correction is necessary, but of course all the zero points differ, presumably by large amounts that are at present indeterminate or at least very uncertain. There are also local effects (such as a possible Stark effect) that may alter the quantities to some extent.

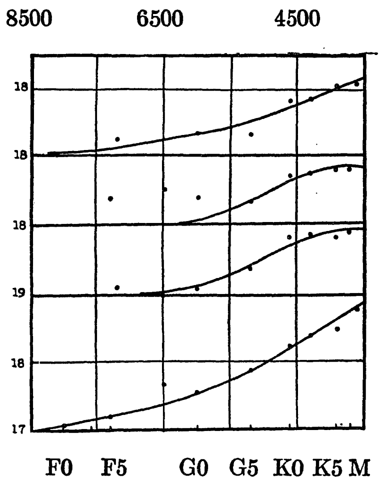

Figure 2. — Logarithms of numbers of effective atoms (ordinates) in the various spectral classes for 4326 (Fe), 4077 (Sr+), 4215 (Sr+), and 4227 (Ca). Spectral classes are shown below, approximate temperatures above.

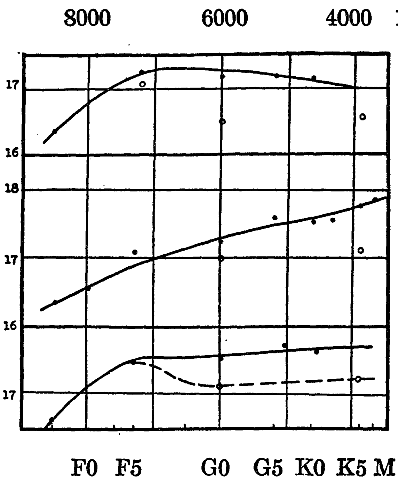

Figure 3. — Number of ionized iron (above) and neutral iron atoms, and their sum (lowest figure) for the spectra of giants (dots) and dwarfs (circles). The continuous and broken lines in the lowest figure indicate the relative amounts of iron atmosphere for giant and dwarf.

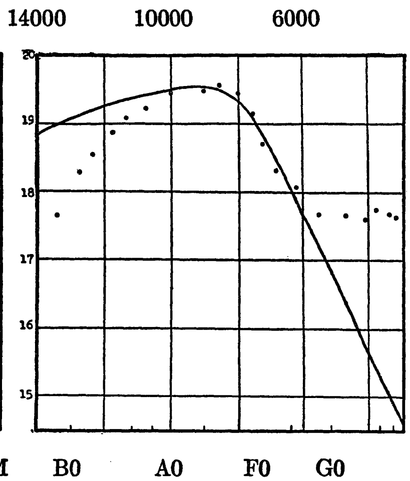

Figure 4. — Numbers of effective hydrogen atoms (mean of Hγ and Hδ) in the spectral sequence. The line represents the numberpredicted on the basis of a fit at the maximum by the Boltzmann factor. It is seen that no possible adjustment of temperatures could bring the observed points on to the curve.

In spite of these sources of uncertainty, it is believed that the information contained in the figures leads to some tangible conclusions. For instance, relative amounts of hydrogen and metallic atmosphere for absolutely bright and faint stars can be inferred; degrees of ionization of calcium and iron can be compared; the number of effective hydrogen atoms compared with the expectations based on the Boltzmann formula, and the ionization and energy methods of determining temperature discriminated. The discussion of such problems is undertaken in Harvard Monograph No. 3.

Cecilia H. Payne

The Mass-Spectrum Relation for Giant Stars in the Globular Cluster Messier 22. — The completion of a photometric study of the bright globular cluster Messier 22 permits the compilation of a color-magnitude array for 623 of its most luminous stars. The array is essentially a correlation table of spectral class and absolute magnitude. From the mass-luminosity relation observed for galactic stars, we can therefore easily derive provisionally the relation of spectrum to mass for giant stars. I believe that a mass-spectrum relation has not heretofore been obtained for a globular cluster.

Perhaps the next most important result of the study of colors in Messier 22 is the support it gives the earlier deduction from other globular clusters that the absolute luminosity of the cluster giants is progressively less for increasing surface temperature; on the average the stars of color index zero are about two and a half magnitudes fainter photovisually than those of color index +1.5.

1. The photographic and photovisual magnitudes for Messier 22 have been based on selected plates from a series made by the writer with the 60-inch reflector at Mount Wilson (Table I). All the plates used for magnitude estimates, except No. 3888, have two exposures on the North Polar Sequence in addition to the exposure on the cluster.

TABLE I

OBSERVATIONAL DATA

Plate	Date	Magnitude	Exposure
3888	1917 Aug. 14	Photographic	5^m
3963	Sept. 10	"	3
4535	1918 July 5	"	2
4624	Aug. 2	Photovisual	5
4625	Aug. 2	Photographic	2
4626	Aug. 2	Photovisual	5
4633	Aug. 3	"	5

In measuring the plates and deducing magnitudes, which may be published in detail at a later time, I have had the assistance of Miss Helen Roper, who made practically all of the many estimates of brightness.

The color-magnitude array in Table II includes all stars brighter than the magnitude limit of the photovisual plates and within about 5′ of the center of the cluster. A few stars are excluded because of crowding, variability, or for other reasons, but without appreciable effect on the general appearance of the array or on the mean results. The color indices for stars of color classes later than m5 are as follows:

Star Number	Photovisual Magnitude	Distance from Center	Color Index
Chevalier 694	10.25	1.3	+1.83
283	10.76	1.4	+2.04
418	10.82	1.7	+2.00
232	10.86	2.0	+1.94
156	10.93	5.2	+1.93
510	11.05	0.5	+1.85
539	11.05	0.2	+1.85
696	11.1	1.75	+1.95

It is noteworthy that more than five per cent of the stars measured in Messier 22 have negative color indices, the cluster resembling in this respect Messier 13 rather than Messier 3.

TABLE II

Color-Magnitude Array for Messier 22

Limits of Photovisual Magnitude	Color class													All colors
	<b0	b0 to b5	b5 to a0	a0 to a5	a5 to f0	f0 to f5	f5 to g0	g0 to g5	g5 to k0	k0 to k5	k5 to m0	m0 to m5	>m5	
10.20-.39	..	..	..	..	..	..	..	..	..	..	..	..	1	1
.40-.59	..	..	..	..	..	..	..	..	..	..	..	..	..	..
.60-.79	..	..	..	..	..	..	..	..	..	..	..	..	1	1
.80-.99	..	..	..	..	..	1	..	..	..	..	..	..	3	4
11.00-.19	..	..	..	..	..	..	..	..	1	..	..	3	3	7
.20-.39	..	..	..	..	..	..	..	..	..	..	3	6	..	9
.40-.59	..	..	..	..	..	..	..	..	..	2	2	1	..	5
.60-.79	..	..	..	..	..	..	..	..	1	2	1	1	..	5
.80-.99	..	..	..	..	..	..	1	..	2	5	1	..	..	9
12.00-.19	..	..	..	..	..	..	..	..	3	..	1	1	..	5
.20-.39	..	..	..	..	..	..	2	2	8	2	..	..	..	14
.40-.59	..	..	..	..	..	..	1	3	5	2	2	..	..	13
.60-.79	..	..	..	..	1	..	1	6	15	2	..	..	..	25
.80-.99	..	..	..	..	..	1	3	4	3	..	..	..	..	11
13.00-.19	..	..	..	..	..	1	1	4	3	1	..	..	..	10
.20-.39	..	..	..	..	..	1	6	9	3	1	..	..	..	20
.40-.59	..	1	..	..	1	8	6	6	1	..	..	..	..	23
.60-.79	..	..	..	..	1	12	28	16	..	..	..	..	..	57
.80-.99	..	..	1	1	4	34	59	7	..	..	..	..	..	106
14.00-.19	..	..	2	1	17	39	12	..	..	..	..	..	..	71
.20-.39	1	1	11	40	61	39	3	..	..	..	..	..	..	156
.40-.59	..	1	19	26	20	2	..	..	..	..	..	..	..	68
.60-.79	..	..	3	..	..	..	..	..	..	..	..	..	..	3
Totals	1	3	36	68	105	138	123	57	45	17	10	12	8	623

2. No correction has been made in the color-magnitude array for superposed stars. The comparatively small dispersion in magnitude for a given color class is therefore surprising; it appears to be less than for Messier 13 and Messier 3, the two globular clusters for which extensive data are available, and which are in such high galactic latitude that they should be essentially free from the effect of superposed non-cluster stars.

Since Messier 22 appears in a large star cloud in Sagittarius, and probably fifteen per cent of the stars of our catalogue are not cluster members, we can only conclude that the cluster is actually within the star cloud, or very near it. Our color-magnitude array is therefore applicable both to the cluster and to the star cloud. A part of the observed dispersion in apparent magnitude can be attributed to thickness.

The moderate spread in apparent photovisual magnitude shown in Table II implies an equally small dispersion in photographic brightness, in absolute bolometric magnitude, and presumably, therefore, in mass. If the magnitudes were sufficiently accurate for finer subdivisions in color class, it is possible that the dis-

TABLE III

Mass-Spectrum Relation for Messier 22

Apparent Pv. Mag.	Spectrum	Absolute Pv. Mag.	Absolute Bol. Mag.	Mass
11.2	M2.5	−2.96	−4.62	29:
.4	K9.0	−2.76	−4.10	22.4:
.6	K5.8	−2.56	−3.72	17.8
.8	K3.0	−2.36	−3.13	14.1
12.0	K1.0	−2.16	−2.74	11.7
.2	G9.0	−1.96	−2.41	10.0
.4	G7.0	−1.76	−2.10	8.3
.6	G5.5	−1.56	−1.84	7.4
.8	G4.0	−1.36	−1.58	6.5
13.0	G2.5	−1.16	−1.30	5.9
.2	G1.2	−0.96	−1.06	5.4
.4	F9.8	−0.76	−0.80	4.8
.6	F7.8	−0.56	−0.58	4.5
.8	F5.8	−0.36	−0.36	4.1
14.0	F3.0	−0.16	−0.16	3.9
.2	A9.5	+0.04	+0.04	3.7
.3	A6.8	+0.14	+0.07	3.6
.4	B7.5	+0.24	−0.49	5.7

persion in luminosity and mass for a given surface temperature would be even less than indicated in the table.

3. The computation of the stellar masses in terms of the sun's mass for successive intervals of photovisual magnitude and color index is shown in Table III. The adopted distance modulus, m − M = 14.16, is derived from data in Harvard Bulletin 869. The reduction to bolometric magnitude and the computation of the masses are made with the aid of tables published by Eddington. If Brill's temperature scale and reduction to bolometric magnitude were used, the masses would be slightly less, especially for the redder stars.

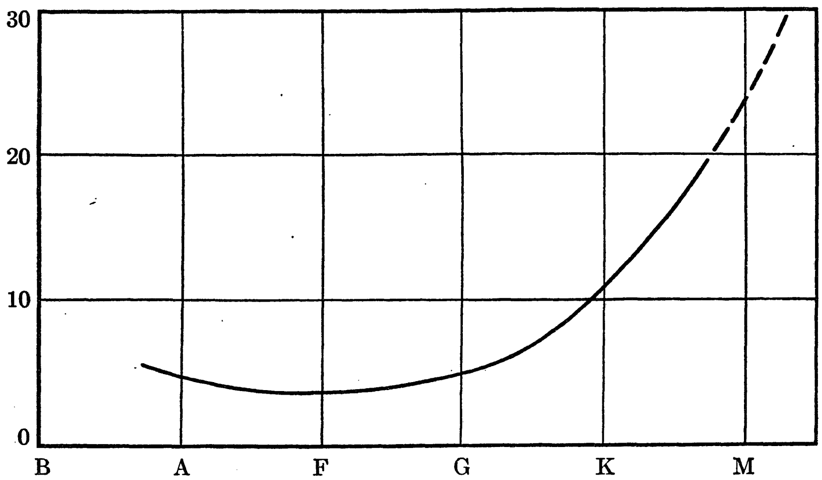

FIGURE 1. — The Mass Spectrum Curve for Messier 22

The uncertainties in replacing color class with spectral class, and in the temperature scale and the mass-luminosity relation used for the computation of the masses, are not negligible, but they probably do not seriously affect the present results, except possibly for Classes K5 and M. Perhaps we have an indication of the inaccuracy of the mass-luminosity relation in this observed dispersion in magnitude (and mass) for a given color index, not only in Messier 22 (Table II) but also in the equally well observed globular clusters Messier 3 and Messier 13. The mass-luminosity relation is based observationally on a limited amount of data, mainly double stars, and it may not apply strictly to single stars, especially to those in the peculiar environment of a globular cluster. With more accurate magnitudes, bolometric reductions, and temperature scales for cluster giants than those we now have, it should be possible to determine to what extent the mass-luminosity relation has a useful meaning.

The values of photovisual magnitude and spectrum in Table III are read directly from a smooth curve drawn through a plot of the data summarized for the individual stars in Table II.

The mass-spectrum curve is shown in the accompanying figure. The masses for types A0 to F5 are only upper limits of average mass because of the incompleteness of the corresponding luminosity curves.

Harlow Shapley

Note on a Remote Cloud of Galaxies in Centaurus. — The available Bruce plates of long exposure record more than forty distinct groups of external galaxies. In some groups the membership is limited to ten or a dozen systems; in other several hundred members are shown on the photographs. Except for a few clouds of bright galaxies, we must suppose that a considerable part of the group membership remains undiscovered below the limit of the photographic plate. Apparently we see nearly all of Coma-Virgo Cloud A, but Clouds C and D probably extend far below our eighteenth magnitude limit (H.B. 865).

A cloud of galaxies in Centaurus that appears to be one of the most populous yet discovered and is otherwise noteworthy is shown on three long exposure Bruce photographs that have recently been examined for faint nebulae. The full extent and population of this cloud cannot be accurately measured or even estimated until photographs showing objects of the twentieth magnitude or fainter can be obtained; but a preliminary account should be of interest because of the great linear dimensions, the numerous population, and the distinctly elongated form.

1. The Centaurus cloud is centered at $13^h\ 23^m.6$, $-31^\circ.1$ (1900), with galactic coordinates 281° and +30°. It appears to be oval in form with dimensions roughly 2°.8 by 0°.8, and an area of 2.2 square degrees. The limits are of course indefinite on the Bruce plates which show only the brightest two magnitudes, 16 to 18. The boundary line suggested in the drawing, Figure 1, encloses a smaller area than used in computations for this note. The position angle of the longer axis is 90°.

2. There is an indefinite extension on the north side of the cloud, comprising approximately thirty systems; its center is at $13^h\ 22^m.3$, $-30^\circ.4$ (1900).

3. The Bruce plates on which the Centaurus cloud appears cover effectively an area of about thirty degrees and show more than a thousand systems. The average