Astronomy. — *"The proper motion of the globular cluster Messier 13 and its internal motion."* By ADRIAAN VAN MAANEN.

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The unexpected discovery of internal motions in the spiral nebulae, from the study of photographs with a relatively short interval made it seem desirable to try analogous measures for one or more globular clusters.

Several photographs of globular clusters were obtained soon after the 80-foot focus arrangement of the 60-inch Mount Wilson reflector had been made available for direct photography (1913). After an interval of over ten years I have measured some plates of the great cluster in Hercules Messier 13, two pair of plates of good quality and with an interval of 9 and 11 years, respectively, being chosen for measurement, which was done with the stereocomparator, with the plates in four positions, East, West, North, and South, respectively, in the direction of the increasing readings of the micrometer screw.

Dr. SHAPLEY had indicated which stars might be members of the cluster and which not, the latter to be used for comparison purposes. With his help fifty comparison stars were selected while sixty-two other stars were measured, which, with considerable probability, might be accepted as members of the cluster. His selection was based on the distance from the center, the magnitude, and the color-index of the individual stars.

As the detailed measures will be published in *Contributions of the Mount Wilson Observatory* N^{0}. 284, I shall here give only the results.

That the motions of the members of the cluster are small was at once evidenced by the fact that the annual motions, regardless of the algebraic sign, are only 0''.003 in both right ascension and declination, while the analogous values for the comparison stars are 0''.006 and 0''.010 respectively.

Taking account of the algebraic sign of the motions, we derive for the motion of the cluster with respect to the mean motion of the comparison stars:

$$\mu_\alpha = -0''.001 \pm 0''.0004$$
$$\mu_\delta = -0''.001 \pm 0''.0003.$$

Subtracting these quantities from μ_α and μ_δ of the individual members of the group, we derive values which represent the internal motions in the cluster. As we might *a priori* expect a contraction or a dispersion, the first thing to do was to derive the mean radial component of the motion. The result is, however, that this component is 0''.0000 ± 0''.0003;

there is little reason to anticipate a component at right angles to the radius, except that in the measures of the spiral nebulae such a component has been shown to exist. In Messier 13 this component is 0''.0005 ± 0''.0004 in the direction N W S E. We may thus conclude that the internal motions in the cluster are of the order of 0''.001 or less.

Similar result can be derived in the following way: the probable error of the motion in each coordinate as derived from a comparison of the measures of each pair of plates is 0''.0023. If we accept all the 62 stars as real members of the group and that therefore, except for any possible internal motions, they all must have the same motion, we can derive a probable error from the deviations from this mean motion of the group; the result is 0''.0026. It is true that this is slightly larger than the value 0''.0023 found before, but it is a well known fact that the internal probable error is always somewhat, and sometimes considerably smaller than the external probable error. The difference between the two values given indicates that the internal motions of the members of the group can scarcely exceed 0''.001 in each coordinate.

The results of the measures are thus negative: the motions are too small to be detected in an interval of ten years; they are, nevertheless, of importance for two reasons: firstly, they show that the parallax of 0''.00009, derived by SHAPLEY for Messier 13, cannot be very much too small, as otherwise with the considerable radial velocities found for the globular clusters, we might have expected a measurable motion at right angles to the line of sight; and secondly, the results are of importance in connection with the internal motions found in several spiral nebulae. The plates were taken and measured with the same instruments as in the case of the nebulae and the possibility that their internal motions, which were found to be of the order of 0''.020 annually, are due either to the 60-inch reflector or to the stereocomparator, is therefore eliminated. The only possibility that the displacements found in the spirals are not real motions would seem to lie in a systematic difference along the arms of the spirals between the old and the new plates. This possibility is extremely doubtful, because in that case the total displacements would hardly be proportional to the time interval, as was found in several of the spirals for which pairs of plates with different time intervals were available. Moreover, such displacements should be quite different in spirals with a large amount of nebulosity present and in objects where the nebula is practically resolved into individual starlike points. Finally, if the displacements were due to some photographic effect, we should expect such a systematic error to be larger near the centre than near the edge of the spiral, while the measures show just the reverse in all cases.