Saguaro Astronomy Club

Metro Phoenix, Arizona

SACNEWS

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The Maunder Minimum:
Some Questions, Some Answers
Peter O. Taylor

"For the space of three years now (the sun) has remained without spots, which at other times, were so frequently to be seen." So wrote the famous Dutch astronomer, Huygens, to his contemporary Hevelius, on September 16, 1658 (Shove, 1983). Strangely, it would be late in the nineteenth century before two well-known solar astronomers, Gustav Spoerer and E.W. Maunder, would describe fully the lull in solar activity that lasted for almost seventy-years, spanning the entire reign of Louis XIV and encompassing the times of Milton and Newton.

During what we now consider to be normal circumstances, the number of sunspots regularly rises and falls in accordance with an average cycle length of approximately eleven years. During cycle "minimum" the numbers often fall to zero, while at "maximum" daily counts have soared to over three-hundred.

Quick Calendar

Saguaro Astronomy Club meeting
Friday, August 23

Deep Sky Subgroup Meeting
Thursday, August 29

Star Party
Buckeye Hills Recreation Area
Saturday, September 7

Was anyone even looking?

Although Spoerer's work (Spoerer, 1887) preceded Maunder's, it is the latter who is generally credited with the most complete description of the strange behavior of the sun in the 17th century. In his second paper on the subject, Maunder (Maunder, 1922) reported the following findings: During the period from 1645 to 1715, only a few spots were seen. For nearly half of this time, 1672 to 1704, no spots were observed on the sun's Northern Hemisphere; and for sixty years, until 1705, there was never more than one group visible at any one time. Thus it appears that the total number of spots for the entire period would have been less than we have come to expect in any one active year since that time.

Did this prolong lull actually occur, or was it a lack of sophisticated equipment, or skilled observers, that only made it seem so? Is there other evidence, from associated, or seemingly unrelated studies, that could confirm its existence? Was anyone even looking? These are some of the fundamental questions that have been asked during the many years that have elapsed since Maunder's time.

Well-known solar physicist, John Eddy, in his analysis of the Maunder Minimum (Eddy, 1976), answered many of these questions. Eddy concluded that the modest equipment that is required for serious sunspot observation was readily available in the 17th century. In fact, drawings of the sun from that era show almost all of the detail that modern drawings show. And of course, the 17th century supported many accomplishments in other areas of astronomy, many by active solar investigators. For example, the first known division in Saturn's ring-system was discovered in 1675, along with five of its moons (1655 to 1684), implying a telescopic resolution of nearly one arc-second. Other examples include Romer's discovery in 1675 of the velocity of light from observations of the orbits of Jupiter's satellites; and transits of Venus and Mercury were recorded, demonstrating a certain familiarity with sunspots and their motions.

Eddy mentions many of the noted astronomers of the day. To name but a few: Flamsteed, Hooke, Halley, Huygens, Hevelius, Romer, Cassini, Grimaldi, and so on; many of whom regularly observed the sun and recorded their observations.

Some supporting evidence for the minimum can be deduced from observations of "naked-eye" sunspot sightings. Reports of sunspots seen without visual aid can be traced back to 28 B.C., and before. These sightings were made when the sun was obscured by heavy haze or smoke, or was low in the sky during early evening or morning hours. (**Note** we now realize that this practice can be highly dangerous, and **must** be avoided.) As naked-eye sightings are relatively rare, the likelihood of their discovery is statistically greatest during times of high sunspot activity. Although a number were observed prior to, and later than the Maunder Minimum, apparently none were recorded during the period from 1639 to 1720 (Kanda, 1933). However, at least two other similar "gaps" do exist in Kanda's compilations.

Additional evidence comes from a generally unrelated field. It concerns the abundance of carbon 14 in tree rings. For technical reasons, we would expect to find a relative abundance of the element when solar activity has been at low levels. During the period of Maunder's minimum this is exactly the case. Increasing amounts do occur that peak in the year 1690 (DeVries, 1958).

Further, both the naked-eye-sunspot and carbon 14 indices correlate extremely well with each other and with long-term auroral activity, a phenomenon closely associated with periods of high sunspot number, and historically viewed with wonder. Aurorae were very rare during the period; far less common than in seventy-year periods previous to, and following the Minimum (Clerke, 1894).

In fact, in his extensive analysis, Eddy found virtually no evidence to dispute the minimum. Thus it appears that the sun did undergo major changes, with possible terrestrial effects, during the 17th century. We are not certain what mechanism could cause such an event to occur. Many explanations have been suggested, ranging from the interaction of secondary and tertiary (or even additional) sunspot cycles, to complex explanations of the physics of the solar dynamo itself.

Perhaps Eddy best summarizes the scenario when he concludes, "the reality of the Maunder Minimum and its implications of basic solar change may be but one more defeat in our long and losing battle to keep the sun perfect, or, if not perfect, constant, and if inconstant, regular."

References

Clerke, A.M. 1894, "Knowledge", 17, 206. DeVries, H. 1958, "Proc. K. Ned. Akad. Wet. B", 61, No. 2, 94. Eddy, J.A. 1976, "Science", 192, 1189. Kanda, S. 1933, "Proc. Imp. Acad. (Tokyo)", 9, 293. Maunder, E.J. 1922, "Jour. Br. Astron. Assoc.", 32, 140. Schove, D.J. 1983, "Sunspot Cycles", Hutchinson Ross Pub. Co., p145. Spoerer, F.W.G. 1887, "Astronom. Gesell. Vierteljahrsschrift", 22, 323.

Comet Comments

by Don Machholz

Two new comets have been discovered and two returning comets recovered recently. Meanwhile, several comets, three of them being in the morning sky, should be visible in our telescopes this month.

Periodic Comet Chernykh (1991o): Jim Scotti and D. Rabinowitz recovered this comet from Kitt Peak on June 8. It orbits the sun every thirteen years, is presently magnitude nineteen, and is not expected to get brighter than magnitude thirteen.

Periodic Comet Shoemaker 1 (1991p): P. Kilmartin and Alan Gilmore recovered this comet from Mt. John Observatory (New Zealand) on June 8. This is its first pass since discovery in 1984 and it is not expected to get brighter than magnitude twelve.

Periodic Comet Machholz

Date	RA-1950-Dec		RA-2000-Dec		Elong	Sky	Mag
07–28	09h20.6m	+28°59'	09h23.5m	+28°47'	16°	E	6.6
07–31	10h00.9m	+28°58'	10h03.8m	+28°43'	22°	E	7.8
08–03	10h39.3m	+27°44'	10h42.1m	+27°22'	27°	E	8.6
08–06	11h15.2m	+25°38'	11h17.9m	+25°22'	33°	E	9.3
08–09	11h48.1m	+22°58'	11h50.6m	+22°42'	37°	E	9.9
08–12	12h17.5m	+19°58'	12h20.0m	+19°42'	42°	E	10.4
08–15	12h43.6m	+16°51'	12h46.1m	+16°35'	46°	E	10.9
08–18	13h06.6m	+13°47'	13h09.1m	+13°31'	49°	E	11.4
08–21	13h26.9m	+10°52'	13h29.4m	+10°36'	52°	E	11.8
08–24	13h44.8m	+08°08'	13h47.3m	+07°53'	54°	E	12.2
08–27	14h00.8m	+05°38'	14h03.3m	+05°24'	55°	E	12.6
08–30	14h15.0m	+03°22'	14h17.6m	+03°08'	56°	E	12.9
09–02	14h27.9m	+01°18'	14h30.5m	+01°05'	57°	E	13.2
09–05	14h39.6m	−00°34'	14h42.2m	−00°47'	57°	E	13.6

Periodic Comet Hartley 2

Date	RA-1950-Dec		RA-2000-Dec		Elong	Sky	Mag
07–28	02h06.5m	+27°23'	02h09.4m	+27°37'	85°	M	11.1
08–02	02h37.5m	+29°15'	02h40.5m	+29°28'	83°	M	10.8
08–07	03h10.8m	+30°41'	03h13.9m	+30°53'	80°	M	10.5
08–12	03h45.7m	+31°36'	03h48.8m	+31°45'	77°	M	10.3
08–17	04h21.3m	+31°53'	04h24.5m	+32°00'	74°	M	10.0
08–22	04h56.6m	+31°33'	04h59.8m	+31°37'	72°	M	9.9
08–27	05h30.6m	+30°38'	05h33.8m	+30°40'	69°	M	9.7
09–01	06h02.6m	+29°15'	06h05.8m	+29°15'	67°	M	9.7
09–06	06h32.3m	+27°30'	06h35.4m	+27°27'	65°	M	9.6
09–11	06h59.4m	+25°30'	07h02.5m	+25°26'	64°	M	9.6

Periodic Comet Wirtanen

Date	RA-1950-Dec		RA-2000-Dec		Elong	Sky	Mag
07–28	04h23.5m	+12°58'	04h26.3m	+13°05'	58°	M	11.6
08–02	04h43.1m	+14°08'	04h46.7m	+14°13'	58°	M	11.4
08–07	05h05.0m	+15°12'	05h07.8m	+15°16'	57°	M	11.1
08–12	05h26.7m	+16°10'	05h29.6m	+16°12'	57°	M	11.0
08–17	05h48.9m	+17°01'	05h51.8m	+17°01'	56°	M	10.8
08–22	06h11.6m	+17°43'	06h14.5m	+17°41'	55°	M	10.6
08–27	06h34.6m	+18°15'	06h37.5m	+18°13'	55°	M	10.5
09–01	06h57.8m	+18°38'	07h00.7m	+18°34'	54°	M	10.4
09–06	07h20.9m	+18°51'	07h23.8m	+18°45'	53°	M	10.3
09–11	07h43.9m	+18°53'	07h46.8m	+18°46'	53°	M	10.2

Comet Levy (1991q): David Levy of Tucson, Arizona discovered this, his seventh visually-found comet, on June 14 in the morning sky. He was using his 16" reflector, and had swept for 81 hours since his previous visual find thirteen months earlier. The comet was near the galaxy

M 74 and at about eight magnitude.

The orbit brought the comet closest to the sun at 0.995 AU on July 7. It will hang in our morning sky for the next few months, dimming to magnitude eleven by mid-October. The comet was in good position for discovery for many weeks before it was actually found, so perhaps it outburst shortly before discovery. I swept the area on June 6 and June 12 without seeing it. At least one other comet hunter swept over it on June 12 under partly cloudy skies.

Comet		**Levy**				**(1991q)**
Date	RA-1950-Dec		RA-2000-Dec	Elong	Sky	Mag
07–28	05h14.4m +35°31’		05h17.4m +35°34’	45°	M	8.1
08–02	05h37.8m +36°17’		05h41.1m +36°19’	45°	M	8.3
08–07	06h00.1m +36°46’		06h03.4m +36°46’	45°	M	8.5
08–12	06h21.2m +36°59’		06h24.6m +36°58’	46°	M	8.6
08–17	06h41.0m +37°00’		06h44.4m +36°57’	46°	M	8.9
08–22	06h59.6m +36°51’		07h03.0m +36°47’	47°	M	9.1
08–27	07h16.9m +36°34’		07h20.2m +36°29’	49°	M	9.4
09–01	07h32.9m +36°11’		07h36.2m +36°05’	50°	M	9.6
09–06	07h47.7m +35°44’		07h51.0m +35°37’	52°	M	9.8
09–11	08h01.3m +35°15’		08h04.6m +35°06’	53°	M	10.0

Comet Helin-Alu (1991r): Eleanor Helin and Jeff Alu discovered this comet on June 13 from Palomar. An early orbit suggests that it was closest the sun at 5.6 AU last March and will not get brighter than magnitude sixteen.

Bits and Pieces

1991 SAC Meetings	**1991 SAC Star Parties**
August 23	September 7
September 20	October 5
October 25	November 9
November 22	December 28
December 14 Party	

Deep Sky Meeting

The Deep Sky meeting will take place on Thursday, August 29 at 7:30pm. All objects in the constellation Cygnus are open for discussion.

Relativity for Small Children:

Time moves slower in a fast moving vehicle.

Directions to SAC Events

SAC General Meetings 7:30 PM at Grand Canyon University, Fleming Building, Room 105 — 1 mile west of Interstate 17 on Camelback Rd., north on 33rd Ave., second building on the right.

SAC Star Parties at Buckeye Hills Recreation Area — Interstate 10 west to Exit 112 (30 miles west of Interstate 17), then south for 10.5 miles, right at entrance to recreation area, one-half mile, on the right. No water and only pit toilets. Please arrive before sunset; allow one hour from central Phoenix.

SAC Deep Sky Subgroup Meeting at John & Tom McGrath's, 11239 N. 75th St., Scottsdale, 998–4661 — Scottsdale Rd. north, Cholla St. east to 75th St., southeast corner.

A First Report on Ektar Films

By Chris Schur

In this article I will write about the first of three of the latest films from Kodak, along with their attributes and possible applications.

At the beginning of 1989 Kodak introduced a new series of films called Ektar. The manufacturer promised that these new films would have ultra fine grain, high sharpness and true vivid colors. Many astrophotographers pounced on these films in hopes that Kodak would regain its lead in color films suitable for astrophotography. In the first six months after Ektar's introduction, a number of mixed reviews slowly trickled out. This prompted me to characterize many of the films attributes and deficiencies for myself.

I evaluated three Ektar films, the ISO 25, ISO 125, and the ISO 1000 emulsions. The results obtained in testing were very encouraging and convinced me that this series of films will have a substantial impact on amateur astrophotography. The trio of speeds allows for the many varied types of astrophotography. The ISO 25 emulsion with its ultra fine grain and high contrast turned out to be ideal for schmidt cameras and fast telephoto lenses when hypered, due to its high sharpness and good red and blue sensitivity. The ISO 125 film's low contrast worked well for objects with a large range of brightness. It hypered moderately well, and is usable with both telephotos and fast prime focus systems. Its real value however became evident in lunar photography where its sharpness, neutral color balance and wide exposure latitude excelled. The ISO 1000 emulsion has surprisingly fine grain compared to the popular ISO 1600 films, and is sensitive to both red and especially blue deep sky objects. Even unhypered, this film provided me with short exposures and less time at the guide scope than with many of the slower films.

To evaluate the three films to determine their characteristics in long exposure astrophotography, a 50mm $f/1.4$ lens was used on a 35mm camera mounted piggyback on a equatorially mounted newtonian. Both the unhypered and hypered films were given the same tests, and developed together for comparable results in Bessler CN2 color negative chemistry at 100 degrees F. Exposures started at one minute, and were double in subsequent exposures until 32 minutes was reached. Also used in the testing were a 135mm $f/2.8$ telephoto lenses, a Celestron 8" $f/1.5$ schmidt camera, and a 14" $f/5$ newtonian.

Ektar 25

I started the evaluations with the slowest of the three films in the series. For most color films, the optimal hypering time occurs when the unexposed frames are slightly darkened by the hypering process with a hypering fog level of about .6 Neutral Density. Longer hypering times will strongly discolor the prints, and shorter times do not achieve maximum film speed. This point occurred in 16 hours at 50 degrees Centigrade at 1 psi pressure with this film. When the hypered versus unhypered negative strips were compared, a speed increase of 8x was apparent in moderate exposure times. The best exposure with the 50mm $f/1.4$ lens on the hypered emulsion was about 8 to 10 minutes. It became evident that the film had a much higher contrast and red sensitivity than the other Ektar emulsions because of the crisp black star images and well rendered emission nebulosities in the rich Cassiopeia star field I used in the test. The grain was invisible with a 10x magnifier on the negatives yielding high hopes for schmidt and telephoto shots.

Next I loaded the hypered film into the schmidt camera and tried 8 to 10 minute exposures on a number of deep sky objects, with a selection of both red emission nebulosities and blue reflection nebulae along with a selection of galaxies and star clusters. We found the results to be excellent. The ten minute exposures yielded crisp colorful images with excellent contrast that brought out internal dark nebula and dust lanes in all types of objects tested. The film responds superbly in both red and blue, crisply recording the Pelican Nebula as well as the brush stroke nebulosity in the Pleiades. The equivalent exposures for $f/2.8$ telephotos puts it in the 30 minute range or so, bringing the fine attributes of this emulsion to the realm of the piggyback wide angle and telephoto lens users. The fine blue and yellow sensitivity of this film also lends itself to high resolution comet photography. The electric blue of a comet's plasma tail and the tawny yellows in the dust component will be well recorded with this contrasty emulsion.

Next month I will cover Kodak Ektar 125. I found that this film had many surprises in store for me.

Newsletter Deadlines

Submissions to the newsletter are to be postmarked on or before the Wednesday, 10 days before the beginning of the month. Don't expect the newsletter editor to take information by phone. If you write down your submission, there is fewer chances of error.

If timely data needs to be included, please say so in your letter and be sure to include your phone number. The editor will contact you before printing the newsletter.

The reason for the seemingly strange deadline is to allow the newsletter editor at least one weekend before the beginning of the month to put together the newsletter. The mailing of the material by the Wednesday will in most cases make sure the editor receives it by that weekend.