Astronomy 337
Spring 2009
Homework 2: Precession; Catalogs and Databases
Due Tuesday, February 24

Equatorial 1950 Coordinates for 3 globular clusters and 1 open cluster:

M5 (NGC 5904)	$\alpha = 15^h16^m01.90^s$	$\delta = 02°15'50.9"$
M92 (NGC 6341)	$\alpha = 17^h15^m35.01^s$	$\delta = 43°11'21.1"$
M15 (NGC 7078)	$\alpha = 21^h27^m33.35^s$	$\delta = 11°56'48.8"$
M67 (NGC 2682)	$\alpha = 8^h48^m18^s$	$\delta = 12°00'$

1. PRECESSION

a) Using the formulae for general precession given out in class, precess the coordinates for M92 to the epoch Jan 1, 2000. Be sure to clearly identify your values for

•the precession terms *m, n* in **arcsec/yr**

•the annual increments $d\alpha, d\delta$ in **arcmin/yr**

•the total increments $\Delta\alpha, \Delta\delta$ in **arcmin**

Express your final precessed coordinates with α in units of time, to the nearest .01 sec, and δ in units of arc, to the nearest 0.1 arcsec. You may want to refer to the notes at the end of this assignment for help with units and conversions.

b) Now precess the coordinates for M92 to Jan. 1, 2000 again, but this time use IDL, specifically the *precess* package from the GSFC IDL Astronomy User's library (AKA Astrolib).

c) Compare the 2000 coordinates for M92 from parts a) and b) by calculating the differences in α, δ between the 2 methods, giving differences in *arcsec*. (The hand calculations and IDL values should be within a few arcsec of each other; if they are not, re-check your calculations!)

d) Using IDL, precess the B1950 coordinates for M 5, M 15 and M 67 to epoch J2000. Make a table comparing the amount of precession in both α, δ for each of the 4 clusters. Give the total precession increments in α in both units of time and units of arc. How do you account for the different amounts of precession among the 4 clusters?

2. CATALOGS and DATABASES

a) Explore the catalogs and archives listed in the *Links > Research* section of the Smith Astronomy Dept. webpages. Write a paragraph summarizing the following three surveys: the Digitized Sky Survey, 2MASS, and the Sloan Digital Sky Survey. Include the year(s) data obtained, wavelength(s) covered, spatial resolution, depth (faintest magnitude), and size (number of images and/or objects) of each survey.

b) Choose a Messier object that appeals to you. Access **two** of the many data archives listed in the *Links > Research* webpage and download two optical and/or near-infrared FITS images of your target, each one 0.25 deg $\times$0.25 deg. Print and include a copy of each with your assignment. Also make a table of the **10 brightest objects (by V magnitude)** in your image from the Hubble Guide Star Catalog (GSC). Also include basic information such as cardinal directions (N/S/E/W), source of image, wavelength, and date taken.

IDL Notes on querying the GSC:

; Make a 10' radius query on the GSC centered on a named object, such as M82

$IDL > \ catalog \ = \ querygsc('M82', 10)$

; OR Make a 10' radius query on the GSC centered on a RA-Dec position!
; note: you need DECIMAL DEGREES for both RA and Dec here!

$IDL > \ ra\_m42 \ = \ 83.822083 \ \& \ dec\_m42 \ = \ -5.3911111$ *; Coordinate for M42*

$IDL > \ catalog \ = \ querygsc([ra\_m42, dec\_m42], 10)$

; To make life a little easier, copy some elements of the output data
; "structure" into IDL vectors ra, dec, and vmag.

$IDL > \ ra \ = \ catalog.ra \ \& \ dec \ = \ catalog.dec \ \& \ vmag \ = \ catalog.vmag$

Use a where statement or a sort statement to find the brightest sources.

Use the print statement to see the RA and Dec for these objects, and then mouse over your image in ATV to find these stars in your image.

Finally, you can mark each with a TextLabel (Labels tab in ATV) once you record the rough X-Y position.

CAUTION: *Skyview* resamples images! This means the pixel scales and resolutions will be changed from the original images. Feel free to download images from Skyview, but do not use them for part (c). Images obtained through the National Virtual Observatory (NVO) are not resampled and are fine to use.

c) Using at least three pairs of the stars you identified in (b), use IDL to measure the plate scale in ″/pixel of each image. You will probably find it easiest to display the image in ATV, then use its features to measure the ”centroided” pixel position of each star (use the Photometry window or **p** key), and then calculate the pixel separations between each pair $r = \sqrt{x^2 + y^2}$. Make a table showing for each pair the pixel separation, the coordinate separations $\Delta\delta$ and $\Delta\alpha$, in arcsec and sec of time, respectively; $\Delta\alpha$ in arcsec (remember $15\cos(\delta)$ factor!); separation of pair in arcsec (assume cartesian, not spherical); and pixel scale in ″/pixel. Finally, calculate the average pixel scale. What are the sources of uncertainty in the measured scale? What would you estimate for the value of that uncertainty? How many pixels would the image of the full moon span?

NOTES ON RIGHT ASCENSION AND DECLINATION:

RA $= \alpha$ is measured in units of **time** (h, m, s).

DEC $= \delta$ is measured in units of **arc** (deg, ′, ″).

Along the celestial equator, $24^h = 360°$. Note that 1^s of time = 15 cos(δ) ″ of arc, so it is important to specify the units of time to one more decimal place than the units of arc for comparable accuracy.

When making **calculations** (addition, subtraction, etc.) with α, δ it is much easier to convert the sexigesimal values for α, δ to decimal hours or degrees, respectively. For example: $15^h16^m01.90^s = 15.26719^h$.

When taking **trigonometric functions** in IDL ($sin(\alpha), cos(\delta)$) you **must** convert both α, δ to decimal *radians*. For example: $15^h16^m01.90^s = 229.00792° = 3.99694$ radians.