EXTRA-GALACTIC NEBULAE[1]

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ABSTRACT

This contribution gives the results of a statistical investigation of 400 extragalactic nebulae for which Holetschek has determined total visual magnitudes. The list is complete for the brighter nebulae in the northern sky and is representative to 12.5 mag. or fainter.

The classification employed is based on the forms of the photographic images. About 3 per cent are irregular, but the remaining nebulae fall into a sequence of type forms characterized by rotational symmetry about dominating nuclei. The sequence is composed of two sections, the elliptical nebulae and the spirals, which merge into each other.

Luminosity relations.—The distribution of magnitudes appears to be uniform throughout the sequence. For each type or stage in the sequence, the total magnitudes are related to the logarithms of the maximum diameters by the formula,

$$m_T = C - 5 \log d \, ,$$

where C varies progressively from type to type, indicating a variation in diameter for a given magnitude or vice versa. By applying corrections to C, the nebulae can be reduced to a standard type and then a single formula expresses the relation for all nebulae from the Magellanic Clouds to the faintest that can be classified. When the minor diameter is used, the value of C is approximately constant throughout the entire sequence. The coefficient of $\log d$ corresponds with the inverse-square law, which suggests that the nebulae are all of the same order of absolute luminosity and that apparent magnitudes are measures of distance. This hypothesis is supported by similar results for the nuclear magnitudes and the magnitudes of the brightest stars involved, and by the small range in luminosities among nebulae whose distances are already known.

Distances and absolute dimensions.—The mean absolute visual magnitude, as derived from the nebulae whose distances are known, is -15.2. The statistical expression for the distance in parsecs is then

$$\log D = 4.04 + 0.2 \, m_T \, ,$$

where m_T is the total apparent magnitude. This leads to mean values for absolute dimensions at various stages in the sequence of types. Masses appear to be of the order of $2.6 \times 10^8 \odot$.

Distribution and density of space.—To apparent magnitude about 16.7, corresponding to an exposure of one hour on fast plates with the 60-inch reflector, the numbers of nebulae to various limits of total magnitude vary directly with the volumes of space represented by the limits. This indicates an approximately uniform density of space, of the order of one nebula per 10^{17} cubic parsecs or 1.5×10^{-31} in C.G.S. units. The corresponding radius of curvature of the finite universe of general relativity is of the order of 2.7×10^{10} parsecs, or about 600 times the distance at which normal nebulae can be detected with the 100-inch reflector.

Recent studies have emphasized the fundamental nature of the division between galactic and extra-galactic nebulae. The relationship is not generic; it is rather that of the part to the whole. Galactic

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