ASTR-3415, *Astrophysics* — Exam 3

Spring 2003

29 April 2003

Name: _____

Useful Constants and Identities

G	=	6.673×10^{-8} dyne cm^2/gm^2	g	=	980 cm/s^2
c	=	2.997925×10^5 km/s	σ	=	5.6696×10^{-5} erg/cm^2/s/K^4
h	=	6.6262×10^{-27} erg s	e	=	4.803×10^{-10} esu
$M_{\rm Moon}$	=	7.35×10^{25} gm	$M_\odot$	=	1.99×10^{33} gm
$M_\oplus$	=	5.98×10^{27} gm	$R_\oplus$	=	6.38×10^8 cm
$R_\odot$	=	6.96×10^{10} cm	$T_\odot$	=	5770 K
1 AU	=	1.496×10^{13} cm	$L_\odot$	=	3.827×10^{33} erg/s
1 ly	=	9.4605×10^{17} cm	1 pc	=	3.0856×10^{18} cm
1 eV	=	1.602×10^{-12} erg	1 eV/hc	=	8065.46 cm^{-1}
1 eV/k_B	=	1.16048×10^4 K	1 amu	=	1.66×10^{-24} gm
m_e	=	9.109×10^{-28} gm	m_H	=	1.67×10^{-24} gm
R_∞	=	109,737.31 cm^{-1}	$k_B = k$	=	1.3806×10^{-16} erg/K
1 Å	=	10^{-8} cm	1 nm	=	10^{-7} cm
Mega	=	10^6	Giga	=	10^9

Answer the questions on the space provided below the question and on the additional blank pages supplied after each question. Feel free to use the back of all pages as well. Remember to **show <u>all</u> work!** The answer is of secondary importance, the technique used to determine the answer is of fundamental importance. Answer your problems as I have done in the solutions I have supplied to you for all of your Problem Sets. Logic and deductive reasoning are being tested here in addition to number crunching! Also remember to pay attention to units and significant digits.

1. (70 pts) We observe the H I line (rest wavelength of 21.10611 cm) at 22.58173 cm in an Sb galaxy that has an apparent magnitude of 13.23 in the blue filter once intergalactic extinction has been subtracted. This 21-cm line has a width that gives a maximum velocity of 406 km/s for the rotation of this galaxy.

(a) (10 pts) What is the absolute magnitude of this galaxy in the blue filter? What is the name of the relationship that you used to figure this out?

(b) (10 pts) What is the distance to this galaxy in Mpc? What is the name of the formula that you used to find this distance?

(c) (10 pts) What is the radial velocity of this galaxy in km/s? What is the name of the formula that you used to figure this out?

(d) (15 pts) From the information above, what is the current Hubble constant? Name the relationship that you used to figure this out. Assuming that the WMAP value of Hubble's constant is the accurate value, what is the percent error of the value of your Hubble's constant?

(e) (10 pts) What must be the maximum age (in years) of the Universe for the Hubble constant determined above? Is this consistent with the age of the globular star clusters in the Milky Way Galaxy?

(f) (15 pts) Based on the data for this galaxy, what is the current mass density of the Universe if $\Omega_\Lambda = 0$ and the deceleration parameter is 0.250? From this data, what is the matter density parameter equal to? Is such a Universe closed, flat, or open? Why do you say this?

Problem 1 continued:

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2. (30 pts) These questions deal with stellar populations:

(a) (10 pts) What are the differences between Population I, Population II, and Population III stars? Give all characteristics of each. Where do we find each type of star in the Milky Way?

(b) (10 pts) Draw the two-color diagram for Population I main sequence stars and compare it to blackbody data. Why do the two deviate and why do main sequence stars show a big dip near A0 spectral class?

(c) (10 pts) How and why does interstellar reddening affect stars plotted on the two-color diagram? Describe in words and indicate on a two-color diagram.

Problem 2 continued: