St. Petersburg University

IAU

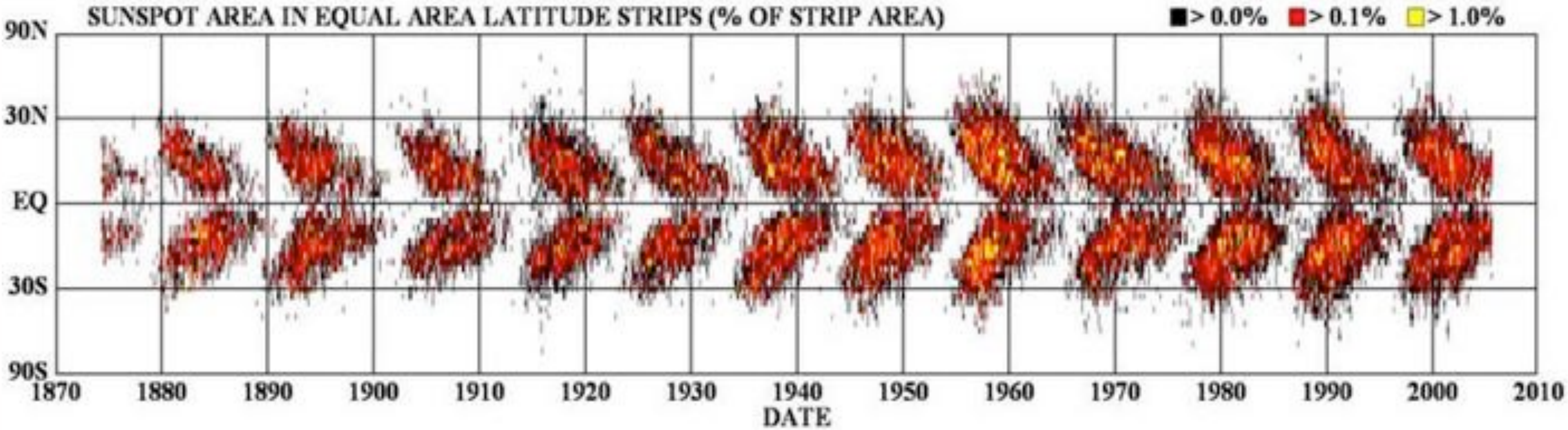
Solar activity reconstruction from the Georg Eimmart's archive of 1616 – 1720

Nadezhda Zolotova, Mikhail Vokhmyanin, and Rainer Arlt

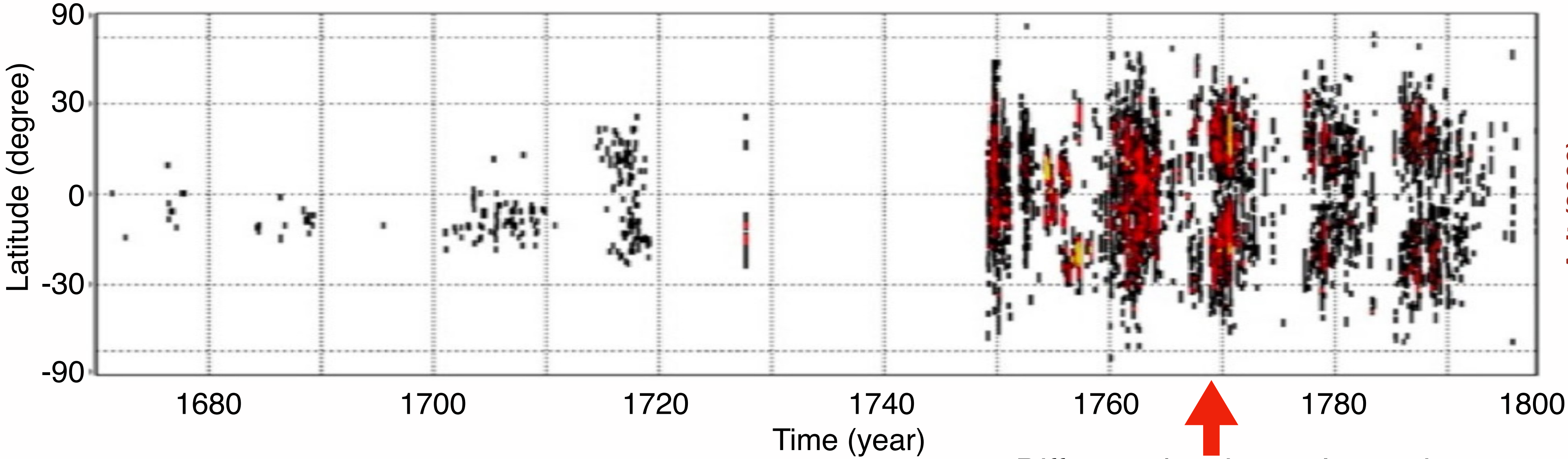
ned@geo.phys.spbu.ru

IAUS 364, Yerevan, Armenia, 21-25 August 2023

Spatio-temporal distribution of sunspots: **has it always been like this?**



Hathaway (2010)



Arlt (2009)

Weiss and Tobias (2016)

Different drawing style starting in the end of 1768

Archives of the Eimmart observatory

The second-richest sunspot data set covering the Maunder minimum: **551** sunspots on **109** drawings of the solar disk reported by eight observers:

Petrus Saxonius, 5–27 March 1616;

Johann Wurzelbau, 11–12 June 1684;

Georg Eimmart, 2–8 July 1684;

Johann Hoffmann, 26 May–16 July 1703;

Maria Eimmart, 30–31 May and 9 July 1703;

Eustachio Manfredi, 28 May–29 June 1703;

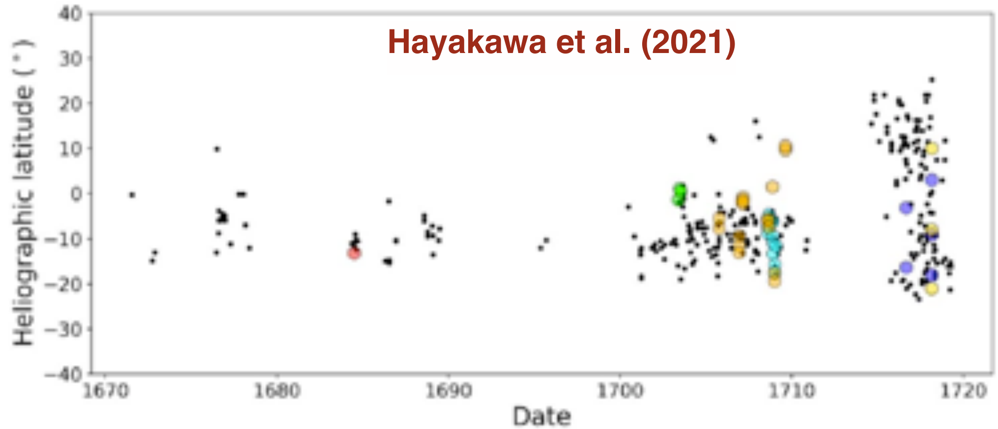
Johann Heinrich Müller, short series in 1705–1709;

Johann Christoph Müller, April 1719–May 1720.

Instruments:

Eimmart's observatory: telescopes (length 16, 12, and 10 foot, **no information on the aperture**), astronomical (pendulum) clocks, cameras obscuras, helioscopium, and machina helioscopia;

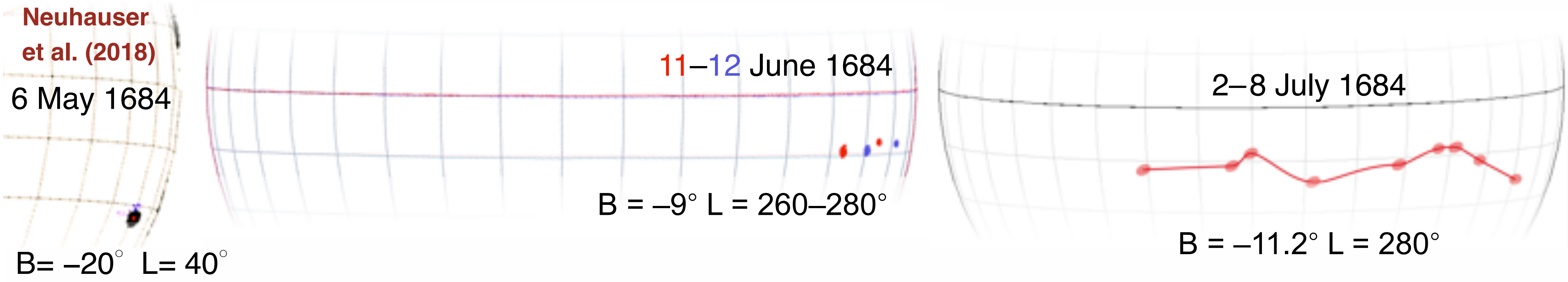
J. Chr. Müller: telescope length 7 foot, lens diameter of 3–4 cm, magnification of 30–60.

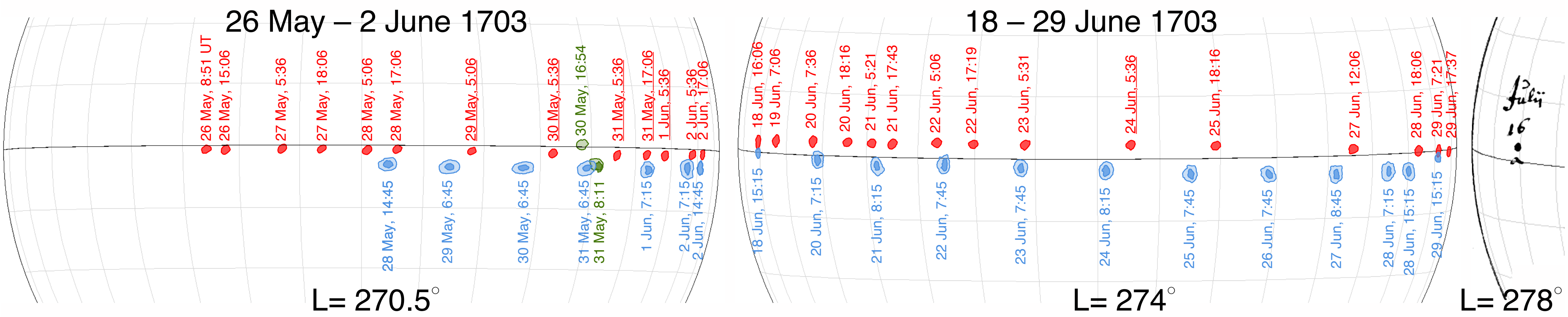


Are there very long-lived sunspots?

Spoerer (1889): Cassini observed a sunspot during three rotations from May to July 1684 at latitude of –10°.

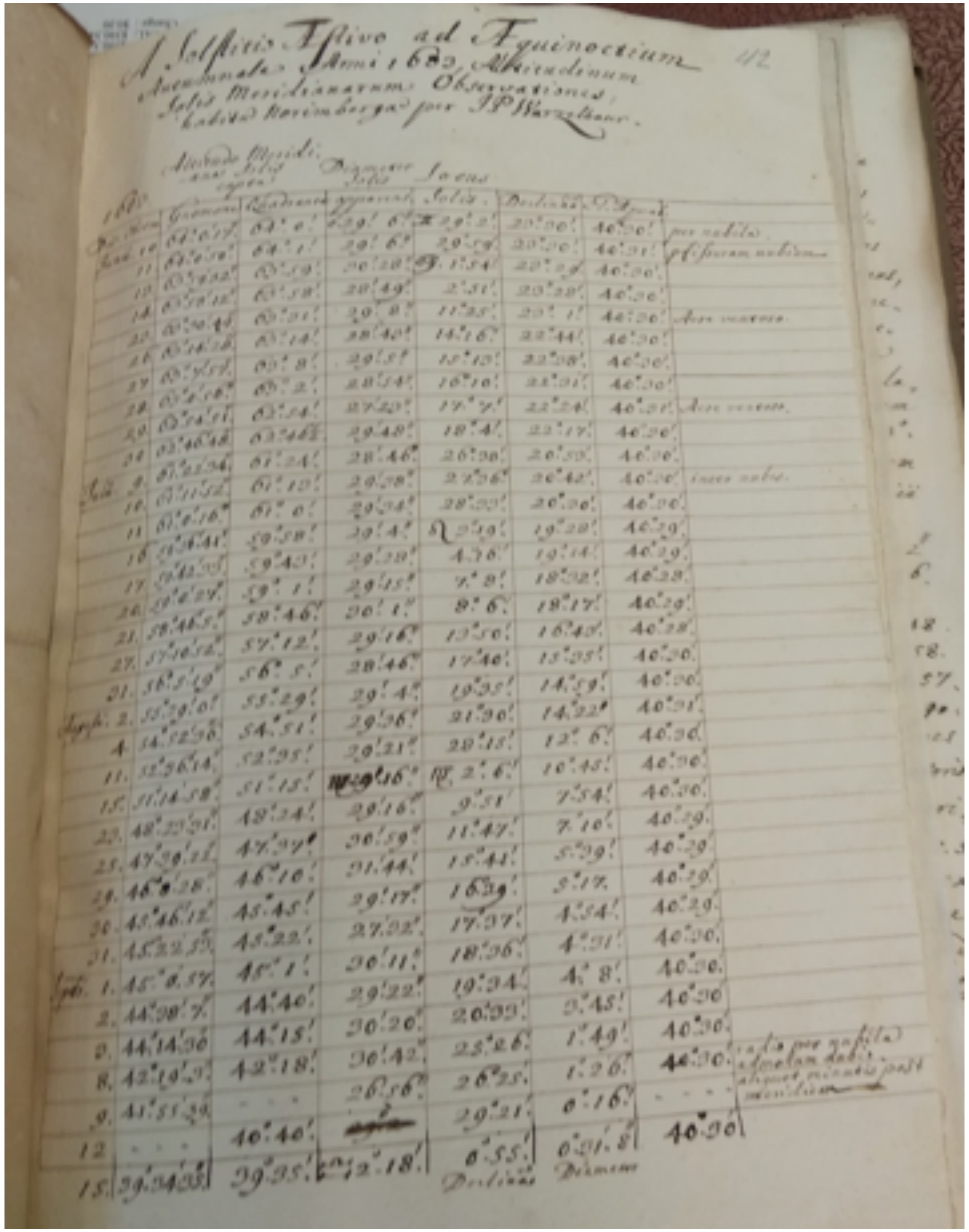
Kirch: the sunspot is large and **might possibly** live four solar rotations.





Long-liv sunspots → $\eta\downarrow$ → $A_p\uparrow$ → $A_p/A_u\uparrow$ but Greenwich $A_p/A_u \geq$ Maund min A_p/A_u

Spotless days of 1677–1704

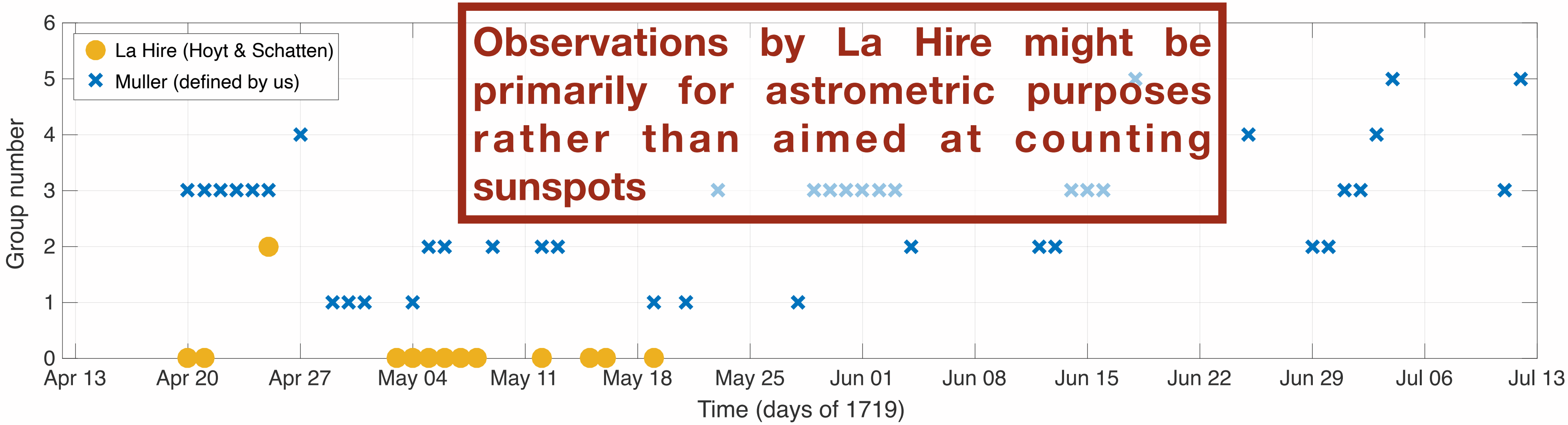


Hoyt & Schatten (1998): G. Eimmart in 1677–1704 a lot of spotless days

Carrasco et al., Clette et al., Hayakawa et al., Vaquero et al.: spotless days have been frequently derived from common mention on an absence of sunspots for some period or solar altitude observations

The majority of the observations by the Eimmart observatory were primarily for astrometric purposes rather than aimed at counting sunspots. These reports should not be interpreted as spotless days

Sunspot counting vs astrometric measurements



Observations by La Hire might be primarily for astrometric purposes rather than aimed at counting sunspots

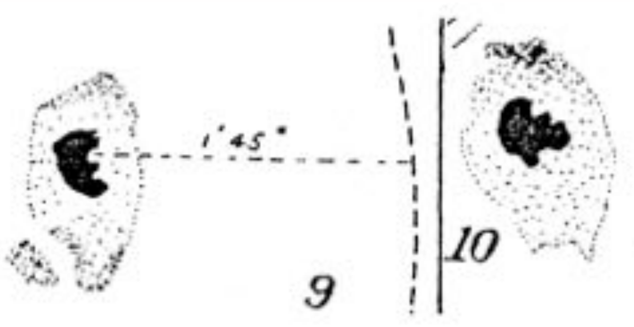
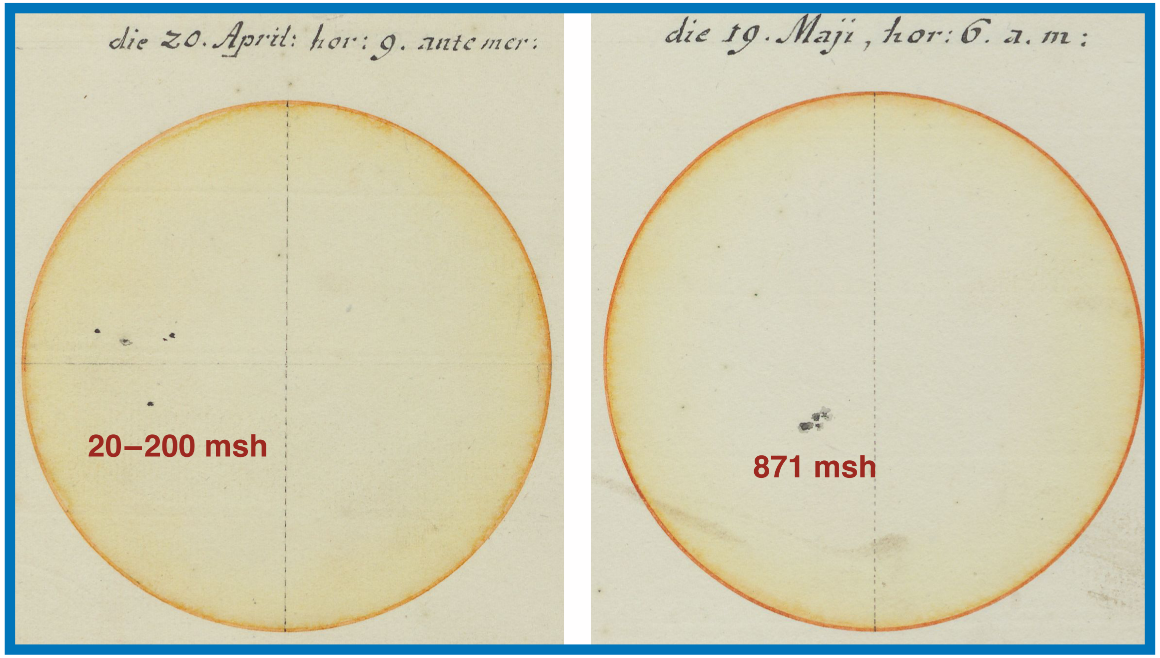
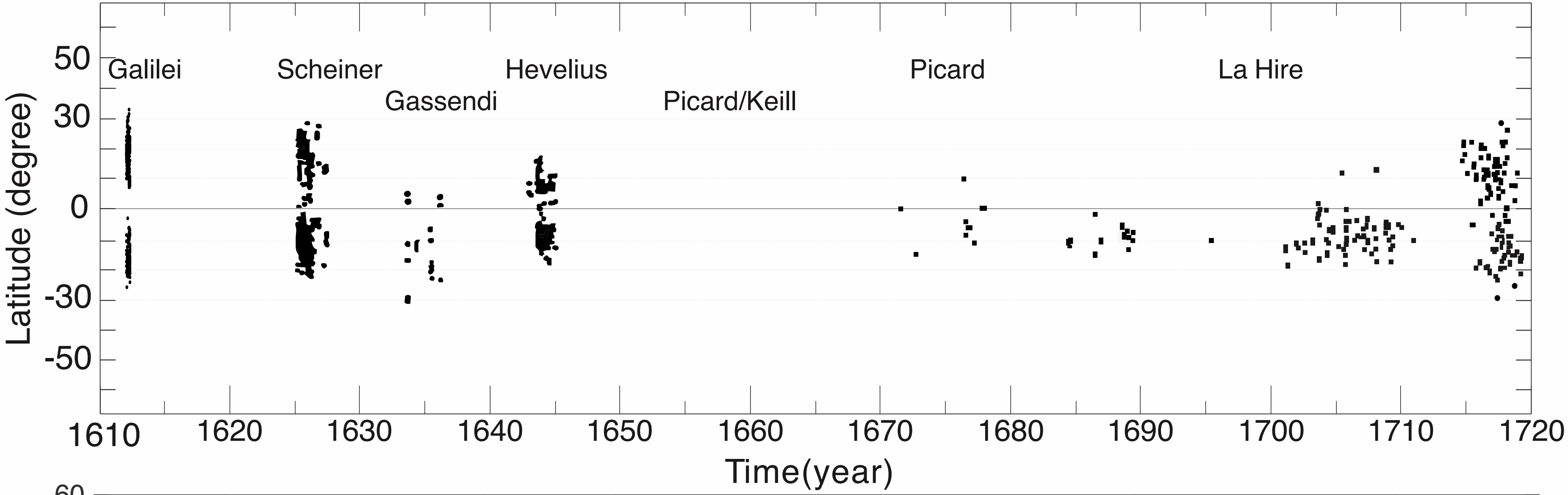


Fig. 1. Sunspot drawings by La Hire

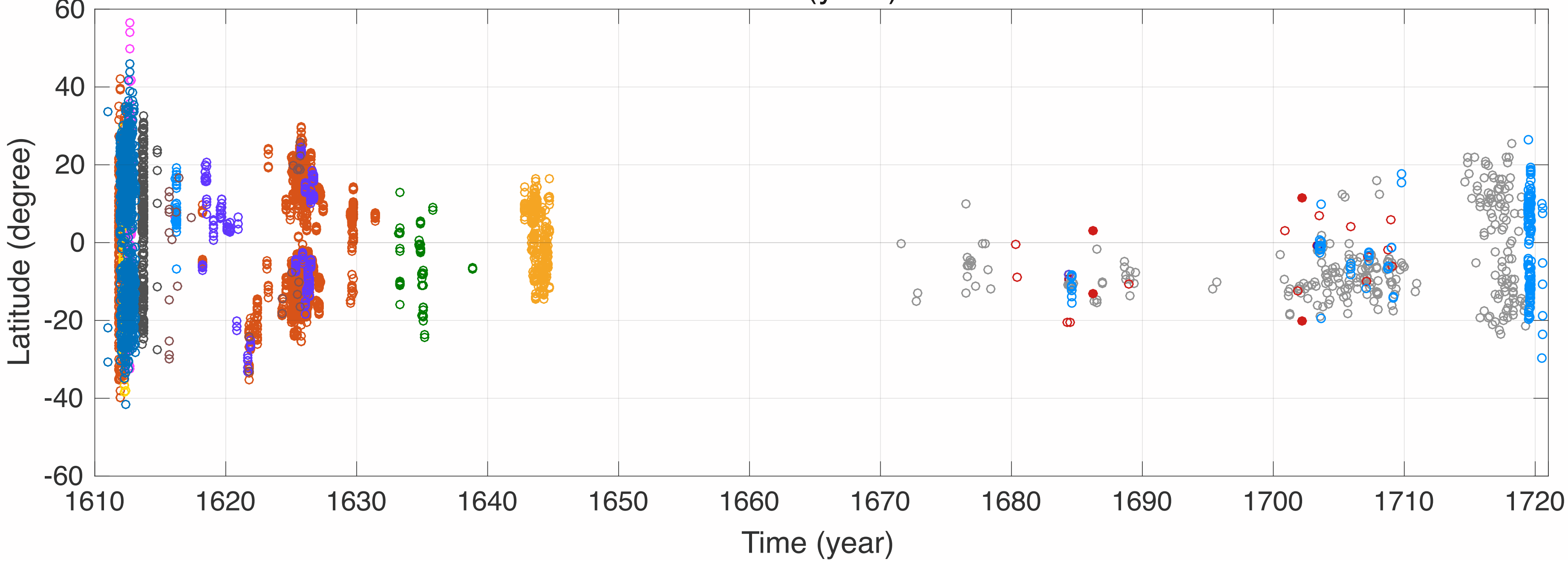
Ribes & Nesme-Ribes (1993): any sunspot as large as 1″ could not be missed with the Parisian telescopes



Spatio-temporal distribution of sunspot groups



Ribes & Nesme-Ribes (1993)
Soon & Yaskell (2003)
Casas et al. (2006)



Arlt et al. (2016) Carrasco et al. (2019a, 2019b, 2021) Hayakawa et al. (2021a, 2021b) Neuhauser at al. (2018) Vokhmyanin & Zolotova (2018a, 2018b) Vokhmyanin et al. (2020, 2021) etc.

Where's the data, Lebowski?

Hoyt & Schatten (1998): only tabular database

Observations by F. von Hagen of 1739–1751 of which Wolf said they are stored in Pulkovo observatory – **LOST**

Archives of Ribes and Nesme-Ribes (1993) – **LOST**, there is only picture and a machine-readable catalogue by Vaquero et al. (2015)

Clette et al. (2023): Zürich archives between 1919 and 1944 – **LOST**

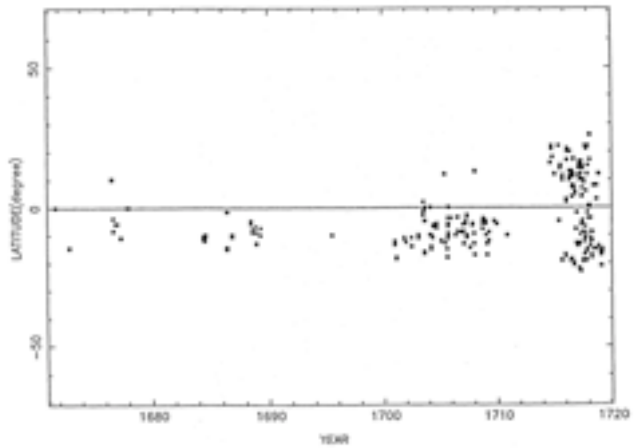

244 Wolf, Mittheilungen über die Sonnenflecken.

1854 Jan. 9; April 23; Nov. 26; Dez. 14.
1855 Jan. 11; Febr. 24; März 16; April 5, 28; Juni 16; Aug. 13; Oct. 17, 18; Dez. 21.
1856 Juni 6; Nov. 2, 19, 24; Dez. 1, 25.
1857 Jan. 5, 6, 9, 12, 13, 14, 19, 26, 27; Oct. 17, 28; Nov. 8, 9, 26, 28, 29; Dez. 11, 20, 21, 24, 31.
1858 Jan. 1, 12, 31; Nov. 6, 21; Dez. 11.

Dagegen ohne Flecken:

1854 Febr. 23; Oct. 19.
1855 Jan. 30; Febr. 21; Mai 9; Juni 20; Aug. 3; Sept. 4, 5; Oct. 10; Nov. 14, 15, 16; Dez. 5, 12.
1856 Jan. 25; April 5; Nov. 23; Dez. 16.
1857 April 27.

130) Collectanea astronomica colligente et obser–



XI	4	1.4	–	20	0.0				–	30	3.62	–	26	5.16
–	8	0.0	–	21	0.0	I	11	5.13	–	31	5.28	–	27	6.17
–	10	0.0	–	22	0.0	–	12	5.12	II	3	3.11	–	28	5.17

Open catalog of historical sunspot drawings


Sunspots from the past

About | Methods | Drawings | Data

Cataloge of sunspot data extracted from historical drawings

This project is aimed to provide open access to historical sunspot drawings. We want to make the processing procedure transparent and open for correction. For instance, the separation of sunspots into groups is a non-trivial task. Also, different approaches aimed to compensate the uncertainty of sunspot drawing result in discrepancy of sunspot positions defined by various researchers. Assigning different criteria for the boundary of an object (sunspot, umbra, penumbra, etc.) also result in a different area of this object. For the benefit of an open discussion, here we describe our technique and post the processed drawings.

Updates

The data obtained can be revised taking into account gradually emerging new information, for example, comparisons of observations of contemporaries. All changes will be displayed here.

Open catalog of historical sunspot drawings

Sunspots from the past

About | Methods | Drawings | Data

Calendar

Observers

Cataloge of sunsp… …ed from historical drawings

This project is aimed to provide open access to historical sunspot drawings. We want to make the processing procedure transparent and open for correction. For instance, the separation of sunspots into groups is a non-trivial task. Also, different approaches aimed to compensate the uncertainty of sunspot drawing result in discrepancy of sunspot positions defined by various researchers. Assigning different criteria for the boundary of an object (sunspot, umbra, penumbra, etc.) also result in a different area of this object. For the benefit of an open discussion, here we describe our technique and post the processed drawings.

Updates

The data obtained can be revised taking into account gradually emerging new information, for example, comparisons of observations of contemporaries. All changes will be displayed here.


What can Observations of Comets Tell Us about the Solar Wind at the Maunder Minimum?

Open catalog of historical sunspot drawings

Sunspots from the past

About | Methods | Drawings | Data

Calendar

Observers

Catalog of sunsp[...]ed from historical drawings

This project is aimed to provide open access to historical sunspot drawings. We want to make the processing procedure transparent and open for correction. For instance, the separation of sunspots into groups is a non-trivial task. Also, different approaches aimed to compensate the uncertainty of sunspot drawing result in discrepancy of sunspot positions defined by various researchers. Assigning different criteria for the boundary of an object (sunspot, umbra, penumbra, etc.) also result in a different area of this object. For the benefit of an open discussion, here we describe our technique and post the processed drawings.

Updates

The data obtained can be revised taking into account gradually emerging new information, for example, comparisons of observations of contemporaries. All changes will be displayed here.

Sunspots Areas and Heliographic Positions on the Drawings Made by Galileo Galilei in 1612

Mikhail V. Vokhmyanin and Nadezhda V. Zolotova

Open catalog of historical sunspot drawings

Sunspots from the past

About | Methods | Drawings | Data

Calendar

1610

January	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	**18**	19	20	21	22	23	24	25	26	27	28	29	30	31
February	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28			
March	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
April	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
May	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
June	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
July	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
August	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
September	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
October	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
November	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
December	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31

1611

January	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	**29**	30	31
February	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29		
March	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
April	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
May	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
June	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
July	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
August	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
September	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
October	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
November	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
December	01	02	03	04	05	06	07	08	09	10	**11**	12	**13**	**14**	**15**	16	17	**18**	**19**	20	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	29	30	**31**

1612

January	**01**	02	03	**04**	**05**	**06**	**07**	08	09	10	**11**	12	**13**	**14**	15	**16**	**17**	18	19	**20**	**21**	22	**23**	**24**	**25**	26	**27**	28	**29**	**30**	31
February	01	**02**	03	04	**05**	**06**	07	08	09	**10**	11	**12**	**13**	**14**	**15**	**16**	**17**	18	**19**	20	**21**	**22**	23	**24**	**25**	**26**	**27**	**28**	**29**		
March	**01**	**02**	03	**04**	**05**	**06**	**07**	**08**	09	10	**11**	**12**	**13**	14	15	16	17	18	**19**	**20**	**21**	**22**	**23**	24	25	**26**	**27**	**28**	29	30	**31**

Open catalog of historical sunspot drawings

Sunspots from the past

About | Methods | Drawings | Data

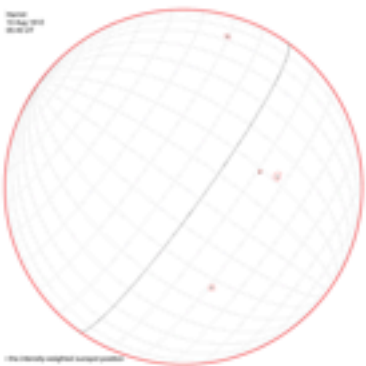
06 Aug 1612 <-- 10 Aug 1612 --> 12 Aug 1612

Thomas Harriot

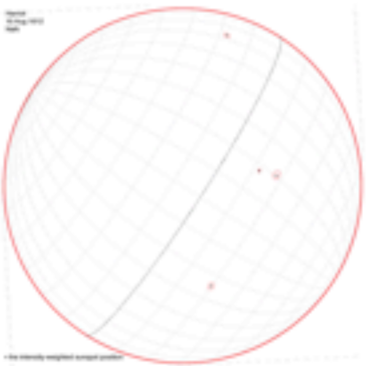
Original note:
Syon. July. 31. Venus. ho. 5 1/4. (5 1/2. mane
sonne somewhat to bright. Thick ayer only no mist, nor cloudes.
4 spots in all. 3 of a greater sort. 1 of a small & dim.

Group (G)	Area (msh)
148	186
152	195
153	76

Method I



Method II



Positions of individual sunspots are in Data

	Method I		Method II	
Group (G)	Lat (deg)	Long (deg)	Lat (deg)	Long (deg)
148	20.51	269.14	17.69	267.48
152	-16.06	227.98	-17.19	224.94
153	-21.38	183.27	-20.08	180.01

Open catalog of historical sunspot drawings

Sunspots from the past

About | Methods | Drawings | Data

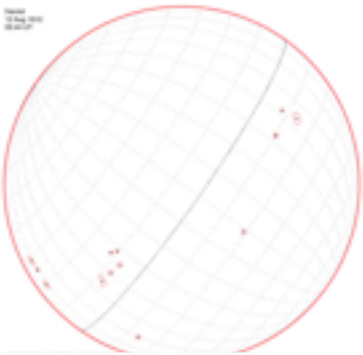
10 Aug 1612 <-- 12 Aug 1612 --> 14 Aug 1612

Thomas Harriot

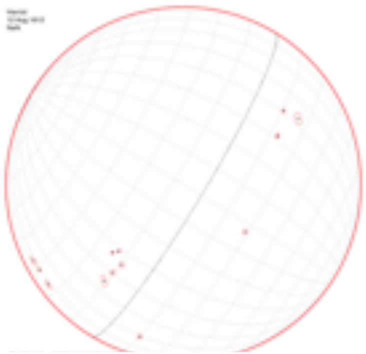
Original note:
Syon. August. 2. Sun. ho. 5 1/2. (5 mane.
sonne somewhat to bright. Thick ayer only.
13 spots in all.
The 4 nerest the edge not so black as the rest.

Group (G)	Area (msh)
152	535
153	112
154	90
155	607
156	944
157	104
158	171

Method I



Method II



Positions of individual sunspots are in Data

Group (G)	Method I Lat (deg)	Method I Long (deg)	Method II Lat (deg)	Method II Long (deg)
152	-12.57	224.1	-15.68	220.94
153	-19.29	179.15	-19.12	175.24
154	-10.37	212.72	-12.76	209.6
155	7.27	138.54	10.28	136.72
156	24.01	107.87	28.32	106.22
157	10.83	147.46	13.27	145.93
158	-14.13	119.99	-10.18	117.18

Open catalog of historical sunspot drawings

Sunspots from the past

About | Methods | Drawings | Data

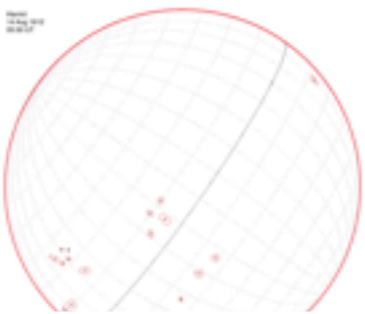
12 Aug 1612 <-- **14 Aug 1612** --> 17 Aug 1612

Thomas Harriot

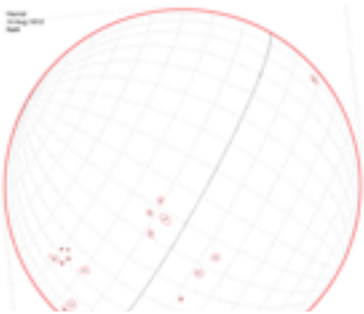
Original note:
Syon. August. 4. Mars. ho. 5. (5 1/2 mane.
Thick ayer only.
16 spots in all.
The 2 uppermost of the 5, small dim & intereminate(?)
The long spot nere the limbe long & very dim, & interminate. The next also not black & somewhat interminate.

Group (G)	Area (msh)
152	499
155	510
156	1001
157	275
158	91
159	496
160	1466

Method I



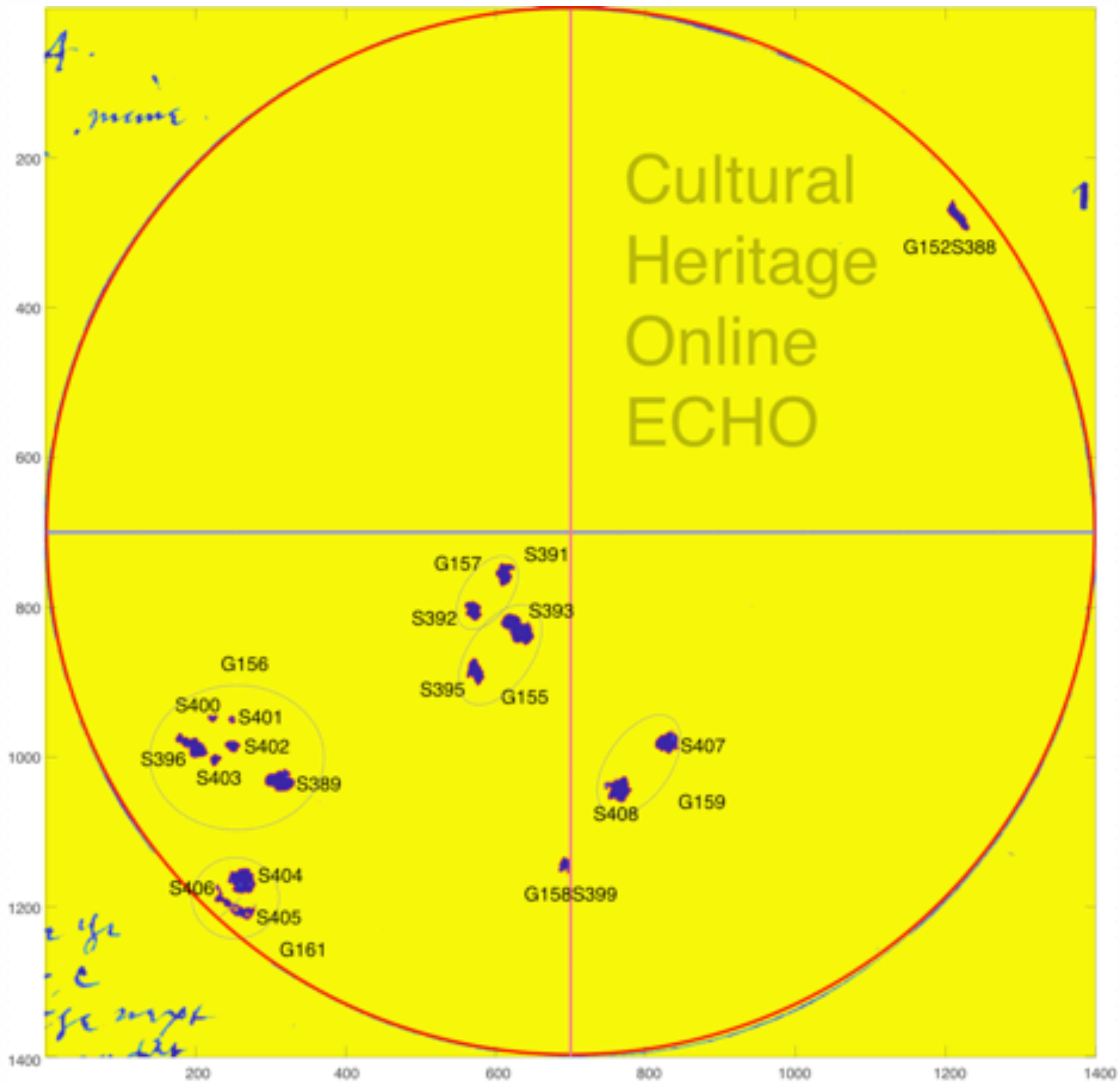
Method II



Positions of individual sunspots are in Data

	Method I		Method II	
Group (G)	Lat (deg)	Long (deg)	Lat (deg)	Long (deg)
152	-12.74	224.53	-18.18	221.36
155	5.5	139.67	6.94	137.66
156	20.55	103	25.01	101.9
157	10.12	143.44	11.16	141.89
158	-15.44	120.82	-12.2	117.02

Open catalog of historical sunspot drawings



Open catalog of historical sunspot drawings

Sunspots from the past

About | Methods | Drawings | Data

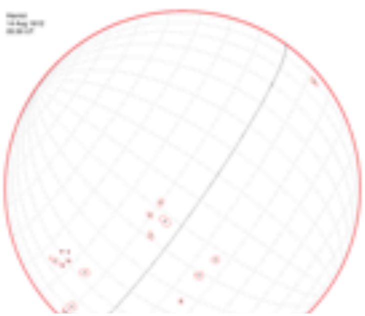
12 Aug 1612 <-- 14 Aug 1612 --> 17 Aug 1612

Thomas Harriot

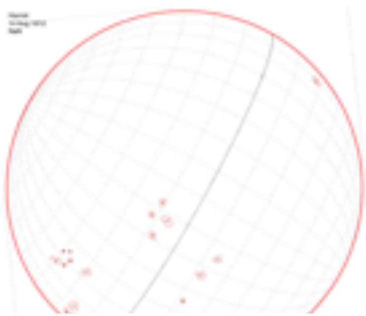
Original note:
Syon. August. 4. Mars. ho. 5. (5 1/2 mane.
Thick ayer only.
16 spots in all.
The 2 uppermost of the 5, small dim & intereminate(?)
The long spot nere the limbe long & very dim, & interminate. The next also not black & somewhat interminate.

Group (G)	Area (msh)
152	499
155	510
156	1001
157	275
158	91
159	496
160	1466

Method I



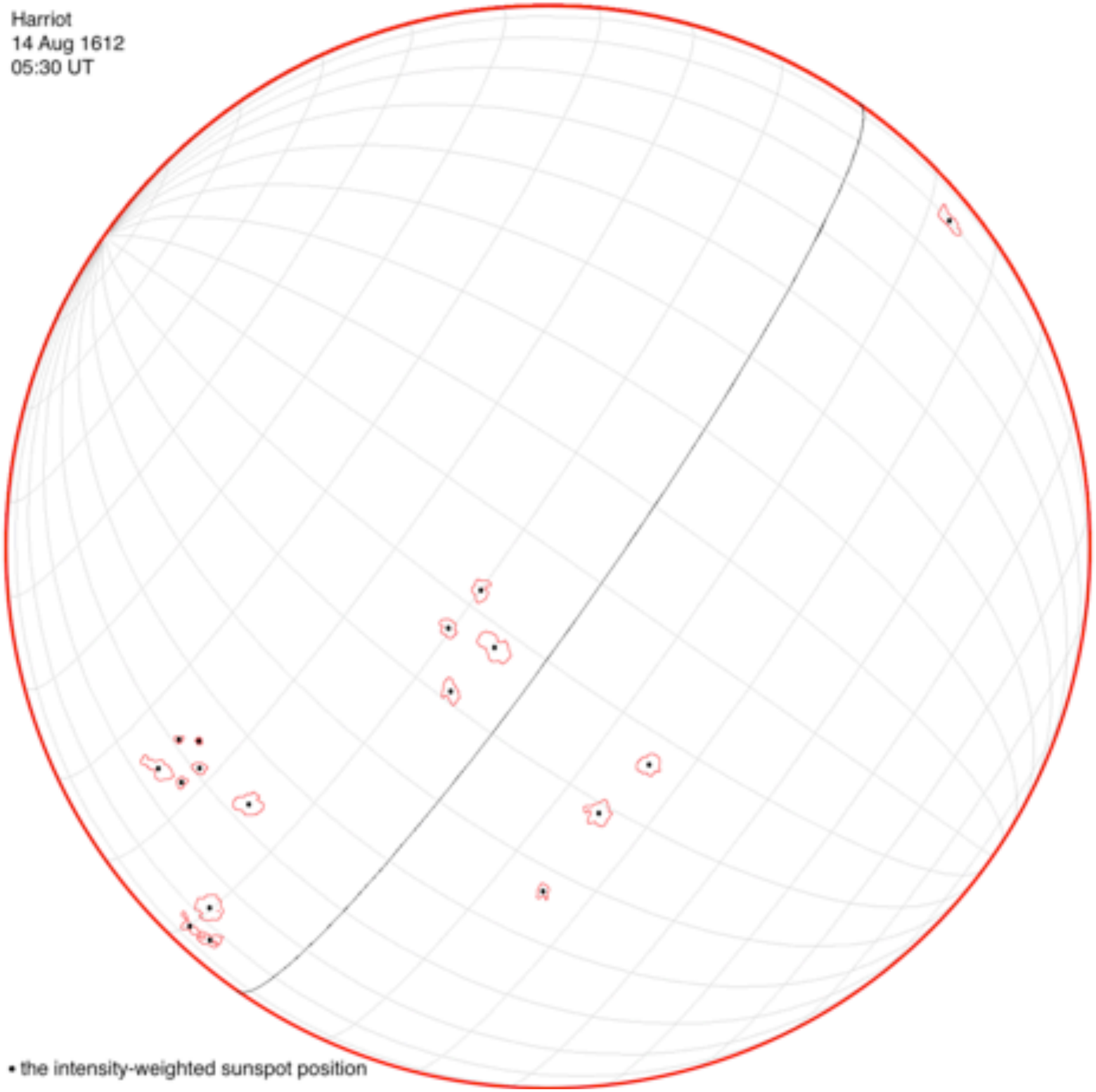
Method II



Positions of individual sunspots are in Data

	Method I		Method II	
Group (G)	Lat (deg)	Long (deg)	Lat (deg)	Long (deg)
152	-12.74	224.53	-18.18	221.36
155	5.5	139.67	6.94	137.66
156	20.55	103	25.01	101.9
157	10.12	143.44	11.16	141.89
158	-15.44	120.82	-12.2	117.02

Open catalog of historical sunspot drawings



Open catalog of historical sunspot drawings

Sunspots from the past

About | Methods | Drawings | Data

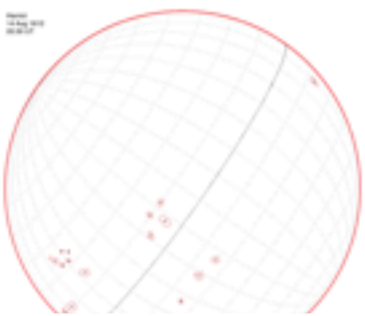
12 Aug 1612 <-- 14 Aug 1612 --> 17 Aug 1612

Thomas Harriot

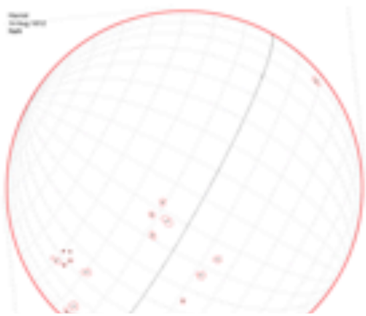
Original note:
Syon. August. 4. Mars. ho. 5. (5 1/2 mane.
Thick ayer only.
16 spots in all.
The 2 uppermost of the 5, small dim & intereminate(?)
The long spot nere the limbe long & very dim, & interminate. The next also not black & somewhat interminate.

Group (G)	Area (msh)
152	499
155	510
156	1001
157	275
158	91
159	496
160	1466

Method I



Method II



Positions of individual sunspots are in Data

	Method I		Method II	
Group (G)	Lat (deg)	Long (deg)	Lat (deg)	Long (deg)
152	-12.74	224.53	-18.18	221.36
155	5.5	139.67	6.94	137.66
156	20.55	103	25.01	101.9
157	10.12	143.44	11.16	141.89
158	-15.44	120.82	-12.2	117.02

Open catalog of historical sunspot drawings

Sunspots from the past

About | Methods | Drawings | Data

Sunspot data

To define sunspot positions, we applied two methods (see Heliocoordinates). Both of them only optimize latitudes of sunspots, omitting their longitudinal displacement. The first one (Method I) exploits the time of observation provided by the observer. Another method (Method II) to extract sunspot positions does not take into account time of observation. Its goal is to minimize the cumulative latitude dispersion of sunspots.

The question arises: **the results of which method are more relevant?** Both methods have their advantages, nevertheless, in general, we would recommend exploiting both sunspot latitudes and longitudes from Method I. Method II itself is not aimed to precisely define the time of observation, but gives the best image rotation to define an average picture of sunspot positions. Results of Method II became more relevant comparing to those of Method I, if they were derived from small schematic drawings or in the case of large uncertainties, e.g. if the drawings were made without a projection apparatus. In these cases, sunspot data should be taken with extreme care.

Observer	Data			Reference
Thomas Harriot 18 Dec 1610 – 28 Jan 1613	Method I	Method II	GN	VAZ, 2020
Lodovico Cardi known as Cigoli 18 Febr – 23 Mar, 29 Apr – 6 May 18–25 Aug 1612	Method I	Method II	GN	VAZ, 2021
Galileo Galilei 12 Febr – 3 May 1612 19–21 Aug 1612	Method I	Method II	GN	VAZ, 2021
Galileo Galilei 3–11 May, 2 Jun – 8 Jul 1612		Method II	GN	VZ, 2018
Sigismondo di Cologna 6 Sept – 9 Oct 1612	Method I	Method II	GN	VAZ, 2021
Fabio Colonna 1 Aug – 30 Sept 1613, 3 Oct 1614; Christoph Scheiner 1 Aug 1613	Method I	Method II	GN	VAZ, 2021
Petrus Saxonius 5–27 Mar 1616		Method II	GN	VZ, 2023
Pierre Gassendi 1633 – 1638		Method II	GN	VZ, 2018

Open catalog of historical sunspot drawings

Sunspot positions and areas from observations by Thomas Harriot defined by Vokhmyanin, Arlt, and Zolotova (in Solar Physics 2020, v. 295:39; https://doi.org/10.1007/s11207-020-01604-4).

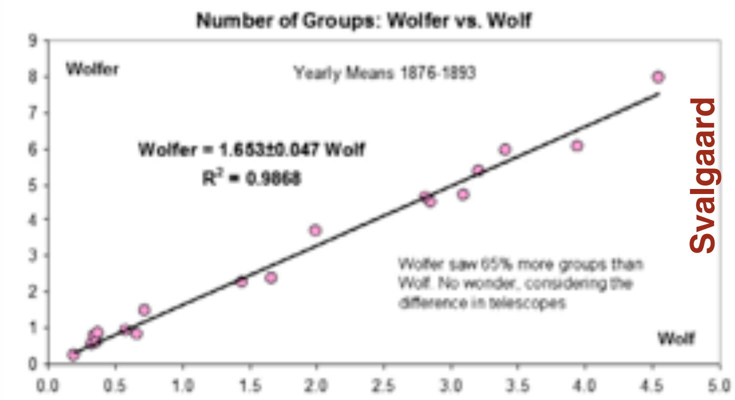
Method I: sunspot positions are defined according to the time of observation reported be Harriot (time_1).
To compensate for possible inaccuracies in the time measurement in the seventeenth century, we introduced a window of one hour (+-0.5 hour around time_1; we also add sunrise-sunset limits) inside of which we minimize the difference between a sunspot latitude on a given day and the average latitude of this object over the preceding drawings (first run) and over subsequent drawings (second run).
After several iterations and calculation of a weighted mean of these two runs, we determine the rotation angle (Rot) of each image. Precisely, we find the orientation of the solar axis (the angle between solar axis and zenith direction) which is Rot = P - q, where P is the position angle of the northern extremity of the solar rotation axis measured eastwards from the north point of the solar disc, q is the parallactic angle (the angle from the north celestial pole, not from the zenith). Finally, these parameters specify the local time (HH and MI) of the observation and other ephemeris, which in turn define sunspot heliocoordinates.
Commonly, the procedure is the same as in Method II, but here the rotation of images were limited in range of +-0.5 hour around Harriot's time of observation (time_1).

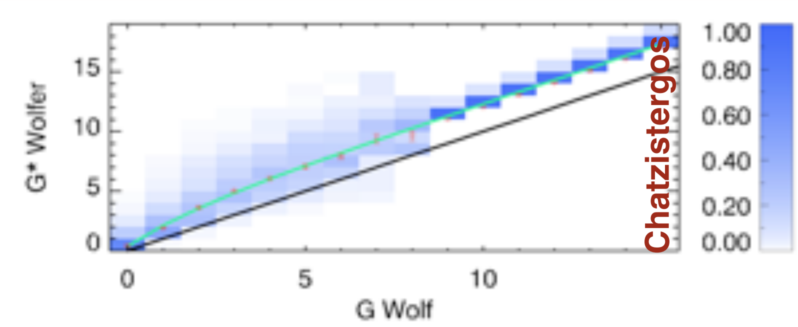
Draw - number of drawing according to Harriot's numeration;
Place - location of observation;
YYYY - Year;
MM - Month;
DD - Day;
HH - UT Hour (Time of observation defined by us);
MI- Minute (Time of observation defined by us);
G - Arbitrary number of a sunspot group;
Sp - Arbitrary number of a sunspot;
BBB.BB - Heliographic latitude. Southern latitudes are negative;
LLL.LL - Heliographic longitude in the Carrington rotation frame;
B0 - Heliographic latitude of apparent disk center;
L0 - Heliographic longitude of apparent disk center;
P - Position angle;
Rot - Rotation angle of solar image in x-y plane;
q - Parallactic angle;
Alt - Altitude;
Azm - Azimuth;
Area - Area in millionths of the solar hemisphere (msh);
alpha - angular distance on the surface of the Sun from the center of the disk to the object;
time_1 time_2 and time_3 - Time of observation noted by Harriot.

Draw	Place	YYYY	MM	DD	HH	MI	G	Sp	BBB.BB	LLL.LL	B0	L0	P	Rot	q	Alt	Azm	Area	alpha	time_1	time_2 and time_3	
0	Syon	1610	12	18	9	15	1	1	-21.73	245.18	-2.01	218.16	8.52	32.46	-23.95	7.16	143.28	1126	32.86	Alt 7-8	mane	
0	Syon	1610	12	18	9	15	2	2	-30.54	223.74	-2.01	218.16	8.52	32.46	-23.95	7.16	143.28	1098	29.02	Alt 7-8	mane	
0	Syon	1610	12	18	9	15	3	3	33.79	211.82	-2.01	218.16	8.52	32.46	-23.95	7.16	143.28	826	36.29	Alt 7-8	mane	
NaN	Syon	1611	1	29	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	Harriot observed, but did not saw spots
1	Syon	1611	12	11	9	59	4	4	20.05	205.84	-1.1	172.41	11.87	29.47	-17.6	11.41	153.47	793	38.99	10	NaN	
1	Syon	1611	12	11	9	59	5	5	-23.63	145.29	-1.1	172.41	11.87	29.47	-17.6	11.41	153.47	718	34.61	10	NaN	
1	Syon	1611	12	11	9	59	6	6	6.91	120.17	-1.1	172.41	11.87	29.47	-17.6	11.41	153.47	1918	52.73	10	NaN	
2	Syon	1611	12	13	9	0	4	4	26.14	207.66	-1.35	146.6	10.98	36.47	-25.49	6.2	140.56	1738	64.92	8.5	8.75	
2	Syon	1611	12	13	9	0	5	5	-14.7	140.15	-1.35	146.6	10.98	36.47	-25.49	6.2	140.56	786	14.8	8.5	8.75	
2	Syon	1611	12	13	9	0	6	6	10.69	114.87	-1.35	146.6	10.98	36.47	-25.49	6.2	140.56	1035	33.78	8.5	8.75	
2	Syon	1611	12	13	9	0	6	7	16.08	119.31	-1.35	146.6	10.98	36.47	-25.49	6.2	140.56	1097	32.09	8.5	8.75	
2	Syon	1611	12	13	9	0	6	8	19.74	112.85	-1.35	146.6	10.98	36.47	-25.49	6.2	140.56	515	39.24	8.5	8.75	
2	Syon	1611	12	13	9	0	6	9	14.79	107.54	-1.35	146.6	10.98	36.47	-25.49	6.2	140.56	491	41.88	8.5	8.75	
2	Syon	1611	12	13	9	0	7	10	-26.71	201.4	-1.35	146.6	10.98	36.47	-25.49	6.2	140.56	681	58.31	8.5	8.75	
2	Syon	1611	12	13	9	0	7	11	-32.79	200.25	-1.35	146.6	10.98	36.47	-25.49	6.2	140.56	882	59.27	8.5	8.75	
NaN	Syon	1611	12	14	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	NaN	9.5	NaN	Harriot saw sunspots, but weather conditions are not allowed to make a drawing
3	Syon	1611	12	15	9	53	5	5	-18.77	139.64	-1.6	119.77	10.04	28.73	-18.7	10.59	151.79	845	25.96	10	10.25	
3	Syon	1611	12	15	9	53	6	6	7.67	119.28	-1.6	119.77	10.04	28.73	-18.7	10.59	151.79	912	9.29	10	10.25	
3	Syon	1611	12	15	9	53	6	7	13.68	114.35	-1.6	119.77	10.04	28.73	-18.7	10.59	151.79	798	16.2	10	10.25	
3	Syon	1611	12	15	9	53	6	8	13.1	106.86	-1.6	119.77	10.04	28.73	-18.7	10.59	151.79	454	19.5	10	10.25	
3	Syon	1611	12	15	9	53	6	9	8.06	111.23	-1.6	119.77	10.04	28.73	-18.7	10.59	151.79	958	12.88	10	10.25	
3	Syon	1611	12	15	9	53	8	12	5.81	72.9	-1.6	119.77	10.04	28.73	-18.7	10.59	151.79	600	47.38	10	10.25	
4	Syon	1611	12	18	9	49	6	6	4.12	120.97	-1.98	80.28	8.62	28.07	-19.45	10.06	150.63	809	41.11	9.5	NaN	
4	Syon	1611	12	18	9	49	6	7	11.3	115.02	-1.98	80.28	8.62	28.07	-19.45	10.06	150.63	533	37	9.5	NaN	

Why do we need an open catalog of historical sunspot drawings?

observer #1	observer #2
11	5
12	8
18	7
24	5
23	6
26	7
22	3
18	6
15	3
11	7
11	6
12	8
17	6
25	8
23	3
25	7
19	9
15	2
13	8
11	6



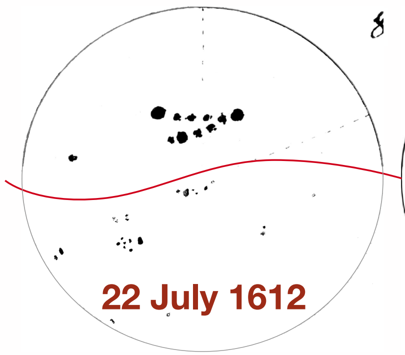


$GN_1=k\cdot GN_2$

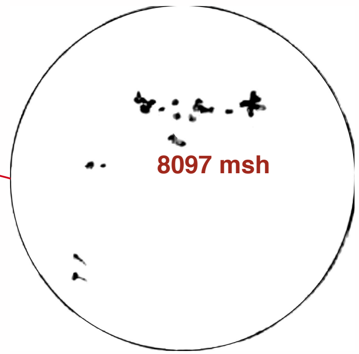
Reconstructed sunspot parameters crucially depend on the observation technique and size of drawings;

Analysis of original drawings may improve recalibration of the Sunspot-Number

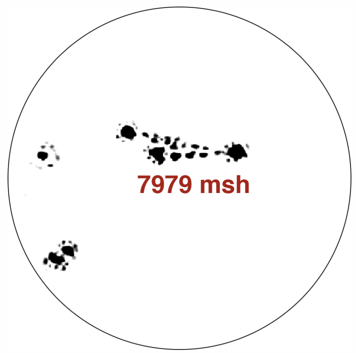
Harriot 3 May 1612



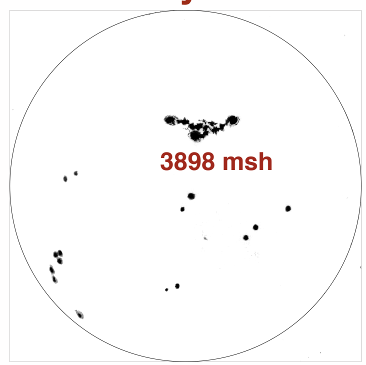
Cigoli 3 May 1612



Galilei 3 May 1612



Galilei 3 May 1612



Conclusions

We reconstruct numbers, areas (umbra and penumbra) and positions of individual sunspots and their groups in the 17th century. An open catalog of historical sunspot drawings may be helpful for the sunspot-number recalibration effort.

The majority of the observations by the Eimmart Observatory were primarily for astrometric purposes (like solar altitude measurements) rather than aimed at counting sunspots. The same is suggested for the observations by La Hire in Paris.

Long-living sunspots apparently were an activity nests or magnetic activity complex, where new magnetic flux emerges near a pre-existing active region.

The spatio-temporal distribution of sunspots is gradually reconstructed. The butterfly pattern is persisted in the 17th century.

ned@geo.phys.spbu.ru