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University Club,
New York.
April 16, 1928.

Dr. Wickliffe Rose,
President, ~~International~~ General Education Board,
61 Broadway,
New York.

Dear Doctor Rose,

In reply to your request, I beg to summarize briefly the chief arguments favoring the construction of a 200-inch telescope and to outline the procedure in view.

(1) The 100-inch Hooker telescope of the Mount Wilson Observatory has solved many fundamental astronomical and physical problems beyond the reach of our 60-inch reflector, and prepared the way for an attack on still more important problems that demand greater light-gathering power for their solution. Among these outstanding questions are:

(a) The structure of the universe, calling for a more intensive study of the Galaxy, of which our solar system is a minute part, and especially of the vast region of spiral nebulae ("island universes") beyond the Milky Way, where the 100-inch telescope has fixed the distance of the two nearest spiral nebulae at about one million light-years and disclosed their true nature by partially resolving them into stars. It has also revealed hundreds of thousands of more remote spirals, many of which could be analyzed and measured with a larger instrument.

(b) The evolution of spiral nebulae, partially suggested by our recent studies.

(c) The evolution of stars, showing their origin, sequence, and physical and chemical development throughout their life history.

(d) The constitution of matter, since the enormously greater range in mass, temperature, pressure, and density of the heavenly bodies presents opportunities for discovery far beyond the possibilities of laboratory experiment.

Scores of other problems calling for a larger telescope might be mentioned if space permitted.

(2) No method of advancing science is so productive as the development of new and more powerful instruments and methods of research. A larger telescope would not only furnish the necessary gain in light, space-penetration, and photographic resolving power, but permit the application of ideas and devices derived chiefly from the recent fundamental advances in physics and chemistry. These advances, which have suddenly transformed spectroscopy from an empirical into an exact and rational science, would undoubtedly render possible many new discoveries with such an instrument.

(3) The time is also especially opportune because of recent engineering and optical progress, such as the development of fused quartz as a very advantageous substitute for glass, and the proof now available that the atmospheric conditions on Mount Wilson are sufficiently perfect to permit a large increase in aperture to be fully utilized. Hitherto, in the absence of such proof, increases in the size of telescopes have been made at the risk of defeat by atmospheric disturbances.

(4) A study of the optical possibilities, which depend chiefly upon the promise of success in the manufacture of a large quartz disc for the paraboloidal telescope mirror, convinces us that the diameter of this disc should be 200 inches. This would collect nearly four times as much light as the 100-inch telescope (the largest yet constructed), penetrate twice as far into space, and reveal hundreds of millions of stars beyond its range. The shorter relative focal length adopted in our new design and the probable substitution of quartz for glass would greatly increase this gain, which could be still further enhanced by the improvement of photographic plates and accessory apparatus.

(5) The procedure in view involves:

(a) A preliminary study, by a group of the ablest experts, of all promising methods of making telescope mirror discs of large diameter.

(b) If, as now seems probable, such a study should point to the use of fused quartz, the next step would be an experimental test of the possibilities of fused quartz, and the manufacture as soon as feasible of a 200-inch mirror disc. I have already outlined to you the steps in this process, which would be carried on under the personal supervision of Dr. Elihu Thomson of the General Electric Company. Several years would be occupied in this work.

(c) A simultaneous comparative study, by a group of experienced astronomers, physicists, opticians, instrument makers, and engineers, of the various optical and mechanical questions involved in the design of the telescope and all its accessory

apparatus, and the preparation of working drawings for the mounting and dome as soon as the completion of a suitable mirror disc may permit.

(d) A simultaneous comparative study, by astronomers, physicists, and meteorologists familiar with the performance of the largest existing telescopes, of possible sites for the instrument, taking into account not only the clearness and steadiness of the atmosphere at various seasons throughout several years, but with due regard to the special requirements of the telescope, the nature of the problems in view, the efficiency of the observers, and the intimate cooperation of such institutions as the Mount Wilson Observatory and the Bridge and Gates Laboratories of the California Institute.

(e) The grinding, polishing, and figuring of the large and small mirror discs when ready. This work, like the casting of the large disc, must be done at the site selected, because of the difficulty of transporting the large disc.

(f) The construction and erection of the telescope mounting, buildings, and accessory apparatus.

(6) As you have remarked, the most important requirement in the construction and operation of the telescope is the close co-operation of the Mount Wilson Observatory and the California Institute. If your board should decide to provide for the undertaking in accordance with the views expressed by yourself in our recent conferences, the following scheme of organization might be suggested:

(a) A policy committee, consisting of the Director of the Norman Bridge Laboratory of Physics (Dr. Robert A. Millikan), the Director of the Mount Wilson Observatory (Dr. Walter S. Adams), and, if desired, the writer.

(b) A director, chosen with careful consideration of the special knowledge required in the construction and use of the telescope.

(c) A permanent staff of observers, assistants, and computers.

(d) An arrangement providing for the intimate cooperation of the scientific and technical staffs of the Mount Wilson Observatory and the Bridge and Gates Laboratories. This cooperation can now be assured.

(e) The temporary appointment from time to time of research associates, assistants, and fellows from institutions in various parts of the world whose investigations have especially qualified them to make the most efficient possible use of the 200-inch telescope.

It goes without saying that this instrument should be employed for investigations beyond the range of other telescopes. The purpose in view is therefore not to duplicate the instrumental equipment of the Mount Wilson Observatory or other similar institutions, but to provide for the extension of astronomical and physical research into fields now inaccessible.

(7) The best estimate of total cost I am now in a position to offer is six million dollars, to be expended over a considerable period (probably from four to six or more years). This would cover preliminary studies of optical problems, design, and site;

manufacture of mirror discs; optical work; temporary and permanent buildings; tools, machinery, instruments, and apparatus; road to site and expense of transporting building materials, machinery, and instruments; construction and erection of the telescope and its accessories. This estimate, which does not include endowment, is believed to cover the various contingences necessarily to be reckoned with in a large undertaking of this kind.

A more complete statement regarding some of the possibilities of large telescopes may be found in my article in the April number of Harpers Magazine.

Very sincerely yours,

George E. Hale

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