

Edwin Powell Hubble (1889-1953)



Revolutionized our view of the Universe.
Considered as the father of observational
cosmology:

- à showed other galaxies exist beyond
the Milky Way using 100 inch
telescope at Mt Wilson
- à developed classification system for
galaxies
- à showed that the Universe is not static
but expanding (cf Einstein's blunder)
- à Initiated construction of 5 m (200 in)
at Palomar
- à Hubble Space Telescope named after
him

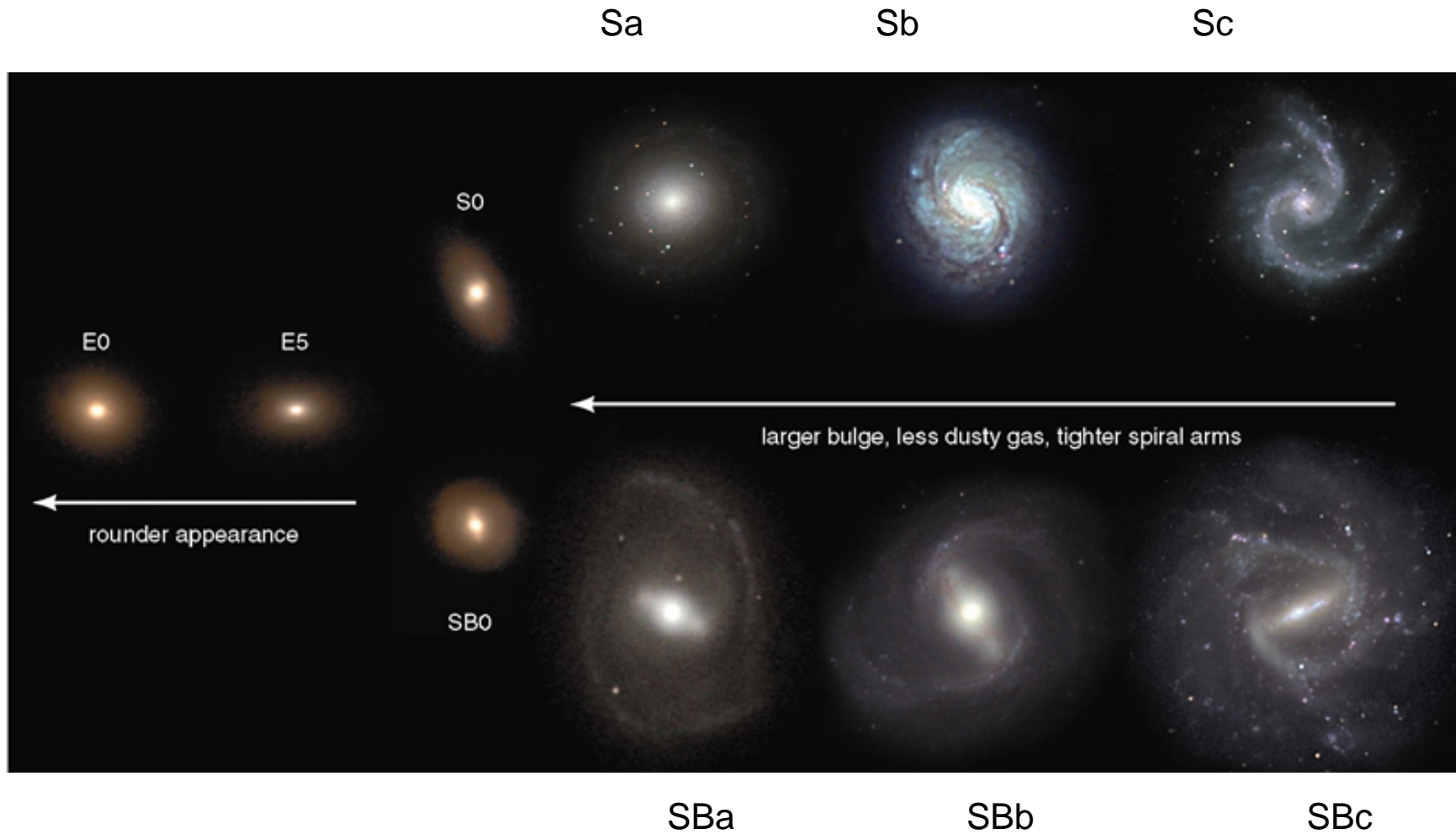
Edwin Hubble using the
100 inch at Mt Wilson



Hubble' law (1929) : Galaxies
separated by a large distance D
recede from each other at speed
 v such that $v = H_0 \times D$

**“At the last dim horizon, we search among
ghostly errors of observations for landmarks
that are scarcely more substantial. The
search will continue. The urge is older than
history. It is not satisfied and it will not be
oppressed.”**

The Hubble's Classification System (1936) with S0s added



Modern : multi parameter space (Size, B/D, Concentration, n, Asymmetry)

At high redshifts: Use (C, A) = Concentration vs Asymmetry plots

Table 5.1 The sequence of luminous disk galaxies

<i>Characteristic</i>	<i>S0–Sa</i>	<i>Sb–Sc</i>	<i>Sd–Sm</i>
Spiral arms	absent or tight		open spiral
Color	red: late G star	early G star	blue: late F star
$B - V$	0.7–0.9	0.6–0.9	0.4–0.8
$1550 \text{ \AA} - V$	4 to 2	2 to 0	0 to –1
Young stars	few		relatively many
HII regions	few, small		more, brighter
Gas	little gas		much gas
$\mathcal{M}(HI)/L_B$	$\lesssim 0.05$ to 0.1		~ 0.25 to > 1
L_B	luminous		less luminous
$I(0)$	$(1-4) \times 10^{10} L_{\odot}$		$(< 0.1-2) \times 10^{10} L_{\odot}$
	high central brightness		low central brightness
	massive		less massive
$\mathcal{M}(< R)$	$(0.5-3) \times 10^{11} M_{\odot}$		$(< 0.2-1) \times 10^{11} M_{\odot}$
Rotation	fast-rising $V(R)$		slowly rising $V(R)$

Note: color $1550 \text{ \AA} - V$ is defined as for $15 - V$ in Table 1.3, using flux-based magnitudes at 1550 \AA measured by OAO and ANS satellites.

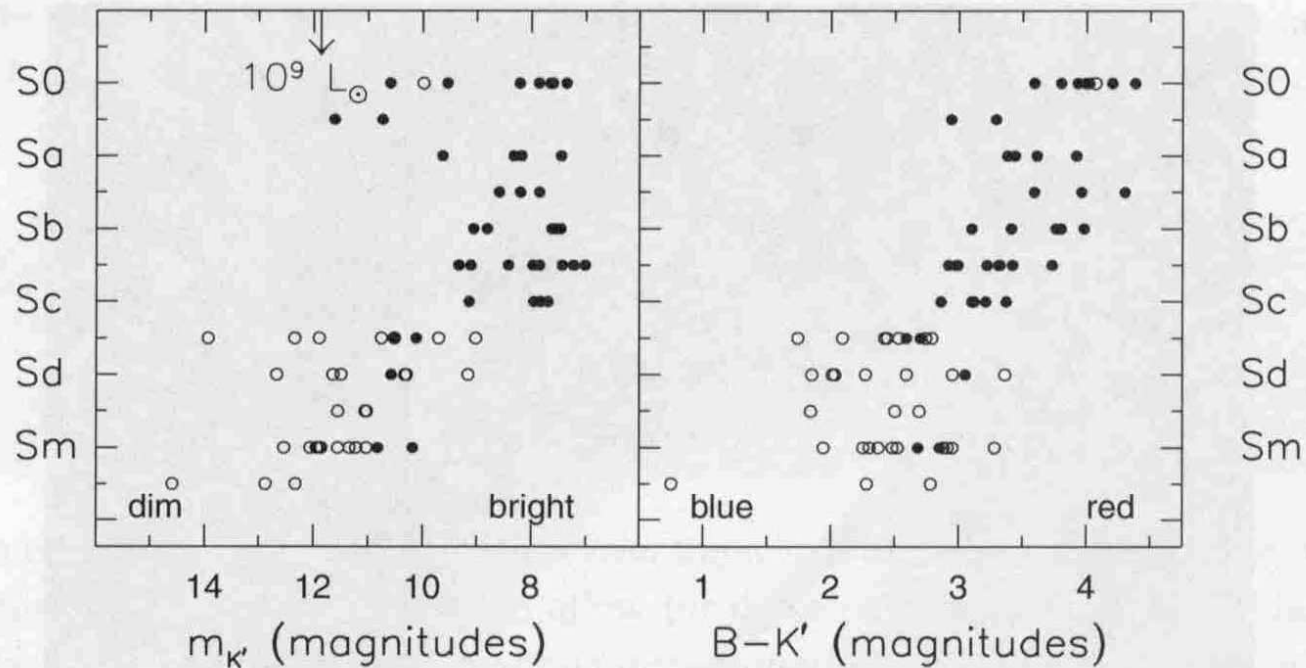


Figure 5.6 Apparent magnitude $m_{K'}$ and $B - K'$ color of galaxies in the Ursa Major group, plotted by galaxy type. Galaxies to the right of the arrow have $L > 10^9 L_{\odot}$ at the group's distance of 15.5 Mpc. Open circles show galaxies where the disk has lower central brightness: $I_{K'}(0) > 19.5$. On average, S0 galaxies are luminous and red, while the Sd and Sm systems are fainter and bluer – M. Verheijen.

Giant disk galaxies (S0 and Sa—Sc) are brighter and redder ($B-K' > 3$) than the low mass disk galaxies (Sd, Sm/Irr)

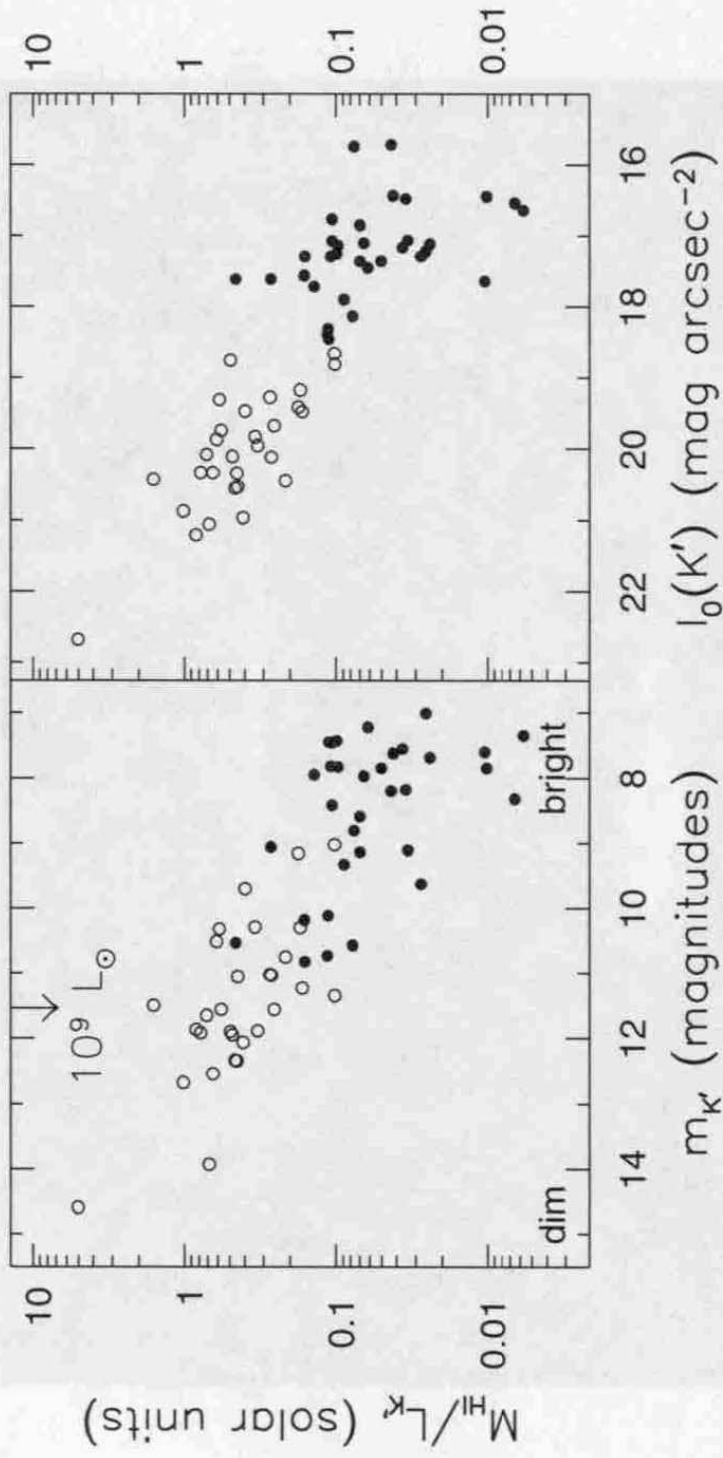


Figure 5.8 HI in galaxies of the Ursa Major group. Left, ratio of HI gas mass to luminosity in the K' band, in units of $M_{\odot}/L_{K',\odot}$. Right, fainter galaxies have proportionately more HI gas and the disk has lower extrapolated central surface brightness $I_{K'}(0)$. Open circles show low-surface-brightness galaxies with $I_{K'}(0) > 19.5$ – M. Verheijen.