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CAPE ASTRONOMICAL ASSOCIATION.

SEVENTEENTH CENTURY ASTRONOMY AT THE CAPE.

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(Paper read before the Cape Astronomical Association on 14th April, 1920).

A Cape Comet.

The first astronomical observation at the Cape of which I have been able to find any record belongs as of right to the founders of the Colony. "Little Thornback" van Riebeek had departed to the East Indies and Commander Zacharias Wagenaar reigned in his stead. The latter is described by Theal as possessing "no ability, either mental or physical, natural or acquired, in any high degree." He was certainly not a great astronomer; neither were his subjects at the Cape acute observers of the heavens, but although the account of the phenomenon is somewhat lacking in astronomical detail we are not left in any doubt as to the cause of the apparition about to be described. The cause was the conduct of the sick-comforter Ernestus Back who was appointed to that office in September, 1663, but who developed too strong an inclination to look upon the wine when it was red. Earthly punishments such as reproof and suspension from office, though repeatedly administered, failing to effect any reform, a higher power seems to have determined to try what a heavenly warning would accomplish. Anyhow, according to the official record "About midnight (of December 14th, 1664), the sky was cloudy and overcast and a star with a darkish ray or tail was seen by us all, which it was said showed itself about three o'clock in the morning much brighter and clearer. The said star had risen in the East and its tail was turned right toward the North."

Here was proof definite enough of Divine Wrath with the whole community if not with one individual. The Commander evidently was not convinced at first that the Sick-Comforter was the sole cause of the awe-inspiring phenomenon, so after due consideration and without undue haste a placaat or proclamation was issued on the 15th of January, 1665, mentioning the comet as a warning and forbidding all company's servants going out into the forests on Sundays without permission. They were further enjoined " to proceed to the hall when the bell is being rung for the third time and there listen to the word of God on pain of " divers punishments. One would think that this would put matters right but the comet still sent forth its nightly warning, so evidently something still remained to be done. Providentially a ship (described as a yacht) lay in the bay getting ready for Batavia, and on the 7th of February the unhappy culprit, together with his family, was " unceremoniously hurried on board." The dispatch to the Governor-General and Council of India which accompanied him states: " Because our God already with his just punishment for our vile conduct now throughout every night for about two months a terrible star with a tail has come into the heavens to threaten us, therefore we have considered it highly necessary to rid ourselves of the aforesaid unworthy sick-comforter and to send him with his family to Batavia in the yacht."

This solution of the problem was undoubtedly the correct one, for we hear no more of the terrible visitor, which, having accomplished the purpose for which it was sent, doubtless departed to other regions on the same kind of business. Be that as it may the purified community at the Cape went on its way rejoicing, though perhaps the worthy Commander sometimes heaved a sigh of relief when, gazing at our glorious skies on a moonless night he failed to perceive another hairy visitor swim into his ken.

This comet is not referred to by Chambers in his " Story of the Comets " or in the catalogues in his " Handbook of Astronomy " unless we identify it with the following entries:—

(1) 1664. Towards the end of this year a comet appeared, and after that two at once; the first was

seen in the S.E. for about two months, the other in the S.W., but their tails were opposite to one another.

The above is quoted by Chambers in his " Story of the Comets " as from Hamel's Travels in Korea and as it stands one cannot say what " the first " refers to.

(2) In catalogue 1, however, of his " Handbook of Astronomy," Chambers gives details of a comet discovered in Spain on November 17, 1664, which was visible for seventeen weeks and of which the orbit was calculated by Lindelhof. Its perihelion point was just outside the earth's orbit and it reached this point on December 4 of that year.

From a rough calculation it would appear that it was at perihelion, near Beta Corvi, and at its ascending node in Gemini soon after the middle of January, 1665. This comet had a tail from six to ten degrees long (that is twelve to twenty moon breadths) and might well terrify the colonists at the Cape if we may consider that this is the same comet. If it be so then it seems likely that it is a periodic comet, for Lecchi discovered one in March, 1853, of which D'Arrest computed the orbit and found a close resemblance to the elements of the one of 1664. Perhaps some Cape astronomer in the year 2042 will observe a return of this heavenly visitor and recall the circumstances under which it was first seen in southern skies. Let us hope that it will not foreshadow any more " deportations."

Père Tachard.

We now come to a more accurate and learned observer in the person of Father Guy Tachard, a Jesuit missionary born in the province of Guyenne, in France. One account of him says that he was inclined by his study of mathematics to a missionary career. The connection is not quite obvious, but there can be no doubt of his zeal and devotion to the great mission work of the Jesuits of that period. He went to the South American colonies in 1680, and remained there nearly four years. He set out for Siam in March, 1685, with the mission sent by Louis XIV to the King of that country. Discovering early in the voyage that the ship actually contained two Protestants he speedily converted them. From Siam he brought back Ambassa-

dors from the King to Louis XIV and had the honour of presenting them to the Pope. Returning to France he set out again in 1687 with twelve other missionaries—" all mathematicians and filled with zeal for the propagation of the Gospel." He went to the Indies yet again in 1689 and ultimately died in Bengal from a disease contracted in the course of his missionary labours. The *Biographie Universelle* says that his style of writing is agreeable, though careless, and the scientific observations, of which his books contain a large number, are exact.

Father Tachard published an account of each of his voyages to Siam and from them I have translated some extracts dealing with astronomy.

He started for Siam early in 1685, as I have said, and the scientific equipment of his party is described thus:—

" They (*i.e.*, the members of the Royal Academy of Science) gave us the Table of the satellites of Jupiter which were compiled with so much labour, and which serve at present to determine longitude. They also presented us with many large telescopes of 12, 15, 18, 25, 50 and 80 feet, some of which we left at the Peking Observatory. . . . . We had made two quadrants, one of eighteen inches radius, the other of twenty-six, three large clocks, an instrument to find at the same time the Right Ascension and the Declination of stars, and an equinoctial dial which marked hours and minutes, and which carried a compass to enable us to find at any hour of the day the declination of the needle. All these instruments were for our astronomical observations."

They also took with them two Roemer machines, one representing the movements of the planets, the other eclipses of the Sun and Moon.

At this point we might pause to consider the state of astronomical knowledge at this date. In England Flamstead had been appointed the first Astronomer Royal in 1675 at a salary of £100 per annum, an amount which is in proportion to the salaries paid in the Union of South Africa to men of literary or scientific attainments at the present day. Out of his own purse he provided most, if not all, of the instruments required, and this was at the bottom of his quarrel with Newton, for he did not consider the latter entitled to demand from him, as a public servant, information which he had acquired largely at his own expense and with private instruments. Flamstead had

published in 1672 a dissertation on the equation of time and as we shall see Father Tachard was acquainted with this important factor in astronomical calculations. Galileo had long before pointed out that longitude could be determined by observations of eclipses of Jupiter's satellites, and J. D. Cassini, who was in charge of the Royal Observatory at Paris, had compiled tables which Father Tachard used. Roemer had noticed that the predicted and observed times of eclipses of the satellites differed, and in 1667 announced that this was due to the fact that light takes about one thousand seconds to cross a space equal to the diameter of the earth's orbit, the observed times being early or late as Jupiter was near opposition or conjunction. Cassini, however, stubbornly refused to accept this theory.

I may mention that Azout and Picard applied telescopes to quadrants about 1667 and that the former invented the movable-wire micrometer; and previous to this Gascoigne in 1640 used a telescope with the quadrant and also used a micrometer. Regarding the size of telescopes, Louis XIV had one with a focal length of 136 feet and Azout one 600 feet long, but Chambers says that he could not use it.

I now proceed to quote from the worthy Father himself.

"As we approached the Line we took pleasure in noting how the stars of the North Pole sank and those of the South Pole ascended in proportion above our heads.

"Of all the new stars which we discovered in the South those which above all struck us the most were those of the Cross, so called because the four principal ones are arranged in the form of a cross. The largest of all is at 27 degrees from the Pole, and it is by this that the navigators are guided, and of which they sometimes measure the altitude.

"As we advanced always in that direction, and discovered every day new stars, we had the leisure to study them, and to compare this new region of the heavens with the astronomical map of Father Pardies, but we scarcely found any conformity therein. This map is in great need of correction, and we may begin with the Cross, the arms of which are more unequal in the sky than on the chart.

"We noticed the Wolf and the Centaur drawn with so little truth that it was difficult to recognise them in the sky. They make the part occupied by them extremely bright by reason of the large number of stars of which they are composed, and which make them appear as a single constellation. But it is very different in the map where the two constellations do not appear as more than mediocre ones.

"The stars of the Southern Triangle are truly placed as regards their positions relatively to one another, but badly placed with regard to other constellations.

"The stars of Taurus are not so bright as they appear in the map, but their disposition is almost the same.

"Grus, in my opinion, is the most correctly mapped constellation of these parts, and it is only necessary to see it once in the map to find it immediately in the heavens. The Bee, Toucan, and Chameleon, though small, are fairly well placed.

"There is also something to correct in the shape and situation of the Magellan Clouds and other southern constellations where one could find other inaccuracies by means of instruments."

He goes on to speak of the motion of the ship preventing the use of instruments.

Before landing with Father Tachard at the Cape I venture to express the hope that the Van Riebeek Society or some other body will translate and publish with the quaint illustrations the whole of his account of the Cape and its inhabitants. I must confine myself to his astronomical observations.

The party reached Table Bay early in June 1685, where they were hospitably received by Hendrik Adriaan van Rheede tot Drakenstein, Lord of Mydrecht and High Commissioner of the Chamber of Seventeen to the East Indies (who was inspecting the Cape Settlement) and the Commander, Simon van der Stel. Permission to land and make observations was readily granted. Rejecting a suggestion to disguise themselves on account of the low esteem in which Jesuits were held by the Dutch Protestants, two of the Fathers went boldly to the Commissioner to explain the object of their visit. They explained that

"We had taken on board several mathematical instruments proper to the finding of the true longitude of places we might visit, without need of eclipses of the moon or the sun. We explained the new method of observing the satellites of Jupiter, of which the learned M. Cassini has made such fine tables. I added that we should do a great service to their navigators in giving them the certain longitude of the Cape of Good Hope, which they only knew by calculation; a doubtful method, and one which often deceived them very considerably.

"He said that we gave them great pleasure, and that since we wished to work at this discovery he would give us a suitable place for observations."

I may mention that the Fort referred to in the following account is the present Castle and the site of the observatory is where the old Supreme Court Buildings now stand.

Longitude of the Cape.

Father Tachard says:—

"At the entrance of the garden they have built a great house, where the slaves of the Company live. They say that there are five hundred there, some of whom are employed in cultivating the garden, and the rest in other necessary duties. Towards the middle of the wall, on the side which looks toward the Fort, there is a small pavilion, which no one inhabits; the lower story contains a vestibule, open both towards the garden and the Castle, which has two rooms on each side.

"Above, there is a room open on all sides between the two terraces, paved and bricked, surrounded by railings, one terrace looking toward the North, the other the South. This pavilion appeared to have been made expressly for our purpose, for on one side one can behold the whole North, the view of which was above all necessary for us, because at that place it corresponds to what the South is to us.

"While they were making this pavilion ready we returned on board to report to the Ambassador and our Fathers all that had taken place.

"The next morning the Commissioner and the Commander sent on board all sorts of supplies. The officer in charge of these told us that these gentlemen had also sent us a boat to carry our mathematical instruments.

"As we had got ready during the night those of which we believed we should have need we put these in the boat, and repaired to the Observatory on the 2nd June, 1685.

"A clock made at Paris by Thuret, having been set to an hour near to that which might be the correct one without our knowing it exactly, we commenced the following observations:—

"The first satellite appeared that evening elongated to a distance a little less than Jupiter's diameter, at three minutes past eleven by the clock, which had not yet been corrected.

"Two parallel belts were seen on Jupiter, through the telescope, one very large towards the South limb, and the other further towards the North.

"The first satellite commenced to touch the limb of Jupiter at 11 hours 57 minutes 30 seconds, and we could not see it any longer at 11 hours 58 minutes 30 seconds.

"These observations were made with an excellent twelve foot telescope belonging to (or made by) the late Mr. le Bas; the times are always those of the uncorrected clock.

"We continuously observed Jupiter until 2 hours 5 minutes after midnight, at which time it became hidden behind the Lion mountain, which bounded the view on the Western side, so that we could not see the emersion of the first satellite that day."

I have referred these observations to Mr. Reid, who very kindly writes as follows:—

"On the whole I think the observation you quote would be an accurate one: it takes a considerable time for a satellite to disappear after first contact. Regarding the time occupied behind Jupiter this is also correct. I don't think whatever the position of the satellite it would be possible for it to appear in the time mentioned.

"Of course, both observations vary according to the position of the satellite with regard to Jupiter. . . . At the time of the observation given in your letter Jupiter must have been near quadrature."

To resume quotation from Father Tachard:—

"The 3rd June, 1685.

"To verify the time of the clock.

"Altitudes before Noon.

deg.	min.	sec.	Time by the Clock. hrs.	min.	sec.
20	16	0	9	35	38
22	56	20	9	*34	47
24	11	0	10	4	50
24	39	55	10	8	48

* Read this as 54 mins.

"Altitudes after noon.

			Time by the clock.		
24	39	55	0	(Observation	missing)
24	11	0	2	50	19
22	56	20	2	57	40
†0	26	0	3	16	38

† Read 20 deg. 16 min.

"These observations were made with a quadrant of eighteen inches radius, made at Paris by Butterfield.

"It should be remarked that these altitudes of the sun were not taken of the same limb; in the morning we took the altitude of the upper limb and in the afternoon that of the lower limb only. It is necessary to be careful (regarding this).

"For the variation of the compass.

"By Butterfield's equinoctial quadrant, which carries a large compass under its meridian.

"The variation of the compass was found to be eleven and a half degrees north-west.

"In the evening, having no particular observations to make, we studied different stars with the twelve foot telescope.

"The foot of the cross marked in Bayer is a double star; that is to say, composed of two bright stars elongated the one from the other only about their diameter, like the more northern of the Twins, without speaking of a third much smaller one, which one also sees there, but further off from these two.

"There are many places below the Cross, in the Milky Way, which with the telescope appear filled with an infinity of stars.

"The two Clouds which are near the South Pole do not appear a cluster of stars, like Praesepe Cancri, nor even a dull light like the nebula in Andromeda. One sees almost nothing with large telescopes, but without a telescope one sees them very white, especially the large cloud.

"Nothing in the heavens is so beautiful as the constellations of the Centaur and the Ship. There are no bright stars near the Pole, but there is a quantity of little ones.

"Bayer and other writers who mention them omit many of them, and the greater part of those they do mention do not appear in the heavens in the same situation.

"The 4th of June, 1685.

"To verify the time of the clock.

"Altitudes before noon.			Time by the clock.		
deg.	min.	sec.	hrs.	min.	sec.
22	23	0	9	50	47
23	31	50	10	0	32
24	37	30	10	9	$18\frac{1}{2}$
25	53	20	10	20	29
"Altitudes after noon.			Time by the clock.		
25	53	20	2	32	33
24	37	30	2	43	38
23	31	50	2	52	47
22	23	0	3	1	$38\frac{1}{2}$

"The horizontal thread of the telescope was not altogether parallel to the horizon We always tried during the verifications of the clock to remedy this by making the limb of the Sun pass by the same part of the thread.

"We had always to take care that these were the altitudes of different limbs of the sun, in the morning the upper limb and in the afternoon the lower.

"On Monday, after dinner, we visited the Fort, to see the gentlemen, and to give them an account of the observations made by us, and of those which we intended to make that evening by which only we could determine the true longitude of the Cape.

"On our return all these gentlemen wished to come with us, to be eye-witnesses of the observation. We were together on the terrace, occupied in showing them our instruments, which they found very fine and curious, when we perceived the Ambassador, who, having come *incognito* to walk in the garden the evening before, found it so agreeable that he had returned to-day, and was walking about, accompanied by the greater part of the ships' officers and the gentlemen of his suite.

". . . . The Commissioner, with Messrs. St. Mâstin, Van der Stel and Botheros, remained with us in the observatory until 10 p.m. The emersion of the first satellite took place at 10 hours 5 minutes 40 seconds by the uncorrected clock.

"We took the meridian line on the northern terrace and the meridian altitude of the Sun, but we did not wish to use them, since the operation was not certain enough.

"After the emersion of the first satellite from the shadow of Jupiter, having compared the observations of the altitudes of the Sun taken in the morning and afternoon of the 3rd and 4th June, and having compared the difference of the times between the same altitudes of the upper and lower limbs of the Sun (as we had observed the upper limb in the morning and the lower limb in the afternoon), we found that the clock was in advance of the Sun each day by twenty-eight minutes."

It is to be regretted that Father Tachard does not give details as to how he arrived at the error of his clock. At first sight it would appear to have been done on the method of equal altitudes, but as he reiterates that he took the sun's upper limb in the morning and the lower in the afternoon the altitudes

were not equal at all, in fact they differ by the diameter of the sun, viz., 31 min. 34 sec.

Then again we do not know whether he took into account the increase of the sun's northerly declination which in the time between his first and last observation would amount to about 1min. 45 sec.

Furthermore, the average error of his clock taking his times as those of observation of equal altitudes and including the equation of time which we must presume he understood and applied amounts to 28 minutes 31 seconds without taking into consideration the change in the sun's declination, but he records the error as being 28 minutes.

To resume

"At the moment of emersion of the first satellite the clock showed 10 hrs. 5 min. 40 sec., from which must be deducted 28 minutes. There remains the true time of the observation, 9 hrs. 37 min. 40 sec.

"The ephemerides of M. Cassini calculated to minutes gave the time of this emersion under the meridian of Paris as 8 hours 26 minutes; but the tables of eclipses calculated to seconds gave the same emersion as 8 hrs. 25 min. 40 sec. This being reduced to the time observed at the Cape of Good Hope gives 9 hrs. 37 min. 40 sec.

"There remains the difference of the meridians of the Cape of Good Hope and Paris of 1 hour 12 minutes, which makes 18 degrees of difference of longitude, and having supposed the longitude of Paris, taken from the first meridian which passes through the island of Ferro (the most western of the Canaries), to be twenty-two degrees and a half, the longitude of the Cape of Good Hope, taken from the same meridian, will be forty degrees and a half, but little different from that which modern charts give it.

"On the morning of Tuesday, 5th June, at ten o'clock, the gentlemen came to the observatory, and remained there until 2 p.m., to see us take the altitude and the distance of Table Mountain, and to examine our instruments

"We showed them particularly the use of the equinoctial quadrant, by means of which we again found this day the variation of the compass to be 11 degrees and a half N.W.

'We can take two advantages of these observations. The first is the variation of the compass, which we found with the astronomical circle to be 11 degrees and a half from N.W., and the second the true longitude of the Cape, which we checked by the emersion of the first satellite of Jupiter, which should have taken place at 8 hours 26 minutes at Paris, and having been observed at the Cape at 9 hours 27 minutes 40 seconds in the evening gives 1 hour 12 minutes 40 seconds of difference between the meridians of these two places, which, reduced to degrees, is 18, and in consequence the charts are in error, and

show the Cape too far to the East by more than 3 degrees, which in reality it is not."

Now this account raises three interesting points. First of all as to the method of ascertaining the longitude; this, as I have already mentioned, was pointed out by Galileo early in the seventeenth century. It may be explained that difference of longitude is simply a difference of time, consequently if you know the correct time of the place where you are and the correct time of some other place at the same moment you know the difference in the two longitudes. Consequently Pere Tachard, having found his clock error, and observing, as he thought, the correct time of emersion from eclipse of Jupiter's first satellite, and also knowing from the tables supplied to him what the time was in Paris at that moment, was in a position to determine the difference in longitude of the two places. Unfortunately for some reason or other he was in error eight minutes six seconds, for the difference between Paris and Capetown is not 1 hour 12 minutes 40 seconds, but 1 hour 4 minutes 34 seconds. How this error comes about I am unable to explain, but the worthy Father is somewhat like the early philologists who were reputed to take very little notice of vowels and less of consonants, for he takes no notice of minutes or seconds of time. Thus he speaks of 1 hour 12 minutes 40 seconds as being equal to 18 degrees, whereas it is equal to 18 degrees 10 minutes and the difference between Capetown and Ferro as 40 degrees 30 minutes, where his own reckoning makes it 40 degrees 40 minutes.

The reference to Ferro raises another interesting point. Ptolemy in 150 A.D. had fixed " the most western of the Fortunate Islands " as a zero meridian and in 1630 a scientific congress in Paris summoned by Cardinal Richelieu had decided to accept this island (Ferro) of the Canaries as a convenient starting point from which to reckon. Unfortunately, however, the longitude of Ferro came to be regarded as 20 degrees west of Paris, but its real longitude (taking the meridian of Punta Dehesa, which it is believed Ptolemy intended) is, as nearly as I can measure it on a large scale map, 18 degrees 8 minutes west of Greenwich or 20 degrees 28 minutes 15 seconds west of Paris. But Father Tachard does not even take the 20 degrees

measurement; he takes Ferro as being 22½ degrees west of Paris, being over 8 minutes of time in error. This, however, does not account for his error as regards the longitude of Capetown which he reckons from Paris.

The third point has to do with the variation of the compass, and regarding this I quote from Theal:—

"Where the Portuguese first doubled Africa the needle was found to be without variation at Agulhas, from which circumstance the Cape received its name. . . . . Christopher Columbus, who found a point of no variation 2 degrees and 30 minutes east of Corvo was the first to suggest that the position of a ship at sea might be known by means of observation of the compass. . . .

"Calculations of longitude based upon the variation of the compass are frequently found in the old log books, though the experience of nearly a century showed they were in most instances valueless."

Father Tachard refers to this "very accurate" method of determining longitude.

Second Visit to the Cape.

On the 7th June the mission left Table Bay for Siam, presenting the Commander with a microscope and a burning glass in recognition of his hospitality. A few years later Louis XIV also sent the Commander a gold chain and medal and his portrait, in return for kindness shown on this occasion, as well as in 1686 when the mission from the King of Siam was wrecked near Agulhas, and again in 1687 when the second French mission called here. The Chamber of Seventeen did not at all approve of Van der Stel's acceptance of this present.

The mission arrived safely in Siam and in the early morning of 12th December, 1685, the Fathers observed a total eclipse of the moon. Father Tachard gives a detailed description of this, but it is too long to quote here. He determined the longitude of the place of observation as 121 degrees 2 minutes east and says that the charts give it as 145 degrees.

Nothing daunted by the hardships endured the zealous Father left France again early in 1687 and we find him at the Cape once more in June of that year. On the voyage out he says:—

"I observed with the parallactic instrument, the declination and R.A. of many stars towards the South Pole, which we could not observe in Siam. As all these stars are very badly

charted, or are not found at all on the globes and celestial charts which have appeared up to the present, I have resolved to make one, which I have already commenced, and which will, if I am not mistaken, be much more exact than all the others. . . . I dare to say to you that I make light of the knowledge of the stars in the situation which they are placed by all the Uranographers up to now, as regards the South, which does not give place to the North in either the number or the beauty of its stars.

"We must correct the larger Magellanic cloud, and still more the small one. The Cross, the Bee, the Triangle, the Centaur, the Chameleon, Grus, and the Milky Way are badly charted, or have stars omitted from them. As for the ship Argo, half of the brightest stars which compose it are not even marked on the celestial charts.

"In addition to all these faults there remain many bright stars which can be seen in France, but which are not quite correctly placed, since we always see them at a great elongation and too near the horizon.

"Father Richard . . . . has endeavoured to fix more correctly in their places four or five constellations, of which I send you the calculations, which he promises to render still more exact with instruments and reiterated observations.

Partial Eclipse of the Sun.

"M. Cassini advised us before our departure that there would be an eclipse of the Sun on the 11th May, and that it would be total at Cape Verde Islands and in Guinea.

"We did not take the trouble to calculate this on the voyage, since we expected to be at that time at the latitude of the Cape of Good Hope, where we believed the eclipse would not be visible, on account of the latitude of the Moon appearing to us to be too far South. But the Siamese ambassadors having heard something, and as they are curious to the point of superstition regarding this sort of phenomenon they asked us at the commencement of the month if they could not view the eclipse with our instruments. We let them understand that we did not believe that it would be visible in the locality we should be in, but failed to content them with our explanations, which did not satisfy them at all, since they did not understand them sufficiently, and . . . . prayed us for the love of them to calculate it.

"Father Comilh undertook this work, by which he was much inconvenienced during the voyage, and for five or six days he gave all the application which this great and very difficult calculation demands.

"His work became more agreeable to him when, contrary to what he had assumed, he found that the Sun would be eclipsed materially at a latitude not far from 23 degrees South and at 358 degrees of longitude, about where he judged we should be at that time.

"The day having arrived, the Father showed a figure in cardboard, on which one could see the Sun coming nearer and nearer behind the Moon, and which explained exactly what one could see in the heavens during the eclipse, and this gave great pleasure to the Siamese ambassadors, who conceived a great opinion of our astronomy.

"They said that the Sun must have been in communication with the Father, and told him what could happen, for he had been so exact in predicting the smallest details. They remained a long time on deck, informing themselves constantly of the hour and minute named in the calculation

"We had mounted some small clocks with minute hands for the noon observation, which the pilots had made the previous day, but as their time was not exact we did not wish to use them.

"We endeavoured to observe the eclipse with telescopes of two or three feet in length, but the motion of the vessel gave us so much trouble that we were obliged to give this up entirely, and to content ourselves with red or smoked glasses, which we used during the whole of the rest of the eclipse.

"As the other vessels approached us from time to time during the long voyage to obtain news we informed the Fathers in the other ships when they approached us that they would see the eclipse of which M. Cassini had spoken.

"This compelled Father Richard, who had gone to much trouble . . . . . to check his calculations during the few days which remained before the 7th May

"He gave so much attention that he was convinced by himself of what he would never have wished to believe. As a matter of fact, on the very day of the eclipse, an hour before it happened, he called out to us that he had verified it. I have thought it proper to report this, of which he has spoken in his diary.

"The eclipse of the Sun was visible to us on the 11th May, when we were at about the latitude of 23° S. and 357° of longitude counting the first meridian from the island of Ferro. The commencement was at 8 o'clock in the morning and about 58 minutes. The middle was at 10 o'clock and the end at 11 o'clock.

"The body of the Sun appeared covered to the extent of 5 digits, and since the latitude of the Moon was then effectively south *l'aparente* was north, since the Moon eclipsed the lowest part of the Sun; that is to say, the part nearest the horizon.

"I wished to make use of a two foot telescope with white pasteboard (making a right angle to the length of the telescope prolonged), to receive an image of the eclipse, but the continual movement of the ship prevented me from noting, except by the eye, the above-mentioned extent of the eclipse.

"That is all I think necessary to say regarding the observation which, as well as satisfying the curiosity of the Siamese ambassadors, and being useful to disabuse their minds of the gross fables which they believed concerning it, served also to confirm the navigators in their opinion of the longitude which was found correct on our arrival at the Cape."

During his short stay at the Cape Father Tachard was very busy. He says:—

"It is true that our time was so occupied and so inconveniently that it was only with incredible pains that we observed two emersions of the first satellite of Jupiter, of which Father Richard speaks, on the 19th June. The same satellite, after having disappeared some time before, was observed to reappear at 11 hours 55 minutes in the evening On the 21st following I

observed its emersion at 6 hours 25 minutes in the evening. Combining the times of these two emersions with those made for Paris in the Ephemerides of M. Cassini, viz., 10 hours 25 minutes and 5 hours 3 minutes, the difference of longitude between Paris and the Cape will be 2 degrees. (Obviously misprint for 22 degrees.)

"It is true that the 14 foot telescope was not altogether well stayed, and it having some movement I fear that the real emersion preceded by some time the time I observed, but this could only be a minute or two at the most."

To comment upon this "exact" observation would be to spoil it!

Before passing to the final observation of Father Tachard's I should like to express my indebtedness to H.M. Astronomer and the staff of the Royal Observatory, and especially to Mr. Pilling, for assistance, and for the loan of lantern slides and the book from which the slides showing seventeenth century instruments were made; also to Mr. Reid, for the great trouble he has taken in making the lantern slides, and to Mr. Long for his help in that work. I am also indebted to Dr. Lunt for the loan of some lantern slides.

The following observations were made apparently in the Bay of Cassomet, near Chantabun, in Siam, the longitude being 102 degrees 30 minutes east and the latitude 12.30 north, both approximately. This is a far cry from the Cape, but I include it because of its interest and because it has apparently been entirely missed by Chambers and other compilers of cometary records. The year is a little uncertain. It is either 1687 or 1688, but Father Tachard is rather inconsistent about his records. I am almost certain however that it is the former year.

"The Pilot of the vessel told us on the 19th August (must be a misprint for 16th) that he had seen that morning a comet towards the South-East. He said that it had a long tail scattered, and of medium brightness. On the 17th we discovered it about 4 o'clock in the morning, between the many clouds which covered the sky, and prevented our seeing the smaller stars.

"The head of the comet appeared to me as large as stars of the first magnitude, and to one of the Fathers who observed with me as those of the second, but much less illuminated.

"With a two and a half foot telescope one could see it as a cloud very plainly. It made a large isosceles triangle with the foot of Orion, called Rigel, and the bright star of the Big Dog, named Sirius. Moreover, it made a little isosceles triangle with Sirius, and the foot of the Big Dog, called in Bayer B. It was also in a straight line with Sirius and Canopus. The tail

touched the star of the hare (Lepus), which Bayer calls Z, and passed over that which he calls N. We saw it at the first of these two stars, altogether of a worn out colour. This was all we could see in the dusk. The heavens were always covered. On the 18th we only observed it for a moment; on the 19th, at 5 a.m., through the clouds, on taking a straight line from Sirius to Procyon, it remained below that about half a degree to the East.

"It made beyond this a true isosceles triangle with Rigel and the right shoulder of Orion, named P. by Baver.

"The tail we could not see, because of the clouds.

"The 20th, the comet appeared in another place, but the bad time and the twilight prevented us from making its position, and we judged that we should have trouble in observing it to advantage, for it was approaching the Sun.

"The 3rd of August the sky was well exposed at 5 a.m., and we devoted our leisure to watching it well. The head appeared at least as bright as the bright star of the little dog and of a very clear brilliancy, which was remarkable, it being very close to the horizon.

"In a $2\frac{1}{2}$ foot telescope, this being the only one which we could use on the vessel, the comet appeared like a cloud, very sparkling, principally in the middle. It was in a straight line, drawn from the left shoulder of Orion, which is of the first magnitude, and through the middle of the two stars of the little dog named Procyon and that of the Col, and also in a straight line with the southern claw of Cancer, which Bayer calls B, and with the shoulder of the Twins, which he calls X.

"The tail made a line perceptibly parallel to the southern claw of Cancer and to Procyon. It was far from reaching this last star. In comparing this observation with the first, one sees that the comet had passed from the southern part of the sky to the north, and that it cut the equator in the third degree of R.A. (an obvious error). The 26th we could not find it at all in the heavens.

"Its journey apparently took it right into the Sun."

Dr. Halm very kindly undertook to compute the orbit of this comet, but upon trial found the data insufficient.

If my readers have been half as interested in the observations of this pious and devoted astronomer missionary as I have been in translating him they will join me in the hope that he will now be immortalised in astronomical records as the discoverer of Tachard's Comet.

(*Note*.—Since this article was written I have found earlier astronomical observations in South Africa. Regarding Tachard's altitudes, it is likely that his observations are given as reduced.)

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