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New Delhi	12-17-10				56

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INDIAN POSTS AND TELEGRAPHS DEPARTMENT.

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INDIA METEOROLOGICAL DEPARTMENT.

MEMORANDUM.

No.XR21

New Delhi, the 13¹² December 1945

The Planning Committee for Astronomy, formed by the Government of India, and consisting of the following will assemble at Kodaikanal Observatory on 21st, 22nd and 23rd December 1945:-

1. Prof. M.N. Saha, D.Sc., F.R.S., F.R.A.S.B., F.N.I., Chairman
2. Prof. A.C. Banerji, M.A., I.E.S., F.N.I.
3. Prof. K.S. Krishnan, F.R.S., D.Sc., F.N.I.
4. Prof. S. Bhagavantam, Hon. D.Sc., F.N.I.
5. Prof. D.S. Kothari, M.Sc., Ph.D., F.N.I.
6. Prof. M. Ishaq, M.A., M.Sc., Ph.D., D.I.C., F.N.I.
7. Rao Sahib T.P. Bhaskara Sastri, M.A., F.N.I.
8. Dr. A.L. Narayan, D.Sc., F.N.I.
9. Dr. S.K. Banerji, O.B.E., D.Sc., F.N.I.

2. The following are the terms of reference:

(a) Preparation of a post-war plan for astronomical and astrophysical observatories in India. (Draft post-war plan has been circulated with Dr. Banerji's D.O. No. XR21 dated 1st December, 1945).

(b) Stages in which the proposed development of Kodaikanal Observatory should take place.

(c) The programme of work at Kodaikanal Observatory during the next five years.

(d) What staff Kodaikanal Observatory should have, their scales of pay and how they are to be recruited.

3. Government of India have sanctioned payment to each member of the Committee (excepting Dr. Narayan) Travelling Allowance and Daily Allowance admissible to Class I officers of Government from their place of residence (or place of duty) to Kodaikanal Observatory and back.

4. Accommodation of the members is being arranged in the Kodaikanal Observatory by Dr. Narayan.

5. Members are requested to arrive at Madras (Egmore) station to catch Trivandrum Express leaving at 7.30 p.m. on 20th December, 1945 at the latest.

6. A copy of provisional agenda is enclosed.

V. K. Raman
Director General of Observatories.

Prof. K.S. Krishnan, F.R.S., D.Sc., F.N.I.,
Professor of Physics and Head of the
Department,
Allahabad University, Allahabad.

Agenda.

21st December 1945.

At 12 Noon I.S.T.

Preliminary meeting to discuss the post-war plan.

22nd December 1945.

0900 - 1200 hrs.

Members will be shown the work done in Kodaikanal Observatory.

1430 - 1600 hrs.

Discussion of items in the agenda relating to Kodaikanal Observatory.

23rd December 1945.

0900 - 1200 hrs.

Final discussion of the post-war plan and signing the agreed plan.

Telegrams: METEORS, NEW DELHI.

Regtd.



D.O. No.XR21

Meteorological Office,

Lodi Road, New Delhi,

Poonah 5 (India), the 13th Aug. 1945.

My dear Prof. Krishnan,

Re Post-war plan for Astronomical and
Astro-physical observatories in India.

Encl:
Refd.to.

The question of post-war plan for Astronomical and Astro-physical observatories in India has been under discussion with the prominent scientists in India for sometime. In this connection I was anxious to have your views but unfortunately we have not met for sometime. Based on the communications received on the subject and also views expressed by the different scientists, a draft post-war plan has been prepared by me. A copy is enclosed.

2. I shall be obliged if you will kindly let me know whether you are in general agreement with this plan. Any remarks which you may wish to make on this subject will be helpful in drafting the final plan before it is submitted to the Govt. of India.

3. If no remarks are received by 15th September, 1945, I shall assume that you have no remarks to make.

Yours sincerely,

S. K. Banerji

(Dr. S. K. Banerji)

Prof. K.S. Krishnan, F.R.S., D.Sc., F.N.I.,
Professor of Physics and Head of the Dept.,
Allahabad University, ALLAHABAD.

Astronomical and Astrophysical Observatories in India.

Post-war Plan

1. General.

Astronomical studies have been encouraged by the King from time immemorial. Astronomy makes a great appeal to the people in this country. The United Kingdom has its Astronomer Royal, and India should have its Astronomer Royal.

In India, there are at present only two astronomical observatories, the Solar Physics Observatory at Kodaikanal and the Nizamiah Observatory at Hyderabad.

Considering the size of the country, several more astronomical observatories could usefully be maintained in India, but no institution of this kind can prosper unless qualified men are available to run them. India has a good number of theoretical astrophysicists but there are very few who have the necessary experience of modern astronomical observations and measurements. Therefore, before multiplication of astronomical observatories is contemplated, we should have men trained in astronomical methods in astronomical observatories of U.K. or U.S.A. In the post-war, it is desirable to plan the establishment of a third astronomical observatory somewhere in Northern India. Astronomy is one of those subjects in which India has taken keen interest for centuries, and made its own contributions.

Astronomical observatories of smaller types should, however, be available for practical training of students who go through post-graduate course in astronomy. There are very few observatories even of this kind in India, with the result that students read Astronomy without even making simple astronomical observations or measurements.

A carefully worked out plan, fully framed and detailed estimates and an attractive set-out of the whole is the first desideratum for any observatory. The second is the certainty of having personnel capable of setting up and making the utmost use of the apparatus.

2. Present position.

To-day, there are only two active astronomical observatories in India, the Solar Physics Observatory at Kodaikanal maintained by the Government of India and the Nizamiah Observatory at Hyderabad maintained by the Nizam's Government. There are transit instruments at the Alipore Observatory, Calcutta and the Colaba and Alibag Observatories, Bombay for determining time. A few small telescopes are maintained in varying degrees of efficiency at colleges of University rank scattered over the country. Individual Professors in Universities have studied and made fundamental contributions to theoretical Astrophysics but there is no observatory in the country where a physical study of stars with modern appliances is systematically pursued.

The Nizamiah Observatory specialises in astrographic work — which includes the determination of the positions and relative intensities of stars in defined zones. It has recently started work on proper motions of stars. Its programme also includes the systematic observation of many long-period variable stars and occultations of stars by the moon.

The work of the Kodaikanal Solar Physics Observatory, as its name implies, is mainly on Solar Physics. Its present programme includes the preparation of daily photo-heliograms (diameter 8"), of photographs of flocculi in K and H α light

and of prominences in calcium light (sometimes in $H\alpha$ light also) with the spectro-heliograph. Visual observations of the sun with Hale's spectro-heliograph and observations of metallic and other lines in prominences and on the disc are also included in the programme. In 1922, the International Astronomical Association allotted to Kodaikanal the task of collecting from all contributing observatories the photographs of solar prominences and of the sun's disc in $H\alpha$ light. In accordance with this, Kodaikanal Observatory systematically collects and publishes the data. Special studies include at present spectro-photometric work on selected lines in the solar spectrum in the disc and on the limb and laboratory work on spectra.

The discovery of the out-flow of gases above sunspots (Evershed Effect) and of the relativity shift of spectral lines made the Kodaikanal Observatory famous. Although the general activity of the observatory has been maintained since Mr. Evershed's time, it cannot be said that the observatory has grown. There has been some small additions to the equipment but none made with a view to extend the general lines of work pursued at the observatory.

5. Plan for Development.

The general consensus of opinion is

(1) that there should be two astronomical observatories, one in South India and one in Northern India, fully staffed and fully equipped.

This means Kodaikanal should be fully equipped and fully staffed for solar studies and also general astrophysical work. Another station is to be started at a suitable locality somewhere in Northern India, and is to be fully equipped and staffed for work on stars generally. Both stations should have good workshop facilities.

(2) That universities are to be granted funds for providing astronomical observatories of smaller types.

(3) That a few selected candidates should be sent, for getting special training in modern astronomical work, to France (Pic du Midi), Britain (Oxford) and to U.S.A. (Mt. Wilson, Mount Hubble and Yerkes).

We shall divide the scheme for development into three stages,

(1) the improvement and modernisation of the Kodaikanal Observatory so that it can take, and maintain to take, a leading place among the Solar Physics Observatories of the world and its further development into a first class Astronomical and Astrophysical Institute;

(2) the establishment of a second Astronomical and Astrophysical Institute somewhere in Northern India. This should be at a place where good seeing conditions prevail for a fair part of the year and be within reasonable distance of a University centre; and

(3) encouragement and help to Universities to start and maintain small astronomical observatories so that students who have a natural taste for the subject can get an opportunity to develop it.

4. Development of Kodaikanal Observatory.

Before we consider what additional equipment and staff should be provided at Kodaikanal, it is well to consider the lines in which development is desirable. The actual line of progress will largely depend on the Director. The question whether astrophysical studies of stars should be undertaken at Kodaikanal is a debatable point. The points in favour of Kodaikanal are: Being near the Equator, southern skies are more accessible than in Europe, North America or other places in India. Although "seeing" conditions in the afternoon are of moderate quality during a large part of the year, the conditions at night may be expected to be definitely good. There will grow up an atmosphere of work about the place, and Solar Physics and Astrophysics will react on each other to their mutual benefit.

In the following, only the additional equipment for Solar Physics work is considered.

Desirable developments in the field are:

- (1) Obtaining motion-pictures of prominences and solar flares.
- (2) Systematic studies of the solar corona with a coronagraph of Lyot's type.
- (3) Study of the general magnetic field of the sun and the field near sun-spots.
- (4) Study of the solar spectrum in the infra-red and the ultra-violet.
- (5) Studies of turbulence in the solar atmosphere --- granulations, spikes, etc. and their time-variations.
- (6) Critical studies of changes in selected solar absorption lines before and during magnetic and auroral disturbances.
- (7) Such other items as may be added from time to time.

Staff and Equipment.-

To plan the details of the development and carry it out, the first requisite is suitable Senior staff. We should take immediate action to appoint a successor to Dr. A.L. Narayan and associate him in planning the development. Of the two officers, Director and Assistant Director, one at least should be a good Physicist with a sound knowledge of optics and instrumental technique and ability to guide workshop and mechanical engineering work on sound lines. The other should be a good Theoretical Physicist with a bias for Astrophysics, which of them will be senior will depend on the relative abilities of the two. The primary equipment needed is the securing of two such men.

Instrumental Equipment.-

This follows the lines of desirable development.

- (1) In addition to the 20" reflecting telescope, parts of which are already available in Kodaikanal, there should be a 16" Photographic refractor on equatorial mount with an astro-camera and an 18" Schmidt type telescope mounted on the 20" reflector and having a focal ratio of 1:2.

(2) Also a modern all-purpose reflecting telescope of the Oxford Solar Telescope type with fused quartz, aluminised mirrors and spectroscope (please see Appendix). Aperture of main mirror to be 12" to 15" should be obtained. This will be useful for infra-red and ultra-violet studies, for planetary studies and for studies of solar turbulence.

(3) Motion-picture equipment for spectroheliograph.

(4) Lyot's Coronagraph with polarising monochrometer. (See Astrophysical Journal, 1944.)

(5) High dispersion instruments (like Lummer plates) and polarisers for studying weak magnetic fields.

(6) Photo-electric and other electronic equipment as required.

(7) Calculating machines.

The cost of the additional instrumental equipment is estimated to be about Rs.1,80,000/-

Telescopes, etc.	Rs. 80,000/-
Motion picture equipment	5,000/-
Coronograph	20,000/-
Equipment for studying work magnetic fields	10,000/-
Calculating machines	2,000/-
Miscellaneous equipments, camera, photo-electric cells, galva- nometer, and other electrical equipment	25,000/-
Workshop Equipment	40,000/-
Total	<u>1,80,000/-</u>

Buildings.-

An observatory building for housing the solar telescope and coronagraph will have to be built. It is best to get mountings for solar telescope from instrument makers like Grubb Parsons & Co. The estimated cost is Rs.20,000/-

Scientific Staff.-

Professor of Astrophysics and Director	1	} Gazetted
Senior Astrophysicists	2	
Junior Astrophysicists	2	} Non-gazetted
Assistants	5	
Mechanical Assistant	1	
Photographic Assistant	1	
Mechanics	2	

Inferior servants

It will be necessary to send out the Physicist-cum-Engineer Officer to France (Pic du Midi) and Britain (Oxford) and if possible also to U.S.A. (Mt. Wilson, Mount Hubble and Yerkes) to study the equipment and use of modern instruments in Solar Physics Observatories.

5. Central Astronomical and Astrophysical Institute

The main lines of work in modern Astronomical and Astrophysical Observatories fall under the following heads:-

(1) Photography of star fields with standard size telescope and plate for studying the positions, proper motions and parallaxes of stars. The Nizamiah Observatory at Hyderabad is specialising in this work and there is no point in duplicating it.

(2) Photometry of stars — both photographically and with photo-electric cells. Includes work on variable stars.

(3) Study of double stars.

(4) Photographs of planets in light of different wavelengths and study of their spectra.

(5) Photography and spectrophotometry of faint stars, nebulae, distant galaxies etc.

(6) Temperatures of stars.

The fifth item is the one in which the most important progress is being made at present. The 100" mirror telescope at Mount Wilson, the 82" telescope of the McDonald Observatory in Texas and the 200" telescope of Mt. Palomar which is approaching completion, are or will be engaged mainly on this work. The objectives desired are in the words of Mr. Pease "increased space penetration, finer resolution of detail and an intensive spectrographic study of selected stars". At this stage, India cannot think of competing with the U.S.A. in the matter of astronomical equipment. The programme has to be more limited in scope until the necessary preliminary experience has been gained and outstanding organisers and artisans with knowledge and enthusiasm come forward. It is considered that it will not be too ambitious to plan an Astrophysical Observatory with the best modern equipment for photographic and spectroscopic work, the main telescope having a 40" mirror of pyrex. Great improvement has been made in recent years in the design of both the optical parts and the mountings of the big telescopes. It is considered that an equatorially mounted telescope with a paraboloidal mirror of 40" aperture used with a Ross corrector lens and extra mirrors to lengthen the focal length in the Cassegrain and Coude forms, motorized guiding, and three or four spectrographs (ultra-violet, high-dispersion and low-dispersion) will, if located on a properly selected site, in a few years enable great progress to be made. In modern mirrors large aperture-ratios like $F/4$ are used, giving large light-gathering power.

The making of the mechanical and optical parts will have to be entrusted to experienced instrument makers like Messrs. Warner and Swasey of U.S.A. or Sir Grubb Parsons & Co. of England.

The pre-war cost of a 40" reflector with dome, observing platform and accessory spectrograph was about $\text{£} 20,000/-$ or 5 lakhs of rupees. The present cost with additional spectrographs may be taken to be roughly Rs. 5 lakhs.

6. The location of the proposed Astronomical and Astrophysical Institute.

The reasons for expanding Kodaikanal itself into a combined Solar Physics and Astrophysical Institute have already been given. If another Astrophysical Observatory is to be established, we have to examine carefully the question of its siting. The relevant points to consider are:

(i) Weather and "seeing" conditions at the place

(ii) Accessibility

and (iii) Proximity to University centres to enable the building up of an intellectual atmosphere.

(1) Weather and seeing conditions. - We know about the "seeing" conditions at Kodaikanal and Hyderabad from the experience of workers there. Mr. Evershed studied the "seeing" conditions in Kashmir and undertook two special expeditions for the purpose. His general conclusions regarding Kashmir are summarised in the Kodaikanal Annual Report for 1916, are as follows:-

"The results obtained during the summer of 1916 amply confirm the original estimates of the general excellence of the climate for solar work. Clear and brilliant skies are the rule during the summer months and the clearness is maintained throughout the day in a large proportion of days, in strong contrast to the conditions prevailing at mountain stations. In more cloudy weather there is a distinct tendency to clear sky along the central axis of the valley while the surrounding hills are thickly covered by clouds.

As regards the winter months the results anticipated in Kodaikanal Observatory Bulletin No. XLII, page 104 were not realised, and during the six months November to April inclusive the conditions as to definition do not appear to differ materially from those found in other localities, that is to say, the definition generally is good in the morning and evening and poor near midday. The four months December to March inclusive must be considered to be considerably less favourable in Kashmir than at Kodaikanal because of the greater prevalence of cloud in Kashmir at that season.

In the month of May in Kashmir a marked improvement occurs in the midday seeing. This appears to coincide with the flooding of the paddy fields, and may also be connected with the growth of crops which then cover the fields and protect the soil from the heating effects of the sun. In the summer months good definition throughout the day is the rule, and superlative definition is of quite frequent occurrence. Very beautiful solar photographs were secured in July and in August under temperature conditions ranging from 80° to 90° in the shade, and good results were also the rule in September and October.

The two principal factors which it is believed conduce to the good definition in Kashmir are the absence of disturbing winds, excluded by the surrounding wall of high mountains; and the very large areas of wet cultivation which in summer greatly reduce the heating effect of the sun on the soil."

In his Administration Report for 1919, Mr. Evershed says about "seeing" conditions in Madras:

"The seeing was found to be extraordinarily good near midday (in December) and it is considered that these observations,

have with others demonstrated the immense advantage for solar work of the proximity of the sea or other extended water surface."

We know that for stellar work, "seeing" at Hyderabad is good and gives more than 200 days of observation nights.

Considering the rainfall, temperature and dustiness, it is not to be expected that stations in the North Indian plains will provide good seeing conditions for more than 100 days in a year. The Central Indian and Central Provinces hills and plateaus also are too rainy or hot and dusty to provide suitable sites. There are places like Fort Sandeman on the lee-side of the N.W. Frontier hills which may be otherwise favourable but are too far away for active centres to be really satisfactory. Mount Abu (3945 ft. above sea-level) is a place worth considering. It has only three months of cloudy and rainy weather — but dust may be a nuisance. Climatological information and experience show that the best location for an Astronomical Observatory would be a place in the region of sub-tropical anticyclones where stable cloudless weather prevails for a large part of the year. Most of the active American observatories are located in such regions. It is necessary that the observatory be well away from cities and above the dust line. Isolated mountain peaks however are often unsatisfactory owing to bad "seeing" caused by convection. Next to Kashmir, best region appears to be the Bombay Deccan. There are places in the districts of Nasik, Poona and Satara which are on the railway line, well away from cities, with annual rainfall less than 50 inches and number of rainy days between 35 and 50. Clear settled weather prevails for over 7 months in the year. These districts are within easy reach of Bombay. "Seeing" conditions have however to be investigated by an experienced observing astronomer. There may be sites in the Girnar Hills in Kathiawar which may be very satisfactory from the climatic point of view, but have to be ruled out owing to inaccessibility.

At the same time there is a great demand for an Astronomical and Astrophysical Institute somewhere in Northern India so that research workers in Northern India have easy access to it. In the course of discussion with the Director General of Observatories, Sir C.V. Raman emphasized that it would be extremely difficult to get any site with good seeing conditions throughout the year. All that should be ensured is a reasonable number of good working days and nights. He considered that if a site provided 50 good working days and nights spread over a year, an enthusiastic band of workers will be able to get enough photographs and other measurements to keep them busy throughout the year. From this point of view, even a site like Delhi need not be discarded. Prof. M. N. Saha, F.R.S., has recorded the following:-

"An observatory with up-to-date instruments and machine shops, and attached to a university will be found very useful. I think a start may be made with an observatory of this type attached to the Delhi University. A practical way of bringing into existence such a laboratory would be to send 5 or 4 young men with knowledge of astronomy and having a natural aptitude in the handling of astronomical instruments abroad to some American observatory for further training. (Some promising young members of existing observatories having the above mentioned requisite qualifications should have preference). There are no dearth of theoretical astronomers for the manning of such an institute."

The Meteorological Department is taking steps to take observations of seeing conditions with a 5" Zeiss Equatorial telescope at Delhi and later at other stations. The question of actual location of site will have to be decided by an expert committee.

(2) Estimate of cost of equipment and staff.-

The cost of a modern 40" reflector with dome, equatorial mounting and arrangements for taking photographs and spectra at the principal, Cassegrain and Coude foci etc. would even before the war have cost about Rs.5 lakhs. At present the cost may be put down as Rs.5 lakhs. Modern mirror telescopes have large aperture ratios like $f/5.5$ (200" mirror of Mt. Palomar) or $f/4$ (McDonald 82" mirror) and are very economical of light. This along with other equipments and buildings will bring the total cost to about Rs.8 lakhs.

Staff.- The staff for the Astrophysical Observatory should be somewhat similar to that provided at Kodaikanal for Solar Physics work. At this stage there is little advantage in going into details. The primary need is to recruit a really competent and enthusiastic person to organise the work on sound lines and get it going. Preferably the person selected should be below 45 years of age, so that he can look forward to a period of earnest endeavour and achievement.

7. Assistance to Universities to start teaching Astronomical observatories.

Few Indian Universities have observatories, and those which have such observatories seldom use them for teaching but mostly for show. If India is to develop her own air and sea navigation, a large number of men having knowledge of astronomy, and skill in handling astronomical instruments will be needed. The universities should be encouraged and assisted in setting up small astronomical observatories. Sir C.V. Raman writes "Apart from the establishment of the Central Astronomical Observatory, if the Government of India are prepared to spend money for encouraging astronomical studies, I would suggest that funds be given to the universities on half and half basis. These would, as already remarked, build up a nation-wide interest in astronomy, and thereby ensure the future of astronomy in this country".

Each of these observatories should have

- (1) One 6" Refractor on equatorial mount with 6" Astro-Camera fixed parallel to the telescope tube.

The telescope should be provided with all accessories for visual observations, such as filar micrometer, absorbing wedges for photometry, filters etc., as well as a spectroscope (like the Zeiss Astrospectroscope).

- (2) One 3" Transit Instrument (of the Prism Transit Type).
- (3) One Sextant.
- (4) One Star Globe and Star Catalogues.
- (5) Sidereal Clocks, Chronometers and other accessories.

Students should become thoroughly familiar with the practical use of the Nautical Almanac. Useful original work can be done on variable stars, meteors and planets.

The grant that will be required to be made to the universities on half and half basis is estimated at Rs.1,50,000.

9. Total cost of the scheme.

Capital

Development of Kodaikanal Observatory	Rs. 2,00,000
Establishment of an Astronomical and Astrophysical Institute in Northern India	8,00,000
Grant to Universities	1,50,000
	<u>Rs.11,50,000</u>

H.E.- This capital expenditure to be spread over 5 years after the war.

Recurring (annual).

Kodaikanal	...	...	...	Rs. 50,000
Central Astronomical and Astrophysical Institute				50,000
				<u>Rs.1,00,000</u>

APPENDIX

Oxford Solar Telescope.

Old Tower 18.6 ft square internally, 24.5 ft high was re-built and used. Equipment by Sir Howard, Grubb Parsons & Co. (Publication No.13, Solar Telescope at Oxford University). See H.H.Plackett.

"On the Oxford Solar Spectroscope and Hartmann test of its performance".

Cassegrain Reflecting Telescope.

Mirrors of fused silica by Thermal Syndicate Ltd., Wallsend on Tyne. Five mirrors of silica glass discs. Deposit of chromium - aluminium in front. Main Paraboloid 12 1/2" clear aperture, 30 ft focal length. Fused silica disc 1 3/4" thick - Cassegrain hyperboloid 5" aperture with negligible zonal aberration and astigmatism. Eq. focal length 65 ft. Aperture ratio f/62. The reflected beam meets a small flat G of aperture 5 1/2" and is turned sideways into a large telescope.

Hyperboloid and Coude mirrors 0".72 thick Coolestat and secondary min 16" aperture and 2 3/4" thick.

Telegrams:-
Meteors
New Delhi.

D.O. No. XR21.

INDIA METEOROLOGICAL DEPARTMENT.

Lodi Road, New Delhi, the 29th Aug., 1945.

My dear Prof. Krishnan,

Encl.
refd.
to.

In continuation of my letter No. XR21 dated 13/8/45, the draft post-war plan was seen by Mr. W.H. Shoobert, C.I.E., E.D., I.C.S., Secretary to the Govt. of India, Department of Posts & Air, which is the controlling department for Astronomical and Astro-physical observatories in India at present. Remarks recorded by Mr. Shoobert have been given in the enclosed note.

2. So far as the site is concerned, Kashmir is undoubtedly the best location for the proposed Astronomical Observatory in Northern India from the point of view of "seeing conditions" and congenial climate ~~and~~, as noted by the Secretary, for hard intellectual work. Better climate cannot be found elsewhere.

3. You will no doubt consider these remarks made by the Secretary in making your suggestions, if any, regarding modifications in the draft post-war plan.

Yours sincerely,

V. K. R.

Prof. K.S. Krishnan, F.R.S., D.Sc., F.N.I.,
Professor of Physics and Head of the Dept.,
Allahabad University, ALLAHABAD.

I recently paid a visit to the Solar Physics Observatory at Kodaikanal and I have today discussed this case with D.G.O.

2. I strongly support the proposal that as a beginning the Kodaikanal Observatory should be developed so that astronomical observations may be made there as well as solar observations. The conditions in Kodaikanal are good for this purpose and the situation of the Observatory itself is excellent. There is also room for expansion and for residential quarters, etc. in the neighbourhood. This would be the first step. The building of a second astrophysics observatory somewhere in northern India would naturally have to come later. The D.G.O. has already included the Kodaikanal Scheme in his postwar plan which will be referred to F.A.(C) in due course.

3. The proposal that the location for the second observatory, if sanctioned, should be in the Vindhya Hills does not seem to me well considered. Apart from other aspects of the case, I would point out that a situation in the Vindhya Hills would be comparatively near Hyderabad so that the three observatories in India would all lie either in the centre or south of the Peninsula. It seems very obvious that the third observatory should be in northern India.

4. The suggestion that if an astrophysics observatory were sanctioned in northern India it should be established in Delhi appears to me, as a layman, most surprising. In my opinion, the following objections are very strong:-

- (i) Delhi is subject to violent dust storms during the hot weather and is, in fact, a very dusty place throughout the year. The maintenance of delicate optical apparatus under such conditions would, presumably, be far more difficult in Delhi than in many other places equally suitable for purposes of observation.
- (ii) Throughout many weeks of the hot weather, the sky above Delhi is full of dust. During part of hot weather and the major period of the rains it is cloudy and overcast. It has been suggested to me that conditions for making observations are not perfect for more than sixty or seventy days in the year.
- (iii) The climate of Delhi from mid April to mid October is almost consistently unpleasant. It is, therefore, not a place conducive to production of research work of the best quality.
- (iv) In my opinion, scientific study and research can in the ideal be carried out best under what might be described as monastic conditions. Kodaikanal is well situated in this way. Delhi, on the other hand, as the seat of the Central Government is a place where the principal general interest is politics. It is perhaps more true today than ever before that "in Delhi it is hardly possible to hear oneself speak because of the grinding of axes." Such surroundings are far from those which are desirable for research studies.
- (v) As far as I can gather the reasons which have led to the suggestion that Delhi might be selected for the site of the proposed additional observatory are the location of the university in that place and because it is the headquarters of the Directorate of Scientific and Industrial Research. These do not seem to me very weighty considerations. Scientists wishing to visit the observatory if it is located elsewhere, could go there within a few hours by air when the new air services have been established and students who wish to take up astrophysics could most suitably be accommodated at the observatory itself.

*(If there are no difficulties about its location in a Ruler's State).

5. The Kashmir Valley, which Mr. Evershed after he had made two special expeditions to study the subject stated to possess a climate of general excellence for solar work, would appear to be the best place for location of the additional observatory.* Apart from good conditions for observation, the general climate itself is good and equable throughout the year. First class work might, therefore, be expected from those employed on research in this locality.

6. I thought it well to place on record my views which may be found useful during future discussions.

Telegrams: 'METEORS, NEW DELHI'.

D.O. No. XR21
Meteorological Office,
Lodi Road, New Delhi.

Dear Prof. Krishnan,

3rd November, 1945.

The Govt. of India have approved of the constitution of a planning committee to draw up a post-war plan for astronomical and astrophysical observatories in India. The following are the members of this committee:-

- | | |
|--------------------------------------|--|
| 1. Prof. M.N.Saha, F.R.S. (Chairman) | 6. Prof. D.S.Kothari, M.Sc., Ph.D. |
| 2. Prof. A.C.Banerji, M.A., I.E.S. | 7. Prof. M. Ishaq, M.A., M.Sc., Ph.D. |
| 3. Prof. K.S.Krishnan, F.R.S. | 8. Rao Sahib T.P.Bhaskara Sastri, M.A. |
| 4. Prof. S. Bhagavantam, Hon.D.Sc. | 9. Director General of
Observatories. |
| 5. Dr. A.L.Narayan, D.Sc. | |

2. The plan which has been followed in this connection is first to discuss this problem with different members of the committee either verbally or by correspondence and then evolve a first draft of the plan of the post-war development for the astronomical and astrophysical observatories in India. The first draft was forwarded to you with my letter No. XR21 dated 13/8/45 for comments. You have already given considerable assistance in this connection I have assumed and hope that you agree to serve as a member of the committee.

3. Comments have been received by me from some of the members in writing and others have given their comments verbally to me. These are being incorporated in the final draft. This draft will be forwarded to you after a few days.

4. It is desirable that we should aim to present to Govt. an agreed post-war plan for astronomical and astrophysical observatories signed by the members of the committee. To facilitate discussion, it will be necessary to convene a meeting of this committee.

5. This question of holding a meeting of the committee has been discussed by me with Prof. M.N.Saha and some other members of the committee whom I have met recently. It has been proposed that a meeting of this committee should be held at Kodaikanal on 27th, 28th and 29th December 1945. It will be necessary to hold the meetings of this Committee for three days because not only the post-war plan will have to be discussed at these meetings but also a few other questions regarding the problem of work at Kodaikanal and its establishment will also be referred to this committee for consideration and report. Details about this will be forwarded in due course. These dates are proposed because it has been suggested by some of the members that it is of advantage to them to have the meetings during the college holidays and also these dates will enable them to proceed from Kodaikanal to Bangalore to attend the meetings of the Indian Science Congress.
Necessary arrangements for accommodation at Kodaikanal will be made.

6. The Govt. of India is expected to sanction the payment to each of the members of the Committee the Travelling Allowance and Daily Allowance at rates admissible to Class I officers of Govt.

7. I shall be greatly obliged if you will kindly let me know by 18th November whether the dates proposed will be convenient to you, and whether you would propose any other near dates, keeping the above considerations in mind.

With kindest regards,

Yours sincerely,

V. K. Ramanji

Prof. K.S.Krishnan, F.R.S., D.Sc., F.N.I.,
Professor of Physics and Head of the Department,
Allahabad University, ALLAHABAD.

K.S. KRISHNAN, D.Sc., F.R.S.,
PROFESSOR OF PHYSICS
UNIVERSITY OF ALLAHABAD

ALLAHABAD,
November 6,

Dear Dr. Bannerji,

I have received your D.O. No. of the 3rd, and I have much pleasure in accepting membership of the planning committee that is to draw up a post-war plan for astronomical and astrophysical observations in India.

As you are probably aware the next annual meetings of the Indian and the National Academies of Sciences will be held in Udaipur during the Christmas week, 26th to 28th Dec. ^{and the meeting of the Indian Mathematical Society at} ~~and I therefore~~ a little earlier. May I therefore suggest

~~and it appears and it will not.~~

I find that Dec. 13th to 20th are
holidays for All India, and I presume they
will be holidays for the Universities too.

My I therefore suggest - either that we
meet either that we meet ^{on Friday} ~~on Friday~~ ^{fixed} ~~to~~ ^{to} ~~the~~
place ^{at Kuddik} ~~the~~ meeting, ~~to~~ ^{to} ~~the~~
some of the members of the Com in the present
able to members of the Com in the present
~~get into~~ ^{into} ~~the~~ ^{the} ~~country~~ ^{country} ~~and~~ ^{and} ~~to~~ ^{to} ~~the~~ ^{the} ~~meeting~~ ^{meeting}
choice of the ^{as} ~~the~~ ^{the} ~~country~~ ^{country} ~~and~~ ^{and} ~~to~~ ^{to} ~~the~~ ^{the} ~~meeting~~ ^{meeting}
for even if the members, is ruled out.

The post-war development of Astronomy and of Astro-Physics can be considered from two view points. There is a programme of work which is so specialised that India can definitely contribute with greater ease than other countries owing to some special facilities available here, (either specialised personnel, apparatus which is not easily available in other countries or due to conditions for which India is specially suited. e.g. weather or seeing conditions.) Or because of the fact that money is available at present which has to be spent in the course of next few years that anything or institution may started so as to spend it.

There can be no two opinions about the size of the country nor about the large population. And judged by these two factors any development would fall short of the standards set up by America, Europe and even Japan. In the U.S.A. alone among the major Institutes of Technology mention can be made of the one at Boston, Massachusetts and that of California. By that analogy, India is not starting at once a number of Institutes of Technology but is satisfied with one to be established at or near Calcutta. If India is considered as a unit, it is of no use starting a number of institutes to satisfy either sentiment or ~~xxxx~~ feed local vanity. In fact ~~parochial~~ science must try to inhibit parochialism.

The main point at issue is how many people are actively interested in either Astronomy or Astro-Physics? in India. Is there such a demand that more than one observatory is required? In the course of their work a few professors of Physics or Mathematics have contributed articles in these subjects. But they are not whole time workers in these subjects. They are primarily engaged in other subjects and which are more in the lime-light like Physics and Mathematics of the atomic structure. It will be doing the universities a disservice by frittering away the energies of these professors into specialised channels in which they only take ephemeral interest and not devote themselves to their primary responsibilities. Running institutions well will need a succession of enthusiastic workers and I think it will be hard to run even the Kodaikanal Observatory ~~xxxxxxx~~ with specialised persons. It is not the lack of facilities at Kodaikanal but the lack of enthusiasm in the workers that has ~~xxx~~ been responsible for its very restricted output. If the Kodaikanal Observatory is expanded to do Solar Physics ~~xxxx~~ and also take part in other astronomical work, it will provide material work for years to come and absorb sufficient workers that are available. Few of the scientific workers would like the type of life to be led by astronomers, like hermits, far away from the towns, and attractions of a university Professorships as they exist in India. Any one interested in Astro-Physics in a university and has sufficient enthusiasm to seriously tackle the problems has plenty of opportunity of spending the various long vacations at Kodaikanal and benefit mutually. In the long history of Kodaikanal, even the better paid professors have not taken sufficient interest. When the peace comes, not much change in outlook can be expected. A few small telescopes and equatorials for students should be sufficient and the more enthusiastic of them can be induced to go to Kodaikanal at either their own expense or with the help of stipends. These stipends can be given by the University or the Central Govt. (The same arguments apply to those who would like to go to Nizamiah Observatory.). By its very nature these subjects can not be professional avenues for than for a very select number.

Until, Kodai and Nizamiah have trained sufficient number of enthusiasts who can be taken to newer fields and for the establishment of new observatories, it would mean that starting new observatories would necessitate the dissipation of the few trained astronomers in constructing observatories and not in contributions to the sciences, or that foreign element would have to be imported to build and man these new observatories. The post-war plan for India, I hope, does not contemplate the latter. It is ~~xxxxxxxx~~ extremely doubtful if any "respectable" astronomer or astro-physicist would care to go over to India and spend his time in building up observatories and equipping them. The early history of the Indian Inst. of Science at Bangalore should be a good pointer.

Now coming to development of Kodaikanal itself and also Nizamiah Observatory which latter can also be subsidised by the Central Govt to expand its activities, the primary workers at these places should be a good theoretical physics or astro-physics background, a specialised mathematical and an experimental background. For this it is necessary that there must be a sort of mathematical adviser available on the spot with a good knowledge of modern technique of applying math. to various subjects (statistics, tensor and other analysis, modern methods of working problems). There must be a Physics and astro-physics group who can correlate the two branches and initiate work. The experimental side should contain highly specialised workers in spectroscopy and optical instruments. They must be able to develop new ~~xxxxxxxx~~ equipment as and when necessary. There must be an good staff of workshop persons who should be able to tackle the engineering side of the observing people and supply most of the day to day requirements by casting molding and turning in its own work-shop. Each one of these groups must have more than one person so as to include all branches as and when necessary.

No. W-

/H-2/S-5.

Telegraphic
Address :-

INDIA METEOROLOGICAL DEPARTMENT.

WEATHER, POONA.

From

The Director General of Observatories,
Poona 5,

To

Poona 5, the

19 .

SUBJECT :- Storm and heavy rainfall warnings.

Sir,

In connection with the preparation of a general annual report on the working of the present warning system, I have the honour to request you kindly to let me have at an early date the following information in respect of the warnings received by you during 1939 -

- (1) whether the warnings were timely, useful and satisfactory in every respect, and, if not, in what points they were defective,
- (2) whether any suggestions as regards changes in the system occur to you, which would make the warnings more useful and effective, and
- (3) whether the warning telegrams were rapidly transmitted and delivered by the Telegraph Department.

In the case of serious storms or floods, detailed reports and criticisms or comments on the warnings are invited.

I have the honour to be,
Sir,
Your most obedient servant,

C. Ramaswamy.
for Director-General.

No. W-

/H-2/S-5.

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INDIA METEOROLOGICAL DEPARTMENT.

WEATHER, POONA.

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The Director General of Observatories,
Poona 5,

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- (3) whether the warning telegrams were rapidly transmitted and delivered by the Telegraph Department.

In the case of serious storms or floods, detailed reports and criticisms or comments on the warnings are invited.

I have the honour to be,
Sir,
Your most obedient servant,

C. Ramaswamy,
for Director-General.

Now regarding the detailed plan of Kodai or Nizamiah, as it is almost certain that very good persons from outside India would not be available to develop these institutions, and any any new recruitment of persons inside India instead of the older staff would be like backing the dark horse. There is no guarantee that the newer persons are going to be more active, than those that have already been associated with these institutions. The stagnation that sets in by leading life of recluses can also mean less work and less original work. The problem is how to get out of the rut that is invariably brought in by the necessary life of the astronomers and the general condition in India, where administrative posts and the so called administrative talent alone get recognition and prospects, So it is necessary to devise schemes to make the people more active, i.e by making more contact with scientific workers in the universities and in the technical depts. by exchanging problems that can be dealt better by redistribution of the work between the observatories, the technical departments and the universities, by encouraging the personnel to attend the International meetings of astronomy, mathematics, Physics etc. (But it must also be understood that the travel must not be so much as to minimise the output at their headquarters). The contact with active workers all over the world by people who know the conditions available in India would certainly improve the status of the science. By sending untrained persons to foreign countries to study the foreign observatories, would often mean that on return, they would get sinecure jobs and ~~it~~ would lapse to inactivity. What actual problems and observations should be carried on at Kodai and Nizamiah in addition to the allotment by the Int.Astro Uni. can only be determined by the actual personnel employed there. It is they that should decide and evolve ideas and ask for extra equipment.

New Delhi, the ^{1st} ~~11th~~ December 1945.

Dear Prof. Saha Prof. Kothari
Prof. Banerji Prof. Ishaq
Prof. Krishnan ✓ Rao Sahab Bhaskara Sastri
Prof. Bhagavantam Dr. Narayan

All the members of the Committee, with the exception of Prof. Krishnan and Prof. Bhagavantam, have agreed to the holding of the meetings of the Committee at Kodaikanal immediately before the session of the Indian Science Congress at Bangalore. Prof. Krishnan and Prof. Bhagavantam have expressed their inability to attend on the ground that they have to attend the annual conference of the Indian Academy of Sciences to be held at Udaipur on 26th, 27th and 28th December. Prof. Bhagavantam has stated that "if these dates are of general convenience, the meetings may be held and I shall communicate my views, if any, in writing". Rao Sahab T.P. Bhaskara Sastri is at present unwell but I am hoping that he will sufficiently recover to attend the meetings at Kodaikanal.

2. I discussed the question of altering the dates for the meeting with the Chairman, Prof. M.N.Saha, to enable Prof. Krishnan and Prof. Bhagavantam to attend but the Chairman pointed out that he was fully occupied during December and was unable to go to Kodaikanal before 27th. He has fixed the dates of the meetings at Kodaikanal to be 28th, 29th and 30th December. But in consideration of the fact that Prof. Krishnan and Prof. Bhagavantam may not be able to come to Kodaikanal on those dates, he has decided that the final decision on the post-war plan for astronomical and astrophysical observatories in India should be taken at a joint *meeting* to be held during the Science Congress week at Bangalore. It is hoped that in that meeting all the members of the Committee will be present.

3. It is now requested that those members of the Committee who have expressed their concurrence to meet at Kodaikanal (Prof. M.N.Saha, Prof. A.C. Banerji, Prof. Kothari, Prof. Ishaq) should start for Kodaikanal so as to arrive at the Kodaikanal Road Station on the morning of the 27th December. Cars will be kept ready for the conveyance of the members from the Kodaikanal Road Station to the Kodaikanal Observatory (*vide* enclosed slip)*. Dr. A.L.Narayan, Director, Kodaikanal Observatory, is kindly arranging for the accommodation of the members of the Committee partly in his own bungalow and partly in the bungalow of the Assistant Director which is at present vacant.

4. Those members of the Committee who will be at Kodaikanal on 28th, 29th and 30th will see the work done at Kodaikanal, discuss the draft post-war plan of which a copy is enclosed^o and recommend such modifications in it as they consider desirable. In addition, the Committee will also consider the following questions:-

- (1) Stages in which the proposed development of the Kodaikanal Observatory should take place, and what equipments should be obtained in each stage,
- (2) The programme of work at Kodaikanal during the next 5 years,
- (3) Staff of the Kodaikanal Observatory, and make a special report to the Government of India.

5. I have recently received a letter from Sir C.V.Raman communicating very valuable suggestions for the post-war plan of astronomical and astrophysical observatories in India. A copy of this letter is enclosed^t. These views have been incorporated in the draft post-war plan.

6. The post-war plan for astronomical and astrophysical observatories, modified as recommended by the members of the Committee meeting at Kodaikanal, will be placed before all the members of the Committee in a specially convened meeting at Bangalore.

7. The members of the Committee will leave Kodaikanal in the afternoon of 30th December and reach Bangalore on the morning of 1st January.

8. I would welcome a visit to the Kodaikanal Observatory by Prof. Krishnan and Prof. Bhagavantam. If they start for Kodaikanal immediately after the conference at Udaipur is over and reach Kodaikanal on 30th, 31st or even on 1st January, I shall wait at Kodaikanal for their arrival and after going

*Encl.I.

Encl.II.

Encl.III.

through the Kodaikanal Observatory with them I shall start with them for the meetings at Bangalore. I shall be grateful if Prof. Krishnan and Prof. Bhagavanta will let me know whether they will be able to do so.

9. The Govt. of India have agreed to pay Travelling as well as Daily allowances to each of the members of the Committee for the visit to Kodaikanal at rates admissible to Class I officers.

With kindest regards,

Yours sincerely,

V. K. Ravi

Prof. K.S. Krishna, F.R.S., D.Sc., F.N.I.,
Professor of Physics and Head of the Department,
Allahabad University, Allahabad.

mintery

Encl. I

The Solar Physics Observatory, Kodaikanal is situated at a height of 7688 feet above the sea level and it is nearly three miles from the Kodaikanal Town, where all the hotels, hospitals and other amenities are situated.

The Trivandrum Express which leaves Madras-Egmore at 7-30 P.M. and reaches Kodaikanal Road Station at 7 A.M. the next morning, is the only convenient train for passengers coming from Madras. Kodai Road Station is nearly 53 miles from the Kodaikanal Observatory. There is a regular bus service from Kodaikanal Road Station to Kodaikanal. Taxis can be got provided sufficient intimation is given to the Kodaikanal Motor Union, in advance. The charges for a car will be roughly Rs. 30/- for a trip.

There are three buses for carrying passengers to Kodaikanal, leaving Kodaikanal Road Station at about 7-45 A.M. Of these three buses, only the taxi-bus leaves the passengers at their residences; the remaining two buses leave the passengers at the Kodaikanal Motor Union Office, wherefrom the passengers will have to hire a taxi if available, or make their own arrangements to come to their residences.

Astronomical and Astrophysical Observatories in India.

Post-war Plan.

1. General.

Astronomical studies have been encouraged by the King from time immemorial. Astronomy is one of those subjects in which India has taken keen interest for centuries, and made its own contributions. It makes a great appeal to the people in this country. The United Kingdom has its Astronomer Royal, and India should have its Astronomer Royal.

In India, there are at present only two astronomical observatories, the Solar Physics Observatory at Kodaikanal and the Nizamiah Observatory at Hyderabad. Considering the size of the country, several more astronomical observatories could usefully be maintained in India, but no institution of this kind can prosper unless qualified men are available to run them. India has a good number of theoretical astrophysicists but there are very few who have the necessary experience of modern astronomical observations and measurements. Therefore, before multiplication of astronomical observatories is contemplated, we should have men trained in astronomical methods in astronomical observatories of U.K. or U.S.A. In the post-war, it is desirable to plan the establishment of a third astronomical observatory somewhere in Northern India.

Astronomical observatories of smaller types should, however, be available for practical training of students who go through post-graduate course in astronomy. There are very few observatories even of this kind in India, with the result that students read Astronomy without even making simple astronomical observations or measurements.

A carefully worked out plan, fully framed and detailed estimates and an attractive set-out of the whole is the first desideratum for any observatory. The second is the certainty of having personnel capable of setting up and making the utmost use of the apparatus.

2. Present position.

To-day, there are only two active astronomical observatories in India, the Solar Physics Observatory at Kodaikanal maintained by the Government of India and the Nizamiah Observatory at Hyderabad maintained by the Nizam's Government. There are transit instruments at the Alipore Observatory, Calcutta and the Colaba and Alibag Observatories, Bombay for determining time. A few small telescopes are maintained in varying degrees of efficiency at colleges of University rank scattered over the country. Individual Professors in Universities have studied and made fundamental contributions to theoretical Astrophysics but there is no observatory in the country where a physical study of stars with modern appliances is systematically pursued.

The Nizamiah Observatory specializes in astrographic work - which includes the determination of the positions and relative intensities of stars in defined zones. It has recently started work on proper motions of stars. Its programme also includes the systematic observation of many long-period variable stars and occultations of stars by the moon.

The work of the Kodaikanal Solar Physics Observatory, as its name implies, is mainly on Solar Physics. Its present programme includes the preparation of daily photo-heliograms (diameter 8"), of photographs of flocculi in K and H_{α} light and of prominences in calcium light (sometimes in H_{α} light also) with the spectro-heliograph. Visual observations of the sun with Hale's spectro-helioscope and observations of metallic and other lines in prominences and on the disc are also included in the programme. In 1922, the International Astronomical Association allotted to Kodaikanal the task of collecting from all contributing observatories the photographs of solar prominences and of the sun's disc in H_{α} light. In accordance with this, Kodaikanal Observatory systematically collects and publishes the data. Special studies include at present spectro-photometric work on selected lines in the solar spectrum in the disc and on the limb and laboratory work on spectra.

The discovery of the out-flow of gases above sunspots (Evershed Effect) and of the relativity shift of spectral lines made the Kodaikanal Observatory famous. Although the general activity of the observatory has been maintained since Mr. Evershed's time, it cannot be said that the observatory has grown. There have been some small additions to the equipment but none made with a view to extend the general lines of work pursued at the observatory.

3. Plan for Development.

The general consensus of opinion is

(a) (1) that there should be two astronomical observatories maintained by the Government of India, one in South India and one in Northern India, fully staffed and fully equipped.

This means Kodaikanal should be fully equipped and fully staffed for solar studies and also general astrophysical work. Another station is to be started at a suitable locality somewhere in Northern India, and is to be fully equipped and staffed for work on stars generally. Both stations should have good workshop facilities.

(2) That universities are to be granted funds for providing astronomical observatories of smaller types.

(3) That a few selected candidates should be sent for getting special training in modern astronomical work, to France (Pic du Midi), Britain (Oxford) and to U.S.A. (Harvard, Mt. Wilson, Mcmath Halbur and Yerkes).

(b) We shall divide the scheme for development into three stages,

(1) the improvement and modernisation of the Kodaikanal Observatory so that it can take, and maintain to take, a leading place among the Solar Physics Observatories of the ~~world~~ and its further development into a first class Astronomical and Astrophysical Institute; world/

(2) the establishment of a second Astronomical and Astrophysical Institute somewhere in Northern India. This should be at a place where good seeing conditions prevail for a fair part of the year, preferably within reasonable distance of the main university centres; and

(3) encouragement and help to Universities to start and maintain small astronomical observatories so that students who have a natural taste for the subject can get an opportunity to develop it.

4. Development of Kodaikanal Observatory.

Before we consider what additional equipment and staff should be provided at Kodaikanal, it is well to consider the lines in which development is desirable. The actual line of progress will largely depend on the Director. The original plan was to set up at Kodaikanal both solar and astrophysical observatories, but the Directors were more interested in studying the sun than the stars, and so Kodaikanal developed as a Solar Physics Observatory. The question whether astrophysical studies of stars should be undertaken at Kodaikanal is a debatable point. The points in favour of Kodaikanal are: Being near the Equator, southern skies are more accessible than in Europe, North America or other places in India. Although "seeing" conditions in the afternoon are of moderate quality during a large part of the year, the conditions at night may be expected to be definitely good. There will grow up an atmosphere of work about the place, and Solar Physics and Astrophysics will react on each other to their mutual benefit. There is no end of problems in solar physics, and as it is proposed to set up an Astronomical and Astrophysical Institute in Northern India, and as there is dearth of qualified men, it seems desirable to develop solar physics only at Kodaikanal, at any rate for the time being.

In the following, only the additional equipment for Solar Physics work is considered.

Desirable developments in the field are:

1. Obtaining motion-pictures of prominences and solar flares.
2. Systematic studies of the solar corona with a coronagraph of Lyot's type.
3. Study of the general magnetic field of the sun and the field near sun-spots.
4. Study of the solar spectrum in the infra-red and the ultra-violet.
5. Studies of turbulence in the solar atmosphere - granulations, spikes, etc. and their time variations.
6. Critical studies of changes in selected solar absorption lines before and during magnetic and auroral disturbances.
7. Photometric and spectrophotometric study of the planets and observations of cepheids and variable stars.
8. Such other items as may be added from time to time.

Staff and Equipment.

To plan the details of the development and carry it out, the first requisite is suitable senior staff. It is desirable to take immediate action to appoint a successor to Dr. A.L. Narayan and associate him in planning the development. Of the two officers, Director and Assistant Director, one at least should be a good Physicist with a sound knowledge of optics and instrumental technique and ability to guide workshop and mechanical engineering work on sound lines. The other should be a good Theoretical Physicist with a bias for Astrophysics, which of them will be senior will depend on the relative abilities of the two. The primary objective is the securing of two such men.

Instrumental Equipment.-

This follows the lines of desirable development.

- (1) In addition to the 20" reflecting telescope, parts of which are already available in Kodaikanal, there should be a 16" Photographic refractor on equatorial mount with an astro-camera and an 18" Schmidt type camera (with a full sized objective prism of fine quality) mounted on the 20" reflector and having a focal ratio of 1:2. Accessories like the spectrographs, and cassegrain attachment would be required
- (2) Also a modern all-purpose reflecting telescope of the Oxford Solar Telescope type with fused quartz, aluminised mirrors and spectroscope (please see Appendix) or a Telescope of the design of those at Mount Wilson or Arcetri. Aperture of main mirror to be 12" to 15". This will be useful for infra-red and ultra-violet studies, for planetary studies and for studies of solar turbulence.

- (3) Motion-picture equipment for spectroheliograph.

- (4) Lyot's Coronagraph with polarising monochrometer. (See Astrophysical Journal, 1944).

- (5) High dispersion instruments (like Lummer plates) and polarisers for studying weak magnetic fields.

- (6) Photo-electric and other electronic equipment as required.

- (7) Calculating machines.

The cost of the additional instrumental equipment is estimated to be about Rs. 2,00,000/-

	Rs.
Telescopes, ^{Schmidt camera and} etc. other accessories	1,00,000/-
Motion picture equipment	5,000/-
Coronograph	20,000/-
Equipment for studying weak magnetic field	10,000/-
Calculating machines	2,000/-
Miscellaneous equipments, camera, photo-electric cells, galvanometer, and other electrical equipment	23,000/-
Workshop and Laboratory equipment	40,000/-
Total	2,00,000/-

BUILDINGS.-

An observatory building for housing the solar telescope and coronagraph will have to be built. It is best to get manning for solar telescope from instrument makers like Grubb Parsons & Co. Four additional revolving domes would be required for housing (a) Coronagraph, (b) the 20" reflector with the Schmidt camera, (c) the 16" photographic reflector on equatorial mount, (d) the all purpose reflecting telescope or Tower telescope. The estimated cost is Rs. 70,000/-.

Scientific Staff.-

Professor of Astrophysics and Director	1)	Gazetted
Senior Astrophysicists	2)	
Junior Astrophysicists	2)	
Assistants	3)	
Mechanical Assistant	1)	Non-gazetted
Photographic Assistant	1)	
Mechanics	2)	

Inferior servants

It will be necessary to send out the Physicist-cum-Engineer Officer to France (Pic du Midi) and Britain (Oxford) and if possible also to U.S.A. (Harvard, Mt. Wilson, Mcmath Hulbert and Yerkes) to study the equipment and use of modern instruments in Solar Physics Observatories.

5. Central Astronomical and Astrophysical Institute.

The main lines of work in modern Astronomical and Astrophysical Observatories fall under the following heads:-

- (1) Photography of star fields with standard size telescope and plate for studying the positions, proper motions and parallaxes of stars. The Nizamiah Observatory at Hyderabad is specialising in this work and there is no point in duplicating it.
- (2) Photometry of stars - both photographically and with photo-electric cells. Includes work on variable stars.
- (3) Study of double stars.
- (4) Photographs of planets in light of different wavelengths and study of their spectra.
- (5) Photography and spectrophotometry of faint stars, nebulae, distant galaxies etc.
- (6) Temperatures of stars.

The fifth item is the one in which the most important progress is being made at present. The 100" mirror telescope at Mount Wilson, the 82" telescope of the McDonald Observatory in Texas and the 200" telescope of Mt. Palomar which is approaching completion, are or will be engaged mainly on this work. The objectives desired are in the words of Mr. Pease "increased space penetration, finer resolution of detail and an intensive spectrographic study of selected stars". At this stage, India cannot think of competing with the U.S.A. in the matter of astronomical equipment. The programme has to be more limited in scope until the necessary preliminary experience has been gained and outstanding organisers and artisans with knowledge and enthusiasm come forward. It is considered that it will not be too ambitious to plan an Astrophysical Observatory with the best modern equipment for photographic and spectroscopic work, the main telescope having a 40" mirror of pyrex. Great improvement has been made in recent years in the design of both the optical parts and the mountings of the big telescopes. It is considered that an equatorially mounted telescope with a paraboloidal mirror of 40" aperture used with a Ross corrector lens and extra mirrors to lengthen the focal length in the Cassegrain and Coude forms, motorised guiding, and three or four spectrographs (ultra-violet, high-dispersion and low-dispersion) will, if located on a properly selected site, in a few years enable great progress to be made. In modern mirrors large aperture-ratios like F/4 are used, giving large light-gathering power.

On this question of astronomical telescopes, Sir C.V.Raman expressed the view that since Government may give only one large-size telescope, it should be at least 60". A 40" telescope may soon be found out of date, and, therefore, as a long term policy a 60" telescope is to be preferred. Even the Dominion Observatory, Canada, has a 72" telescope.

The making of the mechanical and optical parts will have to be entrusted to experienced instrument makers like Messrs. Warner and Swasey of U.S.A. or Sir Grubb Parsons & Co. of England.

The pre-war cost of a 40" reflector with dome, observing platform and accessory spectrograph was about £20,000/- or 3 lakhs of rupees. The present cost with additional spectrographs may be taken to be roughly Rs.5 lakhs. The cost of 60" telescope with accessories is estimated to be Rs.8 lakhs.

6. The location of the proposed Astronomical and Astrophysical Institute.

The reasons for expanding Kodaikanal itself into a combined Solar Physics and Astrophysical Institute have already been given. If another Astrophysical Observatory is to be established, we have to examine carefully the question of its siting. The relevant points to consider are:

(i) Weather and "seeing" conditions at the place

(ii) Accessibility

and (iii) Proximity to University centres to enable the building up of an intellectual atmosphere.

(1) Weather and seeing conditions.— We know about the "seeing" conditions at Kodaikanal and Hyderabad from the experience of workers there. Mr. Evershed studied the "seeing" conditions in Kashmir and undertook two special expeditions for the purpose. His general conclusions regarding Kashmir summarised in the Kodaikanal Annual Report for 1916, are as follows:—

"The results obtained during the summer of 1916 amply confirm the original estimates of the general excellence of the climate for solar work. Clear and brilliant skies are the rule during the summer months and the clearness is maintained throughout the day in a large proportion of days, in strong contrast to the conditions prevailing at mountain stations. In more cloudy weather there is a distinct tendency to clear sky along the central axis of the valley while the surrounding hills are thickly covered by clouds.

As regards the winter months the results anticipated in Kodaikanal Observatory Bulletin No. XLIII, page 104, were not realised, and during the six months November to April inclusive the conditions as to definition of

not appear to differ materially from those found in other localities, that it to say, the definition generally is good in the morning and evening and poor near midday. The four months December to March inclusive must be considered to be considerably less favourable in Kashmir than at Kodaikanal because of the greater prevalence of cloud in Kashmir at that season.

In the month of May in Kashmir a marked improvement occurs in the midday seeing. This appears to coincide with the flooding of the paddy fields and may also be connected with the growth of crops which then cover the fields and protect the soil from the heating effects of the sun. In the summer months good definition throughout the day is the rule, and superlative definition is of quite frequent occurrence. Very beautiful solar photographs were secured in July and in August under temperature conditions ranging from 80° to 90° in the shade, and good results were also the rule in September and October.

The two principal factors which it is believed conduce to the good definition in Kashmir are the absence of disturbing winds, excluded by the surrounding wall of high mountains; and the very large areas of wet cultivation which in summer greatly reduce the heating effect of the sun on the soil."

In his Administration Report for 1919, Mr. Bvershed says about "seeing" conditions in Madras:

"The seeing was found to be extraordinarily good near midday (in December) and it is considered that these observations have with others demonstrated the immense advantage for solar work of the proximity of the sea or other extended water-surface."

We know that for stellar work, "seeing" at Hyderabad is good and gives more than 200 days of observation nights.

Considering the rainfall, temperature and dustiness, it is got to be expected that stations in the North Indian plains will provide good seeing conditions for more than 100 days in a year. The Central Indian and Central Provinces hills and plateaus also are too rainy or hot and dusty to provide suitable sites. There are places like Fort Sandeman on the lee-side of the N.W. Frontier hills which may be otherwise favourable but are too far away for active centres to be really satisfactory. Mount Abu (3945 ft. above sea-level) is a place worth considering. It has only three months of cloudy and rainy weather - but dust may be a nuisance. Climatological information and experience show that the best location for an Astronomical Observatory would be a place in the region of sub-tropical anticyclones where stable cloudless weather prevails for a large part of the year. Most of the active American observatories are located in such regions. It is necessary that the observatory be well away from cities and above the dust line. Isolated mountain peaks however are often unsatisfactory owing to bad "seeing" caused by convection. Next to Kashmir, the best region appears to be the Bombay Deccan. There are places in the districts of Nasik, Poona and Satara which are on the railway line, well away from cities, with annual rainfall less than 30 inches and number of rainy days between 35 and 50. Clear settled weather prevails for over 7 months in the year. These may be sites in the districts are within easy reach of Bombay. "Seeing" conditions have however to be investigated by an experienced observing astronomer. There may be sites in the Girnar Hills in Kathiawar which may be very satisfactory from the climatic point of view, but have to be ruled out owing to inaccessibility.

At the same time there is a great demand for an Astronomical and Astrophysical Institute somewhere in Northern India so that research workers in Northern India have easy access to it. In the course of discussion with the Director General of Observatories, Sir C.V. Raman emphasized that it would be extremely difficult to get any site with good seeing conditions throughout the year. All that should be ensured is a reasonable number of good working days and nights. Prof. M.N. Saha, F.R.S.,

has recorded the following:-

"An observatory with up-to-date instruments and machine shops, and attached to a university will be found very useful. I think a start may be made with an observatory of this type attached to the Delhi University. A practical way of bringing into existence such a laboratory would be to send 3 or 4 young men with knowledge of astronomy and having a natural aptitude in the handling of astronomical instruments abroad to some American observatory for further training. (Some promising young members of existing observatories having the above mentioned requisite qualifications should have preference). There is no dearth of theoretical astronomers for the manning of such an institute."

* Please see attached slip.

The Meteorological Department is proposing to take steps to take observations of seeing conditions, with a 5" Zeiss Equatorial telescope, at promising sites, such as Mount Abu or some station in or near Kashmir. The question of actual location of site will have to be decided by an expert committee. Since there will be only one Astronomical Observatory it should be located at a site with best seeing conditions.

(2) Estimate of cost of equipment and staff.-

The cost of a modern 60" reflector with dome, equatorial mounting and arrangements for taking photographs and spectra at the principal, Cassegrain and Coude foci etc. is estimated to cost about Rs. 8 lakhs. Modern mirror telescopes have large aperture ratios like $f/3.3$ (200" mirror of Mt. Palomar) or $f/4$ (McDonald 82" mirror) and are very economical of light. This along with other equipments and buildings will bring the total cost to about Rs. 12 lakhs.

Staff.- The staff for the Astronomical and Astrophysical Observatory should be somewhat similar to that provided at Kodaikanal for Solar Physics work. At this stage there is little advantage in going into details. The primary need is to recruit a really competent and enthusiastic person to organise the work on sound lines and get it going. Preferably the person selected should be below 45 years of age, so that he can look forward to a period of earnest endeavour and achievement.

7. Assistance to Universities to start teaching Astronomical observatories.

Few Indian Universities have observatories, and those which have such observatories seldom use them for teaching but mostly for show. If India is to develop her own air and sea navigation, a large number of men having knowledge of astronomy, and skill in handling astronomical instruments will be needed. The universities should be encouraged and assisted in setting up small astronomical observatories. Sir C.V. Raman writes "apart from the establishment of the Central Astronomical Observatory, if the Government of India are prepared to spend money for encouraging astronomical studies, I would suggest that funds be given to the universities on half and half basis. These would, as already remarked, build up a nation-wide interest in astronomy, and thereby ensure the future of astronomy in this country".

The universities should be expected to provide out of their own funds, astronomical equipments, consisting of

- (1) One 6" Refractor on equatorial mount with 6" Astro-Camera fixed parallel to the telescope tube.
The telescope should be provided with all accessories for visual observations, such as filar micrometer, absorbing wedges for photometry, filters, etc., as well as a spectroscope (like the Zeiss Astrospectroscope).
- (2) One 3" Transit Instrument (of the Frisn Transit Type).
- (3) One Sextant.
- (4) One Star Globe and Star Catalogues.
- (5) Sidereal Clocks, Chronometers ^{Spectrometers} and other accessories.

Students should become thoroughly familiar with the practical use of the Nautical Almanac. Useful original work can be done on variable stars, novae and planets.

Sir C. V. Raman recommends that "If any Indian University can persuade a donor to establish an Observatory with a telescope of 15" aperture or larger, the Government of India may encourage the work by capital and recurring grants on a fifty-fifty basis, since small research problems could be usefully undertaken with such instruments."

Prof. A. C. Banerji states that "I am of opinion that at least five or six well-established Universities should have well-equipped Observatories attached to them. Each of these observatories should have a 15" Reflecting Telescope. The Central Government may be requested to make suitable grants to selected Universities for purchase of these telescopes and other accessories."

It is considered however that to encourage astronomical work, Government should provide 15" Astronomical Telescope with spectrograph and objective prism, a filar micrometer, a photographic camera and other

* 9. Formation of an Astronomical Committee.

It is considered desirable that a standing committee consisting of five members (including professional astronomers) and two or three distinguished scientists interested in astronomy should be formed to review the research programme of these observatories at periodical meetings.

<u>Capital</u>		
Development of Kodaikanal Observatory ...	...	Rs. 2,70,000
Establishment of an Astronomical and Astrophysical Institute in Northern India ...	...	12,00,000
Grant to Universities ...	...	1,50,000
		<u>Rs. 15,50,000</u>
		16,20,000

N.B. - This capital expenditure to be spread over 5 years.

Recurring (annual).

Kodaikanal ...	...	Rs. 50,000
Central Astronomical and Astrophysical Institute ...	...	50,000
		<u>Rs. 1,00,000</u>

APPENDIX.

Oxford Solar Telescope.

Old Tower 18.6 ft. square internally, 24.5 ft. high was re-built and used. Equipment by Sir Howard, Grubb Parsons & Co. (Publication No. 13, Solar Telescope at Oxford University). See H.H. Plaskett -

"On the Oxford Solar Spectroscope and Hartmann test of its performance".

Cassegrain Reflecting Telescope.

Mirrors of fused silica by Thermal Syndicate Ltd., Wallsend on Tyne. Five mirrors of silica glass discs. Deposit of chromium - aluminium in front. Main Paraboloid 12 1/2" clear aperture, 30 ft. focal length. Fused silica disc 1 1/2" thick - Cassegrain hyperboloid 5" aperture with negligible zonal aberration and astigmatism. Eq. focal length 65 ft. Aperture ratio f/62. The reflected beam meets a small flat G of aperture 5 1/2" and is turned sideways into a large telescope.

Hyperboloid and Coude mirrors 0".72 thick Coelostat and secondary mirror 16" aperture and 2 3/4" thick.

Encl. III

Sir C.V.RAMAN, Kt., F.R.S., Nobel Laureate,
M.A., Hon. Ph.D., Hon. D.Sc., Hon. LL.D.

Indian Institute of Science,
Malleswaram P.O., Bangalore.

19th November, 1945.

My dear Dr. Banerji,

I am in receipt of your kind D.O. No. XR21 dated 15th November 1945.

I am giving my views below for what they are worth.

(a) There is, I think, a case for the Government of India establishing one well-equipped Central Astronomical Observatory which should be located at a place where the observing conditions are the best available in India for sidereal astronomy. This obviously cannot be in the neighbourhood of Delhi or Bombay or Calcutta.

(b) The question whether Kodaikanal would be the best location for such an Observatory requires careful examination. If it proves to be not the best location, it is worthwhile considering the desirability of transferring the solar-physics work now done at Kodaikanal to the same place as the Central Astronomical Observatory. The scientific and administrative advantages of locating both activities at the same place are obvious, in view of the close relationship between solar physics and sidereal astronomy. The larger a group of scientific workers, the less likely it is to suffer from scientific isolation.

(c) For a Central Astronomical Observatory, I think, a 60" telescope or even a bigger size should be aimed at. A 40" telescope is, I think, not a useful size for a Research Observatory.

(d) I can see no point, in these days, in the Govt. of India providing 5" telescopes for Universities. If such small telescopes are wanted by the Universities, they should be in a position to get them from their own resources.

(e) If any Indian University can persuade a donor to establish an Observatory with a telescope of 15" aperture or larger, the Govt. of India may encourage the work by capital and recurring grants on a fifty-fifty basis, since small research problems could be usefully undertaken with such instruments.

With kind regards,

Yours sincerely,

Sd/- C.V.Raman.

To

Dr. S.K. Banerji, O.B.E., D.Sc.,
Director General of Observatories,
Lodi Road, New Delhi.
