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File

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

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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 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