern Cross
Ascension	12.45 hours	20.62 hours
Declination	-59.97 degrees	42,03 degrees
Some stars and their magnitudes	Becrux (1.25) Acrux (1.7 and 2.1; double star) Gacrux (1.63) Deltacrux (2.80) E-crux	Deneb (1.22) Sadr (2.20) Eps Cyg (2.46) Albireo (3.08) Zet Cyg (3.20)

	Kappa	Xi Cyg (3.72) Kap Cyg (3.77) Iot Cyg (3.79)
Nebulae	Coal sack	NGC 6826 North America



Image: representation of the constellation of the Cygnus.

There are always some questions such as: what would have happened if the constellations were situated inversely in the sky that we observe today? This gives place to a whole range of hypothesis, some of them could seem a bit wild, like the one we propose: perhaps our ancestors would have had different beliefs and their rituals would not be what we know today, it is possible that cultures would have resulted inverted...

It is amazing that everywhere in the world there exists a branch of astronomical science!

## X. Final thoughts

We want to use some lines to express the sincere motivation for researching that inspired us during the production of this report. However, we cannot say that this was an easy task. There are always difficulties that complicate any effort, but this was a challenge we accepted as students, as youngsters, as living beings.

Our work aimed to spread what we learnt during the weeks of this long research. We had one main goal: to let the world know how wonderful is everything surrounding us.

In addition, we want to give our personal view of what this project meant for us: we need to assign more importance to the Universe, which is our origin; to the stars, which are our energy; to the galaxies, which are our home; and to the Earth, which is our cradle, the cradle of life.

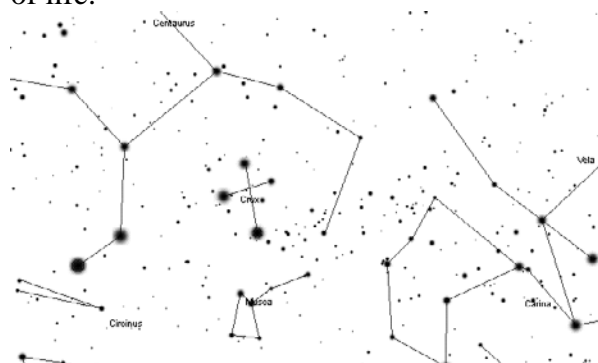


Image: finder chart for the Southern Cross.