International Education Board records (FA062)

Series 1: Appropriations; Subseries 1: Numerical

Box/Reel: Box 21
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Date: 1926-1931

PATRONS ARE REQUESTED TO FAVOR THE COMPANY BY CRITICISM AND SUGGESTION CONCERNING ITS SERVICE

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NEWCOMB CARLTON, PRESIDENT J. C. WILLEVER, FIRST VICE-PRESIDENT

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Received at

SB497 165 NL 1/140=PASADENA CALIF 3 1928 SEP 3 PM 9 17

H J THORKELSON=

INTERNATIONAL EDUCATION BOARD 61 BROADWAY

NEWYORK NY=

DR STJOHN JUST BACK FROM EUROPE REPORTS OPTICAL COMPANIES OF EITHER CARL ZEISS OR SIR CHARLES PARSONS GLAD TO FURNISH TWO HUNDRED INCH DISK IF DESIRED FULL REPORT FROM ELIHU THOMSON PROMISES VERY RAPID PROGRESS AND EXPRESSES GREAT CONFIDENCE OF SUCCESS WITH FUSED QUARTZ STOP OUR ESTIMATES TO MARCH FIRST AS FOLLOWS THOMSONS QUARTZ WORK SEVENTY FIVE THOUSAND OPTICAL AND MECHANICAL DESIGN INCLUDING SOME OPTICAL WORK FIFTEEN THOUSAND INVESTIGATION OF SITES FIVE THOUSAND PURCHASE AND DEVELOPMENT OF AUXILIARY INSTRUMENTS TWENTY THOUSAND CONSTRUCTION OF INSTRUMENT SHOP FIFTY THOUSAND EXPENSES OF COMMITTEES SEVEN THOUSAND SALARIES OF ANDERSON STENOGRAPHER COMPUTER SEVEN THOUSAND TOTAL ONE HUNDRED SEVENTY NINE THOUSAND DESIRABLE TO ADD ITEM FOR CONTINGENCIES STOP MACHINE TOOLS AND OTHER EQUIPMENT FOR SHOP COSTING ABOUT EIGHTY THOUSAND SHOULD BE ORDERED AT LEAST IN PART BEFORE MARCH FIRST DETAILS FOLLOW BY AIR MAIL STOP WE=

1220S

...ERVICE

...a full-rate ... or Cable- ...nless its de- ...character is in- ...ed by a suitable ... above or preced- ...the address.

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Received at

1928 SEP 3 PM 9 17

SB497 2/25=

NOW FEEL COMPLETE SUCCESS OF PROJECT ASURED KINDLY WIRE ACTION OF EXECUTIVE COMMITTEE WE WILL SET NEWSPAPER RELEASE DATE ONE WEEK LATER IF ACTION FAVORABLE=

GEORGE E HALE.

FORM G. E. B. 22

1032

INTERVIEWS: Doctor Robert A. Millikan, President, California Institute of Technology, Pasadena, California - September 5, 1928

Wednesday, September 5, Doctor Millikan called at the office to inquire as to when the Executive Committee would meet. I told him that President Arnett was not expected until after September 10, but that as soon as a date was fixed I would wire to California Institute and wire again after the Executive Committee had considered the item regarding the telescope. I asked Doctor Millikan to go over my first draft of this statement to see if there were any suggestions. He did so and indicated that the statement was correct. I inquired as to the status of the various committees. The majority of these have been consulted with either at Mount Wilson or elsewhere and are cooperating in the undertaking. Those who have not been seen have been written to, but in the case of foreign representatives, Doctor Millikan does not know the status of their active participation as yet.

H. J. Thorkelson

1037

HJT MDB

THE ROCKEFELLER FOUNDATION
INTER-OFFICE CORRESPONDENCE

FORM 106

1032

	Mr. Thorkelsen	9/6/2[illegible]	9-7-28

My dear Mr. Thorkelsen:

I shall be glad if you will give me any comments upon the enclosed letter that occur to you as appropriate. What, if any, relation does this project bear to the undertaking to which the IEB is committed in Southern California?

Sincerely yours,

George E. Vincent

September 7, 1928

My dear Doctor Vincent:

Replying to your note of September 6, I have read with the greatest interest President Campbell's letter of August 22. The project is quite independent of the proposed telescope for the California Institute of Technology and I would assume it could be appropriately presented either to the Rockefeller Foundation or to the International Education Board.

There is now pending before the International Education Board an application from the University of Leiden dated October 28, 1927, for aid in establishing an astronomical station at Johannesburg, South Africa. Doctor Shapley looked into the situation while abroad and has suggested a conditional appropriation of $100,000 for the support of this project.

In view of the fact that the appropriations made by the International Education Board at the May meeting reduced its unappropriated capital to $2,390,000, it would seem highly desirable to have a conference between the officers of the International Education Board and Doctor Mason on projects of this kind which under the interpretation of counsel cannot be considered by the General Education Board.

Out studies in the field of astronomy indicated three promising methods of increasing knowledge of the heavens:

(1) Adding to the number of telescopes available, particularly by the erection of telescopes in the Southern Hemisphere;

(2) Improving photographic plates and thus extending the powers of existing instruments; and

(3) Constructing a larger instrument than any heretofore built.

The third method seems to offer the greatest opportunity for advancing knowledge of the heavens and of the constitution of matter through the use of a 200-inch instrument in connection with an astro-physical laboratory.

The International Education Board on May 29, 1925, made an appropriation of $180,000 toward $360,000 to enable Harvard University to transfer its instrument from Arequipa, Peru, to Bloemfontain, a point in South Africa. On November 17, 1927, the General Education Board also made an appropriation to Harvard of $200,000 toward $600,000 for the construction of a new building and for increasing facilities for research. On May 28, 1926 the International Education Board made an appropriation of $15,000 to the Astronomical Union for publications of planetary research; $5,000 was added to this appropriation on June 4, 1926. This particular project was considered with Doctor Leuschner of California. On May 9, 1928, the International

Education Board made an appropriation of $4,000 toward $8,000 for endowment to the University of Lyons, France, for its observatory. These represent, as far as I know, all appropriations in the field of astronomy.

I am interested in President Campbell's statement that the growth of the City of Santiago has resulted in increased illumination of the skies and interference with the work being done. This is similar to the situation now existing at Mount Wilson where the growth of the City of Los Angeles with the consequent illumination of the skies indicates that the new telescope should be located at a point further distant from a large city.

Doctor Campbell occupies a position of unquestioned eminence among the astronomers of this country. His plan seems sound and if either of the boards mentioned is interested in developing a particular science field such as astronomy, this opportunity is certainly worth looking into.

I notice that Doctor Campbell's specific request is apparently intended to cover the estimated cost of the new observatory together with an endowment fund to maintain it in perpetuity. Compliance with such a request would not be in accord with the methods usually adopted by the education boards. In the case of Harvard the contribution represents one half in one instance and one third in the other. In the case of the California Institute of Technology, while the contribution of the International Education Board may approximate

$6,000,000, the Trustees of the Institute have already agreed to appropriate a minimum of $2,000,000 of endowment, and if needed a third million will be secured by them.

I am returning herewith Doctor Campbell's letter, and will be glad to confer with you or with Doctor Mason on this matter at any convenient time.

Yours very truly,

Doctor George E. Vincent
61 Broadway
New York, New York

HJT MDB

1032

September 6, 1928

My dear Doctor Hale:

Thank you very much for your letter of August 29 and for the telegram which preceded it.

Yesterday Doctor Millikan was in the office and I showed him a copy of my first draft of the item to be presented to the Executive Committee of the International Education Board. He feels, as I do, that all of the items you mentioned are satisfactorily covered.

I cannot tell you how happy it makes us to get the good news you are sending regarding developments. President Arnett has not yet returned from his vacation, but I expect him in a few days and also Secretary Brierley. As soon as they return and we can get in touch with the members of our Executive Committee it will be possible to fix a date for the meeting. When this date is determined I will wire you, and I will also wire you as soon as they have taken action.

I am particularly delighted to get your three-page statement of some of the outstanding results obtained at Mount Wilson. This is a perfectly splendid statement of achievement and strengthens

our belief of the possible results to be secured from an even more powerful instrument.

I trust you will not hesitate at any time to suggest methods or plans by which we can expedite the work you are doing. It is a delight for all of us to cooperate with you.

Yours very truly,

H. J. THORKELSON

Doctor George E. Hale
Mount Wilson Observatory
Pasadena, California

HJT MDB

1032

September 10, 1928

My dear Doctor Hale:

I have just received copy of the letter from A. L. Ellis of the Thomson Research Laboratory sent to you under date of August 27. I am very glad to get this information regarding the status of the experimental work at the Lynn plant.

Can you give me some idea as to what the weight of the 200-inch mirror will come to?

Yours very truly,

E. W. THOMPSON

Doctor George E. Hale
Mount Wilson Observatory
Pasadena, California

HJT MDB

1032

WHT
9-10-28

COPY

General Electric Company

River Works
West Lynn, Mass.
Aug. 27, 1928

Dr. George E. Hale,
Pasadena, California.

200" Quartz Mirror

Dear Sir:

Have just wired you as per the enclosed confirmation in response to your telegram to Elihu Thomson under date of August 23rd.

The estimate is made on the assumption that we will cut all red tape and move the program forward with all possible speed. Much of the work will have to be done on a twenty-four hour basis. Our tentative program is as follows:

We expect to be ready to spray the 22" blank by Sept. 5th, finish spraying by Sept. 7th and remove the blank from the furnace by Sept. 10th. The first blank may be a failure altho we do not anticipate any difficulty in doing this job. We feel that we can safely reason from our experience with an 11" blank to a 22" blank.

The next step in the manufacture of the large mirror, would be to construct a melting furnace for a 60" blank. We are expecting to so design the furnace that the melting furnace can also be used for the subsequent spraying operation and annealing cycle. We estimate that the material for this furnace will be ready by Oct. 1st and that the furnace will be ready for heat Oct. 14th. By Oct. 27th we expect to have burned out the furnace and coated the molds. We estimate that the melting cycle will require ten days. We expect to have difficulty with this large mass and are assuming that we will make four runs before we can get a good one. This will bring us to Dec. 15th.

The blank will have to be prepared for surfacing which we propose to grind flat. Any imperfections in the surfaces will have to be prepared for the spraying process which we estimate will bring us to Dec. 22nd. During this time, we will have the heater element changed from carbon which was necessary to melt the mass, to metallic resistor necessary for the glazing process and annealing cycle. The blank will then be raised to 990° C for spraying which brings us to Dec. 24th.

By spraying the surface at six points, simultaneously we expect to finish spraying by Jan. 7th.

The blank will then be raised to above the annealing point 1120° C, held at that temperature and reduced to room temperature by Jan. 28th.

Allowing for a possible failure a second run could be completed by March 27th.

This schedule, as you see, is practically the limit and is assuming that everything will go smoothly and that we will foresee difficulties in time to obviate unnecessary delays. We are therefore, adding thirty days to the estimate for such contingencies which brings us to May next year, at which time we hope to have passed the 60" stage and have data sufficient to be well under way with the 100" stage.

There is considerable work that will have to be carried on in parallel with the above program. To obtain data to obtain the design of the 200" mirror as well as the design of the furnaces for producing it. We must make sure that such a large mass can be brought back to room temperature, reheated for glazing and annealing processes and brought back to room temperature again without devitrifying. We are starying at once to determine the devitrification of the various kinds of quartz to be used. The determination will be made in the atmosphere of a carbon furnace. Also in the atmosphere of a metal resistance furnace which will be used in the glazing process. Simultaneously with these, determinations will be made in a small metallic resistance furnace having a nitrogen atmosphere against the possibility that we will be unable otherwise to sufficiently protect our carbon resistance heaters when melting the large masses.

We will determine the rate of heat transferred from the center to edge of a rather marge mass of quartz under conditiond similar to those of the melting or glazing processes to enable calculation of the cooling cycle for a large mirror of any design, having in mind that it will be possible on account of the characteristics of quartz to produce a light weight structure by resorting to ribbing.

The available data as to the thermal expansion of quartz, leaves much to be desired. We, therefore, propose to accurately determine the differential thermal expansion expansion of the types of quartz to be used in the construction of the mirror. We will also determine the difference, if any, in quartz from different localities.

In obtaining data on the properties of quartz, we will make use of Massachusetts Institute of Technology, Harvard University and the Bureau of Standards to the fullest extent and would undertake to do nothing at Lynn that can better be done at these points. We, of course, would want to direct such work from this end.

You will recognize that the foregoing is an ambitious program, in view of the fact that our experience is confined to surfacing a blank 11" diameter and the production of a sand backing blank 22" diameter. We would not consider making such an estimate except that we know you fully appreciate the state of the development to date and the possibilities of producing the large mirror. We are confident at this time of the ultimate successful production of the large mirror. The estimate of expenditures during the next eight months is consequently an educated guess. The $75,000 figure is probably not far wrong and I am assuming that you will add a factor of safety to this figure, which in your opinion will best satisfy all conditions. In order to realize these dates, we should be working full force in two weeks and should have formal authorization to proceed with the work along these lines, at an early date, with an expenditure limitation rather than one of accomplishment. As we understand it, such authorization will

be given by Dr. John A. Anderson.

Your comments and criticisms of this program would be appreciated.

(Signed) A. L. Ellis

THOMSON RESEARCH LABORATORY

ALE:K
Cy: Prof. Elihu Thomson

Telegram from A. L. Ellis to George E. Hale

Lynn River Works Aug. 25, 1928

Dr. George E. Hale
Pasadena, California.

Estimate approximate expenditures for eight months including cost to date 75000 effectively employing as many men as possible Hope to have passed the 60" stage into the 100" stage by May next year Writing.

A. L. Ellis.

60 Ocean View Ave. 1032
Santa Barbara, Sept. 15, 1925.

Dear Mr. Thorkelson -

Many thanks for your welcome letter, in which you ask me to suggest means of expediting our work. The most important are to order the machine tools and other equipment of the instrument-shop in the near future, and to proceed at once with the design of the Astrophysical Laboratory on the Institute campus, for which we shall have all necessary data

School of Astrophysics.

(3) Equipment for such astrophysical researches as can be undertaken to advantage in Pasadena by members of the staff and graduate students.

(4) Equipment for the laboratory interpretation of astrophysical phenomena.

(5) Optical shop, for such work as can be done here to best advantage.

I have given much thought to the design of this Laboratory, and am sure we can make it a unique institution, supplementing* to

* Not duplicating.

when I reach home early in October. If your Executive Committee approves, my purpose is to put this into the architects' hands as soon as our sketches are completed.

This building must serve the following purposes:

(1) Headquarters for the Observatory staff in Pasadena, with full provision for the measurement and discussion of our telescopic plates and observations, and offices for members of the scientific staff and computers.

(2) Headquarters for the Graduate

great advantage the Norman Bridge and Gates Laboratories of the Institute and the (Mt. W.) Observatory Laboratory in Pasadena. The equipment should be of the highest class, and some of it (like the very powerful magnet needed for solar research and for physical researches bearing directly on the structure of the atom) would be of service to the physicists, chemists, mineralogists, metallurgists, and probably also the biologists of the Institute. It is of course covered by the estimates sent with our formal request.

The enclosed progress report to the Observatory Council and the Advisory Committee may include a few points not covered in my letters to you.

Very sincerely yours George E. Hale

Dr. Anderson and Dr. Pease leave for the east today.

Marked "Confidential" - 1032

THE POLICY OF THE ASTROPHYSICAL OBSERVATORY

It may be advantageous at this stage of our preliminary work to emphasize the two guiding principles in the policy of the Astrophysical Observatory and Laboratory of the California Institute: the maintenance of an open mind regarding all questions of procedure, and the importance of securing the cordial cooperation of the best authorities in this country and abroad in solving them. Thanks to the unanimous judgment of the Observatory Council, its Advisory Committee, and their many able advisers, several general decisions, which have greatly expedited the preliminary work, have been made. But we cannot be in a position to settle other questions of equal scientific and technical importance, not to speak of matters of detail, until an exhaustive study of all the possibilities suggested by recent progress here and in Europe has been completed.

The principal ~~discussions~~ decisions and results thus far reached are as follows:

(1) The 200-inch mirror disk should be made of solid fused quartz. Through the cordial cooperation of the General Electric Company, promised by its President, Mr. Gerard Swope, work was undertaken in July by Dr. Elihu Thomson at West Lynn with this object in view. Dr. Thomson hopes to complete a 60-inch quartz disk and begin a 100-inch disk by next May, much in advance of earlier estimates.

(2) A rigorous comparative study of promising mountain sites should be made without delay. Precise measures of seeing, rather than estimates, are essential. Dr. Anderson accordingly devised a simple means of measuring the oscillations of star images under a power of 600 with a 4 or 5 inch telescope, and Mr. Ellerman tested it satisfactorily on Mount Wilson, in comparison with the estimates of observers with

the 60-inch and 100-inch telescopes. Preliminary tests by Messrs. Ellerman and Humason of this method indicate that both day and night seeing at Palomar and the day seeing at Horse Flats is somewhat better than at Mount Wilson, while the darkness and purity of the sky at both of these sites are much superior. Preliminary tests at Table Mountain are such as to make it desirable to make further examination of this site. The Chief of the Weather Bureau has kindly loaned three sets of meteorological instruments, which will soon be installed.

My earlier letter, based on a preliminary verbal report, said 100. But this doubtless included close visual binaries.

(3) Data kindly supplied by Dr. Aitken indicate that at least 30 spectroscopic binaries, not to speak of many close visual binaries, could be measured with a 40-foot stellar interferometer, which should be built so as to rotate in position angle without getting out of adjustment. This demands an extremely rigid design, both for the interferometer and the telescope tube.

(4) Theoretical studies of the field of an F/3.3 paraboloidal mirror by Messrs. Anderson and Seares, confirmed by a more complete investigation by Dr. Ross, show that it is small, but large enough to render the use of this ratio desirable. This conclusion is strengthened by Dr. Ross's belief that he can design a lens, for use in front of the plate, which will greatly enlarge this field when desirable. Dr. Ross has also determined the field of an F/10 Cassegrain combination, and finds it to be essentially perfect over 30' in diameter. He will continue his investigations of the optical design of the 200-inch telescope during the coming year.

About 17 inches, a splendidly large field.

(5) Dr. Pease has continued his work on the preliminary design of the mounting, which we hope can be made of the forked equatorial type, with

coudé mirror attachment. The final design will be worked out jointly by Dr. Pease, Dr. Anderson, Mr. Ambrose Swasey and his associates, Mr. Gano Dunn, and others, with the advice of the astronomers, physicists and opticians of the California Institute and the Mount Wilson Observatory, and of others whom we are consulting.

(6) The extensive study of auxiliary instruments that forms a prime feature of the general scheme has been begun, as follows:

(a) Mr. George Eastman and Dr. C.E.K. Mees have generously agreed to deal with many of the photographic problems at the Research Laboratory of the Eastman Kodak Company.

(b) A Zeiss recording micro-photometer has been ordered, for study and possible improvement by Dr. Pettit and other members of our staffs.

(c) Dr. Sinclair Smith will attempt to develop and improve the radiometer recently used very successfully by Dr. Abbot with the 100-inch Hooker telescope. He will also make a study of the best means of producing grating replicas.

(7) A well-equipped astrophysical instrument-shop will soon be erected on the campus of the California Institute.

(8) Preliminary studies have been made for the design of the Astrophysical Laboratory on the campus of the Institute.

(9) A committee has been appointed to prepare a comprehensive scheme for the proposed Graduate School of Astrophysics.

(10) Dr. St. John and Dr. King, who have visited many European observatories, laboratories, and instrument-shops in search of useful ideas and suggestions, have prepared valuable reports on the results of their inquiries.

These strongly emphasize the necessity of our acquiring ample knowledge of recent developments. For example, the radical changes made by Zeiss and others in the design of driving-clocks and of counterpoise systems for equatorial telescopes must be fully studied before we attempt to complete even a preliminary design for the 200-inch mounting.

In general, the work thus far ~~xxxxxxxxx~~ accomplished clearly demonstrates the necessity of effective team-play in every phase of our large undertaking. All who are taking part have cordially shown their willingness to join on equal terms with others in developing their share of the work, and it is through the continuation of this spirit of unselfish cooperation that we may hope for the success we are seeking.

George E. Hale.

July 11, 1928.

1032

September 17, 1928

My dear Doctor Hale:

Thank you very much for your letter of September 13. I am delighted to receive these statements of your progress and plans. The Executive Committee will meet Friday, September 21, at which time we will present to them recommendations covering the whole plan and the specific appropriation to cover estimates for the first six months. I will wire you as soon as they have taken action on these matters.

With kindest personal regards,

Yours very truly,

W. J. THORKELSON

Doctor George E. Hale
60 Ocean View Avenue
Santa Barbara, California

HJT MDB

1032

September 18, 1928

My dear Doctor Adams:

Thank you very much for your letter of September 15. I am surprised to find that the mirror is not going to be nearly as heavy as I anticipated.

Yours very truly,

H. J. THORKELSON

Doctor Walter S. Adams
Mount Wilson Observatory
Pasadena, California

HJT MDB

1032

CARNEGIE INSTITUTION OF WASHINGTON
MOUNT WILSON OBSERVATORY
PASADENA, CALIFORNIA

September 15, 1928

Mr. H. J. Thorkelson
International Education Board
61 Broadway, New York City.

Dear Mr. Thorkelson:

Dr. Hale is at present at Santa Barbara and it is possible that he does not have at hand the figures which would enable him to answer your question regarding the weight of the 200-inch mirror.

I believe that you will be interested in the following data which we have put together regarding the large disk. Naturally, they may be subject to some modification, but at least they represent the best of our knowledge at the present time.

Aperture	200"0
Actual diameter of disk	202.0
Focal length	666.7
Thickness at edge	28.0
Depth of concavity	3.82
Thickness at center	24.18
Diameter of hole in center	30.0

Approximate weight 27± tons

The reason for the uncertainty in the weight is due to the character of the quartz which will be employed in the main body of the mirror. The value which I am giving you, however, should be correct within one or two tons.

With best wishes,

Sincerely yours,

Walter S. Adams

WSA:G

1032

September 18, 1928

Dear Mr. Debevoise:

Mr. Thorkelson has gone over the item proper with you. It is enclosed for your information in connection with the proposed action.

Sincerely yours,

W. W. BRIERLEY

Encl. Docket item of California Institute of Technology - Observatory

Mr. T.M. Debevoise
26 Broadway
New York City

WWB:KEO

LAW OFFICES
OF
THOMAS M. DEBEVOISE

26 BROADWAY

NEW YORK September 18,1928.

Mr. W. W. Brierley,
61 Broadway,
New York City.

Dear Mr. Brierley:

I am returning herewith the papers received with your letter of the 17th instant in regard to the California Institute Telescope.

Would it not be well to show in the last preamble to the proposed Executive Committee resolutions whose "statement dated August 29, 1928" it is to which the preamble refers, and to show also in the second resolution that the "expenses", payment of which is authorized, are those itemized in the said statement?

The resolutions show clearly that the appropriation of $215,000. is part of the $6,000,000. appropriation. The officers will, of course, make this clear in notifying the Institute of the Committee's action.

Does not the first resolution you have prepared make the resolution prepared by Mr. Thorkelson and found on page 9 of his docket item unnecessary?

Yours sincerely,

Thomas M. Debevoise

2 Encs.

1032

September 19, 1928

Dear Doctor Hale:

On return to the office, your letter of July 24 comes to my attention. Thank you very much for the kind expressions in your first paragraph.

We duly received the formal request and related material which accompanied your letter of July 6. The matter is being taken up at an Executive Committee Meeting of the International Education Board to be held on Friday of this week, September 21. Shortly thereafter you will hear from us again.

Please accept my thanks for the copy of "The New Heavens," which you kindly sent me. I appreciate very much having the book, for while given to this kind of reading one's thoughts are liberated and a fine stimulus afforded the imagination. I know I shall enjoy it.

With best wishes,

Yours very truly,

TREVOR ARNETT

Doctor George E. Hale
Mount Wilson Observatory
Pasadena
California
TA:LFA

1032

August 2, 1928

My dear Doctor Hale:

In behalf of Mr. Arnett, who just now is on vacation, we wish to acknowledge with thanks your letter of July 24. We are also in receipt of your book, "The New Heavens," which you kindly sent. (Given to T. A. 9-11-'28)

Mr. Arnett is expected back at the office the first week in September. He will then be much interested to read your letter and its enclosures, and to examine the book.

Very sincerely yours,

INTERNATIONAL EDUCATION BOARD

By LILLIAN F. ADAMS

Doctor George E. Hale
Mount Wilson Observatory
Pasadena
California

LFA

CARNEGIE INSTITUTION OF WASHINGTON
MOUNT WILSON OBSERVATORY
PASADENA, CALIFORNIA

1032

A TA 7/30/28 T.A. Ⓐ 9-19-'28
Filing Rm
I H.J.T. 8/2/28
Ack'd. L.F.A. 8/2/28

July 24, 1928

Listed for T.A.

Mr. Trevor Arnett
President, International Education Board
61 Broadway, New York City.

Dear Mr. Arnett:

I do not know whether you have yet assumed office, but I was delighted to learn recently of your election to the presidency of the International Education Board, and wish to send my heartiest congratulations. You have an extraordinary opportunity for useful service in this position and I know how well you will utilize it.

In accordance with the detailed information received from Dr. Rose and Mr. Thorkelson during their visit here, and in harmony with a plan of procedure which was fully discussed with them, the formal request of the California Institute to the International Education Board was prepared and sent on July 6, after action by the Trustees of the Institute on July 5. This was signed by the members of the Observatory Council, to whom Dr. Rose requested that the Trustees formally delegate full powers to represent and act for them in all matters relating to the 200-inch telescope. The resolutions according these powers and approving our formal request (which was read in full, with all accompanying papers, to the Trustees) were sent with our letter. I hope we have thus carried out correctly the action desired by your Executive Committee.

As for many reasons an immediate attack on the

numerous problems involved in this large project seemed desirable, we asked Dr. Rose whether we might begin at once. He advised us to do so, and suggested that the Trustees of the Institute advance the necessary funds, which he and Mr. Thorkelson were confident your Executive Committee would return later. The Trustees accordingly authorized an advance of $25,000. for the summer's work, and the first steps were taken immediately after a joint meeting of the Observatory Council and the Advisory Committee. I enclose copy of a telegram from Mr. Gerard Swope, President of the General Electric Company to Mr. Robinson and a letter from Dr. Elihu Thomson, showing the cordial cooperation we may expect from them and, I may add with confidence, from all other agencies whose cooperation we shall need.

Our method of procedure, which I have invariably followed since the initiation of the Yerkes Observatory and the Astrophysical Journal, is that of securing the active interest and assistance of the leading authorities in this country and abroad. Our Advisory Committee, comprising the best men available for frequent meetings with the Observatory Council, consists of Messrs. Adams and Seares of the Mount Wilson Observatory, Messrs. Tolman, Epstein, and Bowen of the California Institute, and Messrs. Michelson (Chicago), Russell (Princeton), and Abbot (Smithsonian Institution). The last three spend several months here each year because of their work at Mount Wilson. Many other authorities less easily accessible will be frequently consulted, so that we may be certain to have the benefit of the best possible advice on the astronomical, physical, chemical,

optical, engineering, and meteorological aspects of the undertaking.

I may add that we are taking precautions to keep the plan out of the newspapers. For a time we thought it might be necessary to issue a non-committal statement, which was approved by Dr. Rose just before he sailed, but we are now hoping to avoid publication of any kind before final action by your Executive Committee.

As you may perhaps be interested in seeing a little book of mine describing the 100-inch Hooker telescope and some related matters, I am sending you under separate cover a copy of "The New Heavens". If you care for any other accounts of our work, I shall of course be delighted to send them.

Believe me, with kind regards,

Yours very sincerely,

George E. Hale

COPY OF TELEGRAM

New York, July 6, 1928

Henry M. Robinson
Los Angeles First National Trust & Savings Bank
Los Angeles California

YOUR TELEGRAM RECEIVED GENERAL ELECTRIC COMPANY WILL BE DELIGHTED TO DO THE WORK ON THE FUSED QUARTZ LENS UNDER THE PERSONAL DIRECTION OF PROFESSOR THOMSON WHO IS MUCH INTERESTED IN IT AT MANUFACTURING COST WITHOUT ANY OVERHEAD FOR COMMERCIAL OR ADMINISTRATIVE EXPENSES WHICH I ASSUME IS WHAT YOU HAD IN MIND SINCERELY YOURS

GERARD SWOPE

GENERAL ELECTRIC COMPANY

West Lynn, Mass.

July 16, 1928

Dr. George E. Hale
Mount Wilson Observatory
Pasadena, California.

Dear Dr. Hale:

Your confidential letter of July 11th was received this morning. I will be pleased to talk over the matter with our Mr. A.L. Ellis, and I shall be glad to take up further correspondence in this connection with Dr. Anderson, as you desire.

I am glad that Mr. Swope has taken the very liberal view which he has, putting the supervision of our laboratory here at command for the future development of the quartz mirror. There are doubtless many problems which will have to be solved, but there is no reason why we should not succeed by taking them up one after the other, beginning with the smaller work and by steps reaching the larger.

The focal ratio of f 3.3 is, of course, quite short, and the disk would need considerable hollowing out in the case of the large mirror. There would seem, however, to be no particular difficulty in giving the concavity to the mirror when it is made up of fused sand, as this could readily be done by grinding. Upon the concave surface, the building-up process would be carried on in such a way as to get a layer of clear quartz for the final working out of the optical surface. However, that is in the future, and any further discussion thereon can be left until much further progress has been made.

I wish to congratulate you most heartily on the progreaa of the organization. I hope that you health will improve by your taking a good rest during the summer months, and I am happy to assure you that my own health has greatly improved in the last couple of months, not that I can complain, exactly, of ill health, but rather of a disability due to a gout or rheumatic condition, whichever it may be.

Very truly yours,

(Signed) Elihu Thomson

Copy

1032

File

60 Ocean View Avenue,
Santa Barbara, California,
September 22, 1928.

Mr. Trevor Arnett,
President International Education Board,
61 Broadway,
New York City.

Dear Mr. Arnett:

Your telegram regarding a site for the 200 inch telescope, repeated from Pasadena, reached me here last evening. Since then I have talked over the telephone with Dr. Noyes and Dr. Adams, and find that we are in complete agreement on the question. I shall be ready to come east, if necessary, after Dr. Millikan returns from a mountain expendition for the study of the cosmic rays, but I hope you will agree with us that the case as presented in this letter leaves no doubt as to the best procedure.

The efficient use of a 200 inch telescope depends directly upon a great mass of knowledge obtained with many smaller instruments, which has been slowly accumulated in the northern hemisphere during the last century. This relates to the proper motions, parallaxes, magnitudes, radial velocities, and spectra of stars, given by the long and persistent use of meridian circles, visual and photographic refractors and reflecting telescopes with apertures up to 60 inches. Many years must elapse before such knowledge of southern stars can compare with that now available in the northern hemisphere. The instruments in use there are small, and even the Harvard 60 inch reflector, and the 60 inch reflector which the Mount Wilson Observatory hopes to send within two or three years, must be actively employed there for decades to help close the gap. This aperture of 60 inches we believe to be the size now needed in the southern hemisphere. After these telescopes and others of smaller size have supplied the necessary supporting data, the 200 inch could be moved to a southern station if this should seem wise.

When it is considered, however, that the only proper function of such a large and costly instrument is to deal with problems beyond the range of smaller telescopes, it is evident that its employment in the northern hemisphere should extend over several decades, at least. The many large spiral nebulae that Dr. Hubble has selected for study are easily within its reach at this latitude and their thorough examination will occupy a long period, in view of the extreme faintness of the stars comprised in

them. Remembering that the space open to exploration with this telescope will be at least eight-fold (very likely twenty-fold or more) that within range of the 100 inch Hooker telescope, that the number of stars known in the galactic system should be doubled by its aid, and that it should disclose hundreds of thousands of new spiral and elliptical systems beyond the Milky Way, the immense task before it in the heavens accessible from our latitude is obvious. However, its ultimate transfer to a southern station would be perfectly feasible, as the latitude of the best region in South Africa is nearly the same as that of the only suitable sites in the United States.

These sites undoubtedly lie in Southern California or possibly in Arizona, as the observations of many years have shown. Our present comparative tests, by a new and rigorous method, are being made at four mountain sites in Southern California, but we expect also to make telescopic tests at several points in Arizona, for which we have already obtained extensive meteorological data from the Chief of the Weather Bureau. The summer rainy season in Arizona and the low winter temperatures in the most promising regions, are unfavorable indications. Moreover, a consideration regarded by Dr. Rose as paramount must be kept constantly in mind. This is the importance of establishing the 200 inch telescope within a few hours ride of such a strong group of investigators as we have in Pasadena.

It is unnecessary to urge the desirability of entrusting the design, construction, and use of such an expensive instrument to competent and experienced men. But it may be worth while to point out that the chief significance of the whole plan lies in our joint scheme. At the South African Stations, for example, though they may be visited at intervals by leading astronomers, the actual work of observation is usually conducted in a routine way by one or two assistants, cut off from contact with productive thinkers and of necessity pursuing their duties in a mechanical manner. It is not from such sources that prime advances in principles or methods of observation are likely to proceed. Not one but several investigators of the highest type, constantly stimulated by personal contact and by daily discussion with men of the same high calibre working in related fields, are absolutely necessary if we are to secure such advances as we have in view. I do not mean, of course, that routine observations cannot be effectively made by skilled assistants, or that their ultimate

discussion by very able investigators may not lead to important discoveries. Such discoveries are sure to result from a well-planned expeditionary scheme. But in addition to advances of this nature, we may reasonably expect others of at least equal importance if the telescope is used in the manner that seems to us the only permissable one in a case of the present magnitude.

To appreciate this fully it is necessary to take into account the recent revolutionary advances in the physical sciences, and their vital bearing on the progress of astronomy. The necessity of close and stimulating contact between mathematicians, physicists, astronomers, chemists, geophysicists, geologists, and men in other branches of science is a vital factor in our scheme. Its effect has been plainly shown by the productive investigations directly resulting from such contacts in Pasadena, one of which was the remarkable discovery of the source of the chief nebular lines by Dr. Bowen, one of Dr. Millikan's associates in the Norman Bridge Laboratory, who had never previously worked in astronomy. The significance of this discovery was equally important to astronomy and physics, and if our plan is carried out as projected a great number of similar advances may safely be predicted. I am sure that Dr. Morgan's recent removal to Pasadena, where he is now at work in his new laboratory, was largely due to his appreciation of the value of such contacts with our physicists and chemists and the possibility they suggest of advances in biological research. I also venture to believe that even the Astrophysical Laboratory we are planning as a part of our new project may assist in the accomplishment of Dr. Morgan's purpose.

There is another and no less vital principle underlying our scheme. In addition to the moral and mental stimulus that has resulted from the joint work of the California Institute and the Mount Wilson Observatory, a stimulus which the more intimate relationships involved in the 200 inch telescope project in its present form would surely multiply, I can assure you that the work of the Mount Wilson Observatory could never have been done under conditions widely different from those existing here. Thus Adams' fundamental discovery of his spectroscopic method of measuring stellar distances was the outcome of a combination of solar, laboratory, and stellar researches such as no expeditionary project has ever yielded. The discovery of magnetic fields in sun-spots and of the general magnetic field of the sun are cases in point. Another instance, vital to the wider success of the 200 inch telescope, is illustrated by the work of Michelson and Pease with the 20 foot stellar interferometer attached to the 100 inch telescope. Their epoch-making advance in measuring star diameters and the

separation of the components of two spectroscopic binary stars was dependent upon the immediate availability of large shop and laboratory facilities and the means of experimentation they afforded.

In still higher degree the 40 foot interferometer we have planned for the new telescope, which involves greater technical difficulties than the previous instruments, requires exceptional shop and laboratory facilities. The same is true of the many other auxiliaries and methods which, if provided, will multiply the efficiency of the new telescope many fold. We do not regard it as the traditional refractor or reflector, merely carrying certain readily portable accessories suitable for routine work. If it is to meet our expectations and justify the large expenditure of money involved, it must be a living and growing thing, profiting by the daily interest and advances of a large group of the ablest investigators and steadily increasing in efficiency and usefulness through the development and adaptation of new ideas. In our judgment, such a result can be obtained only in an environment as favorable as we can offer here. The addition of two or more men of the type of Eddington to our staff, and the organization of a Graduate School of Astrophysics resting upon the foundations in mathematics, astronomy, physics, chemistry, and geophysics already prepared, will strengthen still further our present group. Moreover, as you know, we intend to continue the policy of inviting here for special researches such leading investigators, from this country and abroad, as Kapteyn, Shapley, Michelson, Russell, Lorentz, Sommerfeld, and others of equal calibre who have come to us in the past.

I have written in haste, to get this off by air-mail to-day, and probably have failed to answer some of the questions you have in mind. If you will wire these, I will reply at once. Perhaps I might add that we have no evidence that the "seeing" in South Africa or elsewhere in the southern hemisphere is better than here in California, if it is as good.

If Dr. Max Mason is with you I hope you will show him this letter, as he knows many of our group personally and is interested in the plan.

Yours very sincerely,

GEORGE E. HALE

JEB 1032

Monday, September 24, 1928 - New York City

Doctor Harlow Shapley (Director, Harvard College Observatory, Cambridge, Mass.)

While Doctor Shapley was in the office on another matter I took the opportunity to get his judgment on the question of choosing a site for the proposed 200 inch telescope. He said that the matter was complicated to some extent because of the existence of other great telescopes, adding that the Harvard 60 inch telescope in South Africa will cover many of the same problems that the proposed 200 inch reflector would cover. Doctor Shapley went on to say: "Undoubtedly the best place for a great reflector is in the Southern Hemisphere and not in the Northern, because the sky in the south is richer.

"The other complications are: Mr. Robinson's interest in the telescope (that is, his providing for operating expenses), and the desirability of its proximity to great research laboratories. Excellent places in themselves would be: Tibet, Kashmir, Peru, Chile, the Argentine, or Australia, but there are difficulties in connection with them; for example, there would be political difficulties in Tibet. I have a feeling that western Texas or New Mexico would be more satisfactory for climatic conditions, and nearer to the East, than California. Climatic conditions and availability of site must be considered. It is an advantage to have the telescope near the home of the astronomers - people who know how to handle big instruments.

"Another disturbing factor with regard to Southern California is: if the telescope were on the top of a mountain it would be interesting and would attract visitors; but, on the other hand, its location in Southern California would attract more support than some place in New Mexico. It comes down to balancing the different factors."

Doctor Shapley said the project is so big that it would be better able to stand alone, no matter where located, because many of the things needed could be provided in connection with the site itself, which would not be the case in a smaller enterprise. Bear Canyon in New Mexico is as good a site as Palomar, Southern California, if the matter of local support were not involved and if local convenience and comfort were equal. There is a big convenience in having the telescope within overnight traveling distance of Mount Wilson, while in New Mexico there is an advantage of latitude. Doctor Shapley had talked with Doctor Anderson* regarding sites, and thought they are approaching the question rather satisfactorily except that the site seems to be limited to Southern California. There are many things in favor of an interior plateau situation.

Doctor Shapley felt that the opinion of astronomers in general was that the project had been at the initiative of Doctor Hale and the California Institute of Technology and that the site would naturally be considered in its relation to that institution alone. He thought this opinion was the result of the fact that in the initial stages other astronomers had not been consulted.

(*Doctor Anderson's scheme for getting the "seeing" of the sky is very good.)

Doctor Harlow Shapley (Cont.)

I had informed Doctor Shapley of the outside members of the Committee on Site, namely: Doctor Abbot of the Smithsonian Institution, Professor Marvin, Chief of the U.S. Weather Bureau, Doctor Humphreys of the U. S. Weather Bureau, and Doctor Aitken, Assistant Director of the Lick Observatory. He said they were an admirable selection. He said that Abbot was better equipped for this purpose than anyone he knew, and had made extensive studies of this very subject. He also felt that the association of Humphreys would be invaluable if his hands were free; that Humphreys has feeling for the subtle aspects of the problem. Indeed, Doctor Shapley felt there could not be a better committee to get the facts and to appraise them; that this committee would be able to choose a site from the scientific standpoint with considerable success. If it should come down to consulting other persons on site, there are not many men competent to say much about it except those at Harvard who have studied sites. The facts upon which they based their conclusions would be available to the committee.

Doctor Shapley's advice was, not to choose the site too soon. Harvard had had an unfortunate experience in this respect. At Arequipa, Peru, in observations covering forty years, the first year provided numerous satisfactory "breaks," but this did not happen again in the other thirty-nine years. In another instance, where during a period of four months the sky was completely cloudy, it was beautiful throughout the rest of the year.

It would seem that the final decision as to site will be a compromise between the best site available, and human and administrative factors, and perhaps influenced in a degree by the extent to which the telescope is to be operated by Mount Wilson Observatory. I stated that our Board is not interested in specific institutions in this connection, but rather that it is interested in making a contribution which will be most effective in adding to astronomical knowledge. If the telescope were not made available to outsiders, that would tend to limit its effectiveness.

TA:LFA

Angell
Whipple

Form 1228 A

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Send the following message, subject to the terms on back hereof, which are hereby agreed to

SEPTEMBER 25, 1928

DOCTOR GEORGE E. HALE
60 OCEAN XIEW AVENUE
SANTA BARBARA CALIFORNIA

MANY THANKS FOR YOUR EXCELLENT LETTER PLEASE ELABORATE AND GIVE BASIS FOR STATEMENT REGARDING SITES ON PAGE TWO PARAGRAPH TWO QUOTE THESE SITES UNDOUBTEDLY LIE IN SOUTHERN CALIFORNIA OR POSSIBLY IN ARIZONA AS THE OBSERVATIONS OF MANY YEARS HAVE SHOWN UNQUOTE WILL SHOW YOUR LETTER TO MASON WHO ARRIVES NEXT WEEK

Noted
L.F.A.

TREVOR ARNETT

Charge to the account of International Education Board, 61 Broadway, New York $ 1032

Form 1228 A

CLASS OF SERVICE DESIRED			
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Send the following message, subject to the terms on back hereof, which are hereby agreed to

T. A

September 26, 1928

Mr. H. J. Thorkelson
Care of Miss Florence Read
Spelman College
Atlanta, Georgia

EXCELLENT LETTER RECEIVED FROM HALE ANDERSON CALLED THIS MORNING AT HALE'S REQUEST HAVE WIRED FOR SOME MORE INFORMATION NO FURTHER PLANS FOR HALE'S COMING AT PRESENT GREETINGS

Trevor Arnett

File 9/27/28 √

1032.

Wednesday, September 26, 1928 - New York, N. Y.

Doctor J. A. Anderson (Member of staff of Mount Wilson Observatory, Pasadena, Cal.)

Doctor Anderson called at Doctor Hale's suggestion to discuss the inquiry which had been made of Hale regarding plans for selecting a site for the new telescope. Doctor Hale had sent him a copy of his letter of September 22 to T.A. He wished to know what the question at issue was. TA explained that in considering the proposal last week the Executive Committee asked the question whether the Committee on Site in its deliberations would take into consideration suitable sites in any part of the world, or would it confine its inquiries to California - the impression from the correspondence being that the latter was the case. The Executive Committee felt that in a matter of such great importance to astronomy and to science in general the most suitable site - no matter what its location - should be considered. Doctor Anderson said that he thought the position was a sane one but that in discussing the matter in California Doctor Hale and his associates had got the impression from Doctor Rose that contiguity to the California Institute of Technology and the Mount Wilson Observatory was the important consideration, and they therefore had proceeded on that basis although they felt that it would probably be better to discuss the question in its broader aspects, and, indeed, they had done so. He said the southern hemisphere had been discussed for its suitability.

Doctor Anderson reviewed briefly the data which had been collected on suitable sites in connection with the location of the Mount Wilson Observatory, the Observatory at Flagstaff, Arizona, and other observatories - especially inquiries made by Doctor Hussey and Doctor Abbot. He said all these inquiries indicated that in the northern hemisphere Southern California was the most available place because in astronomical work the question of seeing is dependent upon the number of nights available. It was true that the southwest basin of this country (southern Idaho, Nevada, western Colorado, etc.) was clearer, but there were many storms in summer which interfered with the work of the observers. He said there were few storms in Southern California.

Doctor Anderson felt that the question of site was very important and worthy of the most careful thought, and in his opinion Doctor Hale should come on to New York to clear up the matter to the satisfaction of the Executive Committee. He said that he would write to Doctor Hale to that effect on his own account. TA showed him the correspondence which we had had with Doctor Hale and assured him that the inquiry of the Executive Committee was not inspired by any other motive than the desire to have the matter considered on its purely scientific aspect, and had no personal implications whatsoever.

TA:LFA

File

GEB 1032

Wednesday, September 26, 1928 - New Haven, Conn.

Doctor James Rowland Angell (President, Yale University) (Dinner at 6 P.M.)

TA saw President Angell at New Haven on some matters, and inquired his opinion regarding the selection of site for the 200-inch telescope. He said that he would be concerned with the region in Southern California because of the tendency to earthquake, and he wished to be assured of the atmospheric conditions. He read Doctor Hale's letter, and was informed of the personnel of the Committee on Site. He said that he would be satisfied with an opinion prepared by that Committee, especially if Doctor Abbot and Doctors Humphreys and Marvin had a free hand.

Thursday, September 27, 1928 - New York City

Mr. Charles P. Howland (Council on Foreign Relations, 25 W. 43rd St., N.Y.C.)

TA met Mr. Howland at luncheon. He had also talked with President Angell at Yale on September 26 about this matter, and got the same statements from Mr. Angell.

TA:LFA

1032

September 26, 1928

Dear Doctor Hale:

I am greatly obliged to you for your full and explicit letter of the 22nd instant in response to my telegram of September 21 regarding the selection of site for the 200 inch telescope. I sent you the following telegram upon receipt of your letter: "Many thanks for your excellent letter. Please elaborate and give basis for statement regarding sites on page two paragraph two: 'These sites undoubtedly lie in Southern California or possibly in Arizona as the observations of many years have shown.' Will show your letter to Mason, who arrives next week."

The Executive Committee of the International Education Board, in considering the application of the California Institute of Technology for an appropriation for the telescope, wished to be assured that in the determination of the site, all factors involved should be considered by a representative committee, perhaps including European astronomers, without limitation geographically, or otherwise.

Doctor Anderson called to see me this morning at your suggestion to confer with me on the subject. I explained to him the object of our inquiry. He felt the matter was of such importance that you should come on to New York, and said he would write you to that effect, and of our conference.

I agree with Doctor Anderson as to the importance of your coming, and if you can arrange to come without too great sacrifice of health and convenience it would be most desirable. If you do, the date of appointment should be made with reference to having Doctor Max Mason present at the conference. We are expecting him sometime next week, although the date is not definitely known.

Yours very truly,

TREVOR ARNETT

Doctor George E. Hale
60 Ocean View Avenue
Santa Barbara
California

TA:LFA

air Mail

1032

60 Ocean View Avenue,
Santa Barbara, California,
September 22, 1928.

Mr. Trevor Arnett,
President International Education Board,
61 Broadway,
New York City.

Dear Mr. Arnett:

Your telegram regarding a site for the 200 inch telescope, repeated from Pasadena, reached me here last evening. Since then I have talked over the telephone with Dr. Noyes and Dr. Adams, and find that we are in complete agreement on the question. I shall be ready to come east, if necessary, after Dr. Millikan returns from a mountain expedition for the study of the cosmic rays, but I hope you will agree with us that the case as presented in this letter leaves no doubt as to the best procedure.

The efficient use of a 200 inch telescope depends directly upon a great mass of knowledge obtained with many smaller instruments, which has been slowly accumulated in the northern hemisphere during the last century. This relates to the proper motions, parallaxes, magnitudes, radial velocities, and spectra of stars, given by the long and persistent use of meridian circles, visual and photographic refractors and reflecting telescopes with apertures up to 60 inches. Many years must elapse before such knowledge of southern stars can compare with that now available in the northern hemisphere. The instruments in use there are small, and even the Harvard 60 inch reflector, and the 60 inch reflector which the Mount Wilson Observatory hopes to send within two or three years, must be actively employed there for decades to help close the gap. This aperture of 60 inches we believe to be the size now needed in the southern hemisphere. After these telescopes and others of smaller size have supplied the necessary supporting data, the 200 inch could be moved to a southern station if this should seem wise.

When it is considered, however, that the only proper function of such a large and costly instrument is to deal with problems beyond the range of smaller telescopes, it is evident that its employment in the northern hemisphere should extend over several decades, at least. The many large spiral nebulae that Dr. Hubble has selected for study are easily within its reach at this latitude

and their thorough examination will occupy a long period, in view of the extreme faintness of the stars comprised in them. Remembering that the space open to exploration with this telescope will be at least eight-fold (very likely twenty-fold or more) that within range of the 100 inch Hooker telescope, that the number of stars known in the galactic system should be doubled by its aid, and that it should disclose hundreds of thousands of new spiral and elliptical systems beyond the Milky Way, the immense task before it in the heavens accessible from our latitude is obvious. However, its ultimate transfer to a southern station would be perfectly feasible, as the latitude of the best region in South Africa is nearly the same as that of the only suitable sites in the United States.

These sites undoubtedly lie in Southern California or possibly in Arizona, as the observations of many years have shown. Our present comparative tests, by a new and rigorous method, are being made at four mountain sites in Southern California, but we expect also to make telescopic tests at several points in Arizona, for which we have already obtained extensive meteorological data from the Chief of the Weather Bureau. The summer rainy season in Arizona and the low winter temperatures in the most promising regions, are unfavorable indications. Moreover, a consideration regarded by Dr. Rose as paramount must be kept constantly in mind. This is the importance of establishing the 200 inch telescope within a few hours ride of such a strong group of investigators as we have in Pasadena.

It is unnecessary to urge the desirability of entrusting the design, construction, and use of such an expensive instrument to competent and experienced men. But it may be worth while to point out that the chief significance of the whole plan lies in our joint scheme. At the South African stations, for example, though they may be visited at intervals by leading astronomers, the actual work of observation is usually conducted in a routine way by one or two assistants, cut off from contact with productive thinkers and of necessity pursuing their duties in a mechanical manner. It is not from such sources that prime advances in principles or methods of observation are likely to proceed. Not one but several investigators of the highest type, constantly stimulated by personal contact and by daily discussion with men of the same high calibre working in related fields, are absolutely necessary if we are to secure such advances as we have in view. I do not mean, of course, that routine observations cannot be effectively made by skilled assistants, or that their ultimate

discussion by very able investigators may not lead to important discoveries. Such discoveries are sure to result from a well-planned expeditionary scheme. But in addition to advances of this nature, we may reasonably expect others of at least equal importance if the telescope is used in the manner that seems to us the only permissible one in a case of the present magnitude.

To appreciate this fully it is necessary to take into account the recent revolutionary advances in the physical sciences, and their vital bearing on the progress of astronomy. The necessity of close and stimulating contact between mathematicians, physicists, astronomers, chemists, geophysicists, geologists, and men in other branches of science is a vital factor in our scheme. Its effect has been plainly shown by the productive investigatons directly resulting from such contacts in Pasadena, one of which was the remarkable discovery of the source of the chief nebular lines by Dr. Bowen, one of Dr. Millikan's associates in the Norman Bridge Laboratory, who had never previously worked in astronomy. The significance of this discovery was equally important to astronomy and physics, and if our plan is carried out as projected a great number of similar advances may safely be predicted. I am sure that Dr. Morgan's recent removal to Pasadena, where he is now at work in his new laboratory, was largely due to his appreciation of the value of such contacts with our physicists and chemists and the possibility they suggest of advances in biological research. I also venture to believe that even the Astrophysical Laboratory we are planning as a part of our new project may assist in the accomplishment of Dr. Morgan's purpose.

There is another and no less vital principle underlying our scheme. In addition to the moral and mental stimulus that has resulted from the joint work of the California Institute and the Mount Wilson Observatory, a stimulus which the more intimate relationships involved in the 200 inch telescope project in its present form would surely multiply, I can assure you that the work of the Mount Wilson Observatory could never have been done under conditions widely different from those existing here. Thus Adams' fundamental discovery of his spectroscopic method of measuring stellar distances was the outcome of a combination of solar, laboratory, and stellar researches such as no expeditionary project has ever yielded. The discovery of magnetic fields in sun-spots and of the general magnetic field of the sun are other cases in point. Another instance, vital to the wider success of the 200 inch telescope, is illustrated by the work of Michelson and Pease with the 20 foot stellar interferometer attached to the 100 inch telescope. Their epoch-making advance in measuring star diameters and the

separation of the components of two spectroscopic binary stars was dependent upon the immediate availability of large shop and laboratory facilities and the means of experimentation they afforded.

In still higher degree the 40 foot interferometer we have planned for the new telescope, which involves greater technical difficulties than the previous instrument, requires exceptional shop and laboratory facilities. The same is true of the many other auxiliaries and methods which, if provided, will multiply the efficiency of the new telescope many fold. We do not regard it as the traditional refractor or reflector, merely carrying certain readily portable accessories suitable for routine work. If it is to meet our expectations and justify the large expenditure of money involved, it must be a living and growing thing, profiting by the daily interest and advances of a large group of the ablest investigators and steadily increasing in efficiency and usefulness through the development and adaptation of new ideas. In our judgment, such a result can be obtained only in an environment as favorable as we can offer here. The addition of two or more men of the type of Eddington to our staff, and the organization of a Graduate School of Astrophysics resting upon the foundations in mathematics, astronomy, physics, chemistry, and geophysics already prepared, will strengthen still further our present group. Moreover, as you know, we intend to continue the policy of inviting here for special researches such leading investigators, from this country and abroad, as Kapteyn, Shapley, Michelson, Russell, Lorentz, Sommerfeld, and others of equal calibre who have come to us in the past.

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If Dr. Max Mason is with you I hope you will show him this letter, as he knows many of our group personally and is interested in the plan.

Yours very sincerely,

George E. Hale

X2Z

1032

60 Ocean View Avenue,
Santa Barbara, California,
September 26, 1928.

Mr. Trevor Arnett,
President International Education Board,
61 Broadway,
New York.

Dear Mr. Arnett:

Thank you for your telegram received yesterday. As I lack the necessary data to answer your question fully, I telephoned to Professor Seares in Pasadena, who at once prepared the enclosed memorandum. We can give you from the Annual Reports the number of nights of observation and the quality of the "seeing" (sharpness of definition) on Mount Wilson for every night during the past fifteen years or more if you wish them, but other observatories rarely or never publish such figures, so you would have nothing with which to compare them. Professor Seares' memorandum, though without these data, admirably summarizes the case, but some additional remarks may be useful.

Professor S. W. Burnham's telescopic tests of the atmospheric conditions at Mount Hamilton (near San Jose), first drew the attention of astronomers to the advantages of high altitude stations near the southern half of the Pacific coast. They showed such marked superiority over all other observatory sites that Mount Hamilton was selected by the Lick Trustees, acting with the advice of Professor Simon Newcomb, as the best possible location for the Lick 36 inch telescope, the largest refractor of its day. After 1888, when the severe tests made possible by this powerful instrument began to be applied, Mount Hamilton (altitude about 4200 feet) was regarded by astronomers the world over as the finest of all observatory sites. Thus when the 40 inch Yerkes refractor was initiated a few years later, Professor Newcomb thought it should be established in California. But the University of Chicago could not consider a site more than a hundred miles from its campus, and Lake Geneva was finally selected.

In 1903, when the Carnegie Institution began to consider the erection of a large observatory, no restriction as to site was imposed. The committee (of which Professor Campbell of the Lick Observatory, Professor Lewis Boss, and I were the members) selected Professor Hussey of the Lick Observatory to make an extensive series of telescopic tests in California, Arizona, and in the southern hemisphere. He did not find favorable conditions in the southern hemisphere (Australia), but recommended Mount Wilson as the best possible site. As compared with Mount Hamilton, it has the advantage

of greater altitude (5886 feet), much lower wind velocity, and greater distance from the center of the typical cyclonic storms, which enter the Pacific coast in or near Oregon (I am writing from memory, without reference books) and move eastward across the United States. Their diameter is so great that they extend down through the central part of the country, but except in winter,* they do not reach the Mount Wilson region. Such storms affect telescopic observation, not merely in the regions of rain, snow, or cloudiness, but even in their outer zones, where they disturb the air and thus the sharpness of star images.

Our tests at Mount Wilson for twenty four years, made not only with the largest existing telescopes but also with the 20 foot Michelson interferometer, indicate that it is unsurpassed as an observatory site. We photograph the sun on about 300 days in the year, and the average record for the last 15 years shows that observations were made all night on 189 nights and during a part of 95 additional nights. Throughout the long dry season, unbroken by storms, high winds, or clouds for month after month, an enormous amount of observing is done. Moreover, the average sharpness of celestial images, which is the most vital factor in exacting work, is much above that of eastern observatories. The chief question about Mount Wilson as a site for the 200 inch telescope results from the rapid growth of Los Angeles and the surrounding towns and the great increase in the illumination of the night sky caused by the countless lights in the San Gabriel Valley. In 90 percent of our work (all classes of spectroscopic, bolometric, and visual observations, and direct photography with moderate exposures) the conditions are as good as ever, but for very long exposures on faint nebulae with the 200 inch telescope the illumination of the sky may be sufficient to make trouble. We are therefore making a very rigorous test of several mountain sites away from ~~the~~ cities or populous regions, and the results thus far obtained point to Palomar as the most promising, as the "seeing" is distinctly better than at Mount Wilson, while the sky is much darker and purer. However, a long series of tests, both telescopic and meteorological, will be required to settle this important question.

We are not leaving Arizona out of account, but, as I remarked in my last letter, the summer rainy season (from which California is exempt) and the very cold winter nights in the most promising region, are serious objections. Here, again, a most careful study of all the conditions must be made before any decision is reached.

It is a very fortunate fact that the region of the United States which is of suitable latitude (see the memorandum of Seares) and its removal from the path of the

* and then only in part,

typical cyclonic storms that move from west to east (and also those that move along the Atlantic coast) is a great natural laboratory and observatory, offering every variety of high altitude station from the extensive plateau of Arizona to the lofty peaks of San Jacinto and Mount Whitney. Such advantages have served, not only for telescopic observations, but for many other kinds of research, such as Millikan's studies of the cosmic rays. These studies demand, not only high altitudes, but the presence at various high levels of lakes free from radio-active particles in suspension and even of narrow canons, leading to the lakes, to shield his deeply immersed electrometers from the radiations from any part of the sky except, for example, the band of the Milky Way. Needless to say, Millikan's investigations with these great natural telescopes are closely related to the work on the constitution and transformations of matter to be made with the 200 inch reflector.

This brings us back to the argument so strongly emphasized by Dr. Rose as a reason for placing the 200 inch telescope and its auxiliary apparatus in close touch with the group of investigators centered in Pasadena. I wish it were possible for you to obtain his views on this subject, as I know how vital a factor it seemed to him.

Adams and Seares, who came up here last Sunday, have made a further study, in which they were aided by Hubble, of the relative advantages of the northern and southern hemispheres. Their conclusion fully confirms the statements made in my last letter. Thus the spectroscopic binary stars measurable with the proposed 40 foot interferometer can all be reached from Mount Wilson, while the two largest and most important spiral nebulae (Andromeda and Messier 33) lie high in the northern sky, out of reach of any suitable southern station. Moreover, the Magellanic Clouds, which are less important because they are not spirals (the typical form of the "island universes" beyond the Milky Way), can be well investigated with a 60 inch or, at most, a 100 inch telescope.

If I have not sufficiently answered your questions I can send additional data or come east if you wish me to do so.

Very sincerely yours,

George E. Hale

P.S. I am going to Pasadena to-morrow to see Millikan (due Friday) and others, but hope to return here and go home to stay on October 4.

1032

The selection of a site for a large telescope which shall perform with the greatest efficiency is greatly restricted by four limitations, geographical and climatic in character:

(1) Limitation in Latitude

(2) Limitation in Altitude

(3) Range in Temperature

(4) Freedom from Clouds

(1) The latitude should not be less than 30°, otherwise stars at the celestial pole cannot be satisfactorily observed. At the same time, the latitude should not be high, because stars south of the celestial equator, which otherwise would be within reach, would then be sacrificed. Three-fourths of the whole sky is accessible to observation from a station in latitude 30°, and no part of this fraction need ever be observed at altitudes above the horizon which are less than 30°. Conditions in latitudes up to 35° are only slightly less favorable.

(2) To obtain the transparency of sky so essential in photographing the faintest stars, the altitude should not be less than 5000 feet, and preferably should be a 1000 feet more. Still higher altitudes would be desirable except that adverse conditions, such as excessive snow fall, heated air rising from bare rocks above the timber line, etc. then begin to make their appearance.

(3) The range in temperature, both daily and annual, must be moderate. A large daily range is fatal to the finest observational results; deformations of the mirrors of the telescope and of sensitive parts of accessory apparatus, the prisms of spectrographs, for example, cannot be fully compensated against large and sudden changes in temperature. Large annual variations

mean low winter temperatures, which reduce enormously the efficiency of operation. Such temperatures imply bad seeing, arising from unsteadiness of the atmosphere, and a severe strain on the observer.

(4) The reason for freedom from clouds is obvious.

Application of these restrictions to North America at once eliminates all points except those in the southwest of the United States, or possibly a very narrow strip in northern Mexico. Locations in the mountainous region of the east are undesirable because of the latitude or the prevalence of clouds. The Rocky Mountain area is unfavorable because of the great range of temperature. These mountains are in the path of the great cyclonic storms that sweep across the continent. Latitude and other unfavorable conditions eliminate the northern mountains of the Pacific area. Only in the Southwest, Southern California and Arizona, or possibly the extreme north of Mexico, are the four fundamental conditions satisfied.

The conditions mentioned are by no means all that must be satisfied in selecting a suitable site. Steadiness of atmosphere (freedom from the quivering that appears in an exaggerated form on looking across a ploughed field on a hot summer's day) and low wind velocity, are also factors of vital importance, but less significant than those mentioned for general orientation. It need only be added that these conditions are known to be satisfied at various points in the Southwestern area.

(By Frederick H. Seares, Assistant Director of the Mount Wilson Observatory)

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International Education Board

FOUNDED BY JOHN D. ROCKEFELLER, JR. 1923
61 BROADWAY
NEW YORK

September 27, 1928

Dear Mr. Fosdick: - R37

For your information we enclose herewith, at Mr. Arnett's request, copy of a letter sent him under date of September 22 by Doctor George E. Hale with reference to a site for the proposed 200-inch telescope.

Very sincerely yours,

INTERNATIONAL EDUCATION BOARD - Geo. E Hale

By Lillian Adams

Raymond B. Fosdick, Esq.
61 Broadway (Room 3018)
New York, New York

LFA

C
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60 Ocean View Avenue,
Santa Barbara, California,
September 22, 1928.

Mr. Trevor Arnett,
President International Education Board,
61 Broadway,
New York City.

Dear Mr. Arnett:

Your telegram regarding a site for the 200 inch telescope, repeated from Pasadena, reached me here last evening. Since then I have talked over the telephone with Dr. Hoyes and Dr. Adams, and find that we are in complete agreement on the question. I shall be ready to come east, if necessary, after Dr. Millikan returns from a mountain expendition for the study of the cosmic rays, but I hope you will agree with us that the case as presented in this letter leaves no doubt as to the best procedure.

The efficient use of a 200 inch telescope depends directly upon a great mass of knowledge obtained with many smaller instruments, which has been slowly accumulated in the northern hemisphere during the last century. This relates to the proper motions, parallaxes, magnitudes, radial velocities, and spectra of stars, given by the long and persistent use of meridian circles, visual and photographic refractors and reflecting telescopes with apertures up to 60 inches. Many years must elapse before such knowledge of southern stars can compare with that now available in the northern hemisphere. The instruments in use there are small, and even the Harvard 60 inch reflector, and the 60 inch reflector which the Mount Wilson Observatory hopes to send within two or three years, must be actively employed there for decades to help close the gap. This aperture of 60 inches we believe to be the size now needed in the southern hemisphere. After these telescopes and others of smaller size have supplied the necessary supporting data, the 200 inch could be moved to a southern station if this should seem wise.

When it is considered, however, that the only proper function of such a large and costly instrument is to deal with problems beyond the range of smaller telescopes, it is evident that its employment in the northern hemisphere should extend over several decades, at least. The many large spiral nebulae that Dr. Hubble has selected for study are easily within its reach at this latitude and their thorough examination will occupy a long period, in view of the extreme faintness of the stars comprised in

them. Remembering that the space open to exploration with this telescope will be at least eight-fold (very likely twenty-fold or more) that within range of the 100 inch Hooker telescope, that the number of stars known in the galactic system should be doubled by its aid, and that it should disclose hundreds of thousands of new spiral and elliptical systems beyond the Milky Way, the immense task before it in the heavens accessible from our latitude is obvious. However, its ultimate transfer to a southern station would be perfectly feasible, as the latitude of the best region in South Africa is nearly the same as that of the only suitable sites in the United States.

These sites undoubtedly lie in Southern California or possibly in Arizona, as the observations of many years have shown. Our present comparative tests, by a new and rigorous method, are being made at four mountain sites in Southern California, but we expect also to make telescopic tests at several points in Arizona, for which we have already obtained extensive meteorological data from the Chief of the Weather Bureau. The summer rainy season in Arizona and the low winter temperatures in the most promising regions, are unfavorable indications. Moreover, a consideration regarded by Dr. Rose as paramount must be kept constantly in mind. This is the importance of establishing the 200 inch telescope within a few hours ride of such a strong group of investigators as we have in Pasadena.

It is unnecessary to urge the desirability of entrusting the design, construction, and use of such an expensive instrument to competent and experienced men. But it may be worth while to point out that the chief significance of the whole plan lies in our joint scheme. At the South African Stations, for example, though they may be visited at intervals by leading astronomers, the actual work of observation is usually conducted in a routine way by one or two assistants, cut off from contact with productive thinkers and of necessity pursuing their duties in a mechanical manner. It is not from such sources that prime advances in principles or methods of observation are likely to proceed. Not one but several investigators of the highest type, constantly stimulated by personal contact and by daily discussion with men of the same high calibre working in related fields, are absolutely necessary if we are to secure such advances as we have in view. I do not mean, of course, that routine observations cannot be effectively made by skilled assistants, or that their ultimate

discussion by very able investigators may not lead to important discoveries. Such discoveries are sure to result from a well-planned expeditionary scheme. But in addition to advances of this nature, we may reasonably expect others of at least equal importance if the telescope is used in the manner that seems to us the only permissable one in a case of the present magnitude.

To appreciate this fully it is necessary to take into account the recent revolutionary advances in the physical sciences, and their vital bearing on the progress of astronomy. The necessity of close and stimulating contact between mathematicians, physicists, astronomers, chemists, geophysicists, geologists, and men in other branches of science is a vital factor in our scheme. Its effect has been plainly shown by the productive investigations directly resulting from such contacts in Pasadena, one of which was the remarkable discovery of the source of the chief nebular lines by Dr. Bowen, one of Dr. Millikan's associates in the Norman Bridge Laboratory, who had never previously worked in astronomy. The significance of this discovery was equally important to astronomy and physics, and if our plan is carried out as projected a great number of similar advances may safely be predicted. I am sure that Dr. Morgan's recent removal to Pasadena, where he is now at work in his new laboratory, was largely due to his appreciation of the value of such contacts with our physicists and chemists and the possibility they suggest of advances in biological research. I also venture to believe that even the Astrophysical Laboratory we are planning as a part of our new project may assist in the accomplishment of Dr. Morgan's purpose.

There is another and no less vital principle underlying our scheme. In addition to the moral and mental stimulus that has resulted from the joint work of the California Institute and the Mount Wilson Observatory, a stimulus which the more intimate relationships involved in the 200 inch telescope project in its present form would surely multiply, I can assure you that the work of the Mount Wilson Observatory could never have been done under conditions widely different from those existing here. Thus Adams' fundamental discovery of his spectroscopic method of measuring stellar distances was the outcome of a combination of solar, laboratory, and stellar researches such as no expeditionary project has ever yielded. The discovery of magnetic fields in sun-spots and of the general magnetic field of the sun are cases in point. Another instance, vital to the wider success of the 200 inch telescope, is illustrated by the work of Michelson and Pease with the 20 foot stellar interferometer attached to the 100 inch telescope. Their epoch-making advance in measuring star diameters and the

separation of the components of two spectroscopic binary stars was dependent upon the immediate availability of large shop and laboratory facilities and the means of experimentation they afforded.

In still higher degree the 40 foot interferometer we have planned for the new telescope, which involves greater technical difficulties than the previous instruments, requires exceptional shop and laboratory facilities. The same is true of the many other auxiliaries and methods which, if provided, will multiply the efficiency of the new telescope many fold. We do not regard it as the traditional refractor or reflector, merely carrying certain readily portable accessories suitable for routine work. If it is to meet our expectations and justify the large expenditure of money involved, it must be a living and growing thing, profiting by the daily interest and advances of a large group of the ablest investigators and steadily increasing in efficiency and usefulness through the development and adaptation of new ideas. In our judgment, such a result can be obtained only in an environment as favorable as we can offer here. The addition of two or more men of the type of Eddington to our staff, and the organization of a Graduate School of Astrophysics resting upon the foundations in mathematics, astronomy, physics, chemistry, and geophysics already prepared, will strengthen still further our present group. Moreover, as you know, we intend to continue the policy of inviting here for special researches such leading investigators, from this country and abroad, as Kapteyn, Shapley, Michelson, Russell, Lorentz, Sommerfeld, and others of equal calibre who have come to us in the past.

I have written in haste, to get this off by air-mail to-day, and probably have failed to answer some of the questions you have in mind. If you will wire these, I will reply at once. Perhaps I might add that we have no evidence that the "seeing" in South Africa or elsewhere in the southern hemisphere is better than here in California, if it is as good.

If Dr. Max Mason is with you I hope you will show him this letter, as he knows many of our group personally and is interested in the plan.

Yours very sincerely,

GEORGE E. HALE

ARTHUR WOODS
61 BROADWAY
ROOM 3006
NEW YORK CITY

TELEPHONE: WHITEHALL 5010
CABLE AND RADIO: COTSWOLD, NEW YORK

September 28, 1928.

Trevor, Arnett, Esquire
International Education Board
61 Broadway
New York City.

Dear Mr. Arnett:

Thanks for letting me see Dr. Hale's letter of September 22nd. He rather dazzles one with his allusions to space, and he certainly sounds convincing.

The point I should like to clear up, however, is the one which, as I remember, was mentioned in our discussions last spring, and that is that the site should be determined with the advice of representative astronomers. I don't believe you can comply with the implication of the term "representative astronomer" unless you have not merely astronomers from different parts of the United States, but also some from Europe. If such a committee approved what Dr. Hale so convincingly writes, I feel there would be no further question in the matter.

Sincerely yours,

Arthur Woods

AW:EE

T. A. OCT 2 1928 T. A. 10/2/28 5 copies
Filing Room ✓ Telegram
1032

60 Ocean View Avenue,
Santa Barbara, California,
September 29, 1928.

Mr. Trevor Arnett,
President International Education Board,
New York.

Dear Mr. Arnett:

I returned last night from Pasadena where I saw Millikan, Robinson, Noyes, Seares, Hubble, Morgan, and others. Millikan has just returned from a cosmic ray expedition, beginning at Arrowhead Lake, about 3½ hours by motor from Pasadena, where most of his work is done; continuing at several lakes in the high Sierras, at altitudes up to 9000 feet or more (I think one is at 12000 feet); and ending with a trip to Pike's Peak, to check with lead the absorptive effects measured previously in water, and to test the influence of the radio-active rocks at its summit. His fundamental discovery of the different types of highly penetrating rays, which gives the first indication of the formation of the elements in cosmic space, was made at Arrowhead Lake, thus emphasizing the point made in my last letter of the great advantage of having these high level natural laboratories within easy reach of our group in Pasadena that is dealing with the terrestrial and celestial aspects of the problem of the constitution of matter and the light they throw on the structure and evolution of the universe. I think that Dr. Mason, as a physicist, will agree that this cooperative work lies at the very base of our scheme for the new Astrophysical Observatory and its Laboratory, and that its bearing on the question of site is vital.

Professor Seares has been unable to find statistics giving the number of days and nights of observation at eastern observatories, but he is confident that we have at Mount Wilson an advantage of from fifty to a hundred clear nights per year. Moreover, it is not merely a question of a cloudless sky: at the Yerkes Observatory the sparkling clear nights of winter usually give the worst results, greatly inferior to those of the hazy nights of October, when the celestial images are much better. The effect of the sparkling nights is shown by the twinkling of the stars, which is enormously magnified in a large telescope. The images are distorted and displaced by irregular refraction just as the landscape is affected when seen with the naked eye across a heated field. The resulting telescopic image of a star, which should be a very minute sharp point, steady and unmoved under great magnification, is often expanded into a large blurred disc. Even when fairly small it is always in motion, combining a slow-period swing in any direction with

an oscillation so rapid that it cannot be eliminated by any of the devices employed for "following" the image during long photographic exposures. In comparing two sites, therefore, we must know not merely the number of clear days or nights at each. We should also have an exact measure of the quality of images, and this is almost invariably lacking. Measurement of star images on photographs is useful, provided that the photographs are made by equally good observers and with strictly comparable instruments. A large telescope is more affected by atmospheric disturbances than a small one, and for this reason I think our Mount Wilson photographs, made with the largest apertures, afford the most thorough test of this question yet obtained. We now have also the new method of Anderson, devised this summer for the purpose of permitting us to make reliable comparative tests of various sites with portable telescopes. In this method, which has been thoroughly tested alongside the 60 inch and 100 inch telescopes, the oscillations of the star images are visually measured under a magnification of 600 diameters. We are thus able to compare other sites accurately with Mount Wilson.

I have made many studies of the effect of altitude and of local conditions of many kinds during the last forty years, with telescopes ~~of apertures~~ ranging in aperture from 2 inches to 100 inches. My early work was done in Chicago, where the "seeing" is best with a light southwest breeze and is instantly ruined if the wind shifts to the direction of the Lake. At the Yerkes Observatory similar conditions prevail, with the advantage of freedom from the smoke and lights of a large city. In 1889-90 I did considerable observing at Cambridge, Mass., which is not very unlike Chicago. In 1893 I worked for two weeks (in June) at the summit of Pike's Peak, and learned the effects of the daily thunderstorms and the disturbed state of the air in this region. A year later I tested the seeing at Catania, Sicily, and spent a week observing on Mount Etna, where I again saw the effect of heated air rising from bare rock (or lava) and the necessity of avoiding mountain tops which, like Pike's Peak or Etna, are so commonly surrounded by cloud caps even during the best season. At the Yerkes Observatory I made a series of special studies on the effect of the height of the telescope above the ground, the influence of heat from the dome and within the telescope tube, the effect of an indraft of air through the shutter produced by a 4 foot electric fan, etc. In 1904, following Hussey's preliminary work (see his report), I began a series of tests on Mount Wilson, which has been continued with various instruments ever since. I have also made some observations in England and elsewhere, and com-

pared notes with many astronomers in this country and abroad. Here in Santa Barbara I have tried the effect of placing a telescope on the beach at the water's edge and at various distances inland. This experience, combined with a study of the tests made by Piazzi Smyth at Teneriffe, Thollon at the Pic du Midi, and by more recent observers at other sites, has given me some knowledge of the problem, which is much more complex than it may seem at first view.

Many factors must be considered. For example, a single dust-storm, such as I have frequently seen in Egypt, would penetrate any dome and seriously injure the delicate mechanism of a large telescope, even if its optical parts were completely protected. High winds, though free from dust, shake the instrument and prevent the taking of good photographs, not to speak of their bad effect upon the definition. Very cold weather numbs the observers fingers, and prevents him from holding the images accurately in position during the many hours of exposure often required. Several other factors are also very important.

The final test is in the results, and those obtained on Mount Wilson speak for themselves. They include the smallest star images (about 0.5 or 0.6 seconds of arc in diameter), and the sharpest details of nebulae, of the moon, and of solar flocculi ever photographed, and many other direct consequences of good atmospheric conditions not surpassed, if equalled, at other observatory sites. In a letter just received from Dr. Aitken,* Associate Director of the Lick Observatory, he says that in his personal opinion Southern California is superior to Arizona, but our minds are open, and we mean to test the question thoroughly.

Dr. Hubble has called my attention to the fact that the nearest cluster of extra-galactic nebulae, the only one in which spirals of various types are large enough for study with a 200 inch telescope, lies in the northern sky.

Very sincerely yours,

Geo. E. Hale

* The double star observations by Burnham, Hussey, and Aitken at the Lick Observatory afford perhaps the most decisive test of the superiority of Mt. Hamilton over eastern sites.

(California Institute of Technology)

(October 1928) 1032

I am greatly obliged to you for your letters of Sept discussing so fully the merits of a site in Southern California for the new telescope. They do not, however, answer the questions raised by our Executive Committee, which, as Dr Anderson doubtless informed you, relates to the procedure to be followed in the selection of site, and not the merits of the site selected. Our Committee does not wish to express an opinion as to what would be the best location, but it feels that in an enterprise of this magnitude with the possibilities of far reaching effects scientifically, the method

used in making the selection should be one that would commend itself to astronomers and scientists the world over, and that consideration should be given to location without geographical limitations ~~with due importance placed on all the factors involved.~~ ✓ O.K.

In arriving at a decision all the factors which enter into an project of this nature must be given due weight, the relation of location to the project, climate, seeing, accessibility, contacts with other scientists, living conditions, etc., by those competent to appraise them. From the facts before us we feel that the location as suggested should be more representative and should (possibly ! M.M.) include some foreign members, and should not be limited to a consideration of sites in one general location, and that ~~perhaps~~ it would

be desirable to have a conference of distinguished astronomers and scientists to discuss the matter before the (?) work ~~was~~ of selection was begun, and ~~that there should be~~ a conference of the committee on site and the ~~C~~consultants to receive the report and pass upon it when it is complete.

I shall be glad to have your opinion on the feasibility of the suggestions herein made or any suggestions which you may wish to give for a method of procedure which will meet the point raised by our Ex. Com.

I assure you of our wholehearted interest in the enterprise and of ~~the~~ our cordial desire to cooperate.

We are aware of Dr Rose's conviction that the site should be available to Lab. Dist. & Mt. Wilson to permit close cooperation with their scientists, and this of course is one of the important factors which must be considered.

The expenses of the conference would be borne by the I. E. B.

(10/1/28) 1032

CALIFORNIA INSTITUTE OF TECHNOLOGY - TELESCOPE

1. a. Matter referred to Executive Committee by IEB on May 25, 1928 with power to act up to a total obligation of $6,000,000. (1)

   b. Rose and Thorkelson visited California Institute of Technology in June, after Board meeting, and discussed projects and plans for its execution. (See Rose's report, contained in letter to members of the IEB dated June 18, 1928) (2)

   c. Detailed plan, method of procedure and personnel of Committee, together with request for appropriation of $216,000 for work during next six months, submitted to Executive Committee. The Executive Committee also asked to approve the project and authorize execution of a pledge with the California Institute of Technology. (September 21, 1928) (3)

2. Executive Committee raised a question regarding Committee on Site. Thought it not sufficiently representative if sites other than those in Southern California were to be considered. Felt strongly that in a project of such world-wide significance the site should be selected on its merits - without geographical or other limitation - and the selection approved by a thoroughly representative committee on which were American and foreign astronomers.

3. Telegraphed Hale if he could come on and discuss selection of site without geographical limitation. He replied that he was sending a letter explaining matter (see letter from George E. Hale, Sept. 22, 1928) and hoping matter could be settled by correspondence. (4)

CALIFORNIA INSTITUTE OF TECHNOLOGY - TELESCOPE

4. On September 26, 1928 Doctor J. A. Anderson, the executive officer in charge of the project, called at Hale's request. (See TA's memorandum of interview, September 26) At close of interview Anderson said that the matter was so important he would write to ask Hale to come on to New York. (5)

5. Hale sent further information in letter and accompanying reports. (See Hale's letter of September 26, 1928) (6)

6. Saw President Angell in New Haven on Wednesday last (Sept. 26) and Doctor Stokes in Washington on Saturday (Sept. 29). Showed them Hale's letter of September 22. Angell said he would be satisfied with the procedure and the reasons given.
Doctor Stokes felt that it was important that subject be discussed by a conference of American and foreign astronomers.

7. Hale asks that papers be shown to Doctor Max Mason.

8. Executive Committee does not wish to give an opinion on the site, but wishes to be assured that the method of its selection be approved by distinguished astronomers and scientists the world over.

9. Hale reports that Doctor Rose felt strongly that site should be within easy reach of Mount Wilson and the California Institute of Technology.

T. A

10. Dr. Hale's Letter of Sept. 29. (7)

TA:LFA (10-1-28)

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FORM 106

	TA	10/1/28	T. A. (A)	
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THE ROCKEFELLER FOUNDATION
INTER-OFFICE CORRESPONDENCE

I have read this letter from George Hale. I dare say his points are all well taken but I am quite incompetent to pass upon them. All that I as a Trustee ask is that some impartial group of scientists whose interest is solely in the advancement of astronomy will have a chance to pass upon the question of site before the final decision is reached. I am glad you have asked George Hale to come east.

George E. Vincent

GEV:DSB

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60 Ocean View Avenue,
Santa Barbara, California,
September 22, 1928.

Mr. Trevor Arnett,
President International Education Board,
61 Broadway,
New York City.

Dear Mr. Arnett:

Your telegram regarding a site for the 200 inch telescope, repeated from Pasadena, reached me here last evening. Since then I have talked over the telephone with Dr. Noyes and Dr. Adams, and find that we are in complete agreement on the question. I shall be ready to come east, if necessary, after Dr. Millikan returns from a mountain expendition for the study of the cosmic rays, but I hope you will agree with us that the case as presented in this letter leaves no doubt as to the best procedure.

The efficient use of a 200 inch telescope depends directly upon a great mass of knowledge obtained with many smaller instruments, which has been slowly accumulated in the northern hemisphere during the last century. This relates to the proper motions, parallaxes, magnitudes, radial velocities, and spectra of stars, given by the long and persistent use of meridian circles, visual and photographic refractors and reflecting telescopes with apertures up to 60 inches. Many years must elapse before such knowledge of southern stars can compare with that now available in the northern hemisphere. The instruments in use there are small, and even the Harvard 60 inch reflector, and the 60 inch reflector which the Mount Wilson Observatory hopes to send within two or three years, must be actively employed there for decades to help close the gap. This aperture of 60 inches we believe to be the size now needed in the southern hemisphere. After these telescopes and others of smaller size have supplied the necessary supporting data, the 200 inch could be moved to a southern station if this should seem wise.

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It is unnecessary to urge the desirability of entrusting the design, construction, and use of such an expensive instrument to competent and experienced men. But it may be worth while to point out that the chief significance of the whole plan lies in our joint scheme. At the South African Stations, for example, though they may be visited at intervals by leading astronomers, the actual work of observation is usually conducted in a routine way by one or two assistants, cut off from contact with productive thinkers and of necessity pursuing their duties in a mechanical manner. It is not from such sources that prime advances in principles or methods of observation are likely to proceed. Not one but several investigators of the highest type, constantly stimulated by personal contact and by daily discussion with men of the same high calibre working in related fields, are absolutely necessary if we are to secure such advances as we have in view. I do not mean, of course, that routine observations cannot be effectively made by skilled assistants, or that their ultimate

discussion by very able investigators may not lead to important discoveries. Such discoveries are sure to result from a well-planned expeditionary scheme. But in addition to advances of this nature, we may reasonably expect others of at least equal importance if the telescope is used in the manner that seems to us the only permissable one in a case of the present magnitude.

To appreciate this fully it is necessary to take into account the recent revolutionary advances in the physical sciences, and their vital bearing on the progress of astronomy. The necessity of close and stimulating contact between mathematicians, physicists, astronomers, chemists, geophysicists, geologists, and men in other branches of science is a vital factor in our scheme. Its effect has been plainly shown by the productive investigations directly resulting from such contacts in Pasadena, one of which was the remarkable discovery of the source of the chief nebular lines by Dr. Bowen, one of Dr. Millikan's associates in the Norman Bridge Laboratory, who had never previously worked in astronomy. The significance of this discovery was equally important to astronomy and physics, and if our plan is carried out as projected a great number of similar advances may safely be predicted. I am sure that Dr. Morgan's recent removal to Pasadena, where he is now at work in his new laboratory, was largely due to his appreciation of the value of such contacts with our physicists and chemists and the possibility they suggest of advances in biological research. I also venture to believe that even the Astrophysical Laboratory we are planning as a part of our new project may assist in the accomplishment of Dr. Morgan's purpose.

There is another and no less vital principle underlying our scheme. In addition to the moral and mental stimulus that has resulted from the joint work of the California Institute and the Mount Wilson Observatory, a stimulus which the more intimate relationships involved in the 200 inch telescope project in its present form would surely multiply, I can assure you that the work of the Mount Wilson Observatory could never have been done under conditions widely different from those existing here. Thus Adams' fundamental discovery of his spectroscopic method of measuring stellar distances was the outcome of a combination of solar, laboratory, and stellar researches such as no expeditionary project has ever yielded. The discovery of magnetic fields in sun-spots and of the general magnetic field of the sun are cases in point. Another instance, vital to the wider success of the 200 inch telescope, is illustrated by the work of Michelson and Pease with the 20 foot stellar interferometer attached to the 100 inch telescope. Their epoch-making advance in measuring star diameters and the

separation of the components of two spectroscopic binary stars was dependent upon the immediate availability of large shop and laboratory facilities and the means of experimentation they afforded.

In still higher degree the 40 foot interferometer we have planned for the new telescope, which involves greater technical difficulties than the previous instruments, requires exceptional shop and laboratory facilities. The same is true of the many other auxiliaries and methods which, if provided, will multiply the efficiency of the new telescope many fold. We do not regard it as the traditional refractor or reflector, merely carrying certain readily portable accessories suitable for routine work. If it is to meet our expectations and justify the large expenditure of money involved, it must be a living and growing thing, profiting by the daily interest and advances of a large group of the ablest investigators and steadily increasing in efficiency and usefulness through the development and adaptation of new ideas. In our judgment, such a result can be obtained only in an environment as favorable as we can offer here. The addition of two or more men of the type of Eddington to our staff, and the organization of a Graduate School of Astrophysics resting upon the foundations in mathematics, astronomy, physics, chemistry, and geophysics already prepared, will strengthen still further our present group. Moreover, as you know, we intend to continue the policy of inviting here for special researches such leading investigators, from this country and abroad, as Kapteyn, Shapley, Michelson, Russell, Lorentz, Sommerfeld, and others of equal calibre who have come to us in the past.

I have written in haste, to get this off by air-mail to-day, and probably have failed to answer some of the questions you have in mind. If you will wire these, I will reply at once. Perhaps I might add that we have no evidence that the "seeing" in South Africa or elsewhere in the southern hemisphere is better than here in California, if it is as good.

If Dr. Max Mason is with you I hope you will show him this letter, as he knows many of our group personally and is interested in the plan.

Yours very sincerely,

GEORGE E. HALE

1032

October 2, 1928

Dear Doctor Mason:

I am handing you herewith the correspondence and memoranda regarding the California Institute of Technology telescope project. The question at issue, as you will note, is the procedure to be established in the selection of the site.

Yours very truly,

Trevor Arnett

Doctor Max Mason
61 Broadway
New York, New York

TA:LFA

GENERAL EDUCATION BOARD

1032

Form 1228A

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Send the following message, subject to the terms on back hereof, which are hereby agreed to

October 4, 1928.

Mr. George E. Hale
South Pasadena
California

Regret your illness Have consulted Mason Wiring in hope complete understanding and agreement on desirable procedure of selecting site can be reached without trip east No opinion on site is held by us and no desire to pass upon question Board approved principle Quote Observatory to be situated at such place as may be determined by the Trustees of California Technology on advice of a committee of representative astronomers Unquote Our Executive Committee feels force of all your arguments on site but because of magnitude of enterprise and spirit of contribution to whole astronomical world believes that a much more widely representative committee than present one should advise on site and should consider all sites as possible although of course give due weight to all factors including important one of proximity to research group We feel procedure proposed important in itself and also advantageous in ensuring good will and cooperation of all astronomers Can you not have such a committee appointed

Trevor Arnett

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TREVOR ARNETT,PRESIDENT INTERNATIONAL EDUCATION BOARD=

61 BROADWAY NEWYORK NY=

CD

THANKS FOR LETTER AND TELEGRAM GLAD TO DISCUSS WHOLE MATTER WITH YOU AND MASON AM LAID UP IN BED HERE BUT ILLNESS NOT SERIOUS AND SHALL ARRIVE UNIVERSITY CLUB NEWYORK WITH ADAMS NEXT TUESDAY IF PHYSICIAN PERMITS STOP PRESENT SITE COMMITTEE INCLUDES ADAMS MILLIKAN RUSSELL ABBOT ROBINSON AND SEVERAL OTHERS WHO KNOW OBSERVATIONAL CONDITIONS IN CALIFORNIA AND ARIZONA BECAUSE DOCTOR ROSE STATED THAT NEW OBSERVATORY SHOULD BE WITHIN FEW HOURS RIDE OF PASADENA TO INSURE CLOSE CONTACT WITH OUR SCIENTIFIC GROUP AND INTIMATE COOPERATION OF CALIFORNIA INSTITUTE AND MOUNTWILSON OBSERVATORY IN DESIGN CONSTRUCTION AND USE OF TWO HUNDRED INCH TELESCOPE AND ASTROPHYSICAL LABORATORY STOP HE STRESSED PARTICULARLY NECESSITY OF CLOSEST TOUCH WITH STRONG PHYSICAL AND CHEMICAL LABORATORIES OF CALIFORNIA INSTITUTE AND ASTRONOMICAL AND PHYSICAL INSTRUMENTS OF MOUNTWILSON==

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SV415 2/64=

OBSERVATORY SEVERAL OTHER PLANS WERE CONSIDERED BY HIM AND ELIMINATED ALL SUBSEQUENT WORK AND CONFIDENTIAL DISCUSSIONS WITH SCIENTIFIC MEN HERE AND ABROAD WERE BASED ON THIS UNDERSTANDING AND ROSE FULL APPROVAL KINDLY CONSULT THORKELSON AND SIMON FLEXNER WHO KNOW CIRCUMSTANCES THIS TELEGRAM IS PREPARED IN CONFERENCE WITH AND PRESENTS VIEWS OF MEMBERS OF OBSERVATORY COUNCIL AND OTHERS PRESENT AT DISCUSSIONS WITH ROSE AND THORLSELSON=

GEORGE E HALE.

Form 1228 A

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Send the following message, subject to the terms on back hereof, which are hereby agreed to

T. A.

October 5, 1928

Doctor George E. Hale
South Pasadena (739 Hermosa Street)
California

Telegram received. Ten o'clock Wednesday morning tentatively reserved for interview with you, Adams and Mason.

Trevor Arnett

TA:LFA

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A T. A. 10/5/28 T. A. 10/5/28

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TREVOR ARNETT=PRESIDENT INTERNATIONAL EDUCATION BOARD

61 BROADWAY NEWYORK NY=

THANKS FOR TELEGRAM CALIFORNIA INSTITUTE CERTAINLY WANTS BEST POSSIBLE SITE BUT ITS DETERMINATION INVOLVES FUNDAMENTAL QUESTIONS OF POLICY WHICH WE MUST DISCUSS WITH YOU GREATLY APPRECIATE YOUR SUGGESTION BUT HOPE TO LEAVE WITH ADAMS FRIDAY DUE UNIVERSITY CLUB NEWYORK TUESDAY EVENING=

GEORGE E HALE.

Reply by wire, 10/5/28: Telegram received. Ten o'clock Wednesday morning tentatively reserved for interview with you, Adams, and Mason. Trevor Arnett (Copy sent to Univ.Club 10/6/28)

THE QUICKEST, SUREST AND SAFEST WAY TO SEND MONEY IS BY TELEGRAPH OR CABLE

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1632

EXCERPT FROM RECORD OF MR. ARNETT'S INTERVIEWS

Wednesday, October 10, 1928 - New York

Doctor George E. Hale (Mt. Wilson Observatory, Pasadena, California)
Doctor Walter S. Adams (Director, Mt. Wilson Observatory)
Doctor Max Mason (Director, Division of Natural Sciences for GEB and IEB)

Further discussion regarding site for proposed telescope. Interview continued later at University Club, where Doctor Mason met Doctors Hale and Adams. No record of interview dictated by TA.

TA:LFA

FORM 106

1032

THE ROCKEFELLER FOUNDATION
INTER-OFFICE CORRESPONDENCE

From MM's diary

October 11, 1928.

Mr. George E. Hale and Mr. Walter S. Adams

Continued discussion of telescope project, going into more detail as to method of determination of site, plans for auxiliary instruments, astrophysical laboratory at Pasadena, and all phases of the project.

Discussed as well the desirability of appointment by California Technology of a more widely representative committee of astronomers to select the site. Mr. Hale and Mr. Adams expressed themselves completely willing to promote the appointment of such a committee but it was their opinion, as it was mine, that such an appointment would be for the record rather than on account of any scientific knowledge which was necessary, in as much as the committee and advisers who are now active combine in the highest degree the capabilities required for the task.

Further elaboration of the fact that all negotiations have been on the ground of the fundamental idea that the telescope was an adjunct of the great astrophysical institution which is being formed, and therefore should be within a very short distance of Pasadena. Nevertheless A. and H. were perfectly willing to leave decision on this point to a committee which would be representative in a geographical sense, if that was the desire of the Executive Committee.

October 17, 1928.

Mr. Anson Phelps Stokes - Washington, D.C.

Called on Mr. Stokes and explained to him viewpoint in regard to the location of the 200-inch telescope of the California Institute of Technology.

Mr. S.'s questions in the Board meeting were to bring out clearly that there would be adequate study of the conditions, seismological, etc, but said that there should be close cooperation between the work done with the telescope and the group of astronomers and physicists at Mt. Wilson and Pasadena. I explained the situation at the present time and the opinion of GEV, RBF and TA as expressed in our conference, and Mr. S. said he would join cordially with this opinion and was thoroughly satisfied that it was wise and safe to leave the decision to the committee as at present constituted, in as much as they are proceeding with such detailed investigation into all aspects of the question, although with the understanding that the observatory will be located, say, within a night's ride of Pasadena.

Yerkes Observatory
The University of Chicago
Williams Bay, Wis.

Oct. 23, 1928

Dear Dr. Anderson:

Was glad to hear from you. Am happy to state that the zero power corrector is now an accomplished fact, and we can go ahead with the construction of one. I think it would be wiser to make one for the 60", since, for the same size, it would give me a much larger field to test over. I would make it 8" in diameter, and test it on a 5x7 plate. The cost, from Fecker, should be not far from $700.* If you care to give me the authority, I can take it up with him. I think he better do it, since they are so skillful in their surfacing. The glass will have to be extra fine quality. The corrector is of simple two piece design, and will be very transmissive. It however was by no means easy to design, being one of the peskiest things I ever tackled, since the requirements were so numerous, and I wanted to keep it as simple as possible. This lens should prove enormously useful for both the 100" and the 60" for the fine astrometric work involved in getting the internal motions in spirals, and relative proper motions of faint and bright stars, which at present are vitiated by coma. With best regards, I remain,

Very truly yours,

(Signed) F. E. Ross

* It will cost more than this, because the best Jena glass must be used. F.E.R.

1032

MR. ARNETT:

ON SATURDAY DOCTOR HALE TELEPHONED TO GIVE YOU THE FOLLOWING MESSAGE: SINCE SPEAKING WITH YOU ABOUT THE DATE OF RELEASE OF THE ARTICLE ON THE TELESCOPE, HE HAS TALKED WITH ONE OF THE EDITORS OF THE NEW YORK TIMES, WHO, FOR TECHNICAL REASONS, STRONGLY RECOMMENDED MONDAY, OCTOBER 29, RATHER THAN SUNDAY, THE 28TH (WHICH DOCTOR HALE SAID HAD SEEMED TO BE YOUR PREFERENCE).

MR. HENRY M. ROBINSON HAS JOINED DOCTOR HALE IN NEW YORK, AND IN CONFERENCE THEY DECIDED TO ACCEPT MONDAY, THE 29TH, AS THE RELEASE DATE SINCE DOCTOR HALE UNDERSTOOD THAT IT DID NOT MATTER GREATLY TO YOU WHICH ONE WAS CHOSEN.

LFA

O.K.
Ja

10/20/28

For the newspapers - To be released Oct. 29, 1928

1032

A NEW ASTROPHYSICAL OBSERVATORY

WITH A 200-INCH TELESCOPE

The International Education Board has made an appropriation to the California Institute of Technology in Pasadena for the construction of an astrophysical observatory and laboratory, to be equipped with a 200-inch reflecting telescope and many auxiliary instruments. A prime purpose of the gift is to assure the new observatory the advantage in its design, construction, and operation, of the combined knowledge and experience of the strong group of investigators in the research laboratories of the Institute and in the neighboring Mount Wilson Observatory of the Carnegie Institution of Washington. This has been guaranteed by the unanimous approval of the Trustees of the California Institute and by that of the Executive Committee of the Carnegie Institution, taken on recommendation of its President, John C. Merriam, as well as by the cordial support of the members of the research staffs of both institutions, who have closely cooperated for several years in a study of the constitution of matter. ~~Other departments of the Carnegie Institution will also join in the plan of cooperation.~~

The terms of the gift are so broad as to offer a unique opportunity for securing scientific results of the greatest interest. This can be seen from the nature of the equipment, the problems to be solved, and the group of men assembled to attack them.

The new observatory, which will be designed to supplement, not to duplicate, the Mount Wilson Observatory, will comprise two main parts. One of these will be the 200-inch telescope with its buildings, dome, and auxiliary equipment, to be erected on the most favorable mountain

within effective working distance of Pasadena,
site that can be found ~~in Southern California~~. The other will be an Astrophysical Laboratory on the campus of the California Institute, ~~in Pasadena~~. This new Laboratory will be equipped with instruments and all necessary facilities for the study and interpretation of the observational results obtained with the 200-inch telescope, and for graduate instruction and research in astrophysics. It will be supplemented by optical and instrument shops capable of constructing the largest and most delicate instruments required for use in conjunction with the 200 inch telescope.

What may we hope to learn with the new telescope and its auxiliary instruments? It should render possible the exploration of many "island universes" beyond the Milky Way, the nearest two or three of which are now but slightly known. It should tell us something about the evolution of these spiral nebulae, millions of light-years distant, and much about the development of the stars of our own galactic system, one of which is the sun with its encircling planets. It should solve many of the problems of physics or chemistry that depend upon the enormous masses or temperatures, or upon the immense density or extreme tenuity, exhibited by celestial bodies in which titanic experiments exceeding the capacity of any terrestrial laboratory are constantly in progress. Incidentally, it should reveal hundreds of millions of stars and hundreds of thousands of nebulae beyond the range of existing telescopes.

Special emphasis is laid on the fact that a modern telescope for astrophysical research is not merely the traditional lens or concave mirror, gathering up starlight and concentrating it at its focus. Equally vital is the whole battery of instruments and devices developed in recent years to receive, record, and interpret the telescopic images of celestial objects. These are so important that by doubling or treb-

ling their efficiency we may multiply the power of the telescope in the same proportion. The new gift provides for the first time for a general study of all these auxiliary instruments and devices, and for ~~xhmxr~~ their development to such a point as to give the telescope the highest efficiency attainable.

Possibly omit.

The largest auxiliary of the telescope will be a 40-foot Michelson stellar interferometer, attached across the upper end of the tube and arranged so that it can be rotated. This should make possible the measurement of the separation of many so-called spectroscopic ~~xmx~~ binary stars, giving us new knowledge of the evolution of these stellar systems, and throwing a flood of light on the life-histories of stars.

A prime necessity is the photographic plate in its many varieties, sensitized to light of all wave-lengths from the extreme ultra-violet to the remote infra-red. Through the generous aid of Mr. George Eastman and of Dr. C.E.K. Mees, Director of the Research Laboratory of the Eastman Kodak Company, further important improvements in photographic plates for astronomical and spectroscopic research, equal to those recently accomplished under the direction of Dr. Mees, will doubtless be perfected.

Similar special studies of all the other auxiliaries of the telescope will be made by the ablest specialists in this country and abroad. These include the spectroscope in its various forms, for the analysis of the light of celestial objects; the radiometer, the thermocouple, and the photoelectric cell, for the measurement of energy radiation by them; and the various special forms of laboratory instruments needed to interpret the results of telescopic observations.

The success of the undertaking depends upon the intimate cooperation

of many experienced investigators. The California Institute has appointed four members of its Executive Council in general charge of the project. The Observatory Council thus established comprises Messrs. George Ellery Hale, Honorary Director of the Mount Wilson Observatory; Robert A. Millikan, Director of the Norman Bridge Laboratory of the Institute; Arthur A. Noyes, Director of the Gates Laboratory of Chemistry, and Henry M. Robinson, ~~Vice-President of the Trustees~~ a leading trustee of the Institute. Through the courtesy of the Carnegie Institution of Washington, Dr. John A. Anderson, a member of the staff of the Mount Wilson Observatory, will serve as Executive Officer in direct charge of design and construction. An Advisory Committee has been appointed consisting of Dr. Walter S. Adams, Director of the Mount Wilson Observatory, Professor Frederick H. Seares, its Assistant Director; Dr. Charles G. Abbot, Secretary of the Smithsonian Institution; Professor A. A. Michelson of the University of Chicago; Professor Henry Norris Russell of Princeton University; and Professors Richard C. Tolman, Paul S. Epstein, and Ira S. Bowen of the California Institute. This Committee will actively assist the Observatory Council and Dr. Anderson in determining matters of policy.

Many other leading astronomers, physicists, chemists, meteorologists, and engineers in these and other institutions have been and will be called upon for advice and assistance. Thus the General Electric Company, through its President, Mr. Gerard Swope, has offered its invaluable cooperation; and Dr. Elihu Thomson with the assistance of Mr. A. L. Ellis, an able research engineer of the company, has begun preliminary work which he believes will lead to the successful casting of a 200-inch mirror disk of fused quartz, a material greatly superior to glass for this purpose, because its form remains almost unchanged under variations of temperature.

Mr. Ambrose Swasey, Chairman of the Board of the Warner & Swasey Company;
Mr. Gano Dunn, President of the J. G. White Engineering Corporation,
and other eminent authorities, have
~~has~~ also promised the Observatory Council the benefit of their
experience in engineering and instrumental design and construction.
Dr. Frank E. Ross of the Yerkes Observatory has undertaken the
~~has come to Pasadena to~~ study some of the optical problems, and the design of the telescope
and its mounting will be worked out jointly by Dr. Francis G. Pease,
Dr. Anderson, and other members of the Mount Wilson Observatory and
the California Institute, together with Dr. Ross, Mr. Dunn, and Mr. Swasey
especially qualified to take part.

For "Science":

THE ASTROPHYSICAL OBSERVATORY OF THE CALIFORNIA INSTITUTE OF TECHNOLOGY

The International Education Board, at its recent annual meeting in May, authorized its Executive Committee to provide for the construction of an Astrophysical Observatory, equipped with a 200-inch reflecting telescope and many auxiliary instruments, for the California Institute of Technology in Pasadena. A prime purpose of the gift was to secure for the new Observatory the advantage, in its design, construction and operation, of the combined knowledge and experience of the strong group of investigators in the research laboratories of the Institute and in the neighboring Mount Wilson Observatory of the Carnegie Institution of Washington. The assurance of such cooperation, and of the willingness of the Institute to assume full responsibility for the ~~construction~~ establishment of the Observatory and its maintenance when completed, were accordingly made conditions of the gift. These conditions were unanimously agreed to by the Board of Trustees of the Institute on July 5, and the Executive Committee of the International Education Board, at its ~~first autumn~~ meeting on Oct. 18, has ratified the arrangement and provided for its execution.

The prompt action of the Institute trustees was made possible by the fact that on May 13 President John C. Merriam of the Carnegie Institution of Washington, with the unanimous approval of the Executive Committee of the Institution and of Director Walter S. Adams and his associates of the Mount Wilson Observatory, cordially accepted a request for cooperation from the California Institute and assured President Wickliffe Rose

of the International Education Board of the willingness of the Carnegie Institution to join in the proposed undertaking. Formal approval has thus been given to the continuation and extension of the cooperation which has been in progress between the California Institute and the Mount Wilson Observatory for several years, especially in the study of the astronomical, physical, and chemical aspects of the constitution of matter.

The purpose of the Astrophysical Observatory is thus to supplement and not to duplicate the Mount Wilson Observatory. The chief problems in view are those that naturally fit into the general scheme of research in which the two institutions are engaged. Thus the increased light-collecting power of the 200-inch telescope should permit further studies of the size and structure of the galactic system, the distance, radiation, and evolution of stars, the spectra of the brighter stars under very high dispersion, the distance and nature of spiral nebulae, and many phenomena bearing directly on the constitution of matter. It is hoped that a 40-foot Michelson stellar interferometer, designed to rotate in position angle, may be attached to the telescope. In the opinion of Professor Aitken and others who have joined us in considering the matter, this should permit the measurement of the separation of the components of more than thirty spectroscopic binary stars, thus giving very complete information regarding the nature of these systems and the masses of their components.

Possibly omit this (to be discussed with Russell and others)

The new observatory will consist of two parts. One of these will comprise the 200-inch telescope, with its building, dome, and auxiliary equipment, to be erected on the most favor-

within effective working distance of Pasadena.

able high-altitude site that can be found. The other will be an Astrophysical Laboratory on the campus of the California Institute. This Laboratory will serve as the headquarters in Pasadena of the Observatory staff and the Graduate School of Astrophysics. Its equipment will include instruments and apparatus for the measurement of photographs, the reduction and discussion of observations, and for such astrophysical investigations as can be made there to the best advantage. Its instruments for the interpretation of astrophysical phenomena will be designed to supplement those of the laboratories of the Institute and the Pasadena laboratory of the Mount Wilson Observatory. It will also include an optical shop, but the astrophysical instrument shop will be housed in a separate building, to avoid the effects of the vibration of machine tools.

The value of a telescope depends as much upon the efficiency of the instruments and apparatus used to receive, record, and interpret celestial images as upon its optical and mechanical perfection and its light-collecting power. In the present plan special emphasis is therefore laid upon the development of all forms of auxiliary apparatus, such as spectrographs and their optical parts; photographic plates of the various types required for astrophysical and spectroscopic research; radiometers, thermocouples, and photoelectric cells; recording microphotometers and other forms of measuring machines; and laboratory apparatus for reproducing or interpreting celestial phenomena. The study of these auxiliaries will be pushed forward as rapidly as possible, in view of the fact that any results obtained will be immediately applicable in existing observatories and laboratories.

In order to expedite the work, President Wickliffe Rose approved its initiation immediately after the meeting of the California Institute trustees on July 5. An Observatory Council, consisting of four members of the Executive Council of the California Institute, was placed by the trustees in full charge of the design, construction, and operation of the Astrophysical Observatory and Laboratory. This Council consists of Messrs. Robert A. Millikan, Arthur A. Noyes, Henry M. Robinson, and George E. Hale (chairman). Through the courtesy of the Carnegie Institution of Washington, Dr. John A. Anderson of the Mount Wilson Observatory has been appointed by the Observatory Council as its Executive Officer, in direct charge of design and construction. An Advisory Committee, including Dr. Walter S. Adams, Director of the Mount Wilson Observatory; Professor Frederick H. Seares, Assistant Director; Dr. Charles G. Abbot, Secretary of the Smithsonian Institution; Professor A. A. Michelson of the University of Chicago; Professor Henry Norris Russell of Princeton University; and Professors Richard C. Tolman, Paul S. Epstein, and Ira S. Bowen of the California Institute, will aid the Observatory Council and Dr. Anderson in determining matters of policy, and many other leading astronomers, physicists, chemists, meteorologists, and engineers in these and other institutions will be called upon for advice and assistance. Dr. St. John and Dr. King of the Mount Wilson Observatory, who were attending the meeting of the International Astronomical Union in Leyden, were at once requested by cable to look up many matters calling for early decision, and the reports they have presented embody much valuable information kindly given by leading authorities on the design

and construction of instruments.

The first decision of the Observatory Council and the Advisory Committee, supported by the unanimous opinion of everyone consulted in this country and abroad, favored the use of fused silica for the 200-inch and other mirrors of the large telescope. President Gerard Swope and Dr. Elihu Thomson immediately promised the cordial cooperation of the General Electric Company, and work was undertaken in July at West Lynn, Massachusetts, under the personal direction of Dr. Thomson. After coating with bubble-free silica the face of a 22-inch disk already in hand, a 60-inch disk will be undertaken, for use as one of the minor mirrors of the telescope. If this proves to be satisfactory, a still larger disk will be made before the casting of the 200-inch mirror disk is attempted.

A mathematical study of the optical design of the telescope which Dr. Frank E. Ross of the Yerkes Observatory, with the kind approval of Director Edwin B. Frost, ~~has come~~ came to Pasadena to undertake, has led to the adoption of the ratio F: 3.3 for the 200-inch mirror. The field of sharp definition in the principal focus of such a mirror will be small, but the possibility of photographing extremely faint stars, especially in the spiral nebulae, makes such a powerful concentration of light highly advantageous. Dr. Ross, who will devote himself to these optical problems during the coming year, also believes that a lens can be designed, for use in the converging beam, which will serve when desired to give a much larger field, also with a short equivalent focal length. It is planned to use a Cassegrainian combination with a ratio of F: 10, having a sharp field 30' (17 inches) in diameter, for spectrographic and other

work. A coude arrangement similar to that of the 100-inch Hooker telescope, permitting the images of celestial objects to be formed in a constant temperature laboratory, for study with large fixed spectrographs, radiometers, or other auxiliary instruments, is also projected.

Dr. Pease has devoted considerable time to a study of the telescope mounting, which has been facilitated by his previous work in designing ~~a mounting for his proposed 300-inch reflector.~~ large instruments. Much additional study will be necessary, however, before even a preliminary design can be adopted, because of recent advances accomplished by telescope builders in this country and abroad. It is our hope that an equatorial design of the fork type, of sufficient rigidity to carry a 40-foot interferometer and meet other severe requirements, can ultimately be worked out. In this task we ~~trust we may have~~ have been promised the cooperation of many leading engineers, including Mr. Gano Dunn, Mr. Ambrose Swasey and his associates of the Warner & Swasey Company, and others of wide experience.

The extensive investigation of auxiliary instruments that forms a prime feature of the general scheme has been begun, and will soon be developed in various directions. Mr. George Eastman and Dr. C. E. K. Mees have generously agreed to deal with many of the special photographic problems at the Research Laboratory of the Eastman Kodak Company. A Zeiss recording microphotometer has been ordered, and will be used in a comparative study of various forms of this instrument. Dr. Sinclair Smith will attempt to develop and improve the radiometer recently used very

successfully by Dr. Abbot with the Hooker telescope in measuring the distribution of energy in the spectra of stars of several types. and work on other auxiliary instruments will soon be begun.

A comparative study of several possible high-altitude sites has been undertaken. Precise measures of the seeing, rather than estimates, are desirable. Dr. Anderson accordingly devised a simple means of measuring the atmospheric oscillations of star images under a power of 600 with a 4 or 5-inch telescope, and Mr. Ellerman tested it satisfactorily on Mount Wilson, in comparison with the estimates of experienced observers with the 60-inch and 100-inch telescopes. Preliminary observations with this method by Messrs. Ellerman and Humason have been made at Palomar and Horse Flats, and some tests made by Dr. Abbot and Mr. Moore at Table Mountain show that this site, like the others, deserves careful examination. Dr. Hubble is also making telescopic tests in Arizona. This will be facilitated by the loan of three sets of recording meteorological instruments by Dr. Charles G. Marvin, Chief of the U. S. Weather Bureau, who has also kindly supplied us with many meteorological data for various sites in California and Arizona.

The policy of the Observatory Council, in all phases of this undertaking, is to bring into cooperation the most competent authorities in their respective fields. The willingness of so many leading men of science to lend their assistance, and the fact that all our decisions have been unanimous, give promise of such results as the broad-minded ~~generosity of Dr. Wickliffe Rose and his associates~~ of the International Education Board most certainly deserve.

attitude ?

M. M. ?

FORM 17

FOLD HERE

	MM		MM	
	TA	DEC 11 28	T. A.	(A)

Attached is correspondence from Stewart to Hale about taking motion pictures of the building of the new telescope. I am transmitting this to you at the request of Prof. Trowbridge.

S. K. G.

SMG:PH: 1E
11/7/28

Selskar M. Gunn

1032

To Dean Trowbridge
For his information
J. Q. Stewart 11-1-28

November 1, 1928

Dr. George E. Hale
Mt. Wilson Observatory
Pasadena, Calif.

My dear Hale:

At the suggestion of Professor Russell, I am sending you the attached "plan for a motion-picture of the 200-inch telescope." The plan has benefited from his criticism, and he heartily approves the idea of making such a record of at least the chief technical features involved in the construction of the new telescope.

The idea may already have occurred to you of depicting in motion-pictures the building of this instrument. I hope that in any case it may receive your careful consideration.

Dean Trowbridge thinks well of the scheme, in principle, and has promised to bring it to the attention of Dr. Mason and Dr. Millikan.

The idea could, of course, be carried out in any one of a variety of ways. My thought would be to combine a series of careful records of scientific and engineering phases of the design, construction, and use of the instrument with motion-pictures of some of the dramatic incidents involved, even though many of these lack scientific significance.

It will be obvious that if this plan is to be carried out action should be initiated at once.

Yours sincerely,

JQS/HY

John Q. Stewart

PLAN FOR

A MOTION PICTURE OF THE TWO-HUNDRED INCH TELESCOPE

1. Urgency.-

It will be obvious that if this plan is to be carried out action should be initiated at once.

2. Purposes and nature of the picture.-

a) To afford teachers and students of astronomy pictorial studies of the many interesting technical processes involved in the design, construction, testing, and use of the new telescope. For example, the casting, grinding, polishing, testing, and silvering of the mirror (so far as trade policies and expediency permit.) A ruling-engine could be shown as if at work making a grating. There will be a great number of processes of this sort which should be depicted.

b) I would suggest broadening the field to include non-astronomical technical features: scenes sketching the diverse contributions of the industry of the world to the making of the telescope. Pictures of the transportation of the mirror to the mountain-top would be shown.

c) I would further suggest the photographing of some of the dramatic incidents associated with the new instrument. For example, views of expeditions at work searching for a suitable site, of the formal dedication of the telescope, and, so far as policy and personal considerations permit, pictures of all significant events in the development of the telescope from idea to realization. By careful attention, the inherent dramatic elements can properly be exploited without loss of technical value.

d) If pictures of the type (c) are included, the whole film will have a significance broader than the abstractly technical. It will indeed stand as an "industrial-astronomical epic," a concrete record of a major historical event, as history is reckoned nowadays. As such it could successfully be shown to the general public - an inclusive picture, of definite validity, the usefulness of which we cannot now guage.

e) The climax will be the presentation of views taken through the completed instrument. I would suggest, for example, a motion-picture of sunrise on Mare Crisium; and another of star-clouds and nebulae crowding across the shifting field of view as the telescope searches the Milky Way. (This latter might be accomplished by rephotographing through a moving circular aperture a series of plates of adjoining regions actually made with the 200-inch -- a technical trick that seems justifiable.) Professor Russell, however, is of the opinion that only such views should be taken with the 200-inch as will not require interference with the scientific program.

3. Cost and control.-

The cost of taking such a picture will be very considerable, even though most of the actors will require no salaries. In order to eliminate danger of distortions introduced for commercial ends the initial costs would require to be covered by special funds. Title and complete control of the films should, of course, be vested in the owners of the telescope.

Professional camera men should be hired (with experience as news photographers, preferably.) Perhaps a professional scenario-writer should be employed as consultant.

John Q. Stewart

Department of Astronomy
Princeton University

November 1, 1928

1032

November 7, 1928

Dear Doctor Millikan:

In accord with the action taken by the International Education Board on May 25, 1928, the Executive Committee of the Board at a meeting held October 18, 1928, gave careful consideration to the proposal submitted by the Observatory Council on behalf of the Board of Trustees of the California Institute of Technology in a letter dated July 6, 1928, and in correspondence prior and subsequent thereto, embodying a formal application to the International Education Board for an appropriation of Six million Dollars ($6,000,000), or so much thereof as may be necessary, to provide funds as needed for

1) a 200-inch reflecting telescope,
2) a site, including land and land improvements,
3) an Observatory and other necessary buildings,
4) auxiliary apparatus, and
5) other expenses in connection with making the Observatory available for use.

It was observed that the Board of Trustees of the California Institute of Technology at a meeting held July 5, 1928, took formal action

a) creating an "Observatory Council," consisting of Messrs. Hale, Millikan, Noyes, and Robinson, with full powers to represent and act on behalf of the Board of Trustees in all dealings with the International Education Board or other agencies relating to the proposed Observatory;

b) approving the proposed scheme of organization, construction, and operation subject to any amendments made by the Observatory Council;

c) agreeing to assume full responsibility for building the Observatory and to provide the necessary funds for operating it after its completion;

d) approving the formal request for financial assistance indicated above;

e) authorizing the Observatory Council to set up a regular organization, hold regular meetings, and report quarterly to the Board of Trustees; and

f) providing for payments of all expenses upon requisition and agreeing to render an accounting of all expenditures to the International Education Board each calendar six months, or more frequently, as desired;

and that

1) The Observatory Council has appointed Doctor J. Anderson, a member of the staff of the Mount Wilson Observatory, executive officer during the period of construction, and has adopted a definite plan of organization for the guidance of the Council, and has appointed representative committees to deal with all phases of the project;

2) The Executive Committee of the Carnegie Institution of Washington, D.C., has accepted the invitation of the California Institute of Technology to assist and coöperate in the proposed undertaking as evidenced by letters dated May 13, 1928, from President John C. Merriam to Doctor R.A. Millikan of the California Institute of Technology and to the President of the International Education Board;

3) Doctor Walter S. Adams, Director of the Mount Wilson Observatory, Pasadena, California, in a letter dated April 30, 1928, assures the California Institute of Technology that the staff of the Mount Wilson Observatory, which is under the control of the Carnegie Institution of Washington, is prepared to aid in every way possible in the design, optical and mechanical construction, erection, and plan of work of the instrument; and

4) It is estimated that sums aggregating Two hundred fifteen thousand Dollars ($215,000) will be required up to March 1, 1929, as itemized in a statement from Doctor George E. Hale, Chairman of the Observatory Council, dated August 29, 1928.

I desire formally to notify you that in conformance with the said letter of application, the Executive Committee of the International Education Board authorized the executive officers in consultation with Counsel to execute a pledge to the Board of Trustees of the California Institute of Technology, Pasadena, California, assuring said Board of Trustees that the International Education Board will provide funds from time to time as needed, but not more rapidly than developments justify, not exceeding in the aggregate Six million Dollars ($6,000,000) for the purchase of a site and the construction of an Observatory including a 200-inch reflecting telescope, with accessories, and any and all other expenses incurred in making the Observatory available for use.

The officers will confer with Counsel at an early date with a view to preparing a pledge covering the Executive Committee's action. The Executive Committee also voted to make immediately available a sum not to exceed $215,000 for the payment of expenses which will be incurred by the Observatory Council up to March 1, 1929 in connection with this undertaking.

The procedure to be followed in making payments on account of sums voted by the Executive Committee is being outlined in a separate communication to Doctor Hale.

Sincerely yours,

W. W. BRIERLEY

1032

November 10, 1928.

Dear Doctor Hale:-

I enclose a copy of my formal letter of notification to President R. A. Millikan concerning the recent action of the Executive Committee of the International Education Board on the formal application submitted by the Board of Trustees of the California Institute of Technology for an appropriation to construct a 200-inch telescope.

Mr. Arnett informs me that you will submit a statement of sums expended to date under the following heads, each grouping being subdivided into a few important sub-headings:

I. Expenses of Committees
II. Expenses of experimentation and manufacture of reflectors
III. Expenses of land improvements
IV. Expenses of buildings and telescope mountings
V. Expenses of other equipment
VI. Contingent expenses

When this statement is received, the officers will make an advance on account of the sum made available, to serve as a revolving fund, and will reimburse this fund from time to time upon receipt of statements of expenditures.

In accordance with Mr. Arnett's promise, I am

sending you a supply of expense books which are similar to those used by the officers of the Board in keeping account of their traveling expenses.

Very truly yours,

W. W. BRIERLEY

Doctor George E. Hale,
Mount Wilson Observatory,
Pasadena, California.

WWB/CMC

INTERNATIONAL EDUCATION BOARD

FOUNDED BY JOHN D. ROCKEFELLER, JR. 1923
61, BROADWAY, NEW-YORK, U. S. A.

EUROPEAN OFFICE
20, RUE DE LA BAUME, PARIS
Cable address "Interboard" Paris - Telephone : Elysées 92-08, Elysées 92-09

T. A. (A)

13th November, 1928.

Mr. W.W. Brierley,
61, Broadway,
New York City.

My dear Mr. Brierley,

I thank you for your letter of October 24th, to which you attach the confidential memorandum concerning the Observatory requested by the Californian Institute of Technology.

This item looms rather large on the horizon in Europe, and for the information of yourself and others interested, in New York, I am attaching hereto two clippings from papers which I picked up casually in England on the occasion of my last trip there.

Sincerely yours,

W.E. Tisdale

W.E. TISDALE.

WET/FO
Encl. Two clippings.

1038

October 24, 1928

Dear Doctor Tisdale:

from Docket of Oct. 18, 1928 meeting

The attached item presented at the adjourned meeting of the Executive Committee on October 18, 1928, concerning the request from the California Institute of Technology for the construction of an observatory is being sent for the confidential information of the members of the Paris Office.

Sincerely yours,

W. W. BRIERLEY

Doctor W.E. Tisdale
20 rue de la Baume
Paris, France

CARNEGIE INSTITUTION OF WASHINGTON
MOUNT WILSON OBSERVATORY
PASADENA, CALIFORNIA

1032

November 14, 1928

Mr. W. W. Brierly
International Education Board
61 Broadway, New York City.

Dear Mr. Brierly:

I appreciate your courtesy in sending me a copy of your formal letter of notification to Dr. Millikan, enclosed with your kind letter of November 10. In his absence from town I beg to assure you and your associates of our deep appreciation of the action of the International Education Board, which we are endeavoring to justify in the fullest possible degree.

A statement of sums expended to date will be submitted in the near future, grouped in the manner suggested. We shall also be glad to make use of the supply of expense books you have been good enough to send.

Believe me,

Yours very sincerely,

George E. Hale

1032

INTERVIEW WITH MR. ARNETT

Monday, November 19, 1928 - New York, New York

Doctor Robert A. Millikan (Norman Bridge Laboratory of Physics, California Institute of Technology, Pasadena, California)

Doctor Millikan came in to express his appreciation of the action which the IEB had taken with respect to the 200-inch telescope.

He also discussed informally a project which had been brought to him for broadcasting educational matter from the standpoint of the good of the people. He said the plan was sponsored by a Mr. Alexander and that he himself had gone over the plan in detail; that while he thought it had great possibilities he was unwilling to allow his name to be used as a sponsor of the scheme largely because he had not full confidence in Alexander's judgment. The plan of Mr. Alexander was to interest churches, Y.W.C.A.'s, women's clubs and other such organizations to the extent of helping in raising a fund of $5,000,000. Doctor Millikan said probably the scheme would at some time be presented to the GEB and that he wished to express his own views of the great possibilities in the case. On November 17 Doctor Millikan discussed the matter with Doctor Keppel because of Keppel's interest in adult education.

T.A.-L.F.A.

1032

November 21, 1928

My dear Professor Thomson:

I have a letter of introduction to you for Mr. Trevor Arnett, President of the Internatinnal Education Board and the General Education Board, and me from Doctor George E. Hale. We are both deeply interested in the proposed 200-inch telescope for California Institute of Technology and would like the opportunity of visiting your laboratory Tuesday, November 27, if this is agreeable to you.

Unfortunately, our engagements make it difficult to pick out another date at this particular season of the year, but if this is agreeable we will reach West Lynn about nine o'clock.

Yours very truly,

H. J. Thorkelson

Professor Elihu Thomson
Thomson Research Laboratory
General Electric Company
West Lynn, Massachusetts

HJT MDB

1632

COPY OF TELEGRAM RECEIVED AT 61 B'WAY. NOV. 26, 1928

"PRESCOTT, ARIZONA, 24

"INTERNATIONAL EDUCATION BOARD

ATTENTION DOCTOR J. A. ANDERSON, NEW YORK, N. Y.

"PRESCOTT ARIZONA INVITES YOU TO INVESTIGATE ATMOSPHERIC CONDITION PRESCOTT AND SURROUNDING TERRITORY FOR PROPOSED 200 INCH REFLECTING TELESCOPE. OUR COOPERATION ASSURED.

"YAVAPAI CHAMBER OF COMMERCE"

(FORWARDED TO DR. ANDERSON AT MT. WILSON OBSERVATORY, PASADENA, CALIFORNIA ON NOV. 27, AFTER INQUIRIES WERE MADE AT GENERAL CARTY'S OFFICE - CORTLAND OFFICIAL 60 - MR. GANO DUNN'S OFFICE, AND DOCTOR MAX MASON'S OFFICE, THE LATTER BEING OUT OF TOWN.) (INQUIRIES ALSO MADE FROM TA, HJT AND WWB.)

LFA

11/27/28

1032

INTERVIEW WITH MR. ARNETT

Tuesday, November 27, 1928 - West Lynn, Mass.

Laboratories of The General Electric Company (West Lynn, Massachusetts)

HJT and TA saw Professor Elihu Thompson, his Chief Director Mr. Ellis, and his assistant, Mr. Watson. They explained to us the experiments which they had made relative to the use of quartz and showed us the method which they were using to cast large blocks of sand quartz to form a surface for the mirror of the two-hundred-inch telescope. On the top of that base they found that they could fuse clear quartz, excluding all air bubbles and other imperfections by applying, on the principle of the blow-pipe method, clear quartz, filling up holes, making repairs, and so forth. They wished us to understand clearly that their work was experimental, and that while they were optimistic regarding overcoming all difficulties which might be incurred in the making of the mirror for the reflecting telescope, they were not dogmatic with respect to it.

TA:LFA

1032

November 30, 1928.

Dear Doctor Hale:

I am very glad to have your good letter of November 21 regarding the progress you are making. The systematic way in which you are proceeding toward every possible improvement in design and in method of application is most interesting. I hope the contribution of Ross is as fine as it sounds. I had a talk with Russell this week at Princeton on astronomical affairs in general, and only wish that you were near New York so that I should have a continuous source of information from you and him in the whole field.

I had not known until your letter of the case of Mr. Pike but shall take it up with Mr. Lund at once.

Thank you for sending me the copy of Science which includes a statement in regard to the astrophysical observatory. The publicity in connection with the telescope was fine.

Sincerely yours,

MAX MASON

Dr. George E. Hale,
Mount Wilson Observatory,
Pasadena, California.

MM:AEB

P.S. Since dictating this letter I have heard with regret of Pike's death. Arnett tells me of the financial assistance that was guaranteed in a letter to Adams. If there are other needs I am sure he would be glad to learn of them.

CARNEGIE INSTITUTION OF WASHINGTON
MOUNT WILSON OBSERVATORY
PASADENA, CALIFORNIA

November 21, 1928

Dr. Max Mason
Rockefeller Foundation
61 Broadway, New York City.

My dear Mason:

I meant before now to report to you on the situation here, but after my return I was kept in bed a good while and since getting up I have not been able to work much, partly in view of our great worry over the case of Mr. Pike, the brilliant International Research Fellow, whose serious condition shows no sign of improvement. We have done everything we could, and have obtained the advice of Dr. Simon Flexner and of Dr. George Dock, who fortunately now lives in Pasadena and has given us the splendid aid of his long experience and wise counsel at critical times. Ten days ago, partly as the apparent result of three blood transfusions and the arrival from Leeds of Mr. Pike's fiancée, Miss Garstang (daughter of the well-known zoologist), there seemed to be some evidence of improvement. This encouraged us sufficiently to send for his mother, but she had to find a home for her old father and cannot sail until day after tomorrow on the "Leviathan". Dr. Dunham, the National Research Fellow from New York, who has devoted himself unsparingly to Pike, and contributed (before my return) far more than he could possibly afford toward his heavy medical, surgical, and hospital expenses, has written Mr. Lund several times about the case. Mrs. Pike has nothing to live on but the pension of

her husband, a captain in the British Army, who died when Pike was a child. I am very gladly providing (of course anonymously) for the expenses of her trip, and taking care of Pike's expenses here, but I trust your Board can remunerate Dunham and Adams for what they spent before I knew the circumstances, not to speak of what it costs Dunham to board Miss Garstang.* Dunham wanted to contribute $250. toward Mrs. Pike's expenses, but of course I would not allow this. It is a very pitiful case, but if there is any possibility of saving Pike we certainly mean to utilize it.

As for the Observatory project, we were much pleased to receive from Mr. Brierly the formal action of the Executive Committee, which we owe so directly to your careful study of the problem and the cordial support given by Mr. Arnett. You may be sure that every effort will be made to find the most favorable site in the United States. While Adams and I were away Hubble made preliminary studies of four sites in Arizona, at three of which tests are going on daily, using our scale of "seeing". We are preparing for a much more extensive campaign at ten or more points in California and Arizona, to be begun as soon as the (inexpensive) instruments can be completed and the observers trained. As for the southern hemisphere, Shapley says in a recent letter to me: "The second 100-inch or 200-inch should of course go south; but not the first one". Russell agrees, and I think there is no difference of opinion about this.

Dr. F. E. Ross, the ablest man we know in calculating

*This I am sure he would not accept.

lens combinations, was called here from the Yerkes Observatory in the summer to aid in the optical design of the 200-inch telescope. As you know, the only objection to the use of a paraboloidal mirror of ratio F:3.3 is its small field of sharp definition. Such a mirror is decidedly worth using in any case, because we may reasonably expect in its principal focus to photograph stars one tenth as bright as the 100-inch Hooker telescope can record. But a material enlargement of this sharp field would be an immense advantage. The enclosed copy of a letter from Ross leads us to believe a way has been found, as he seems to have solved already the first problem we gave him: that of devising a correcting lens to fix in front of the plate and to reduce the arrow-headed images away from the center of the field to sharp points. Anderson thinks this an advance comparable with Dolland's discovery of the achromatic lens. After it has been tested with the 60-inch reflector, its full possibilities with the 200-inch (including the chance of devising a lens giving the enormous concentration of light attainable with a ratio F:2), will become known. We have given Ross (who is working half-time at the Yerkes Observatory on our optical problems) a computer, and will see that his rare qualities are fully utilized in the design of our various instruments.

In this connection an editorial remark in the New York Herald-Tribune, which we have not thought worthy of reply, may be mentioned. They say (October 30):

"It is an open secret that the 100-inch reflector at Mount Wilson,

now the world's largest telescope, has been something of a disappointment".

This "secret" has never before been sufficiently "open"to reach us here. As stated in my article in the April Harper's on "The Possibilities of Large Telescopes",

"Fortunately we have found, after several years of constant use, that on all good nights the gain of the 100-inch telescope over the 60-inch is fully in proportion to its greater aperture".

When the "seeing" is 3 or better on a scale of 10, which happens on a great number of nights annually at Mount Wilson, the 100-inch thus gives us the benefit of all the additional concentrated light its increased area gathers up, in direct photography, spectrographic work, and other observations, and in spite of the fact that both mirror discs are of the same kind of glass.

Fused silica, on account of its very low coefficient of expansion, should be greatly superior, and the change of focal ratio from F:5 to F:3.3will also mean a great gain. This is why Adams, Anderson, and I think that instead of getting four times as much light concentrated in sharp star images we shall get about ten times as much. Such English astronomers as Turner, Dyson (Astronomer Royal), and Jeans have written to express their strong approval of the project.

I have worked out the general design for the spectrograph, coelostat telescope, and auxiliary apparatus that fix the character of the Astrophysical Laboratory, so the task of planning the building will now be a simple matter, though we shall give every detail close study. The design for the shop is well advanced, but we

are obtaining expert advice from various quarters before turning it over to the architects. All other phases of the work are also making good progress.

With warm regards and thanks for all the time and trouble you have given to this project,

Yours very cordially,

George E. Hale

1032

December 10, 1928

My dear Doctor Hale:

Thank you very much for planning to care for Mrs. Woods and show her the Mount Wilson Observatory. Colonel Woods has informed me this morning that she will be unable on this visit to California to go to Mount Wilson, but she is looking forward to that pleasure at some future time.

I am very much interested to hear of the plan which Doctor Ross has devised for overcoming a defect in the reflecting telescope, and I shall await with eagerness the result of the test which you plan to make on the 60-inch Mount Wilson reflector. There are many problems in connection with this enterprise which will test the ingenuity and ability of you and your colleagues to the utmost, but I have implicit confidence that you will find a proper solution.

Cordially yours,

Trevor Arnett

Doctor George E. Hale
Mount Wilson Observatory
Pasadena
California

TA:LFA

CARNEGIE INSTITUTION OF WASHINGTON
MOUNT WILSON OBSERVATORY
PASADENA, CALIFORNIA

1032

December 5, 1928

Files

T. A. (A) 12/10/28

Mr. Trevor Arnett, President
International Education Board
61 Broadway, New York City.

My dear Mr. Arnett:

Many thanks for your kind letter. It will be a great pleasure to meet Mrs. Woods when she arrives and to arrange for her trip to Mount Wilson. Perhaps she may also care to see the California Institute and the Huntington Library.

I was very glad to receive from Mr. Brierley formal notice of the action of your Executive Committee, which provided so admirably for the continuation of our work. It is moving on effectively in all its branches, and the first result obtained in the general study of auxiliary apparatus is of great importance.

Hitherto the most serious defect of our reflecting telescopes has been the small size of the field of sharp definition. At the center of the field the star images are circular points, but a short distance away they begin to assume an arrow-headed form, which becomes worse and worse, and greatly limits the size of the photographic plates. Dr. Ross of the Yerkes Observatory, who is employed (half time) by us to study the optical problems of the 200-inch telescope, has already devised a beautiful method of overcoming this defect, which we hope to test with our 60-inch Mount Wilson reflector as soon as the necessary lens can be made. This should greatly increase the usefulness of existing telescopes and be of special importance in

connection with the 200-inch reflector, which would otherwise have an exceptionally small field, because of the short focal length we have chosen for the purpose of effecting an immense concentration of starlight, and thus rendering possible the photography of stars beyond the grasp of a long focus instrument.

Accept my best wishes for the holiday season and believe me, with kindest regards,

Yours very cordially,

George E. Hale

1032

December 19, 1928.

My dear Mr. Debevoise:-

I enclose a form of pledge to the California Institute of Technology covering the appropriation authorized by the International Education Board for the telescope. I enclose also the docket item presented to the Executive Committee on October 18, 1928, which embodies the action of the Board on May 25, 1928. May I have the benefit of your suggestions before forwarding the pledge form to the authorities of the Institute?

Very truly yours,

W. W. CRIERLEY

Mr. Thomas M. Debevoise,
26 Broadway,
New York City.

WWB/GMC

1032

December 19, 1928.

My dear Mr. Anderson:-

I am replying to your letter of December 11th covering certain bills submitted in connection with the proposed 200-inch telescope. I wish to inquire if you have seen my letter of November 10th to Dr. Hale, outlining briefly the procedure in calling upon the Board from time to time for payments. I enclose a copy for your information.

It will not be necessary for you to go into too much detail. If expenses are listed in accordance with the six groupings, each grouping being subdivided into a few important subheadings, it will serve our purpose admirably. For example, the first two items listed in your letter of December 11th might be referred to under the appropriate headings:

Development of Burners	$488.10
Glazing Furnace	109.03

If, at any time, additional information be desired concerning any item of expense, we will write you.

The form of pledge covering the Board's appropriation has been prepared and forwarded to our Counsel for his examination before it is forwarded to the authorities of the

Institute. As soon as the agreement has been accepted by the authorities of the Institute, the officers will authorize an advance on account of the sum recently voted.

Very truly yours,

W. W. BRIERLEY

Mr. J. A. Anderson,
Mount Wilson Observatory,
Pasadena, California.

WWB/GMC

CARNEGIE INSTITUTION OF WASHINGTON
MOUNT WILSON OBSERVATORY
PASADENA, CALIFORNIA

1032

December 11, 1928

Mr. W. W. Brierley
International Education Board
61 Broadway, New York City.

Dear Mr. Brierley:

We are beginning to receive bills for expenses in connection with the proposed 200-inch telescope. These come in all sorts of forms, unfortunately, some of which are obviously unsatisfactory while others are doubtful. We should therefore like to know how minutely you wish to have bills itemized. Here is an example of a bill from the General Electric Company for November:

"DA-59610...Development of Burners..... $488.10
Burners used in glazing the small mirrors are not suitable for glazing larger masses. Considerable progress has been made in the development of a burner more suitable for this work.

DA-59611...22" Glazing Furnace..... $109.03
Further work is being done in training men to glaze quartz and get data to design a furnace for 60" mirror.

DA-59612...Ammonia Dissociator..... $793.05
Quartz surfaces glazed to date have been glazed using oxy-hydrogen burners. The gas consumption is large. Some quartz has been laid down using dissociated ammonia and oxygen. This has the advantage of being readily obtainable in large quantities at constant pressure. A substitute for hydrogen over the electrolytic process may be a vital link in the production of the large sized mirror.

DA-59617...Investigation of Method for Spraying Granular quartz on fused quartz surfaces.....$1776.12
Large sizeblanks cannot be covered in the manner in which the 11" blank was surfaced. Work done to date on the 22" gives promise of a better method and one which we hope can be extended to the surfacing of the 200".

DA-59618...Method for Automatically Applying a Layer of Clear Fused Quartz to a Fused Quartz Surface... $118.00

While it is a simple matter to work over a small blank by hand, it would be out of the question on a blank even 22" in diameter. Automatic means for carrying out the spraying process will be necessary. This investigation is tied in with the burner development and the method of spraying quartz.

DA-59620...Temperature Measurements and Control..... 45.00

" 59622...Expense Material..... 171.63

" 59624...Preparing Quartz for Spraying..... 9.14

" 59626...Travelling..... 112.00

This item covers travelling expenses necessary to procure special material, interest contributing manufacturers in the problem to insure prompt service in the production of special materials and apparatus, and confer with technicians in Boston, New York, Washington, and elsewhere.

DA-59627...Investigation of Mold Design..... 244.07

This item covers the extension of our regular process to include the 60" step in the production of a fused quartz sand backing.

DA-59628...Determine the Feasibility of Clearing a Fused Quartz Sand Surface..... 43.97

There is a possibility that the sand surface can be cleared by means of an arc, as has been done on a small scale. This process is being investigated further as insurance against possible failure of the process of spraying. "

$3910.11

Is this satisfactory, or should it be further itemized?

With best wishes, I am

Yours truly,

J. A. Anderson

Executive Officer,
Observatory Council.

JAA:G

1032

OBSERVATORY COUNCIL

and

ADVISORY COMMITTEE

December 22, 1928

The Observatory Council and Advisory Committee met at Dr. Hale's Laboratory December 22, 1928, at 2:30 P. M.

Present: George E. Hale, Chairman, R. A. Millikan, A. A. Noyes and Henry M. Robinson of the Observatory Council; J. A. Anderson, Walter S. Adams, I. S. Bowen, Paul Epstein, Edwin Hubble, F. G. Pease, R. W. Porter, H. N. Russell, F. H. Seares, C. E. St. John, and Richard C. Tolman; with the Secretary.

Dr. Hale reported in regard to the progress of the work being done on the mirror disc by the General Electric Company and presented a proposed form of contract which the General Electric Company had submitted. After the reading of this contract and discussion, it was moved by Mr. Robinson, seconded by Dr. Noyes, that Mr. Robinson be requested to take up with the General Electric Company a question which had been raised with respect to the overhead expenses which were to be charged to the Institute, namely; whether these overhead expenses were clearly manufacturing overhead and not administrative overhead; and that he be authorized to modify the paragraph relating to this question as may be necessary and then to submit the contract to the Institute with the recommendation of the Observatory Council that it be approved. Carried.

Dr. Hale further reported that he had received an optimistic general letter from Elihu Thomson in regard to the work on the disc, in which Dr. Thomson reached the conclusion that it would be best to cast the 200-inch disc in the east and ship it to the site of the telescope, rather than to cast it at the site itself.

Dr. Hale then pointed out that there were important questions to be determined with reference to the thickness of the disc and the mode of its support, and suggested that a committee be appointed to make a careful study of the problem of the thickness of the disc and the mode of its support.

Dr. St. John made a statement in regard to his visits to the laboratory of Sir Charles Parsons in England and in regard to the process being made use of there to make up mirror discs by using several discs with fused struts between them rather than make the mirror disc in one solid piece, and reported that they believed this built-up process would prove to be a successful one.

It was then moved by Mr. Robinson, seconded by Dr. Millikan, that a committee as recommended by Dr. Hale be designated by the Chairman, and that the committee be authorized to begin discussions looking toward the making of an agreement for the construction of one or more of the coelostat discs from glass or other material and of the Parsons built-up construction or otherwise, and that the committee be authorized to recommend to the Observatory Council the making of a contract of this sort. Carried.

Dr. Hale reported that preliminary studies had been made and were still in progress in regard to the design of the

optical and instrument shops and the astrophysical laboratory; that preliminary layouts had been made; that the study should continue for several months; and that one question of particular importance was the problem of vibrations in various locations considered for these buildings.

After informal discussion, it was agreed that the committee on these buildings should give careful consideration to the point raised with respect to vibration, and other questions, and continue to study the design of the buildings with a view to arriving at a final design in the spring.

The Chairman next brought up the question of the design and construction of the mounting for the telescope and raised the question whether the construction of this mounting should be done in Los Angeles under the supervision of our own group, or through a firm like Warner and Swasey or perhaps the General Electric Company. He reported that while the larger parts of the mounting for the 60-inch telescope had been built by the Union Iron Works in San Francisco and those for the 100-inch telescope at Fall River, Massachusettes, because there were no shops in Los Angeles capable of handling work of this size at the time these mountings were built, now the Llewellyn Iron Works had machinery capable of handling work of this size, but there was a question as to whether their workmen were qualified to do work of this quality. The suggestion was made that they might be willing to let men designated by the Council go into their shops and handle this particular work. The matter was left open for further investigation and decision at a later date.

There was discussion of the possibility of securing Professor Milne of Oxford as head of the Graduate School of Astrophysics, but no action was taken.

Consideration was given to the question of the beginning of instruction in astronomy at the Institute with particular reference, first, to an undergraduate option in astronomy. After discussion, the Chairman stated that it was expected that the committee on the graduate school would continue to study the question of instruction, and consult with Dr. Millikan, and advise the Council at a later date whether it is feasible for the Institute to give such an option in the near future.

A report was made by Dr. Anderson in regard to the site investigations in progress at Palomar Mountain, Horse Flats, Lockwood Valley, and Table Mountain in California. He stated that observations at Prescott, Arizona, were to be started soon; that the ten lenses which were authorized at an earlier meeting, had been ordered and were expected in Pasadena in January. He said that in examining sites a study should be made of the possible effect of local conditions; also that there was some indication that difference in altitude plays a very great part in seeing, and that this also should be investigated.

Dr. Hubble made a report on site investigations he had made in Arizona and the provision made to continue observations there.

Dr. Hale reported that in order to manufacture the correcting lens, heretofore authorized to be made under the direction of Dr. Ross, of Jena glass the cost would be increased $300 or $400, but that it was thought necessary to use the Jena glass.

On motion of Dr. Millikan, seconded by Mr. Robinson, it was voted that the Council approve the additional cost of $300 or $400 occasioned by the use of Jena glass for the lens being made under the direction of Dr. Ross.

Dr. Hale raised the question of the desirability of getting Dr. Stebbins of the University of Wisconsin to work on the astronomical use of photo-electric cells in connection with a group who are familar with the construction of the cells.

On motion of Mr. Robinson, seconded by Dr. Millikan, it was voted that the Chairman be authorized to arrange with Dr. Stebbins to undertake this work in connection with a group as suggested, at an expense not to exceed $1,500.

Dr. Hale suggested that in his absence, the Observatory Council go ahead and have meetings occasionally, bringing in the Advisory Committee, and that they get the special committees to report to this group. It was understood that Dr. Anderson, Dr. Millikan, and Dr. Adams, in conference, would determine when such meetings would be held.

The meeting adjourned.

1032

December 31, 1928

Dear Doctor Millikan:

Enclosed is a form of agreement to cover the appropriation authorized by the International Education Board for the 200-inch telescope. Kindly inform me promptly if a pledge in accordance with this form would meet with the approval of the trustees of the Institute. Upon hearing from you affirmatively, the officers will prepare and send you the signed agreement.

Sincerely yours,

W. W. BRIERLEY

Doctor Robert A. Millikan
California Institute of Technology
Pasadena, California

Approved by Mr. Debevoise Dec. 31/28

Approved by George E. Hale

1032

AGREEMENT

INTERNATIONAL EDUCATION BOARD
and
CALIFORNIA INSTITUTE OF TECHNOLOGY

No. 7

$6,000,000

Copy Only

WHEREAS, California Institute of Technology, located at Pasadena, in the State of California (hereinafter referred to as the "Institute"), has submitted a proposal to the International Education Board (hereinafter referred to as the "Board") in a letter dated July 6, 1928, through the Observatory Council, for an appropriation of Six million Dollars ($6,000,000), or so much thereof as may be necessary, to provide funds as needed for

1) A 200-inch reflecting telescope
2) Site, including land and land improvements
3) Observatory and other necessary buildings
4) Auxiliary apparatus
5) Other expenses in connection with making the Observatory available for use;

said proposal having been formally approved by the Institute on July 5, 1928; and

WHEREAS, On July 5, 1928, said Institute took formal action

1) creating the aforementioned Observatory Council with full powers to represent and act on behalf of the Institute in all dealings with the Board and/or other agencies relating to the proposed Observatory;

2) approving the proposed scheme of organization, construction, and operation, subject to any amendments made by the Observatory Council;

3) agreeing to assume full responsibility for building the Observatory, including the telescope, and to provide the necessary funds for operating it after its completion;

4) authorizing the Observatory Council to set up a regular organization, hold meetings and report quarterly to the Institute; and

5) providing for payments of all expenses upon requisition and agreeing to render an accounting of all expenditures to the Board each six months or more frequently, as desired;

and

WHEREAS, The Observatory Council has adopted a definite plan of organization for its guidance and has appointed representative committees to deal with all phases of the project; and

WHEREAS, The Carnegie Institution of Washington, District of Columbia, and the Mount Wilson Observatory, Pasadena, California, have approved the proposal herein mentioned and have indicated their willingness to assist and coöperate in the project;

THEREFORE, In consideration of the Institute's agreement to carry out this project said Board agrees to provide the Institute with funds not exceeding in the aggregate Six million Dollars ($6,000,000) from time to time, but not more rapidly than developments of the project justify for (a) the purchase of a site and the construction of an Observatory, including a 200-inch reflecting telescope, with accessories, in general conformity with the outline of purposes above set forth and stating in the aforesaid letter of the Observatory Council, dated July 6, 1928, and (b) any and all other expenses incurred in making the Observatory available for use;

PROVIDED, That if at any stage of the project it be decided that the construction of the telescope is not feasible, any remainder of the amount hereby pledged by the Board, according to the terms above prescribed, shall be and become null and void.

It is mutually understood and made a condition of this agreement that said Institute will provide the funds required for the upkeep and maintenance of the Observatory including the telecope, if constructed.

It is also mutually understood and made a condition of this agreement that, as to any remainder of the amount hereby pledged not due and payable according to the terms above prescribed by January 1, ~~1939~~ 1945, this pledge shall be and become null and void.

The Institute, by the acceptance of this pledge, agrees to comply with the conditions above set forth on which this pledge is made and on which the payments under it are to be made.

This pledge is executed pursuant to resolutions adopted by the Members of the Board of Trustees of the International Education Board on the 25th day of May, 1928, and by its Executive Committee on the 18th day of October, 1928.

In Witness Whereof, the Board has caused this pledge to be signed and its seal hereunto affixed by its duly authorized executive officers this 21st day of January, 1929.

INTERNATIONAL EDUCATION BOARD

By_____
President

(Seal)

Attest:_____
Secretary

1947
1929

(To be attached to pledge) 1032

CALIFORNIA INSTITUTE OF TECHNOLOGY

At a meeting of the Executive Committee of the International Education Board held on March 27, 1931, the following action was taken:

WHEREAS, On February 25, 1931, Doctor George E. Hale, Chairman of the Observatory Council of the California Institute of Technology, submitted a memorandum embodying revised estimates, as follows for the astrophysical observatory, including a 200-inch reflecting telescope with accessories:

	Preliminary Estimates	Revised Estimates
I. Expenses of Committees	$ 50,000.00	$ 128,584.21
II. Expenses of experimentation and manufacture of reflectors, including $450,000 for a 17-foot grinding machine and other equipment for the optical shop	1,150,000.00	2,066,106.22
III. Expenses of land and land improvements	600,000.00	350,000.00
IV. Expenses of buildings and telescope mountings	2,700,000.00	2,699,232.05
V. Expenses of other equipment	400,000.00	241,786.77
VI. Contingent expenses (salvage and other rebates not included)	1,100,000.00	514,290.75
	$6,000,000.00	$6,000,000.00;

and

WHEREAS, It is estimated that between January 1 and September 30, 1931, approximately $580,000 will be needed by the Institute to cover expenses in connection with the project;

THEREFORE, BE IT

RESOLVED, That the Executive Committee of the International Education Board hereby approves the revised estimates submitted by the Observatory Council of the California Institute of Technology, Pasadena, California, on February 25, 1931, covering "the purchase of a site and the construction of an observatory, including a 200-inch reflecting telescope, with accessories, and any and all other expenses incurred in making the observatory available for use," with the exception of Four hundred fifty thousand Dollars ($450,000) for the optical shop included under "II - Expenses of experimentation and manufacture of reflector."