Magnitudes

more negative values are brighter

absolute M vs. apparent magnitude m

from 10 pc at the distance it is

Luminosity W brightness W/m^2 $b = \frac{L}{4\pi d^2}$

a difference of 5 mags = factor of 100 in b

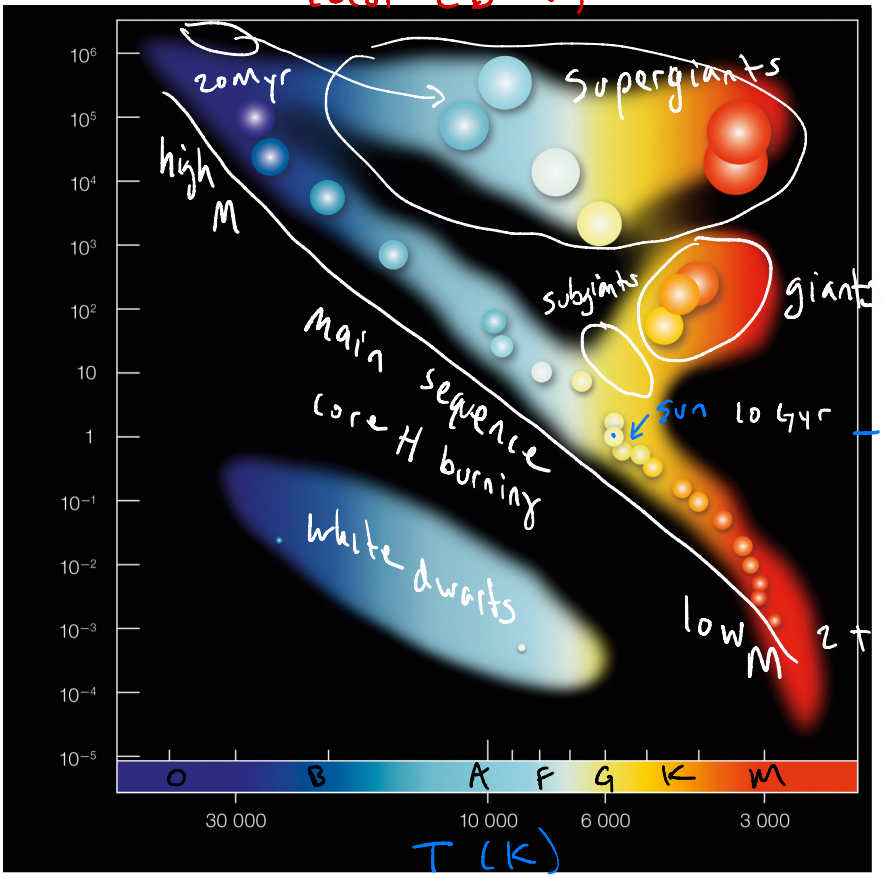
$$m_1 - m_2 = -2.5 \log_{10}\left(\frac{b_2}{b_1}\right) \qquad m_1 = -2.5 \log(b_1)$$

$$m - M = 5\log(d) - 5 \quad \text{"distance modulus"}$$

HR Diagrams vs. Color-Magnitude diagram (CMD)

theoretical

observed



"the Galaxy" Galactic

galaxy (n.)

late 14c., from French *galaxie* or directly from Late Latin *galaxias* "the Milky Way" as a feature in the night sky (in classical Latin *via lactea* or *circulus lacteus*), from Greek *galaxias* (adj.), in *galaxias kyklos*, literally "milky circle," from *gala* (genitive *galaktos*) "milk" (from PIE root *g(a)lag- “milk").

— “See yonder, lo, the Galaxyë Which men clepeth the Milky Wey, For hit is whyt.”

[Chaucer, "House of Fame"]

As a second example I have depicted the six stars of the constellation Taurus, called the Pleiades (I say *six* intentionally, since the seventh is scarcely ever visible), a group of stars which is enclosed in the heavens within very narrow precincts. Near these there lie more than forty others invisible to the naked eye, no one of which is much more than half a degree off any of the aforesaid six; of these I have noticed only thirty-six in my diagram. I have preserved their intervals, magnitudes, and the distinction between the old and the new stars, just as in the case of the constellation Orion.

The Milky Way consists entirely of stars in countless numbers and of various magnitudes.

The next object which I have observed is the essence or substance of the Milky Way. By the aid of a telescope any one may behold this in a manner which so distinctly appeals to the senses that all the disputes which have tormented philosophers through so many ages are exploded at once by the irrefragable evidence of our eyes, and we are freed from wordy disputes upon this subject, for the Galaxy is nothing else but a mass of innumerable stars planted together in clusters. Upon whatever part of it you direct the

telescope straightway a vast crowd of stars presents itself to view; many of them are tolerably large and extremely bright, but the number of small ones is quite beyond determination.

Nebulæ resolved into clusters of stars: as examples, the nebula in Orion's Head and Præsepe.

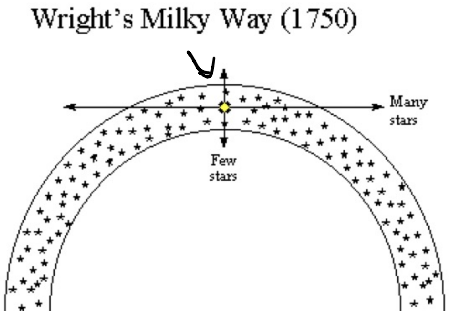
And whereas that milky brightness, like the brightness of a white cloud, is not only to be seen in the Milky Way, but several spots of a similar colour shine faintly here and there in the heavens, if you turn the telescope upon any of them you will find a cluster of stars packed close together. Further—and you will be more surprised at this,—the stars which have been called by every one of the astronomers up to this day *nebulous*, are groups of small stars set thick together in a wonderful way, and although each one of them on account of its smallness, or its immense distance from us, escapes our sight, from the commingling of their rays there arises that brightness which has hitherto been believed to be the denser part of the heavens, able to reflect the rays of the stars or the Sun.

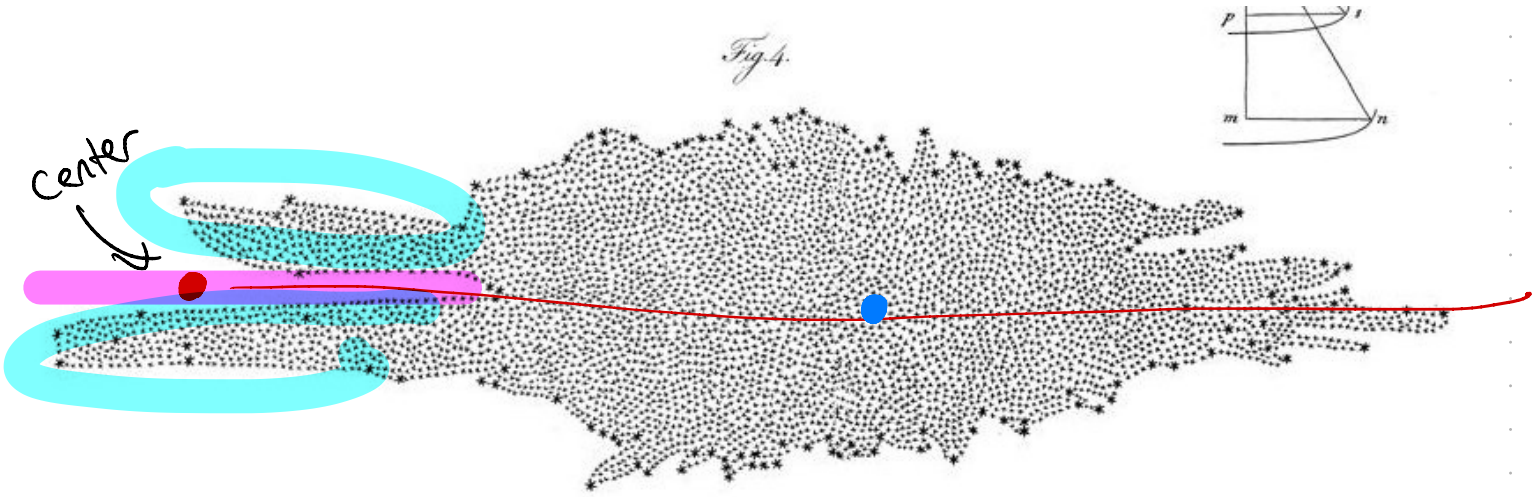
I have observed some of these, and I wish to subjoin the star-clusters of two of these nebulæ. First, you have a diagram of the nebula called that of Orion's Head, in which I have counted twenty-one stars.

The second cluster contains the nebula called Præsepe, which is not one star only, but a mass of more

—Galileo Galilei (1610)

“It is far more natural and conceivable to regard them as being not such enormous single stars but systems of many, whose distance presents them in such a narrow space that the light, which is individually imperceptible from each of them, reaches us on account of their immense multitude in a uniform pale glimmer. Their analogy with the stellar system in which we find ourselves, their shape, which is just what it ought to be according to our theory, the feebleness of their light which demands a presupposed infinite distance: all this is in perfect harmony with the view that these elliptical figures are just universes and, so to speak, Milky Ways, like those whose constitution we have just unfolded.” —Immanuel Kant (1755)





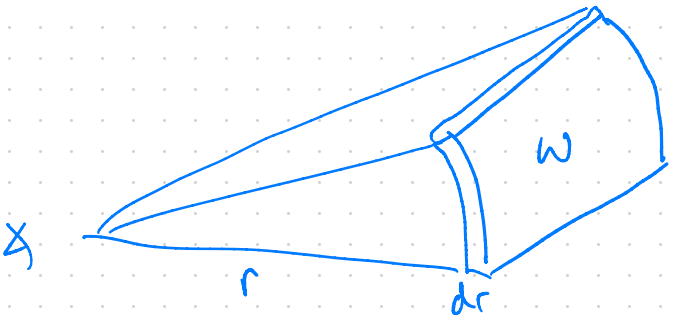
—Caroline & William Herschel (1785)

Star Counts

what is the spatial distribution of stars around us?

$$m - M = 5 \log \frac{d}{r} - 5 \quad \rightarrow \quad r = 10^{\frac{1}{5}(m - M) + 1}$$

M: constant



wr^2 = Area

$dV = wr^2 dr$

$$N(r) = wn \int_0^r r^2 dr = \frac{1}{3} wnr^3$$

$$N(m) = 10^{0.6m + C}$$

$$\log N(m) = 0.6m + C$$

$$l(m) = l_0 \, 10^{-0.4m} \qquad m = -2.5 \log(l)$$

$$dL(m) = l(m) \frac{dN(m)}{dm} = C \, 10^{0.2m}$$

$$L_{tot}(m) = \int_{-\infty}^{m} dL(m)dm = C \int_{-\infty}^{m} 10^{0.2m} d = K 10^{0.2m}$$

goes

Olbers' Paradox

"the sky is dark at night"

Univere homogeneous & infinite