

Supernovae Search Project

Objective

The objective of this project is to give students practice at making systematic observations by periodically observing a number of galaxies over the course of the semester in order to discover supernovae. The probability of discovering a supernova is rather small but the point of this project is to give the student experience with making long term observations. The students are to work in two person teams.

Introduction

Supernovae are the spectacular explosions of stars that can outshine their host galaxies. First of all the events are very rare. On the other hand they provide astronomers with the ability to determine the distances of the host galaxies and they also provide information on the deaths of stars. It is estimated that the typical galaxy is host to one to two supernovae per century. In order to maximize the chances of observing a supernova we can observe many galaxies over a period of time. The more we observe the better the chance of observing a supernova.

Equipment

- Tzec Maun Observatory 8 inch refractor or 14 inch reflector and CCD camera.
- Internet connected computer. A high speed connection is preferred.
- USB Flash Drive or DVD/CD burner for storing images.
- Notebook for recording observations.

Procedure

You and your observing team members will begin by scheduling time on one of the Tzec Maun Observatory telescopes. The earlier that you schedule your time the better. Schedule one or two hours at a time during each week. **Be sure to use the time that you schedule.** During your scheduled observing time take images of as many galaxies on the observing list as possible. You will need to take at least two images 20 or 30 minutes apart. The reason for taking two images is to distinguish a possible supernova from an asteroid that just happens to be in the same field as the galaxy or a cosmic ray hit on the CCD camera. After your scheduled observing time you can download the JPEG and FITS formatted image files from the Tzec Maun web site. The JPEGs can be retrieved from your browser as they are displayed. Take the images that you acquired and compare them with archived images if they are available. If archive images are not available on the College network drive then your first image will become your reference or you might try searching for an image on the Internet. Look for any new stars that are not on the reference images.

Exposures

The exposure times for the galaxies will depend on the brightness of each object. A galaxy with an apparent magnitude of 8 will be about 16 times brighter than a galaxy with an apparent magnitude of 11. To capture the same amount of detail in an 11th magnitude galaxy as captured in a two minute exposure of an 8th magnitude galaxy would require an exposure time that is 16 times longer (32 minutes). Since we are interested in

capturing a bright supernova within its host galaxy we won't need to capture all of the detail within the galaxy. So shorter exposures are possible. A faint 11th magnitude galaxy might require 40 minutes to capture all of the fainter details but we should be able to capture a supernova in a 10 or 15 minute exposure. For a brighter galaxy three or four minutes should be sufficient. For a given galaxy your exposures need to be standardized. So for an 8th magnitude galaxy all of your exposure might be three minutes and for an 11th magnitude galaxy all of the exposures might be 15 minutes. The reference images that we compare our images to need to have more detail so that we can distinguish between suspected supernovae and a faint foreground variable stars. If a long exposure of a particular galaxy is not available as a reference then your first image of the galaxy should be long enough to capture the fainter details.

Telescope Scheduling Considerations

- You need to plan your imaging sessions around the phases of the moon. The best time to image fainter galaxies is around the new moon when the sky is dark. Brighter galaxies can be imaged at other times but it can be very difficult if not impossible to do any imaging near a full moon. The reservation slots can fill up very quickly around the new moon so you will need to make your reservations at least one or two weeks in advance to get these prime observing times.
- You will need to check the weather in New Mexico before you start observing. The Tzec Maun Observatory web site has current weather conditions posted on it and they have an all sky camera that shows you a real-time view of the sky conditions at the observatory.
- Keep in mind that New Mexico is on Mountain Time, which is one hour behind Kansas City.

Observing Logs

Each galaxy observation must be recorded in the attached log sheets. You will need to record the object name, date, time (specify the time zone), observer's name, length of exposure, image file name, telescope, and comments such as weather conditions and any suspected supernovae or any other pertinent information. Keep the observing logs in a three ring binder, which you will turn in at the end of the semester.

Image Data

While you are observing you will want to download the images to a USB storage device or save them off to a CD or DVD. Make sure that you make a backup copy of your images. The AP206 allows you to save a JPEG version of the image from your web browser. You will also need to download a copy of the FITS version of each image. The FITS files can be rather large. The 8 inch AP206 images are about 5 Mb in size and the 14 inch Maksutov-Newtonian images are about 3 Mb in size. Each week bring your downloaded images and your log books to class. The images will be uploaded and stored to the College's network.

Handling Suspected Supernovae

1. Estimate the position north, south, east and west in arc seconds or arc minutes of the suspected object relative to the galaxy's nucleus and any other stars in the field.

2. Make sure that the object appears on both images from that night.
3. Make sure that it is not a hot pixel or cosmic ray hit on the CCD chip.
4. Eliminate the possibility of the object being an asteroid by using Astrometrica (consult the Near Earth Asteroid Project handout for instructions on using Astrometrica) and the most current minor planet database to check the field for known asteroids. Asteroids will appear to move over a 20 to 60 minute time period unless they are near the stationary point of their retrograde loop. If it is a known asteroid Astrometrica can be used to identify it. If it is a previously unknown asteroid you may have to follow it over a couple of nights to see any motion.
5. Using coordinates of the object from Astrometrica consult lists of known variable stars to make sure that it is not a variable star within our own galaxy. Also, compare the image with a long exposure image to see if there is a star in the position of the suspect.
6. Positive supernovae suspects should first be reported to Central Bureau for Astronomical Telegrams and then the AAVSO Headquarters

Assessment

You will be assessed on the number of observations and the quality of your record keeping. You are expected to make observations about once per week (about 12 one to two hour observing sessions) and your observing logs should have a complete record of each object that was observed. The observing needs to be shared with your lab partner if you are working in a team.

Number of observing sessions: 25%

Quality of observations (number of objects per session and image quality): 25%

Record keeping (completeness of observing logs): 25%

Teamwork (if working in a team): 25%

If working individually the first three assessments will count 33% each.

Total Point Value: 50

Discussion Questions

1. Why is it best to observe near a new moon?
2. Why is it important to have a reference image of each galaxy that is a longer exposure than the rest?
3. Why do you need to take at least two images of a galaxy about 30 to 60 minutes apart on a given night?

Target List

NGC #	Messier #	RA	DEC	Type	Magnitude	Angular Size (arc minutes)	Notes
2403		07 36.9	+65 36	SABc	8.5	26 x 13	
2683		08 52.7	+33 25	SAb	10.5	8.4 x 2.4	
2655		08 55.6	+78 13	SAB0	11	6 x 5.3	
2841		09 22.0	+50 58	SAb	9.2	6.8 x 3.3	
2903		09 32.2	+21 30	SABbc	9	12 x 6	
3003		09 48.6	+33 25	SBc	11.9	5.2 x 1.6	
3031	M81	09 55.6	+69 04	SAab	6.9	24 x 13	
3034	M82	09 55.8	+69 41	I0	8.4	12 x 6	In same field as M81.
3079		10 02.2	+55 41	SBc	10.9	8 x 1.5	
3115		10 05.2	-07 43	S0	10.1	7.3 x 3.4	
3184		10 18.3	+41 25	SABc	9.8	7.8 x 7.2	
3344		10 43.5	+24 55	SABbc	9.9	6.9 x 6.4	
3351	M95	10 44.0	+11 42	SBb	9.7	7.8 x 4.6	
3368	M96	10 46.8	+11 49	SABab	9.2	6.9 x 4.6	
3379	M105	10 47.8	+12 35	E1	9.3	3.9 x 3.9	
3384		10 48.3	+12 38	SB0	9.9	5.5 x 2.9	
3432		10 52.5	+36 37	SBm	11.2	6.9 x 1.9	
3521		11 05.8	-00 02	Sab	10	12 x 6	
3556	M108	11 11.5	+55 40	SBcd	10	8.1 x 2.1	
3607		11 16.9	+18 03	SA0	9.9	4.6 x 4.1	
3623	M65	11 18.9	+13 05	SABa	9.3	8.7 x 2.2	
3627	M66	11 20.2	+12 59	SABb	8.9	8.2 x 3.9	
3628		11 20.3	+13 36	Sb pec	9.5	14 x 4	
3877		11 46.1	+47 30	SAC	11	5.1 x 1.1	
3941		11 52.9	+36 59	SB0	10.3	3.7 x 2.6	
3992	M109	11 57.6	+53 23	SBbc	9.8	7.6 x 4.3	
4026		11 59.4	+50 58	S0	10.8	4.6 x 1.2	
4038/9		12 01.9	-18 52	SB/IB	10.4	5 x 3 each	"Antennae" interacting galaxies.
4088		12 05.6	+50 33	SABbc	10.6	5.4 x 2.1	
4111		12 07.1	+43 04	SA0	10.7	4.4 x 0.9	
4157		12 11.1	+50 29	SABb	11.3	7.1 x 1.2	
4192	M98	12 13.8	+14 54	SABab	10.1	9.1 x 2.1	
4214		12 15.6	+36 20	I AB	9.8	10 x 8	
4216		12 15.9	+13 09	SABb	10	7.8 x 1.6	
4244		12 17.5	+37 49	SA cd	10.4	17 x 2	
4254	M99	12 18.8	+14 25	SAC	9.9	4.6 x 4.3	
4258	M106	12 19.0	+47 18	SABbc	8.4	20 x 8	
4274		12 19.8	+29 37	SBab	11.3	6.7 x 2.5	NGCs 4278/83/86 are in the same field.
4303	M61	12 21.9	+04 28	SABbc	9.7	6.0 x 5.9	
4321	M100	12 22.9	+15 49	SABbc	9.3	6.2 x 5.3	
4374	M84	12 25.1	+12 53	E1	9.1	5.1 x 4.1	
4382	M85	12 25.4	+18 11	SA0	9.1	7.5 x 5.7	
4388		12 25.8	+12 40	SA0/a	10.2	8.9 x 3.6	
4406	M86	12 26.2	+12 57	E3	8.9	12 x 9	

NGC #	Messier #	RA	DEC	Type	Magnitude	Angular Size (arc minutes)	Notes
4414		12 26.4	+31 13	SAc	10.1	4.4 x 3.0	
4449		12 28.2	+44 06	I Bm	9.6	5.5 x 4.1	
4472	M49	12 29.8	+08 00	E2	8.4	8.1 x 7.1	
4490		12 30.6	+41 38	SBd p	9.8	6.4 x 3.3	
4486	M87	12 30.8	+12 24	E0-1	8.6	7.1 x 7.1	
4494		12 31.4	+25 47	E1-2	9.8	4.6 x 4.4	
4501	M88	12 32.0	+14 25	SAb	9.6	6.1 x 2.8	
4517		12 32.8	+00 07	Scd	10.4	9.9 x 1.4	
4526		12 34.0	+07 42	SAB0	9.7	7.1 x 2.9	
4535		12 34.3	+08 12	SABc	10	7.1 x 6.4	
4548	M91	12 35.4	+14 30	SBb	10.2	5.0 x 4.1	
4552	M89	12 35.7	+12 33	E	9.8	3.4 x 3.4	
4559		12 36.0	+27 58	SABc	10	12 x 5	
4565		12 36.3	+25 59	Sab	9.6	14 x 2	
4567/8		12 36.5	+11 15	SAbc	11	3 x 2 each	Interacting galaxies.
4569	M90	12 36.8	+13 10	SABab	9.5	10 x 4	
4579	M58	12 37.7	+11 49	SABb	9.7	5.5 x 4.6	
4605		12 40.0	+61 37	SBcp	10.3	6.4 x 2.3	
4594	M104	12 40.0	-11 37	SA	8	7.1 x 4.4	
4621	M59	12 42.0	+11 39	E5	9.6	4.6 x 3.6	
4631		12 42.1	+32 32	SBd	9.2	16 x 3	
4649	M60	12 43.7	+11 33	E2	8.8	7.1 x 6.1	
4656/7		12 44.0	+32 10	SBm p	10.5	20 x 3	
4699		12 49.0	-08 40	Sab	9.5	4.4 x 3.2	
4725		12 50.4	+25 30	SABab	9.4	10 x 8	
4736	M94	12 50.9	+41 07	SAab	8.2	13 x 11	
4762		12 52.9	+11 14	SB0	10.3	9.1 x 2.2	
4826	M64	12 56.7	+21 41	SAab	8.5	9.2 x 4.6	
5005		13 10.9	+37 03	SABbc	9.8	5.8 x 2.8	
5033		13 13.4	+36 36	SAc	10.2	10 x 5	
5055	M63	13 15.8	+42 02	SAbc	8.6	14 x 8	
5194/5	M51	13 29.9	+47 12	SAbc	8.4	8 x 7	
5236	M83	13 37.0	-29 52	SABc	7.6	16 x 13	
5457	M101	14 03.2	+54 21	SABcd	7.9	26 x 26	
5746		14 44.9	+01 57	SA?b	10.3	6.8 x 1.0	
5907		15 15.9	+56 20	SAc	10.3	12 x 2	
6503		17 49.4	+70 09	SACd	10.2	7.3 x 2.4	

