THE STRUCTURE OF THE LARGE MAGELLANIC CLOUD

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Plate I is a picture of the Large Magellanic Cloud made from a sandwich of a red-negative original and a blue-positive copy enlarged on paper. The original plates were taken with the 8-inch Meinel-Pearson Schmidt camera of the Mount Stromlo Observatory on November 18, 1958. They were a 103a-E with an OR 1 filter ($\lambda\lambda$ 6400–6640: Plate II) and a 103a-O with no filter ($\lambda\lambda$ 3400–5100: Plate III), exposed 20 minutes and 100 seconds, respectively, to the same sky density. The result shows H II regions white and blue stars black. The known H II regions larger than 50″ in diameter can be seen on the print from which Plate I was made. It appears that Hα is a stronger source than the sum of the other Balmer lines and the blue emissions of other ions. No instance of a reversal of this predominance has been found in the Large Magellanic Cloud. The chromatic change of scale introduced by the field flattener of the camera leads to the imperfect suppression of the "neutral" images except at one point of the field near the center. However, the power of the sandwich-plate method to show the details of the color distribution in the Large Cloud is great compared with the photoelectric method.[1,2] The latter obtains too few quantitative measures to be qualitatively recognizable as a picture. It is impossible to construct a picture (or accurate isophotes) from a set of discrete photoelectric observations unless their number is extraordinarily large.

The average neutral tone is sufficiently well kept over the field of Plate I to demonstrate that the "bar" of the Large Cloud is very nearly the same color as the galactic star field ($\bar{b} = -33°$) around it, for the "bar" is almost completely suppressed instead of being the strongest feature as on an ordinary plate. Wider areas of the Cloud are generally bluer than the "bar," and are contained in a fairly circular area with a diameter more than two-thirds of

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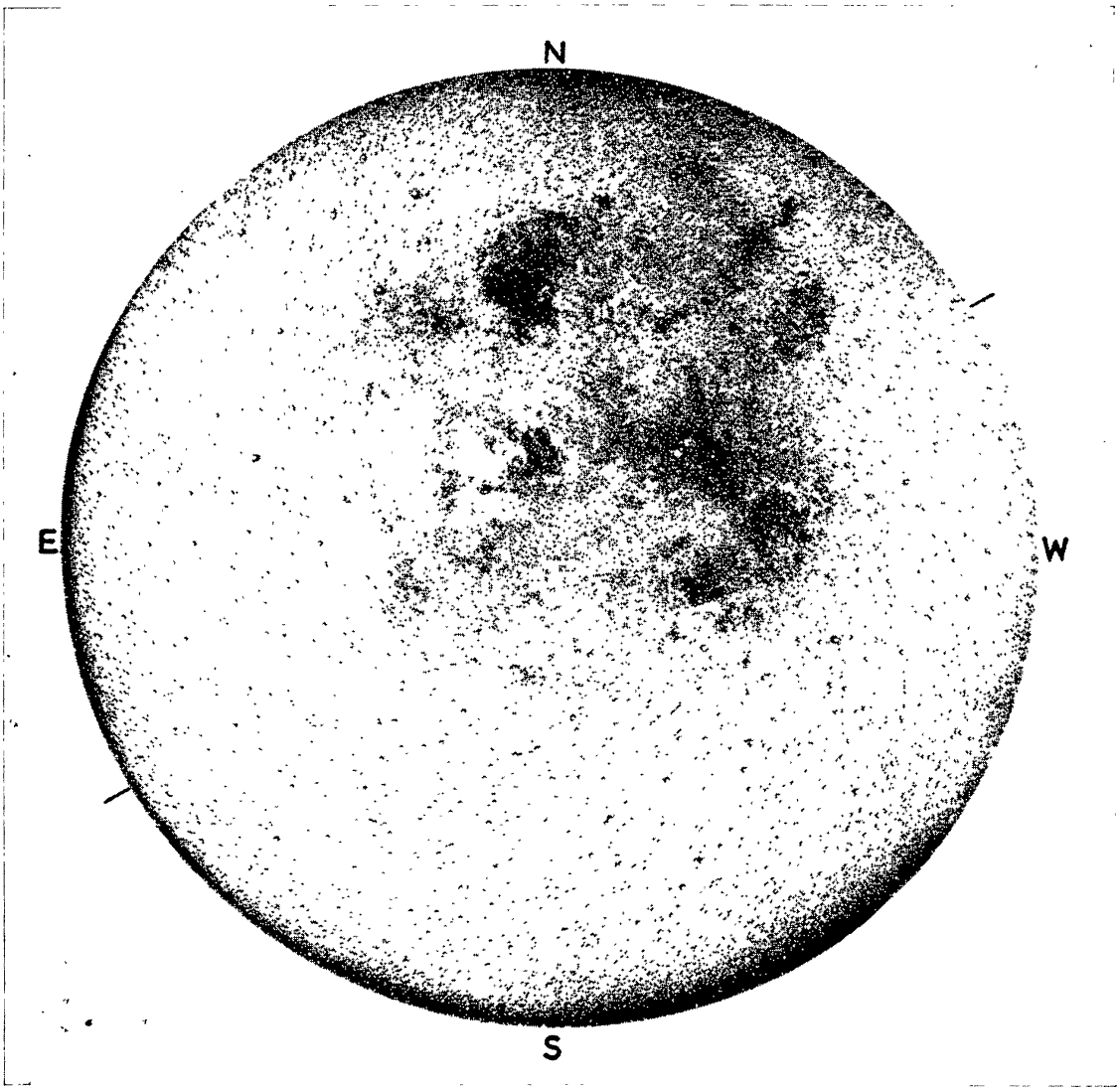
the field diameter. In-focus and out-of-focus inspections of the van Wijk sequence[3] suggest that only a negative color index makes the sandwich print darker than neutral. An O9 V star in the Cloud is nearly at the limiting magnitude of the 8-inch Schmidt plates. These data show that the black areas in Plate I are due to stars that are predominantly earlier than A0, and that the resolved stars in black areas such as "constellation III"[4] are mostly main sequence O or supergiant B stars.

The H II regions are scattered in about the same circular area as the blue stars, but it is an important feature that the gas and hot stars do not have any specific correlation in distribution. For example, constellation III is the strongest blue (or black on Plate I) region in the Large Cloud, but is relatively barren of H II regions. This is not to say that the observed H II regions lack exciting stars in the Large Magellanic Cloud. The absence of H II regions near h and χ Persei is often cited as the galactic instance of an apparent segregation of hot stars from interstellar gas. Bok[5] ($l = 260°$–$365°$), Genkin[6] ($l = 65°$–$200°$), and others have shown that the case of h and χ Persei is not unique. Plate I is probably the most conclusive evidence that H II regions in another galaxy can be distributed rather differently from the blue stars in general.

Superposed on the general area of gas and blue stars is a tendency toward spiral structure in the fainter and smoother blue areas. The brightest blue regions and the H II regions tend to condense separately a little off spiral alignment. The 30 Doradus nebula appears to be the *nuclear* center of the spiral system, although it is not the system's *areal* center, which is about 1° north of the "bar" center. The ionized 30 Doradus nucleus is appended to the densest H I region in the Large Cloud, according to 21-cm observations,[7] and is the center of the strongest 3.5-m continuous radiation even after the thermal component of the 30 Doradus H II region is subtracted.[8] Resolvable H II regions outside 30 Doradus tend to be small loops or arcs in Plate I. The largest H II arc in the field is east of 30 Doradus and spirals around that center with a radius of several hundred parsecs. Its nature is probably different from that of the smaller arcs.

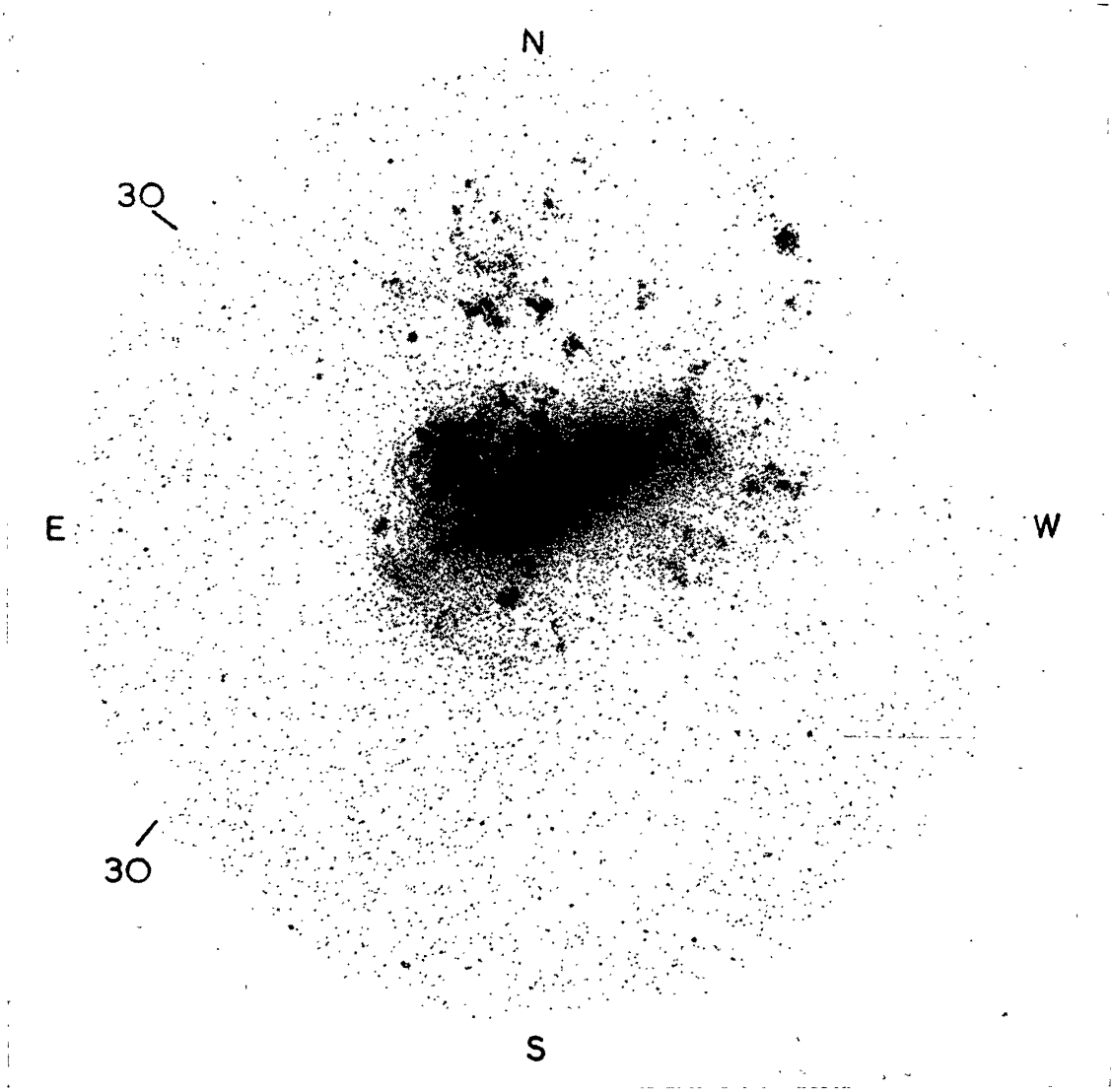
Plate I also suggests that the yellow "bar" of the Large

PLATE I



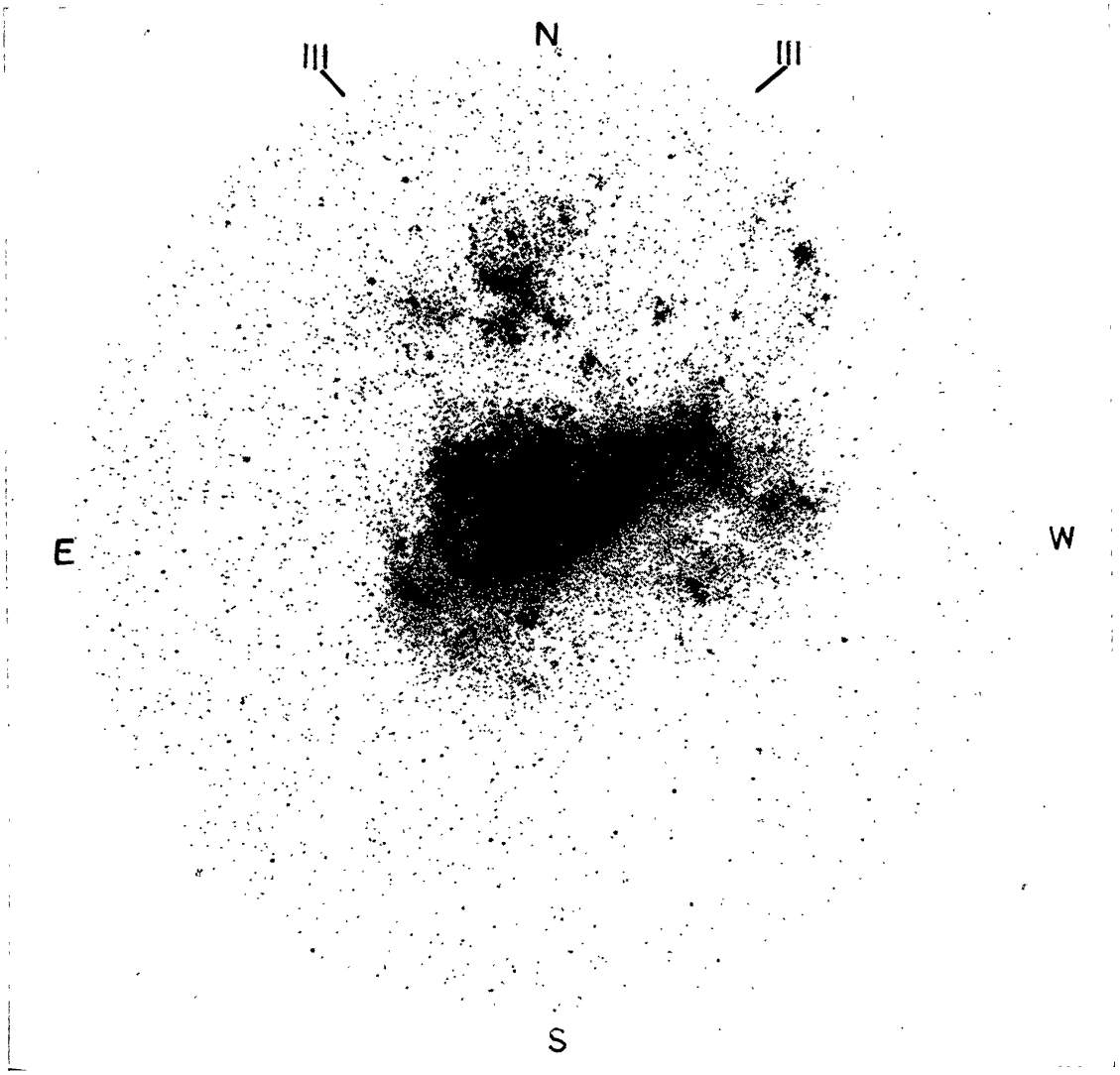
The Large Magellanic Cloud, showing H II regions white, and blue or hot stars black. The "bar" is neutral or the same color as the galactic star field; its axis is indicated by the diametral line at $PA = 120°$. The center of the field is at $\alpha = 5^h\ 28^m.0$, $\delta = -70°.3$ (1950) and the diameter is $12°.0$. The white streak is a defect.

PLATE II



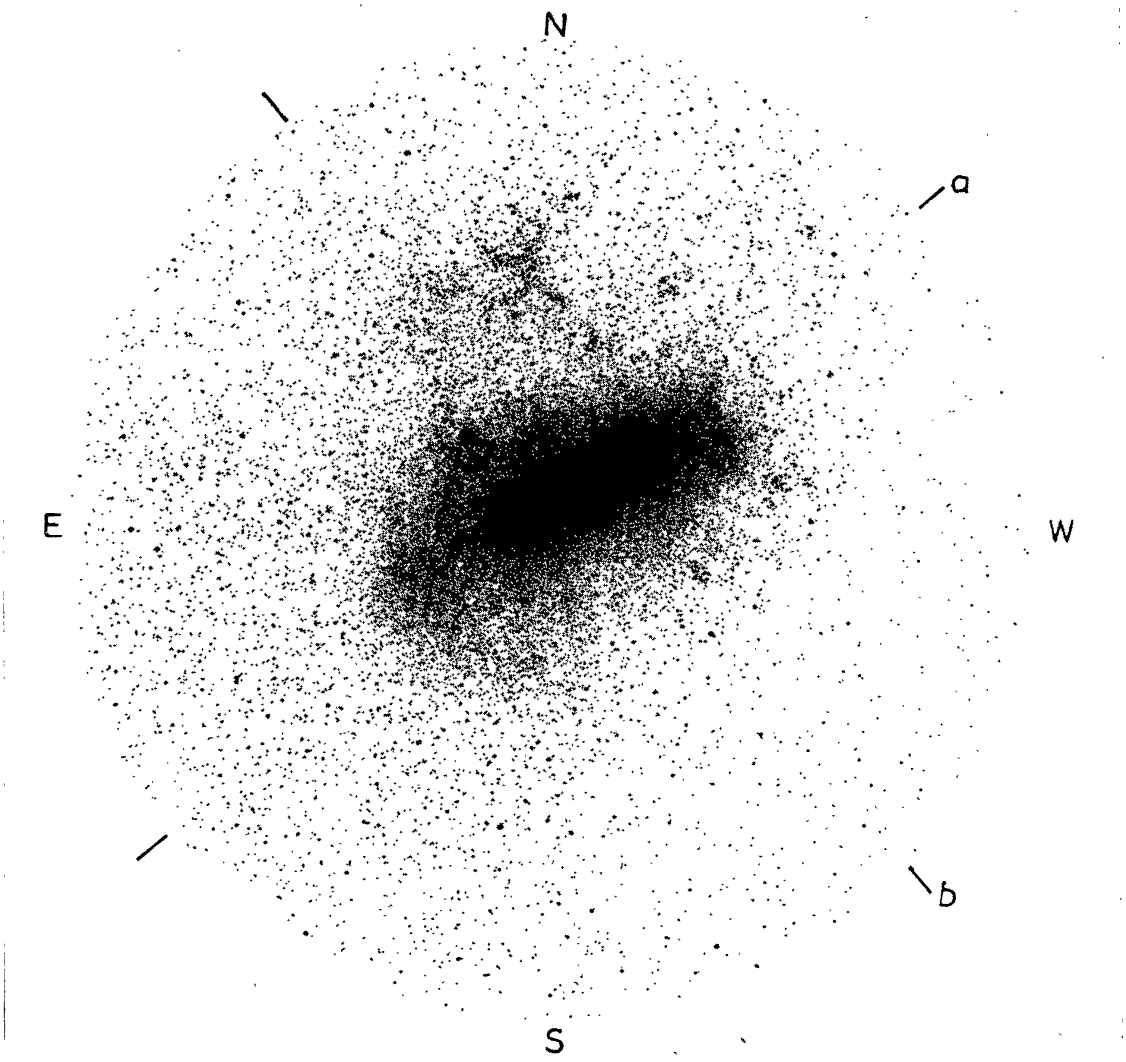
The Hα-plate half of Plate I. The position of 30 Doradus is at the intersection of the lines labeled "30."

PLATE III



The blue-plate half of Plate I. The position of constellation III is at the intersection of the lines labeled "III."

PLATE IV



An infrared plate showing a diffuse elliptical patch that may have the characteristics of an E5 galaxy whose major and minor axes extend along the lines labeled "a" and "b," respectively.

Magellanic Cloud is not intimately tied to the larger, bluer structure. It seems quite reasonable to regard the Large Cloud as an asymmetrical Sc galaxy, seen nearly pole-on and with its nucleus at 30 Doradus, in front of another "population," which is part of the "bar." This is in no way to be confused with the barred-spiral structure that has sometimes been imagined in the Large Cloud. About the "bar" population we know only that its brighter members apparently include open clusters and stars of O, B, K, and M spectral types and relatively lack A, F, and G types.[9] Its integrated spectrum may confirm the scarcity of A, F, and G types.[10] Open clusters and OB stars in the "bar" region are probably in one Sc arm that emerges from 30 Doradus, sweeps along the "bar" axis, and curves toward the northwest through and out of the "bar." The arm is visible on some blue plates taken with various telescopes and on the print from which Plate III was made. The arc of this arm is also partially resolved and indicated by the innermost H I isotherm of Kerr, Hindman, and Robinson.[7] Since neutral hydrogen is mildly concentrated toward the middle of the Cloud, it is not surprising that objects like cepheids can be found most frequently overlying the "bar."

Plate IV was made from a 1-N plate with an OR 1 filter ($\lambda\lambda$ 6400–8700) exposed 20 minutes on November 18, 1958, again to the same sky density as the other plates. It brings out a diffuse elliptical structure that appears to have some of the characteristics of an E5 galaxy. The observed dimensions are about $1^\circ.1 \times 2^\circ.2$, the major axis $PA = 130^\circ$, and the center is at about $\alpha = 5^h\,24^m.0$, $\delta = -69^\circ.7$ (1950). The reasons why an E5 population would be seen best on the infrared plate are: (1) its stars radiate much in that passband; (2) the H II and blue "noise" of the proposed Sc galaxy are conversely reduced; and (3) interstellar dust absorption in the intervening Sc galaxy is reduced at the longer wavelengths. The northeast edge of the red elliptical patch remains somewhat screened by the heavy dust near 30 Doradus. If the elliptical system is at one-tenth of the distance of M 31 and its companions, it should be possible to resolve its brighter red stars with a 10-inch telescope. The structure of the mass of the stars of the Large Cloud in Henize's Figures 6–7 halftones[11] strongly resembles the structure of NGC 185 in Baade's Plate VI half-

tone.[12] Both plates were taken in a passband centered near λ 6500, Henize's with a 10-inch camera, Baade's with the 100-inch.

The writer has also taken plates of the Large Magellanic Cloud in passbands defined by 103a-D emulsion plus OY 1 filter (yellow) and 103a-O emulsion plus Polaroid filter. The latter plates were exposed with the axis of the Polaroid successively parallel and perpendicular to the axis of the "bar" of the Cloud. Positive copies of all of the plates have been made for experiments in several sandwich combinations of color or crossed axes of the Polaroid analyzer. Most of the chromatic information in such sandwiches is contained in Plate I. Polarization is detectable in the Large Cloud by the blinking method, but its degree cannot be estimated, and the resolving power with the available sheet of Polaroid is lower than it is with the color filters, so that small polarized areas might be missed, even if strongly polarized.

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[5] B. J. Bok, *Mém. Soc. Roy. Sci. Liège*, Ser. 4, **15**, 480, 1955 (*Liège Inst. d'Ap. Repr.* No. 368).

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[11] K. G. Henize, *Ap. J. Supplements*, **2**, 315, 1956 (No. 22).

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