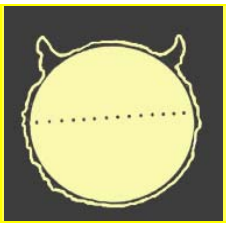

Feature Story: ALPO Solar Section

A Report on Carrington Rotations 2195 through 2198 (2017 09 12.7285 to 2017 12 30.93)

By Richard (Rik) Hill,
Coordinator &
Scientific Advisor,
ALPO Solar Section
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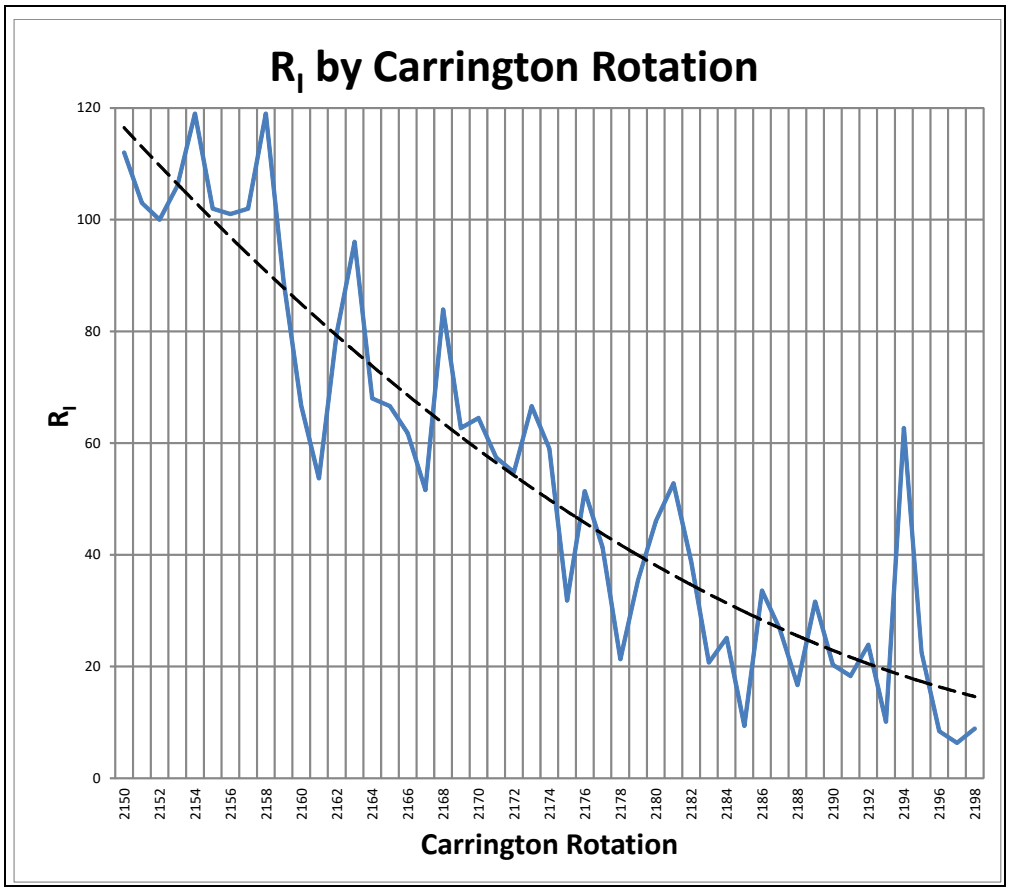
To our hard-copy readers: This paper can be viewed in full-color in the online (pdf) version of this Journal.



Overview

Activity this reporting period was low to extremely low levels not seen in eight years. All predictions are for a continued decrease in activity to a minimum sometime in 2020. The only rotation with significant activity in this period was the first one, CR 2195. Then the activity fell to very low numbers as Plot 1 shows. There were no naked eye sunspots during this reporting period and no flares were reported beyond B-class in any rotation.

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" means the ability to see these spots on the Sun without amplification but through proper and safe solar

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).

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.

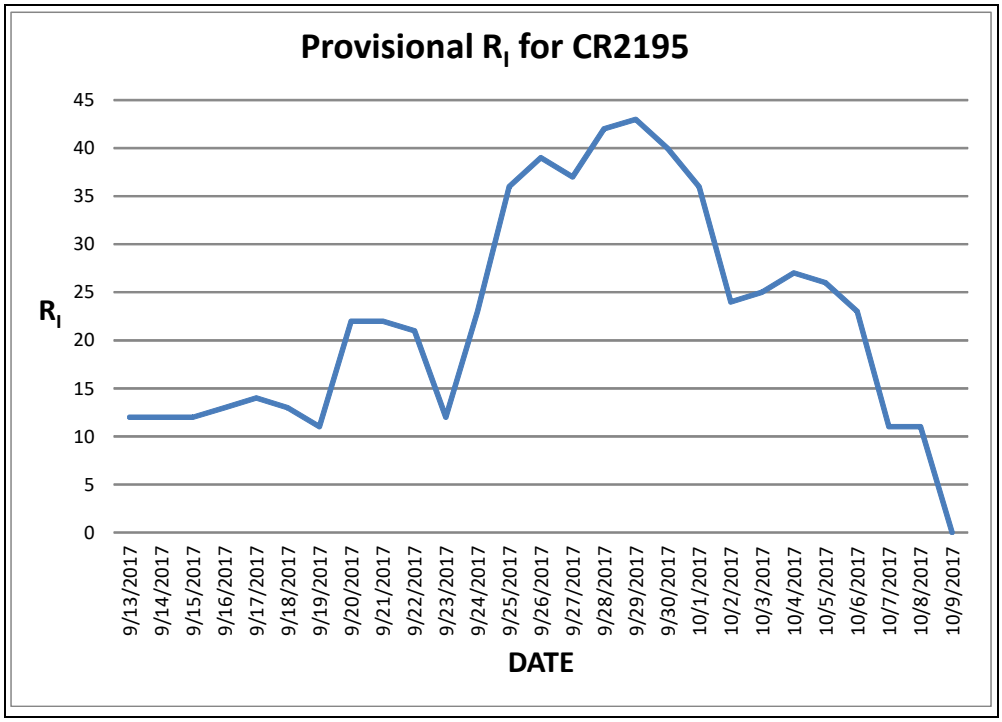
Additional references used in the preparation of this report:

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/

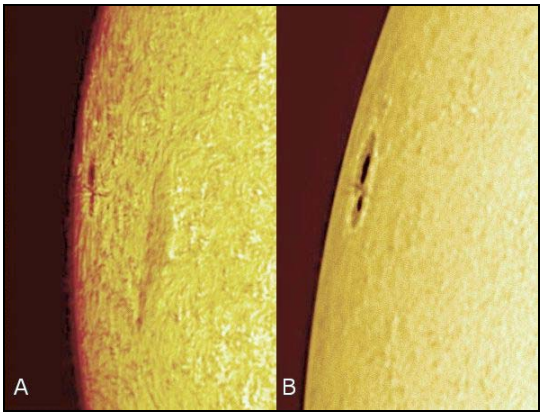


Carrington Rotation 2195

Dates: 2017 09 12.73 to 2017 10 10.01

Avg. R_I= 22.5
High R_I = 43 (9/29)
Low R_I = 0 (10/9)

This rotation saw only four regions, none of which exceeded 300 millionths and this was the best activity of the reporting period! The largest and most active region one was AR 2683 which was first caught by Grassmann on 9/25 in both w-l and H-a (**Figure 1**). These images showed two umbrae in a single penumbra with the whole region preceded by a nice, broad filament. The region was not designated until late in the day, at which time it was Hkx, 260 millionths area (alpha). The next day we got a good high-resolution w-l look by Dave Tyler. He showed the two umbrae in a single umbra with a small, short light-bridge between the umbrae but contained within the penumbra (**Figure 2**). Ramakers got a CaK image of the three main regions on the Sun that day including AR 2683 in the upper left (**Figure 3**). There was little evolution over the next few days. The professional designation, and that of our observers, remained Hkx or Hhx except for Levinthal who on 9/28 classed it as Cki. Meridian passage was on 10/01, when AR 2683 reached 290 millionths (alpha) but only produced a dozen flares in 48 hours. Of the other three regions that exceeded 200 millionths, all were H-class. The only C and D class groups were when these other three regions were < 200 millionths area. AR 2683 divided into two spots shortly after meridian passage on 10/03. This is typical dissolution of a sunspot and the two pieces each reduced in size from that point. Ramakers compiled w-l and H-a histories for this region that very well summaries its evolution (**Figure 4** and **Figure 5**). Grassmann got a nice image of a prominence associate with the region as it was on the limb on 8/10 (**Figure 6**).



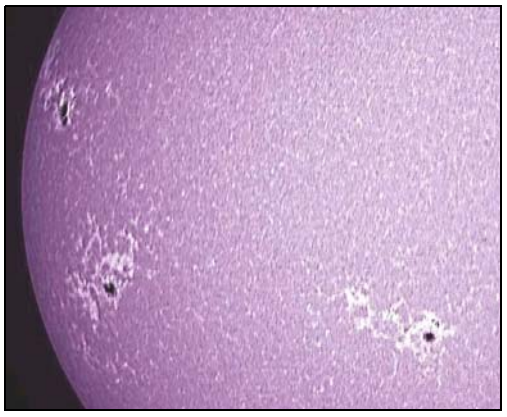
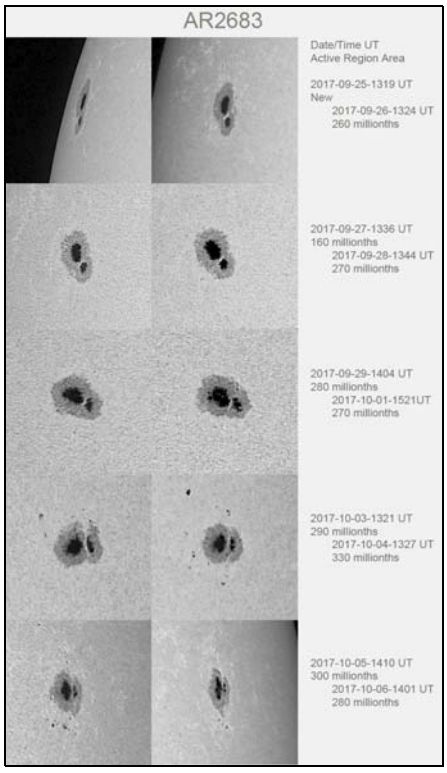
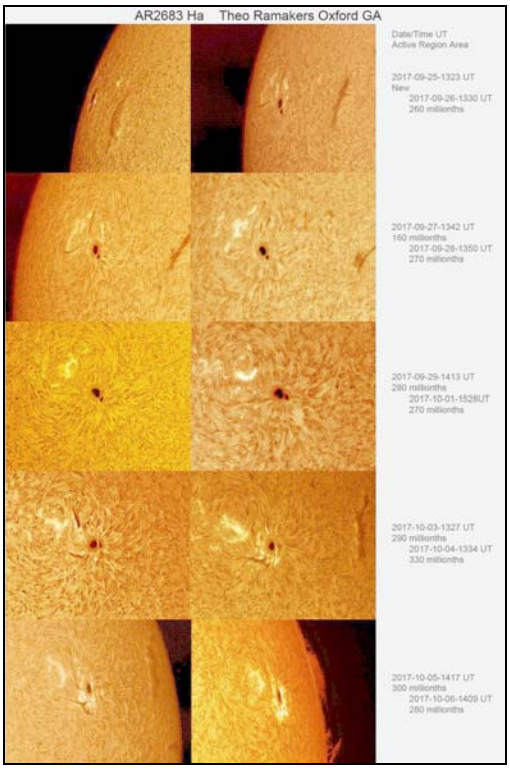


Figure 1. (above left) H-a (A) and w-l (B) images of AR 2683 on 9/25 at 11:25 UT (A) and 11:45 UT (B).
Figure 2. (above center) A w-l image of AR2683 by Tyler on 9/26 at 10:01 UT.
Figure 3. (Above right) CaK view of all 3 active regions AR2683 above on the limb, AR2682 below it and AR2681 on the right on 9/26 at 13:36 UT.





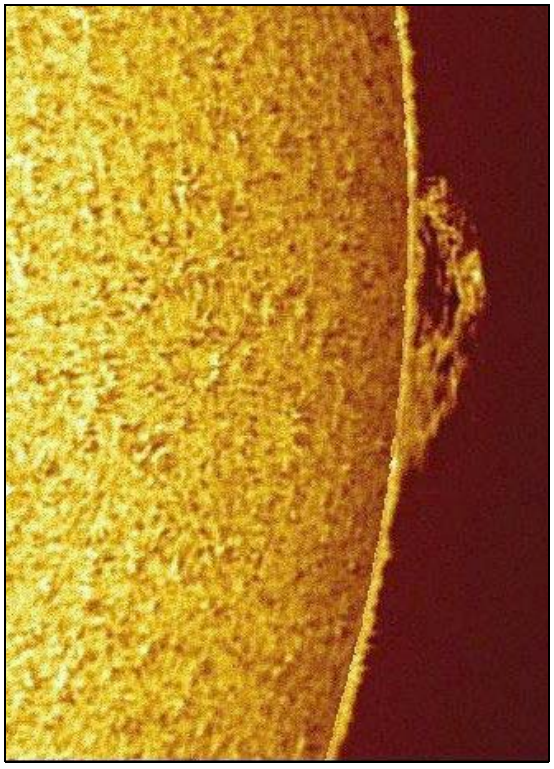
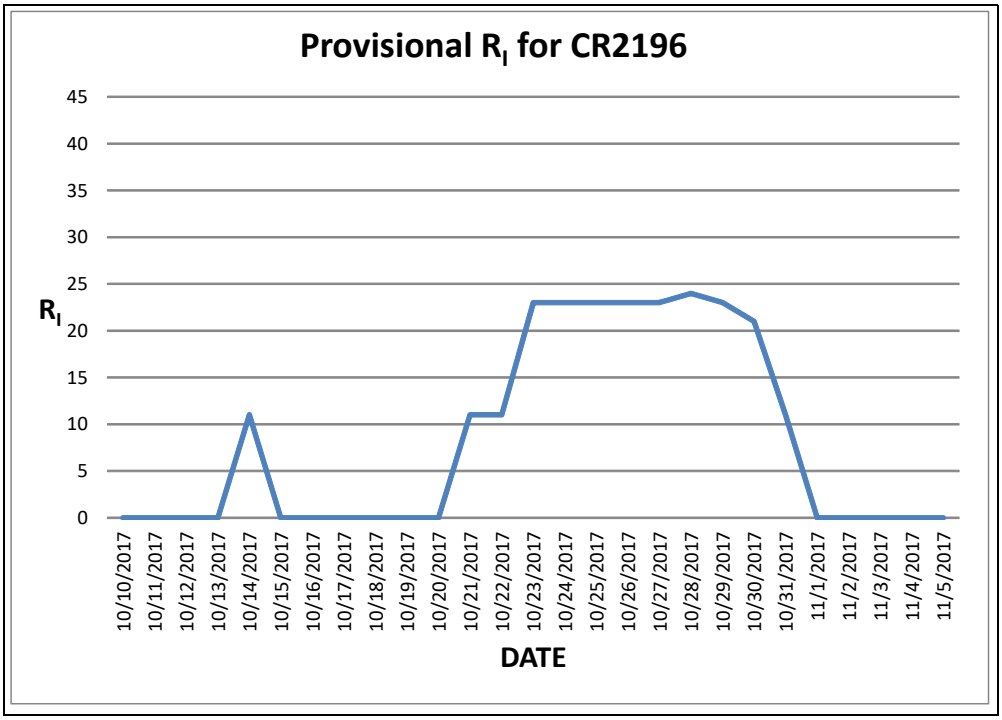


Figure 4. (above left) Ramakers w-l evolutionary history of AR2683.
Figure 5. (above center) Ramakers H-a evolutionary history of AR2683.
Figure 6. (above right) Limb prominence in H-a associated with AR2683 by Grassmann on 10/8 at 12:07 UT.



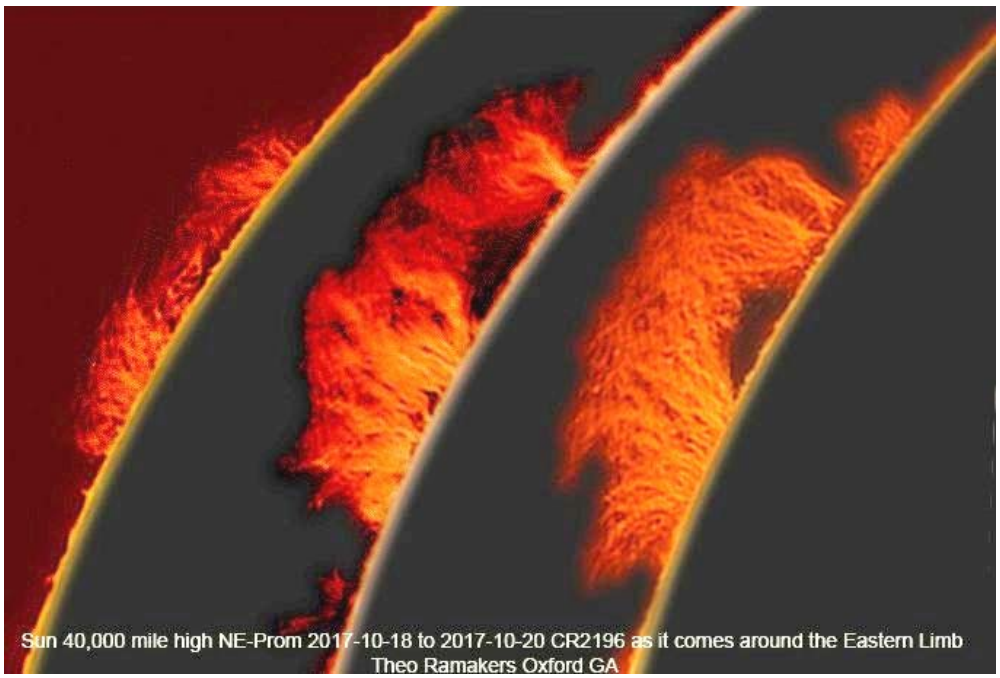


Figure 7. Three-day evolutionary history of a large prominence on the NE limb in H-a by Ramakers on 10/18-20.

Carrington Rotation 2196

Dates: 2017 10 10.01 to 2017 11 06.30

Avg. R_I= 8.41
High R_I = 24 (10/28)
Low R_I = 0 (15 days)

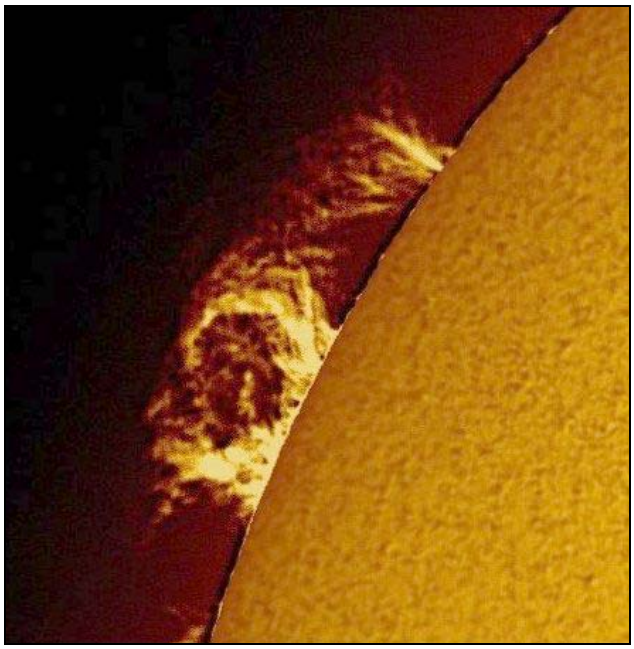
Of the three regions in this rotation, none attained an area as great as 100 millionths or classes other than A or H class. So most observers concentrated on observing prominences on the limb. This was fortunate, since on 10/18-20 we were treated to a very large prominence on the NE limb. Ramakers got a good time sequence of it spanning all three days (**Figure 7**). Maximum development was on 10/19 and we have some great images by Grassmann (**Figure 8**), Teske (**Figure 9**) and Levinthal (**Figure 10**). This prominence was so bright and large that the author was able to obtain an image using a handheld camera and an H-a PST (**Figure 11**)!

Carrington Rotation 2197

Dates: 2017 11 06.30 to 2017 12 03.61

Avg. R_I = 6.33
High R_I = 25 (11/17)
Low R_I = 0 (17 days)

Activity dropped further in this rotation to an average RI of only 6.33. Again, there were only three regions in this rotation and only one was worth mentioning, AR 2687, first observed by Grassmann on 11/14 as three centers of activity in H-a (**Figure 12**). It was listed as Cao of 50 millionths (beta). On 11/16, he showed the large plage area that comprised this region in CaK (**Figure 13**). This day was maximum development, as it was listed as Cao of 90 millionths (beta), but produced only a half-dozen flares in a 48-hour period. By meridian passage on 11/20, it was no more than a plage. However, on 11/20, a filament was observed on the disk that was very impressive. It formed a large open oval that was about the distance from Earth to Moon in long dimension. It is well seen in a Borman whole disk H-a image as it crossed the meridian (**Figure 14**). As these large filaments usually do, it changed little as it crossed the Sun and afforded observers days of something to record. Ramakers imaged it as it approached the limb on 11/28, which shows how little change took



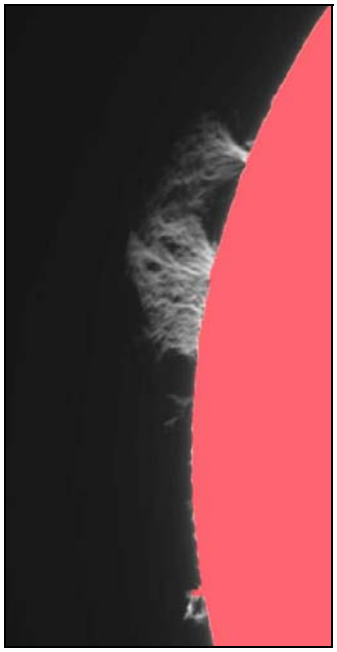
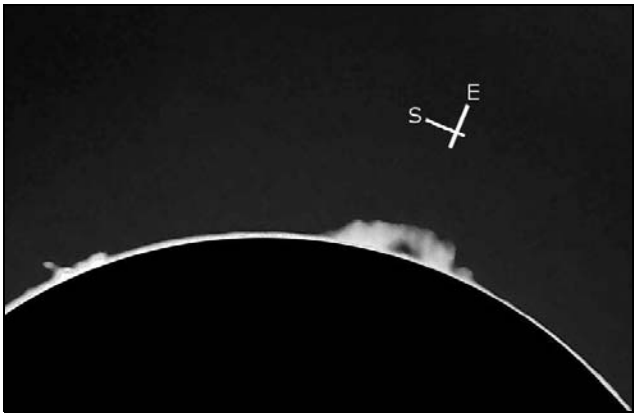


Figure 8. (above left) The large prominence on the NE limb as seen in H-a by Grassmann on 10/19 at 11:08 UT.
Figure 9. (above center) The same prominence on the NE limb as seen in H-a by Teske on 10/19 at 16:34 UT.
Figure 10. (above right) The NE limb prominence in H-a on 10/20 imaged by Leventhal at 21:20 UT.



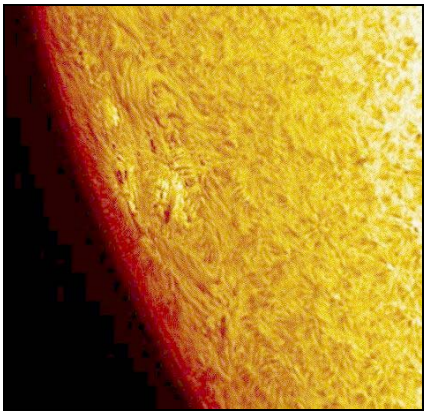


Figure 11. (above left) Image by Hill through an H-a PST of the NE limb prominence on 10/21 at 00:05 UT.
Figure 12. (above center) AR2687 on the limb in H-a by Grassmann on 11/14 at 12:03 UT.
Figure 13. (above right) CaK image of AR2687 by Grassmann on 11/15 at 12:00 UT.

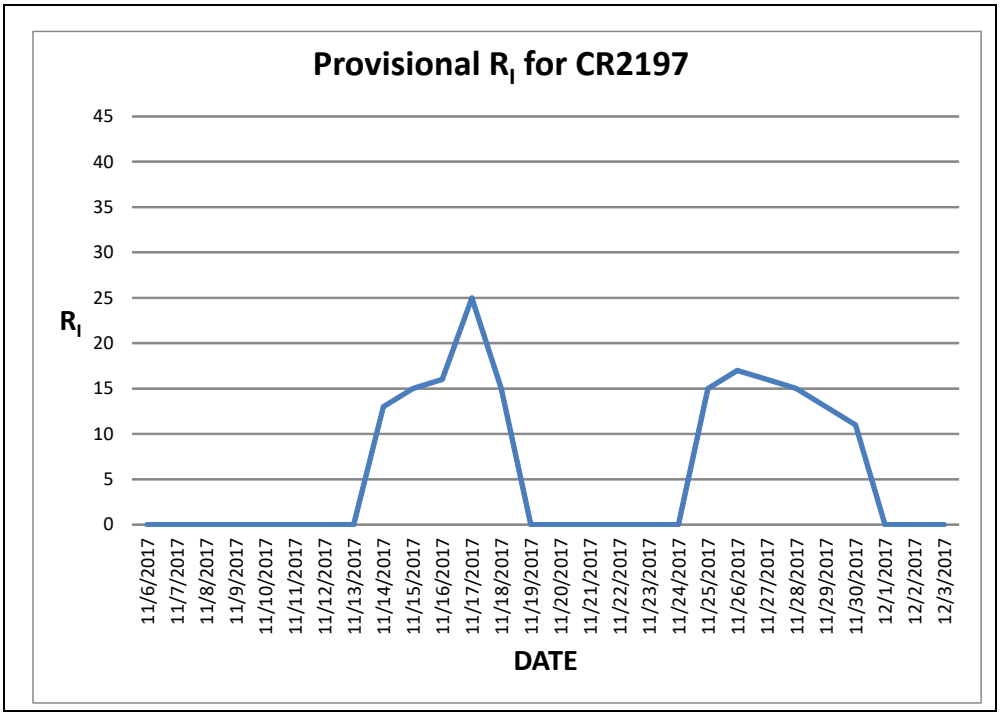


Figure 14. A Borman whole disk H-a image of the sun on 11/23 at 17:23 UT showing the large filament on the meridian. .

place (**Figure 15**). Grassmann shows it a day later as prominences on the limb (**Figure 16**).

Carrington Rotation 2198

Dates: 2017 12 03.61 to 2017 12 30.93

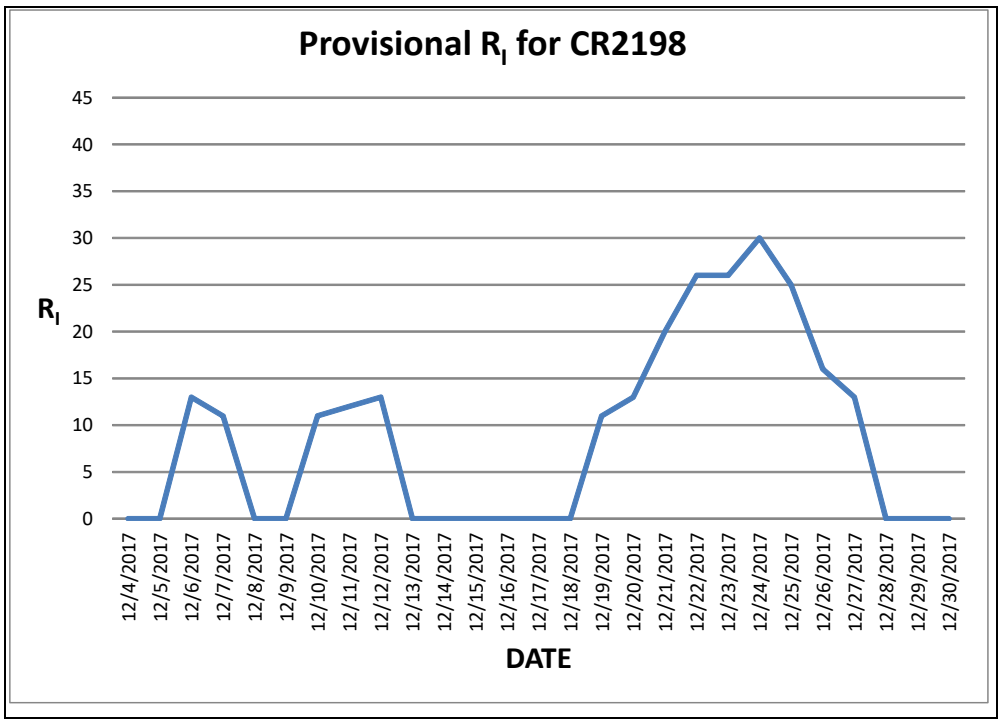
Avg. R_I = 8.89
High R_I = 30 (12/24)
Low R_I = 0 (13 days)

Activity rose slightly this rotation to levels comparable to CR 2196. Only one of the three regions during this rotation developed beyond B-class and 20 millionths. This was AR 2692, which was first observed by as a Cao group of 70 millionths the first day as observed by Teske in w-l. Meridian passage was three days later when it had evolved to Dao, 90 millionths (beta), producing around a dozen small flares in a 48-hour period. Levinthal was the only one who observed it on this day, noting it as Dki. On 12/25, Bosman got the best image of it for its entire passage in CaK (**Figure 17**). It died on the solar disk before reaching the limb on 12/29 and was only a plage as it left on 12/30.

Conclusion

Lastly, our new observer, Laura Schreiber, sent in her observations for the previous reporting period after the report was written. Two of these observations are of such excellent quality that I want to nevertheless present them here for the reader's enjoyment and edification. They are both of AR 2665 and of sub-arc-second quality (**Figure 18** and **Figure 19**). Great work Laura, and we look forward to seeing more of your images in the future!

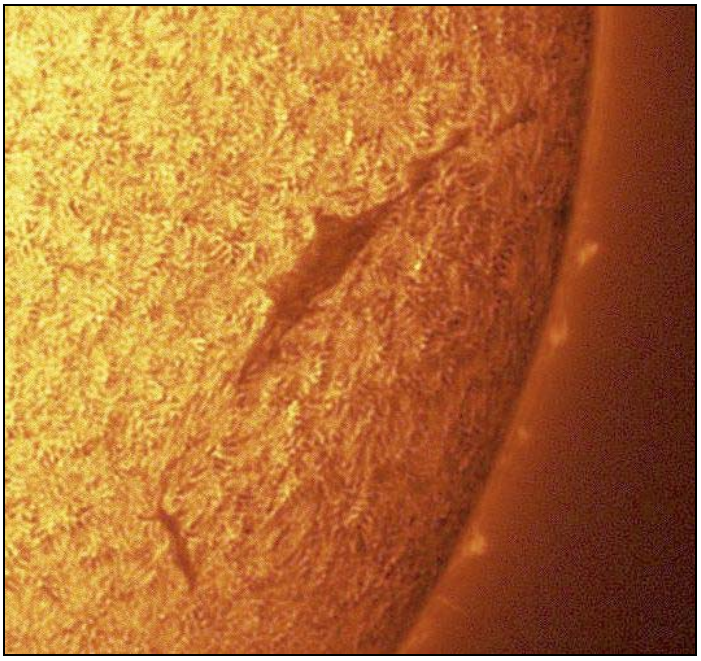
In closing, it bears repeating that we are heading into solar minimum predicted for 2020 but we are



already at very low levels. Many predictions are for a minimum stronger and longer and a next maximum weaker than any we have seen in over a century. It is up to solar observers to validate this with their observations and I would encourage one and all to note what activity there is. There are even predictions that we are heading into another Maunder-type minimum which would be very interesting but about as exciting as watching grass grow!

Acknowledgements

The author would like to extend a special thanks to Assistant Coordinator Theo Ramakers, who provided the data for this report on DVD when it was unavailable through normal means. Without that help, this report would not have been possible.



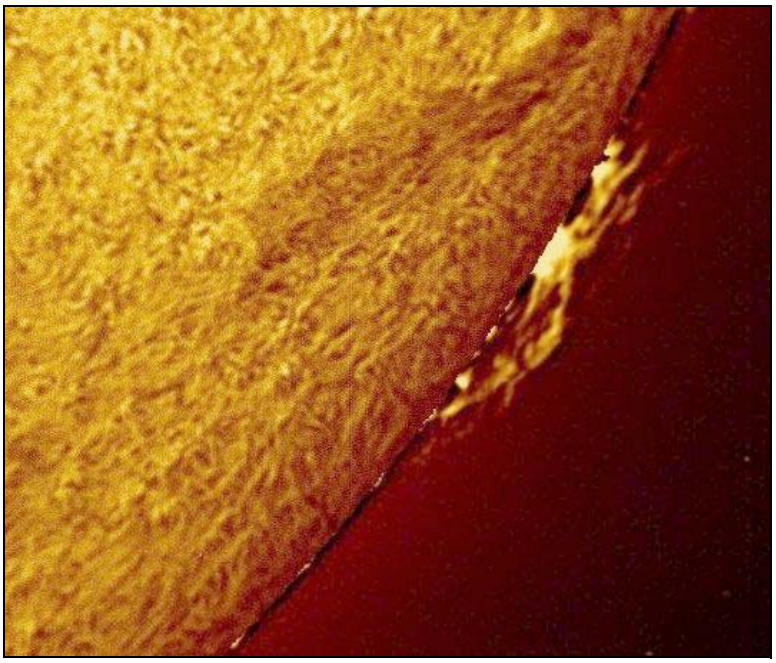


Figure 15. (above left) Ramakers H-a image showing the filament approaching the limb on 11/28 at 14:55 UT.
Figure 16. (above center) H-a image of parts of the filament on the limb in projection showing prominences. H-a image by Grassmann on 11/29 at 10:55 UT.

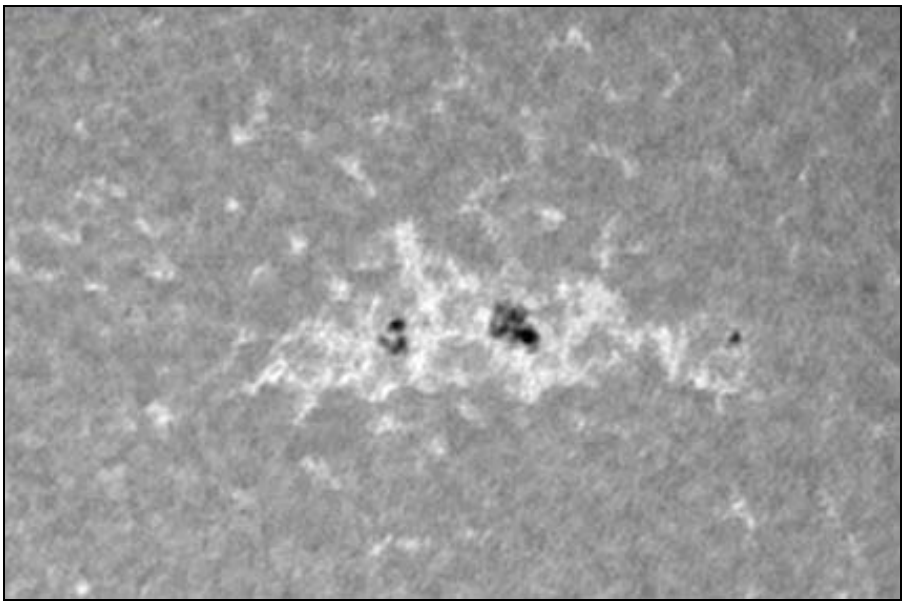
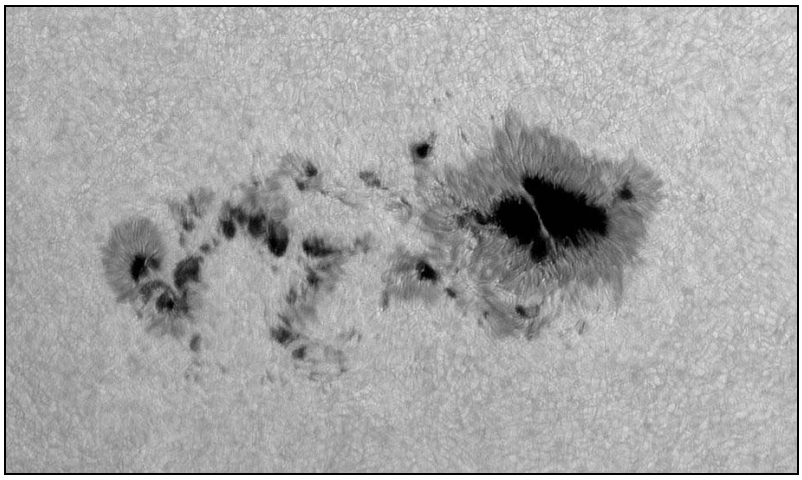


Figure 17. Bosman CaK image of 2692 on 12/25 at 00:00 UT.



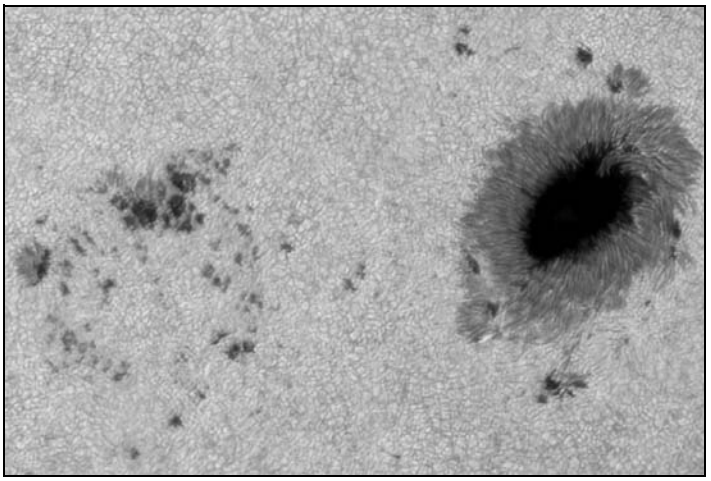


Figure 18. (above left) Sub-arc-second image of AR2665 by Schreiber on 7/09 at 08:27 UT.
Figure 19. (above right) Another sub-arc-second image of AR2665 by Schreiber on 7/13 at 06:23 UT.

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)

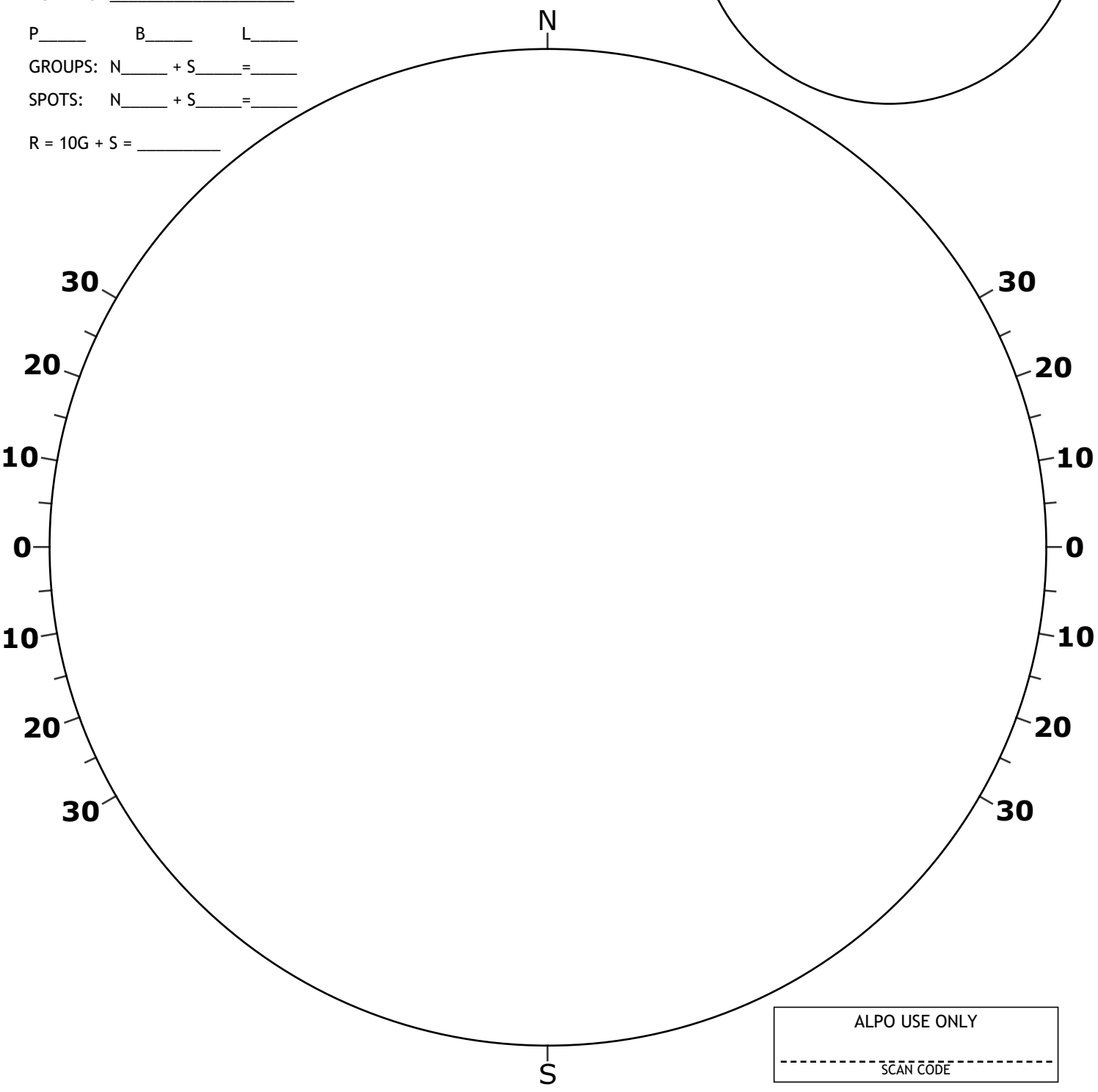
ROTATION_____

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_____