HUBBLE REDSHIFT–DISTANCE RELATION
Astronomy 124/348 - Version 2.7 2003

Instructions: Please fill in the following forms and data sheets, and hand this in as your lab. Any additional sheets you provide should be securely attached. If you have any questions please ask the teaching assistant on duty.

Name: _____

ID Number: _____

Date and Time Completed: _____

Instructor: _____

Grade and Comments: _____

Please sign the following special pledge:

On my honor as a student, the work I am submitting here is entirely my own. I have not collaborated with or received help in any way from any other person on this laboratory (except those officially designated by the Astronomy Department). I understand that collaboration in any form would be a serious honor violation, would be considered reprehensible by the academic standards in force in this course, and will immediately be brought to the attention of the Honor Committee.

(signature)_____ (date)_____

NAME: _____ ID: _____ Grade: _____

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Here is a quick review of all of the equations you will need to complete this lab. Also include all computations (NEATLY!) below.

(**i**) The distance is derived from the apparent and absolute magnitudes

$M = m + 5 - 5 \times log_{10} D$ M = absolute magnitude = –22

OR m = apparent magnitude

$log_{10} D = \frac{m - M + 5}{5}$ D = distance in parsecs

(**ii**) The redshifts are derived from the observed and apparent laboratory wavelengths

$$\Delta\lambda_K = \lambda_{Kmeasured} - \lambda_K \qquad \Delta\lambda_H = \lambda_{Hmeasured} - \lambda_H$$

λ_K, λ_H =laboratory wavelengths of K and H lines (3934Å & 3969Å)

(**iii**) The recession velocities are derived from the Doppler formula

$v_K = c \times \frac{\Delta\lambda_K}{\lambda_K}$ v_K, v_H = Recession velocity of galaxy as deduced from the K and H lines of calcium

$v_H = c \times \frac{\Delta\lambda_H}{\lambda_H}$ c= speed of light = 3×10^5 km s^{-1}

(**iv**) The Hubble Distance Relation $v = H_0 \times D$

SHOW ALL MATH BELOW IN AN ORGANIZED FASHION

Hubble Redshift–Distance Relation Data Sheet

Name:_____ Computer Number:#_____

Galaxy Name	Apparent Magnitude	Photon Count	Integration Time

λ_K Angstroms	λ_H Angstroms	$\Delta\lambda_K$ Angstroms	$\Delta\lambda_H$ Angstroms	v_K km s^{-1}	v_H km s^{-1}	v km s^{-1}

Apparent Magnitude	Absolute Magnitude	$\log_{10}$ D	D parsecs	D Mpc
	–22			
	–22			
	–22			
	–22			
	–22			

Hubble Parameter, H_0=_____ km s^{-1} Mpc^{-1}

Determining the Age of the Universe

The Hubble Law, equation (**iv**), can be used to determine the age of the universe. Using your average value of H_0, calculate the recessional velocity of a galaxy which is 800 Mpc away.

Velocity of a galaxy 800 Mpc away: _____ km s^{-1}

Verify your velocity by looking it up on your Hubble diagram. You now have two important pieces of information:

(1) How far away the galaxy is.
(2) How fast it is going away from us.

You can visualize the process if you think about a trip in your car. If you tell a friend that you are 120 miles away from your starting point and that you traveled 60 mph, your friend would know you had been traveling TWO hours. That is, your trip started two hours ago. You know this from the relationship:

Distance equals Velocity × Time

Which we can write as

(**v**) D = v × T or T = D/v

Thus, 2hrs=120mi/60 mi/hour

Now let's determine when the universe "started its trip." The distance is 800 Mpc, but first convert Mpc into km because the rate, or velocity is in km s^{-1} (1 Mpc=3.1×10^{19}km).

800 Mpc = _____ km

Use equation (**v**) to determine how many seconds ago the universe started:

T = _____ secs

There are about 3.15×10^{7} seconds in one year. Convert your answer into years:

T = _____ years

This is your estimate for the age of the Universe, assuming the galaxies have all moved at a constant velocity since the Big Bang.