A Fifty-foot Interferometer Telescope.[1]

By Dr. GEORGE E. HALE, For.Mem.R.S.

THE angular diameter of a star was measured for the first time by Mr. Francis G. Pease at the Mount Wilson Observatory on December 13, 1920, with a 20-foot Michelson interferometer attached to the 100-inch reflecting telescope. The method employed is due to Prof. Michelson, who had adjusted the interferometer and tested it on stars during the previous summer, with the assistance of Mr. Pease. Since that time Mr. Pease has measured the diameters of Betelgeuse, Arcturus, Aldebaran, and Antares. On the basis of the best available values of their parallaxes, the corresponding linear diameters are 215,000,000, 21,000,000, 270,000,000, and 400,000,000 miles respectively. These stars are all in the giant stage, with densities ranging from 0·000001 (Antares) to 0·0002 (Arcturus). The Sun, a dwarf star 866,000 miles in diameter, in a much more advanced state of development, has a density of 1·4 (water = 1).

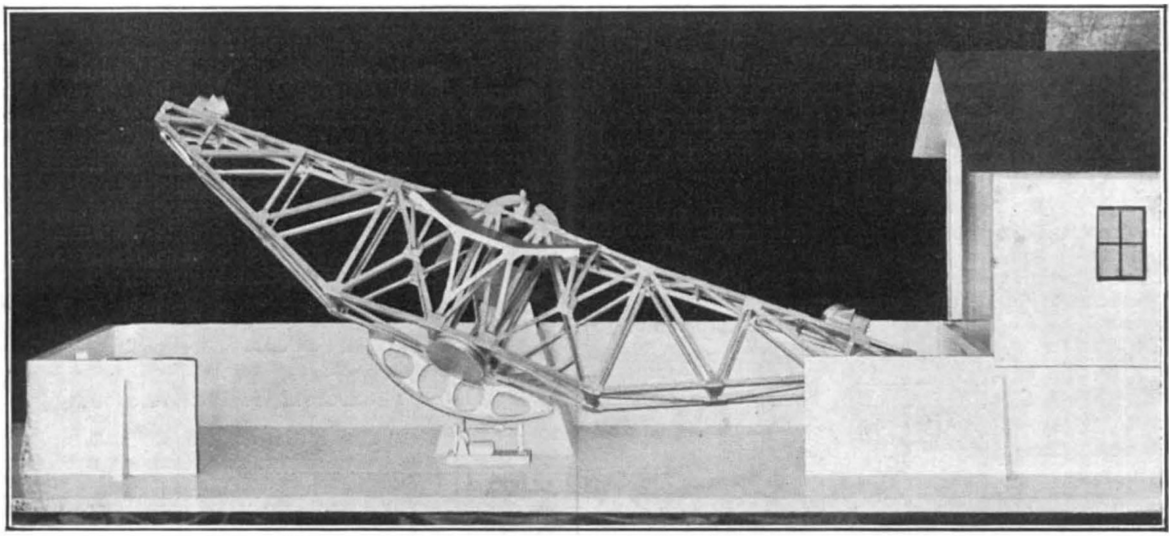

FIG. 1.—50-foot interferometer telescope for the Mount Wilson Observatory.
Model seen from the north (part of wall removed to show 36-inch mirror cell and driving mechanism).

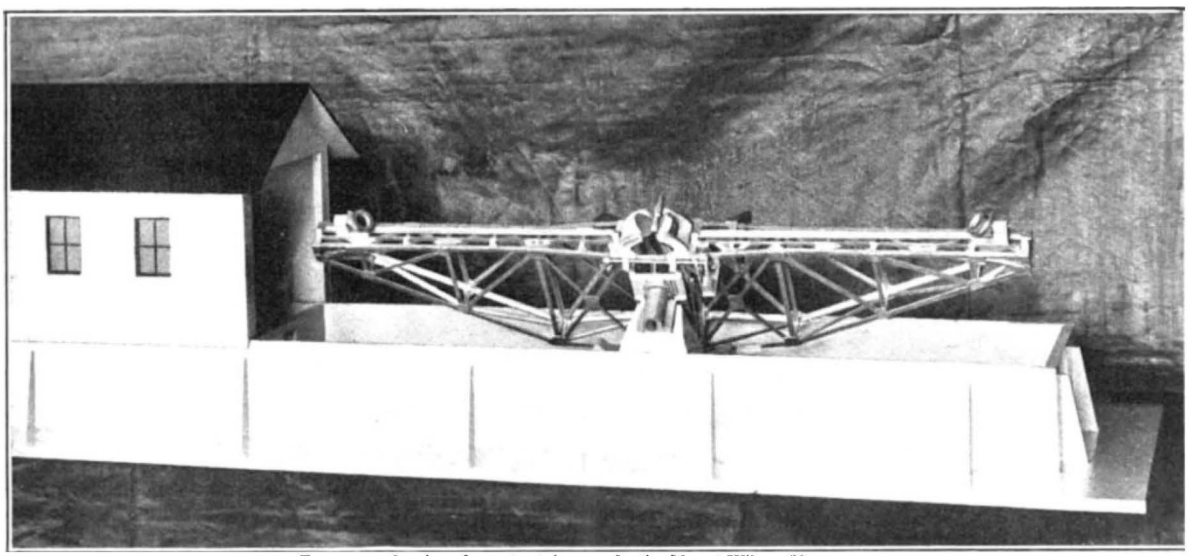

FIG. 2.—50-foot interferometer telescope for the Mount Wilson Observatory.
Model seen from the south, showing movable house that covers the instrument when not in use.

It would evidently be of great interest to measure the diameters of other stars, of various spectral types, because of the direct bearing of the results on the problem of stellar evolution. Unfortunately, very few are within the range of the 20-foot interferometer, and neither the capacity of the telescope mounting nor the width of the observing aperture in the dome will permit a larger instrument to be used with the 100-inch re-

[1] The substance of this article was communicated to Section A of the British Association at Hull on Monday, Sept. 11, by Prof. H. H. Turner, who showed the photographs of the model on the screen.

flector. Immediately after the first successful measures by Mr. Pease, both he and I made several designs of large interferometers with independent equatorial mountings, but their cost would have been too great to warrant their construction. It was also thought advisable to postpone further instrumental developments until they could be undertaken in the light of prolonged experience with the 20-foot interferometer.

The method has since proved so successful, and its wider application so desirable, that the mechanical problem has recently been taken up anew. Optically the 20-foot instrument leaves nothing to be desired. The new instrument is therefore simply a larger Michelson stellar interferometer adapted for the observation of fainter and smaller stars, embodying no new optical features, but carried by a mounting so simplified in design as to reduce the cost of construction to a minimum. My specifications for the mounting, which have been improved in certain respects and developed into working drawings by Mr. Pease and his associates in the Division of Instrument Design of the Mount Wilson Observatory, call for a light but very rigid skeleton girder about 54 feet long and 10 feet deep at its centre, where its cross-section is about $4\frac{1}{2}$ feet (Figs. 1 and 2). This is to be built of standard steel shapes, cut to length at the mill and riveted together on Mount Wilson. The girder will be bolted to a heavy plate carried by the upper extremity of the polar axis, which is a short steel forging turning in standard roller bearings, mounted on the upper face of a massive concrete pier. The polar axis passes through the centre of gravity of the girder, thus assuring its balance in all positions. A worm-gear sector of long radius, bolted to the girder, is driven by a worm connected with a driving-clock fixed near the north face of the pier. The range of motion in right ascension is $1\frac{1}{2}$ hours east and west, thus allowing ample time for the observation of a star when near its meridian passage.

The optical parts comprise a paraboloidal mirror of 36 inches aperture and about 15 feet focal length, mounted within the girder, as shown in the illustrations. The two outer plane mirrors, each 15 inches in diameter, mounted at 45° on carriages which slide along rails bolted to the upper face of the girder, receive light from the star and reflect it to two similar 45° plane mirrors, fixed in position above the 36-inch mirror, to which they send the two parallel beams. These are returned as converging beams toward the focus, but are intercepted by a (Newtonian) 45° plane mirror above the centre of the girder, which sends the light to the focal plane, in the direction of the north pole. The observer, seated on a platform carried by the girder, makes the necessary adjustments and determines the visibility of the interference fringes corresponding to various settings of the outer 45° mirrors, which are periodically moved apart by a single long screw driven by an electric motor. The distance between these mirrors, when the fringes disappear completely, gives the angular diameter of the star if the mean wave-length of its light is known.

To reach stars north or south of the equator, the two outer 45° mirrors are rotated simultaneously by synchronous motors about the axis joining their centres. In this way any star from the pole to 30° south declination can be observed when near the meridian.

Throughout the design precautions have been taken to reduce the amount of large and expensive machine work to a minimum. The girder need be only approximately straight, as the rails, carefully planed in 12-foot lengths (the limit of our planer bed), will be optically lined up by adjusting screws. The final compensation for length of path will be effected by a sliding wedge, of the type designed by Prof. Michelson for the 20-foot interferometer. Comparison fringes, adjustable for visibility, will be provided as an aid to the observer. The instrument will be covered when not in use by a sheet steel house with double walls, the upper part of which can be rolled away longitudinally by an electric motor.

This interferometer should permit the measurement of more than thirty stars brighter than the fourth magnitude, representing a wide range of spectral types. It is now under construction in the instrument and optical shops of the Mount Wilson Observatory.[2]

[2] For a brief account of the 20-foot interferometer and its method of operation, see the chapter on "Giant Stars" in the writer's recent book "The New Heavens," reviewed in NATURE of July 11, p. 2. Full details are given by Messrs. Michelson, Pease, and Anderson in the *Astrophysical Journal*.

Motorless or Wind Flight.

By Dr. S. BRODETSKY.

RECENT achievements in motorless flight, variously designated as *gliding*, *soaring*, and *sailing*, have attracted considerable attention, and much discussion has arisen as to the practical and military value of this new development, as well as to its scientific significance. While many authorities anticipate nothing more than the emergence of a new "sport," and ascribe little importance to motorless flights, others of a more imaginative turn of mind foresee great possibilities in this type of aerial navigation. The motorless flying machine has even been proclaimed as heralding the doom of the engine-driven aeroplane!

It is certainly premature to attempt a forecast of the future of flight in a glider. The art of gliding is, of course, older than that of flight in an engine-driven machine: Lilienthal's experiments with gliders were made more than a generation ago, long before any aeroplane containing a motor rose into the air and executed a real flight. But Lilienthal, Pilcher, Chanute, Orville Wright, and others were not able to stay aloft in a glider more than a few minutes; whereas during the recent competitions in Germany, Martens remained in the air nearly three-quarters of an hour, and Hentzen stayed in the air two hours, and later three hours, performing evolutions of an intricate character. It is therefore clear that the art of gliding has entered upon a new phase, and the scientific problems involved merit careful discussion.

As already indicated, there is considerable diversity in the names given to the flights thus carried out