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THE AWARD OF THE BRUCE GOLD MEDAL TO DR. WALTER BAADE

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Each year the Astronomical Society of the Pacific awards the Catherine Wolfe Bruce Gold Medal to an outstanding astronomer. The award is made by the Directors of the Society who select the recipient from a list of nominees presented by the directors of six large observatories. To ensure a truly international viewpoint, three of the nominating observatories are not located in the United States. The Directors of the Astronomical Society of the Pacific have, by unanimous vote, chosen as Medalist for 1955 Dr. Walter Baade, astronomer on the staff of the Mount Wilson and Palomar Observatories.

Walter Baade was born in Schröttinghausen, Germany, in 1893, where his father was a school director. Although his interest in astronomy was aroused early, he apparently felt that astronomy was an unlikely profession in which to earn an adequate living. Accordingly, the earlier stages of his education were rather heavily weighted toward languages, including Hebrew, with the idea that theology might offer more satisfactory professional opportunities. However, after one year at the University of Münster, Baade went to Göttingen where he acquired his doctorate in astronomy in 1918.

During his stay at Göttingen, Baade served as assistant to the famous German mathematician Felix Klein for a period of three years. Although Baade's subsequent career has not been along mathematical lines, his association with Klein appears to have been very influential in instilling in him sound and rigorous



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methods of thinking through the various problems which he has successfully attacked. An even more practical result was that, on Klein's recommendation, Baade was appointed assistant astronomer at the then new Hamburg Observatory upon completion of his studies in 1918. He remained at Hamburg, rising in rank to astronomer, until 1931 when he came to the United States to accept an appointment as astronomer at Mount Wilson. During the years at Hamburg Baade participated in two eclipse expeditions, in 1926 to Lapland and in 1929 to the Philippines, and also held a Rockefeller Fellowship in 1926. This fellowship enabled him to spend some time in the United States where he visited, among other institutions, both the Lick and the Mount Wilson Observatories.

Baade's scientific career, from the very start, has been built upon a central theme from which he has never deviated for very long. There have been side lines, of course, and although these have often been of great interest and importance in themselves, they have never distracted him noticeably from his main stream of research. To put it briefly, and rather inadequately, Baade has followed a steady course of investigation of the structural features and stellar content of systems of stars, particularly of the largest systems of all, the galaxies themselves. This work began as soon as Baade received his appointment at Hamburg in 1918. At that time it had long been known that short-period intrinsic variables, those with periods of about half a day, were fairly common in the globular clusters. In fact, because of this, such objects had come to be known as cluster-type variables, since only a handful were known to exist in the galaxy at large, and these were assumed to be stragglers or expellees from the clusters. Shortly before 1918, Shapley had demonstrated at Mount Wilson that the globular clusters formed a spherical system very different from the highly flattened main body of the galaxy. Putting these facts together, Baade asked whether the spherical grouping of the clusters might not merely outline a halo of stars whose existence was as yet unknown. If so, it appeared logical to expect that among such halo stars there should be found short-period variables like those in the clusters themselves. Baade's observations proved that this was indeed the case, and that there were many thousands of

cluster-type variables extending to great distances from the galactic plane and forming a spherical halo more or less coextensive with that outlined by the globular clusters.

Baade next turned his attention to the problem of finding cepheid variables in external galaxies. In this he was unsuccessful, because of inadequate telescopic power, but he did succeed in finding a few of the extremely bright irregular variables which exist in some of the near-by spirals. Even today fewer than a dozen such objects are known, and detailed knowledge of them is scarce. However, the discovery of these few individual objects in external galaxies led Baade to make detailed studies of two fields in the Milky Way, one in the Cygnus Cloud and the other in Sagitta. Here he failed, for reasons that are now obvious, to find local examples of the irregular variables of great luminosity which he was seeking, but he noted that in such galactic regions most of the variables were eclipsing stars rather than stars of intrinsic variability. Thus it began to be apparent that different types of stars tended to predominate in different regions of our galactic system.

By now Baade was established at Mount Wilson, where, in the meantime, Hubble had already succeeded in finding cepheids in near-by spirals and in evaluating provisionally the distances and luminosities of the nebulae. The detailed study of our own galaxy is hampered very severely by the obscuration produced by interstellar dust clouds, and although Baade continued some work on galactic problems, he began an intensive study of the Andromeda nebula. Here the whole stellar system is displayed to the observer who has adequate telescopic power at his disposal. His task is somewhat analogous to investigating a vast forest-covered region from the air rather than from inside the forest itself where, as the saying goes, one may not be able to see the woods for the trees. Both types of study are ultimately needed if the properties of the individual trees, as well as their distribution, are to be discovered, but the survey from outside is best suited to uncovering spatial relationships of various kinds of trees.

One of Baade's first results was that bright blue giants and cepheids are found only in the spiral arms of the Andromeda nebula, in conjunction with dust clouds. Curiously, the restric-

tion of the interstellar gas to the spiral arms in our own system has been confirmed only very recently, as a result of observation of the 21-cm radio emission of hydrogen. Between, and underlying, the arms was an amorphous sheet of luminosity which for a long time remained unresolved. Finally, during the dim-out of the last war, Baade was able with the 100-inch to resolve the brightest stars of this background. These stars proved to have a color and luminosity similar to those of the brightest stars in the globular clusters of our own system, and this fact, together with other clues, led him to propose that stars in general fall into two main groups which he has labeled populations I and II. Typical of population I are the supergiants, B-stars, classical cepheids, etc., while population II includes the globular clusters, high-velocity stars, planetary nebulae, etc. This concept has been tremendously stimulating for various branches of astronomy. Recent studies of color-magnitude arrays in globular clusters, modern views of stellar evolution, theoretical work on stellar interiors, have all been influenced by, and benefited from, the unifying nature of Baade's results.

When the two-hundred-inch telescope was placed in operation Baade confidently expected to be able to photograph cluster-type variables in the Andromeda nebula. His failure to do so immediately suggested to him that the nebula must be more distant than had been supposed. Further investigation led him to a revision of the distance scale of the nebulae such that all previous distances must be multiplied by a factor of about 2.

Baade's work on Andromeda is still continuing; when finished, we should have an excellent picture of the structure and distribution of stars within a galaxy very similar to our own, a much better picture, in fact, than we can derive of our own galaxy as seen from inside. To illustrate the observational difficulties in our own system, the nucleus of our galaxy may be mentioned. It is hidden from us by the dense, opaque dust clouds of the Milky Way, but diligent search by Baade revealed a couple of "windows" in the clouds through which the outer portions of the galactic bulge may be seen. Observation through these windows has shown an extraordinary wealth of cluster-type variables associ-

ated with the bulge, and the conclusion is that the galactic nucleus is probably composed of pure population II objects as are the globular clusters.

In 1954 Dr. Baade received the Gold Medal of the Royal Astronomical Society. In awarding him the Bruce Medal for 1955 we can perhaps emphasize the fact that few modern astronomers have been able to contribute as much to their science as he has.