Feature Story: ALPO Solar Section

A Report on Carrington Rotations 2199 through 2201 (2017 12 30.9382 to 2018 03 22.9368)

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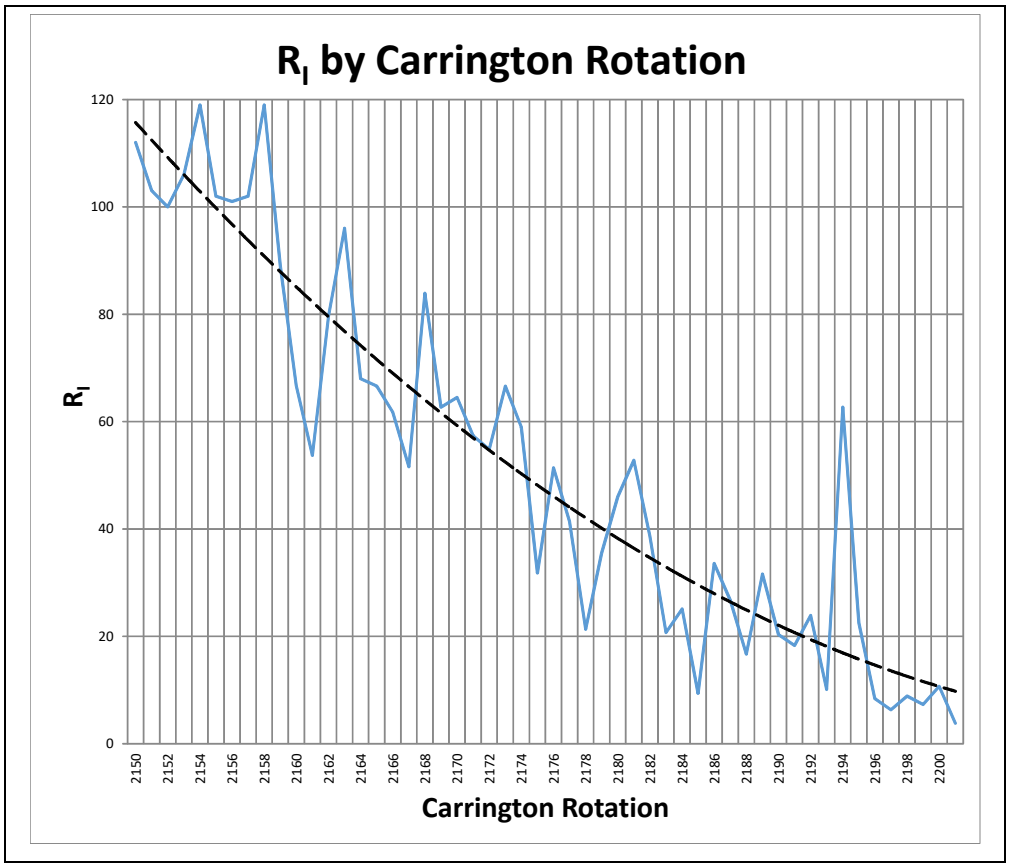
To our hard-copy readers: This paper can be viewed in full-color in the online (pdf) version of this Journal.



Overview

Activity dropped to very low levels during this reporting period as we head for minimum sometime in 2020. These were the lowest levels seen since mid-2009. There was a total of 9 Active Regions designated during the roughly 3 months of this reporting period! The most active and largest Active Region was AR 2699 which got only to 230 millionths of the solar disk, about a quarter the minimum size for it to be a "naked eye" spot. There were 45 days with no sunspots at all. The vast majority of flares during this period were due to AR 2699 but all were A-C class with the strongest being C4.6.

Terms and Abbreviations Used In This Report

While this brief section is similar to the same in earlier reports it should be at least reviewed. As in previous reports, the ALPO Solar Section will be referred to as "the Section" and Carrington Rotations will be called "CRs". Active Regions are designated by the National Oceanic and Atmospheric Administration (NOAA) and will refer to all activity in all wavelengths for that region and will be abbreviated "AR" with only the last four digits of the full number being used. The term "groups" refers to the visible light or "white light" sunspots associated with an Active Region. Statistics compiled by the author have their origin in the finalized daily International Sunspot Number data published by the WDC-SILSO (World Data Center - Solar Index and Long Term Solar Observations) at the Royal Observatory of Belgium. All times used here are Coordinated Universal Time and dates are reckoned from that. Dates will be expressed numerically, with month/day such as "9/6" or "10/23". Carrington Rotation commencement dates are from the table listed on the Section webpage on the ALPO website *http://alpo-astronomy.org/solarblog/wp-content/uploads/ephems/CNSun_2159_2306_A.pdf*

The terms "leader" and "follower" are used instead of "east" or "west" on the Sun to avoid misunderstandings. This follows the "right-hand rule" where, using your right hand, your thumb pointing up is the north pole and the rotation follows the curl of your fingers. Orientation of images shown here will be north up and celestial west to the right (northern hemisphere chauvinism). The cardinal directions (north, south, east, west) if used at all, will be abbreviated as N, S, E and W.

The abbreviation to indicate white-light observations is "w-l", while hydrogen-alpha is "H-a" and calcium K-line is "CaK". "Naked-eye sunspots"

Table 1. Contributors to This Report

Observer	Location	Telescope (aperture, type)	Camera	Mode	Format
Michael Borman	Evansville IN	102mm, RFR	Point Grey GS3	w-l	digital images
		90mm		H-a	
		102mm, RFR		CaK	
Richard Bosman	Enschede, Netherlands	110mm, RFR	Basler Ace 1280		
		355mm, SCT			
Raffaello Braga	Milano, Italy	112mm,RFR	PGR Chameleon mono 2.0	H-a	digital images
Tony Broxton	Cornwall, UK	127mm, SCT	N/A	w-l	drawings
Jean-Francois (Jeff) Coliac	France	30mm, Projection	N/A	w-l	drawings
Gabriel Corban	Bucharest, Romania	120mm, RFL-N	Point Grey GS3-U3	H-a	digital images
				w-l	
Brennerad Damacenco	Sao Palo, Brazil	90mm, MCT	ASI224MC	w-l	digital images
Franky Dubois	West-Vlaanderen, Belgium	125mm, RFR	N/A	visual sunspot reports	
Howard Eskildsen	Ocala, FL	80mm, RFR	DMK41AF02	w-l wedge	digital images
				CaK	
Joe Gianninoto	Tucson, AZ	115mm, RFR	N/A	w-l	drawings
		80mm, RFR		H-a	
		90mm, MCT		w-l, H-a	
Guilherme Grassmann	Curitiba, Brazil	60mm, RFR	Lumenera Skynyx 2.0	H-a	digital images
Richard Hill	Tucson, AZ	90mm, MCT	Skyris 445m	w-l	digital images
		120mm, SCT			
Bill Hrudey	Grand Cayman	200mm, RFL-N	ASI174MM	w-l	digital images
		60mm, RFR		H-a	
David Jackson	Reynoldsburg, OH	124mm, SCT	N/A	w-l	drawings
Jamey Jenkins	Homer, IL	102mm, RFR	DMK41AF02	w-l	digital images
		125mm, RFR		CaK	
Pete Lawrence	Selsey, UK	102.5mm, RFR	ZWO ASI174MM	H-a	digital images
Monty Leventhal	Sydney, Australia	250mm, SCT	N/A	w-l/H-a	drawings
			Canon-Rebel	H-a	digital images
Efrain Morales	Aguadilla, Puerto Rico	50mm, RFR	Point Grey Flea 3	H-a	digital images
German Morales C.	Bolivia	200mm, SCT	N/A	visual sunspot reports	
Theo Ramakers	Oxford, GA	80mm, RFR	ZWO ASI174MM	H-a	digital images
		11 in. SCT	DMK41AU02AS	w-l	
		40mm, H-a PST	DMK21AU03AS	H-a	
		40mm, CaK PST		CaK	
Ryc Rienks	Baker City OR	203mm, SCT	N/A	w-l	drawings
		40mm, H-a PST		H-a	
Chris Schur	Payson, AZ	152mm, RFR	DMK51	CaK	digital images
				w-l (CaK-offband continuum)	
		100mm, RFR	DMK51	H-a	
Randy Shivak	Prescott, AZ	152mm, RFR	ZWO-ASI174	H-a	digital images
Avani Soares	Canoas, Brazil	120mm, RFR	ZWO-ASI 224	w-l	digital images
Randy Tatum	Bon Air, VA	180mm, RFR	DFK31AU	W-L-pentaprism	digital images
David Teske	Starkville MS	60mm, RFR	N/A	W-L/H-a	drawings
			Malincam	W-L	digital images
James Kevin Ty	Manila, Philippines	TV101, RFR	ZWO-ASI 120MM	H-a	digital images
David Tyler	Buckinghamshire, UK	178mm, RFR	ZWO	W-L	digital images
		90mm, RFR		H-a	
Christian Viladrich	Nattages, France	300mm, RFN	Basler 1920-155	W-L	digital images

NOTE: Telescope types: Refractor (RFR), Newtonian Reflector (RFL-N), Schmidt Cassegrain (SCT) Maksutov-Cassegrain (MCT), Meade Personal Solar Telescope (PST).

means the ability to see these spots on the Sun without amplification but through proper and safe solar filtration. As a reminder, you should never look at the Sun, however briefly, without such filtration even at sunrise/set.

Areas of regions and groups are expressed in the standard units of millionths of the solar disk, with a naked-eye spot generally being about 900-1,000 millionths for the average observer. The McIntosh Sunspot Classification used here is the one defined by Patrick McIntosh of NOAA (McIntosh 1981, 1989) and detailed in an article in the JALPO Volume 33 (Hill 1989). This classification system is also detailed by the author on the Section website at *http://www.alpo-astronomy.org/solar/W-Lft.html* in an article on white-light flare observation. This will be referred to as the McIntosh Class. The magnetic class of regions is assigned by NOAA and will be entered parenthetically after the McIntosh class or elsewhere referred to as "mag. class".

Lastly, due to the constraints of publishing, most of the images in this report have been cropped, reduced or otherwise edited. The reader is advised that all images in this report, and a hundred times more, can be viewed at full resolution in the ALPO Solar Archives. This can be accessed by going to the Solar Section webpage and following the Archives link at the top of the right sidebar. You can also go to the Archives through this link: *http://www.alpo-astronomy.org/gallery/main.php?g2_itemId=1699*

Section observers, their equipment and modes of observing are summarized in Table 1 on this page. While not all individuals necessarily contributed to this specific report, they have contributed to recent

reports and are ALPO Solar Section members. This should be used as a reference throughout this report.

References

Hill, R.E., (1989) "A Three-Dimensional Sunspot Classification System" Journal of the Assn of Lunar & Planetary Observers, Vol. 33, p. 10. *http://articles.adsabs.harvard.edu/cgi-bin/nph-iarticle_query?1989JALPO..33...10H&data_type=PDF_HIGH&whole_paper=YES&type=PRINTER&filetype=.pdf*

Livingston, W., Penn, M.; (2008) "Sunspots may vanish by 2015." *https://wattsupwiththat.files.wordpress.com/2008/06/livingston-penn_sunspots2.pdf*

McIntosh, Patrick S., (1989) "The Classification of Sunspot Groups" Solar Physics, Vol. 125, Feb. 1990, pp. 251-267.

McIntosh, Patrick S., (1981) The Physics Of Sunspots. Sacramento Peak National Observatory, Sunspot, NM; L.E. Cram and J.H.Thomas (eds.), p.7.

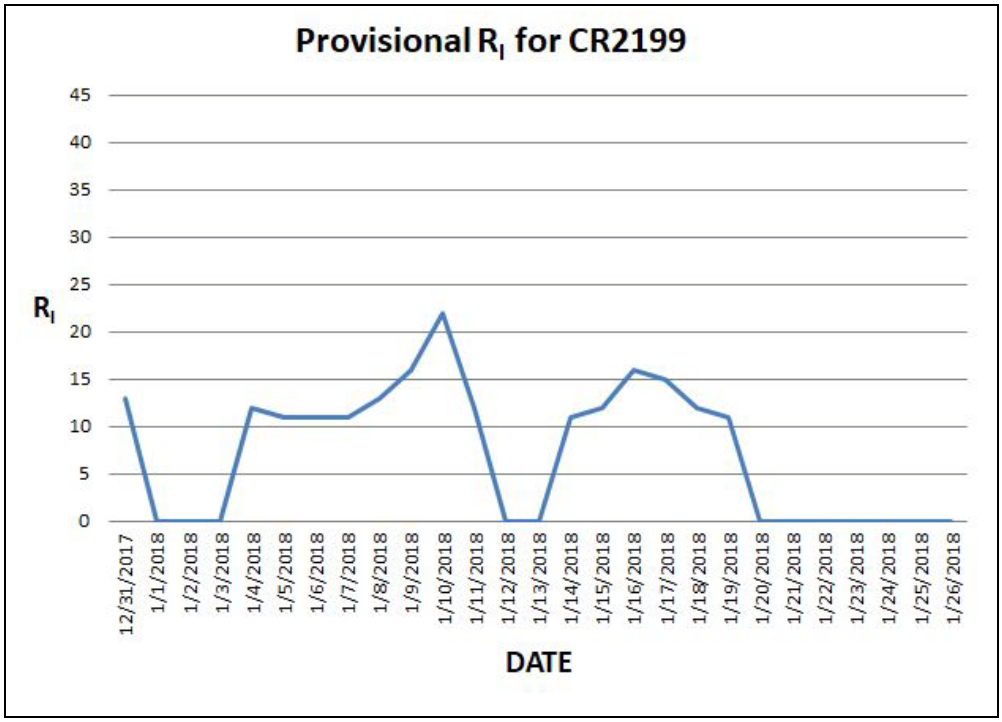
Additional references used in the preparation of this report:

Solar Map of Active Regions
https://www.raben.com/maps/date

SILSO World Data Center
http://sidc.be/silso/home

SILSO Sunspot Number
http://www.sidc.be/silso/datafiles

The Mass Time-of-Flight spectrometer (MTOF) and the solar wind Proton Monitor (PM) Data by Carrington Rotation
http://umtof.umd.edu/pm/crn/



Carrington Rotation 2199

Dates: 2017 12 30.9382 to 2018 01 27.2771

Avg. R_I= 7.3
High R_I = 22 (1/10)
Low R_I = 0 (12 days)

Of the four regions designated during this rotation, none exceeded 30 millionths in area and the one region that did, AR2696, attained that size for only one day. There were 12 days of no sunspots and only a half-dozen flares for the entire rotation!

Even so, there were some notable observations that deserve some mention. A a w-l image by Ramakers (Figure 1) shows the largest group, AR2696, on 1/18, a day after maximum area. It was classed as a Bxo region of 20 millionths area (mag. Beta). An H-alpha image the same day, also by Ramakers, shows the main group in a bright tight plage with a clear E-W magnetic neutral line dividing the plage just above the main spot (Figure 2). The region was preceded by a dark filament. Levinthal noted this filament as a small prominence on the limb on 1/24.

There were several notable prominences seen in this rotation. Both of these observations were by Ramakers as well. The earliest one was on 1/04 and appears to be a tornadic prominence off the SE limb not associated with an active region (Figure 3) and the latter is beautifully detailed prominence image on 1/15 on the NW limb also not associated with a designated active region (Figure 4).

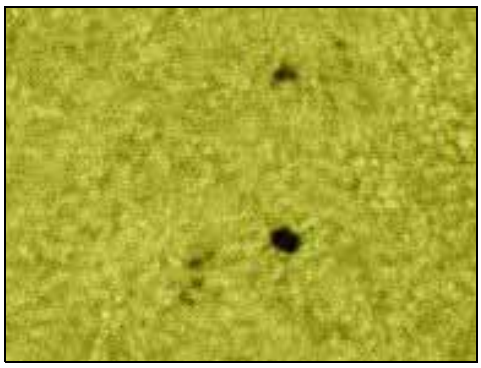


Figure 1. A w-l image of AR 2696 by Ramakers on 1/18 at 16:40 UT.

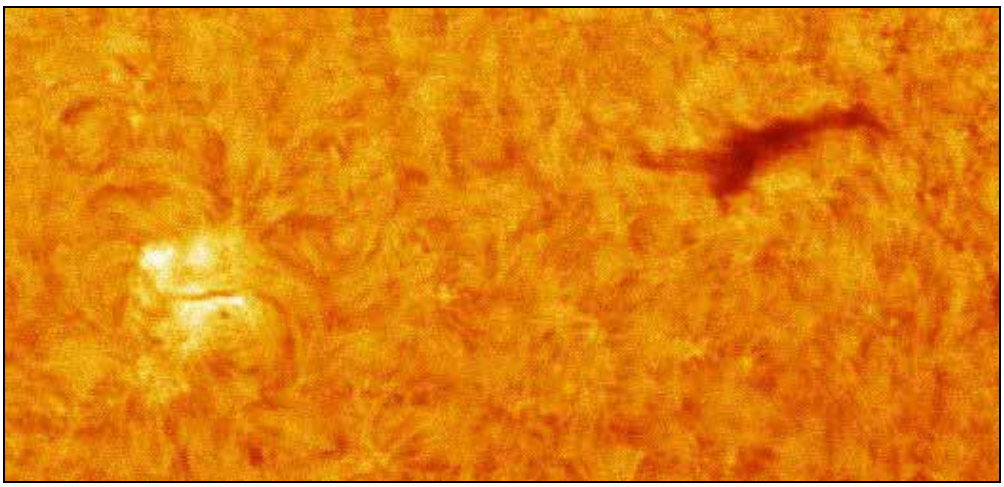


Figure 2. An H-a image of AR 2696 at 1/18 at 16:48 UT by Ramakers.

Figure 3. A Ramakers H-a image of SE limb prominence on 1/4 at 15:19 UT.

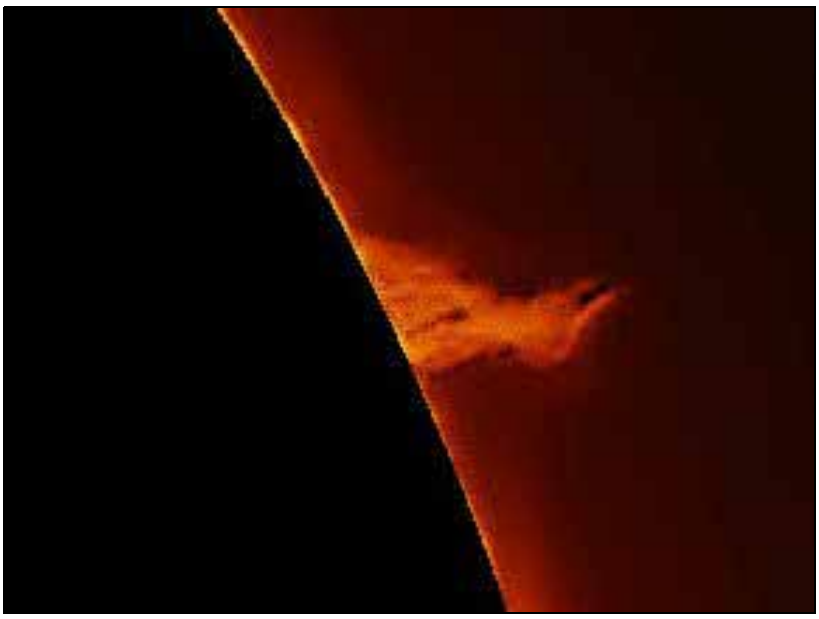
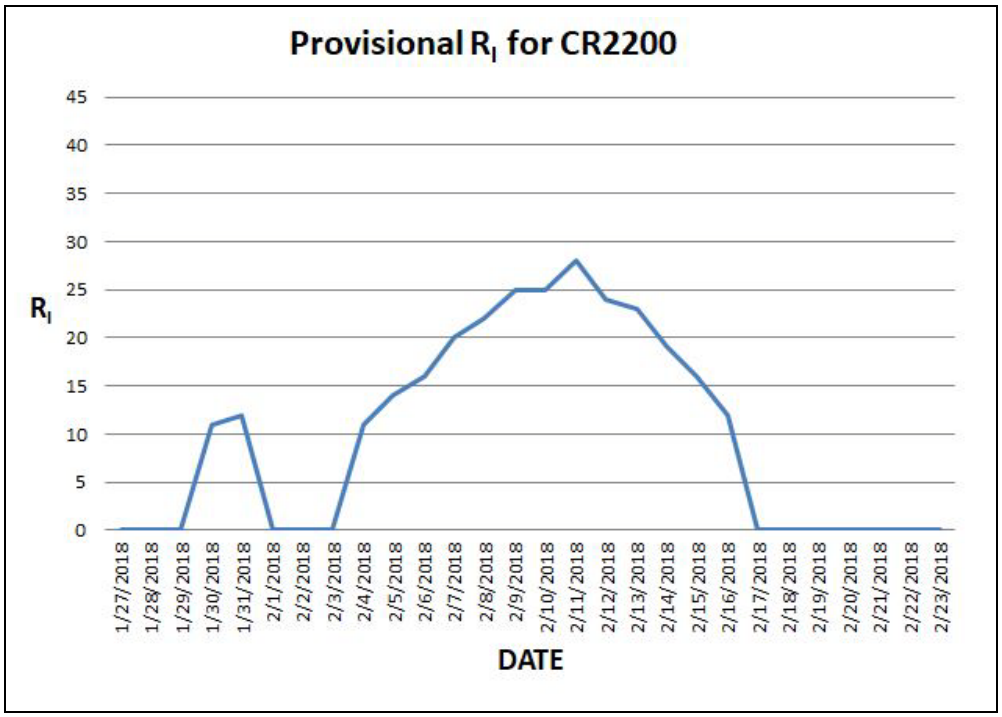


Figure 4. A prominence on the NW limb in H-a by Ramakers on 1/15 at 15:33 UT.



Carrington Rotation 2200

Dates: 2018 01 27.2771 to 2018 02 23.6167

Avg. R_I = 10.7
High R_I = 28 (2/11)
Low R_I = 0 (13 days)

With an average RI of 10.7, this was the most active rotation of the reporting period! There were 13 days with no sunspots at all, one more than the previous rotation and only three active regions of which AR 2699 accounted for the bulk of the activity.

AR 2699 came fully onto the disk on 2/5, though the first hints of it were seen by Grassmann in H-a on 2/4 (Figure 5). We get a good view of the region on 2/5 in a pair of Grassmann H-a images (one online and the other shifted off-line to simulate w-l) that show good activity in the follower portions of the region. The leader was seen to be two large umbrae in one penumbra followed by a small umbra with rudimentary penumbra; this was followed by a N-S arc of about a dozen spots, the northernmost with fragmentary penumbra (Figure 6).

On 2/7, Tyler gives us a good w-l view of this region now classed as Dao (160 millionths, mag. class beta) (Figure 7). The two umbrae in the leader were merged into a N-S-oriented mass in one well-organized penumbra, followed by a small middle spot that was a few tiny umbrae in rudimentary penumbra. There was a curious white arc in the photosphere following this leader that was parallel to the edge of its penumbra. The follower consisted of one large spot that was four or five umbrae in one penumbra with an arc of umbral spots and fragmentary penumbrae originating from the following side of the follower spot arcing to the N, ending at the middle spot. During the previous 48 hours there had been over 40 flares all of A-C class.

We got another good comprehensive look at this region on 2/9 in quasi-w-l, H-a and CaK images by Grassmann (Figure 8). At this time, it was classed as Dai (200 millionths, mag. class beta-gamma). The "quasi-w-l" is again an off-line continuum image through the H-a filter. In that image, the leader umbra had split into four pieces with a bright E-W light bridge running through them. In the middle

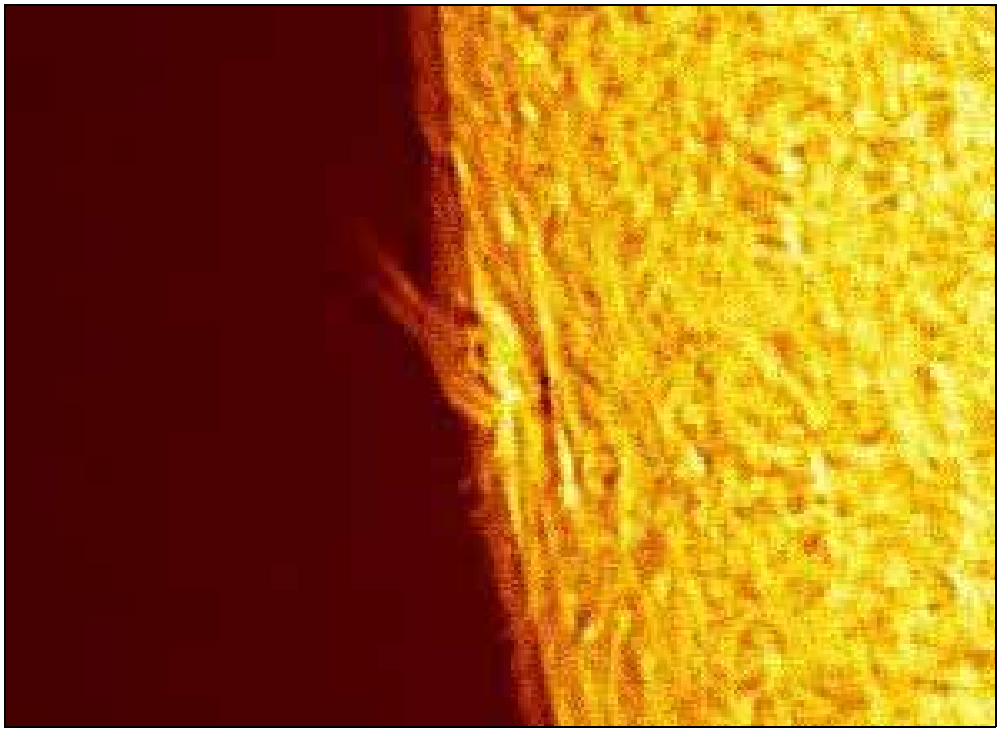


Figure 5. An H-a image of AR 2699 on 2/4 at 12:00 UT by Grassmann.

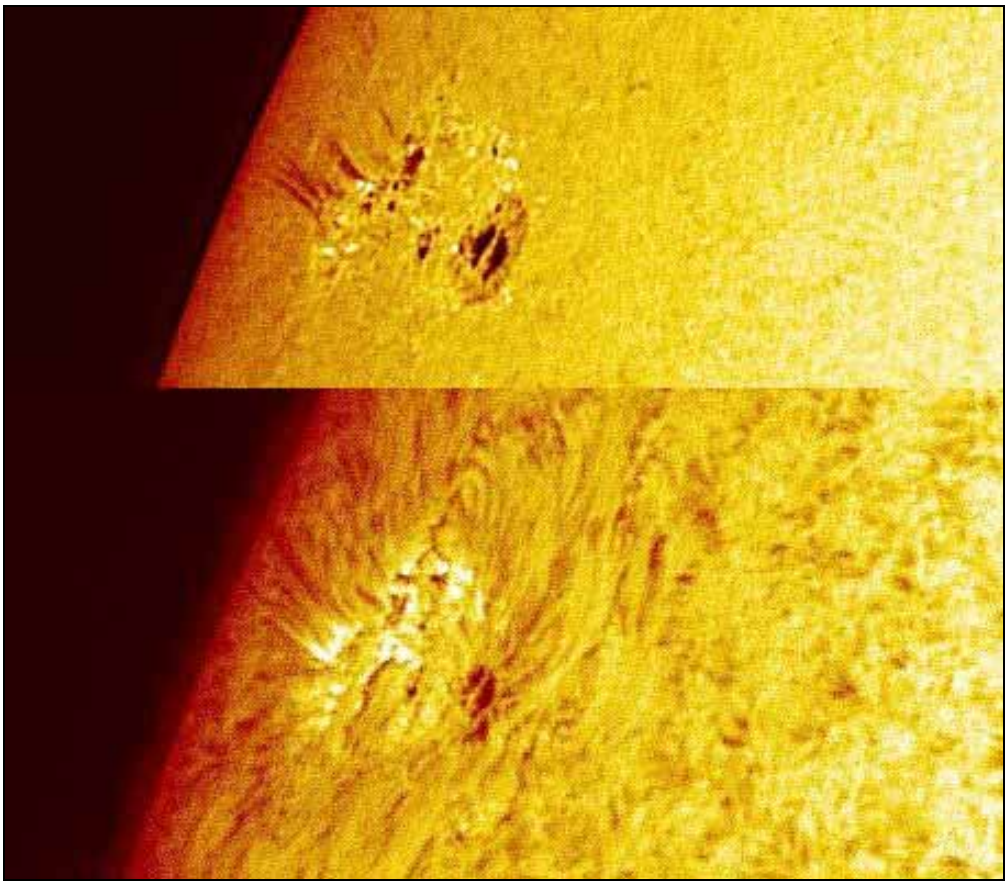


Figure 6. Two H-a views of AR 2699 on 2/5, one on-line (below at 13:09 UT) and one off-line (above at 13:02 UT) by Grassmann.

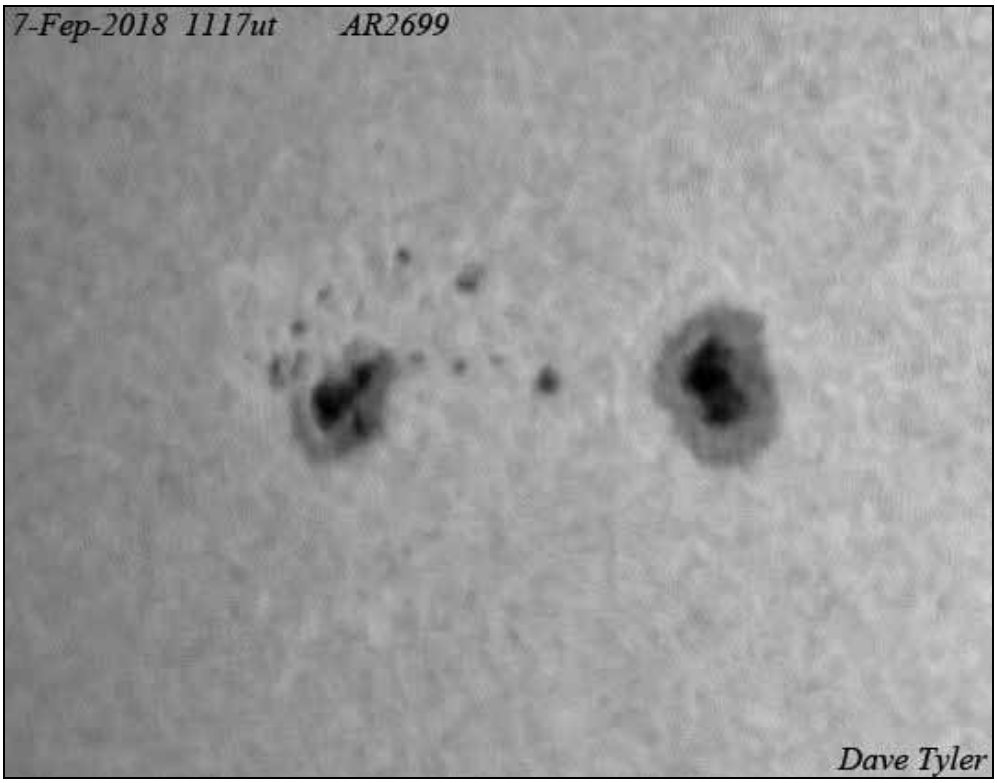


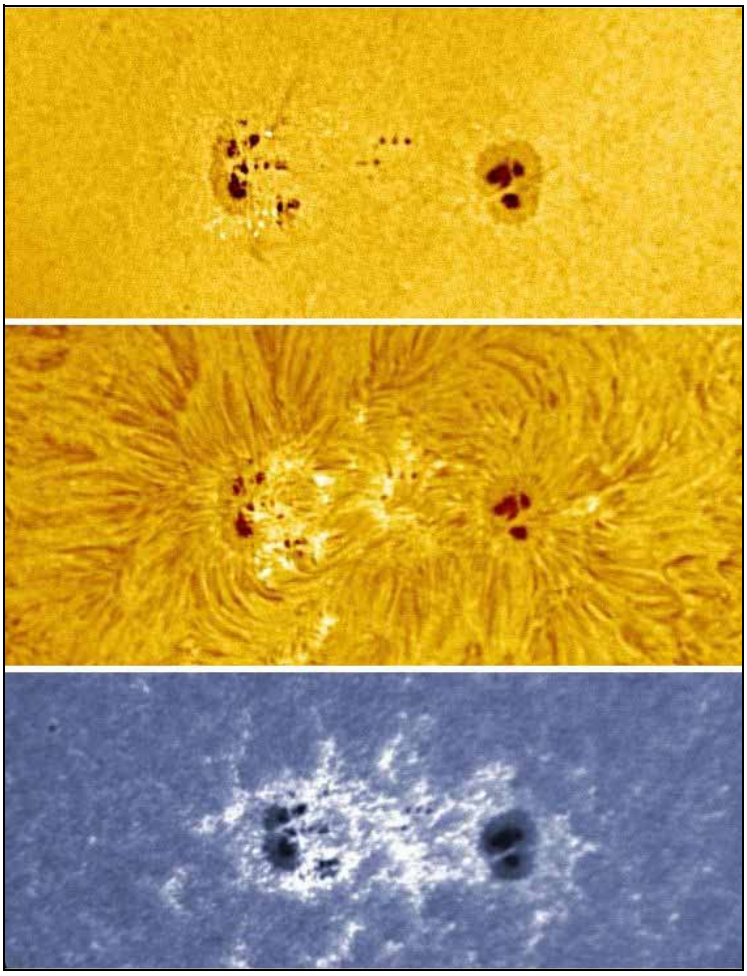
Figure 7. A w-l view of AR 2699 by Tyler on 2/7 at 11:17 UT.

of the group were six or seven small umbral spots in two short parallel lines. The follower was a spot almost as big as the leader consisting of four N-S arranged umbrae with penumbra only on the following side with separated umbral spots on the preceding side. There were hot spots seen to the S and one to the N that showed a jet. In H-a, the region on the preceding side of the follower was hot or bright and an obvious site for flaring. The CaK image displays much the same thing.

A three-pane w-l montage by Hill shows the evolution of the group from 2/9-2/11 (Figure 9). The notable developments shown were the increase in area and number of spots in the middle of the group, the decrease in area of the large follower spot, and smaller surrounding follower spots and the changes in the light bridge in the leader spot. By 2/11, the day of meridian passage and maximum development, there were two collections of middle spots while the whole group was classed as Dai (240 millionths, mag. class beta) and still producing about one B- or C-class flare per hour.

Tyler gives us a nice look at the region in w-l and H-a on 2/12 (Figure 10). It mostly shows the middle spots becoming more consolidated and from the H-a image they are clearly the center of flare activity. But the most interesting thing is the bright region leading the leader spot with what looks to be a leading filament emanating from it. The region was little changed, still Dai (230 millionths, mag. class beta), but flare production had dropped by half to about one every two hours.

This was the last detailed look our members got of this region until it was on the limb on but three of our whole disk visual observers (Broxton, Levinthal, and Teske) did follow it and



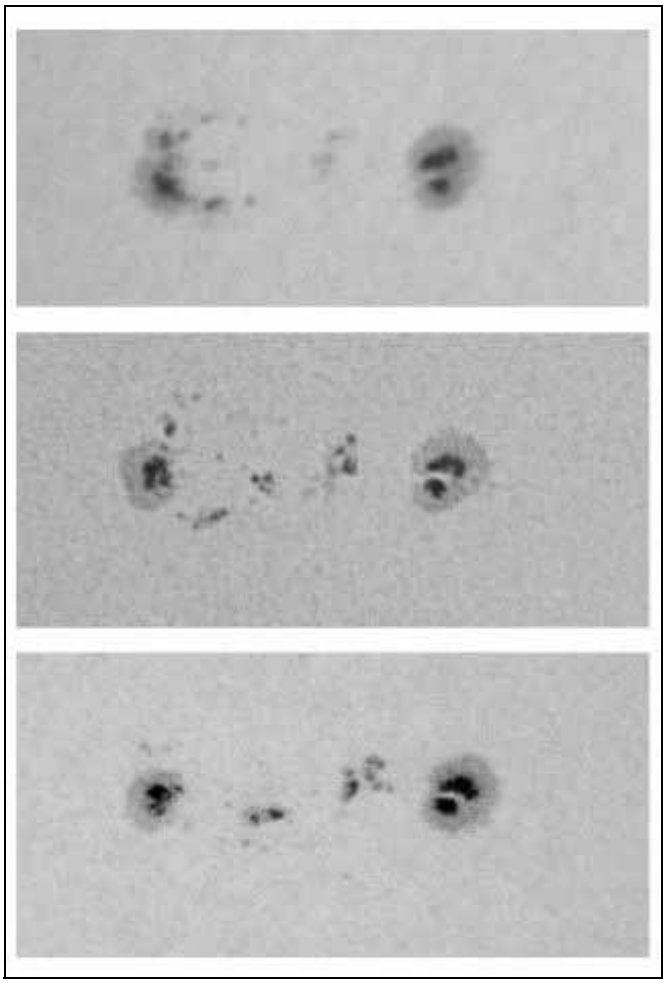


Figure 8. AR 2699 on 2/9 by Grassmann. Upper off-line H-a at 11:09 UT. Middle H-a at 11:09 UT. Lower CaK at 12:01 UT.
Figure 9. Three w-l views of AR 2699 by Hill: top 2/9 at 22:44 UT, middle 2/10 21:38 UT and bottom 2/11 21:01 UT.

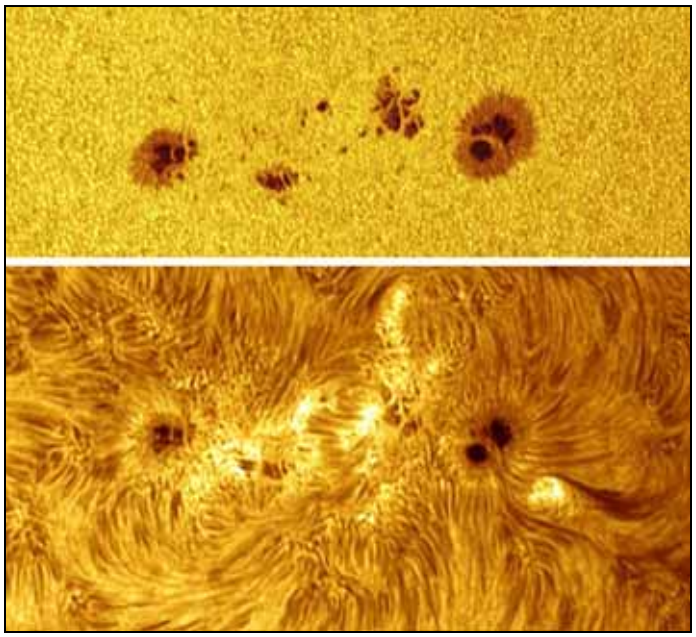


Figure 10. Tyler images of AR 2699 on 2/12: top w-l at 10:50 UT, bottom H-a at 11:14 UT.

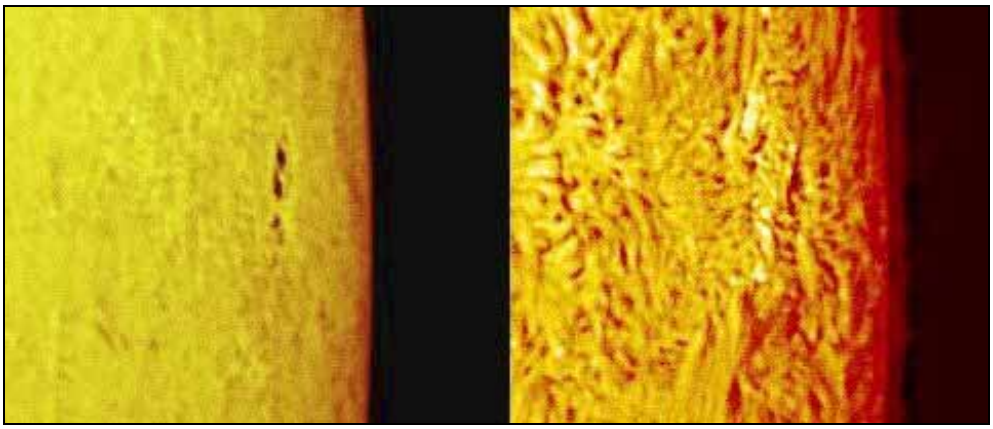


Figure 11. Last views of AR 2699 on the limb by Grassmann: left off-line H-a at 11:10 UT, right on-line H-a 10:55 UT.

showed the region to be reducing in area and complexity. On 2/17, Grassmann got a last on-line/off-line pair of H-a images of the region as it was very near the limb (Figure 11). By this time, it was reduced to Cao (100 mil, mag. class beta).

Carrington Rotation 2201

Dates: 2018 02 23.6167 to 2018 03 22.9368

Avg. R_I = 8.89
High R_I = 16 (2/26)
Low R_I = 0 (20 days)

The activity can't get much lower. There were only three active regions for this rotation, and only one got above 10 millionths, and that was AR2700 with 30 millionths for one day and classed as Cro (mag. class beta) with only 10 B-class flares.

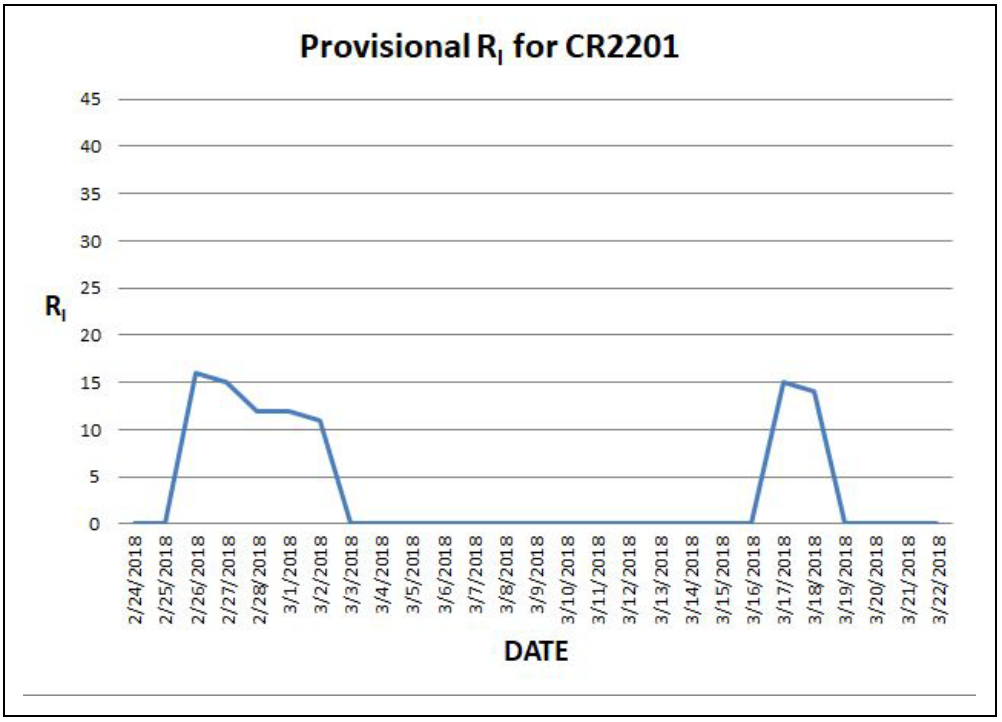
However, even with this low level of activity, there were some interesting things happening on the Sun in the form of limb prominences. The major prominence was one observed by three observers from 3/02-3/03. The first image was by Ramakers on 3/02 at 17:27 UT (Figure 12). It shows a broad bright column prominence perpendicular to the SE limb. A day later, Grassmann shows the core of this prominence and several small ones at 11:49 UT (Figure 13). Three hours later, at 14:25 UT, Ramakers again caught this prominence showing the outer feathery portions. The larger one was possibly tornadic (Figure 14). Finally Teske got a last look at 17:20 UT, revealing even more of the outer details (Figure 15).

Conclusion

While activity is low, it will get lower. How low and for how long we can't know for certain, though some predictions are for a long, very low (read zero) period of spot numbers. However, observers should be alert for McIntosh class A and B groups that pop up and are so short lived that they don't get a designation before they are gone. But then there are the surprises like AR 2699, where we have some good activity in the middle of doldrums.

What we do need in our archive are prominence images that are identified as to which limb they are on, and what Active Region they are associated with. When both pieces of information are missing, it is difficult to know the level of activity of the prominence or region.

The work that is being submitted, though lower in numbers, is of generally good quality, so keep up the diligent observing!



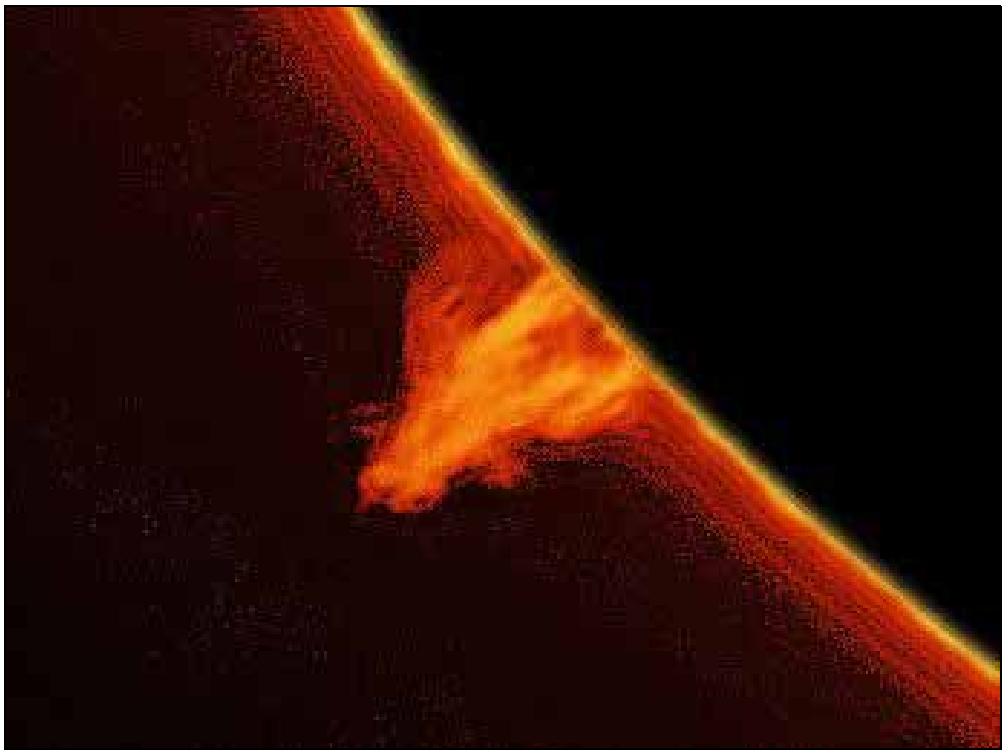


Figure 12. SE limb prominence by Ramakers on 3/2 at 17:27 UT.

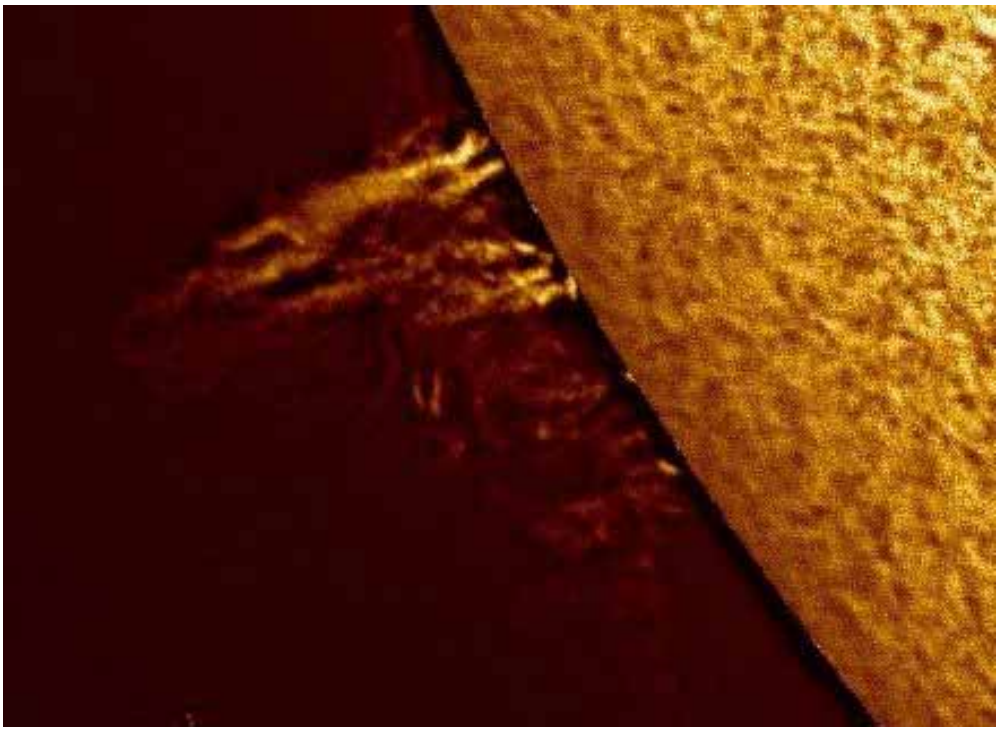


Figure 13. Promence by Grassmann on 3/3 at 11:49 UT.

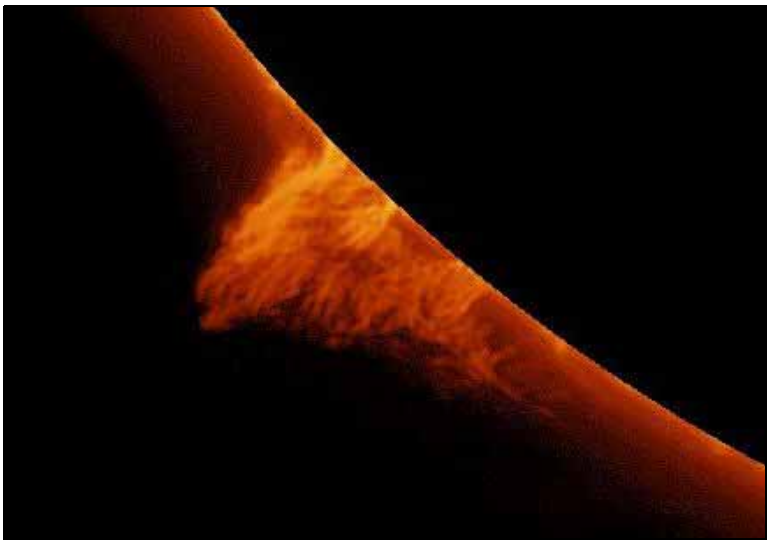


Figure 14. SE limb prominence by Ramakers on 3/3 at 14:25 UT.

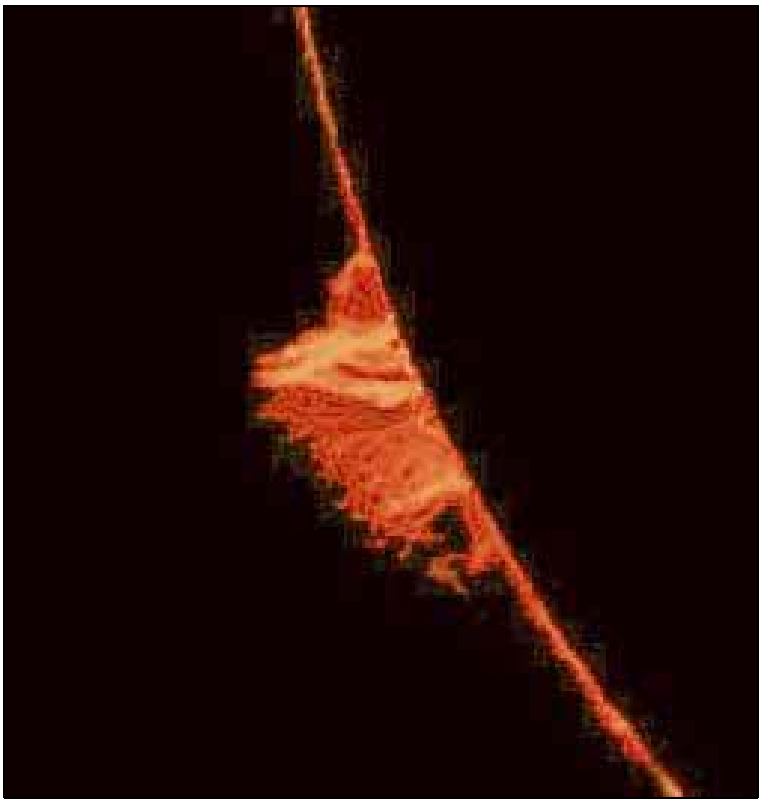


Figure 15. Teske limb prominence image on 3/3 at 17:20 UT.

A.L.P.O. Solar Section

OBSERVER_____

ADDRESS_____

DATE/TIME_____UT

SEEING_____ CLOUDS_____ WIND_____

APERTURE_____mm FOCAL LENGTH_____mm TYPE_____

EYEPIECE_____mm FILTRATION_____

OBSERVATION: *DIRECT* OR *PROJECTED*? (CIRCLE ONE)

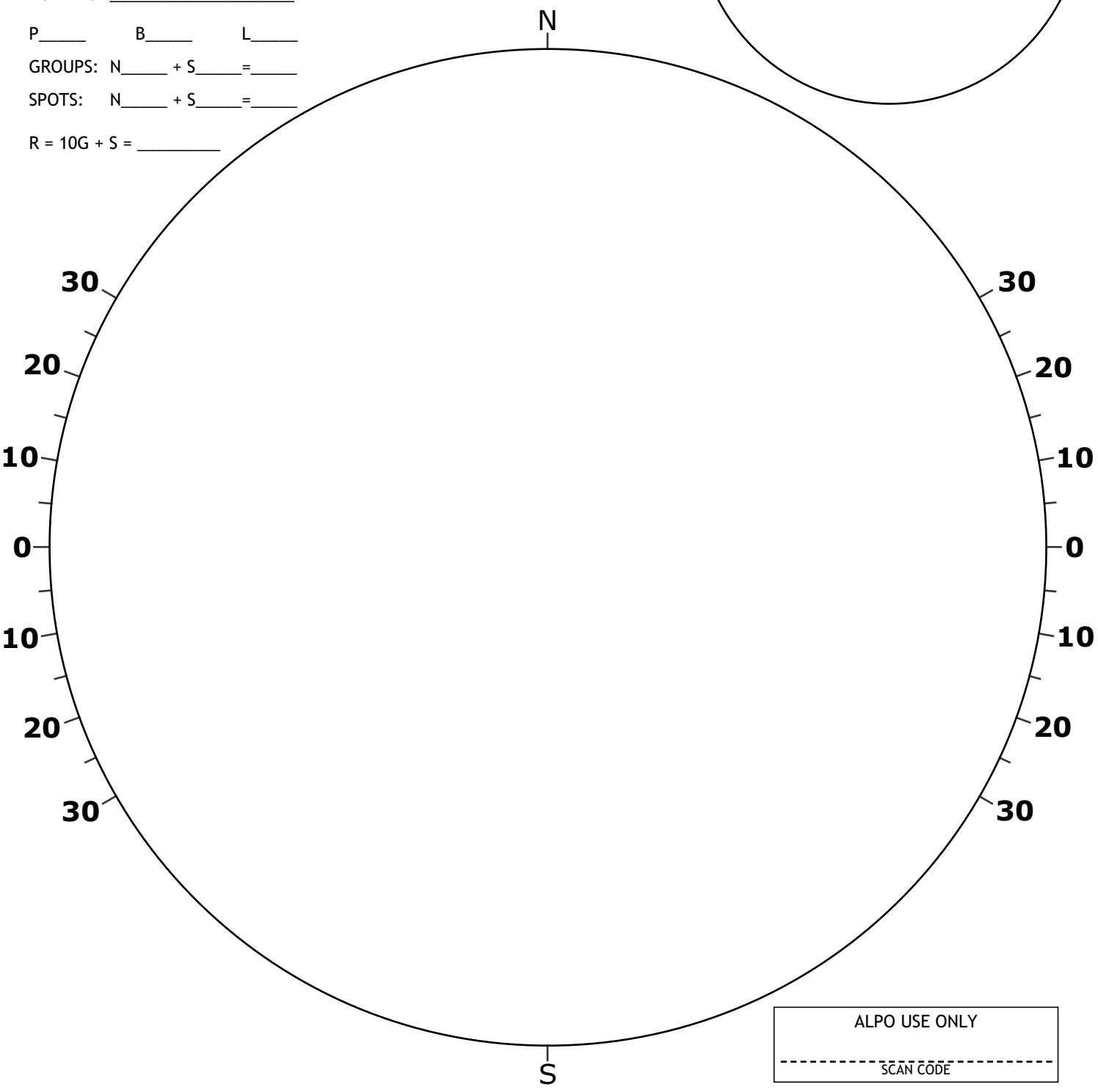
ROTATION_____

P_____ B_____ L_____

GROUPS: N_____ + S_____=_____

SPOTS: N_____ + S_____=_____

R = 10G + S = _____



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SCAN CODE

A.L.P.O.SOLAR SECTION

ACTIVE REGION DRAWING REPORT FORM

SKY/SITE

Date/Time(UT) _____

Rotat.No. _____ A.R. _____ Cen.Meridian _____ Altitude _____

Sky cond. _____ Seeing _____ Clouds _____ Wind _____

Observatory type (circle one): roll off roof, roll off bldg., dome, none

TELESCOPE:

Inst. type _____ Mounting type _____

Clock drive? _____ Type of drive _____

Full aperture _____ Focal length _____ f/_____

Aperture stop/type _____ Final f/_____

Address: Phone No. ( )area code_____