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While the procedure is not definitive for any individual galaxy, the authors contend that it is correct for the majority of galaxies and gives a good overall view of the distribution of distances of the galaxies seen in the Hubble image. If the redshifts are correct, then the light from these galaxies was emitted when the universe was less than one billion years old.

''I am delighted to see the images being used for such studies. The discovery of very high-redshift galaxies is a very provocative result, and extremely interesting if it is right,'' says Harry Ferguson of the Space Science Telescope Institute in Baltimore, MD, a member of the team that obtained the Deep Field Observations. ''It's going to be extremely difficult to confirm, but that will be a high priority for the new infrared camera that is going on the telescope next February.''

The Hubble Space Telescope spent ten days in December 1995 observing a single tiny patch of sky. These observations resulted in the deepest image of the sky, revealing galaxies fainter than had ever been seen before. The striking full-color image of the distant universe was unveiled at the American Astronomical Society Meeting in January 1996, and for the last six months has been the subject of intense study worldwide.

Drs. Lanzetta and Yahil may be reached as follows:

Dr. Lanzetta: office: (516) 632-8222, fax: (516) 632-8240,
home: (516) 361-7422, e-mail: Kenneth.Lanzetta@sunysb.edu

Dr. Yahil: office: (516) 632-8224, fax: (516) 632-8240,
home: (516) 689-3258, e-mail: Amos.Yahil@sunysb.edu

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The Space Telescope Science Institute is operated by the Association of Universities for Research in Astronomy, Inc. (AURA), for NASA, under contract with the Goddard Space Flight Center, Greenbelt, MD. The Hubble Space Telescope is a project of international cooperation between NASA and the European Space Agency (ESA).

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Image files in GIF and JPEG format and captions may be accessed on Internet via anonymous ftp from oposite.stsci.edu in /pubinfo.

	GIF	JPEG
PRC96-24a HDFhighZ	gif/HDFhighZ.gif	jpeg/HDFhighZ.jpg
PRC96-24b HDFhiZc	gif/HDFhiZc.gif	jpeg/HDFhiZc.jpg

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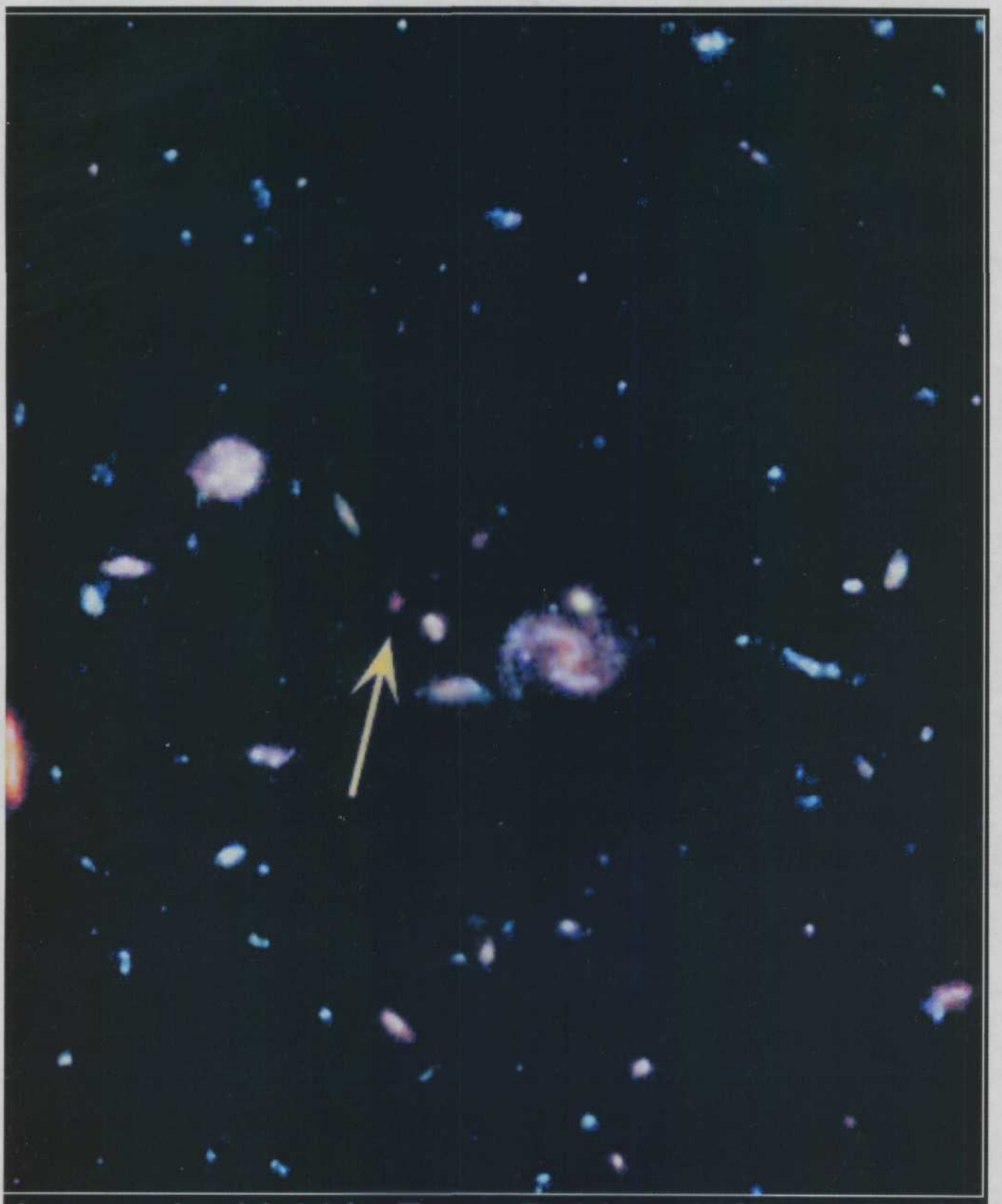
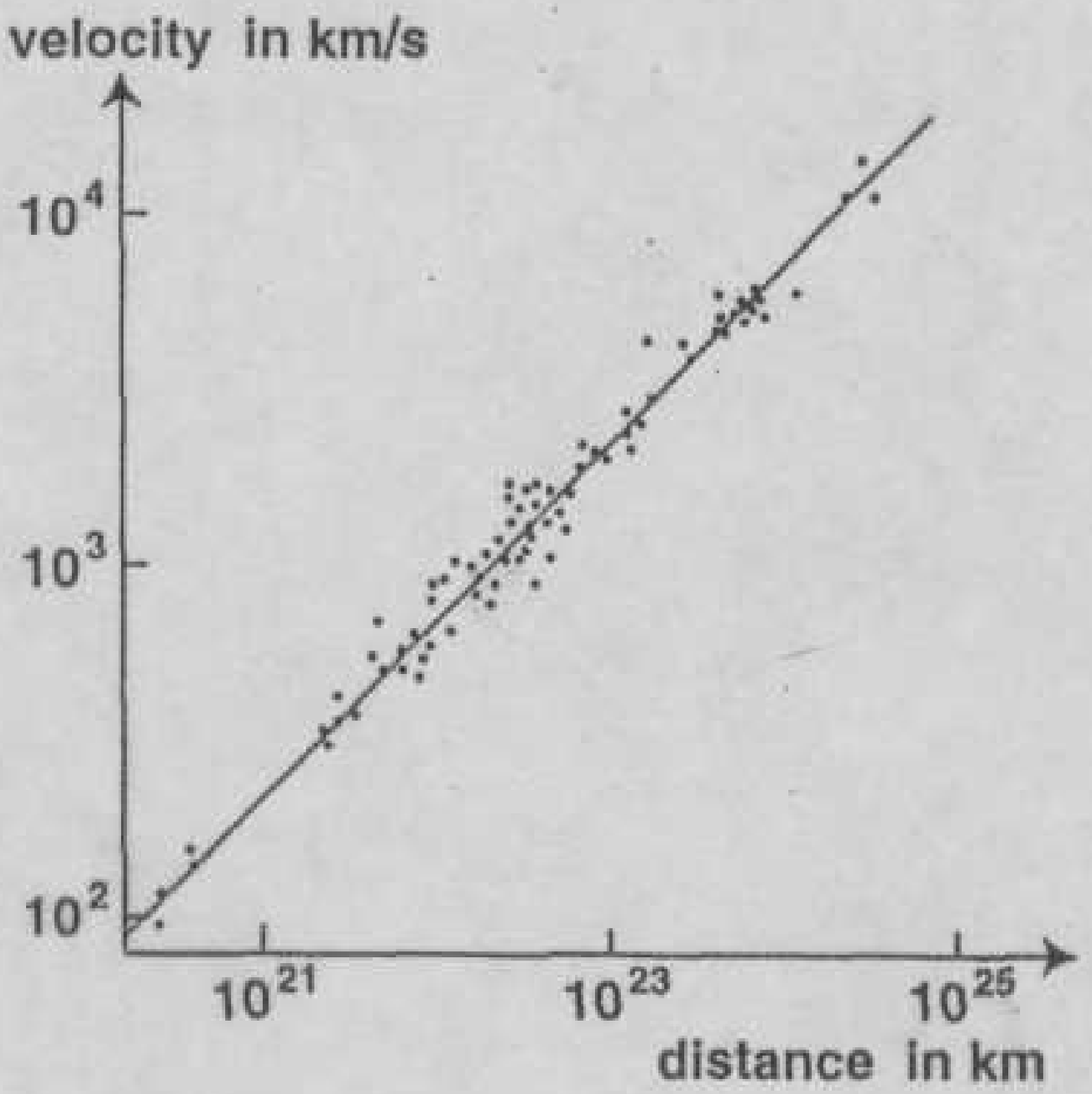


alaxy in the Hubble Deep Field HST • WFPC2
T Scl OPO • June 26, 1996 • K. Lanzetta (SUNY Stony Brook) and NASA

Fig. 14.10 Edwin Hubble at his desk, in the early 1930s. (From the archives of the Observatories of the Carnegie Institution of Washington)


velocity in km/s
10^4
10^3
10^2
10^{21}
10^{23}
10^{25}
distance in km

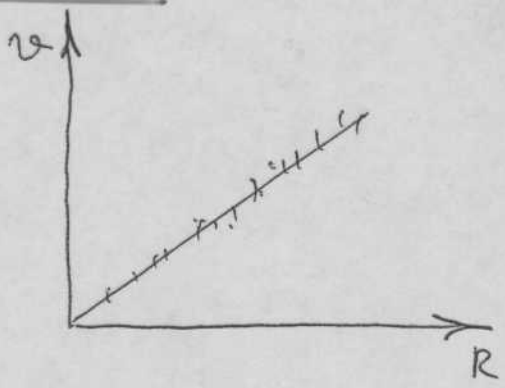
Красное смещение. Постоянная Хаббла.

1920 г – Хаббл.

Эффект Доплера

$$\omega_1 - \omega_2 = \omega_1 \frac{v}{c}$$

$$\frac{\omega_1 - \omega_2}{\omega_1} = \frac{v}{c}$$



$v = H_0 \cdot R$ – закон Хаббла

$H_0 = 100$ км/(с·Мпс)

Расширение Вселенной. Теория Большого Взрыва

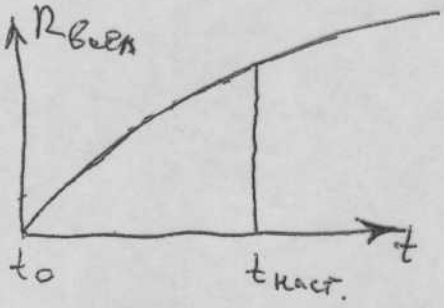
Отказ Эйнштейна от стационарной модели Вселенной

Решение Фридмана. Возраст Вселенной

Поиск отклонений от закона Хаббла.

2000 г: $H_0 = 72 \pm 10$ км/(с·Мпс)

65 ± 10



$t_0 = \frac{2}{3} H_0^{-1}$

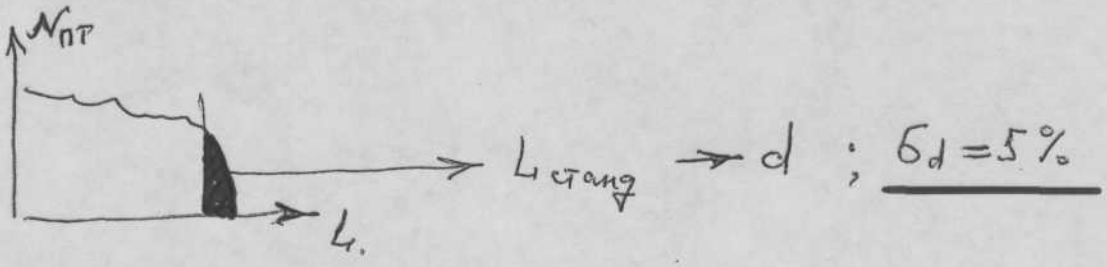
$t_0 = (14 \pm 2) \times 10^9$ лет

(4) Планетарные туманности (PNLF)

Звезда → Белый карлик → флюоресценция оболочки.

в результате поглощения X rays от БК.

ПТ ~ 10^4 в Галактике и есть граница по яркости



Technique	Range of distance	Accuracy (1σ)	Verification/ calibration
• Cepheids	<LMC to 25 Mpc	0.15 mag	LMC/parallax
• SNIa	4 Mpc to > 2 Gpc	0.2 mag	Hubble/Cepheid
• EPM/SNII	LMC to 200 Mpc	0.4 mag	Hubble/Cepheid
• PNLF	LMC to 20 Mpc	0.1 mag	SBF/Cepheid
SBF	1 Mpc to 100 Mpc	0.1 mag	PNLF/Cepheid
TF	1 Mpc to 100 Mpc	0.3 mag	Hubble/Cepheid
BCG	50 Mpc to 1 Gpc	0.3 mag	Hubble/SBF
GCLF	1 Mpc to 100 Mpc	0.4 mag	SBF/MWG
SZ	100 Mpc to > 1 Gpc	0.4 mag	Hubble/Model
GL	~5 Gpc	0.4 mag	Model
Hubble	20 Mpc to $\gtrsim$1Gpc	500 km s^{-1} ÷ H_0D	BCG, SNeIa/H_0

MWG = Milky Way Galaxy

Some recent estimates of Hubble's constant

Technique	Calibration	Ties to Hubble flow	Result (km s^{-1} Mpc^{-1})	Ref.
EPM	EPM model, Cepheids	Direct EPM Hubble Diagram + Flow model or TF	$73 \pm 6 \pm 7$	[29,19]
SNeIa	Host galaxy Cepheids	Direct SNIa Hubble Diagram	63 ± 3.4	[25]
			58 ± 8	[21]

The field round Supernova SN1987A in images from the Anglo Australian Telescope. The image of the star that exploded to create the supernova (arrow) is clearly elongated. This does not indicate any particular peculiarity or a close companion; it is the effect of stars being aligned by chance along similar lines of sight. Several other examples can be seen here and other, different, blended images are seen in the photograph of the same field taken two weeks after the supernova appeared. The difference in image quality ("seeing") is an effect of the Earth's atmosphere, which was steadier on the first occasion. (David Mailin).

Цефеиды – переменные звёзды, средних классов.

короткопериодичные – 1 час – 1.5 суток

долгопериодичные – 1.5 суток – 45 суток

долгопериодичные цефеиды – обладают связью между периодом переменности и звёздной величиной ~~переменности~~

обычно изменение яркости 1–2 звёздные величины

Методы определения расстояний во Вселенной.

1. Цефеиды – яркие переменные звёзды. Период осцилляций связан с абсолютной светимостью.

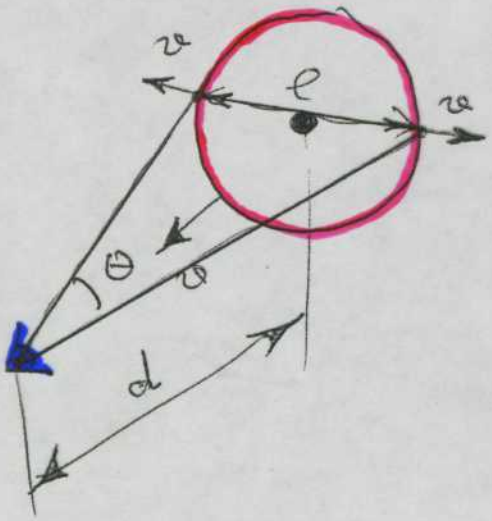
$L_4 = 5 \log_{10}(d) - 5.0 \Rightarrow$

$\sigma_L \simeq 0.1$ mag $\Rightarrow$ $\sigma_d \simeq 5\%$

2. Сверхновые (SN Ia) типа: звёзды с $M \simeq 1.4 M_\odot$ превра-ся в белых карликов, при остывании давление падает и под действием гра-ии проис-т горение (взрывное) эл-ов (Ni, Co, Fe)

$\sigma_L \simeq 0.2$ mag, $\sigma_d \simeq 10\%$

3. Сверхновые (SN II) типа. Массивные звёзды. Масса ядра $\rightarrow 1.4 M_\odot$ (ЧП) $\rightarrow$ НЗ $\rightarrow$ высвобождаемая энергия идёт на выброс внешних слоёв в-ва звезды.



$\Delta l = 2v\Delta t$, $\theta = \frac{\Delta l}{d} \Rightarrow d$

$\sigma_L \simeq 0.4$ mag

$\sigma_d \simeq 20\%$