α Lyrae. All of these declinations had been corrected for variation of the latitude.

The same scheme of exhibiting these varying values of the latitude by hours was used in plotting this chart. Into each mean had been collected all those latitudes the values of which had been derived from observed declinations of stars where the meridian passage of the stars occured between any two hours of mean time. A similar chart to the above with those data plotted on it will also be found in the volume.

A study of these latitudes thus plotted leads to a much stronger conclusion than in the case of those of the declination of α Lyrae, that stars when observed with a prime vertical transit with the sun above the horizon are strongly affected, not with an internal house temperature, but by an influence which exists in the strata of air immediately above the open shutters. The cause for that effect will be taken up in another paper to be read to the Society.

CEPHEIDS IN SPIRAL NEBULAE.

By Edwin P. Hubble.

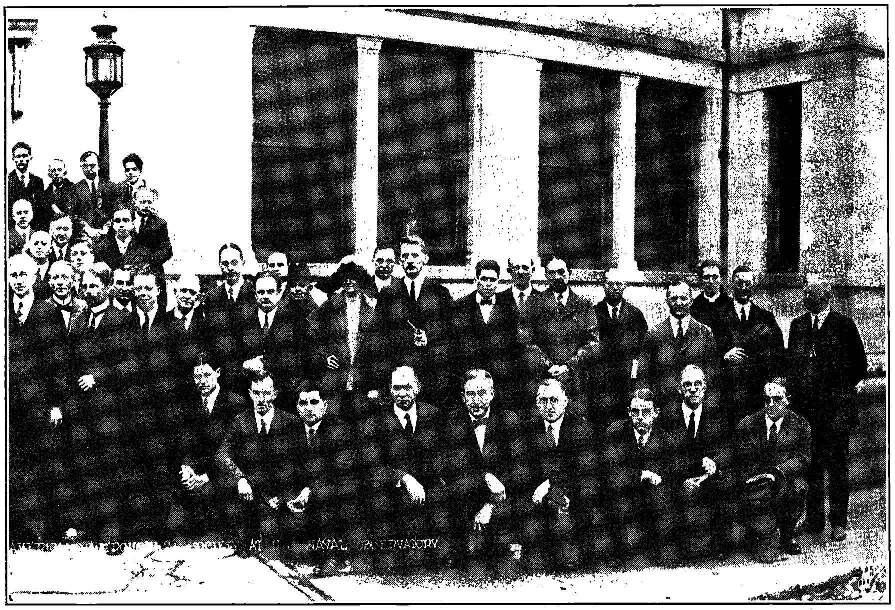
Messier 31 and 33, the only spirals that can be seen with the naked eye, have recently been made the subject of detailed investigations with the 100-inch and 60-inch reflectors of the Mount Wilson Observatory. Novae are a common phenomenon in M 31, and Duncan has reported three variables within the area covered by M 33.[1] With these exceptions there seems to have been no definite evidence of actual stars involved in spirals. Under good observing conditions, however, the outer regions of both spirals are resolved into dense swarms of images in no way differing from those of ordinary stars. A survey of the plates made with the blink-comparator has revealed many variables among the stars, a large proportion of which show the characteristic light-curve of the Cepheids.

Up to the present time some 47 variables, including Duncan's three, and one true nova have been found in M 33. For M 31, the numbers are 36 variables and 46 novae, including the 22 novae previously discovered by Mount Wilson observers. Periods and photographic magnitudes have been determined for 22 Cepheids in M 33 and 12 in M 31. Others of the variables are probably Cepheids, judging from their sharp rise and slow decline, but some are definitely not of this type. One in particular, Duncan's No. 2 in M 33, has been brightening fairly steadily with only minor fluctuations since about 1906. It has now reached the 15th magnitude and has a spectrum of the bright line B type.

For the determinations of periods and normal curves of the Cepheids, 65 plates are available for M 33, and 130 for M 31. The latter object is too large for the area of good definition on one plate, so attention has been concentrated on three regions: around B D

[1] *Publications of the Astronomical Society of the Pacific*, **35**, 290, 1922.

PLATE XVI—CONTINUED.



AMERICAN ASTRONOMICAL SOCIETY.

KEY TO PLATE.

55. Sollenberger.
56. Brown.
57. French.
59. Menzel.
60. Sparrow.
61. Roe.
62. Rogers.
63. Luyten.
64. Bowie.
65. Pollock.
66. Fath.
67. Silberstein.
68. Turner.
69. Urie.
71. Shapley.
72. R. M. Stewart.
73. E. C. Slipher.
74. Henderson.
75. Willis.
76. Pawling.
77. Vanderlinden.
78. Hamilton.
79. Bower.
80. Stokley.
81. Olivier.
82. Vyssotsky.
83. Lambert.
84. Millis.
85. Kiess.
86. Miss Payne.
87. Burton.
88. Humphreys.
89. Alter.
91. Myers.
92. Stebbins.
95. Marriott.
97. Albrecht.
98. R. H. Curtiss.
99. Brock.
100. Slocum.
101. D. R. Curtiss.
102. Peters.

+ 41°151, B D + 40°145, and a region some 45′ along the major axis south preceding the nucleus.

Photographic magnitudes have been determined from twelve comparisons with selected areas No. 21 and 45, made with the 100-inch using exposures from 30 to 40 minutes. This procedure seemed preferable to the much longer exposures required for direct polar comparisons with the 60-inch. It involves, however, a considerable extrapolation based on scales determined from the faintest magnitudes available for the selected areas.

TABLE I.

CEPHEIDS IN M 33.

Var. No.	Period in Days	Log. P	Photographic Magnitudes Max.	Min.
30	46.0	1.66	18.35	19.25
3	41.6	1.62	18.45	19.4
36	38.2	1.58	18.45	19.1
31	37.3	1.57	18.30	19.2
29	37.2	1.57	18.55	19.15
20	35.95	1.56	18.50	19.2
18	35.5	1.55	18.45	19.15
35	31.5	1.50	18.55	19.35
42	31.1	1.49	18.65	19.35
44	30.2	1.48	18.70	
40	26.0	1.41	19.00	
17	23.6	1.37	18.80	
11	23.4	1.37	18.85	
22	21.75	1.34	19.00	
12	21.2	1.33	18.80	
27	21.05	1.32	18.85	
43	20.8	1.32	18.95	
33	20.8	1.32	18.75	
10	19.6	1.29	18.80	
41	19.15	1.28	18.75	
37	18.05	1.26	18.95	
15	17.65	1.25	19.05	

TABLE II.

CEPHEIDS IN M 31.

Var. No.	Period in Days	Log. P	Photographic Magnitude Max.
5	50.17	1.70	18.4
7	45.04	1.65	18.15
16	41.14	1.61	18.6
9	38	1.58	18.3
1	31.41	1.50	18.2
12	22.03	1.34	19.0
13	22	1.34	19.0
10	21.5	1.33	18.75
2	20.10	1.30	18.5
17	18.77	1.28	18.55
18	18.54	1.27	18.9
14	18	1.26	19.1

Tables I and II give the data for the Cepheids in M 33 and M 31 respectively. No magnitudes fainter than 19.5 are recorded, because of the uncertainty involved in their precise determinations. The now familiar period-luminosity relation is conspicuously present.

For more detailed investigation of the relation, the magnitudes at maxima have been plotted against the logarithm of the period in days. This procedure is necessary, not only because of the uncertainties in the fainter magnitudes, but also because most of the fainter variables at minimum are below the limiting magnitude of the plates. It assumes that there is no relation between period and range, for otherwise a systematic error in the slope of the period-luminosity curve is introduced. Among the brighter Cepheids of M 33 the assumption appears to be allowable, for the ranges show a very small dispersion about the mean value of 0.8 magnitude. The average range and the dispersion are somewhat larger in M 31, but the data are too limited for a complete investigation.

The curve for M 33 appears to be very definite. The average deviation is about 0.1 magnitude, although a considerable systematic error is allowable in the slope. For M 31 the slope is very closely the same but the dispersion is much greater, averaging about 0.2 magnitude. This is probably greater than the accidental errors of measurement.

Shapley's period-luminosity curve[2] for Cepheids, as given in his study of globular clusters, is constructed on a basis of visual magnitudes. It can be reduced to photographic magnitudes by means of his relation between period and color-index, given in the same paper, and the result represents his original data. The slope is of the order of that for the spirals, but is not precisely the same. In comparing the two, greater weight must be given the brighter portion of the curve for the spirals, because of the greater reliability of the magnitude determinations. When this is done, the resulting values of $M - m$ are —21.8 and —21.9 for M 31 and M 33, respectively. These must be corrected by half the average ranges of the Cepheids in the two spirals, and the final values are then on the order of —22.3 for both nebulae. The corresponding distance is about 285,000 parsecs. The greatest uncertainty is probably in the zero point of Shapley's curve.

The results rest on three major assumptions: (1) The variables are actually connected with the spirals. (2) There is no serious amount of absorption due to amorphous nebulosity in the spirals. (3) The nature of Cepheid variation is uniform throughout the observable portion of the universe. As for the first, besides the weighty arguments based on analogy and probability, it may be mentioned that no Cepheids have been found on the several plates of the neighboring selected areas No. 21 and 45, on a special series of plates centered on B D + 35°207, just midway between the two spirals, nor in ten other fields well distributed in galactic latitude, for which six or more long exposures are available. The second assumption is very strongly supported by the small dispersion in the period-luminosity curve for M 33. In M 31, in spite of the somewhat larger dispersion, there is no evidence of an ab-

[2] *Mt. Wilson Contribution* No. 151. *Astrophysical Journal*, **48**, 89, 1918.