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February 28, 1929

Dear Mr. Fosdick:

I am enclosing the following material which may be of use to you in connection with the California Institute of Technology:

Minutes - May 25, 1928 Board meeting
October 18, 1928 Executive Committee meeting
Extracts from letters
Statement on work accomplished by the Mount Wilson Observatory
Memorandum of telephone conversation on January 31, 1929, with Doctor George E. Hale
Copy of the Possibilities of Large Telescopes - Harper's - by Doctor Hale (Will you kindly return this to our files?).

You will be interested to know that the Board's appropriation of $6,000,000 to the California Institute of Technology has been accepted by its Board of Trustees and payments are already being made thereon.

Sincerely yours,

W. W. BRIERLEY

Mr. Raymond B. Fosdick
61 Broadway, New York

K.E.O.

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CALIFORNIA INSTITUTE OF TECHNOLOGY

Hale, G.E. 2/14/28: "The progress of recent research, especially in the study of stellar evolution, the nature and development of spiral nebulae, and the constitution and transformations of matter and radiation, has greatly emphasized the importance of large telescopes. In fact, the range of celestial temperatures, densities, masses, and states of matter so enormously transcends that of the physical laboratory that many of the most fundamental advances in physics depend upon the utilization of these conditions. Moreover, we now have definite observational evidence that at such a favorable site as Mount Wilson a large increase in aperture could be made with confidence, whereas we formerly had to risk defeat through atmospheric unsteadiness. I have brdfly discussed these matters in an article on "The Possibilities of Large Telescopes", which I have asked the editor to send you as soon as it appears in Harper's Magazine."

Thorkelson, H.J. 3/26/28: "The construction of the proposed telescope will extend the boundaries of knowledge regarding the heavens in enabling studies to be made of nebular structure at one extreme and the moon's surface at the other extreme. It was also shown that such an improved telescope would be more productive than the construction of new telescopes similar to the Hooker 100-inch located at other places on the globe.....Mount Wilson is the center of astrophysical work for the world. While this group of scientists have a great program of studies under way, it seems clear that progress in our knowledge of the heavens will be very greatly advanced if in some way the proposed more powerful telescope can be made available."

Adams, W.S., Dir. Mt. Wilson Observatory 4/30/28: "The possibility of the construction of a 200-inch reflector would mean so much to the progress of science that it is difficult to use temperate language in referring to it, and the way in which it has taken hold of theinterest and imagination of every scientific man who has considered it is nothing short of extraordinary. Michelson, Russell and Abbot are only a few of those whose enthusiastic support of such a project is equalled only by that of the men who are constantly working with large instruments and realize the immediate consequences to their own work of a reflector of such enormous power."

Pupin, Michael I. 5/9/28:"Every physicist and astronomer knows the great importance of studying the physics of the stars in our pursuit of the knowledge of matter, not only of matter belonging to our stellar system but also of that belonging to universes beyond our stellar system."

Adams, W.S. 4/30/28:"Of the physical advances to be expected from the enormous light-gathering power of such an instrument it is almost impossible to speak. The study of stellar spectra taken on a very large scale shows promise already of an advance in our knowledge of stellar processes and conditions which we could not imagine a few years ago. Measurements of the heat-radiation of stars and of the temperatures of the surface of the planets will be immensely extended with a larger instrument. In fact the accurate mapping of the temperatures of the surface details of the planets will, I believe, provide us with more valuable information regarding physical conditions than all other observations put together.

The following was submitted by Doctor George E. Hale of the Mount Wilson early in September 1928.

What new knowledge of the heavens may be expected from a great telescope, more powerful than any now existing?

Advances at the Mount Wilson Observatory of the Carnegie Institution of Washington which followed the construction of its powerful instruments suggest an answer. Some of the outstanding results obtained at Mount Wilson are:

1. Precise determination of the rotation period of the sun (which does not rotate as a solid body) at different distances from the sun's equator and at different levels in the solar atmosphere.

2. Discovery that sun-spots are associated with great whirling vortices in the upper atmosphere of the sun.

3. That sun-spots are centers of powerful magnetic fields, with north poles prevailing in one hemisphere and south poles in the other - the first evidence of magnetism outside the earth - and that the poles reverse at intervals of 11 years, at the beginning of each new cycle of spots.

4. That the sun, like the earth, is a huge magnet with its north and south poles near the poles of its axis of rotation.

5. Identification in the sun of six elements not previously known to occur there, and the discovery of chemical compounds in sun-spots.

6. Measurement of the ultra-violet radiation of the sun over a period of several years, showing that the sun is a variable star, with the largest changes affecting its ultra-violet light.

7. Detailed study in the physical laboratory of the effect of a magnetic field on the spectral lines of different chemical elements (the Zeeman effect) as a means of measuring the strength of the magnetic fields of sun-spots and of the sun's general magnetic field.

8. Laboratory study of the way in which different lines appear in the spectrum of a chemical element as the temperature of the source of light is increased. These data permit the conclusion that sun-spots are regions of relatively low temperature and are of the greatest importance in studying the temperatures of stars; they are also of fundamental importance in learning how the atoms of different elements produce their characteristic spectra.

9. Analysis of the distribution and intensity of the spectral lines of certain elements on the basis of modern atomic theory - the beginnings of a rational

theory of spectrum analysis, which already has explained many long-standing puzzles in the spectra of the sun and the stars and thrown much light on the physical characteristics of stars.

10. Measurement of the velocities in the line of sight - toward or away from the earth - of approximately 3500 stars, results which have been made the basis for a detailed study of the systematic motions of stars.

11. Discovery of the asymetry of stellar motions, - that the stars having the hieghest velocities all move in the same general direction, and in general, that the motions of stars are not wholly random, but highly systematic, each different class of stars having its own regularities.

12. Accurate measurement of the distance of 250 of the nearer stars, among them several small, faint stars of exceptional importance in determining how the stars are scattered throughout space. Aside from the value of the results for individual stars, these measures are of great importance in perfecting the method of determining the distance of a star from its spectrum.

13. Discovery of the methods of spectroscopic parallaxes and determination of the distances of 4000 stars from their spectra. The relative intensity of certain lines in the spectrum tells the intrinsic brightness of the star - its candle power. This, combined with the brightness as seen by the eye, gives the distance. Measures of distance are fundamental for a study of the structure of the stellar system.

14. Confirmation of the giant and dwarf theory of stars - that most classes of stars comprise two groups differing enormously in size and intrinsic brightness.

15. Direct measurement with the interferometer of the diameters of seven giant stars, thus confirming theoretical values found in other ways. The diameter of Antares is nearly 500 times that of the sun. At the other extreme are the dwarfs, some of them having diameters of only a few thousand miles.

16. Proof that the densities of giant stars are astonishingly low, in some cases only a thousandth of the density of air at the earth's surface. The companion of Sirius, on the other hand, with a diameter of about 20,000 miles, has a density of the order of 50,000 times that of water.

17. Perfection of the vacuum thermocouple and measurement of the total radiation of more than a hundred stars.

18. Determination of the temperatures of stars from (a) measures of their colors, (b) comparison of measures of total radiation with radiation in special regions of the spectrum, (c) measures with the radiometer at different points in the spectrum, (d) theoretical relations connecting the temperatures of stars with the intensities of the lines in their spectra.

19. Development of the method of wire explosions, produced by passing a large amount of electrical energy through a fine wire of iron or other suitable metal. The temperatures accompanying the explosion - about 20,000°C. - are the highest ever produced in the laboratory and comparable with those of the hottest stars. The spectrum of the explosion aids in the interpretation of the spectra of stars.

20. Determination of the scale of stellar brightness now adopted as the international standard and measurement of the brightness of about 70,000 faint stars, thus affording an improved determination of the number of stars and their distribution over the sky.

21. Extended study of the structure of the stellar system which strengthens the idea of similarity between our own system and some of the great spiral nebulae.

22. Development of the method for determining the distance of a Cepheid variable star from the interval required for it to complete its variations in light, and derivation of the distances of all known Cepheids and of all globular clusters of stars, thus greatly extending our ideas as to the size of the stellar system.

23. Intensive observation, classification, and study of the nebulae, leading to the conclusion that the diffuse nebulae, like that in Orion, are clouds of dust and gas in our own system shining either with reflected light or with a luminescence stimulated by the radiation of neighboring stars of very high temperature; the spiral and elliptical nebulae, on the other hand, are outside our stellar system, scattered more or less uniformly throughout space, and are to be counted in millions.

24. Discovery in the larger spiral nebulae of new stars ("Noval"), Cepheid variables, diffuse nebulosity, and ordinary giant stars of different spectral types, thus showing that some of the spirals at least are gigantic systems, similar to our own stellar system, situated at distances of the order of a million light years. This points to still greater distances for the smaller spirals and again revolutionizes our ideas as to the extent of the visible universe.

25. Close quantitative verification of the displacement of the lines in the spectrum of a star required by Einstein's theory of relativity, both by observations on the sun and on the companion of Sirius.

26. Repetition of the famous Michelson-Morley experiment with a precision hitherto unattained; the confirmation of the negative result found in the original trials strengthens the foundation of the theory of relativity.

27. Redetermination of the velocity of light by Professor Michelson with greatly increased precision by measurements over a path of 45 miles, longer than any hitherto used.