Dismantling Hubble's Legacy?

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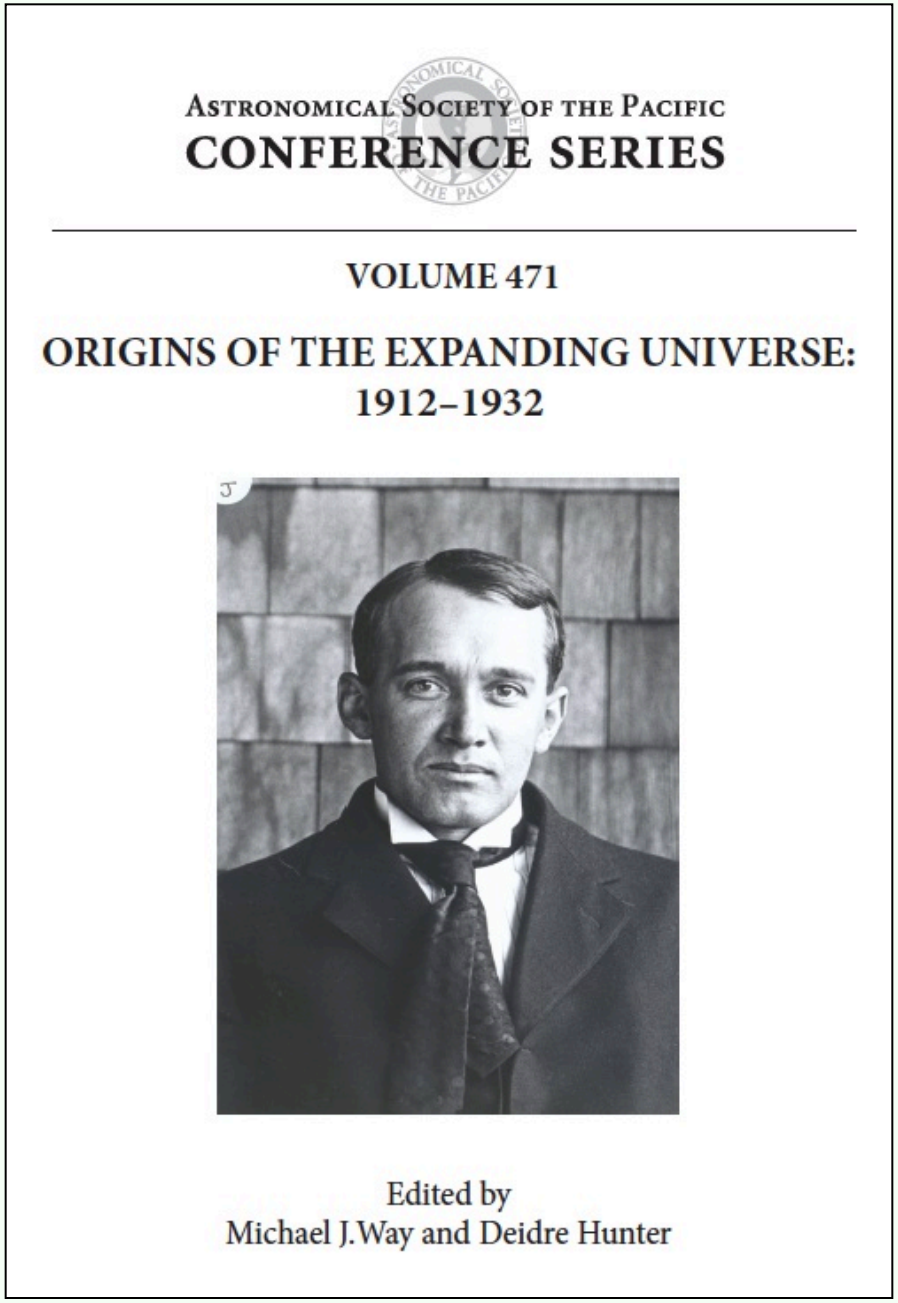

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Dismantling Hubble's Legacy

arxiv.org/abs/1301.7294

Hubble's Legacy?

1 Confirming the island universe theory of Swedenborg, Wright, Kant, etc.

Hubble's Legacy?

1 **Confirming the island universe theory of Swedenborg, Wright, Kant, etc.**

2 **The Classification of Galaxies**

Hubble's Legacy?

1 **Confirming the island universe theory of Swedenborg, Wright, Kant, etc.**

2 **The Classification of Galaxies**

3 **The Expanding Universe**

The Island Universe Theory

Reference	Object	Distance[a]	Method
Herschel (1786)	M31	<17,200 [b]	color/magnitude
Nichol (1850)	"cluster"	154,800[c]	magnitude comparison
–		302,505	–
Clark (1890)	M31	564?	nova of 1885
Clark (1903)	M31	<1000	Size
Bohlin (1907)	M31	19	parallax
Very (1911)	M31	4,000	diameters
Very (1911)	M31	1,600	S Andromedae
Wolf (1912)	M31[d]	32,000	diameters
Curtis (1915b)	spirals	10,000	astrometry/radial velocity
Pease (1916)	NGC 4594	25,000	astrometry/radial velocity
Curtis (1917)	M31	20,000,000	novae
–	–	100,000	novae[e]
Shapley (1917)	M31	1,000,000	"bright stars"
van Maanen (1918)	M31	250	parallax
Lundmark (1919)	M31	650,000	novae
Curtis (1920)	misc	4,000,000	novae
–	misc	1,000,000	novae
–	misc	500,000	novae

The Island Universe Theory

Curtis (1920)	misc	4,000,000	novae
–	misc	1,000,000	novae
–	misc	500,000	novae
Lundmark (1921h)	M33	1,000,000	"bright stars"
Luplau-Janssen & Haarh (1922)	M31	326,000	novae[f]
★ Öpik (1922)	M31	1,500,000	luminosity/mass
Hubble (1922d)	M33	100,000	"stars"
Shapley (1923)	NGC 6822	1,000,000	diameters/"bright stars"
Hubble (1925a)	M31/33	930,000	Cepheids
Hubble (1925c)	NGC 6822	700,000	Cepheids,"bright-stars"
Lundmark (1925)	M31,M87	1,400,000	novae
–	–	8,000,000	novae
Lundmark (1925)	M104	56,000,000	Öpik (1922) method
Hubble (1926a)	M33	850,000	Cepheids,Blue-Giants
Hubble (1929c)	M31	900,000	Cepheids,novae
M31 value (Dec. 2012)[g]	M31	2,588,440	19 Methods

Leavitt (1912) HarCi 173, 1

First published period-luminosity relation for Cepheids.

Hertzsprung, Russell & Shapley [make it useful]

The Classification of Galaxies

The Classification of Galaxies

Reference	Notes
Herschel (1786)	"first comprehensive scheme?"
Rosse (1850)	terminology "Spirals" used
Wolf (1908)	"widely cited scheme"
Bailey (1908)	–
Pahlen (1911)	–
Bigourdan (1914)	–
Shaw (1915)	–
Curtis et al. (1918)	"bars"
Curtis (1919)	–
Jeans (1919)	Theoretical
Reynolds (1920)	Classification of spirals like Hubble (1922a)
Hubble (1922a)	Preliminary scheme
Lundmark (1926a)	Preliminary scheme
Hubble (1926b)	More complete scheme
Lundmark (1927e)	Full scheme
Shapley (1927)	–
Jeans (1928)	Tuning-fork diagram suggestion
(Hubble 1936)	Tuning fork diagram added to create complete scheme

The Classification of Galaxies

- Jeans 1929 “Astronomy & Cosmogony“ Tuning Fork

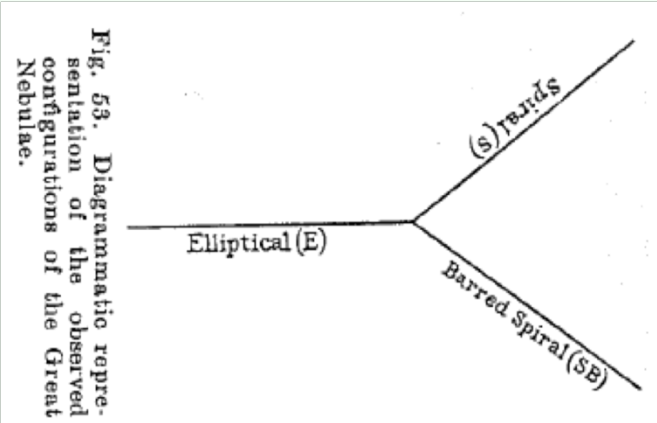
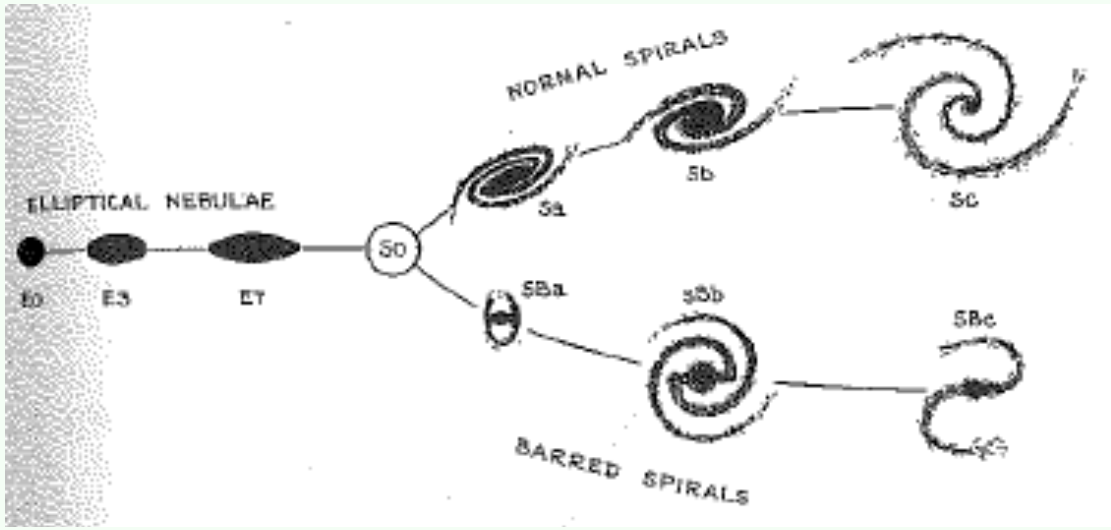


Fig. 53. Diagrammatic representation of the observed configurations of the Great Nebulae.

- Hubble (1936) “Realm of Nebulae”



The Expanding Universe

The Expanding Universe

Table 3. Early estimates of solar motion, curvature radius and H_o via spiral nebulae

Reference	Date	Notes
Truman (1916)[a]	1915/12/30	RA=20h, Dec=-20°, V=–670km s^{-1} (14 spirals)
Young & Harper (1916)[a]	1916/02/01	RA=20h24m, Dec=-12°10′, V=–598±234km s^{-1} (15 spirals + MC)
Paddock (1916)[b]	1916/05/00	V=–295±202 km s^{-1}, K=+248±88 km s^{-1} Using Young & Harper (1916) data.
Wirtz (1916)	1916/08/00	Various values of RA, Dec, V, but no K term
Wirtz (1917)	1916/12/06	Various values of RA, Dec, V, but no K term
Slipher (1917)	1917/04/13	RA=22h, Dec=-22°, V=–700 km s^{-1}
de Sitter (1917)	1917/07/00	First estimates of R for Models A and B
Wirtz (1918)	1917/12/00	K=+656 km s^{-1}, V=–830 km s^{-1}
Shapley & Shapley (1919)	1918/11/00	Magnitude vs. Velocity
Lundmark (1920)	1920/01/26	K=+587 km s^{-1} (29 spirals, page 75)
Wirtz (1922)	1921/10/00	K=+656 km s^{-1}, V=–820 km s^{-1}
Friedmann (1922)	1922/05/29	Set $M=5\times10^{21} M_{\odot}$, $\lambda=0$ and found "world period"=10^{10} years
Wirtz (1924)	1924/03/00	Distance vs. velocity: v(km)=2200–1200×log(Dm)[c]
Silberstein (1924d)	1924/03/00	Distance vs. velocity Relation and calculation of curvature radius (R)
Silberstein (1924e)	1924/03/08	Calculates R for 11 GC[d]
Silberstein (1924a)	1924/04/26	First distance vs. velocity plot for *GC and LMC/SMC*
Lundmark (1924b)	1924/06/00	First distance vs. velocity plot for *spiral nebulae*, $K_{spirals}$= +800 km s^{-1}
Silberstein (1924b)	1924/06/07	Same method and data as before with new estimate of R
Silberstein (1924c)	1924/10/00	
Silberstein (1924f)	1924/Late	Distance vs. velocity plot

The Expanding Universe

Silberstein (1924f)	1924/Late	Distance vs. velocity plot
Silberstein (1925)	1925/01/00	$R=7.2\times10^{12}$ A.U. and updated plot of distance vs. velocity for GC+MC+M33
Strömberg (1925)	1925/06/00	Estimates of K, but no relation found for distance vs. velocity
★ Lundmark (1925)	1925/06/00	Re-defines: $K=k+lr+mr^2$, First time for a variable K–term
Dose (1927)	1926/11/00	$K=+765\pm111$ km s^{-1} for spirals (no variable K–term)
★ Lemaître (1927)	1927/04/00	Discovers that K is linearly dependent on distance
Robertson (1928)	1928/00/00	Expects a correlation between velocity and distance
Hubble (1929b)	1929/01/17	Distance vs. Velocity plot using Cepheid distances yields a linear fit
de Sitter (1930)	1930/05/26	Using observational data calculates R and estimates slope of velocity vs. distance
Hubble & Humason (1931)	1931/03/00	Updated list of distances and velocities yields 558 km s^{-1} Mpc^{-1}
Oort (1931)	1931/11/30	Finds $H_o=290$ km s^{-1} Mpc^{-1} after finding some distance inaccuracies

The Expanding Universe

Silberstein 1924, Nature 113, 602

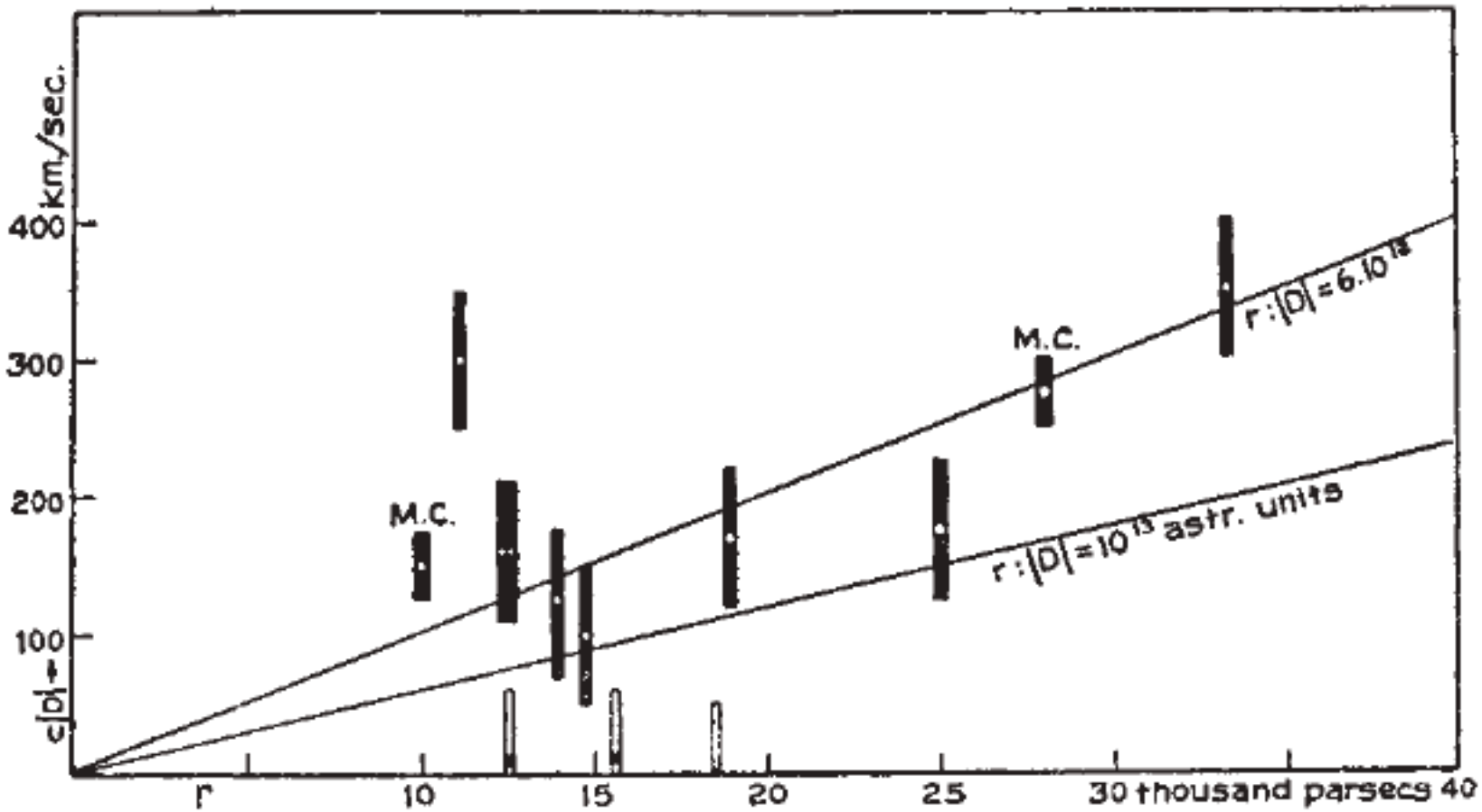


FIG. 1.

The Expanding Universe

- Slipher (1912) [25 Radial Velocities by 1917]
- Leavitt (1912) & Hubble (1925) [Distances]
- Paddock (1916) $V=v_x\cos\alpha\cos\delta+v_y\sin\alpha\cos\delta+v_z\sin\delta + \mathbf{K}$
- Einstein (1915-17) & de Sitter
  - General Relativity and Static Solutions
- Friedman (1922 & 1924)
  - Ad-hoc assumptions give an age of 10^{10} years.
- Lemaitre (1927)
  - Independently derives Friedman's non-static solutions

The Expanding Universe

- Lemaitre (1927) ASSB 47, 49
  - The velocity of recession is *"the apparent Doppler effect due to the variation of the radius of the universe"*
  - Derives distance vs. radial-velocity relationship for spiral nebulae using data from Strömberg (Slipher) & Hubble
  - Using 42 galaxies found values of **625** & **575** km/s/Mpc
  - **De Sitter 1930, BAN 3, 211 & BAN 5, 157**
    Eddington 1930, MNRAS, 90, 668
  - Republished in 1931 in MNRAS, but w/o H_o numbers

NOT The Expanding Universe

- Hubble (1929) PNAS 168, 73
  - Using 24 galaxies to find **465** & **513** km/s/Mpc
  - Mentions previous attempt by Lundmark
  - No citation for Slipher (21/24 are Slipher radial velocities)

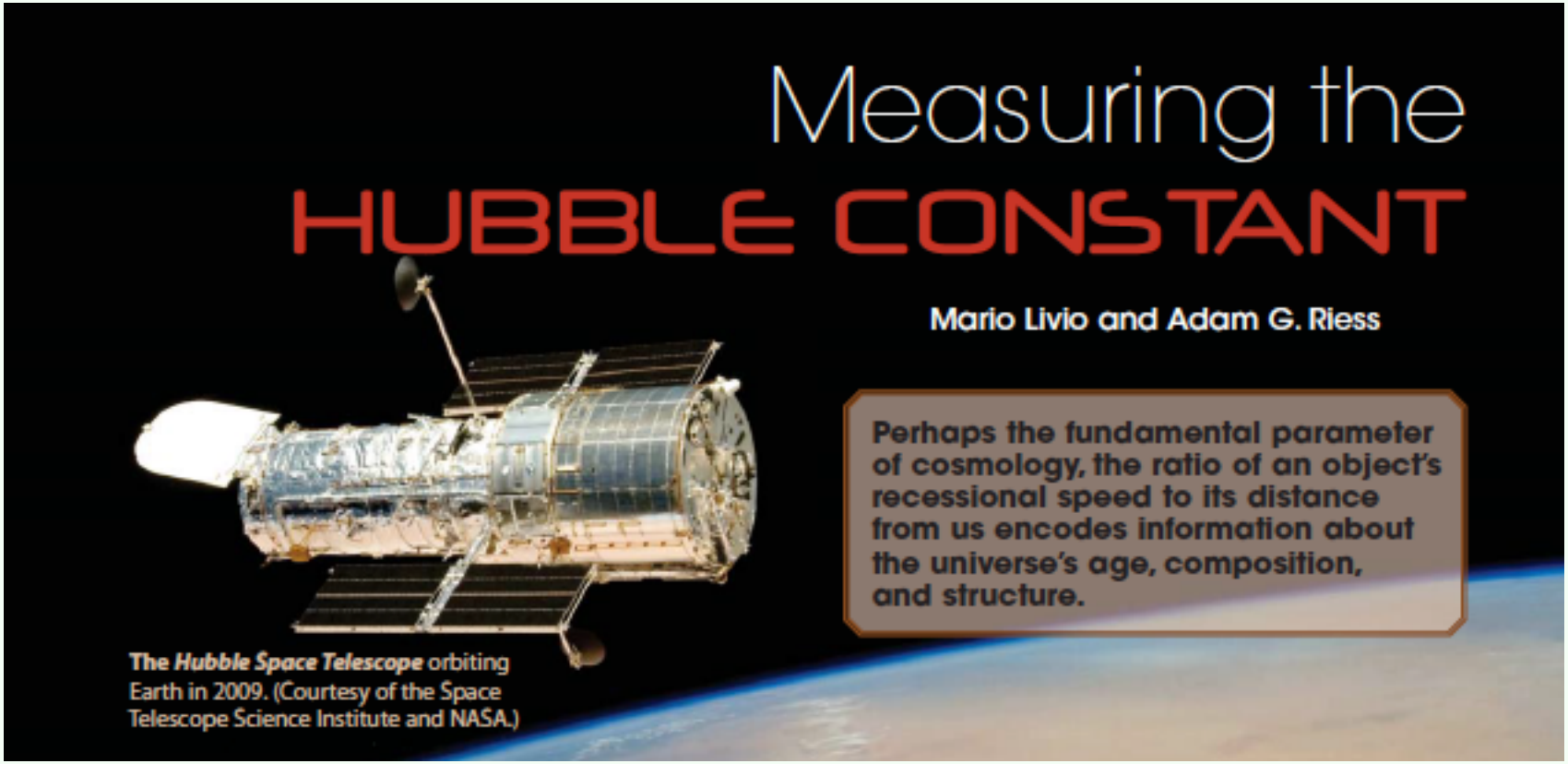
"The outstanding feature, however, is the possibility that the velocity-distance relation may represent **the de Sitter effect**"

The Expanding Universe

Today there is STILL confusion about the meaning of the velocity-distance relation and its conection to the Expanding Universe solutions of Friedman/Lemaitre **despite a LARGE amount of historical research to clarify things.**

The Expanding Universe

Livio & Riess 2013/10 Physics Today



The Expanding Universe

Livio & Riess 2013/10 Physics Today

Lundmark "provided tentative, qualitative evidence for the expansion."

Lundmark's results "relied on the implausible assumption that all galaxies have the same diameter..."

The Expanding Universe

Livio & Riess 2013/10 Physics Today

"Ever since the 1920s physicists have known that we live in an expanding universe."

The only people we know of who postulated or knew about non-static solutions before May of 1930 were Friedman, Krutkov, Ehrenfest, Lemaitre, Einstein and Robertson (see Belenkiy 2013).

Conclusions

1.) A great deal of prior work went into the 3 “discoveries” of Edwin Hubble:
distances, classification, distance-velocity

2.) Edwin Hubble did NOT discover the expanding universe and most work prior to 1930 was related to *static solutions*.

3.) Lemaitre was the first to connect observational data to an expanding universe model.