ASTR 4100 / 6100

Observing Project - Part 1

Due Date: Friday April 3 by 5pm (in my email or in person)

The purpose of this project is to give you hands-on experience with astronomical imaging, basic data reduction, and basic image analysis. This project is worth 100 points and comprises 20% of your grade in the class.

Part 1 includes instructions and requirements for the observing part of the project. Part 2 (which will be distributed later in the semester) will describe the analysis goals after your data have been collected at the observatory.

Each student is assigned to a group of 3-4, and each group is scheduled to spend three evenings observing at Hard Labor Creek Observatory (Rutledge, GA). While at HLCO, *students are expected to take turns operating the telescope and imaging camera so that all students can develop a familiarity with the equipment*.

Objectives:

-- practice operating a telescope and imaging camera
-- practice carrying out proper observing techniques
-- familiarity with IRAF, the astronomical community's standard software for data reduction and simple analysis
-- practice with basic data reduction for astronomical imaging
-- practice making simple measurements and plots

While datasets acquired at HLCO will be shared between students, **each student is required to submit his/her own project showing the results of his/her own data reduction and analysis.**

The project summary:

You will be observing two asteroids and measuring their rotation periods. One full night, from evening twilight to morning twilight, will be dedicated to monitoring the primary asteroid in a single filter. The remaining nights will be spent monitoring the secondary asteroid through a series of different filters. The primary asteroid has a well-known and easily measurable rotation period. The secondary asteroid has significantly less information known. After the class project ends, everyone's observations will be combined together in an attempt to carefully constrain the rotation period of the secondary asteroid so that we can publish our results in the Minor Planet Bulletin (results from the 2017 class observing project are published here: 2018 MPBu Vol. 45 p. 311)

The observatory:

Hard Labor Creek Observatory is located in Rutledge, GA. Directions and GPS coordinates can be found here: http://www.astro.gsu.edu/HLCO/directions.html

Each student has been assigned to a group of 3-4, and each group has been scheduled for 3 nights at the observatory during the semester. The observing schedule is reproduced below for reference.

	S	M	T	W	Th	F	Sa
FEB	2	3	4	5	6 Group 1	7 Group 2	8 Group 3
	9	10	11	12	13	14	15
	16	17	18	19	20 Group 1	21 Group 2	22 Group 3
	23	24	25	26	27 Group 1	28 Group 2	29 Group 3

1	Ellie	Kristin	Nicholas	
2	KhaDeem	Chris	Gillian	Anderson
3	Becky	Ty	Patrick	

The graduate student(s) in each group are responsible for making the final decision about whether to travel to the observatory on a scheduled night or not, and for communicating this to the group through whatever method the group has decided upon (i.e., phone, email, text...)

Reasons not to go to HLCO:
- it is snowing or icy and the roads are dangerous
- it is foggy and the roads are dangerous
- there is a tornado warning for the area or severe thunderstorms
- there are very high winds, causing potential danger from falling trees
- it is pouring rain in Atlanta and in Rutledge with no signs of stopping all night long

Important Note:
All groups are required to go to HLCO for their first night, as long as it is safe, even if it is impossible to open the dome. This is for training and familiarity with the equipment. You should arrive **at least** 30 minutes before sunset - earlier is better.

If it is partly cloudy, your group should still go to HLCO and plan to observe what you can. Useful resources for monitoring the weather and making a “go/no-go” decision:
- HLCO weather page http://www.astro.gsu.edu/HLCO/weather.php
- Rutledge weather from NOAA (with satellite images) http://goo.gl/EcPEmq
- other weather pages with radar animations, like AccuWeather https://goo.gl/wqAhJ9

Reasons to keep the dome closed or shut it immediately if it's open:
- there is snow or ice on top of the dome
- it is raining or snowing or sleeting (moisture is falling from the sky)
- it is foggy or you can see moisture in the air in a flashlight beam or see it condensing on cars or metal outside
- high winds are coming from the direction you need to point the telescope
- the humidity has increased and the numbers have turned red on the HLCO weather page
- the radar shows rain coming towards HLCO (turn on the animation to see the loop)

***** Remember: your top priority is always your group's safety, followed by the safety of the telescope and instrument. Do not ever put yourselves or the equipment in danger.**

Dress warmly and bring extra layers with you. Middle of the night winter weather in Georgia can easily be below freezing, and you will be tired and sitting still, making it much worse. Hats, gloves, scarves, thick coats, thick socks, extra layers under pants and shirts, whatever you have, bring it with you. Blankets too. It's better to be over-prepared rather than shivering and wishing you had brought something with you.

Food and hot beverages are encouraged, but you must clean up after yourself. No one is paid to clean up after you. The observatory is not visited often in the winter, so messes tend to stay for a long period of time, attracting pests that can sometimes be dangerous (e.g., scorpions). There is a coffee maker, microwave, refrigerator, and stove top available, so you can have a continuous supply of coffee or hot chocolate or ramen to keep you warm and awake. Bring your own drinking water -- I personally don't trust the tap water out there. **Take all trash with you when you leave, and clean up crumbs and spills.**

The observations:

It is important that everyone has read the observing manual (on the class website) in advance to help prepare for the observations as much as possible. Check it before each trip for any changes or updates.

Goal 1: Each group will spend one full night monitoring the primary asteroid in the V filter for as long as possible.

Goal 2: Each group will spend their remaining nights monitoring the secondary asteroid in the B, V, and R filters for as long as possible. Images should be taken in the following pattern: B, V, R, dither, repeat.

Preparation before you get to the telescope: The first task will be to identify the region of the sky where the asteroid will be each night. You will need a good finding chart showing the star field around the asteroid's expected location (so that you can figure out which smudge is the asteroid). It is helpful to use finding charts that match the field of view of the detector Many finding chart generators exist online, but it's also important to find one that uses digital images of the sky for comparison with the observations that you will be taking. I like this particular finding chart generator: http://astro.swarthmore.edu/finding_charts.cgi

Asteroid targets:

Number	Name	P(hours)	ΔV(mag)	V(mag)	
782	Montefiore	4.08	0.4	13.5-14.0	primary
2531	Cambridge	12.2?	0.2	15.0-15.5	secondary

Because asteroids move quickly relative to the background stars, you will need to know where to look every night. The tables below give the asteroid positions as a function of date for February and early March.

The apparent rate of motion for the asteroids range from 0.4-0.7" per minute. This means that your exposure times should be no more than 4-5 minutes in each filter to minimize the streaking of the asteroid in the images.

***** Important Note: UT 2020 02 07 at 0200 hours = local date 2020 02 06 at 9:00pm *****

782 Montefiore

UT Date h m s	R.A. (J2000) Decl.	V (mag)	Motion "/min
2020 02 07 020000	10 33 39.2 +18 35 20	13.8	0.60
2020 02 08 020000	10 32 47.2 +18 43 26	13.7	0.61
2020 02 09 020000	10 31 53.8 +18 51 32	13.7	0.62
2020 02 10 020000	10 30 59.1 +18 59 36	13.7	0.63
2020 02 11 020000	10 30 03.2 +19 07 38	13.7	0.64
2020 02 12 020000	10 29 06.1 +19 15 38	13.6	0.65
2020 02 13 020000	10 28 08.0 +19 23 34	13.6	0.65
2020 02 14 020000	10 27 09.0 +19 31 26	13.6	0.66
2020 02 15 020000	10 26 09.0 +19 39 13	13.6	0.66
2020 02 16 020000	10 25 08.3 +19 46 55	13.6	0.67
2020 02 17 020000	10 24 06.9 +19 54 30	13.5	0.67
2020 02 18 020000	10 23 04.8 +20 01 58	13.5	0.67
2020 02 19 020000	10 22 02.3 +20 09 18	13.5	0.67
2020 02 20 020000	10 20 59.4 +20 16 30	13.5	0.67
2020 02 21 020000	10 19 56.3 +20 23 33	13.5	0.67
2020 02 22 020000	10 18 52.9 +20 30 25	13.5	0.67
2020 02 23 020000	10 17 49.5 +20 37 08	13.6	0.66
2020 02 24 020000	10 16 46.2 +20 43 39	13.6	0.66
2020 02 25 020000	10 15 43.0 +20 49 59	13.6	0.65
2020 02 26 020000	10 14 40.1 +20 56 07	13.6	0.65
2020 02 27 020000	10 13 37.6 +21 02 02	13.6	0.64
2020 02 28 020000	10 12 35.5 +21 07 44	13.7	0.63
2020 02 29 020000	10 11 34.1 +21 13 13	13.7	0.62
2020 03 01 020000	10 10 33.3 +21 18 27	13.7	0.61
2020 03 02 020000	10 09 33.3 +21 23 28	13.7	0.60
2020 03 03 020000	10 08 34.2 +21 28 13	13.8	0.58
2020 03 04 020000	10 07 36.1 +21 32 44	13.8	0.57
2020 03 05 020000	10 06 39.1 +21 37 00	13.8	0.56
2020 03 06 020000	10 05 43.2 +21 41 01	13.9	0.54
2020 03 07 020000	10 04 48.5 +21 44 46	13.9	0.53
2020 03 08 020000	10 03 55.2 +21 48 16	13.9	0.51

It is each group's responsibility to determine what time of night the asteroid can first be safely observed --- err on the side of caution here and <u>DO NOT</u> slew to a position with airmass >2.5 !!!

***** Important Note: UT 2020 02 07 at 0200 hours = local date 2020 02 06 at 9:00pm *****

2531 Cambridge

UT Date (h m s)	R.A. (J2000)	Decl.	V (mag)	Motion "/min
2020 02 07 020000	10 11 43.4	+22 35 27	15.0	0.54
2020 02 08 020000	10 10 58.2	+22 43 20	15.0	0.54
2020 02 09 020000	10 10 12.4	+22 51 09	15.0	0.54
2020 02 10 020000	10 09 26.1	+22 58 54	15.0	0.54
2020 02 11 020000	10 08 39.2	+23 06 35	15.0	0.55
2020 02 12 020000	10 07 51.8	+23 14 10	15.0	0.55
2020 02 13 020000	10 07 04.0	+23 21 39	15.0	0.55
2020 02 14 020000	10 06 15.8	+23 29 03	15.0	0.55
2020 02 15 020000	10 05 27.4	+23 36 20	15.0	0.55
2020 02 16 020000	10 04 38.7	+23 43 31	15.0	0.54
2020 02 17 020000	10 03 49.9	+23 50 34	15.0	0.54
2020 02 18 020000	10 03 00.9	+23 57 29	15.0	0.54
2020 02 19 020000	10 02 11.9	+24 04 17	15.0	0.54
2020 02 20 020000	10 01 22.9	+24 10 56	15.0	0.53
2020 02 21 020000	10 00 34.0	+24 17 26	15.0	0.53
2020 02 22 020000	09 59 45.2	+24 23 48	15.1	0.52
2020 02 23 020000	09 58 56.6	+24 30 00	15.1	0.52
2020 02 24 020000	09 58 08.4	+24 36 02	15.1	0.51
2020 02 25 020000	09 57 20.4	+24 41 54	15.1	0.50
2020 02 26 020000	09 56 32.9	+24 47 35	15.1	0.49
2020 02 27 020000	09 55 45.9	+24 53 07	15.1	0.49
2020 02 28 020000	09 54 59.3	+24 58 27	15.2	0.48
2020 02 29 020000	09 54 13.4	+25 03 37	15.2	0.47
2020 03 01 020000	09 53 28.1	+25 08 35	15.2	0.46
2020 03 02 020000	09 52 43.5	+25 13 22	15.2	0.45
2020 03 03 020000	09 51 59.7	+25 17 58	15.2	0.44
2020 03 04 020000	09 51 16.6	+25 22 22	15.3	0.43
2020 03 05 020000	09 50 34.5	+25 26 34	15.3	0.42
2020 03 06 020000	09 49 53.2	+25 30 35	15.3	0.40
2020 03 07 020000	09 49 12.9	+25 34 24	15.3	0.39
2020 03 08 020000	09 48 33.5	+25 38 01	15.3	0.38

It is each group's responsibility to determine what time of night the asteroid can first be safely observed --- err on the side of caution here and <u>DO NOT</u> slew to a position with airmass >2.5 !!!

Calibrations and supporting observations for both goals:
In addition to the science goals, you will need to take calibrations each night at HLCO to help you make accurate measurements from your observations when you get home. These calibrations include the following:

(1) Beginning of the night calibrations
-- biases x 10
-- dome flats (aim for 20,000-30,000 counts per image in >2sec exposure)
9xV for first night of observations
5xB 5xV 5XR for additional nights of observations
The observing manual will help you with these. We will also talk about them in detail in class.

Usually, you would also want to take images of standard stars throughout the night to calibrate your measurements, but we will focus on relative brightness variations (and you will have enough to do anyway).

(2) *End of the night calibrations*
-- dark frames x 5 to match every exposure time used for flats and science exposures
-- additional set of 10 x biases

If you haven't read the observing manual yet, stop now and immediately refer to it so that you can plan your observations appropriately. **NEVER EVER EVER show up at the telescope unprepared. Telescope time is a rare, and often expensive, commodity. Don't waste it.**

Keys:

Dr. Bentz will give a key to the observatory to one person in each group in the class immediately before the group's trip. That person is solely responsible for the key and may not entrust it to anyone else. Keys must be returned in class immediately after each trip.

Absences:

No one but Dr. Bentz is allowed to approve an absence on an assigned observing night. It is possible that a make-up time could be determined after discussion with Dr. Bentz, but this is not guaranteed. Unapproved absences will negatively impact your grade.

Observing logs:

Observing logs must be completed for **each** trip to HLCO, whether you are able to open the dome or not. It will work best if one person is designated to handle the log for each trip (but not necessarily the same person for every trip). Logs should be shared with all the group members upon return after each trip, as should all data collected.

Example electronic logs can be found here:
http://www.astro.gsu.edu/~bentz/a4100.6100/photlog_template.xls

Be sure to fill in all of the fields. Use your log to help you remember every little thing that happened that night. You will be working with your data days or weeks after you take it. Don't expect that you will remember what happened in the middle of the night. Log it. In particular, use the notes column extensively to help you identify problem images immediately. Was it a test image? Were the lights on? Did someone turn on a flashlight in the middle of the image? Anything of note, no matter how small, should go here. It will make your life easier later.

Weather conditions should be thoroughly monitored throughout the night on the HLCO weather page and documented in your log including the following:
-- clouds
-- wind
-- humidity

-- moon phase and proximity
-- temperature

---- End of the night: don't forget! ----

Be sure to copy all your data from the night to a thumb drive and bring it back with you. Put an extra copy on the laptop of the person who was in charge of the observing log for the night too, in case anything should happen to the thumb drive.

Collect all trash and food leftovers and bring them back with you. There are no janitorial services at HCLO during the winter because we have no winter open houses for the public. Leaving trash or food of any kind will invite pests into the building (mice, cockroaches, scorpions, and other yucky creepy crawlies).

Triple-check that everything is closed and shut down. You will be tired, but there will be three of you. Don't assume someone did something, make sure you see it for yourself.

Watch carefully for deer on the drive home. Everyone should be helping the driver stay vigilant, no one gets to snooze on the drive back.

Part 2 will describe what to do with your data once you get it home.