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# The Canada-France-Hawaii Telescope

*R. Cayrel*

*The 3.6 m telescope of the Canada-France-Hawaii Corporation on the summit of Mauna Kea, on one of the Hawaiian islands, was put into operation last March. This nice instrument, located on what seems to be one of the best possible sites in the world, is presented to the readers of the Messenger by Dr. Roger Cayrel, director of the Corporation.*

Visiting astronomers have now used the Canada-France-Hawaii telescope for 4 months in the prime-focus configuration. It is then an appropriate time to give the first impressions gathered during these initial weeks of operation. Let us first present the telescope which, although fairly similar to the ESO 3.6 m telescope, has a few different features.

## Sky Coverage

The most qualitative difference between the two telescopes is of course that they do not look at the same hemisphere of the sky. There is, though, a fairly large overlapping in particular because of the low latitude of Hawaii (+19°45′). The break-even point where an object is seen at the same zenithal distance from ESO and from Mauna Kea, when it crosses the meridian, is $\delta = -5°$. But taking into consideration also the difference in elevation between the observatories, the declination at which one has equal air mass is moved down to $\delta = -18°$. The extreme limit of observing from Mauna Kea is −60° (10° above horizon) but all programmes below −20° are most efficiently carried out from ESO. It is a fortuitous but agreeable circumstance that the ratio of sky coverage from ESO and from Mauna Kea is more or less in the proportion of the fraction of observing time that French astronomers get on these two facilities.

## Optics

For an optically-minded astronomer (there are still a few) the main difference between the two instruments is that one is a Ritchey-Chretien telescope whereas the other one is not. As the CFHT telescope has been used only at the prime focus, it is not the best time to tell what difference it makes. However, it should be noted that the "naked" prime focus has not been requested very much (this use was the main reason for having a parabolic

## Please Note!

During the month of August, the ESO administration, which was already in Garching, and the Scientific/Technical Group, which until then had been the guests of CERN in Geneva, moved into the just completed Headquarters building in Garching.

The new address for all ESO Services in Europe is now:

European Southern Observatory
Karl-Schwarzschild-Str. 2
D-8046 Garching bei München
Telephone (089) 3 20 06-0
Telex 05-28 282-0 es d

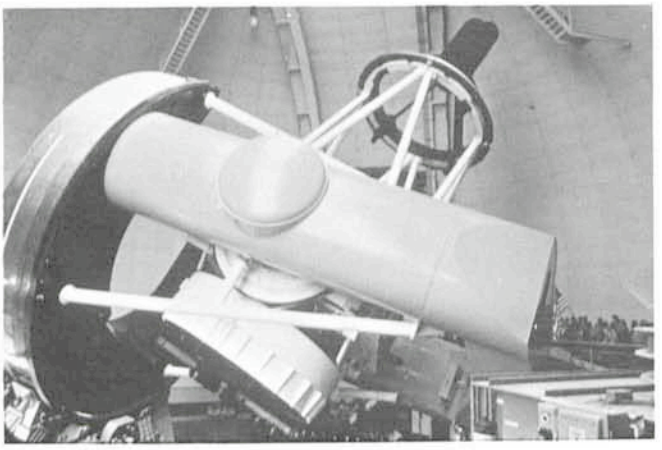

Fig. 1: *Canada-France-Hawaii Telescope, prime-focus configuration (picture taken in 1979).*

primary) whereas the wide-field corrector designed by C. G. Wynne has been very requested and very successful. The corrector gives almost one degree of field with a scale of 72 μm per arc second well suited for IIIa-J, IIIa-F plates or for L 4 electronographic emulsion. So both arguments, widely used during the discussions about classical versus Ritchey-Chretien, have been more or less defeated. One was that the naked prime focus was essential for limiting work, and the other that no good wide-field corrector could be designed for a parabolic primary!

Nothing can be said yet about the Richardson design of the coudé focus (high reflectance coated flats of small size) because it is not yet ready for use.

## Control System and Mechanical Structure

The driving of the telescope at the horseshoe makes the response of the telescope as fast in hour-angle as in declination, even if the inertia involved is three times larger. Typically the response on both axes to a step function signal of amplitude *a* shows just a few strongly damped oscillations which are down to 5% of *a* after 1.6 second of time (so-called settling time). The tracking turned out to be very good. The automatic slewing to a position of given coordinates is not yet implemented.

None of the mechanical problems identified during the shop tests have reappeared on site: they have then been all successfully corrected at La Rochelle in France before shipping the telescope.

The pointing accuracy of the telescope has not been studied yet with full accuracy because one of the defining points of the primary mirror had a problem when we performed the pointing tests. The numbers collected show that after atmospheric refraction is corrected (this is done by the tracking software) there are ±1.′5 of residual corrections which are due to a variety of causes, including flexures of the structure, slight misalignment to the pole, etc. When good reproductible data will be obtained they will be tested by P. Wallace at the AAO for analysis of the causes of pointing errors.

## Exchange of Upper Ends

Both the ESO and the CFH telescope have exchangeable upper ends. The exchange and the access to the prime-focus cage are done with the telescope horizontal at ESO and vertical at the Canada-France-Hawaii. The ride to the prime focus takes 5 minutes at CFHT and the primary mirror cover must be on in order to prevent possible damage resulting from accidental dropping of loose objects onto the main mirror. This is causing a delay which looks long to the observing astronomer, but from another side the telescope remains close to its average observing position, so it is difficult to find a great advantage in one or the other of the two approaches. The handling ring which carries the upper ends from the observing floor to the top of the tube and vice-versa is a fairly delicate equipment, which did have some problems initially.

## Dome

The CFHT dome has no forced ventilation in the double skin but has a thick thermal insulation and, more important, a cooling floor, containing kilometres of pipes with circulating chilled glycol which allows to keep the temperature in the dome through the day a few degrees below the night outside temperature. This cooling floor appears to be a key element in preventing bad dome-seeing. Each time the cooling floor was off, we have observed a very poor seeing.

## Operational Problems and Staffing

Technically the main problem we had was the insufficient size of the unit supposed to dry out the air supplied to the 18 axial supporting pads of the primary mirror. This air which is continuously flowing was condensing water in the system which subsequently was freezing in the pipes and obstructing them. The result was of course a malfunctioning of the supporting system, with excess load on the defining points.

Operationally, we have a very weak point with respect to ESO. Our total staff is sized for a single telescope observatory, so we do not have the possibility to draw people, as needed, from a larger pool as ESO or Kitt Peak can do. So we found very difficult to cope with the triple task of (1) properly supporting visiting astronomers who sometimes come with their own equipment and have needs which have not always been anticipated and tend to overload our logistic capabilities; (2) performing the maintenance of telescope and dome equipment (breakdowns are not rare and replacement of parts is much more difficult on an island than elsewhere); (3) preparing the installation of new foci and of new instruments, with the telescope available an always decreasing fraction of the time.

Our technical staff is made of 6 engineers supervising 14 technicians. This does not allow us to have two technicians on duty every night and we can afford a second technician by night only if the instrument has an unusual level of sophistication. We ask visiting astronomers using the prime focus direct photography to come with a colleague. In such a way that they can take turns in the prime-focus cage, in which it is not too pleasant to stay more than 4 hours in a row.

## Effects of Altitude

The staff going frequently to the summit has a kind of permanent acclimatization and is not otherwise bothered by the elevation of Mauna Kea, except for the unavoidable loss of physical strength and a slight slowdown in the mental activity.

The score for visiting astronomers has been fairly satisfactory, only two visitors out of 21 having experienced serious discomfort. However, there was a kind of epidemy in the mid-level camp at that time, so it is not clear if the origin of the problem was not actually more flu or food-poisoning rather than hypoxia.

### First Scientific Results

The very first scientific result obtained with the CFH telescope has been the resolution by Sidney van den Bergh of the spiral structure of NGC 3928 = Markarian 190 which was formerly classified S0 of E0. As this galaxy appears to be member of the Ursa Majoris cluster, it means that this galaxy is a miniature spiral, likely the smallest spiral ever identified.

New globular clusters habe been identified by Harris around elliptical galaxies (see Fig. 2).

Structures have been observed around QSOs of low redshifts by B. Campbell, one of our staff members.

The satellite of Pluton has been almost resolved in very good seeing by Bonneau and Foy performing speckle interferometry at the prime focus.

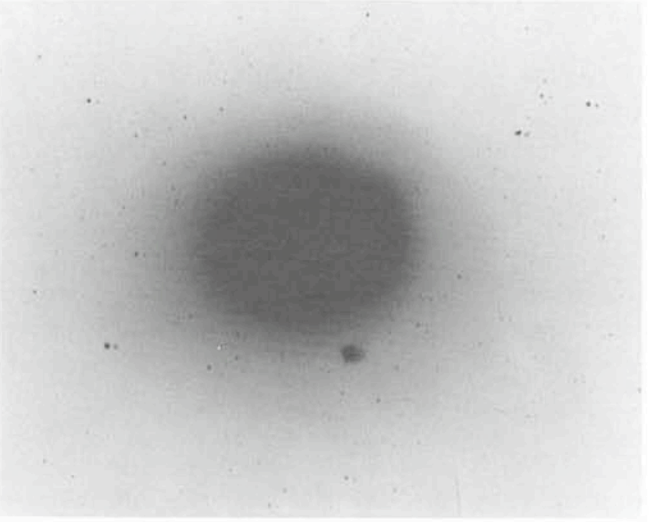

Fig. 2: *NGC 4472. 1-hour exposure on IIIa-J emulsion baked in forming gas. Note the swarm of globular clusters around this elliptical galaxy. The angular diameter of the first stellar images is between 0.7 and 0.9 arcsec.*

### Work in Progress and Instrumentation Status

The telescope is expected to be kept in the prime-focus configuration until October 1980. Available are the photographic assembly, accommodating 160 × 160 mm and 10" × 10" plates, one wide-field corrector for the interval 340-800 nm ($\simeq 1^{\circ}$ field), and one small field (20') corrector for the UV and blue (300-500 nm). Grisms and a Racine Wedge are to come soon now.

The next focus to be put into operation is the coudé focus. It is scheduled for October 1980 with a coudé spectrograph equipped with 2 mosaic gratings (308 × 412 mm), one of them giving 2.8 Å/mm in the bue with the f/7.4 camera and two Richardson image-slicers. As the large spherical camera mirror is not yet available (such as Hindle sphere in testing the secondary f/8) we have replaced it by a small 60 cm mirror large enough for the field of high quantum efficiency modern detectors. The detector available in October will be a 1872-element reticon. Later, a one-piece holographic grating (300 × 450 mm$^2$) will be added.

The next focus to be implemented is likely the f/35 infrared Cassegrain (oscillating mirror). The two main instruments for this focus are already finished or nearly finished and are a photometer with a variable thickness filter (1 to 5 and 5 to 30 $\mu$m) and a Fourier transform spectrometer. The special IR upper end has been recently redesigned and should be available in the spring of 1981.

The availability of the f/8 optical Cassegrain focus depends upon the polishing of the secondary, which is still in progress at the Dominion Astrophysical Observatory in Victoria, B. C. Hopefully, this focus might be operational mid-1981.

Several instruments are planned for this f/8 Cassegrain focus, a faint-object spectrograph also built at D.A.O., a photometer for the visible built by Lyon Observatory and already delivered in Hawaii, a polarimeter built by the University of Toronto (delivery late 1980) according to a design made by Landstreet (University of Western Ontario), and an intermediate-resolution spectrograph built by the Institut d'Astronomie et de Géophysique according to a design made by Baranne (to be delivered in 1982).

In construction at the Laboratoire d'Astronomie Spatiale de Marseille is also an Image Photon Counting System which could be used at any focus of the telescope (delivery late 1980).

We should also mention that we have a Data-Acquisition and Instrumentation-Control System using CAMAC and HP21MX computers that we are upgrading to the F series, to be able to operate under RTE-IV instead of RTE-III.

### Conclusion

The Canada-France-Hawaii telescope is now just starting its "scientific life". The first results obtained on the sky seem to justify the effort of having gone as far as the Mauna Kea in order to obtain optimal observing conditions. As far as we can tell, there is no design mistake in the telescope or in the dome which would cause a significant loss of these natural good conditions. Much work remains to be done to have the telescope equipped with all the instruments which have been planned for it, and the speed at which this work can be done depends critically on the staff power which will be there in the coming years.

# Data Reduction Facilities at Garching

The ESO measuring machines and image-processing system (described in the December 1979 issue of the *Messenger*) are presently being installed in the new building, and will again be available for general use as of November 1, 1980.