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Astronomy and Space Science Class

Project Glob

Purpose- To search for a nova within a selected globular cluster and chart the magnitude of a known variable star to affirm that our technique of measuring it would be valid if we found one.

Abstract- We began this lab when out astronomy instructor approached us with a challenge as we began to look for novas in pictures taken and purchased. He described a scientific task that would count for our nova search project and major research project for the year. It entailed taking pictures from New Mexico by remote and then editing, aligning, and calibrating these images to acceptable by astronomy organizations without being looked down upon for. With these images, the next step was to blink these in search of a nova, which has not yet provided any discoveries for us. We took our data and found a few variable stars to work with and check that our work as been in the right direction.

It has been and will be exciting to continue working on this project, as it has just been revealed to us that an assignment of this caliber is rarely done before the junior or senior years of an astronomy major in college.

Hypothesis- We will attempt to discover a nova within a selected globular cluster and chart the magnitude of a known variable star to affirm that our technique is valid.

Procedure-

1. Make a selection of globular clusters.
2. Log onto New Mexico Skies (www.telescope2.net) to use the telescope to photograph the selected objects.
    - Photograph with logical exposure times consistently using a reasonable interval to show adequate fluctuations.
3. For each cluster, use steps 4 and 5.
4. Nova searching
    - Using NIH/Scion Image (http://rsb.info.nih.gov/nih-image/download.html), open images with settings (view fig.1),

figure 1

16 Bit Signed

Settings:
Height 512
Width 512
Offset 5760
Slices 1

Unfixed import scale

- Align (rotate and scale to achieve identical size and location throughout images)
- Stack images in order to "blink" the digital photographs with the intention of observing a change in apparent magnitude that has the potential of being a nova.
- If a nova is observed, continue. If no nova is observed, move on to step 5.
- Using the Simbad clickable star maps (available at http://simbad.u-strasbg.fr/sim-fid.pl) locate standard stars (2-4) and record magnitudes to be used to calibrate images.
- Open the images in Hands on Universe Image Processing and calibrate all images by taking the "sky" of each image, and to each one, adding that same number to the image with the "add" function resulting in standardizing the sky counts to zero.
- Plot standard star and nova magnitudes.
- Graph the magnitudes of the nova over time with Fathom (http://www.keypress.com/fathom/update.html) (time in days for the X axis, magnitude for the Y)

5. Variable Star and Nova measurements
    - Using the Simbad clickable star maps (available at http://simbad.u-strasbg.fr/sim-fid.pl) select and locate standard stars (2-4) and record magnitudes to be used to calibrate images.
    - Save image as new picture.
    - Open the images in Hands on Universe Image Processing (http://www.handsonuniverse.org/about_hou/index.html) and calibrate all images by taking the "sky" of each image, and to each one, adding that same number to the image with the "add" function resulting in standardizing the sky counts to zero.
    - Find brightness counts for each standard star using the auto aperture/"bull's-eye" function in each image.
    - Divide the brightness count of each standard star in the first picture by the standard stars in the second picture to get the ratio for the variable to be labeled "Z" which is to be multiplied to the image in order to turn the brightness counts into a magnitude.
    - Repeat with other images.
    - Plot all results on a spreadsheet.
    - Average the Zs for each individual image and use the "multiply" function to compound the Z averages to each picture to properly calibrate images.
    - Select a variable star using a Simbad clickable star map (available at http://simbad.u-strasbg.fr/sim-fid.pl) relevant to the cluster.
    - Measure the brightness counts of the variable star and plot on the same spreadsheet in a new column.

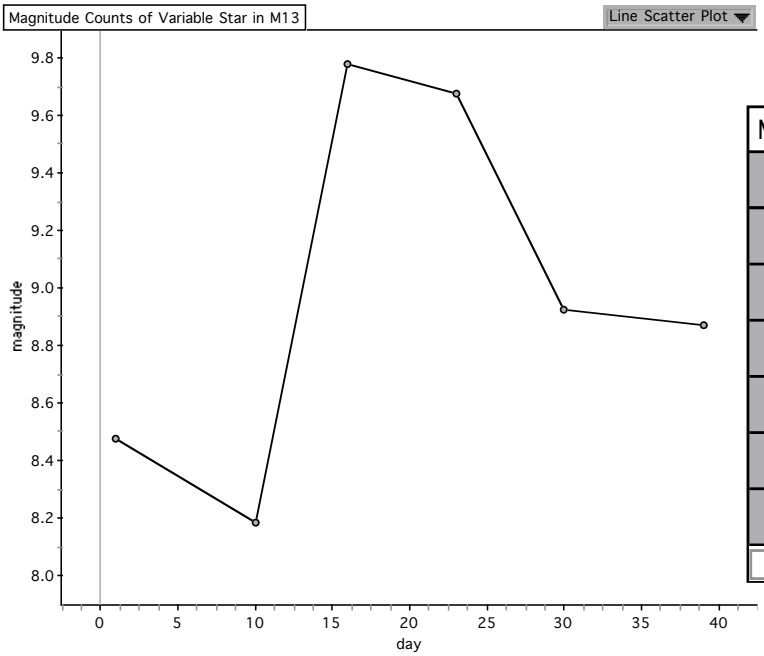
- Using the equation (figure 2), plot the magnitudes of the variable for each epoch.
- Graph the magnitudes of the variable over time with Fathom (time in days for the X axis, magnitude for the Y)

$M_1 + 2.5 \times \log(B_2/B_1) = M_2$

M_1 = magnitude of standard star
B_2 = brightness counts of variable star
B_1 = brightness counts of standard star
M_2 = magnitude of variable star

Data-

M13 information



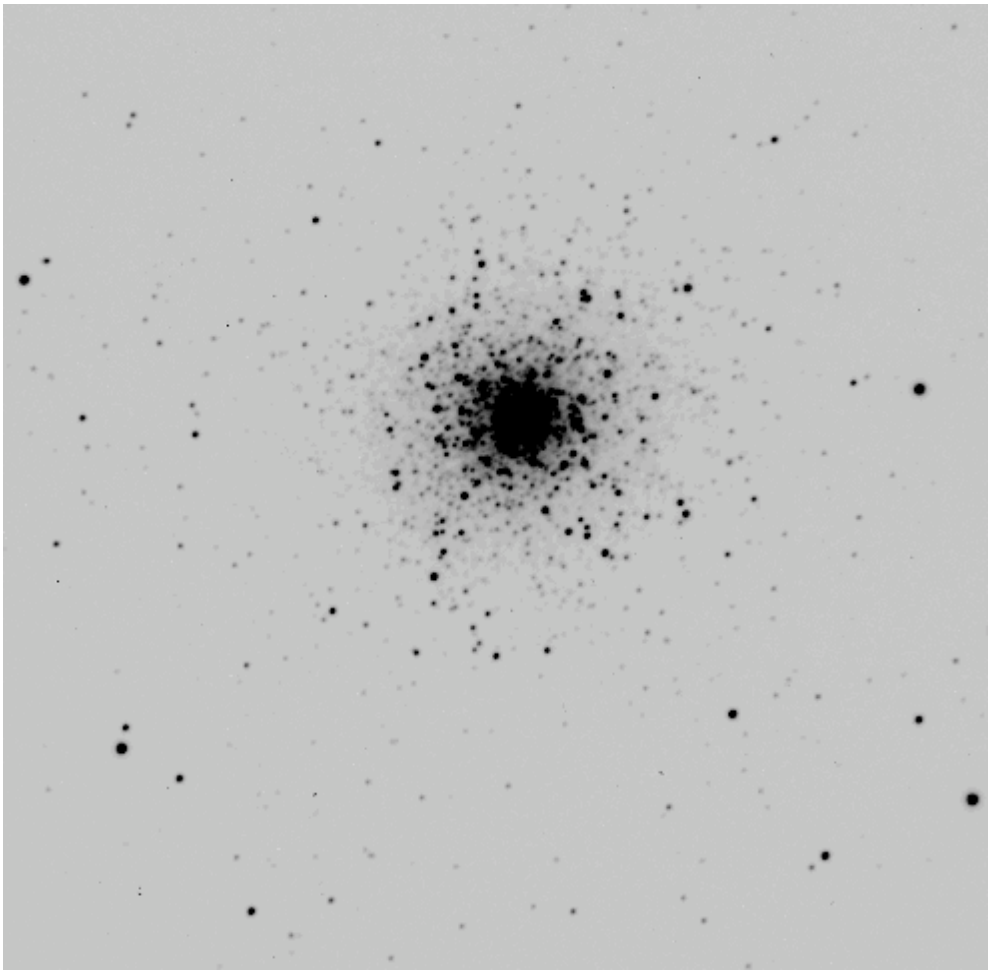
Magnitude Counts of Variable Star i...

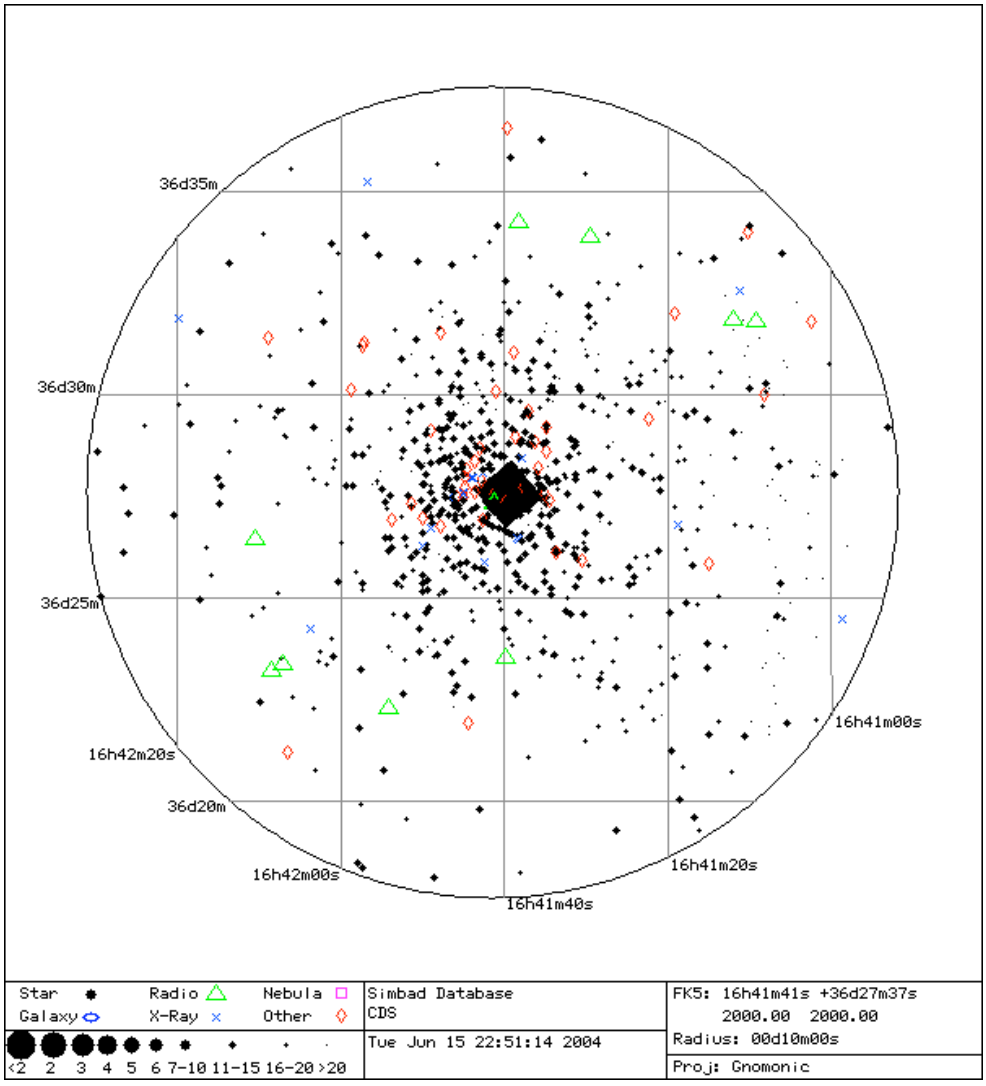
	day	magnitude
1	1	8.473499...
2	10	8.183994...
3	16	9.777333...
4	23	9.677009...
5	30	8.924308...
6	39	8.871502...

Data collection

	m3	m5	m13	m53	m68	m92
4/20/2004	x	x	x	x	x	x
4/29/2004	x	x	x			x
5/4/2004	x	x	x		x	x
5/11/2004	x	x	x	x		x
5/18/2004	x	x	x	x		x
5/27/2004		x	x			x

KEY
X = got picture





Star ✸ Radio △ Nebula □
Galaxy ⬭ X-Ray × Other ◇

<2 2 3 4 5 6 7-10 11-15 16-20 >20

Simbad Database
CDS

Tue Jun 15 22:51:14 2004

FK5: 16h41m41s +36d27m37s
2000.00 2000.00
Radius: 00d10m00s

Proj: Gnomonic

Brightness Count 1	Brightness Count 2	Brightness Count 3	Brightness Count Var	Brightness Count Var
8087	46973	35710	Picture 1	65221
6252	86230	26415	Picture 2	85151
10499	BAD Pixel	62519	Picture 3	19627
10736	BAD Pixel	58695	Picture 4	21527
2910	78012	44205	Picture 5	43059
5139	113122	76644	Picture 6	45205

Magnitude of Variable
8.473499974
8.183994226
9.777333802
9.677009831
8.924308759
8.871502424

Key
Brightness count 1 = brightness count of standard star 1
Brightness count 2 = brightness count of standard star 2
Brightness count 3 = brightness count of standard star 3
Brightness count var = brightness count of variable star
Magnitude of Variable = larger numbers are dimmer

V Magnitude 1	V Magnitude 2	V Magnitude 3	Z Avg	Z1	Z2	Z3
10.74	15.12	17.54	N/A	N/A	N/A	N/A
" "	" "	" "	1.3226947	1.2935061	BAD Pixel	1.3518834
" "	" "	" "	0.6707251	0.7702638	BAD Pixel	0.57118636
" "	" "	" "	0.6808297	0.7532601	BAD Pixel	0.60839935
" "	" "	" "	0.7049762	BAD Pixel	0.6021253	0.80782717
" "	" "	" "	0.4405812	BAD Pixel	0.415242	0.46592036

Date	Cluster	Standard Star 1	Standard Star 2	Standard Star 3
4/20/2004	M13	BD+36 2766	Cl* NGC 6205 KAD 670	Cl* NGC 6205 AJ B110
4/29/2004	"	" "	" "	" "
5/4/2004	"	" "	" "	" "
5/11/2004	"	" "	" "	" "
5/18/2004	"	" "	" "	" "
5/27/2004	"	" "	" "	" "

Key
V magnitude 1 = magnitude of standard star 1
V magnitude 2 = magnitude of standard star 2
V magnitude 3 = magnitude of standard star 3
Z1 = brightness counts of standard star 1 in 1st picture divided by brightness count of the same star in the 2nd picture
Z2 = brightness counts of standard star 1 in 1st picture divided by brightness count of the same star in the 2nd picture
Z3 = brightness counts of standard star 1 in 1st picture divided by brightness count of the same star in the 2nd picture
Z Avg = (Z1+Z2+z3) / 3
Standard star 1 = name of standard star 1
Standard star 2 = name of standard star 2
Standard star 3 = name of standard star 3
Cluster = name of globular cluster used

Conclusion- This endeavor was started with the intention of discovering a nova in one of the globular clusters that was selected. Although no nova was found, we were given the opportunity to track the magnitudes of not only a variable star in m13, but also a variable star in m5. Of these two queries, the beginnings of a light curve have been constructed. We remain optimistic knowing that we will have the opportunity to continue this project over summer and during the next year in the Astronomy and Physics Research class, with the epochs with the potential to be added, it is quite exciting to think our research is relevant enough to be published.

Reference

- This project was supported by TLBRESE, who are running an observing program, which has provided the time at NMSO in which we took our pictures to be analyzed. (http://www.noao.edu/outreach/tlrbse/rct.html)
- Fathom 2.0 Alpha - (http://www.keypress.com/fathom/update.html)
- Hands on Universe Image Processing (http://www.handsonuniverse.org/about_hou/index.html)
- NIH Image - (http://rsb.info.nih.gov/nih-image/download.html)
- NMSkies - (www.telescope2.net)
- Simbad clickable star maps - (http://simbad.u-strasbg.fr/sim-fid.pl)