

Astronomy on the Riviera at the Observatoire de la Côte D'Azur

By Barry Davidoff

The Riviera is famous for its wonderful beaches, tanned beautiful women, fabulous food and the fine wines of Provence. Although the Riviera is the most popular tourist destination in Europe, few visitors discover that in the hills above its beaches is one of the leading observatories in the world. The Observatoire de la Côte D'Azur (OCA) is a major center for geodynamic research, laser range finding, and the precise measurement of the positions of stars and galaxies.

The location of OCA makes it a wonderful destination for visitors who want to combine culture and stargazing. A visit to OCA during a vacation is perfect for a couple, where one party enjoys sun worshipping on the beach, and the other is devoted to astronomy.



OCA's 1.52 meter Schmidt telescope

Commencing with its turquoise beaches, the hills and valleys of Provence are astounding. The drive to OCA passes through some of the most fascinating and cultural towns and villages in the world and makes a delightful and informational day trip. The scenery is ever changing as the road passes through mountain gorges, medieval walled cities and the rocky *Plateau de Caussols*, where OCA's domes shine above the hills.

Most visitors to the Riviera spend their vacations in Nice or Cannes with their fabulous beaches and boutique shopping. Along the way to OCA, some of the cultural highlights are briefly listed below. The many attractions are worth long visits on their own, or brief encounters on the way to the observatory. Each of the towns also offers excellent restaurants for lunch or cafes for a croissant or *pain de chocolat*.

Starting in Nice, the route to OCA passes through Cagnes-sur-Mer where Renoir lived the last part of his career. His home, *Les Domaine des Collettes*, its gardens, and olive groves have been preserved perfectly, almost as if the artist was still painting. Several works are displayed rooms which have the same views from which the paintings were created.

The road to OCA then passes through two related centers of art, Vence and St. Paul de Vence. The medieval center of Vence has many fascinating art galleries, restaurants and shops. Its most famous attraction is the *Chapelle de Rosaire* which was designed and decorated by Matisse. The wealth of colors and shape bring astounding life to the stark white walls of the small church as sunlight filters through Matisse's bright stained glass windows.

St. Paul de Vence is entirely walled by its medieval fortress. Its narrow streets are barely wide enough for all the tourists to pass through. Almost every other store is an art gallery with works ranging from modestly priced contemporary to the great impressionists themselves. At the southern end of town, Marc Chagall is buried. An entire museum is devoted to the Russian émigré's work in Nice. An entire museum is devoted to the Russian émigré's work in Nice. The Foundation Maeght Museum on the outskirts of town has one of the leading collections of 20th century art in a beautiful setting.



The medieval village of Tourettes-Sur Lopp

The road has been climbing ever since the coast and perched on top of rocky hills is Tourettes-sur-Loup. It is a perfectly preserved medieval village without crowds of tourists. It is called the violet capital of the world, and the hills surrounding the village flow with bright purple flowers. While in town, try the violet ice cream which is flavored by its flower petals. There are incredible views of the Cote d'Azur, all the way back to Cannes and Nice on the coast, from the village walls.

Just a few kilometers from this hilltop village, the road cascades down in the Gorges de Loop. The Loop river has created a deep gorge with breathtaking views and waterfalls as it winds its way seaward from the hills of Alpes-Maritime. Along the gorge is the tiny town of Pont-du-Loop with a perfume factory.



Gourdon Perched above the Gorges du Loop

Across the gorge and after many hairpin turns, a high cliff with straight walls looms more than 500 meters above the Loop river. At the very top is the town of Gourdon. The town is truly where eagles nest. The precariously perched village was originally a Saracen fortress in the 9th century. Gourdon is popular with hang gliders and it is a very long way down in all directions. The entire village has been given over to tourism. However, the views from the village are worth the trip up the windy road.

Gourdon is the last major stop before OCA. The rocky promontories give way to the *Plane de Calern* of craggy mountains as the road rises to an altitude of 1270 meters. Although approximately 25 kilometers from the glitter of Cannes, OCA's location is very isolated as befitting a major observatory which requires excellent viewing conditions. The white domes of OCA contrast with the rugged desolation of the mountainside. The observatory welcomes visitors to tour its facilities on weekends.

OCA's major area of research is determining the exact position and motion of celestial bodies and the development of improved instrumentation and technology. One of its specialties is laser range finding of the moon and satellites. It is the second largest observatory in France. OCA's 200 personnel are divided among the main observatory in Cassouls, a research and office center in Grasse, (the perfume capital of the world), and the old observatory in Nice.

Upon arriving on the *Plane de Calern*, the largest of the domes houses the 1.52 meter Schmidt telescope, which has a focal distance of 3161 millimeters.

A second large telescope is used in laser range finding experiments. The 1.54 meter Cassegrain telescope is used to locate the laser reflectors that were left on the moon by three Apollo missions and on two Lunakhods. A laser pulse is fired through the large telescope and the amount of time that it takes for the signal to return to an array of photodiodes is precisely timed by an atomic clock. The team at OCA has been able to exact distance to the moon with an accuracy of 1.3 millimeters. A similar one meter Cassegrain telescope is used for laser range finding on several satellites that have laser reflectors. The laser range finding activities have provided a vast data on the size, motion and composition of the earth and the moon, which are more fully described in the accompanying article.



The 1 meter satellite laser ranging telescope

In conjunction with its laser ranging, OCA has three cesium atomic clocks that are accurate to within 10 picoseconds (10^{-12} seconds).

One of its functions is to provide extremely accurate time measurement in conjunction with the International Bureau of Weights and Measures. It also has developed new methods using satellite laser ranging of transferring time measurements between two locations so that they are coordinated precisely.

It is a spectacular sight on the Plateau de Caussols when the laser from OCA fire at the moon and at satellites. On many clear nights the rugged mountainside and white domes of the observatory are ablaze with the bright pulses as they are fired at the heavens. Photos of the lasers firing are on the cover page and bildgalleriet.

Although it is more natural to think of white sand and sunshine on the Riviera, OCA during the winter is frequently covered with white snow due to its 1270 meter altitude. The white domes for the telescopes almost give the impression of igloos on the snow covered plateau.



Winter at the high altitudes of OCA

OCA is one of the leading institutions in the development of interferometry and adaptive optics. It has three pairs of telescopes that when their images are combined are equivalent to telescopes that are many times larger. Many of the methods that are used in the European Very Large Telescope (VLT) and the Optical Very Large Array (OVLA) were first pioneered at OCA.

When viewing the GI2T site it is difficult to believe that the almost alien looking array is currently the largest optical interferometer in the world. GI2T stands for Grand Interféromètre à 2 Télescopes, or the Large Interferometer of 2 Telescopes. The large metal jar shaped objects each house a 1.52 meter telescope, which are each about the same size as the laser range finding Cassegrain telescope and the main observational Schmidt telescope.

The two telescopes are housed in the metal jars so that they can be moved on rails along the north south axis to provide a separation of between 13 and 65 meters. Behind the jars are a series of free form concrete cylinders with windows that house offices and work space for experiments involving the interferometer.



The GI2I and the 1.52 m Schmidt

The GI2T has been important in making many strides forward in the development of the science of optical interferometry. Due to its high resolution, it is used extensively to resolve the individual components of very close together double stars. It also is used to study the photospheres of other stars and the gas structures of clusters

Prior to the GI2T, the observatory constructed the petit I2T array which consists of two much smaller 26 centimeter telescopes that can be separated by 140 meters. It is great news to amateur astronomers that OCA has a program in which the smaller interferometer can be used by selected amateurs for their own projects. Some of the photos taken by amateurs with the unique device provide extremely clear views of nebulas. The third array is the Soirdete Interferometer, which observes stars, including red giants, in the near infrared spectrum. It uses two fixed telescopes in a twin domed building that have a fixed east-west baseline. Another important instrument at OCA is a huge astrolabe that is used to find the exact position of stars. The astrolabe has an accuracy of $1/100^{\text{th}}$ of a second of a degree and has cataloged over 120,000 stars since 1989. The astrolabe uses a pool of mercury as the mirror. In addition to all its professional activities, OCA actively promotes amateur astronomy. On the main observatory site, there are several areas for amateurs to set up their own telescopes and take advantage of the superb viewing conditions of the *Plane de Calern*. The observatory regularly offers lectures and conferences on astronomy for the general public.

The Riviera has several other major attractions for amateur astronomers. The old observatory in Nice was designed by Gustav Eiffel. When it opened in 1887 its 76 centimeter refractor was the largest in the world. The Nice Observatory is now part of OCA. The large Romanesque cupola of the Nice Observatory on Mont Gros is visible from the city's many fine beaches.

Along the Grande Corniche on the way from Nice to Monaco, near the walled village of Eze, is Astrorama, a center for amateur astronomy. Astrorama offers observational evenings of the heavens using several 8"-16" telescopes. The center provides a weekly lecture series, many given by astronomers from OCA, and exhibits on astronomy.

After an afternoon touring OCA, the evening can be spent in the sparkle of Cannes about 45 minutes away. In Cannes there is an opportunity for star watching of a different type, especially during its Film Festival, when many movie celebrities and scantily clad starlets frequent the trendy beaches and restaurants.