

The Objective View

Newsletter of the Northern Colorado Astronomical Society

July 2004

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July 2004 closure for construction
<http://www.starkids.org>

Cheyenne Astronomical Society, Cheyenne Botanical Garden
July 16 7 pm
<http://home.bresnan.net/~curranm/>

Open House, Chamberlain Observatory, dusk to 10 pm
Jul 24, Aug 21, Sep 18 303 871 5172
<http://www.du.edu/~rstencel/Chamberlin/>

Longmont Astronomical Society
July 15 7 pm Longmont Christian School, 550 Coffman St
<http://longmontastro.org/>

Next Meeting: July 1 7:30 PM

University of Arizona Astronomy Camp and AAS Meeting Highlights

Max Moe, NCAS Vice President

NCAS Business at 7 PM

Meeting directions Discovery Science Center
703 East Prospect Rd, Fort Collins
<http://www.dcsm.org/index.html>

In Fort Collins, from the intersection of College Ave and Prospect Rd, head East about 1/2 mile. See the Discovery Center sign to the South. Enter the West Wing at the NE corner. From I-25, take Exit 268, West to Lemay Ave, continue West 1/2 mile, see Discovery Center on the left.

NCAS Programs

August 5 Steve Lee Mars Rover Update

Rocky Mountain National Park Starwatching 2004

Site is the end of the Upper Beaver Meadows road, starting at dusk. Ranger Jeff Maugans plans to add New Moon weekends. Summer 2004 dates: July 9, 16, 23. August 6, 13, 20. Contact Dan Laszlo if you are interested as a volunteer, djlaszlo@aol.com, 970 498 9226.

NCAS Dark Sky Star Party Dates

July 9, 10, 16, 17

Cactus Flats site is on undeveloped parcel of prairie about 6 miles West of Briggsdale. Take Colo Hwy 14 East from I-25 (Exit 269). Go 19 miles East to Ault. Continue 18 miles East of Ault. At County Rd 65 (Milepost 170), turn North, go one mile. Site is through the wire gate on the right, no road, close gate and set up. Beware of the cactus. The site is now officially wheelchair accessible, but there are no facilities so bring essentials. Call **Tom Teters**, tomt@starmon.com, with questions about star party status or dates, 482-5702.

Other Events

Little Thompson Observatory Star Night, Berthoud

About Our July 1 Speaker

Max has finished his senior year at Heritage Christian and will attend the University of Colorado this August. He is an active visual observer and has a strong interest in astrophysics. He was accepted a second time for participation in the University of Arizona Summer Astronomy Camp in 2004. He was awarded First Place honors as the Astronomical League's National Young Astronomer Award in 2003. He has contributed to NCAS as a frequent volunteer at public star parties, and scheduling speakers for our monthly programs. He has recently teamed with Rodney Howe on photometry of variable stars.

June 3 Program

The Mystery of High Energy Cosmic Rays:

The Pierre Auger Observatory

By Dr. Pablo Bauleo

CSU Associate Astronomer

Ninety years ago, Victor Hess measured radiation with a particle chamber in his balloon. To his surprise, his counts increased at 5000 meters elevation, indicating penetrating radiation was coming from space. Robert Millikan labeled them cosmic rays. In 1932, Pierre Auger used a pair of rapid electronic detectors to discover the large air showers produced by cosmic rays. If the spacing between detectors was increased from 50 meters to 1 km, counts were unchanged. He also was surprised to learn that the energy of cosmic rays was over a million times higher than particles from radioactive sources in the lab. The cosmic ray spectrum covers 13 orders of magnitude in energy over which the flux varies by 32 orders of magnitude. We are interested in the highest energy end of the spectrum. The particles at the end of the spectrum are very interesting as there is no good explanation for such enormous energy. The energy is so high that they suffer little deflection by magnetic fields in space – they must come from beyond the galaxy and they should point back to their source. But these cosmic are extremely rare – one per square km per century. A number of events above 10^{20} eV have been seen over the past 40 years. There is some evidence that the high energy are not heavy particles, probably mostly protons. At the high end of the spectrum, the energies are macroscopic. Two $\times 10^{20}$ eV = 30 joules, the energy of a laptop falling from shoulder height, or a tennis ball at 40 mph, or a person walking slowly, deep in thought. These protons strike at a rate of 1 per

square km per century. The cosmic background radiation was discovered by Penzias and Wilson in 1962. For particles with energy greater than 5×10^{19} eV, the background radiation impedes their travel like honey. The Greisen, Zatsepin-Kuzmin Cutoff limits the distance to the source of high energy cosmic rays to a few times $50 \times \text{Mpc}$. We have no convincing explanation for cosmic ray energy over 10^{20} eV

They are traveling at 99. (33 9s) times the speed of light. Only a handful of these events have been detected. One was caught by the Fly Eye detector in Utah. The source must be relatively nearby, but no sources have been identified. The track should point back to its source, with so few, we don't know if the sources are in few directions or widely scattered around the sky. The Auger Collaboration teams 16 countries, 50 institutions, and over 250 scientists. A primary cosmic ray initiates a shower. The shower particles can be detected on the ground at 1500 meters elevation, and they trigger nitrogen fluorescence in the air at about 20 km. Malargue, Argentina is the first site and is 1/3 complete. A second site will be selected soon in Utah or Colorado. The Malargue site is about 35 miles across. It will have 1600 detector stations spaced 1.5 km apart. Around the perimeter are 4 telescope enclosures, each with 6 telescopes which monitor the air on clear nights. The detector stations will perform shower front timing, which is analyzed to give shower direction. The number of particles will give the total energy. The particle species will give the primary chemical composition. If the weather is clear, the Moon is down, the telescopes will detect fluorescence. The light will be like a 25 W lamp, 20 km away, in UV A. It lasts about 20 microseconds. Each telescope has a 30x30 degree field, so 6 give 30x180 degree coverage. Each telescope is 3.4 meters diameter, composed of hexagonal segments. They are a modified Schmidt camera, with an array or 440 photomultiplier tubes at focus. They can produce 10 million photos per second. Events lasting over 250 microseconds are rejected, eliminating stars and airplanes. The Schmidt corrector is a segmented ring which gives 2.2 meter aperture. An event seen by 2 telescopes can be reconstructed in stereo. The direction can be determined with a precision of 0.1 degree. The Surface Detector Units are plastic tanks filled with 12 tons of ultrapure water. Particles are detected by Cerenkov effect by 3 nine inch PMTs. Units are solar powered. Total cost to build and deploy is \$23,000 each. The Auger Center Building houses central data processing, staff offices, and a visitor center. Local landowners are involved in deployment of the units on the plains. The tanks each have a name and history. They coexist with cows, goats, and burrowing rodents. One US candidate site is near Lamar CO, about 3 hours drive from Denver. Pablo has surveyed the site at Pruitt Mound and would be pleased to see it selected. In 20 years of operation, he hopes for 2000+ events to analyze. For more information, see <http://www.auger.org/>

NCAS Business, June 3 2004

President Dan Laszlo called the meeting to order. Brad Jarvis announced the upcoming Mars Society meeting. Nate Perkins gave the treasurer's report. Lee Gregory has obtained a number of astronomy books, including a German text Rukl Atlas of the Moon, and the Consolidated Lunar Atlas on CD. Donald Willson brought Astronomy Magazines to donate. Andrea Schweitzer brought handouts from the AAS meeting in Denver. Dan Laszlo announced dates for Rocky Mountain National

Park. Joe Robinson provided park passes and is available for questions, 586 1372.

International Space Station Transits Sun During Venus Transit

Yesssssss !!!

I put out a request on the VT2004 list for help regarding the ISS/Venus simultaneous transit, and this morning got an advice that someone in Slovakia managed a capture!

You can see it here.....

<http://www.vt-2004.org/photos/images/vt-photo-01-toma.jpg>

Excellent work by Tomas Muraska....congratulations to him ;O)

John Locker

<http://www.satcom.freemove.co.uk/>

<http://www.satcom.freemove.co.uk/geos.htm>

<http://www.satcom.freemove.co.uk/isstrans.htm>

From Tom Fly:

http://www.esa.int/esaHS/SEMBBK3VQUD_iss_0.html

It states, "Few of the images of this unusual astronomical event will have been as unique as those taken by Tomás."

In fact, apparently none are; nor is there any guarantee that during the Venus transit of 2012, the orbit of the ISS will be favorably aligned, relative to the Earth's terminator, even to allow such a photo / video; so Tomás' photo may be IT, now and forever.

Hopefully, of course, something grander will be in the skies during the transit of Venus in 2138, though it's not unlikely that anyone reading this will see it...

Probably the most charming aspect of this story is that, after all of my efforts, and those of Arnold Barmettler / CalSKY, to precisely forecast the ISS / Venus transit path, Tomás was merely trying to get a video of the ISS passing across the Sun coincident with Venus, SOMEWHAT NEAR Venus! When he saw that his Uncle's home was within the ISS / Sun transit path, that was where he went.

So, Tomás' video, which gives an impression (quoting Ted Molczan) of:

"A beautiful display of celestial mechanics, resulting from a considerable knowledge of what's under the hood." *

in fact had as much to do with where his Uncle happened to buy a house!...

* And, I might add, brilliant software engineering!

"As with life in general, luck plays a big part in the pursuit of transits ;-)"

<http://www.satobs.org/seesat/Jun-2004/0257.html>

Currently, there also appears to be some confusion regarding the accuracy of the predictions, (and some ironies, as well!).

As late as my final predictions of June 7, I'd been trumpeting the superiority of the MCC generated TLEs (at least, when they're not too old) that I use for my transit alerts, over the OIG TLEs that CalSKY presently uses (when they're nearer in time to the event than an available MCC TLE).

However my finding, after the fact- using Rob's SkyMap 6.6, which normally is in extremely close agreement with my WorldView-generated ground tracks- is that the MCC computed track was about 225 meters SSE of the actual path, while a likely OIG computed ground track would have been about 140 meters NNW of the actual path; Tomás' uncle's patio was only about 65 meters NNW of the actual path!

And in fact, for about 25 milliseconds, the main solar panels of the ISS- as well as a bit more of it- passed directly between Tomás, Gitka, and Zuzka, and the planetary disk of Venus!

<http://iss-transit.sourceforge.net/MissionAccomplished.html>

However, Arnold is indicating that, by his computations, the MCC TLE would have predicted a dead-hit from Tomás' location (and thus was 67 meters NNW of the actual path), while the OIG TLE nearest to the event (which actually corresponds to a time about 68 seconds after Tomás' observation, and so would not have been available for predictive purposes) would have predicted a path 2.4 Venus's (312 meters) NNW of the actual path.

<http://eclipse.astronomie.info/transit/venus/isstransit/historicallimage.html>

By my analysis of Tomás' MapQuest map (combined with his transit photo), which was generated from CalSKY's prediction, the CalSKY prediction at the time was about 97 meters NNW of the actual transit path.

The relevant TLEs are:

ISSmcc
1 25544U 98067A 04159.51929753 .00020000 00000-0
20000-3 0 9009
2 25544 51.6330 15.0298 0005537 207.1571 152.9300
15.68796178 36803
ISSoig1
1 25544U 98067A 04160.18136574 .00014863 00000-0
13184-3 0 9471
2 25544 51.6330 11.6482 0005508 205.6040 296.1391
15.68807781316908
ISSoig2
1 25544U 98067A 04160.34703704 .00014830 00000-0
13154-3 0 9486
2 25544 51.6332 10.8038 0005500 206.3688 151.6668
15.68812729316928
ISSoig3
1 25544U 98067A 04160.42390752 .00014992 00000-0
13290-3 0 9491
2 25544 51.6329 10.4117 0005395 206.7073 225.7658
15.68815833316945

The observer location data is:
48.2579° N (i.e., 48°15'28.6" N); 17.0272° E (i.e., 17°01'38" E);
elevation 208 meters (relative to the WGS84 ellipsoid).
Some people may be interested in running this thru Guide 8.0,
The Sky, etc., to see how their results compare.

Walter Nissen had pointed out the coincidence of the date of the Venus transit: ("Two, Four, Six, Eight . . .)
2004-06-08, and noted that Venus was in transit across the face of the Sun at:
y m d h m s
2004-06-08 10 12 14.16182022... UTC

Russell Eberst subsequently pointed out the "double coincidence" that last year, Mercury was in transit at:
y m d h m s
2003-05-07 09 11 13.15171921...

SL 12 Rocket Decay Observed June 26 2004 in PA, ON

I may have just seen my first satellite re-entry or it was the most incredible fireball I could imagine. I saw, at first, 3 objects burning very bright and leaving long smoke trails behind them. They started in the NW and were heading East. When I first saw them they were about 20 degrees above the horizon. The objects broke up into many smaller pieces, approximately a dozen, each with its own tail. I watched the pieces until they burned out very close to Deneb. They burned for about a 60 degree span.

This took place at 10:54 local time(02:54 UTC). My location is 39.6731N 75.7239W . At first I thought it may be a Bootid meteor but it was nowhere near the radiant. If anyone could help identify this I would be grateful. Scott D

=====

I believe I may have observed this event. Unfortunately I am quite new to this and caught it quite by chance as I stepped outside. I was around 22:50 or 55 EDT / 02:50UT. I caught a group of 3-4 meteor like objects at 260 degrees by 30 elevation. They were getting quite bright by the time they went behind a tree and when they reappeared at 180 degrees by 20 elevation it was a long and bright trail of multiple objects. I was in a poor position to see much of it due to trees and in my lack of experience have no doubt left out some important info but would be happy to offer any further info if I am able.

My coordinates are: 43.6485° N, 79.5818° W - N43.38.910000, W79.34.908000

Elevation: 141 meters (464 feet)
Brian C Toronto (Etobicoke) Ontario Canada

=====

A report from NY state from another list.
While sitting around the fire in the backyard tonight I noticed what appeared to be a satellite reentry. It happened about 2:53UT 27Jun04, observed from 76.9W 42.1N. It was first observed at about 225 az, 40 el, traveling due east. The speed was consistent with a reentry. There were about 5 separate pieces, three fainter ones which lasted the longest finally disappearing at about 120 az, 30 el. The brightest piece was lagging behind the three fainter pieces by about 5

degrees, with a star like point trailing by a couple of degrees. All the objects passed a few degrees above the 1st quarter moon.
Author not available

Definitely, I saw the same thing... while at Lehigh Valley Amateur Astronomy Society's monthly public star party in Allentown, PA, about 20 to 30 of us saw it, too...
At first, I thought it was an airplane with its landing lights on, but it had a grainy sparkly contrail. So I thought it was the beginning of a fireworks finale slowly rising rocket above the trees and it had a few companion rockets... but it just kept rising and rising very nearly past zenith and to the other side of the sky... it seemed to be breaking up as it went on, maybe 10 to 15 pieces - some moving ahead of the others and some showing flare brightening for a few seconds. All in all it was exactly like videos that we all on TV on the space shuttle reentry disaster videos in Texas, only not as brilliant. The event would not be even noticed in the daylight. The brightest objects were about -2 or -3 magnitude. I wish I had a video camera to keep a record... it was so exciting. I looked at my watch when it was over... It was 10:54:45 EDT. The speed was a bit faster than most all satellites, starting in the WSW, getting to about 80 degrees (South) and dimmed quit a bit when it headed to the horizon at ESE.

Terry P, Allentown, PA 40.5700N, 75.4480W
=====

What an awesome show that was! Three of us saw it too except it was more like 7-8 fireballs. We picked them up in the handle of the Big Dipper (trees block the rest of the West sky), and watched them through Draco, Lyra and Altair (roughly, I was too excited to pay close attention to exact location). Lasted about 45 seconds and ended at 22:52 EDT June 26, 02:52 June 27 UTC. Fantastic sight, better than Raduga 33. Especially since we were just sitting around BSing and was totally unexpected!

Bill M
42.072N 80.143W
=====

This image on Mark Wade's Astronautix.com site is said to show the BOZ ullage motor system:

<http://www.astronautix.com/graphics/0/11d68det.jpg>

It appears to be visible on the image on this page also:

<http://www.astronautix.com/engines/rd58.htm>

I guess the BOZ is jettisoned in some way, separated from the main stage? All of those nozzles would explain multiple fireballs pretty well.

Ed C - ecannon@mail.utexas.edu - Austin, Texas, USA
=====

In fact, there are two BOZ engine clusters that get ejected from the Proton upper stage on each launch. There are often catalogued as the E and F objects in the international designations. This one was the first of the two to reenter, the other one is still in a 198 x 21895 km x 46.7 deg. orbit.

Dan Deak
=====

Thanks to Dan Deak, I realized what I was seeing at 22:51 pm EDT June 26 (2:51 UT June 27) when SL-12 went blazing through our northeastern skies. Several dozen people at our star party (Wagman Observatory, 40.626 N, 79.813 W

Pittsburgh, PA, USA) got to see their first satellite re-entry. Due to a technical error on my part, I was not anticipating a pass of SL-12 at that time. Obviously, it does not matter if a re-entering object is in the Earth's shadow or not, so I should have output ALL passes instead of just the VISIBLE passes :-). But even if I had been anticipating it, it was so exciting that I would not have been able to make any useful observations. All I noted was three bright pieces with the naked eye, several other pieces visible in binoculars breaking off of the main chunk, and reaching 20 or 25 degrees elevation in the northeast. Also, this was about 6 to 7 minutes earlier than predicted with the elsat posted by Ed Cannon (epoch 04178.90776223). Amazingly, I and two other of our most active observers have something like 80 to 100 years of combined observing experience, yet this is our first satellite re-entry. Time to find a better observing location than continuously-cloudy southwestern Pennsylvania!
Sincerely, John H JWHoltz@aol.com
=====

I saw something, that appeared to be the reentry. I did not know that anything was due to reenter but while I was out looking at sats I saw something that looked to be a possible reentry. At about 2:55Z (or just before) something in the north caught my attention. Blazing across the sky was multiple burning objects. When I first saw them they were near the north star and they continued toward the east, and disappeared due east. I was not paying close attention to time or position while I was watching such a sight but I think they may have been just above the north star when I first saw them and might have reached about 50 degrees max elv. I'd estimate it took close to 15 seconds to go from the north to the east. The trajectory seemed to match 22273 but from the elset below it should have passed to my southwest about 75 degree elv. Since it was 5 minutes or so early that would have changed it.

A notable characteristic of these fireballs was that they were not just bright objects trailing fire, but had a glow or haze around them. There also was not a lot of continuous bright fireballs. Its not the easiest to make a picture with words but it was not like the bright sharp meteors with thin trails. My first decay sighting. AWESOME!
Floyd W Lebanon PA 40.39N -76.42W

Cassini Orbital Insertion Event at LASP

--- Steve Albers <Steve.Albers@noaa.gov> wrote:
The Cassini Saturn Orbital Insertion is being shown live, the evening of June 30th at LASP in Boulder. More info is at: <http://lasp.colorado.edu/soi/index.html>

Space Suits Anyone?

From Tom Teters:

With the recent success by civilians to make t o'space'. It just may be time to work on the accouterments.
http://www.spacetoy.com/index.php?session_id=1088052232584&submit=true&category=Space_Suits

Binoculars for Sale

11x80 binoculars in excellent condition, with caps and case.
\$145. Contact RESeline@aol.com

URL for Clear Sky Clocks for Colorado

http://cleardarksky.com/csk/prov/Colorado_clocks.shtml

Best Looks

Moon	By Venus 7/13, 14 By Mars 7/18 By Mercury 7/19 By Jupiter 7/20, 21
Mercury	Less than 1/2 degree from Mars 7/10 dusk
Venus	In E predawn. By Aldebaran 7/4, 5
Mars	Difficult in WNW at dusk
Jupiter	High in W evenings
Saturn	Low in NE predawn at month's end
Uranus	In Aquarius predawn
Neptune	In Capricornus predawn
Pluto	In Serpens Cauda late evenings

From: Dan Laszlo
2001 S Shields St Building H
Fort Collins CO 80526

TO:

International Space Station Passes for Loveland – Fort Collins

July 2004

Date	Mag	Starts Time	Max. Altitude				Ends Time	Alt	Az	
			Alt	Az	Time	Alt				
29 Jun	-0.0	02:59:27	53	NE	02:59:27	53	NE	03:01:53	10	NE
29 Jun	1.9	04:32:51	10	WNW	04:34:47	16	NNW	04:36:44	10	NNE
30 Jun	1.1	03:27:09	21	WNW	03:28:11	26	NNW	03:30:47	10	NNE
01 Jul	1.4	02:23:04	27	NE	02:23:04	27	NE	02:24:40	10	NE
01 Jul	2.2	03:55:58	10	NW	03:57:42	14	NNW	03:59:26	10	NNE
02 Jul	1.5	02:50:39	22	NW	02:51:00	22	NNW	02:53:28	10	NNE
02 Jul	2.6	04:26:42	10	NNW	04:27:22	11	N	04:28:03	10	N
03 Jul	2.1	01:46:26	17	NE	01:46:26	17	NE	01:47:21	10	NE
03 Jul	2.4	03:19:00	10	NW	03:20:31	13	NNW	03:22:02	10	NNE
03 Jul	2.8	04:56:10	10	N	04:57:04	11	N	04:57:57	10	NNE
04 Jul	1.9	02:13:52	19	NNW	02:13:52	19	NNW	02:16:02	10	NNE
04 Jul	2.8	03:49:39	10	NNW	03:50:09	10	N	03:50:39	10	N
05 Jul	2.5	01:09:31	13	NE	01:09:31	13	NE	01:09:54	10	NE
05 Jul	2.6	02:41:56	10	NW	02:43:13	12	NNW	02:44:32	10	NNE
05 Jul	2.8	04:18:41	10	NNW	04:19:47	11	N	04:20:52	10	NNE
06 Jul	2.3	01:36:46	17	N	01:36:46	17	N	01:38:29	10	NNE
06 Jul	2.9	03:12:24	10	N	03:12:49	10	N	03:13:14	10	N
06 Jul	2.4	04:47:08	10	NNW	04:49:16	17	NNE	04:51:24	10	ENE
07 Jul	2.6	00:32:11	11	NE	00:32:11	11	NE	00:32:20	10	NE
07 Jul	2.8	02:04:46	10	NNW	02:05:51	11	N	02:06:55	10	NNE
07 Jul	2.9	03:41:05	10	NNW	03:42:22	12	N	03:43:41	10	NE
08 Jul	2.4	00:59:01	16	NNW	00:59:01	16	NNW	01:00:49	10	NNE
08 Jul	3.0	02:34:55	10	N	02:35:23	10	N	02:35:51	10	NNE
08 Jul	2.2	04:09:29	10	NNW	04:11:47	20	NNE	04:14:05	10	ENE
08 Jul	2.0	23:53:29	18	NNE	23:53:29	18	NNE	23:54:39	10	NNE
09 Jul	3.0	01:27:30	10	NNW	01:28:21	11	N	01:29:11	10	N
09 Jul	2.8	03:03:22	10	NNW	03:04:52	13	NNE	03:06:23	10	NE
09 Jul	0.5	04:38:02	10	NW	04:40:57	46	NNE	04:43:52	10	ESE
09 Jul	1.2	21:08:56	10	SSE	21:10:13	12	SE	21:11:30	10	ESE
09 Jul	-0.3	22:42:24	10	WSW	22:45:21	60	NNW	22:48:19	10	NE
10 Jul	2.6	00:19:37	10	NW	00:21:20	14	NNW	00:23:04	10	NNE
10 Jul	3.1	01:57:14	10	N	01:57:51	10	N	01:58:28	10	NNE
10 Jul	2.0	03:31:44	10	NNW	03:34:12	22	NNE	03:36:39	10	E
10 Jul	-0.5	05:06:55	10	WNW	05:09:49	46	SW	05:12:43	10	SSE
10 Jul	-0.5	21:35:56	10	SSW	21:38:46	44	SE	21:41:40	10	ENE
10 Jul	1.9	23:11:58	10	W	23:14:24	22	NNW	23:16:52	10	NNE
11 Jul	3.0	00:50:08	10	NNW	00:50:45	10	N	00:51:22	10	N
11 Jul	2.7	02:25:33	10	NNW	02:27:16	14	NNE	02:28:58	10	NE
11 Jul	-0.1	04:00:17	10	NW	04:03:15	58	NE	04:06:13	10	ESE
11 Jul	0.3	22:04:43	10	WSW	22:07:36	47	NNW	22:10:31	10	NE
11 Jul	2.8	23:42:09	10	NW	23:43:40	13	NNW	23:45:11	10	NNE
12 Jul	3.0	01:19:23	10	N	01:20:12	11	N	01:21:00	10	NNE
12 Jul	1.6	02:53:53	10	NNW	02:56:29	25	NNE	02:59:04	10	E
12 Jul	-0.2	04:29:14	10	WNW	04:32:00	35	SW	04:34:47	10	SSE
12 Jul	-0.7	20:58:02	10	SW	21:00:58	58	SE	21:03:54	10	ENE
12 Jul	2.2	22:34:22	10	WNW	22:36:39	20	NNW	22:38:57	10	NNE
13 Jul	3.1	00:12:37	10	N	00:13:03	10	N	00:13:28	10	N
13 Jul	2.5	01:47:38	10	NNW	01:49:32	15	NNE	01:50:50	12	NE
13 Jul	2.1	03:28:20	11	ESE	03:28:20	11	ESE	03:22:06	8	NW
13 Jul	0.9	21:26:57	10	WSW	21:29:45	38	NNW	21:32:36	10	NE

Date	Mag	Starts Time	Max. Altitude			Ends				
			Alt	Az	Time	Alt	Az	Time	Alt	Az
13 Jul	2.9	23:04:36	10	NW	23:05:53	12	NNW	23:07:12	10	NNE
14 Jul	2.9	00:41:25	10	N	00:42:26	11	N	00:43:27	10	NNE
14 Jul	2.4	21:56:41	10	WNW	21:58:49	18	NNW	22:00:56	10	NNE
14 Jul	3.0	23:34:56	10	N	23:35:14	10	N	23:35:32	10	N
15 Jul	2.7	01:09:36	10	NNW	01:10:13	13	NNW	01:10:13	13	NNW
15 Jul	2.9	22:26:57	10	NNW	22:28:02	11	N	22:29:06	10	NNE
16 Jul	2.7	00:03:20	10	NNW	00:04:34	12	N	00:05:19	11	NNE
16 Jul	2.5	21:18:55	10	WNW	21:20:52	16	NNW	21:22:49	10	NNE
16 Jul	2.9	22:56:59	10	N	22:57:19	10	N	22:57:39	10	N
17 Jul	2.6	00:31:29	10	NNW	00:32:13	14	NNW	00:32:13	14	NNW
17 Jul	2.8	21:49:12	10	NNW	21:50:03	11	N	21:50:54	10	N
17 Jul	2.5	23:25:09	10	NNW	23:26:34	13	NNE	23:27:30	11	NNE
18 Jul	2.7	22:18:48	10	N	22:19:18	10	N	22:19:48	10	NNE
18 Jul	2.3	23:53:15	10	NNW	23:54:30	17	N	23:54:30	17	N
19 Jul	2.7	21:11:21	10	NNW	21:11:58	10	N	21:12:36	10	N
19 Jul	2.3	22:46:51	10	NNW	22:48:28	14	NNE	22:49:50	11	NE
20 Jul	2.5	21:40:29	10	N	21:41:10	11	N	21:41:52	10	NNE
20 Jul	1.6	23:14:56	10	NNW	23:16:52	23	N	23:16:52	23	N
21 Jul	2.0	22:08:27	10	NNW	22:10:16	15	NNE	22:12:05	10	NE
21 Jul	2.3	23:43:12	10	NW	23:43:55	16	NW	23:43:55	16	NW
22 Jul	2.4	21:02:01	10	N	21:02:56	11	N	21:03:50	10	NNE
22 Jul	0.9	22:36:30	10	NW	22:39:10	28	NNE	22:39:17	28	NNE
23 Jul	1.8	21:29:57	10	NNW	21:31:56	16	NNE	21:33:56	10	ENE
23 Jul	1.3	23:04:47	10	NW	23:06:21	28	NW	23:06:21	28	NW
24 Jul	0.6	21:57:59	10	NW	22:00:43	33	NNE	22:01:45	25	ENE
25 Jul	1.6	20:51:21	10	NNW	20:53:30	18	NNE	20:55:39	10	ENE
25 Jul	-0.4	22:26:17	10	WNW	22:28:51	60	W	22:28:51	60	W
26 Jul	0.2	21:19:22	10	NW	21:22:12	39	NNE	21:24:18	16	E
26 Jul	2.0	22:55:16	10	W	22:56:00	14	W	22:56:00	14	W
27 Jul	-0.5	21:47:41	10	WNW	21:50:37	56	SW	21:51:28	38	SSE
28 Jul	-0.2	20:40:39	10	NW	20:43:35	48	NE	20:46:27	10	ESE
28 Jul	1.6	22:16:54	10	W	22:18:40	15	SW	22:18:40	15	SW
29 Jul	0.0	21:09:01	10	WNW	21:11:52	44	SW	21:14:13	14	SSE
30 Jul	2.0	21:38:36	10	WSW	21:39:54	12	SW	21:41:11	10	SSW