

Het Noorderlicht

Versie 2024-04-16

Het Noorderlicht

Leidse Weer- en Sterrenkundige Kring

2024-04-16



Het Noorderlicht

Leidse Weer- en Sterrenkundige Kring

2024-04-16

Cees Ooms













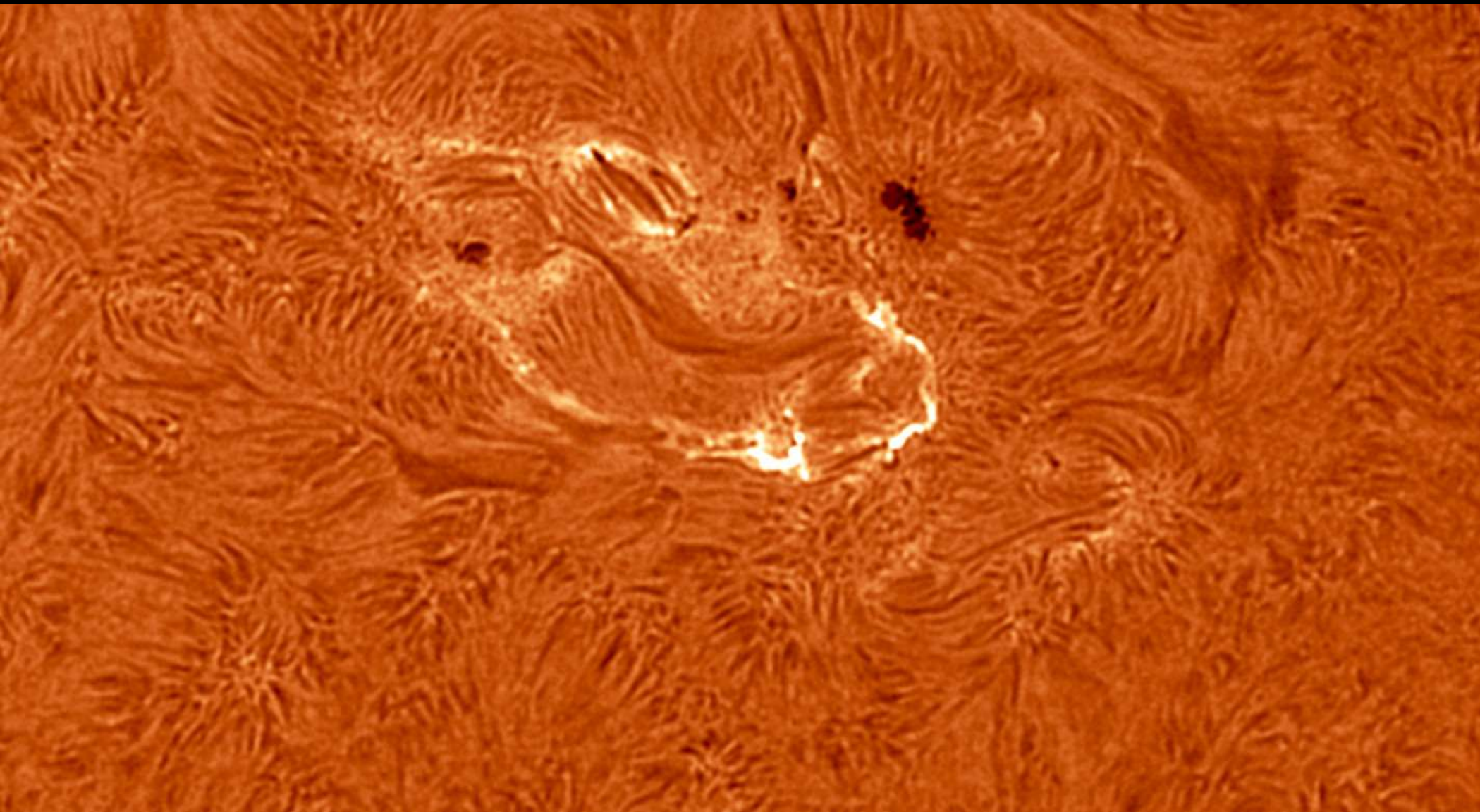


Noorderlicht op 200 km hoogte aan nachtkant aarde.
Door geladen deeltjes van de zon?

Ruimteweer *Space Weather*

- Processen in:
 - ARs (Active Regions) zon;
 - Magnetosfeer & atmosfeer aarde.
- *Geladen deeltjes van de zon veroorzaken Noorderlicht, maar botsen niet.....*
- Zon in H-alpha.

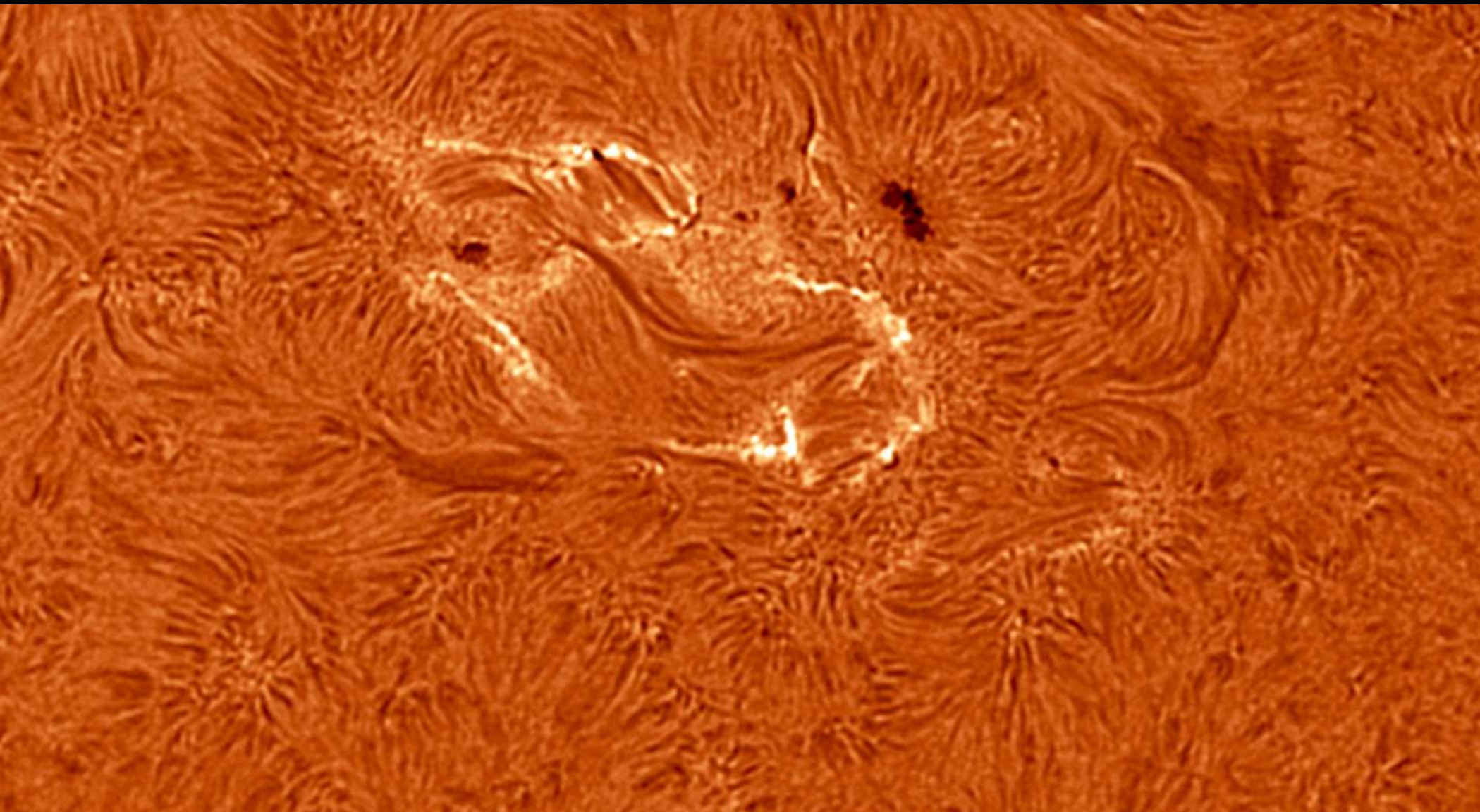




2023-06-24

Zon H-alpha

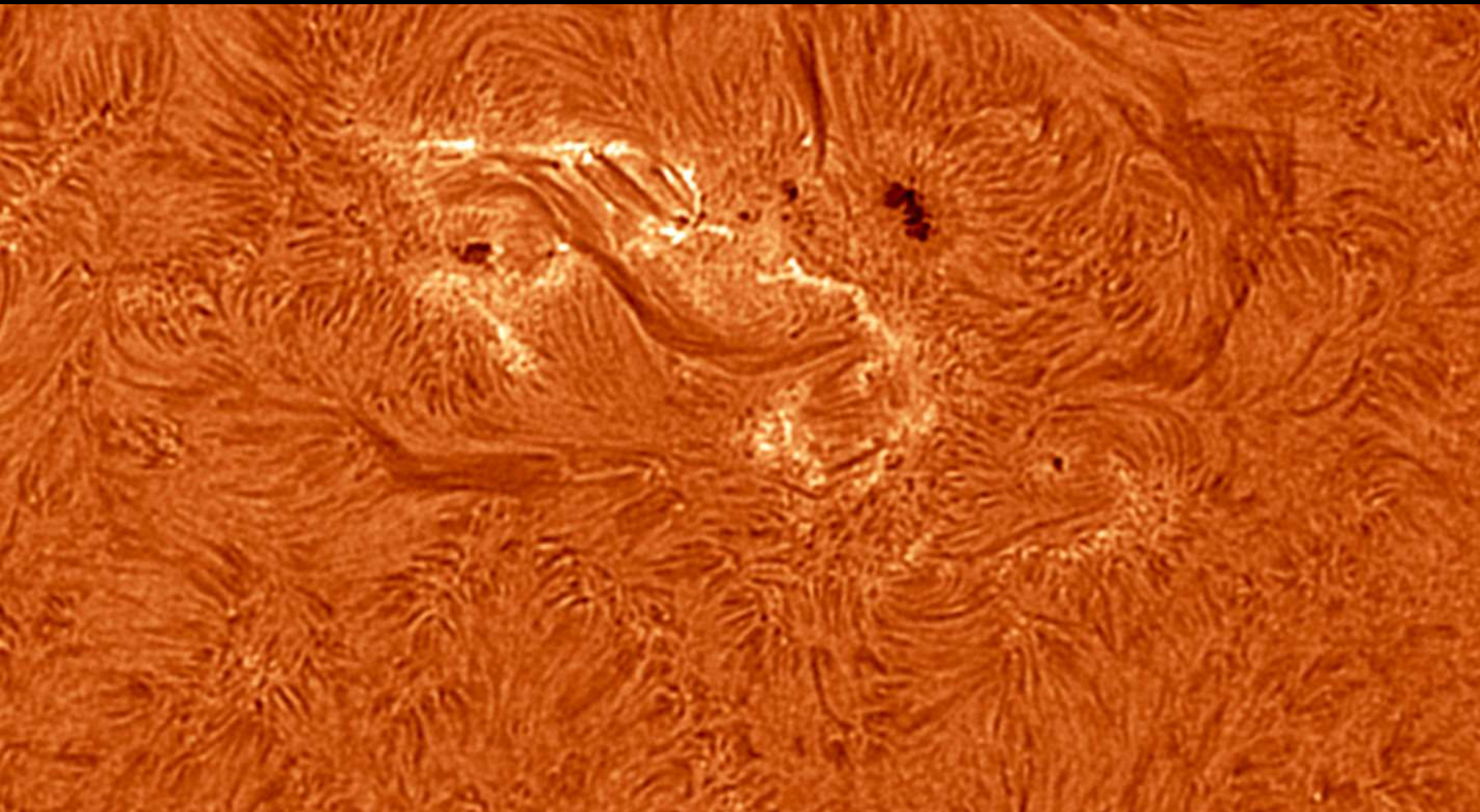
12:05 uur



2023-06-24

Zon H-alpha

12:20 uur



2023-06-24

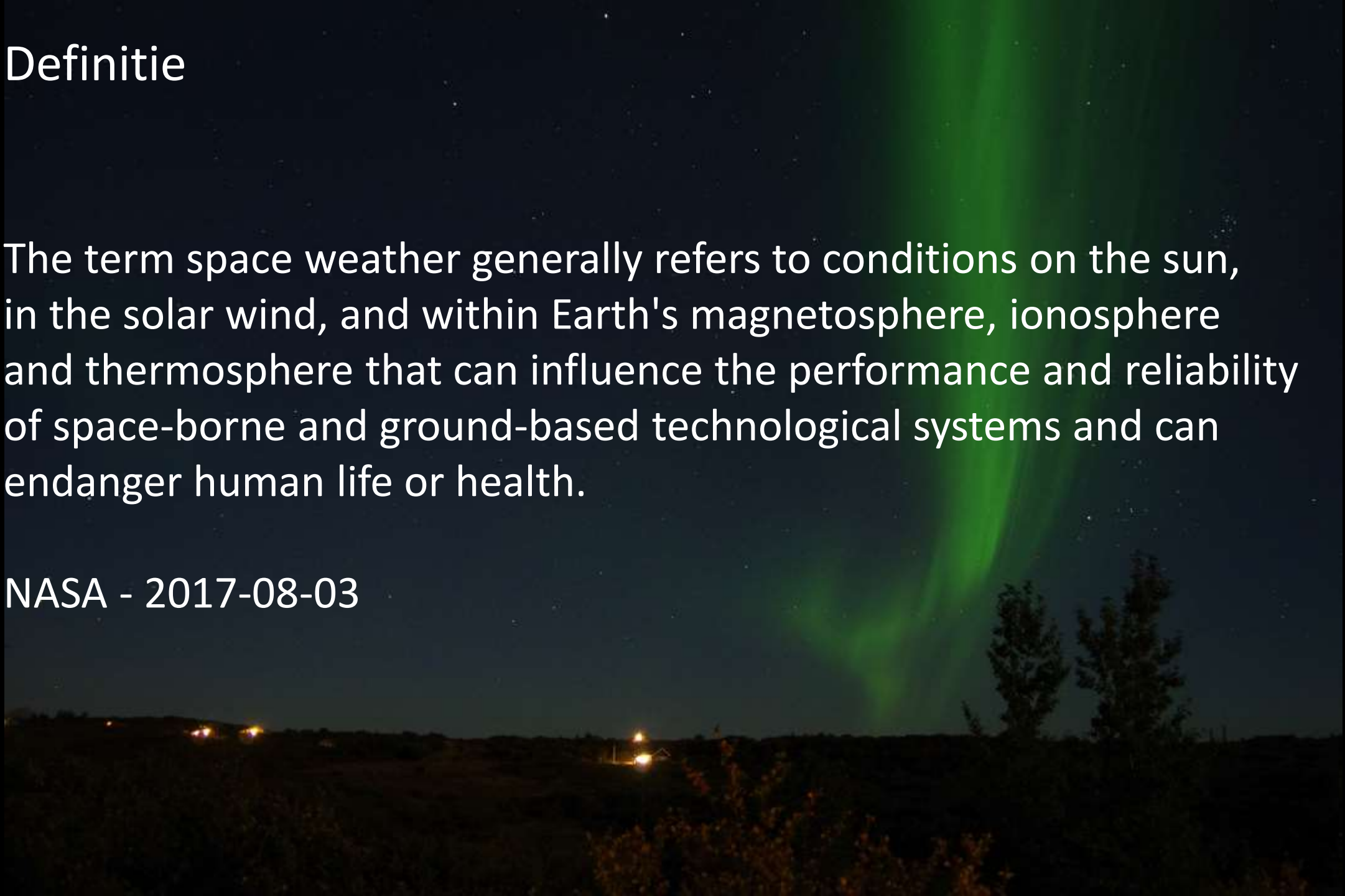
Zon H-alpha

12:35 uur

Definitie

The term space weather generally refers to conditions on the sun, in the solar wind, and within Earth's magnetosphere, ionosphere and thermosphere that can influence the performance and reliability of space-borne and ground-based technological systems and can endanger human life or health.

NASA - 2017-08-03



AGENDA

1 Inleiding

Actueel ruimteweerbericht
Space Weather onderdelen

2 Processen zon & aarde

Magnetische reconnectie
Zon
Aarde
Werking Noorderlicht

3 Ruimteweerbericht

2023-10-15 voorbeeld 3-Day Forecast
Noorderlicht voorspellen
Noorderlicht NL 2023-02-27
2022-10-09 ARs 3112 & 3116

1 Inleiding

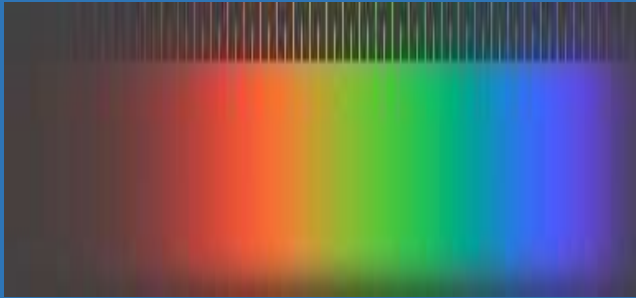
Ruimteweerbericht 2024-04-16



Ruimteweerbericht 2024-04-16

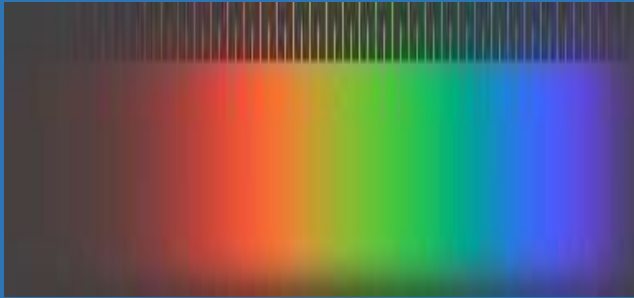


Straling van de zon



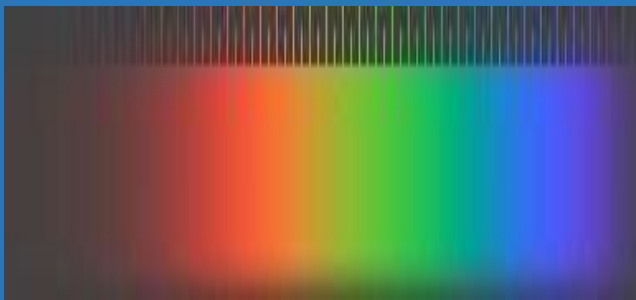
Radio IR Zichtbaar licht UV

Straling van de zon



Radio IR Zichtbaar licht UV X-ray

Straling van de zon

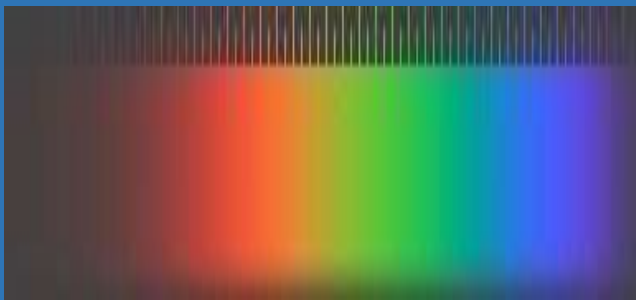


Radio IR Zichtbaar licht UV X-ray



R

Straling van de zon



Radio

IR

Zichtbaar licht

UV

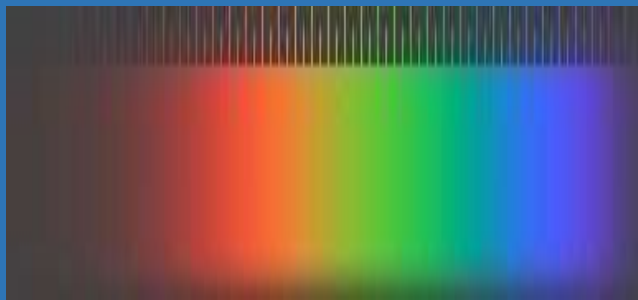
X-ray

SEPs



R

Straling van de zon



Radio

IR

Zichtbaar licht

UV

X-ray

SEPs

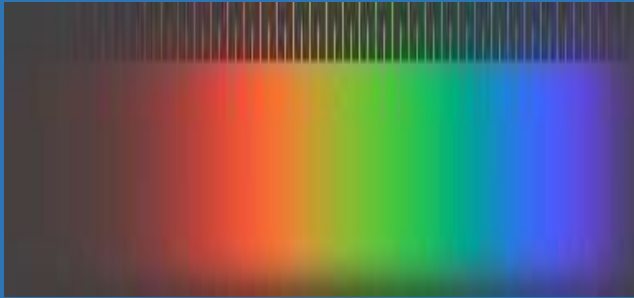
*Solar
Energized
Particles*
50.000

km/sec



R

Straling van de zon



Radio

IR

Zichtbaar licht

UV

X-ray

SEPs

*Solar
Energized
Particles*

50.000

km/sec

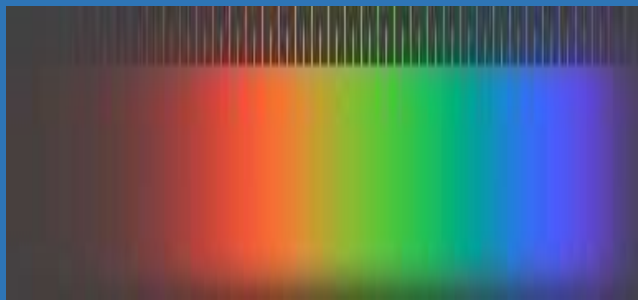


R



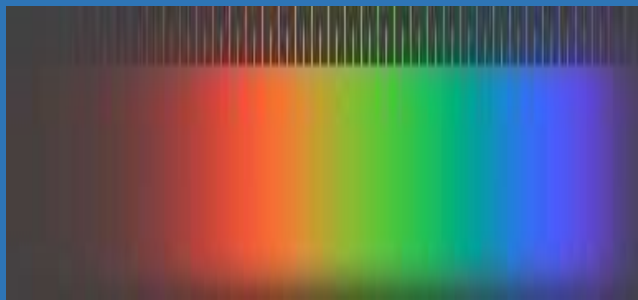
S

Straling van de zon



Radio	IR	Zichtbaar licht	UV	X-ray	SEPs	Zonnewind
					<i>Solar Energized Particles</i>	
					50.000	500 km/sec
				↓	↓	
				R	S	

Straling van de zon



Radio

IR

Zichtbaar licht

UV

X-ray

SEPs

Zonnewind

*Solar
Energized
Particles*

50.000

500 km/sec



R



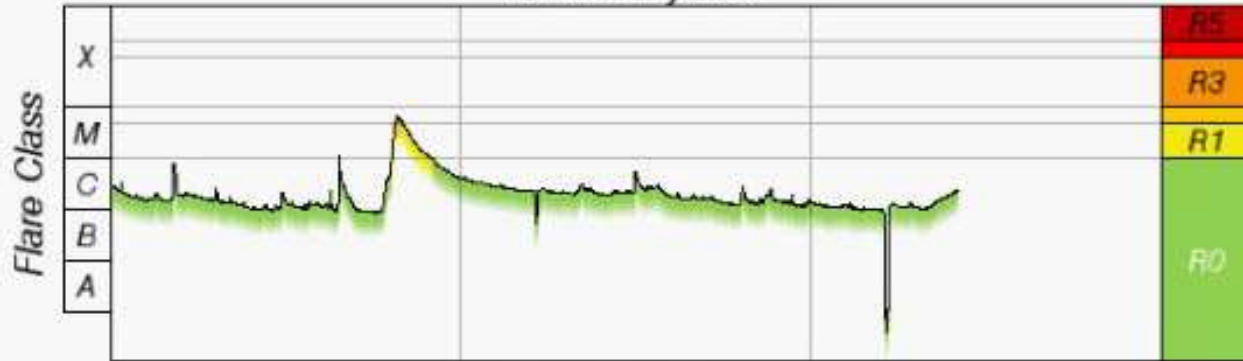
S



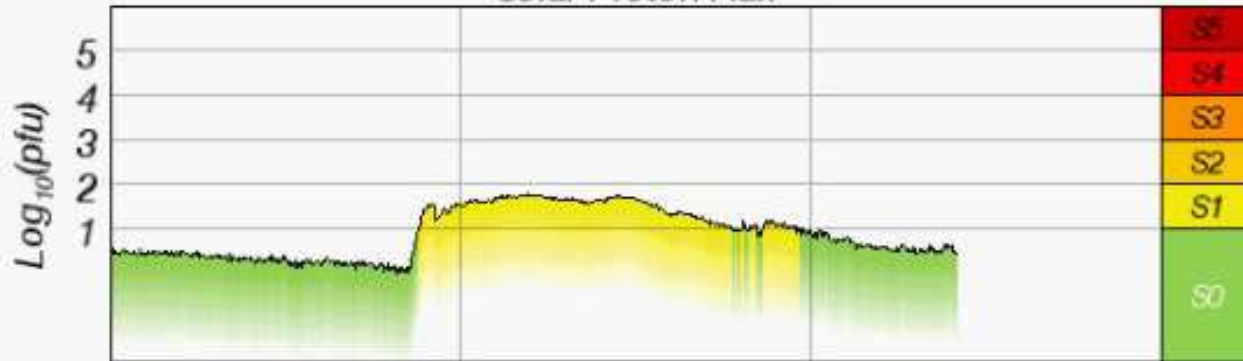
G

SPACE WEATHER OVERVIEW

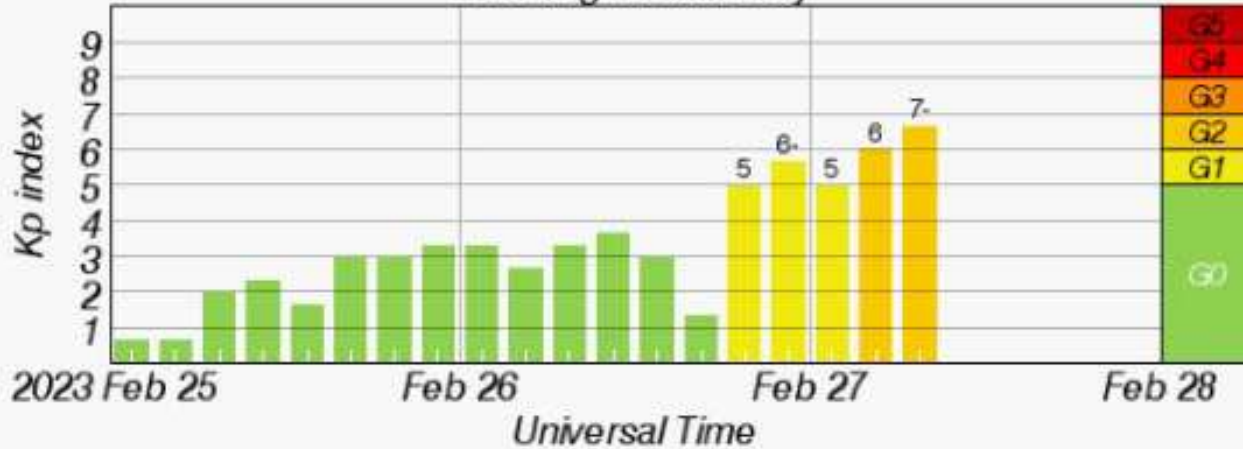
Solar X-ray Flux



Solar Proton Flux

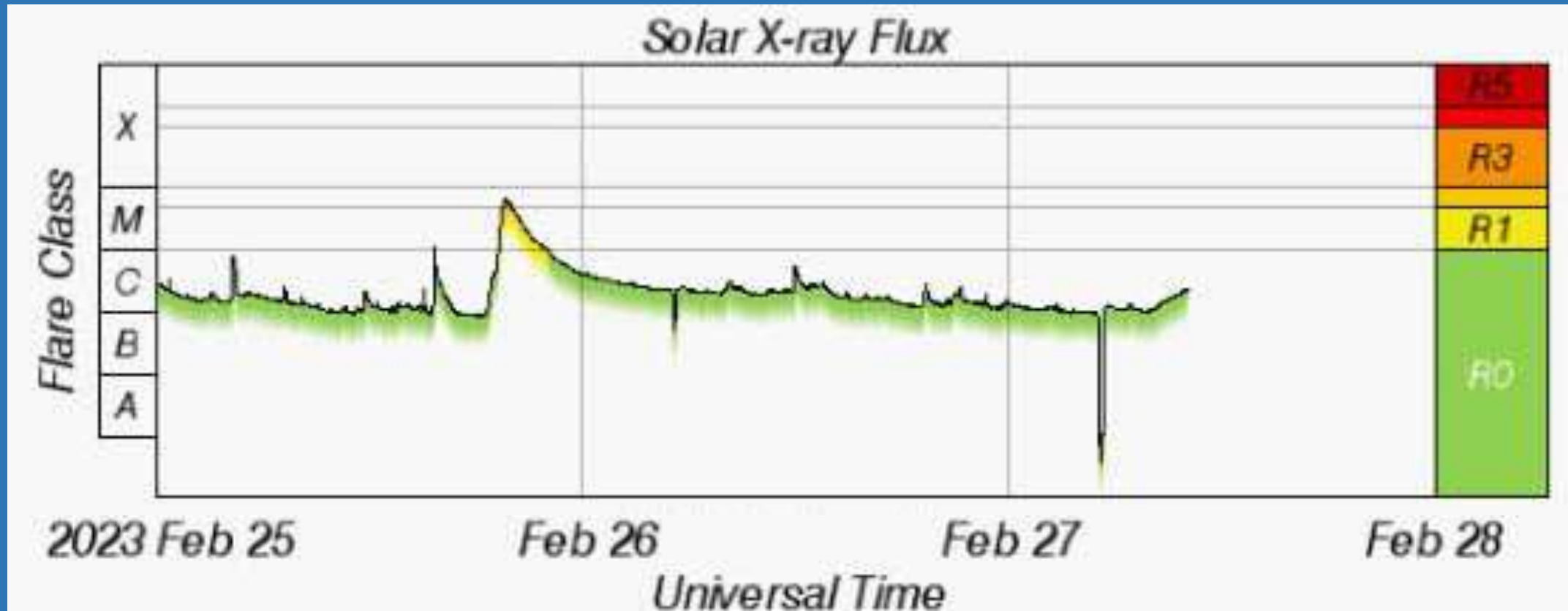


Geomagnetic Activity



Ruimte weerbericht 2023-02-27

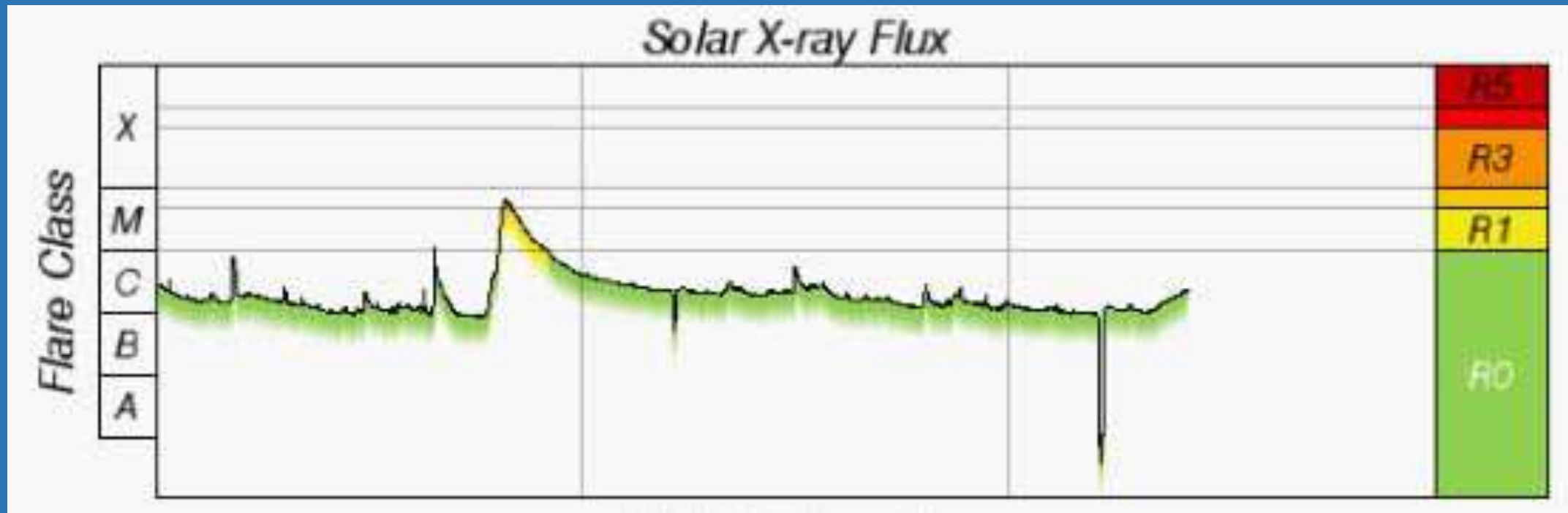
R



Atmosfeer aarde beschermt 100 %.

Hoog in de atmosfeer en in de ruimte: ionisatie.

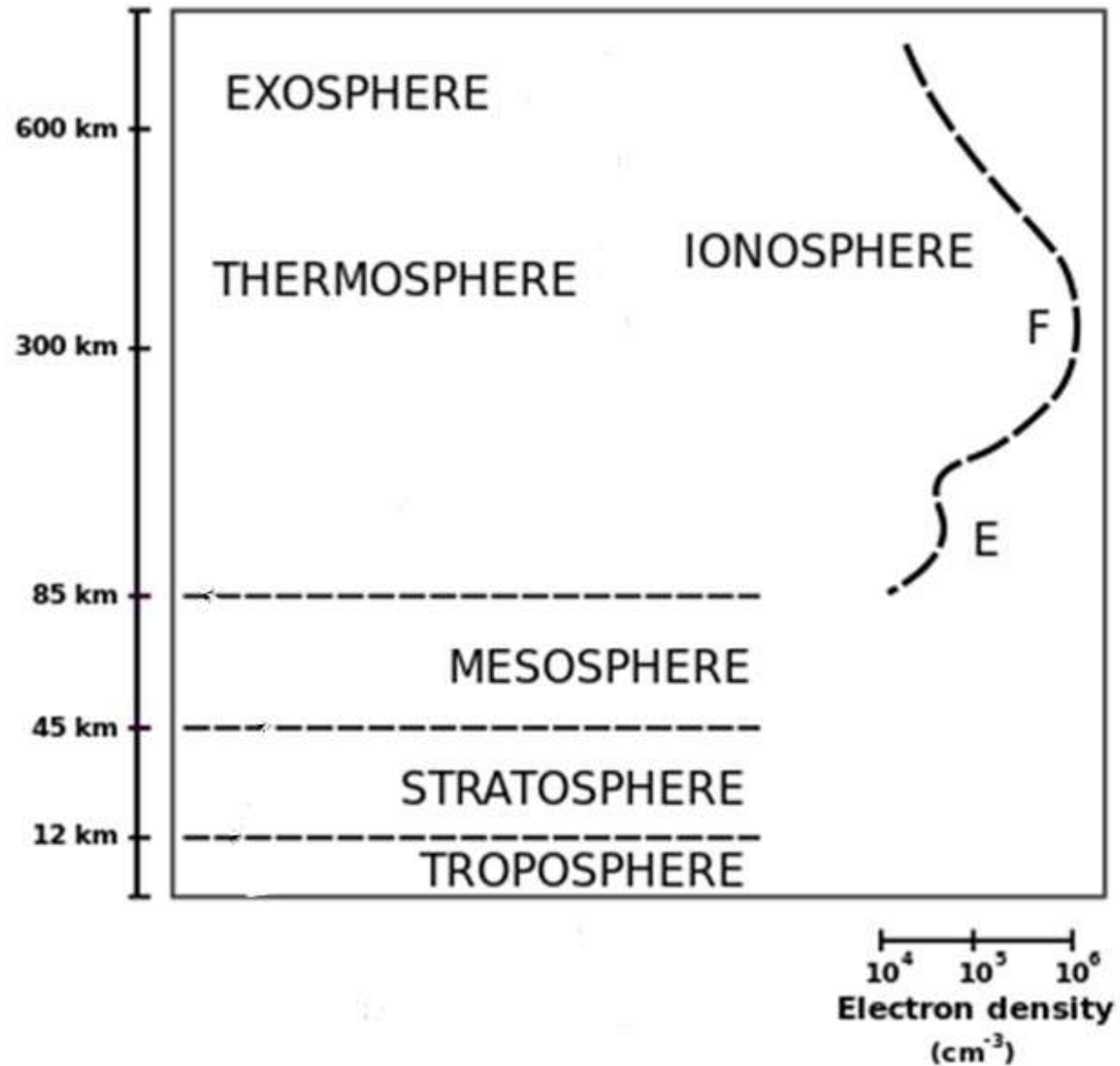
R



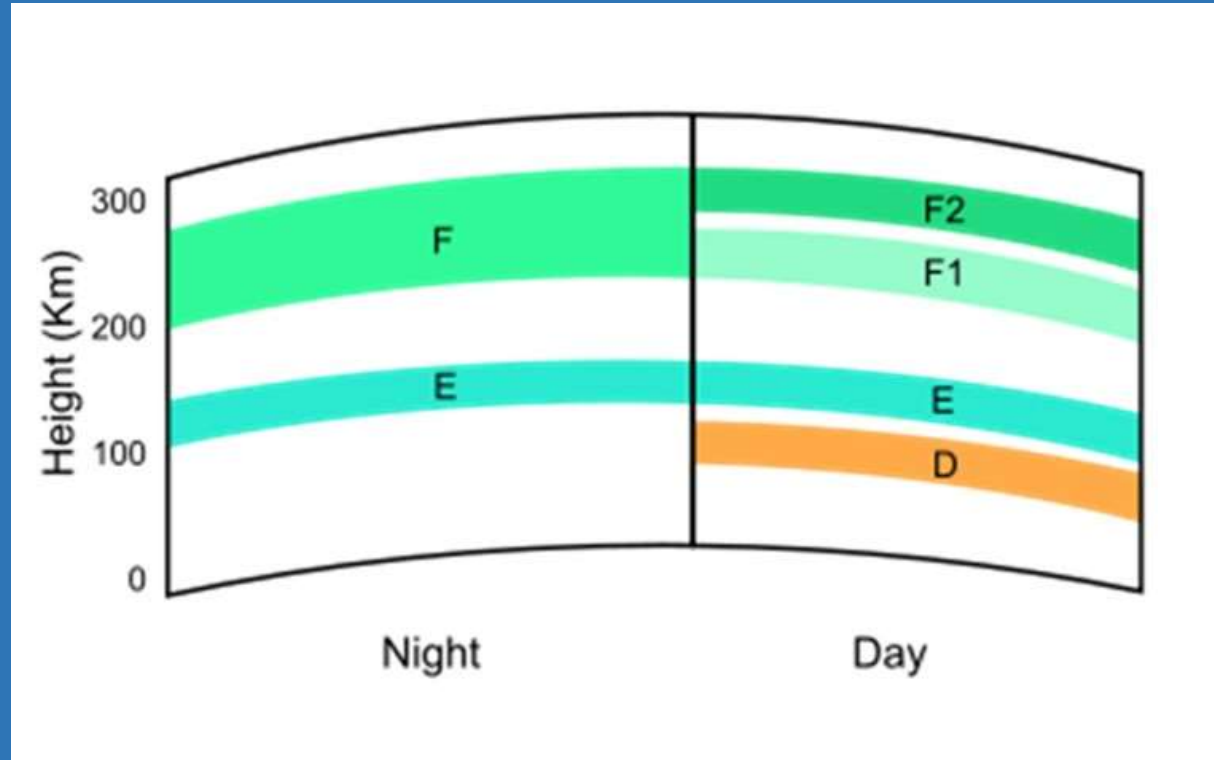
Max peak soft X-rays:

X-Ray Flare	Flux (W/m ²)	Severity Descriptor	
X20	0,002	Extreme	R5
X10	0,001	Severe	R4
X1	0,0001	Strong	R3
M5	0,00005	Moderate	R2
M1	0,00001	Minor	R1

R

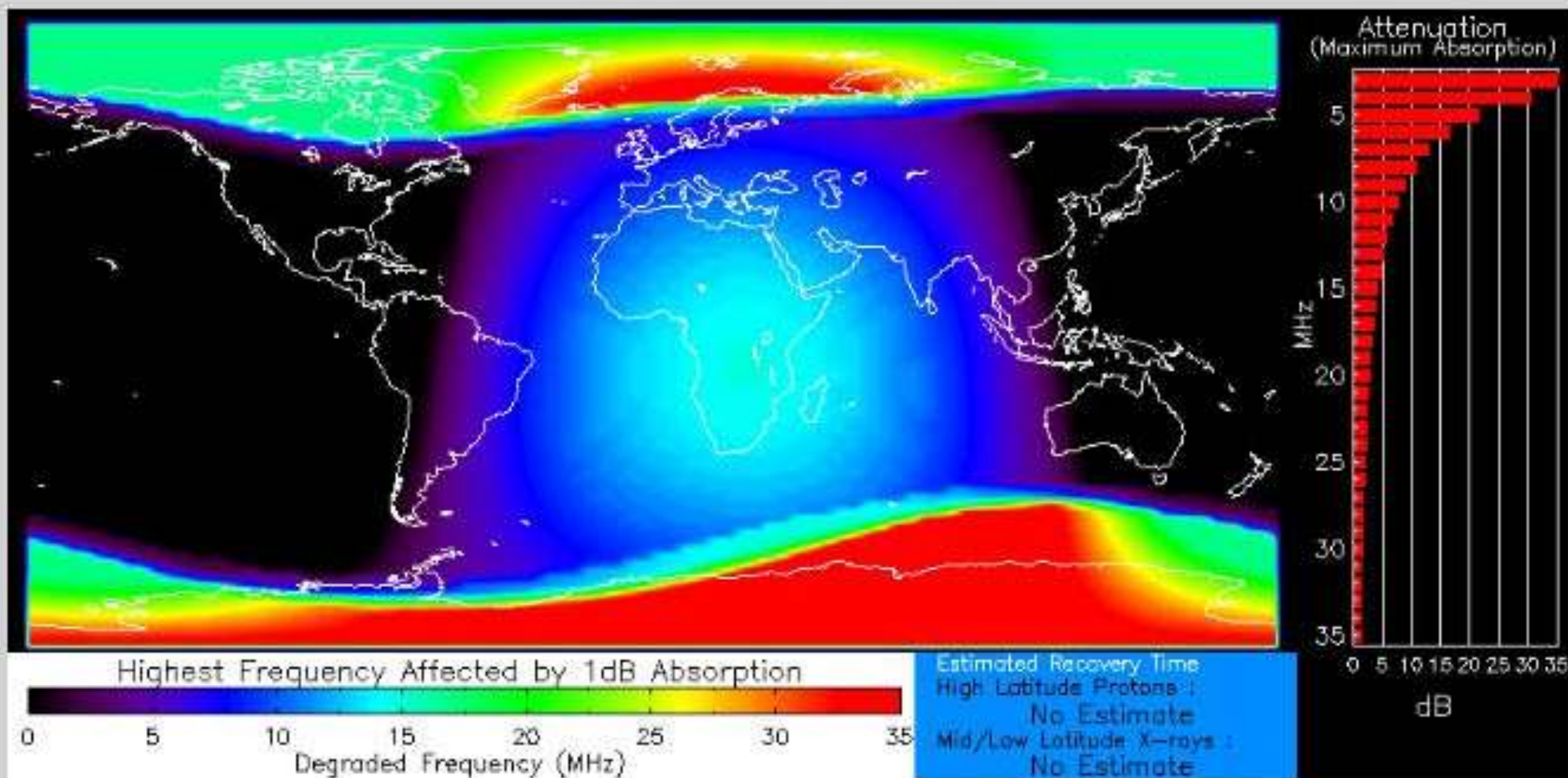


Ionosfeer



D Region Absorption

D REGION ABSORPTION PREDICTION



Elevated X-ray flux
Product Valid At : 2023-02-27 10:15 UTC

Normal Proton Background
NOAA/SWPC Boulder, CO USA

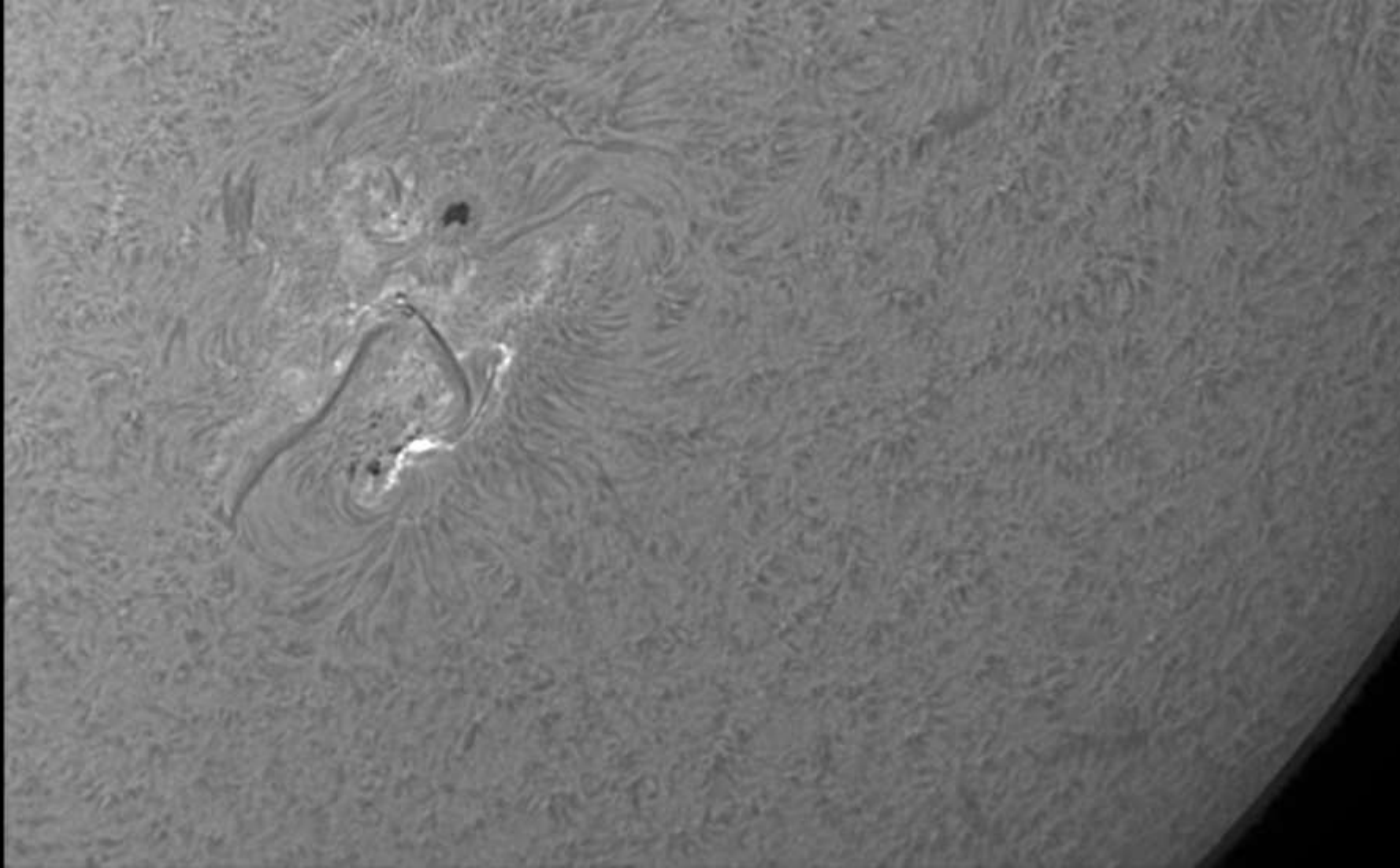
Effecten R

Astronauten;
Satellieten;
GPS;
Satelliet verbindingen;
Radio verbindingen.

R-storm: enkele keren per week.

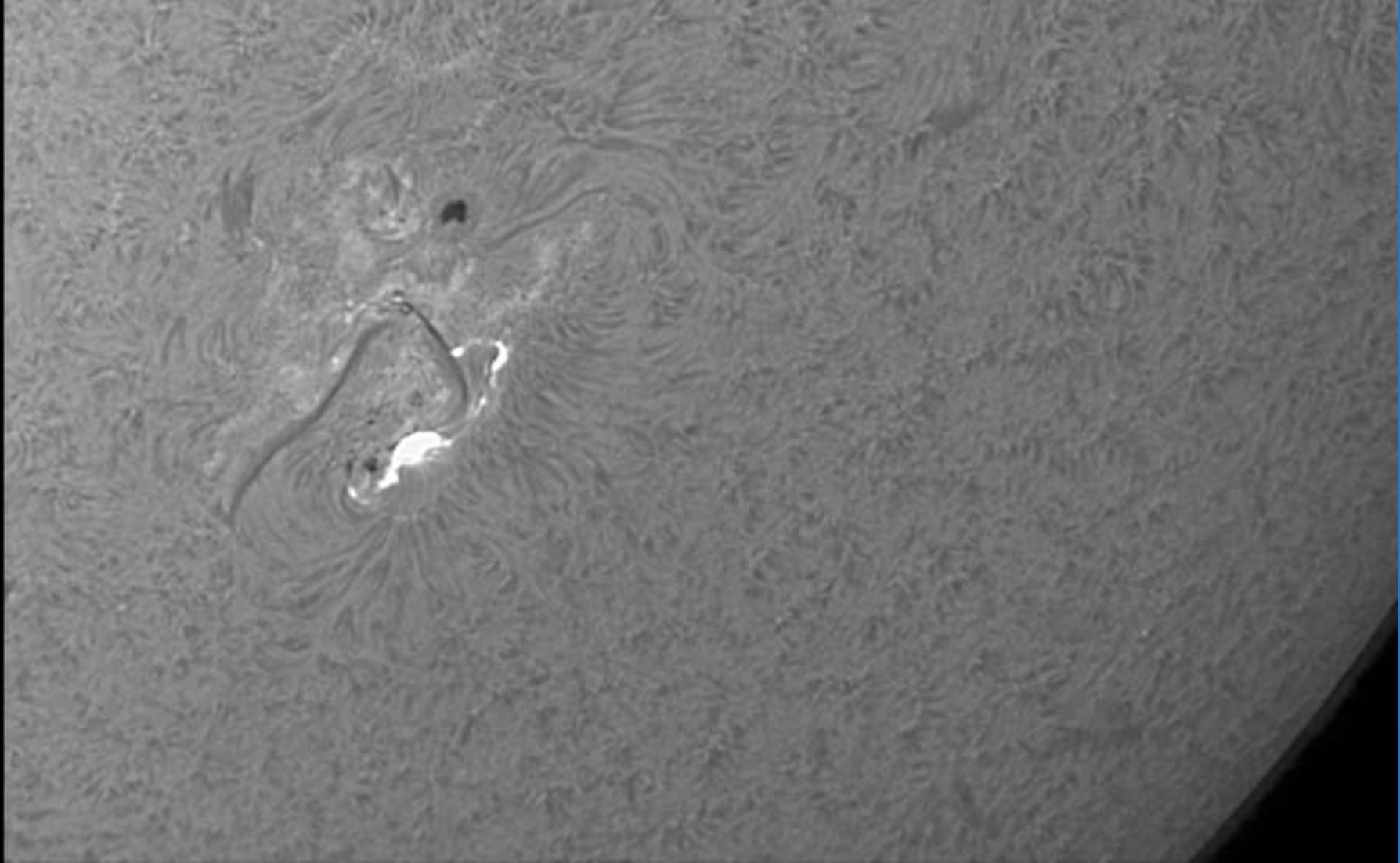


R-flare 2021-10-28

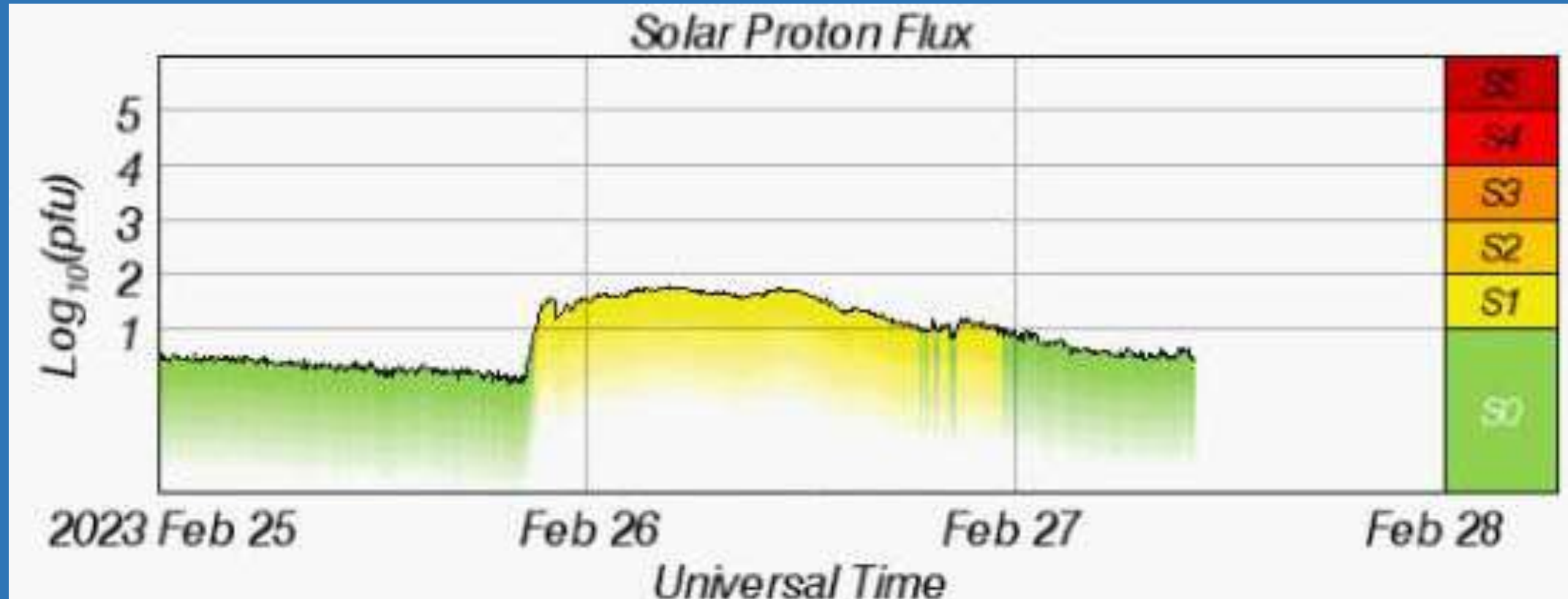


Volgende H-alpha foto is 30 sec later.

R-flare 2021-10-28



S



Atmosfeer aarde beschermt niet volledig.

Kettingreactie met fonteynen van hoog energetische deeltjes.
Hoogste flux secundaire deeltjes op 18 km hoogte.

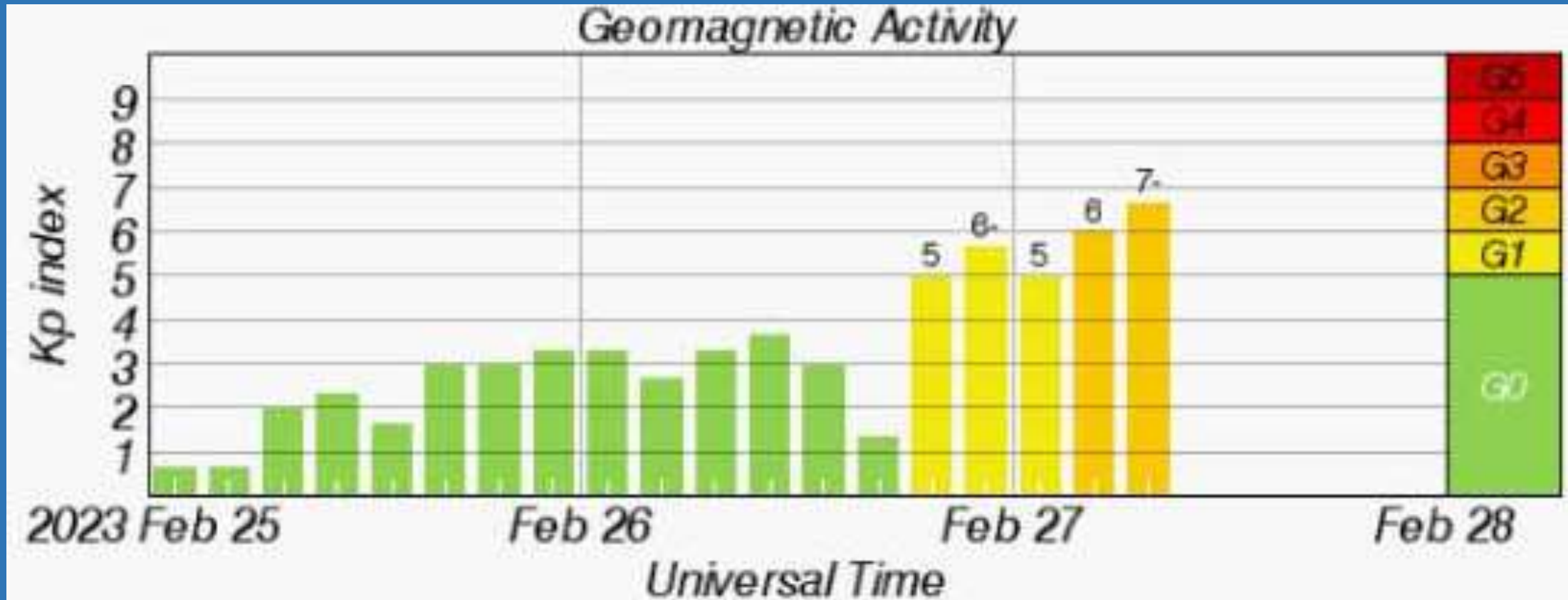
Effecten S

Astronauten;
Satellieten;
Bemanning vliegtuigen.

S-storm: enkele keren per jaar.

Dark 2019-02-23

G



Magneetveld aarde beschermt niet altijd.

Door **G-storm** wordt het magneetveld van aarde aan de dag-kant verder gecomprimeerd én ontstaan **Sub-storms**.

Effecten G

Satellieten;
Hoogspanning systemen;
Noorderlicht.

G-activiteit ($K_p > 3$): enkele keren per week.



Hoofdstuk 2 – Processen zon & aarde

Magnetische reconnectie



Plasma

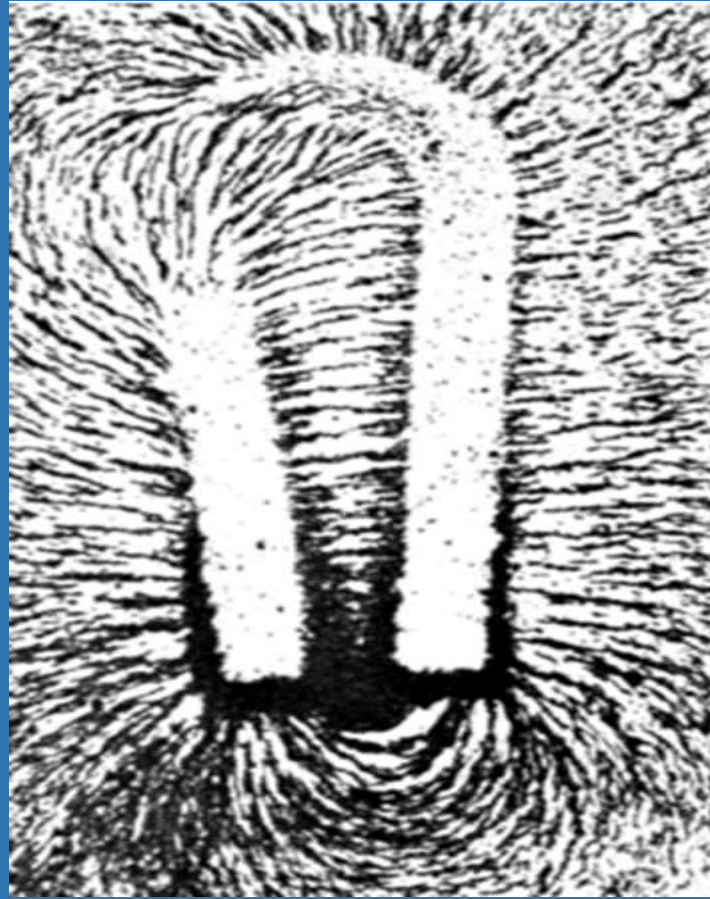
Aggregatietoestanden:

- Vast;
- Vloeibaar;
- Gas;
- Plasma.

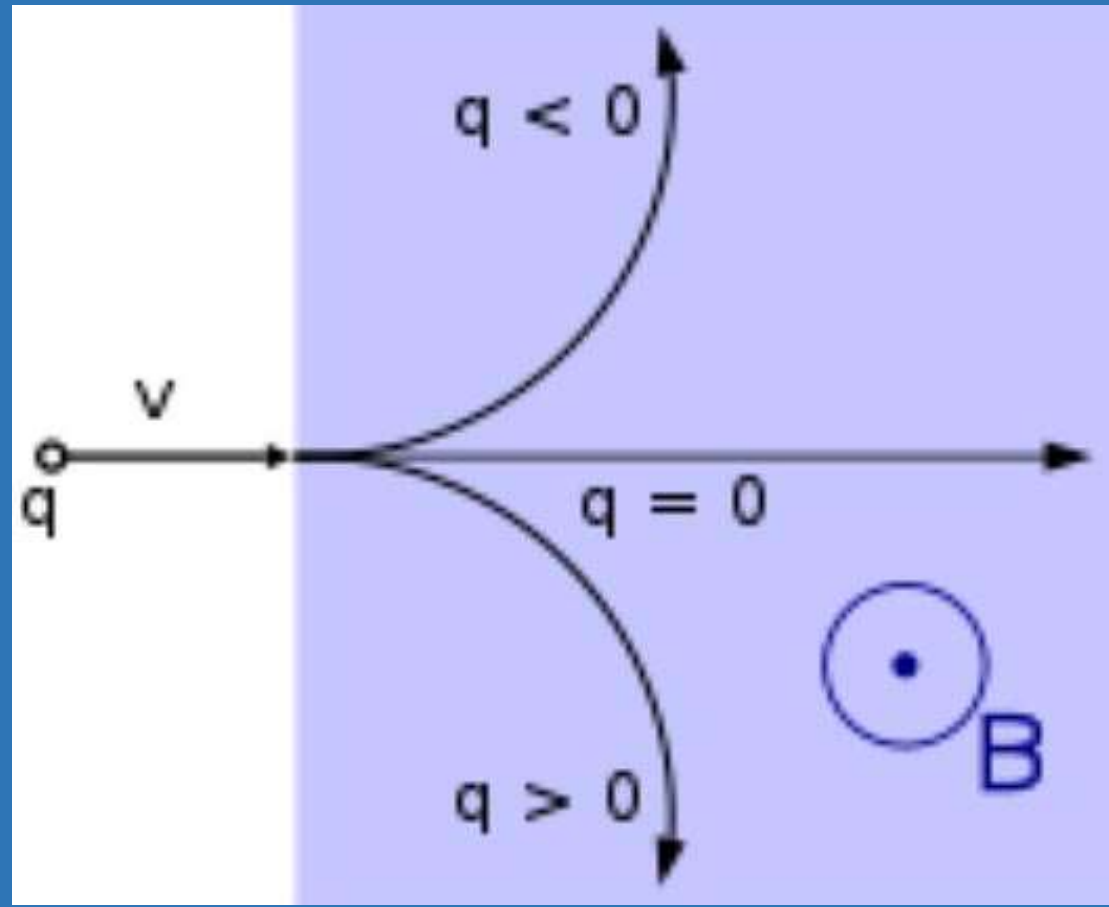
Plasma is een elektrisch geleidend gas met positieve ionen en elektronen.



Magnetische velden



Magnetische veldlijnen



Lorentz kracht

Magnetische velden

Hersenactiviteit:	0,001 nT (nanotesla)
	25
Magneetveld aarde (evenaar):	50.000
Koelkastmagneet:	5.000.000
Buitenkant zon	150.000.000
Zonnevlekken	500.000.000
Magneet grote luidspreker	1.000.000.000
1 G (gauss)	= 100.000

Magnetohydrodynamica (MHD) beschrijft beweging elektrisch geleidend gas (plasma) óf vloeistof in een magnetisch veld.

Grondlegger is Hannes Alfvén - 1970 Nobelprijs natuurkunde.

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“Frozen-in flux” benadering van Alfvén:

- Magnetische veldlijnen behouden hun identiteit;
- Magnetische veldlijnen kunnen niet breken;
- Wanneer plasma beweegt, wordt magnetisch veld meegenomen en wanneer magnetisch veld beweegt wordt plasma meegenomen;
- Wanneer twee plasma hoeveelheden op een moment door een magnetische veldlijn zijn verbonden, dan blijven ze dat altijd.

“Frozen-in flux” geldt wanneer geleidbaarheid plasma oneindig is:
Ideaal MHD (weerstand = 0).

Plasma moet ook ijl zijn, zodat onderlinge ionenbotsingen van ondergeschikt belang zijn.

Volgens “Frozen-in flux” blijft het plasma altijd binnen een klein gebied rond de magnetische veldlijnen.

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Plasma moet ook ijl zijn, zodat onderlinge ionenbotsingen van ondergeschikt belang zijn.

Volgens “Frozen-in flux” blijft het plasma altijd binnen een klein gebied rond de magnetische veldlijnen.

Peter Sweet en Eugene Parker hebben in de jaren 1950 gewerkt aan een theorie die het wel mogelijk maakt magnetische veldlijnen met verschillende oorsprong te openen en weer te sluiten tot een magnetisch veld met andere samenhang en oriëntatie.

SP-theorie was 50 jaar bepalend voor “Magnetic reconnection”,
een verschijnsel dat zich overal in de ruimte voordoet.

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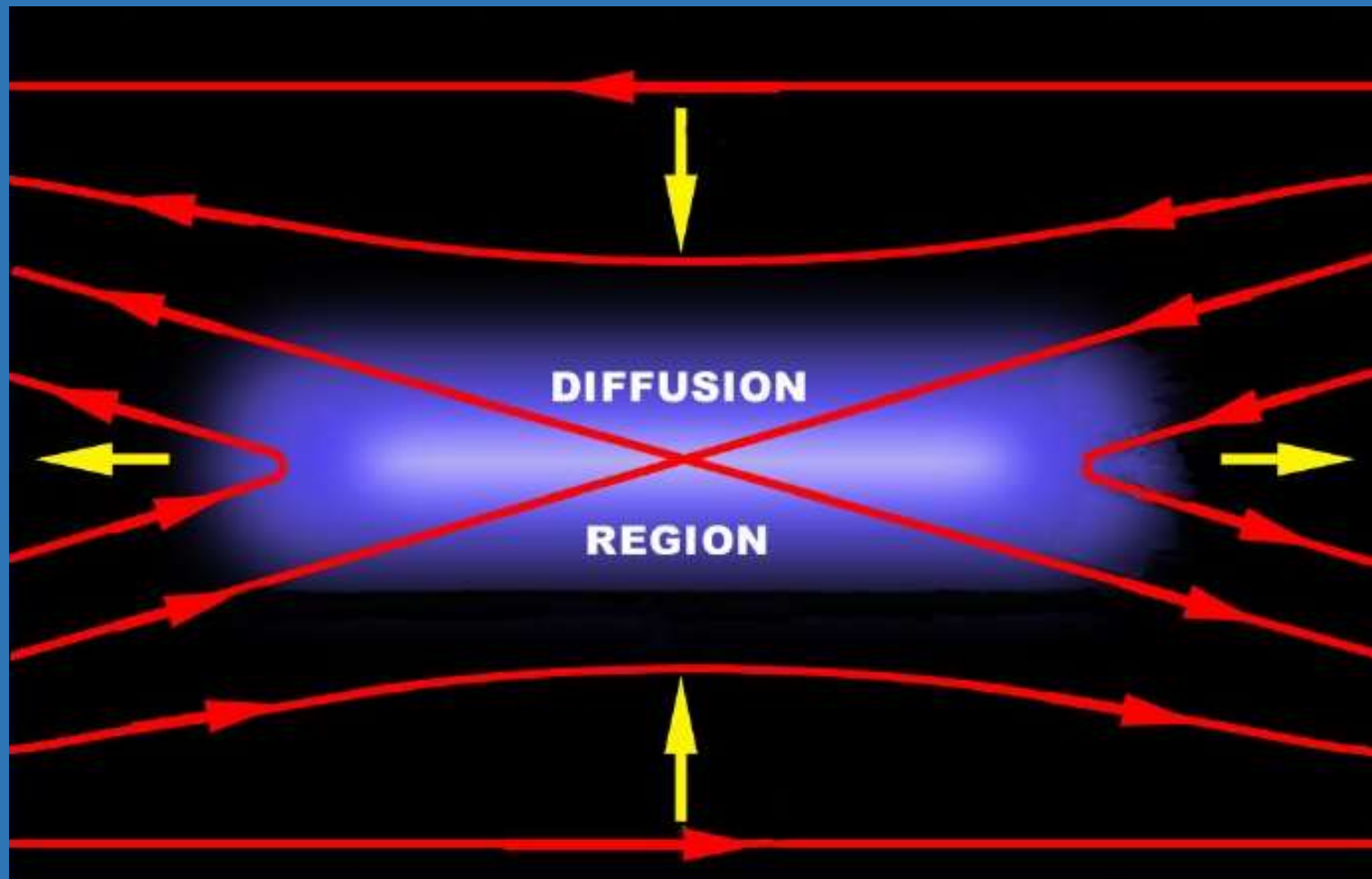
Magnetic reconnection:

- Reconfiguration of magnetic field in a plasma;
- Violent release of energy;
- Particle acceleration.

&

- Breaking of the frozen-in flux constraint of Ideal MHD.

Magnetische reconnectie volgens SP:

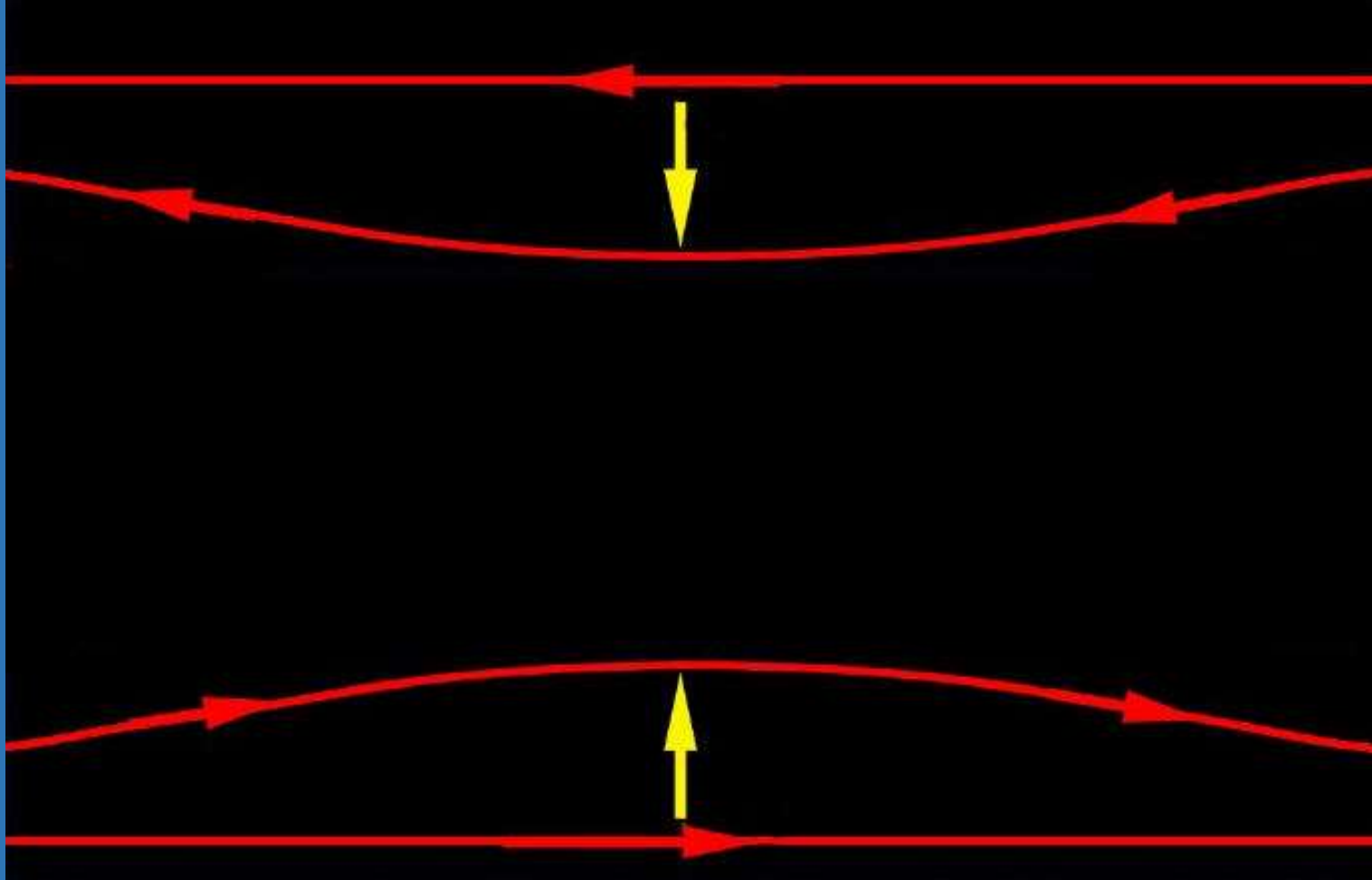


Uitgangspunten:

Systeem is stabiel (ideaal MHD);

Elektronen stromen in een richting loodrecht op de tekening (plasma).

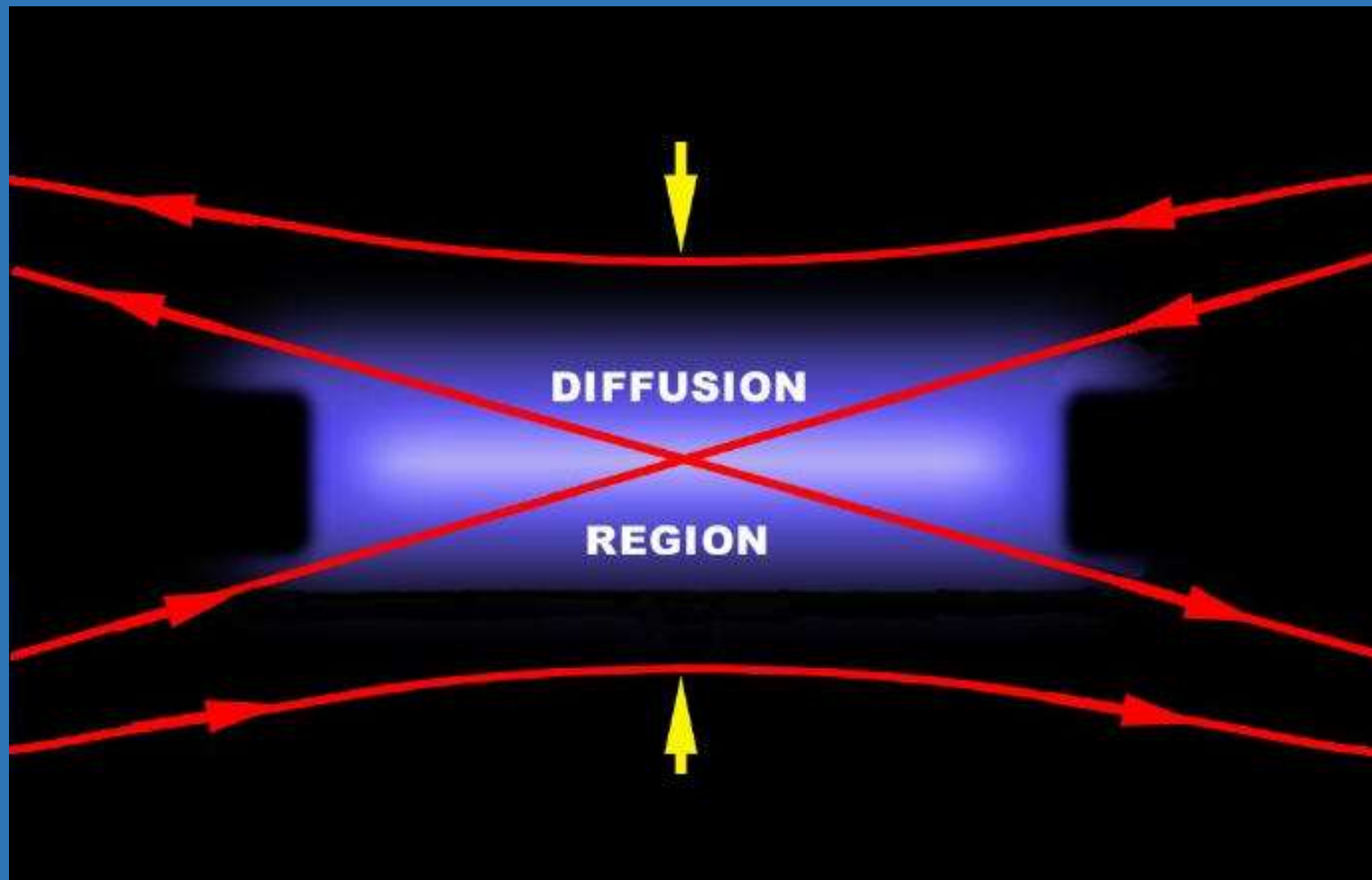
Magnetische reconnectie volgens SP:



Stap 1:

Parallele magnetische veldlijnen, met tegengestelde veldrichting, bewegen naar elkaar.

Magnetische reconnectie volgens SP:

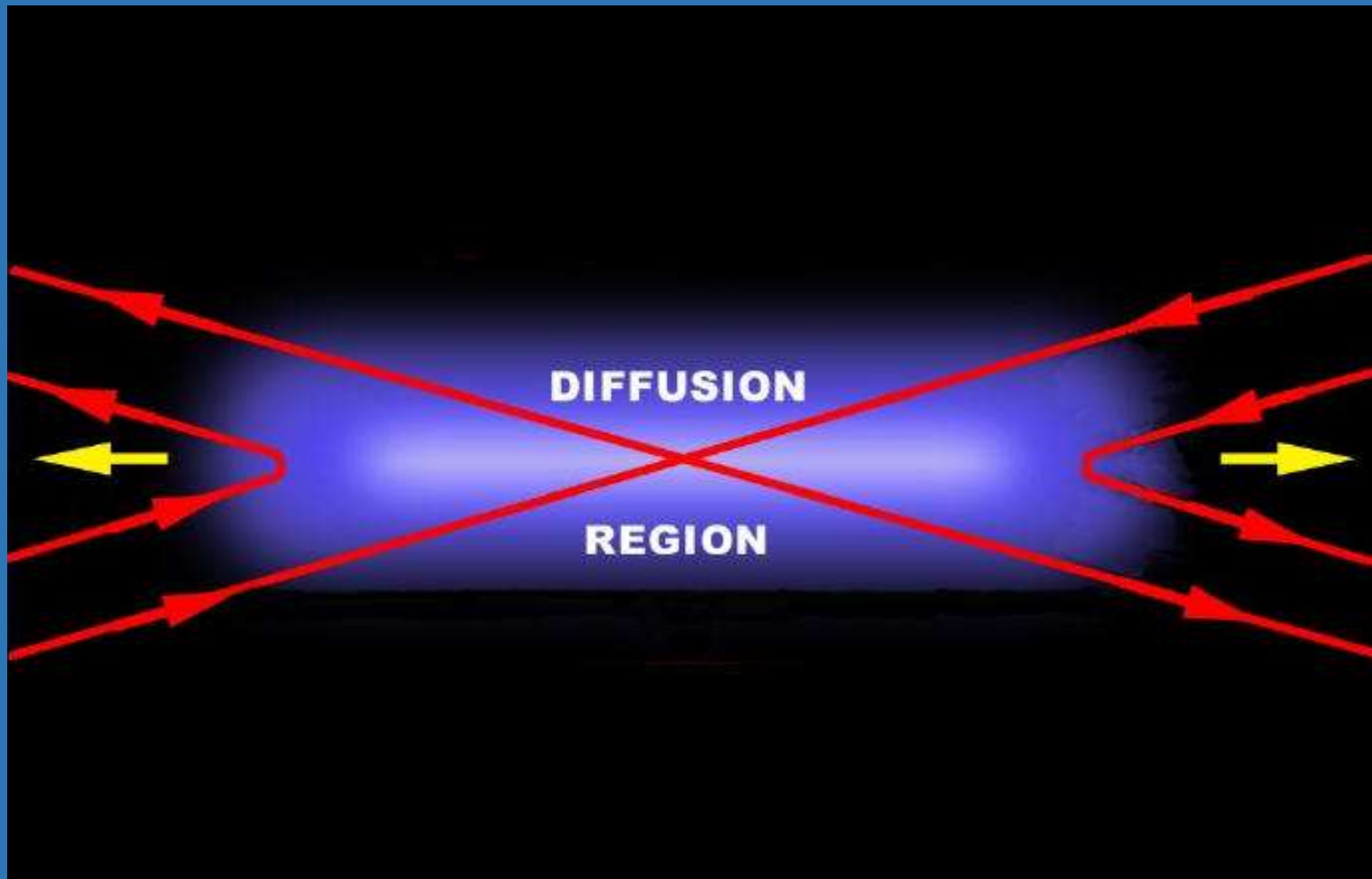


Stap 2:

Sterkte magnetisch veld wordt 0 in diffusiegebied.

Magnetische veldlijnen gaan open en sluiten kruislings.

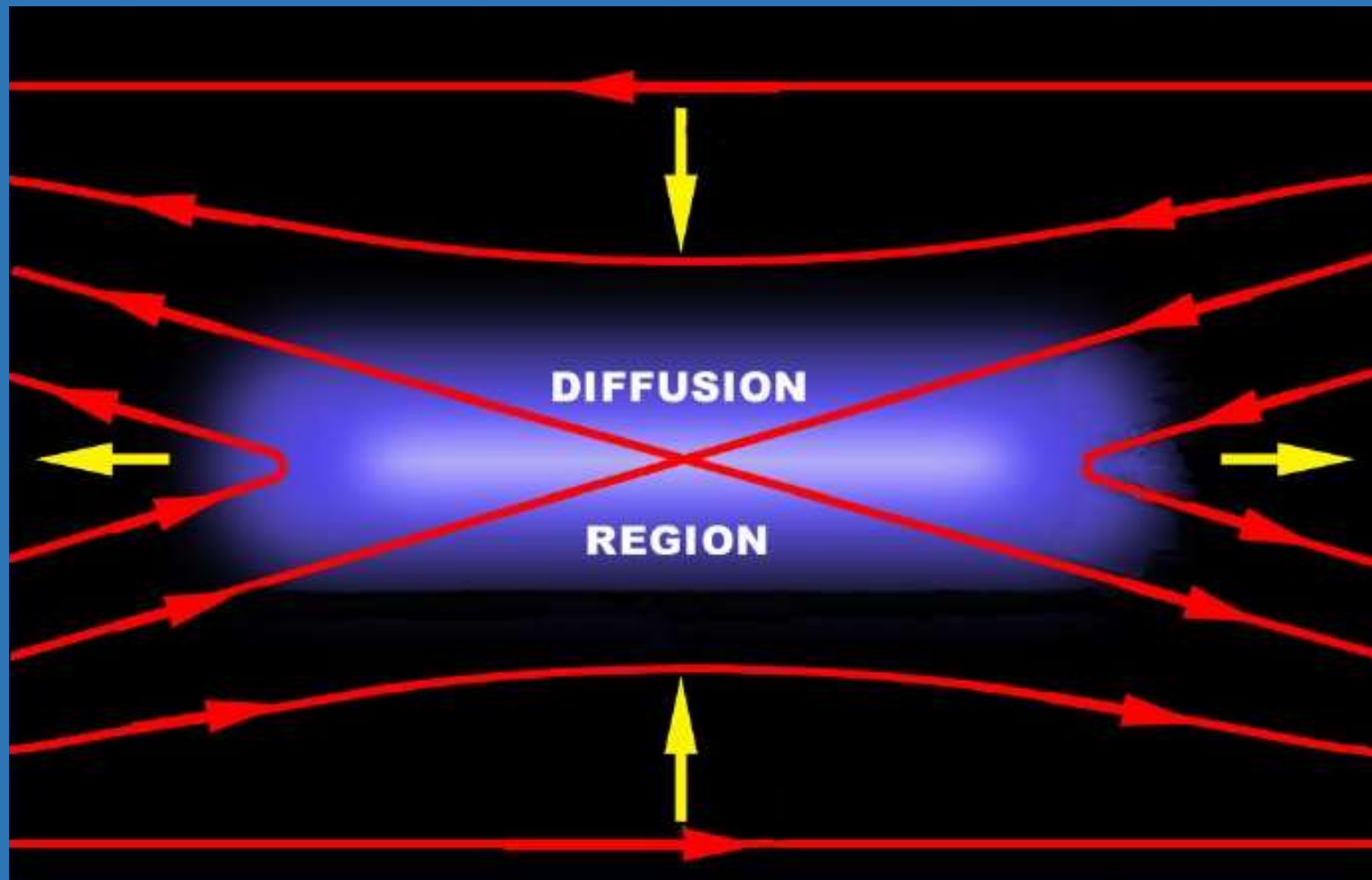
Magnetische reconnectie volgens SP:



Stap 3:

Elektronen volgen de gesloten magnetische veldlijnen en worden, door energie uit het magneetveld, sterk versneld afgevoerd.

Magnetische reconnectie volgens SP:

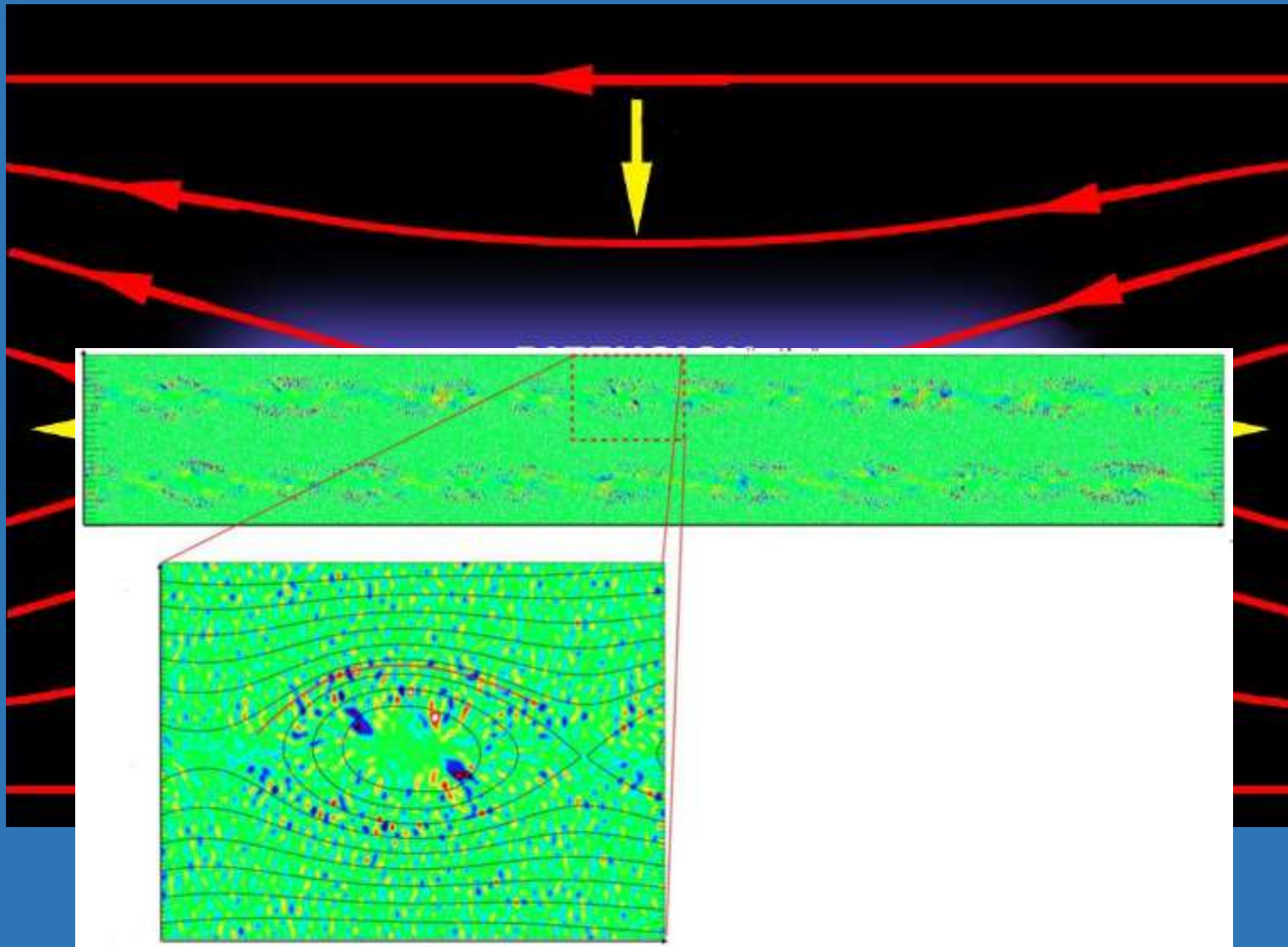


Probleem:

Volgens berekeningen met het SP-model duurt een zonnevlam weken.

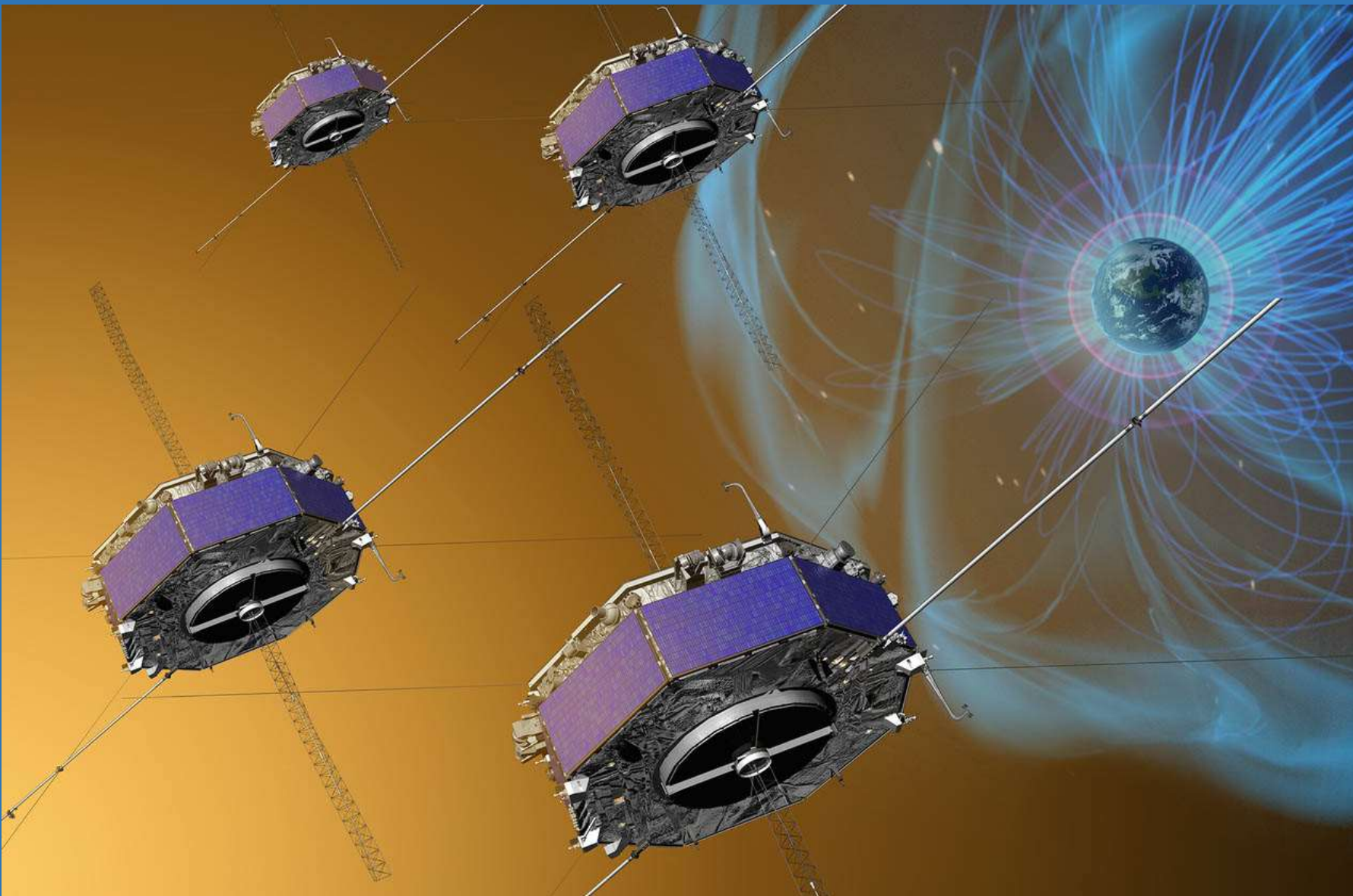
In de praktijk gaat het in minuten.

Magnetische reconnectie – variant op SP:



Oplossing: **Stochastic
Plasmoid Chains**

Plasmoids ontstaan, spatten uiteen en vormen zich opnieuw. Elektronen worden opgenomen en versneld via de kruislings gesloten magnetische veldlijnen afgevoerd.



Magnetospheric Multiscale Mission (MMS) 4 Probes

2015-03-13

2016: magnetische
reconnectie aange-
toond.

Tot 2040 in bedrijf.

Zon



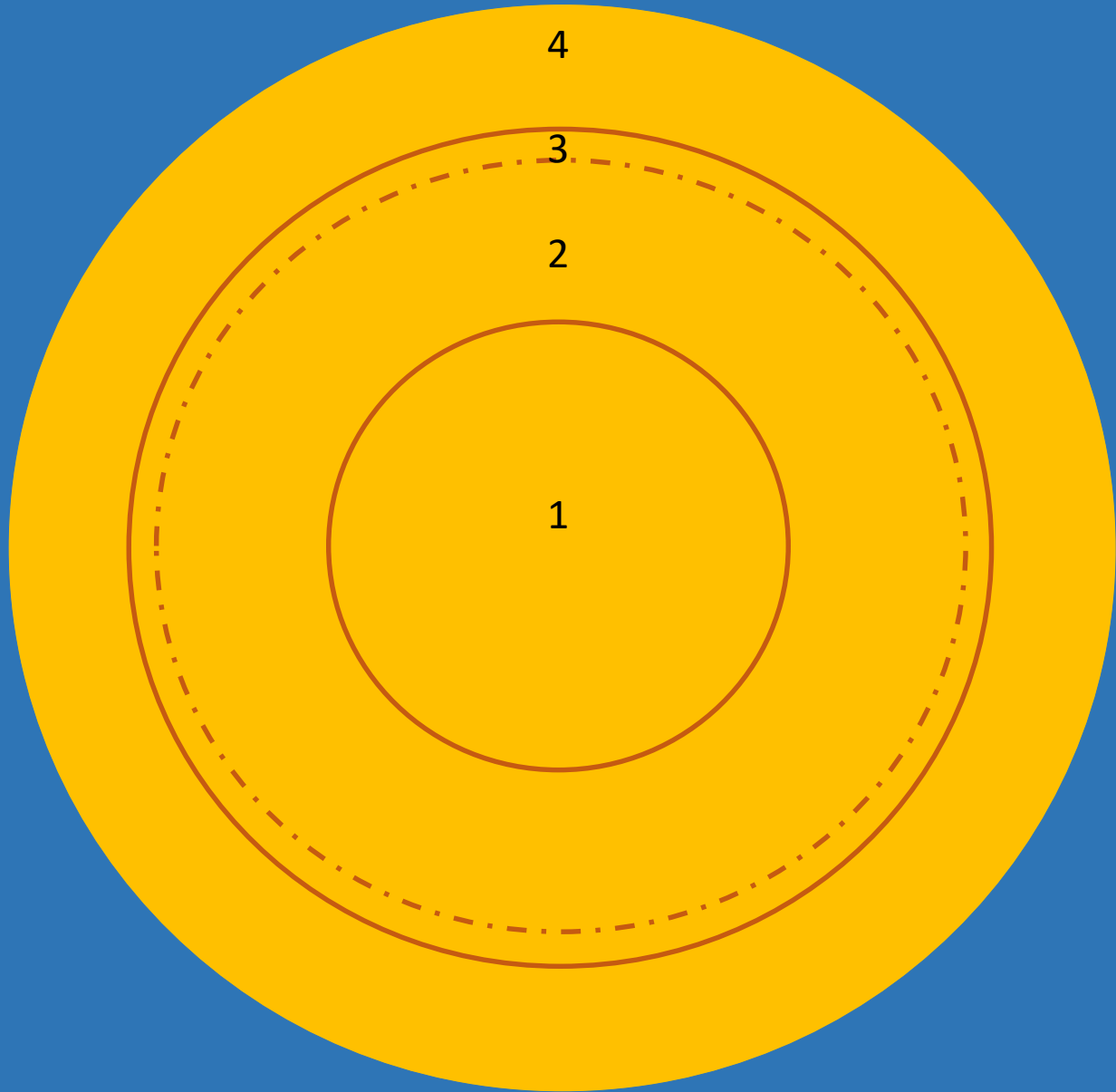
Zonsverduistering
2017 - USA





Zonsverduistering
2019 Chili

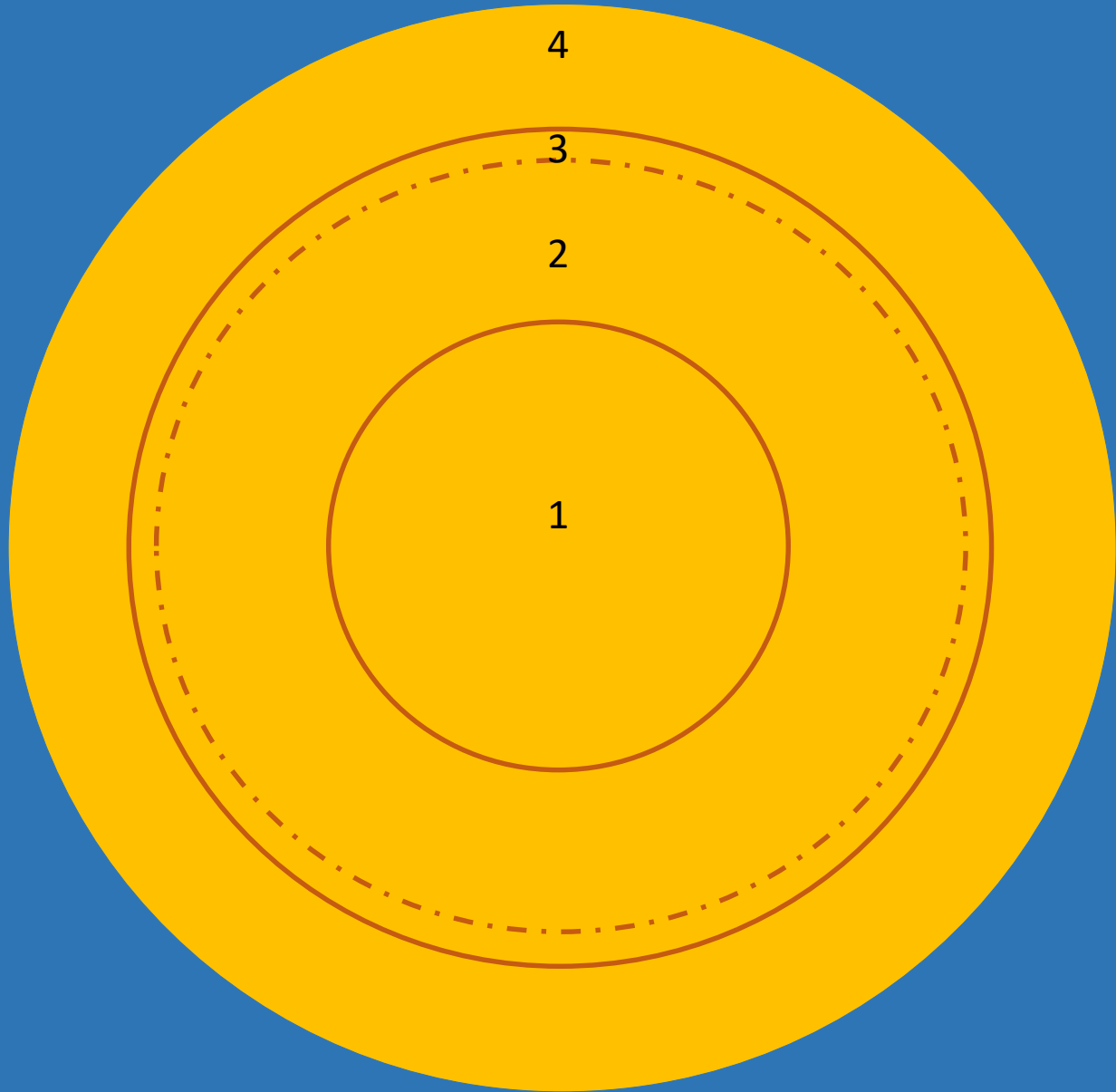




1 – Kern

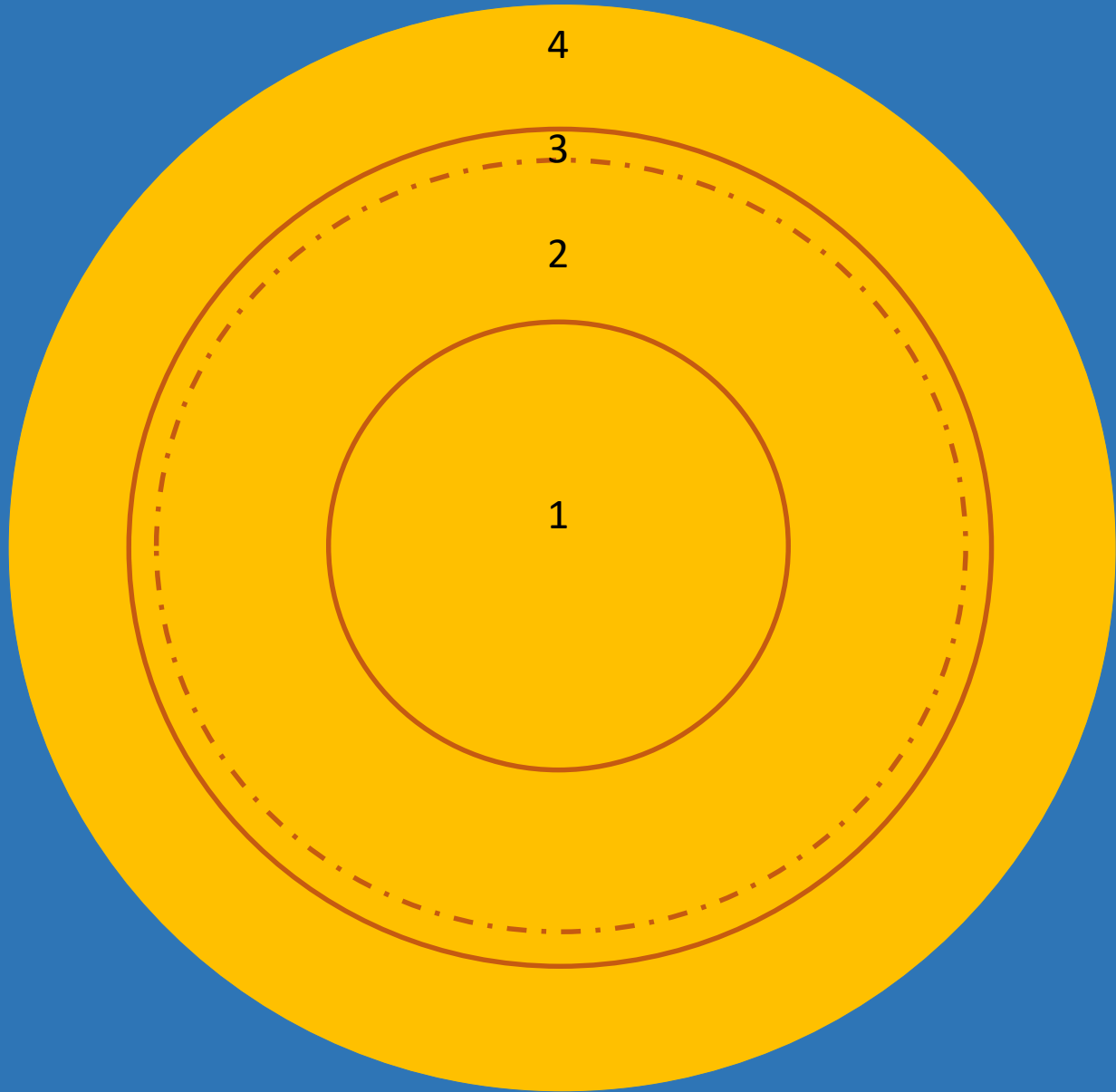
Waterstoffusie.

15 miljoen K.



2 – Stralingszone (geen convectie)

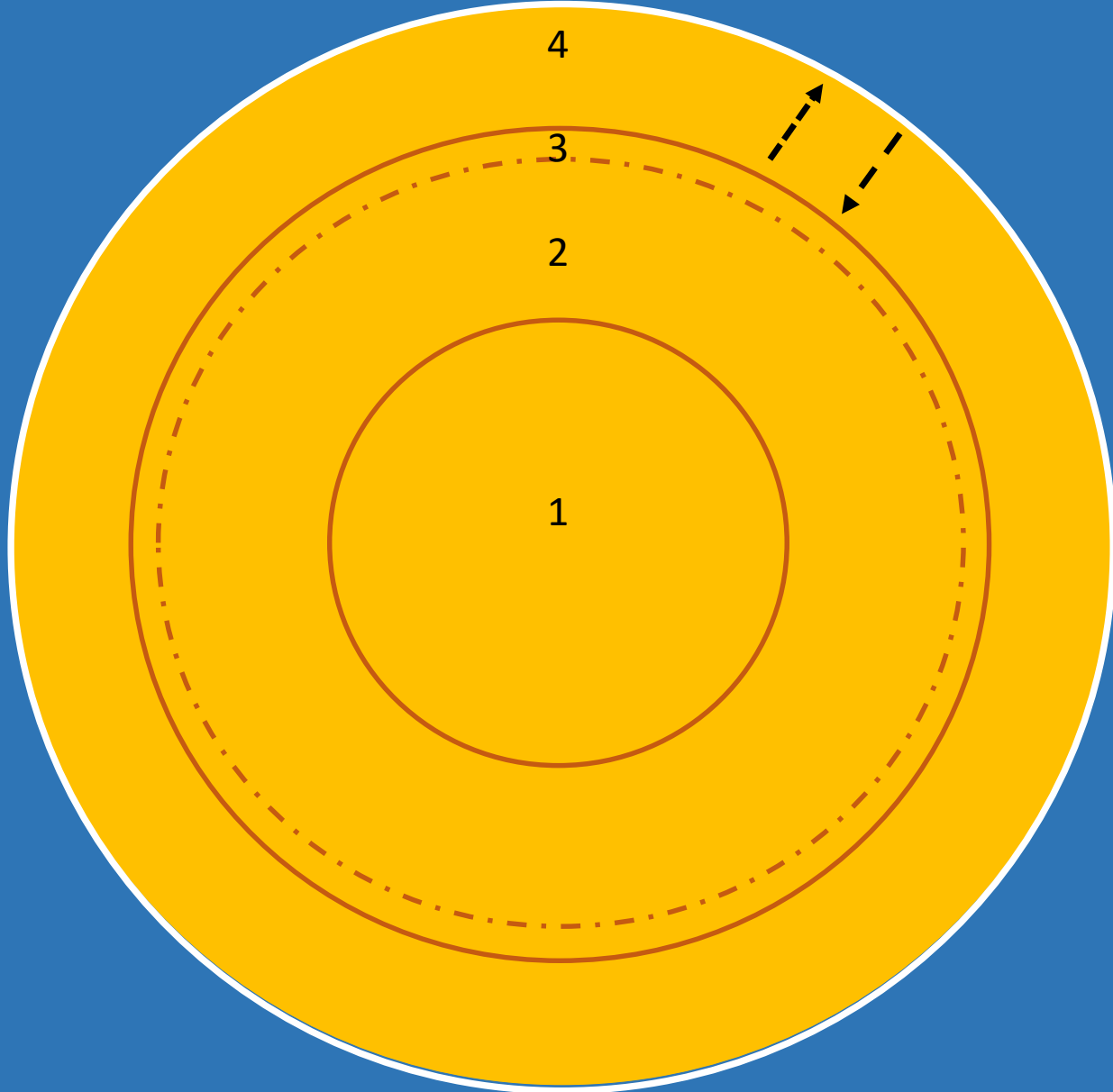
Dichtheid 0,25 Rzon: 20 g/cm³;
0,7 Rzon: 0,2 g/cm³.



3 – Tachocline (overgangsgebied)
100.000 km onder zonsoppervlak

Magnetisch veld van de zon ontstaat,
waarschijnlijk, in de Tachocline.

Nog heel veel onbekend.



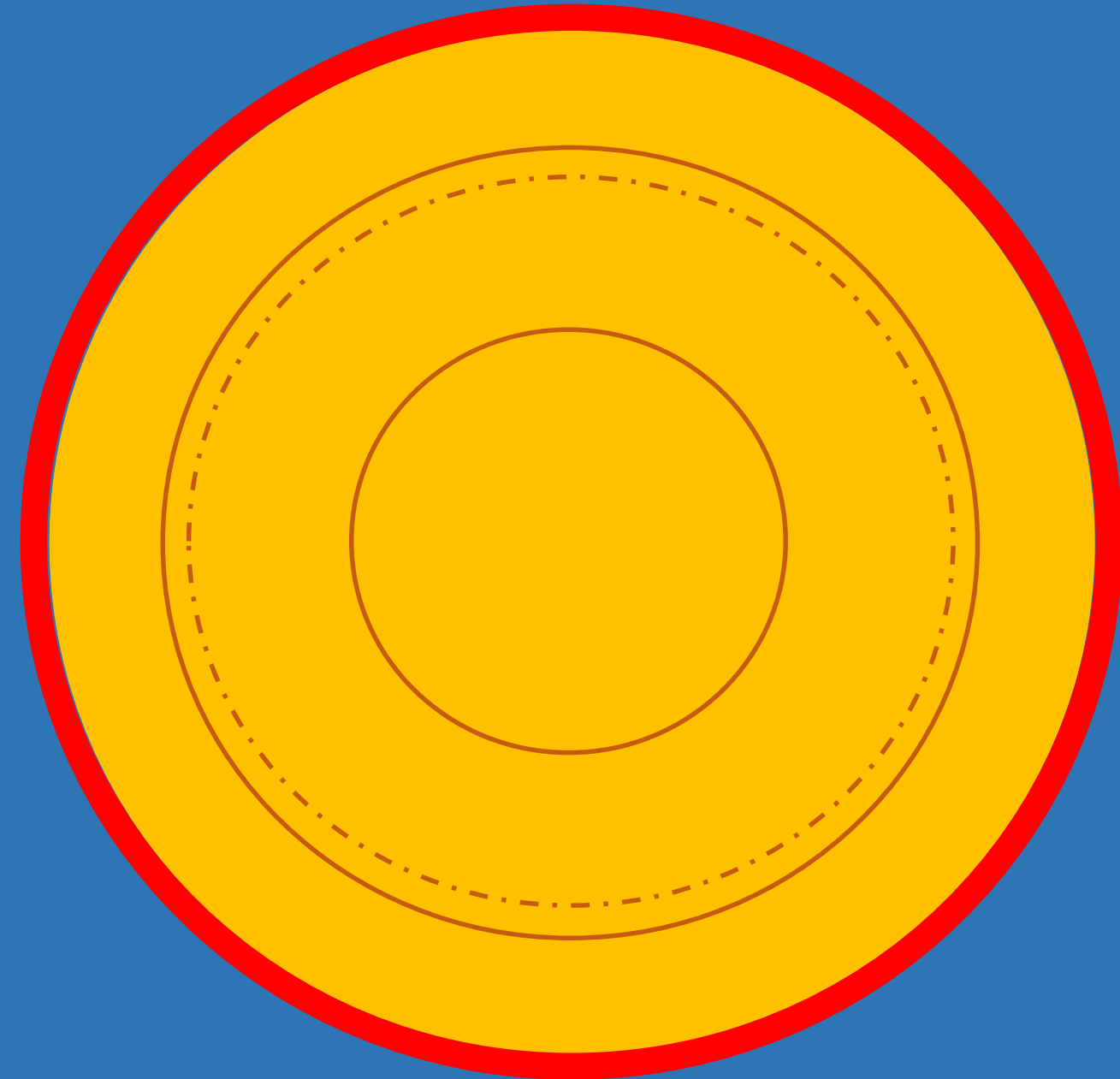
4 – Convectiezone en fotosfeer

Onderste laag: 2 miljoen K;

Buitenste laag: 5.700 K – **Fotosfeer**.

Fotosfeer: Zichtbaar oppervlak zon.
Doorzichtig - 450 km dik

0,0000002 g/cm³;
(1/10.000 van lucht 1 bar).



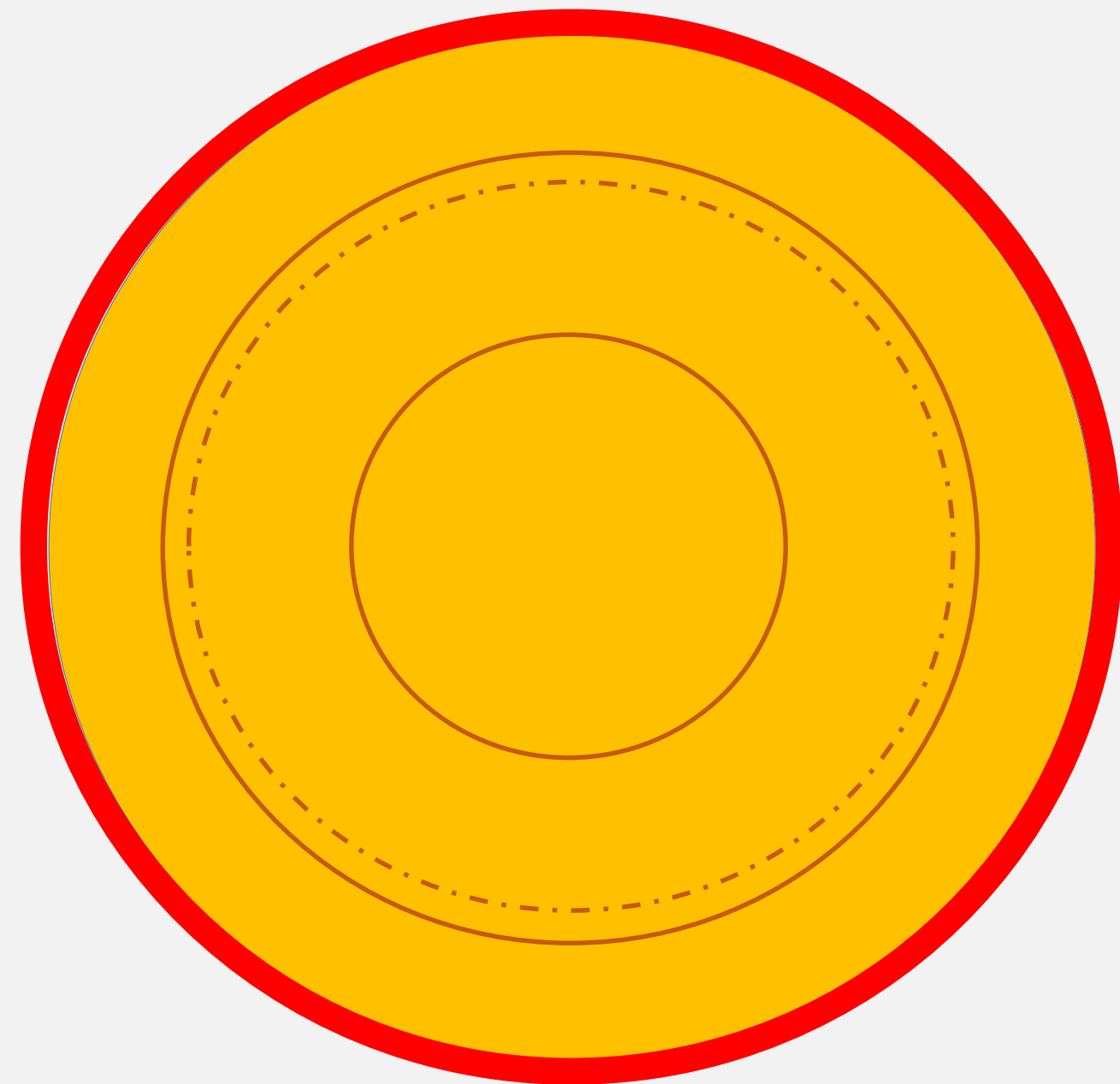
Chromosfeer

Onderste laag: 6.000 K;

Buitenste laag: 20.000 K.

Zichtbaar in H-alpha (656 nm) 2.500 km dik.

Onregelmatige beweeglijke structuren die magnetische veldlijnen volgen.



Corona

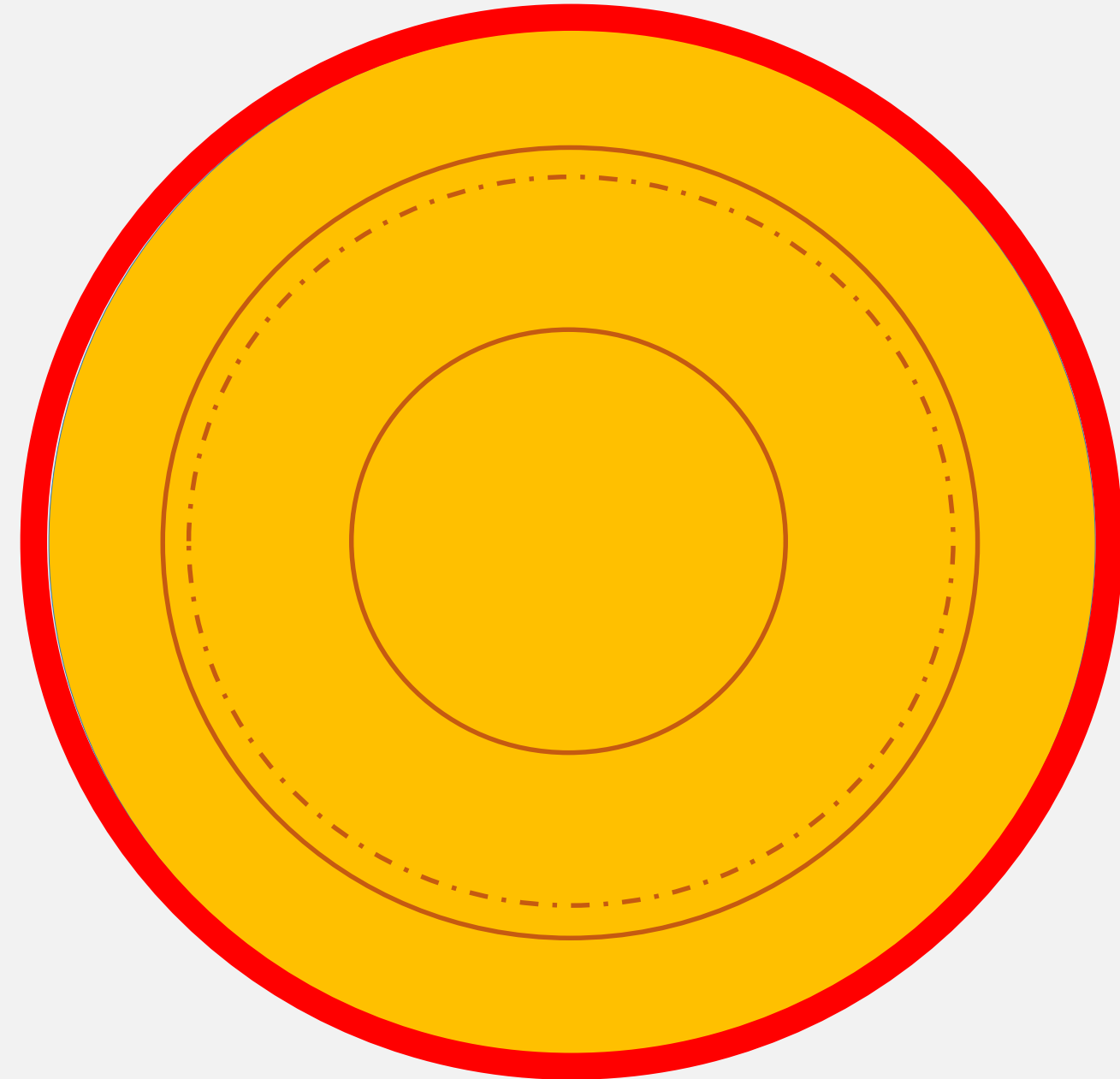
> 1 miljoen K.

Zichtbaar in zichtbaar licht (eclips) en X-Ray.

Plasma waarin H t/m O alle elektronen kwijt zijn.

Dichtheid: heel laag.

Diameter: miljoenen kms.



Corona

Materiaal stroomt uit Corona de ruimte in:
de **zonnewind**.

2 miljoen ton/sec (0,02 % zonmassa in
9 miljard jaar).

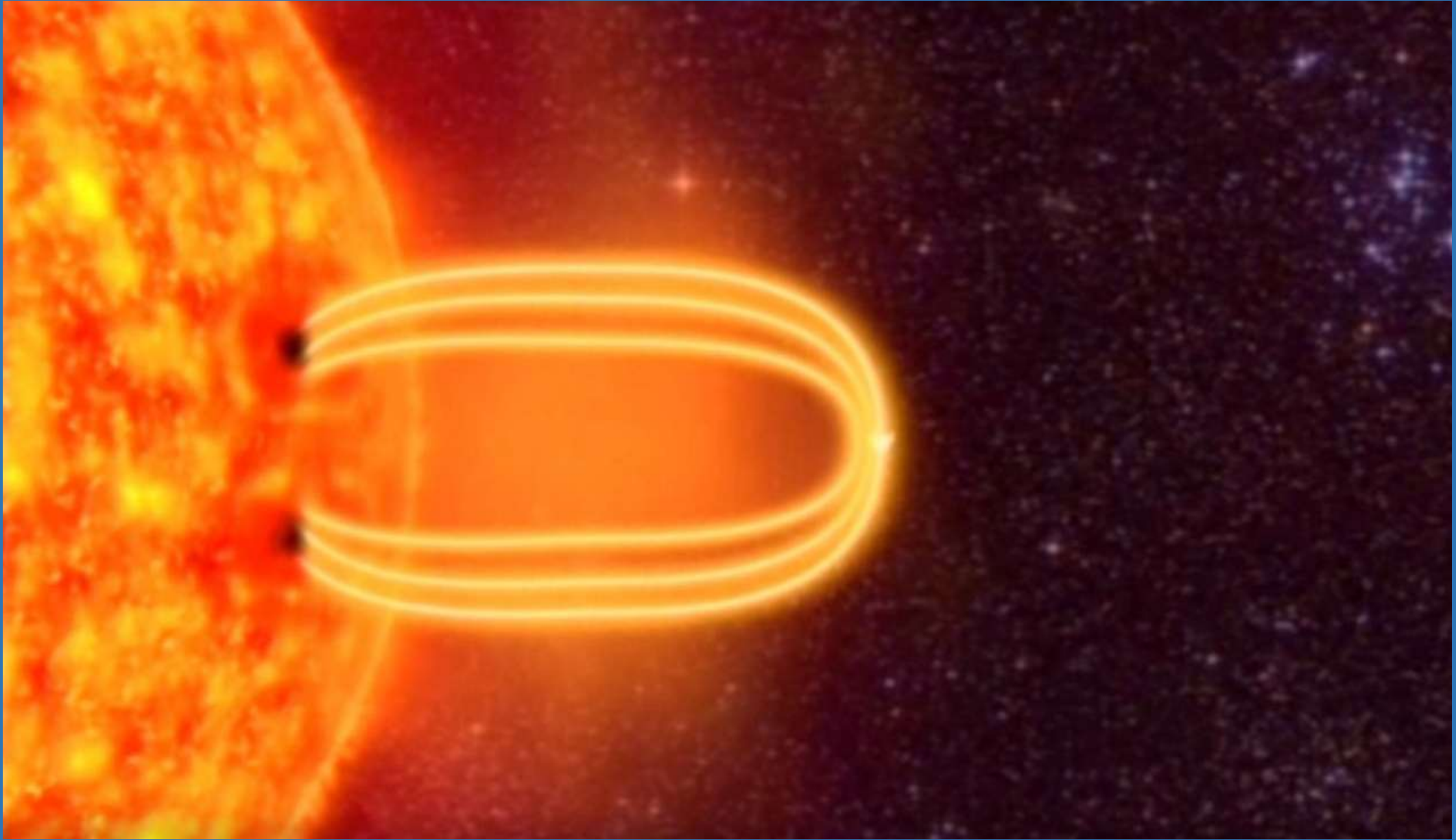
Door zonnewind ontstaat het IMF.

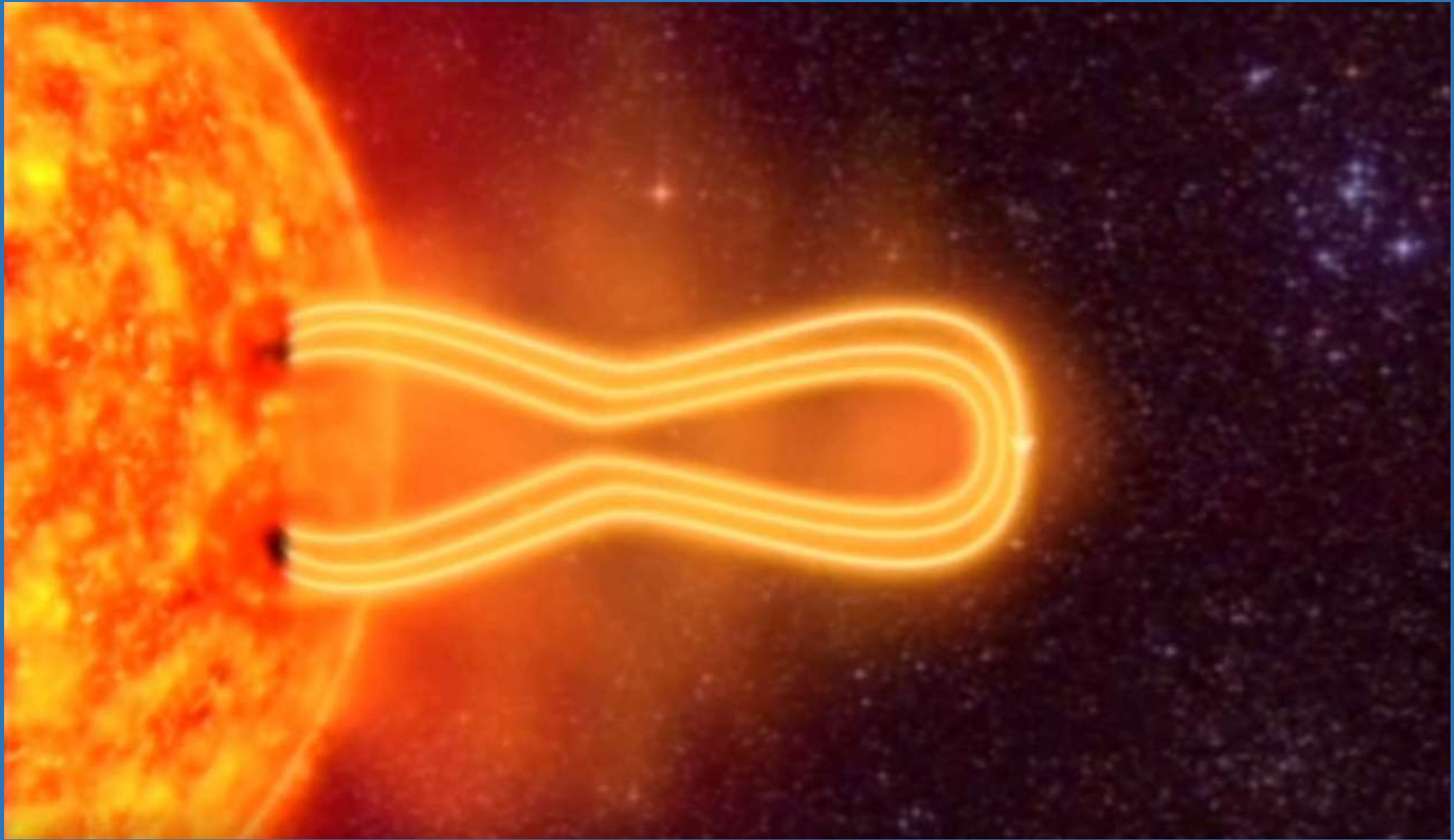
IMF – Interplanetary Magnetic Field

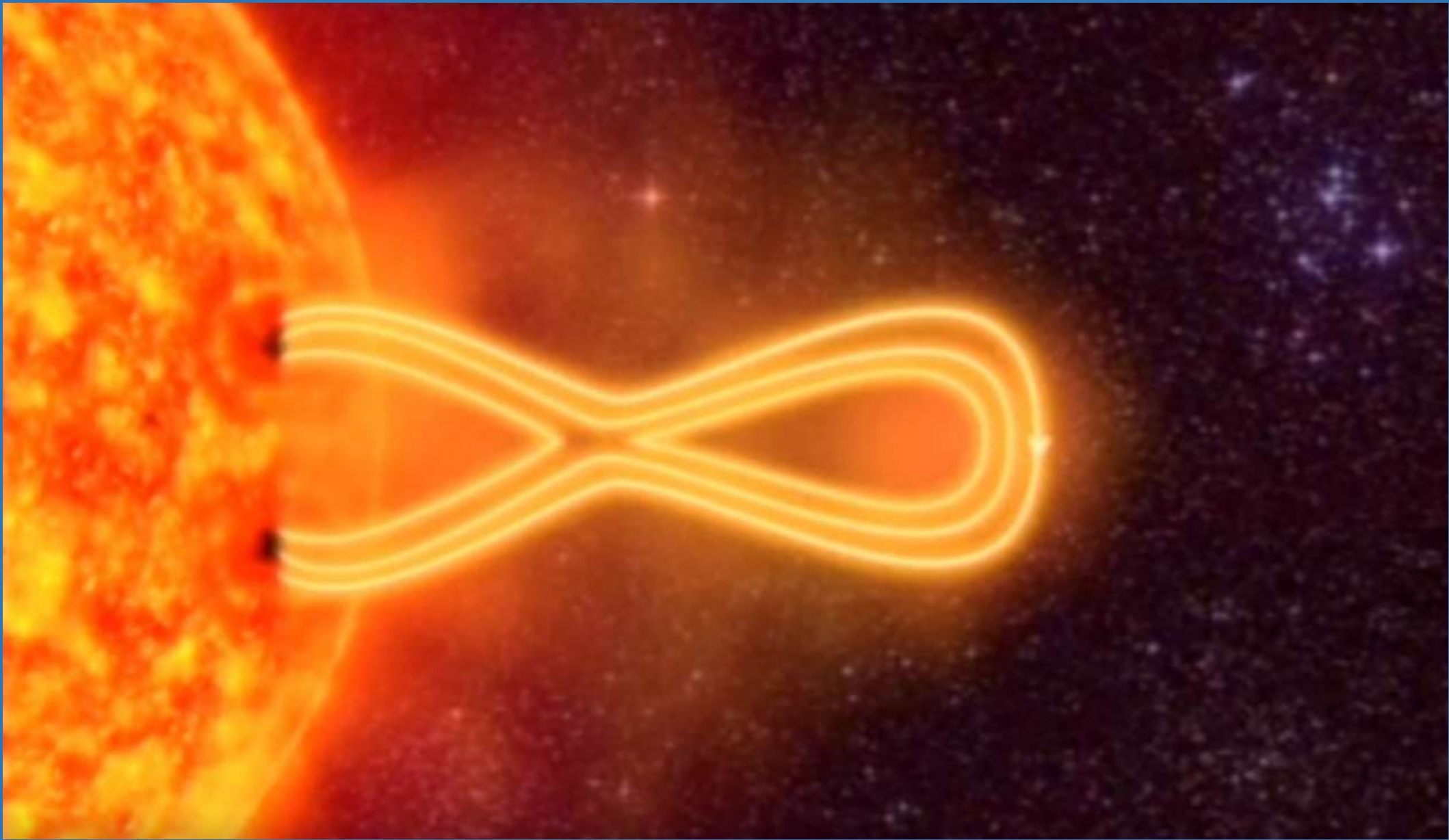
Soms wordt de zonnewind een
zonnestorm:

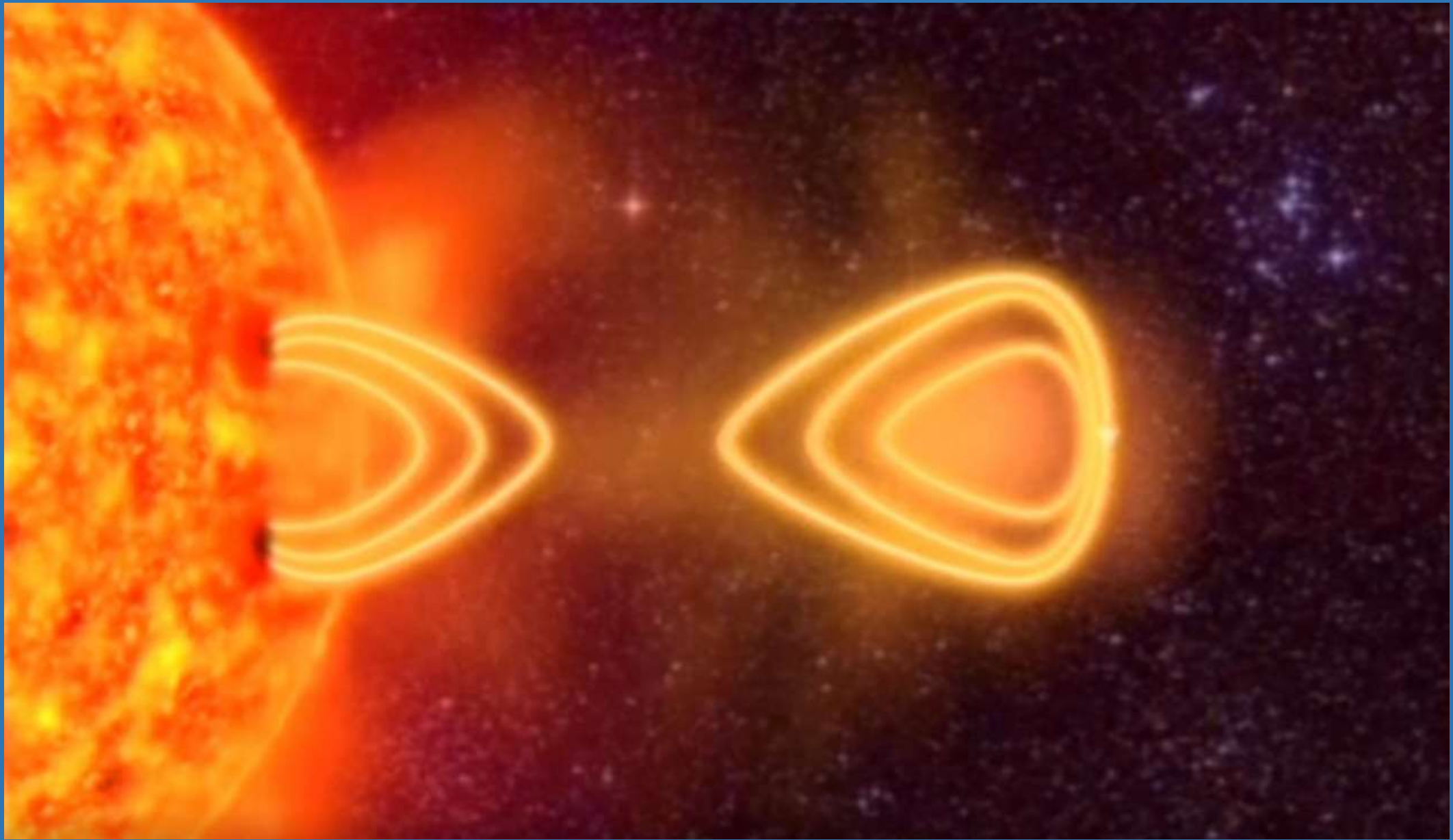
CME = Coronal Mass Ejection.

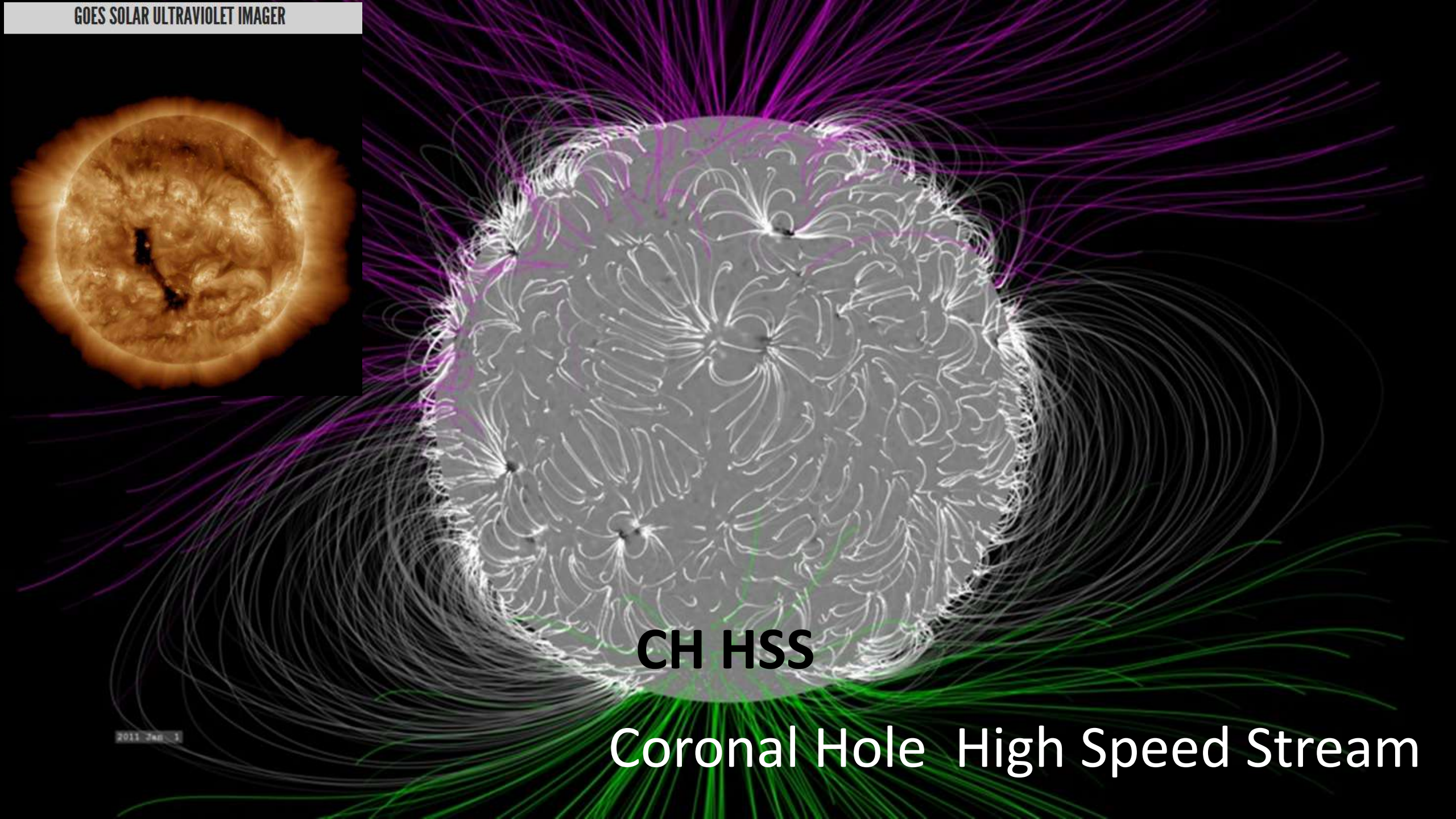
CME's ontstaan door magnetische reconnectie







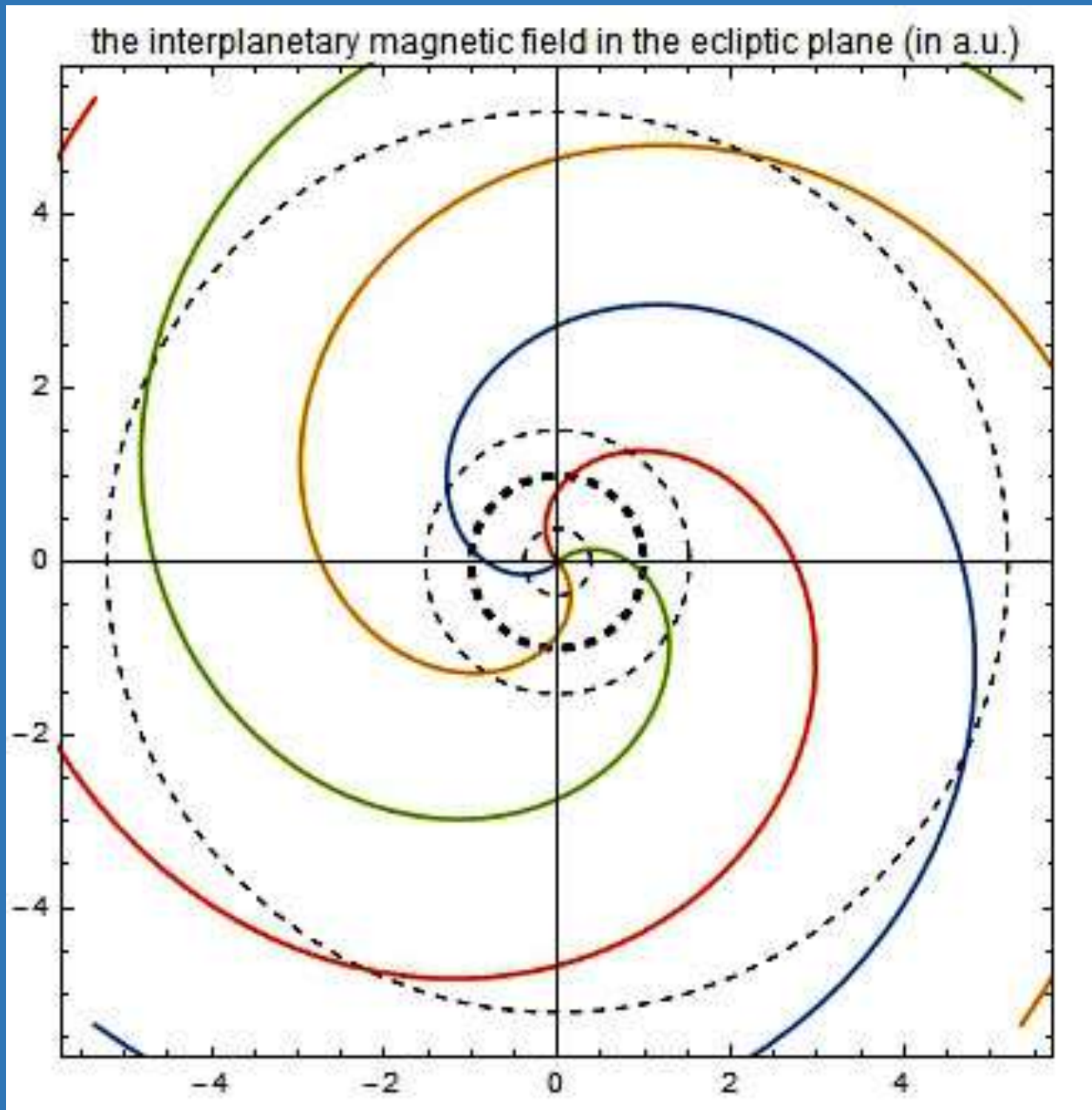


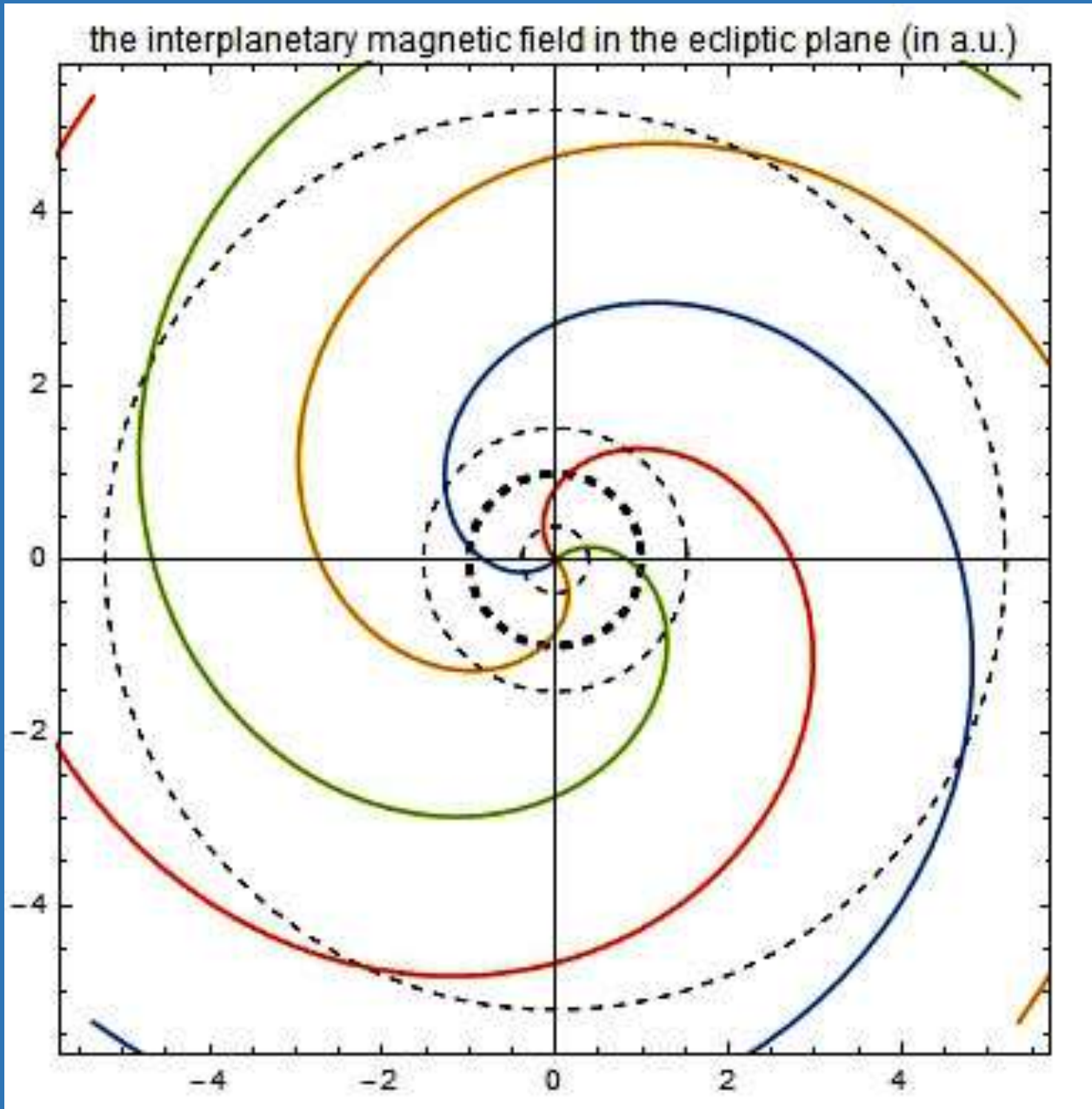


CH HSS

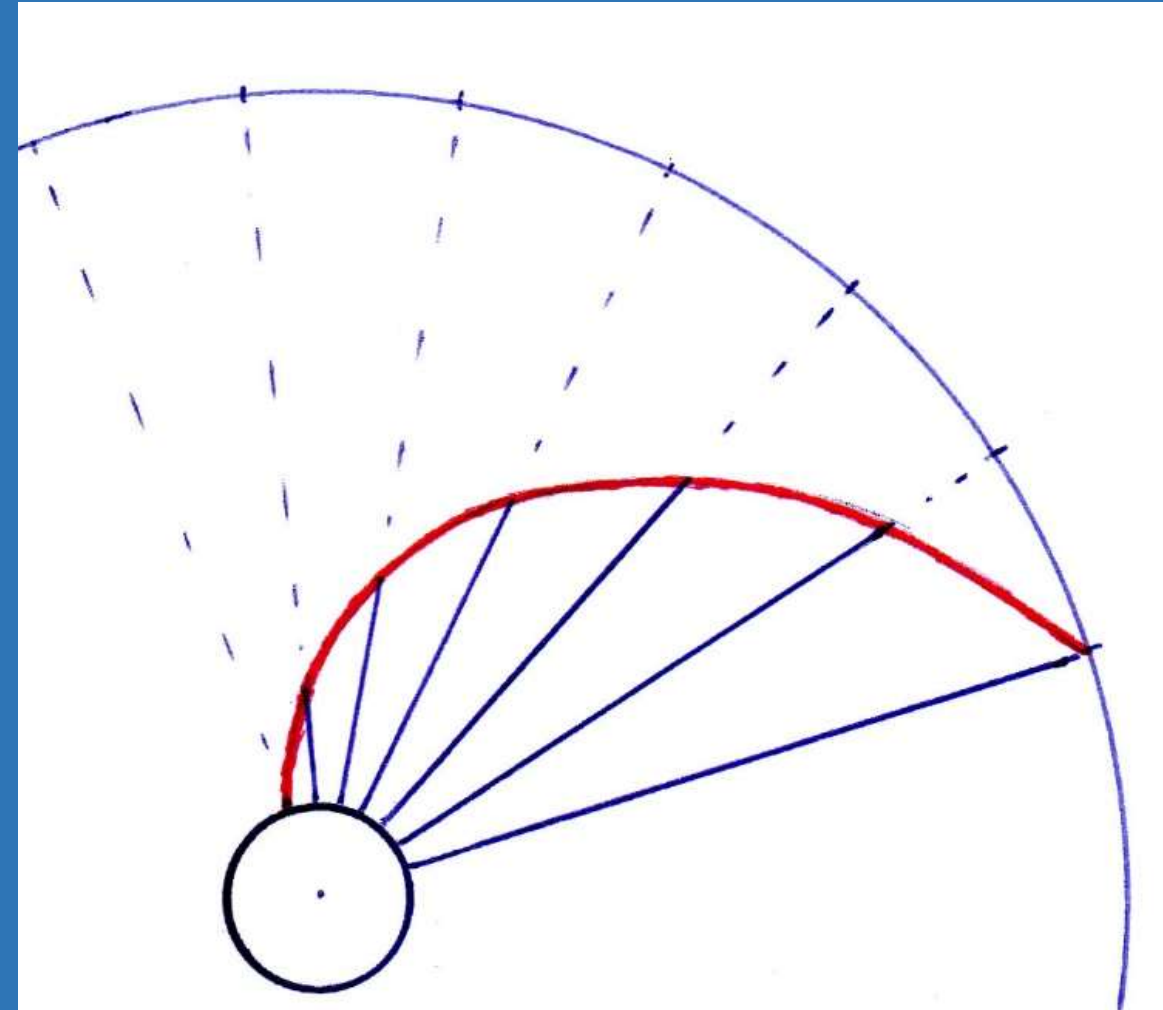
Coronal Hole High Speed Stream

Parker Spiral

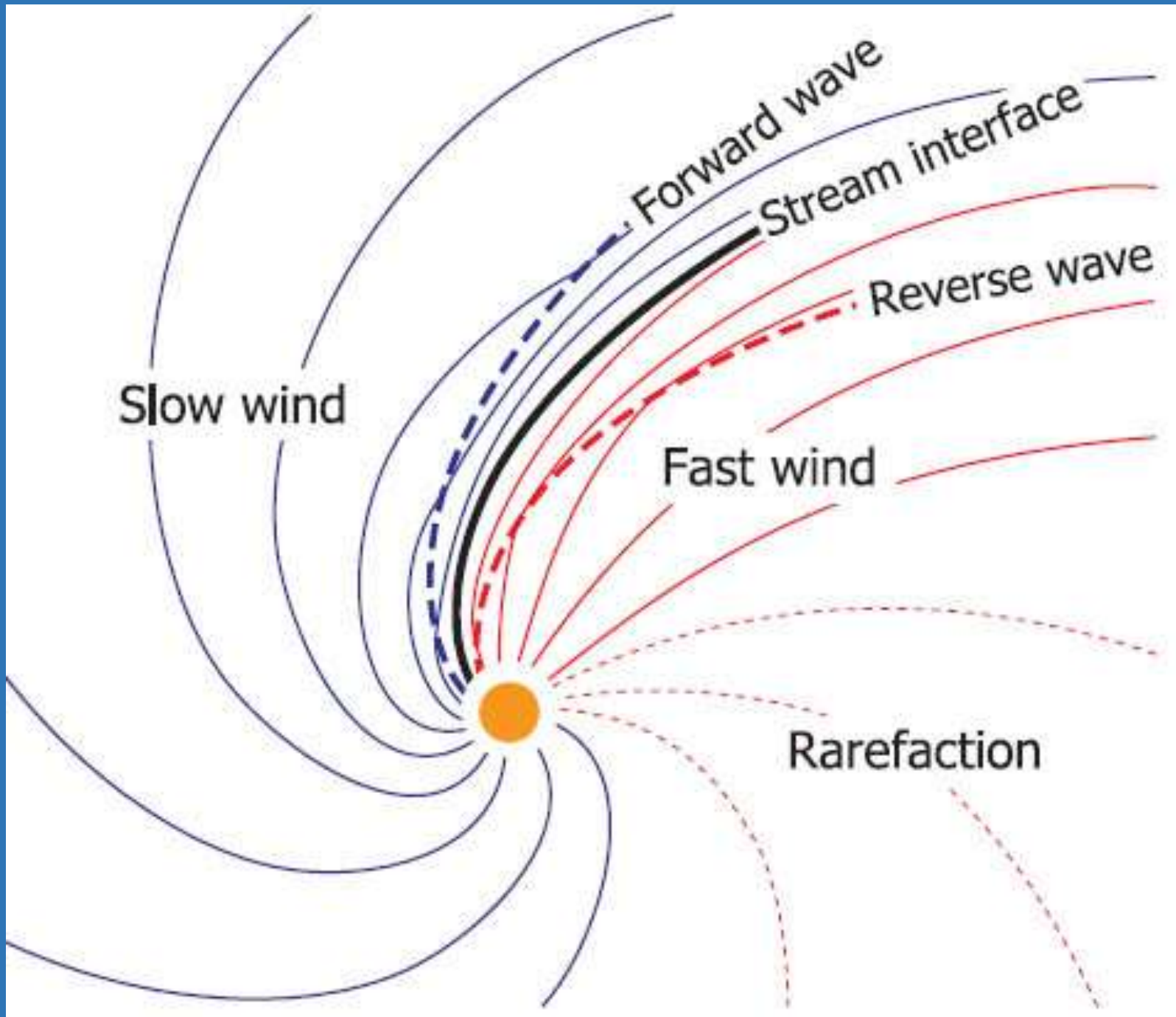




Parker Spiral

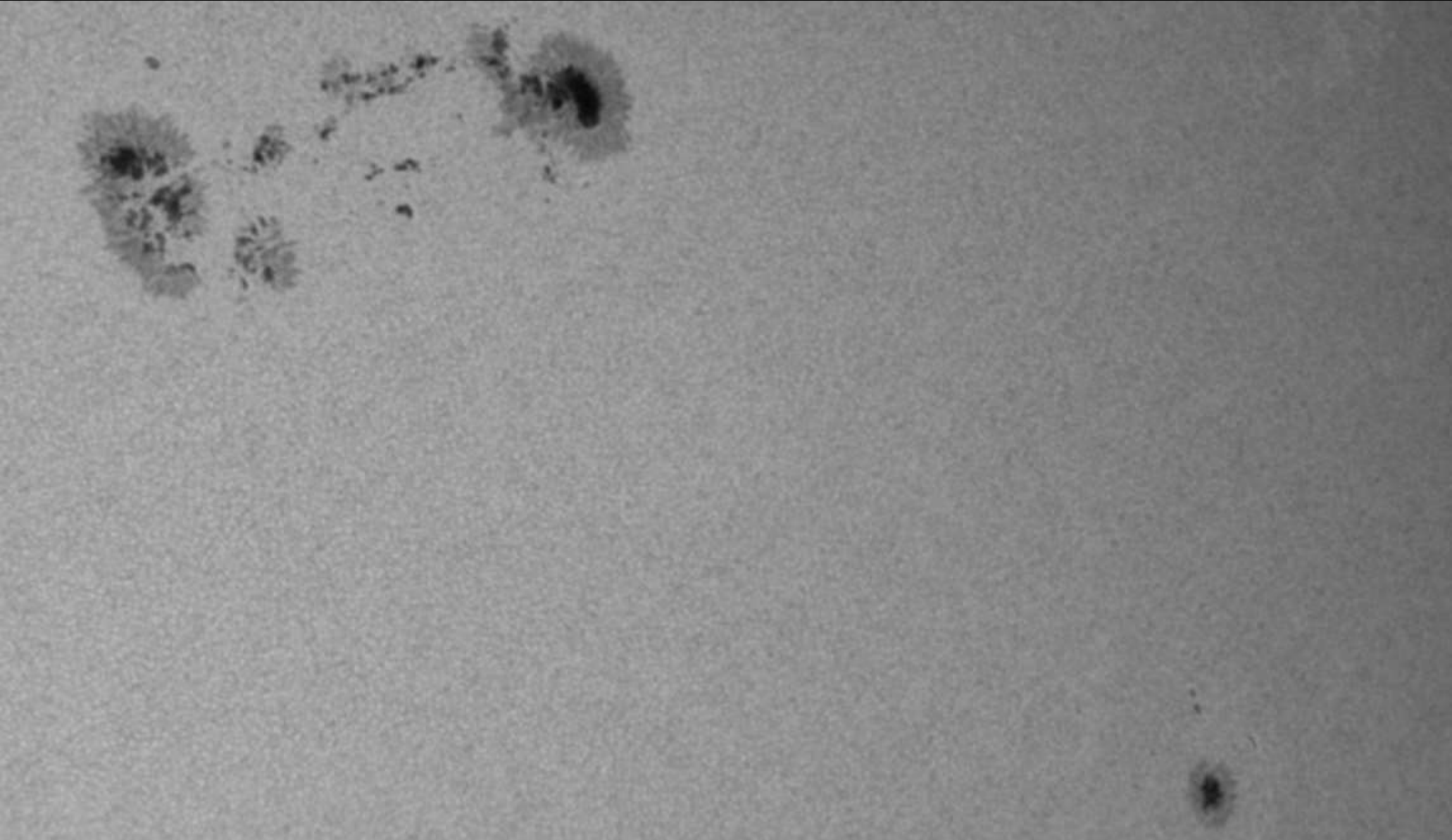


Constructie magnetische veldlijn (7 dagen).

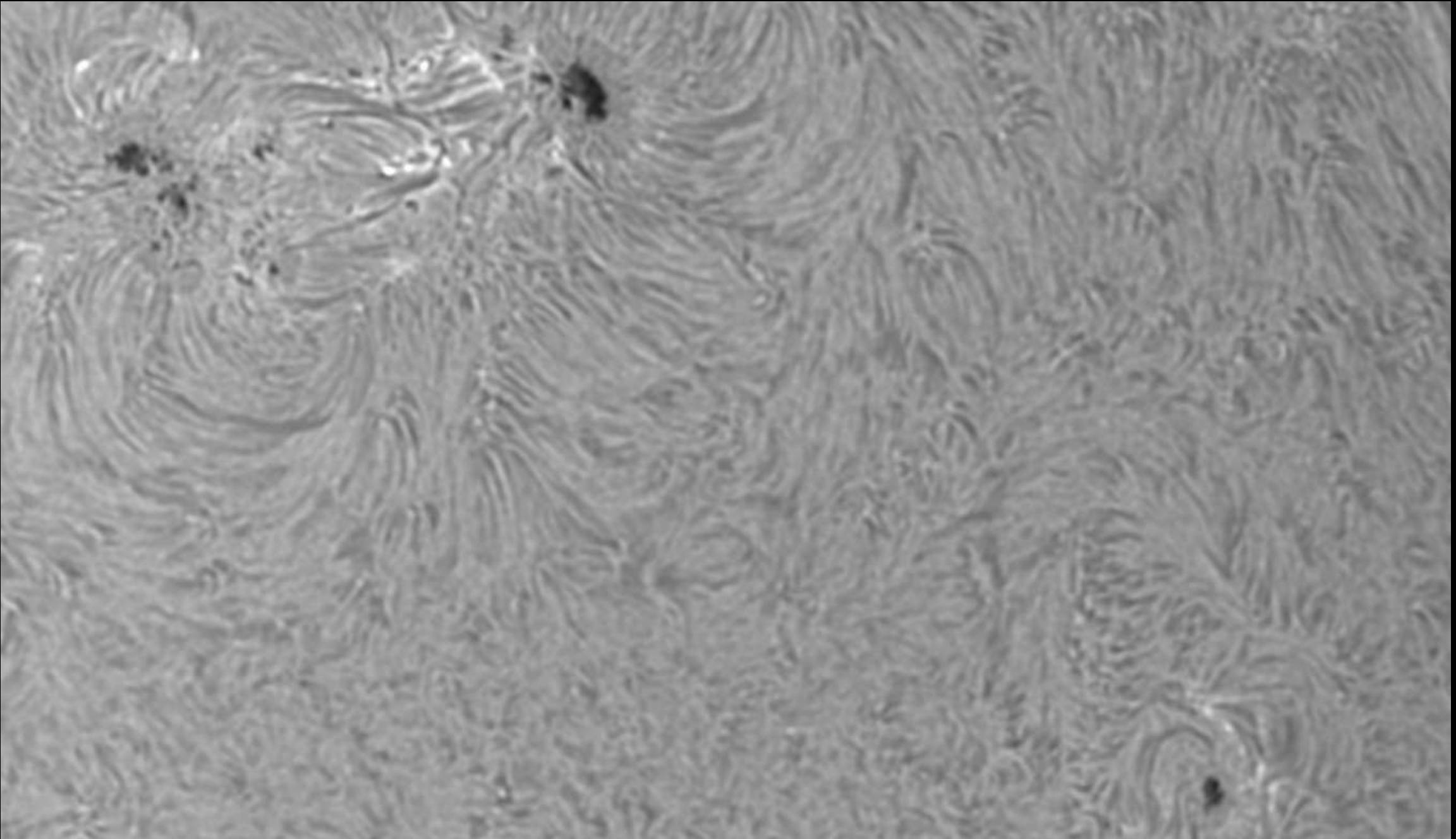


CIR / CH HSS

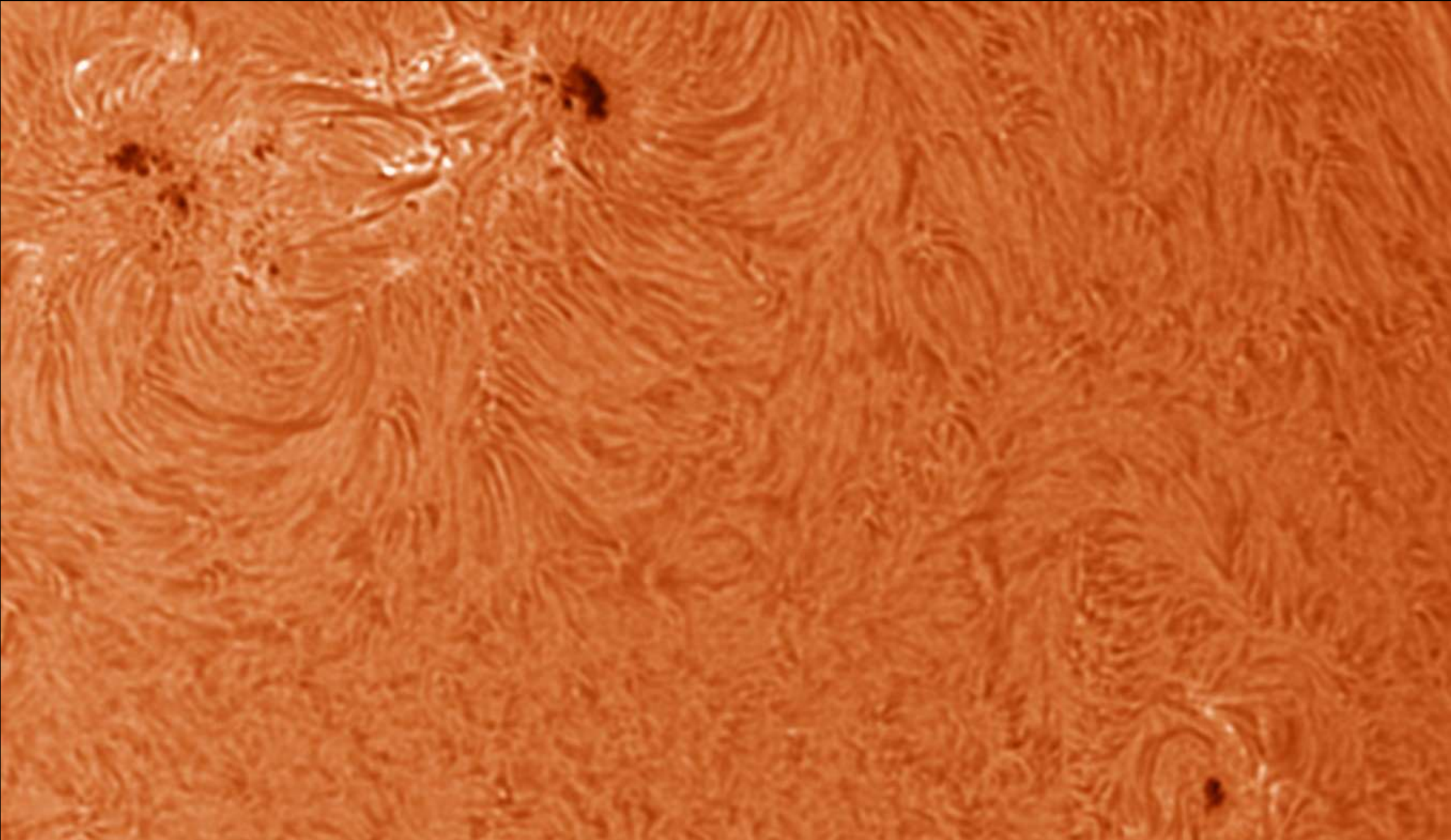
CIR: Co-rotating
Interaction Region



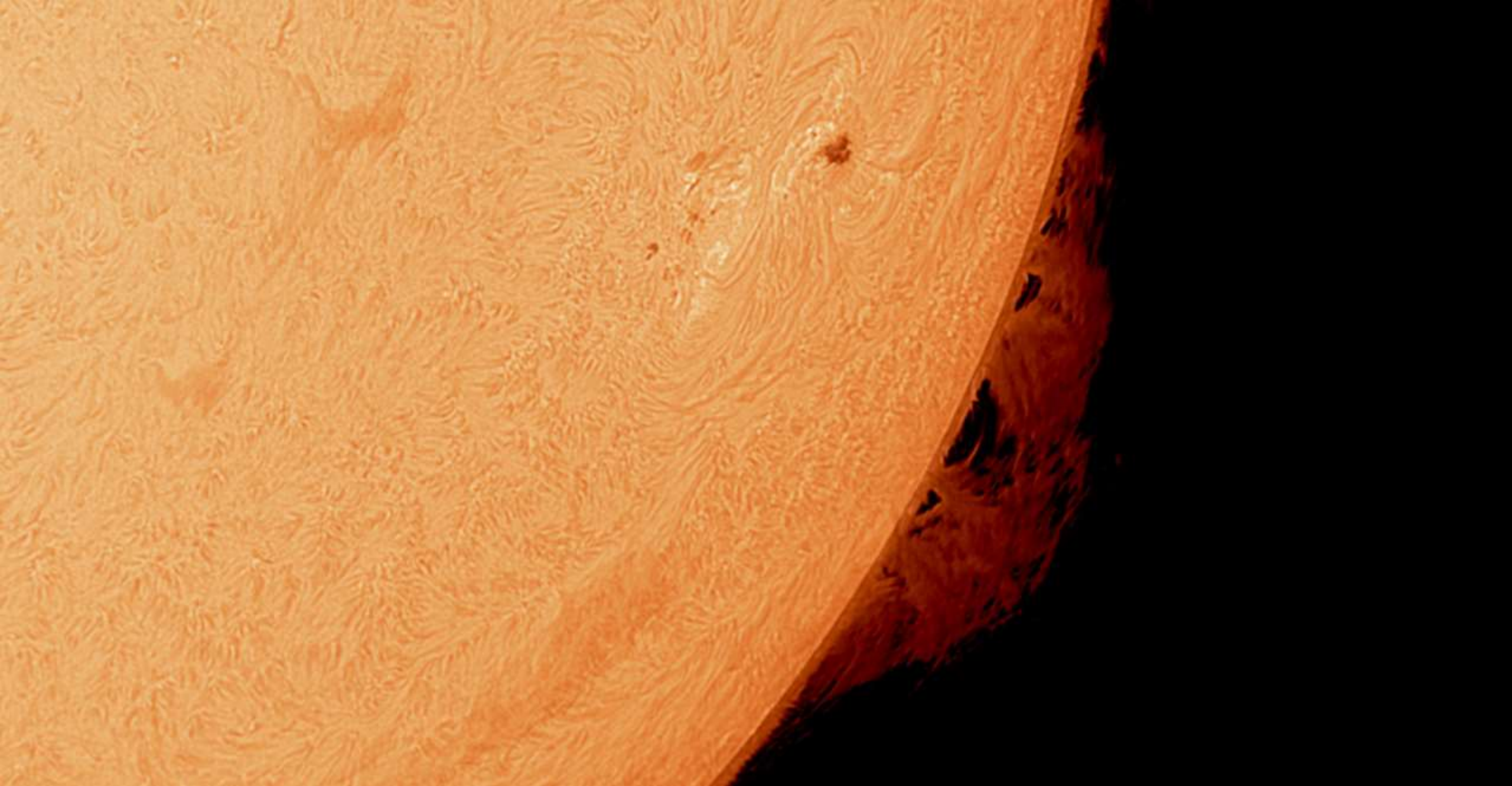
2022-06-22 Fotosfeer Groen filter – B&W



2022-06-22 Chromosfeer Quark H α – B&W



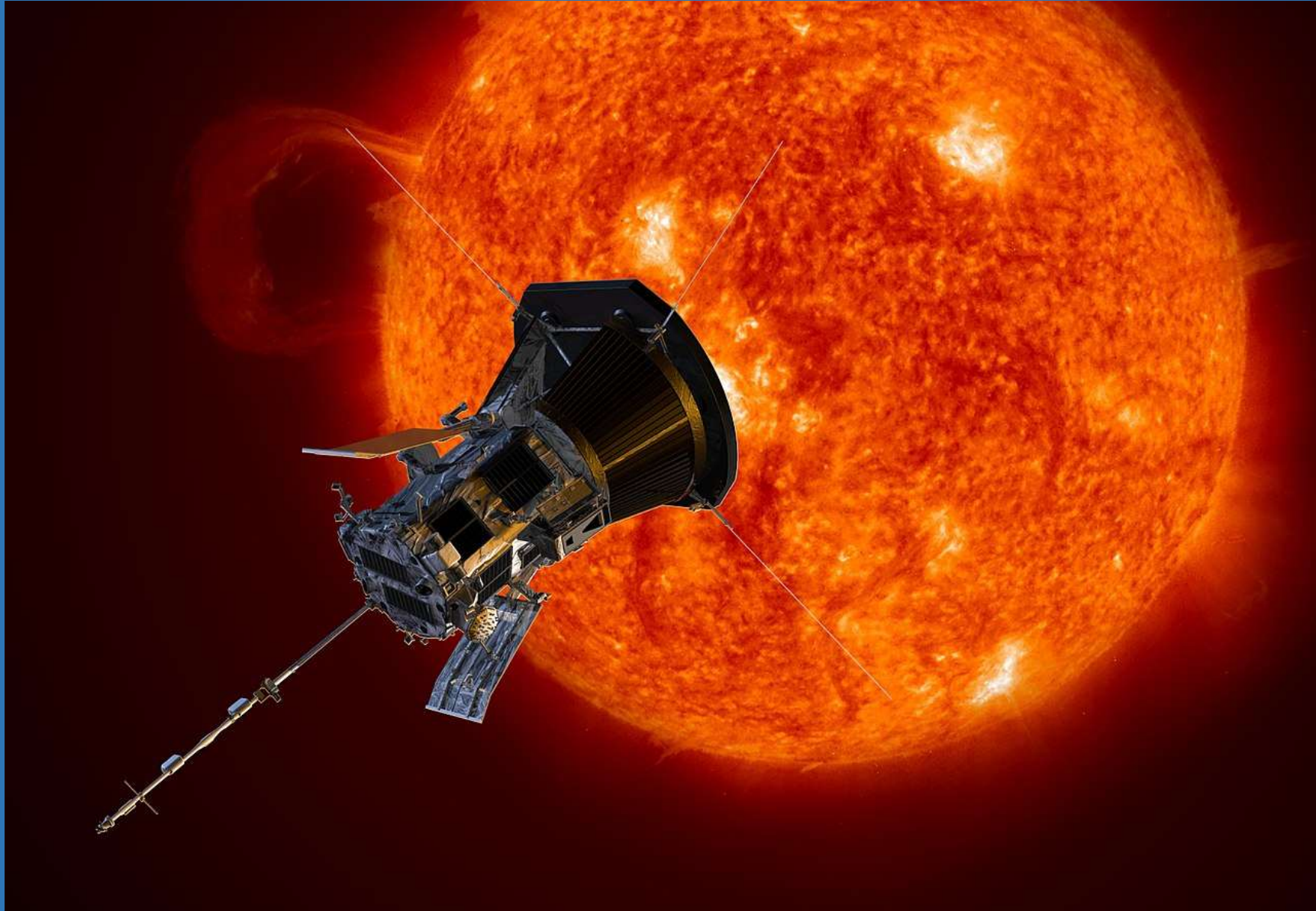
2022-06-22 Chromosfeer Quark H α - valse kleuren



2022-07-16 Quark H α - valse kleuren



2022-08-28 Quark $H\alpha$ - valse kleuren



Parker Solar Probe

NASA

2018-08-12

SCIENCE & EXPLORATION

solar orbiter

Taking the closest ever images of the Sun,
observing the solar wind and the Sun's polar
regions like never before, unravelling the
mysteries of the solar cycle

ESA

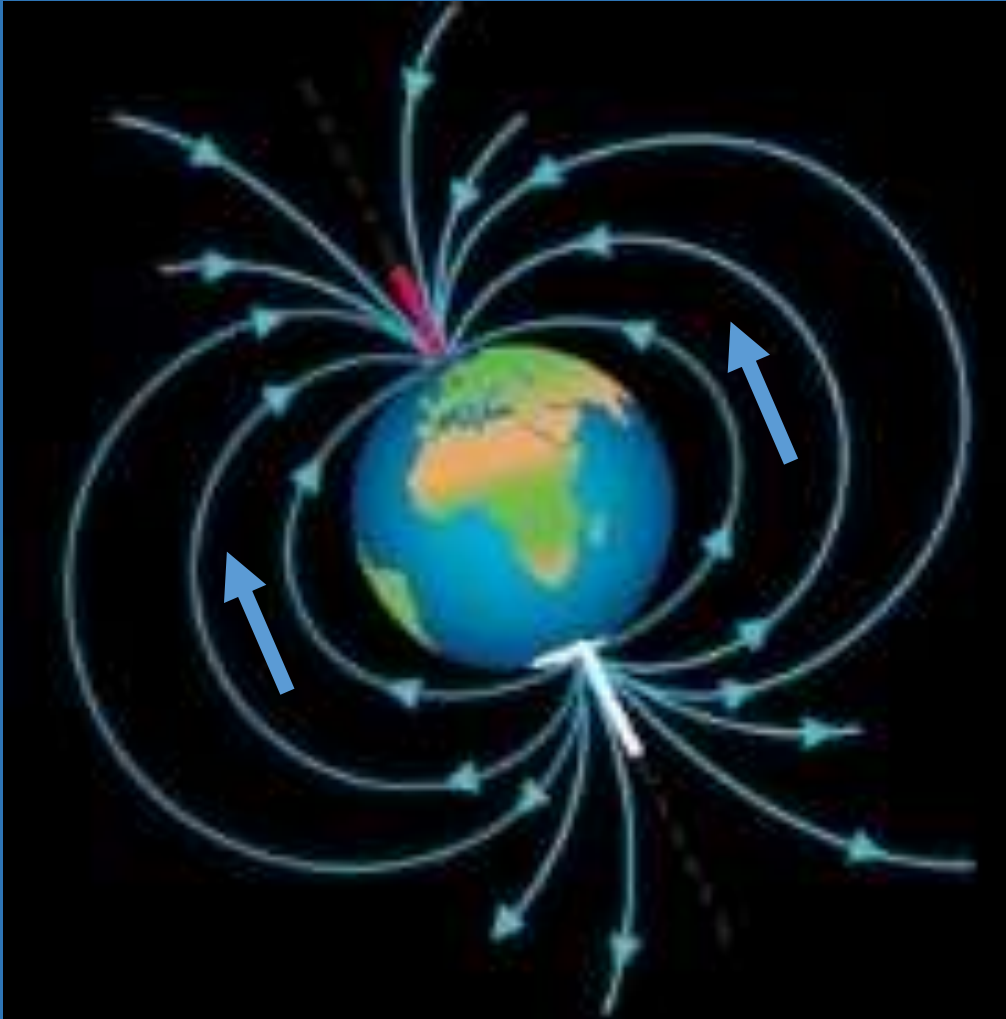
2020-02-10



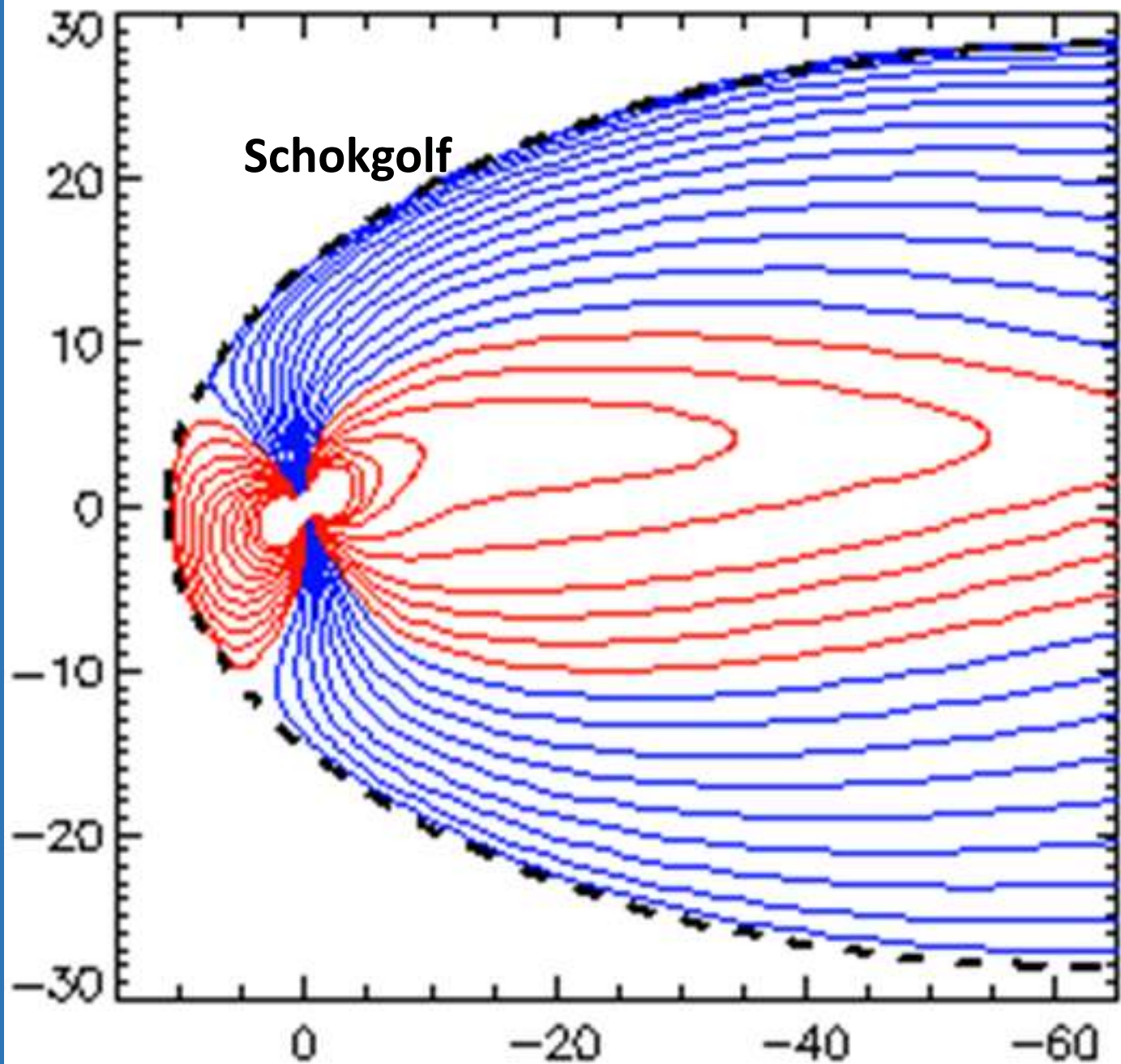
Aarde



Magnetisch veld aarde



Richting magnetisch veld
aarde in de atmosfeer is
van Zuid naar Noord.



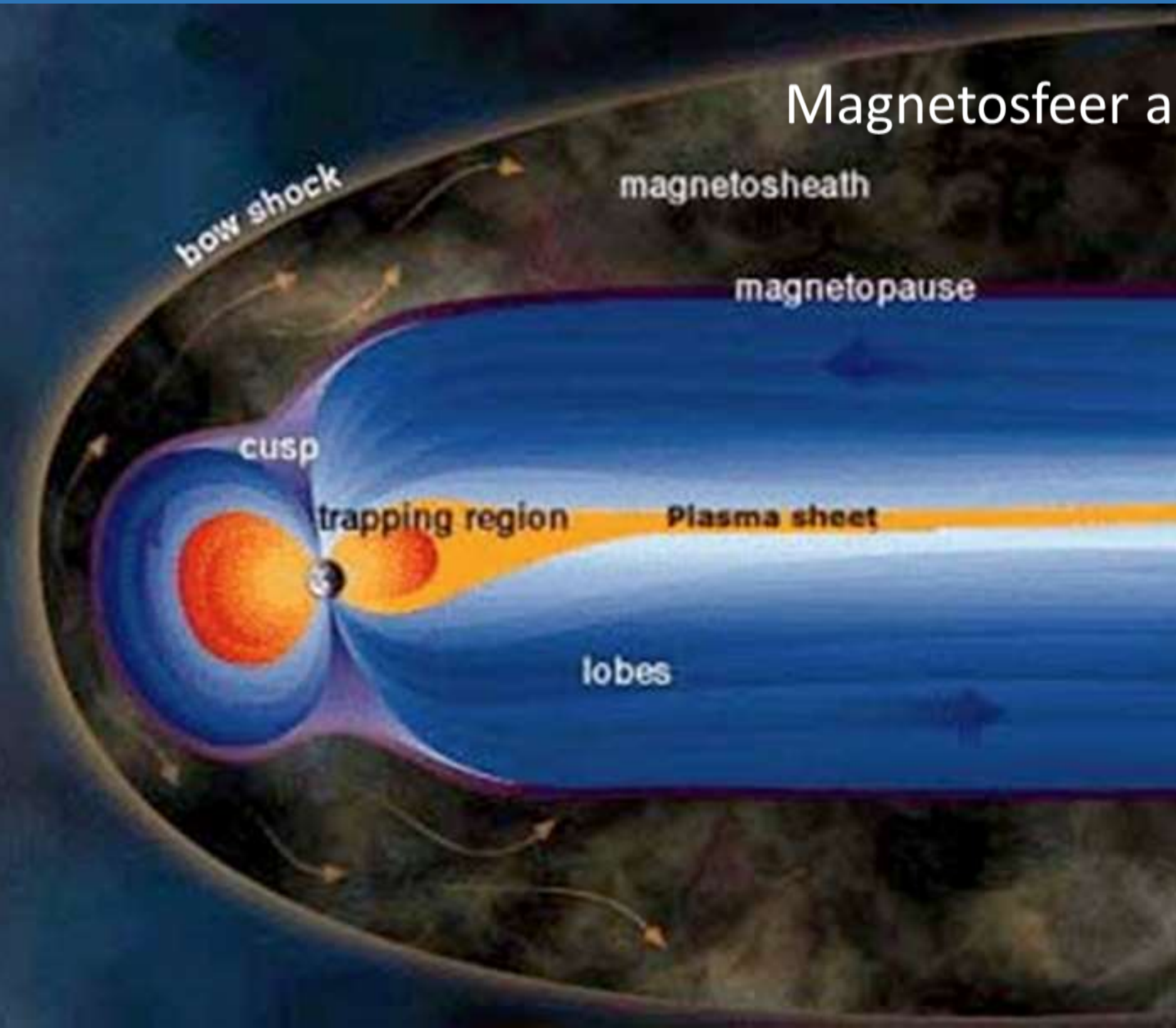
Magnetosfeer aarde

Effect zonnewind:

- Constante vervorming;
- Veel opgeslagen energie.

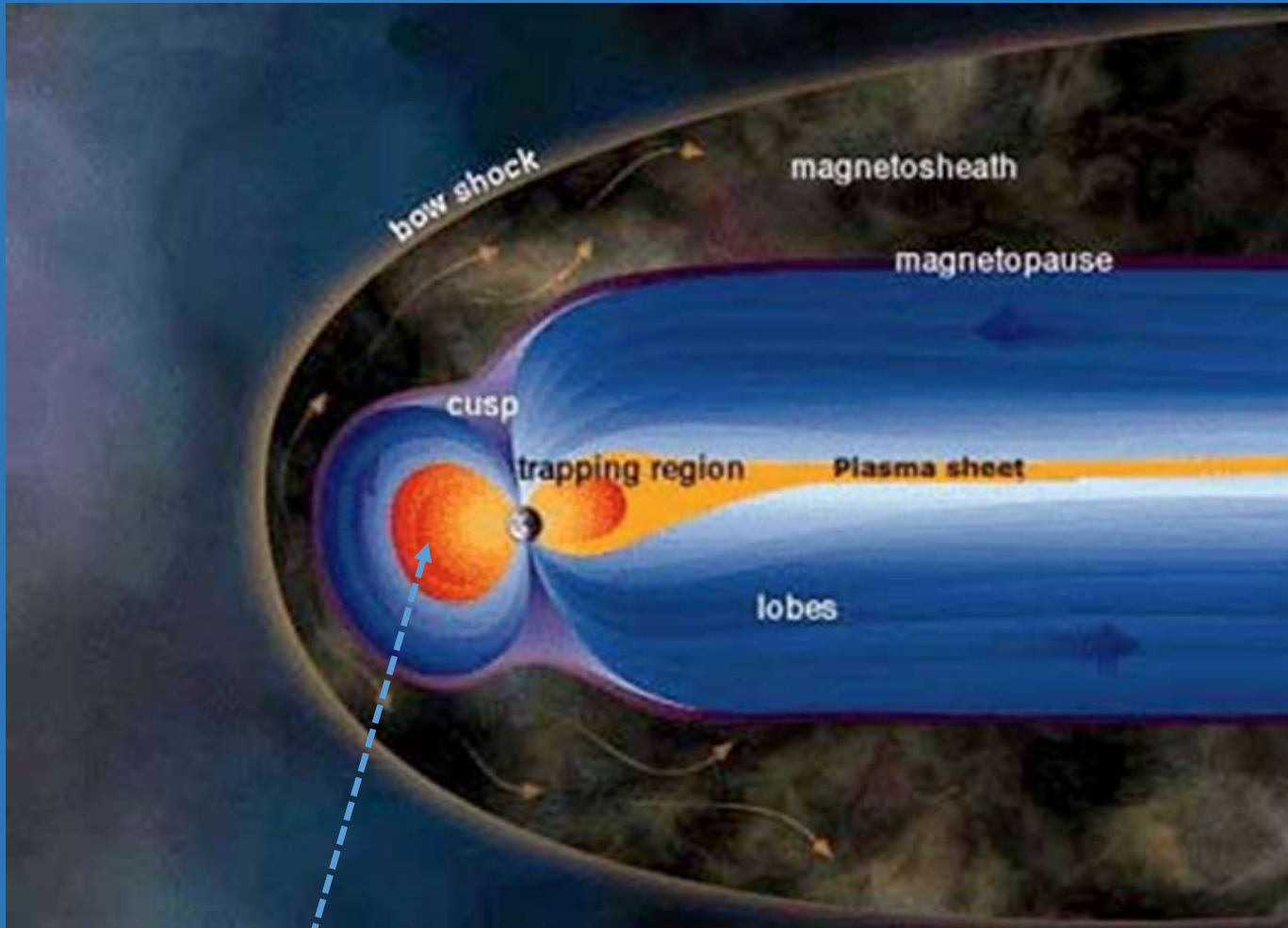
Raarde

Magnetosfeer aarde

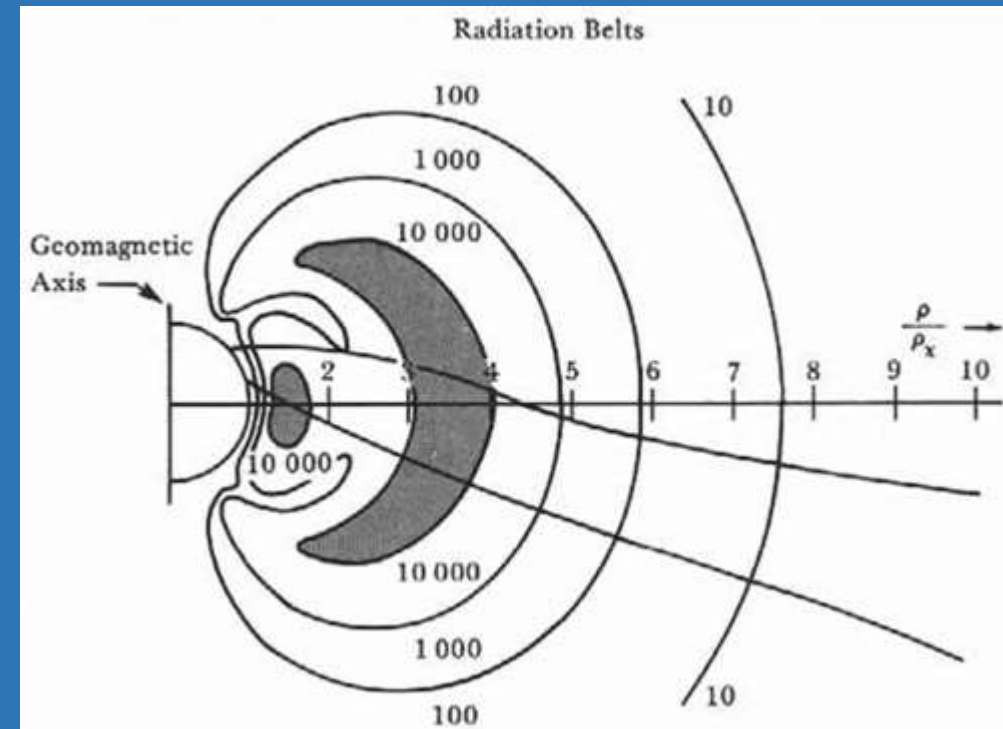


Magnetosfeer aarde

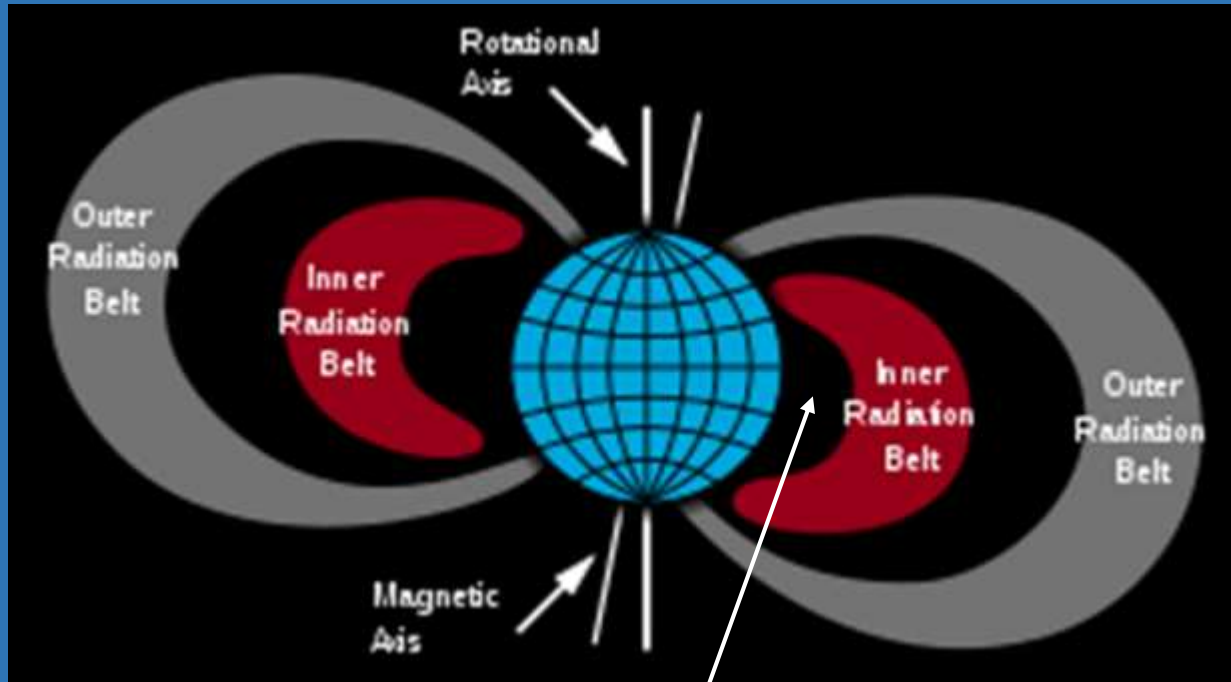
James van Allen: 1958
Geigerteller Explorer 1.



Van Allen Radiation Belts



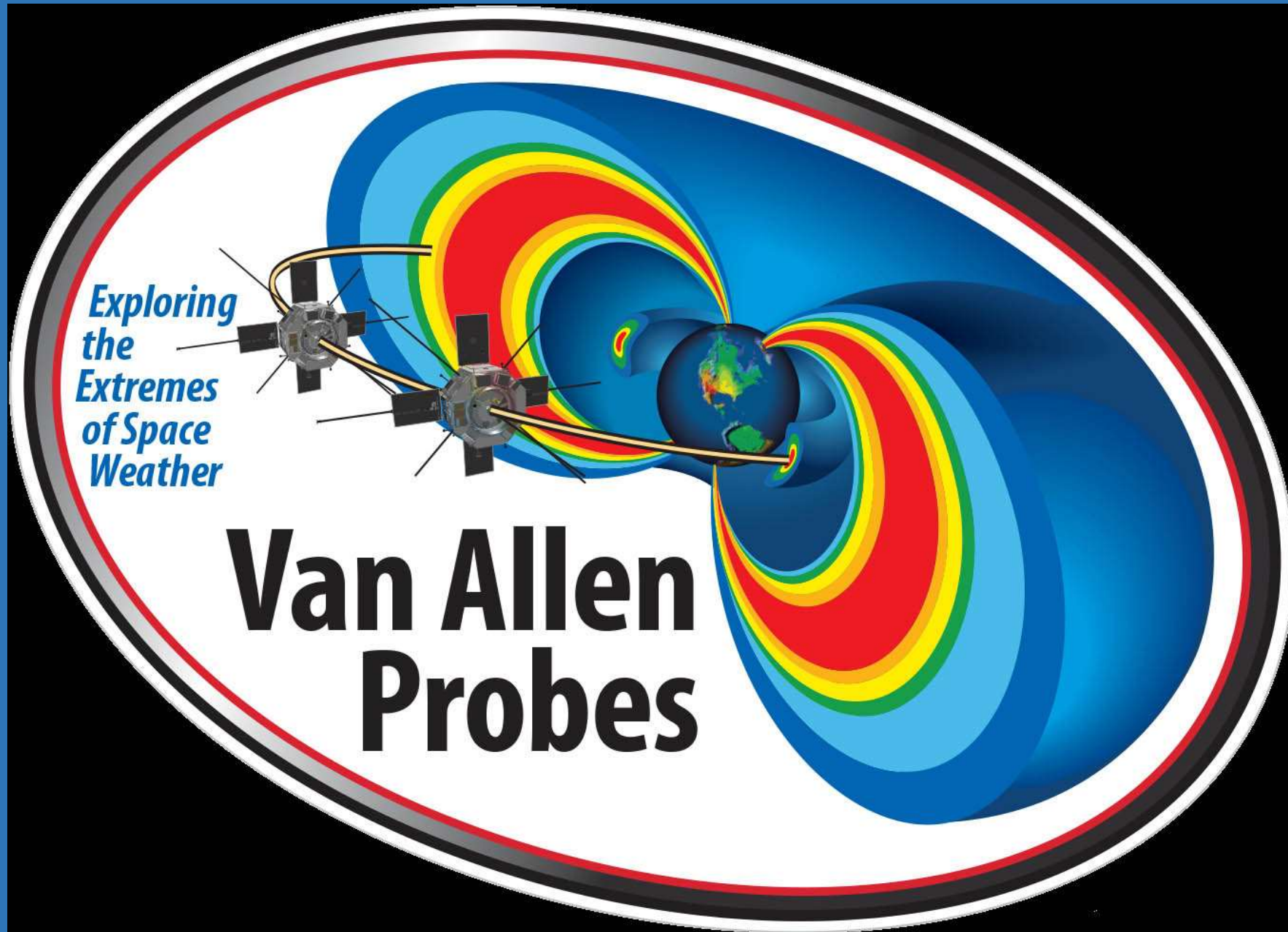
Van Allen Radiation Belts



ISS & Hubble

Inner:
Protonen (kosmische straling)

Outer:
Elektronen (zonnewind)



Van Allen Probes

Probe A & Probe B

2012-08-30

2019 uit bedrijf.

Werking Noorderlicht.



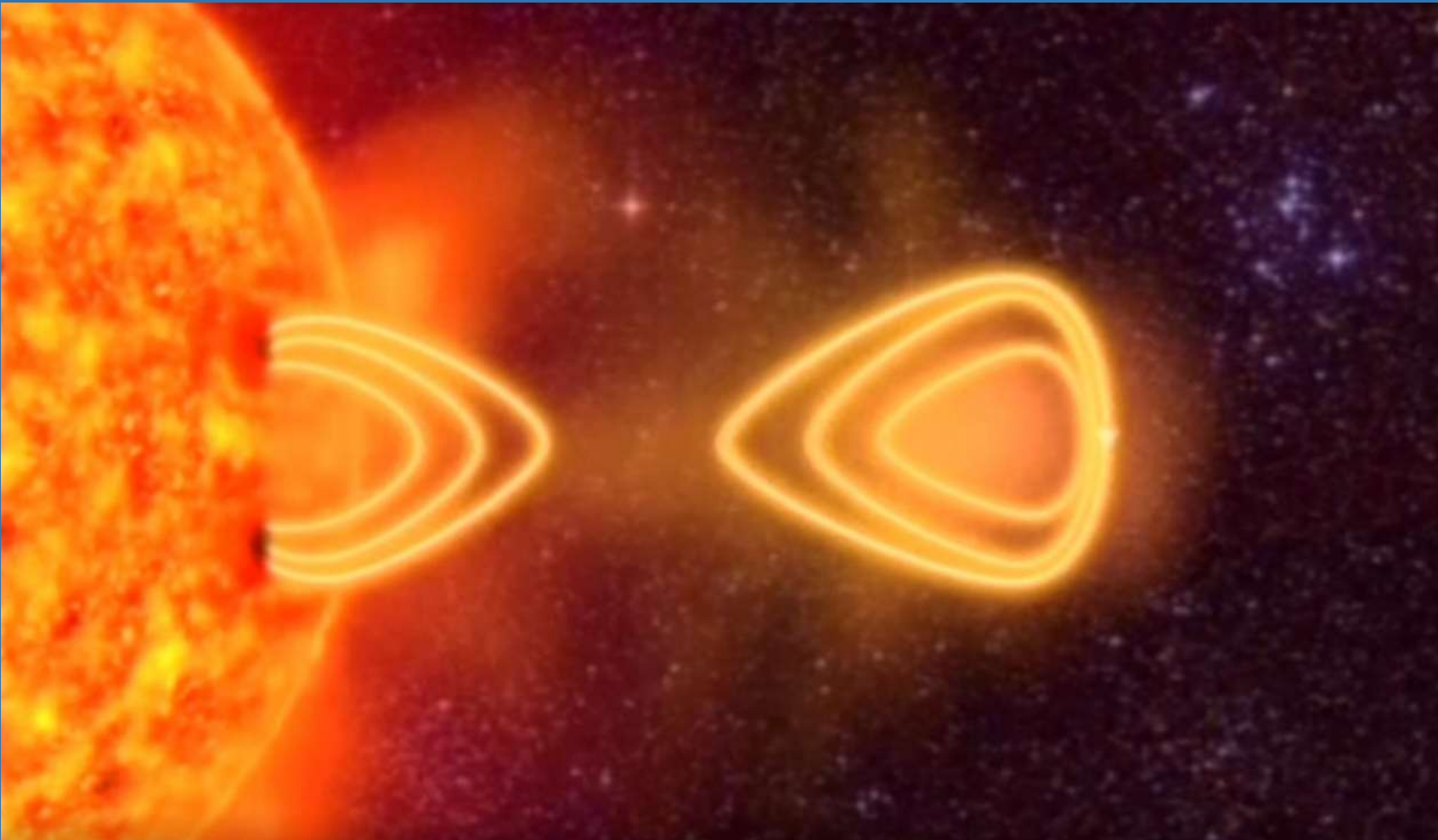
Dungey cycle - 1961

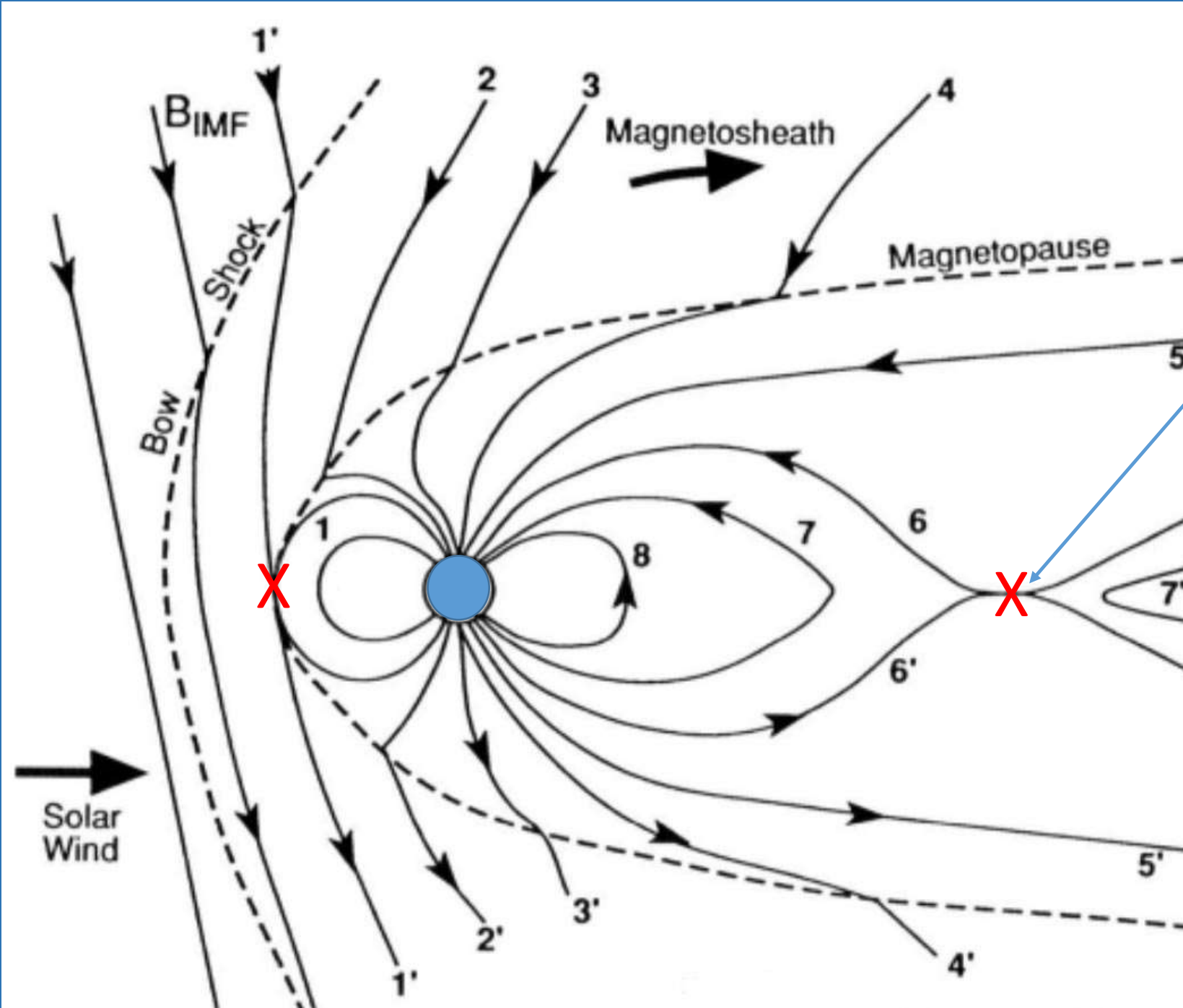
James Dungey

Zonnestorm én IMF met magnetische veldrichting tegengesteld aan aarde.

Magnetische reconnectie

- Dagkant aarde;
- Nachtkant aarde.





Dungey cycle

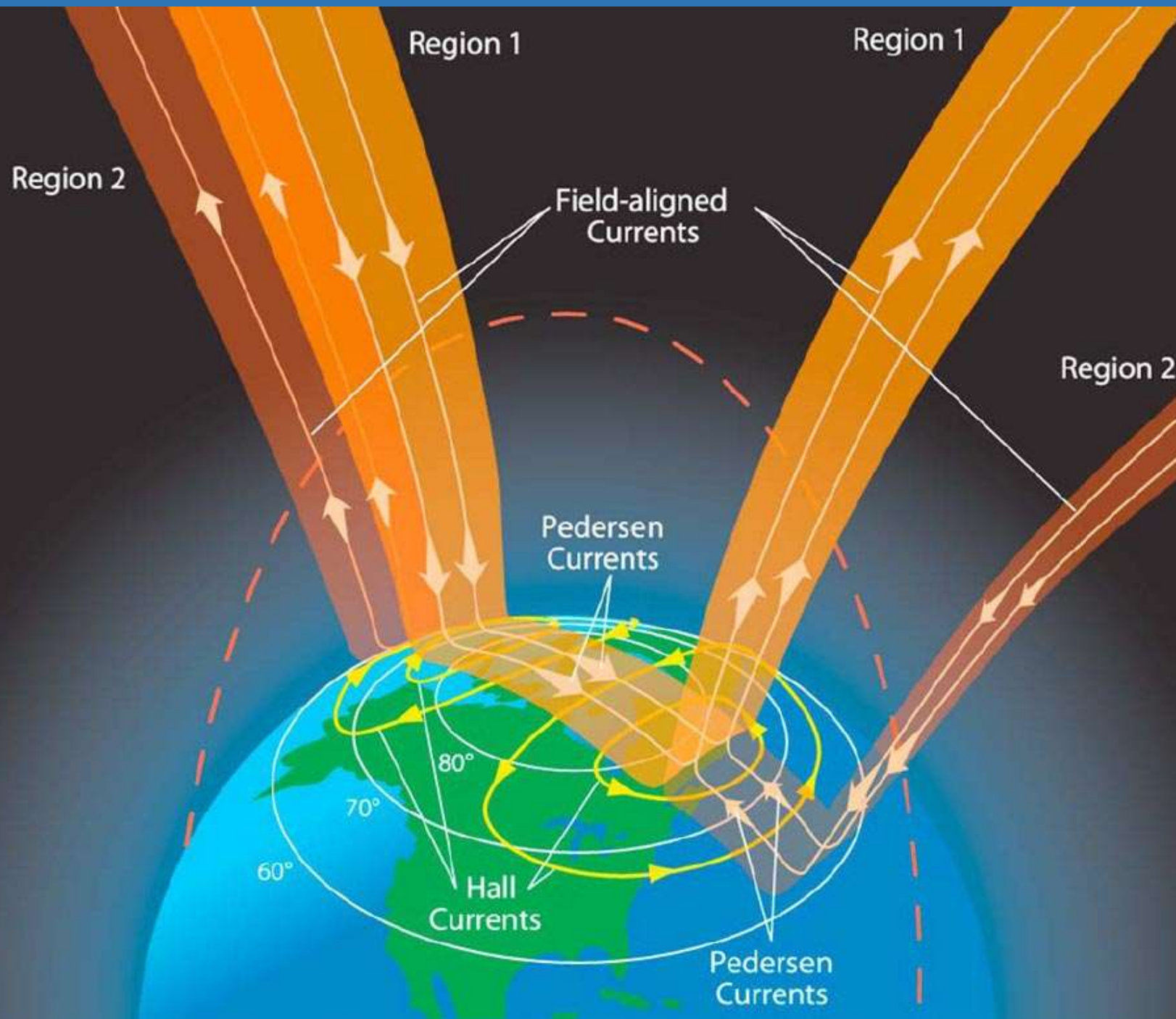
X Magnetische reconnectie

Nachtkant aarde:

Elektronen worden versneld richting N & Z pool en botsen op atmosfeer:

***Noorderlicht
& Zuiderlicht;***

Plasma verdwijnt de ruimte in.



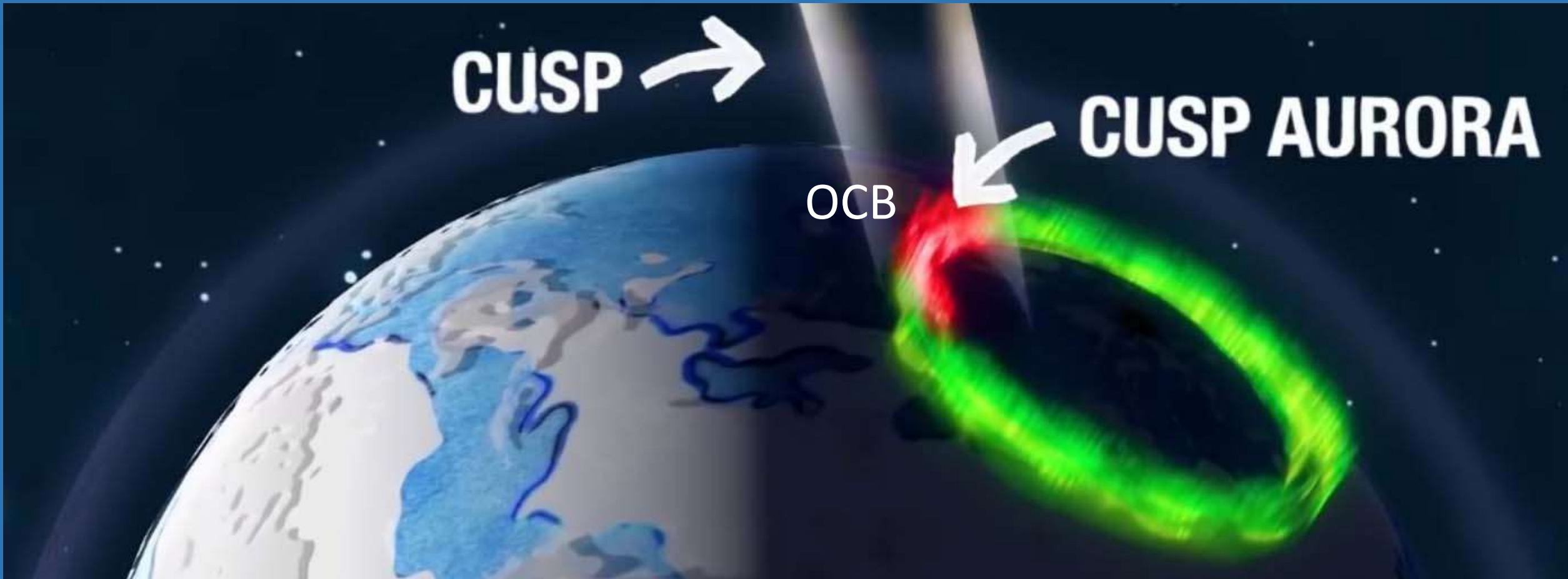
Birkeland currents
of
Field-aligned Currents

Elektrische stromen die
de Magnetosfeer met de
Ionosfeer verbinden.

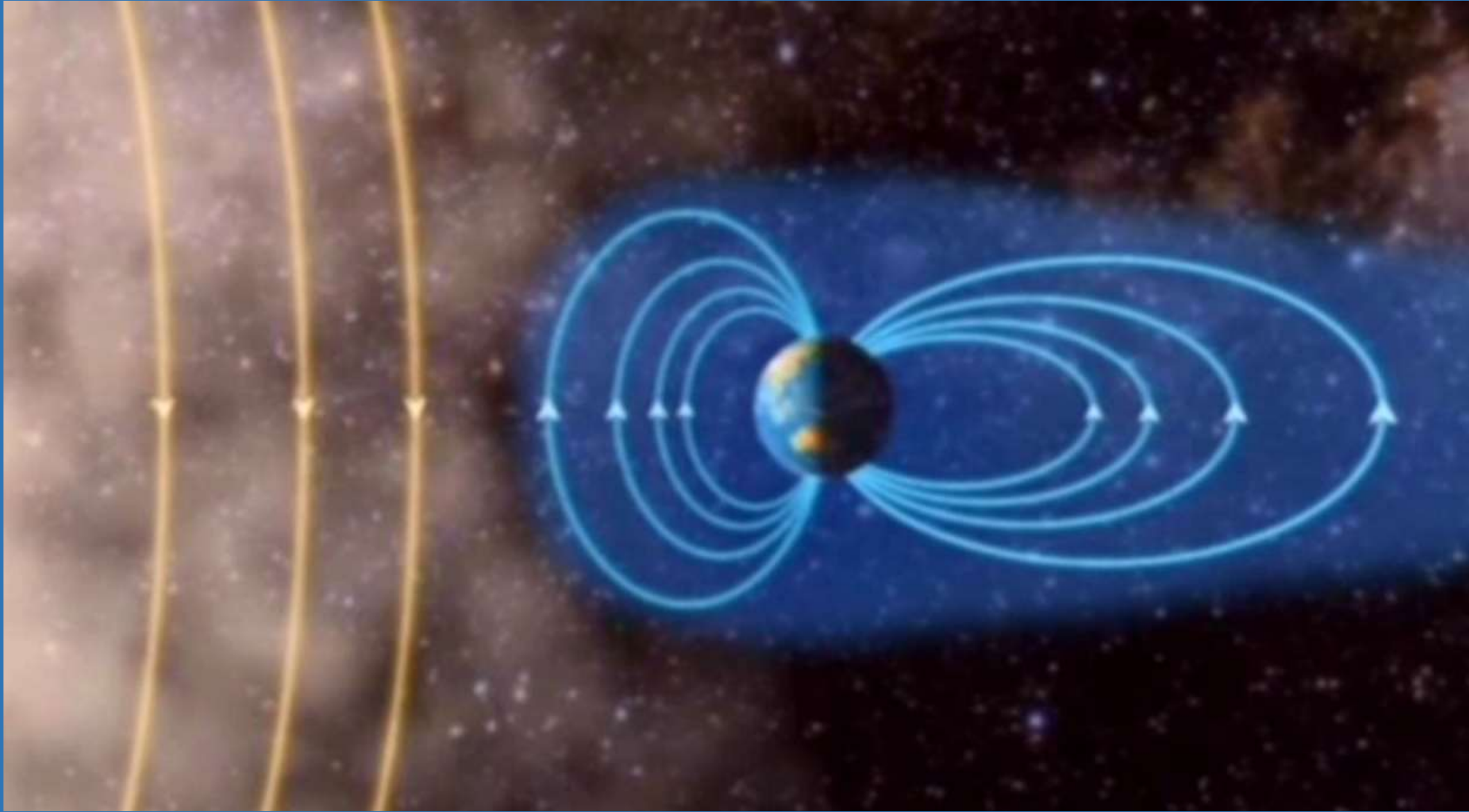
CUSP →

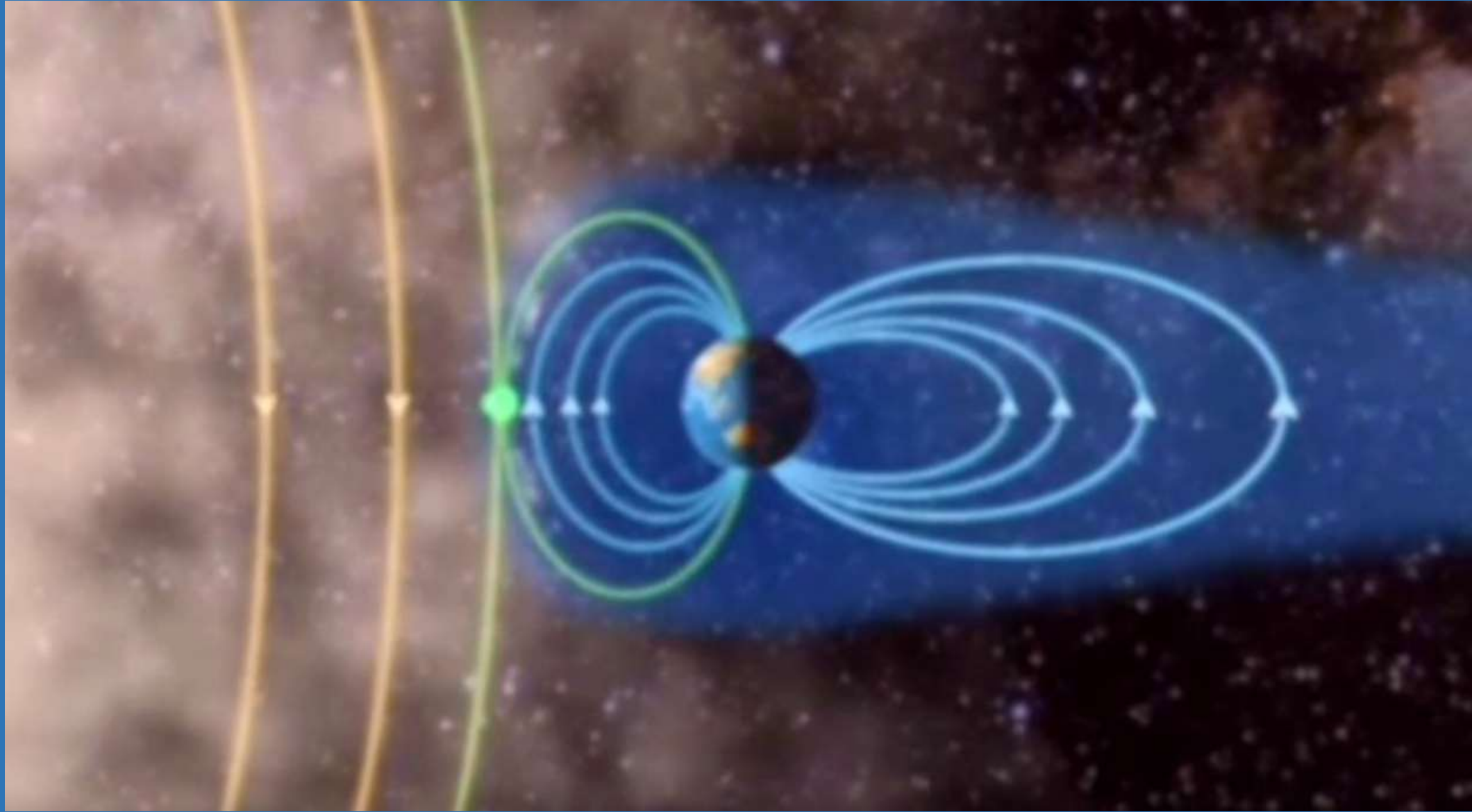
CUSP AURORA

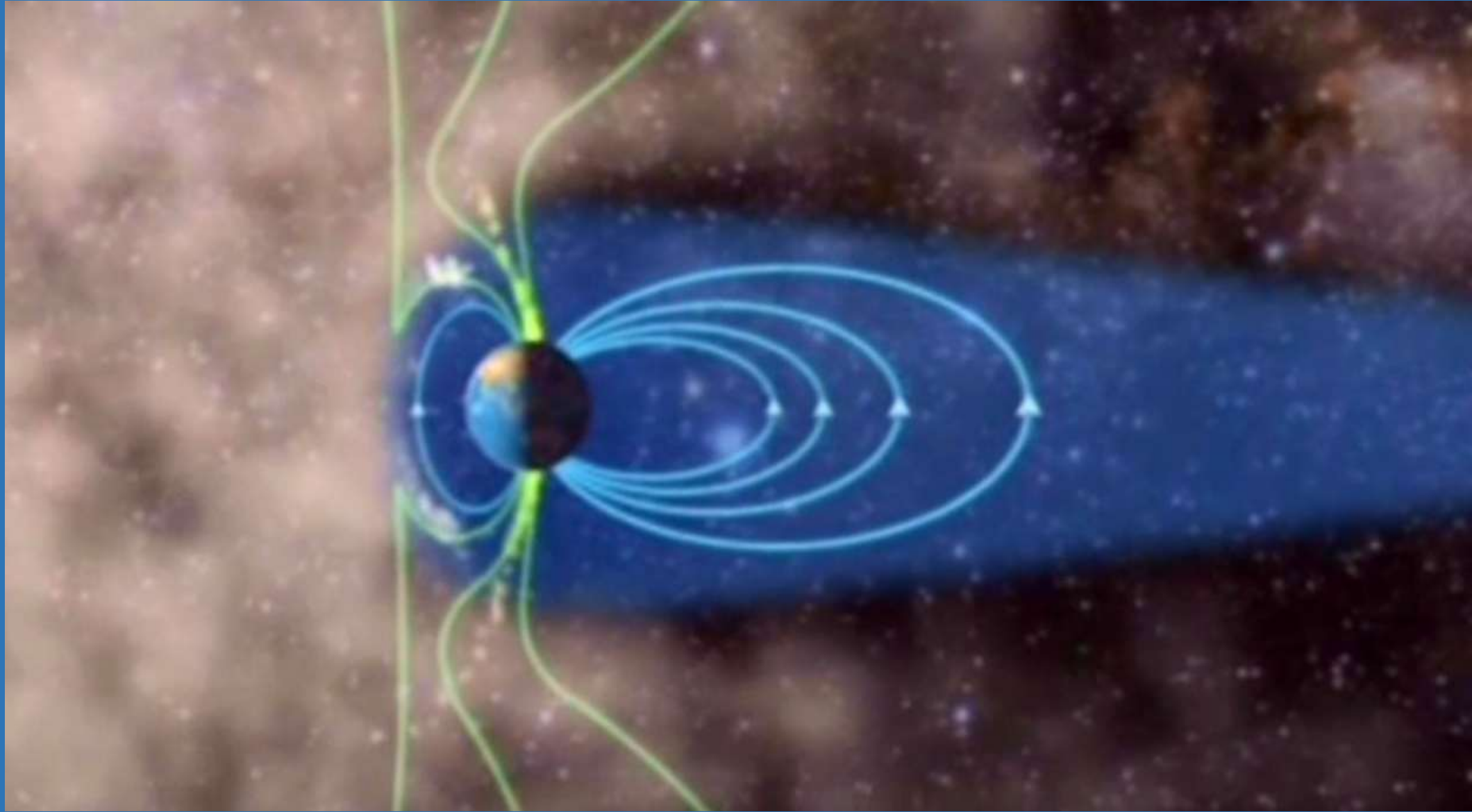
OCB

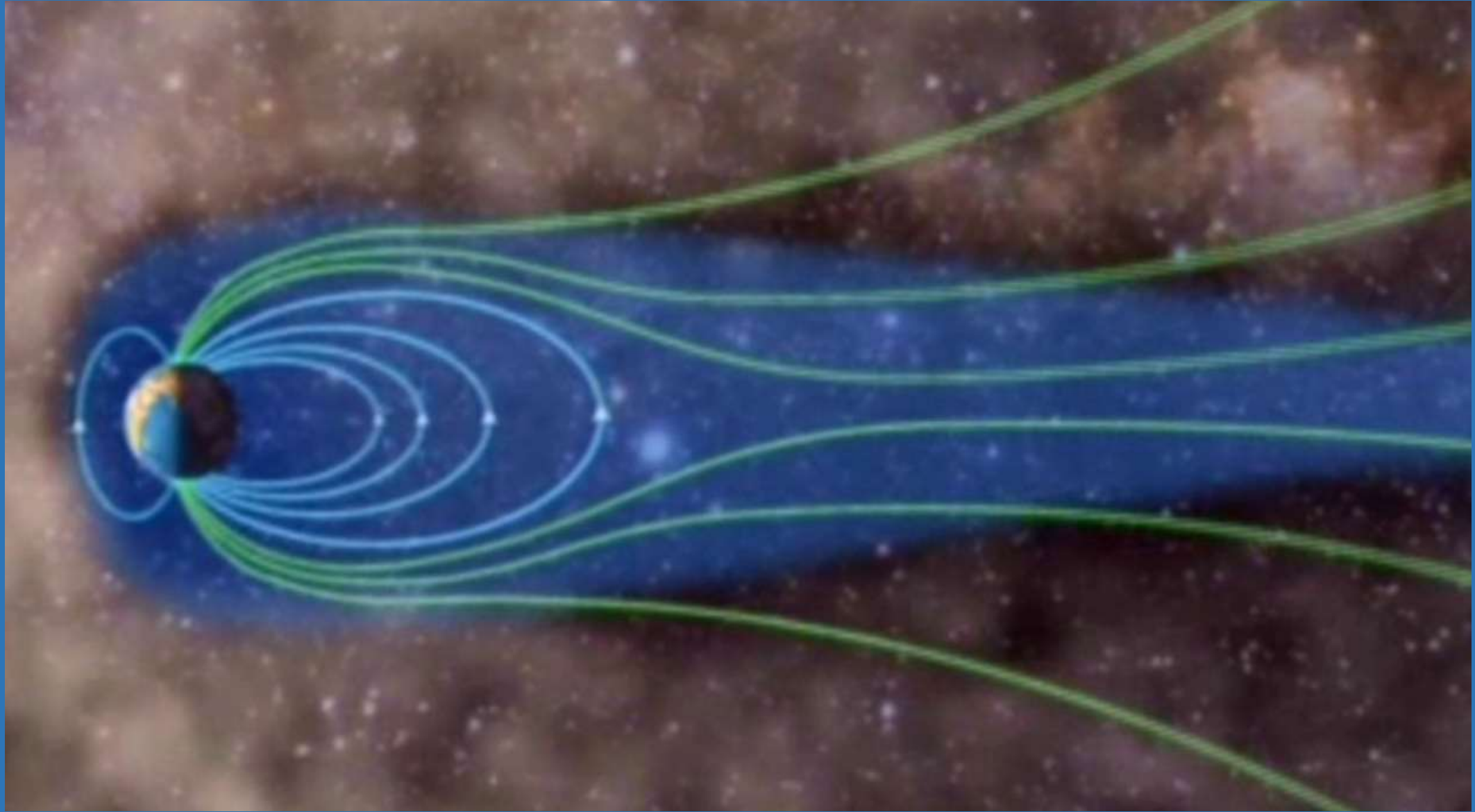


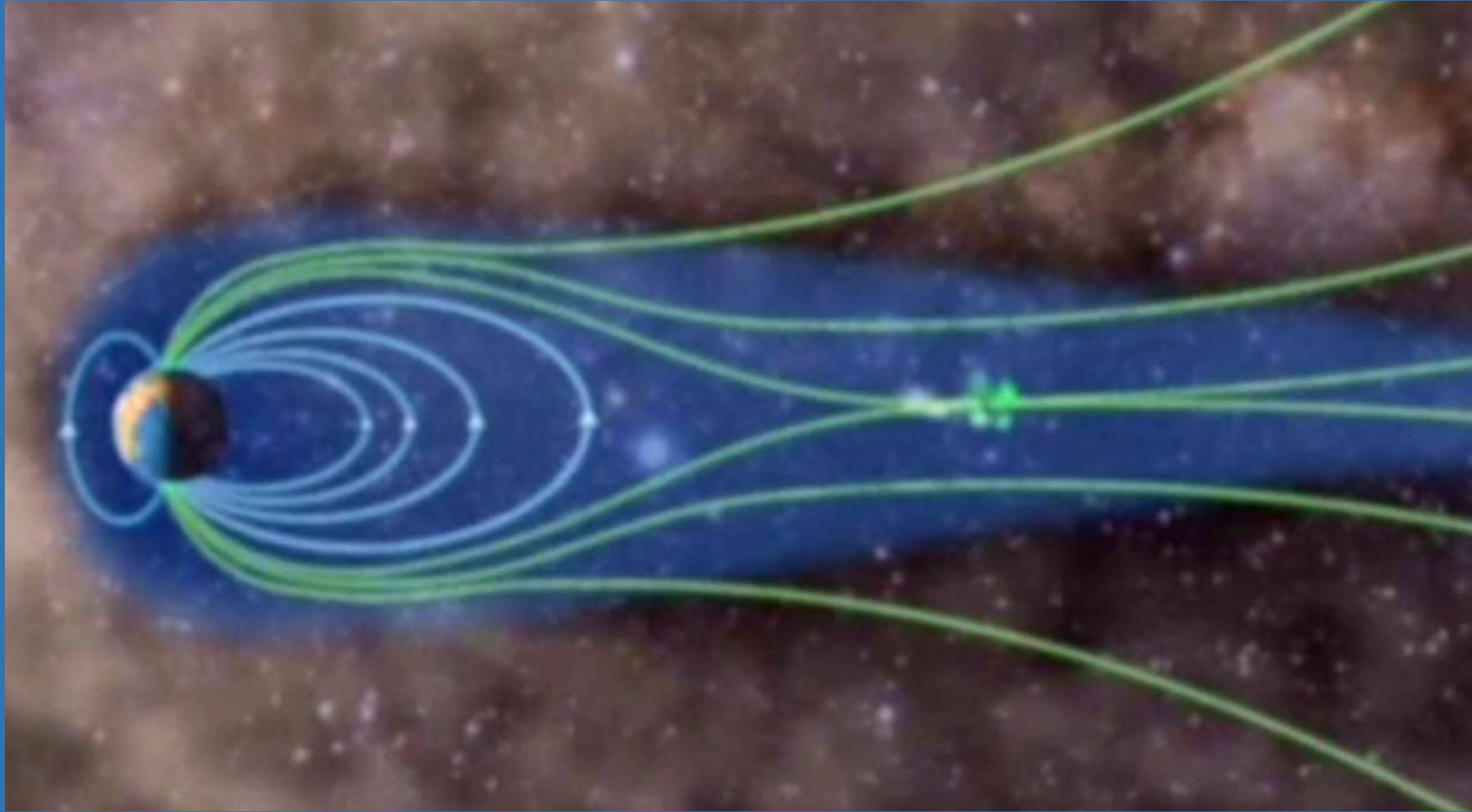
Dungey cycle

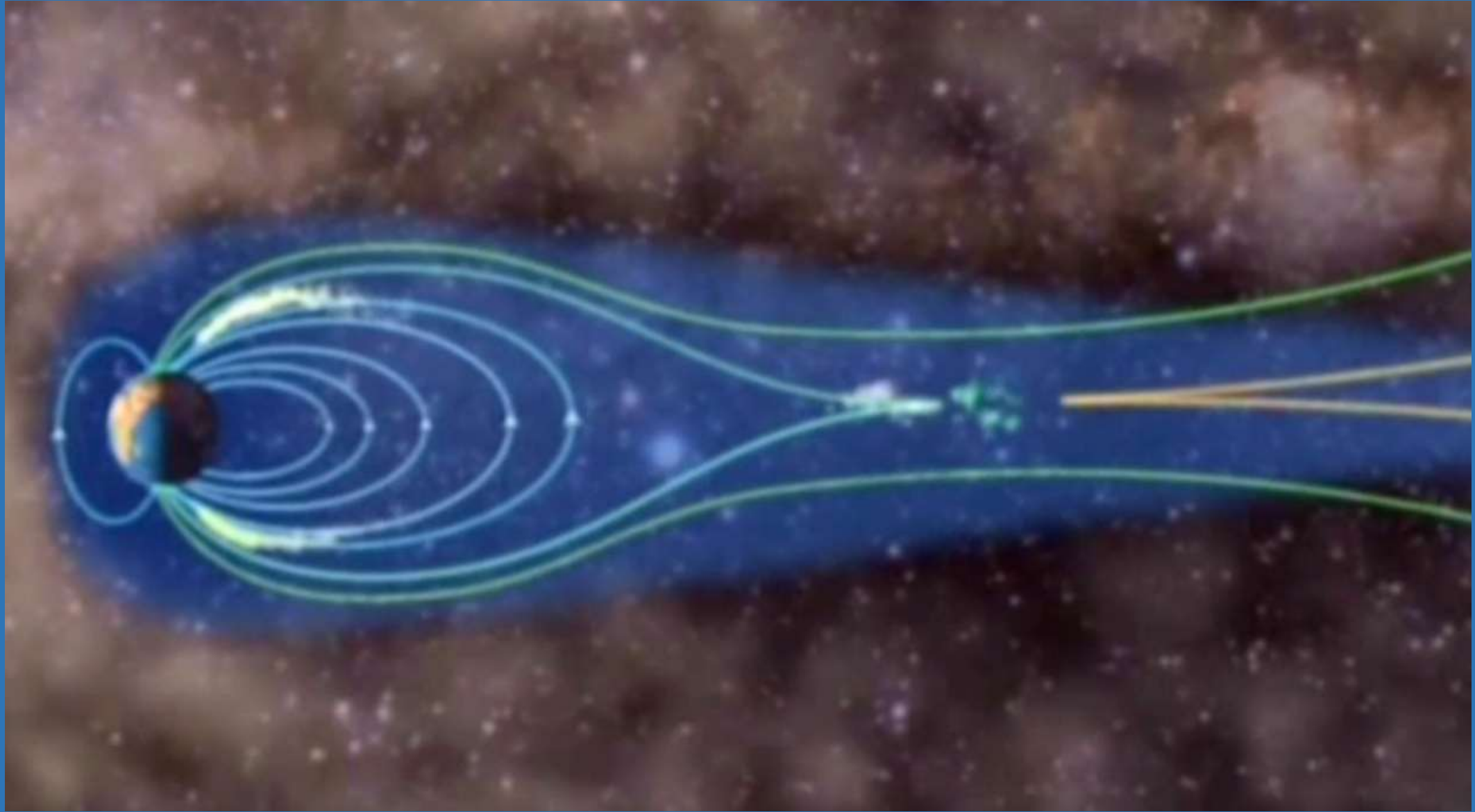














Noorderlicht kleuren:	Rood	630 nm	O
	Groen	558	O
	Donker rood	650-680	N ₂
	Blauw-violet	428	N ₂ ⁺



Hoofdstuk 3 – Ruimteweerbericht



NOAA – National Oceanic and Atmospheric Administration

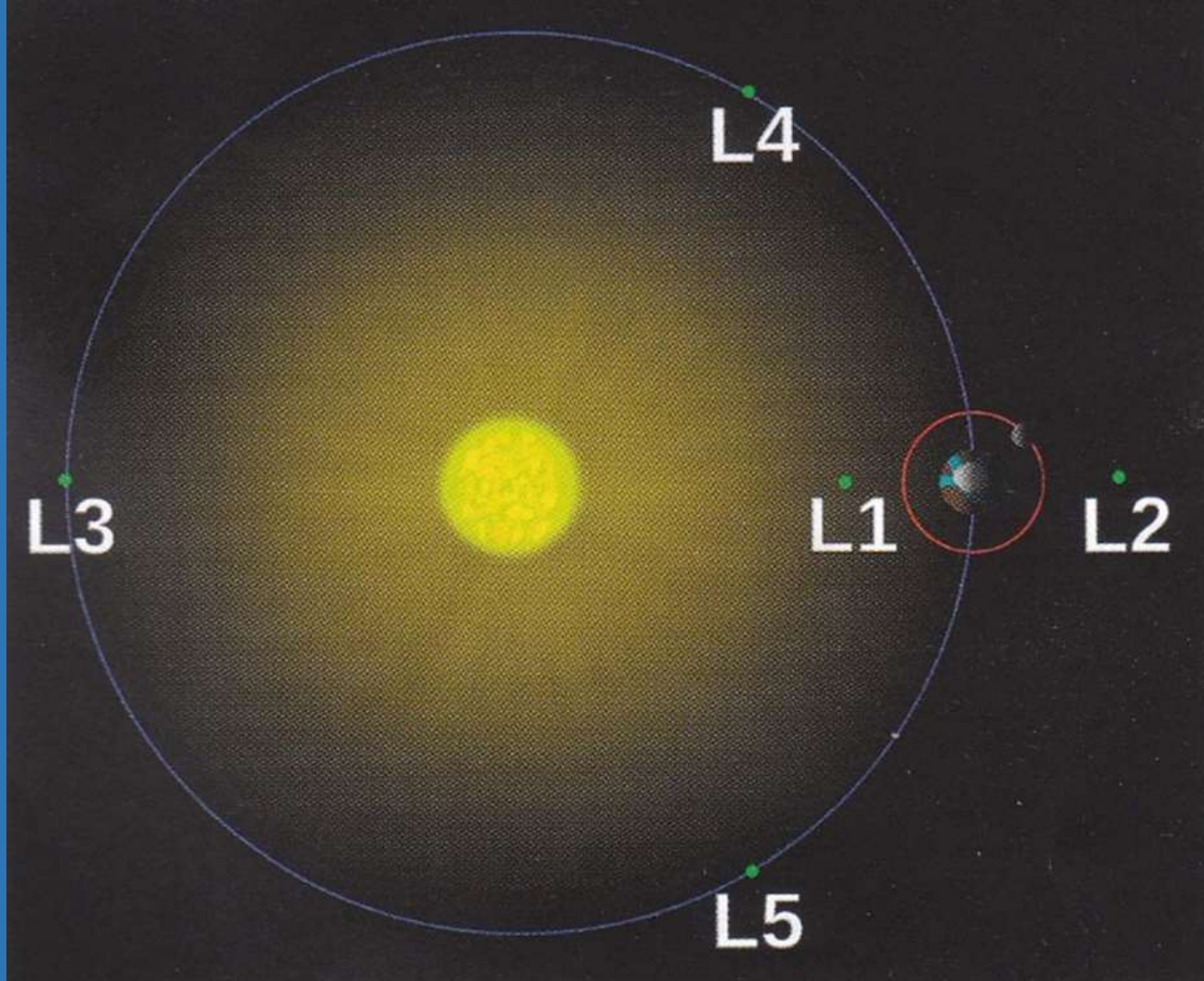
<https://www.swpc.noaa.gov/>



SWPC

Space Weather
Prediction Center

Boulder
Colorado



Satellieten in L1

Zon – L1 = 0,99 AU

L1 – aarde = 0,01 AU

Na 30 – 60 min is zonnewind van L1 bij aarde.

SEPs te snel om op te reageren.

X-Ray komt zonder vertraging aan.

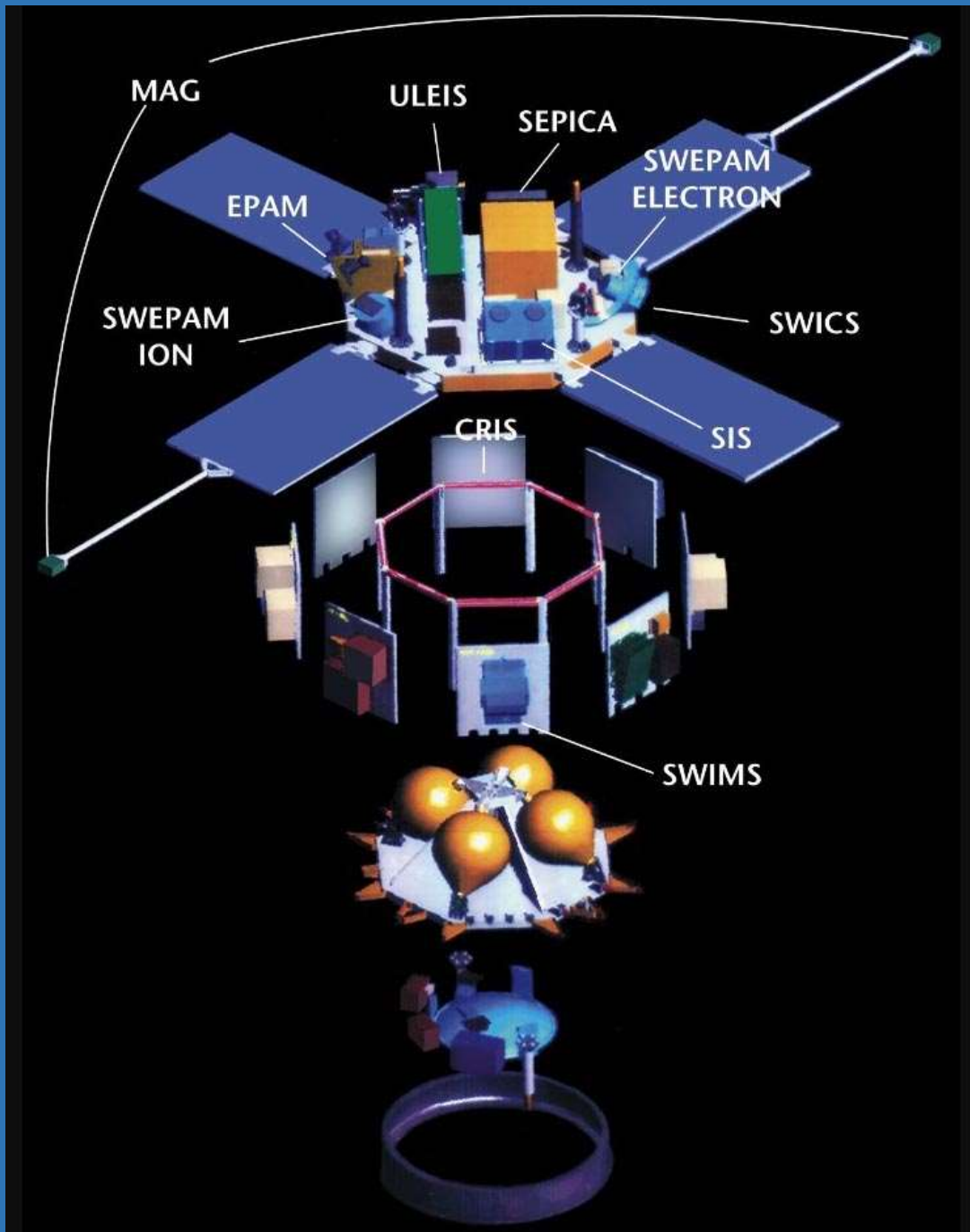
Satellieten in L1

ACE Advanced Composition
Explorer

NASA

1997-08-25

SWEPAM – Solar Wind Electron, Proton
and Alpha Monitor.

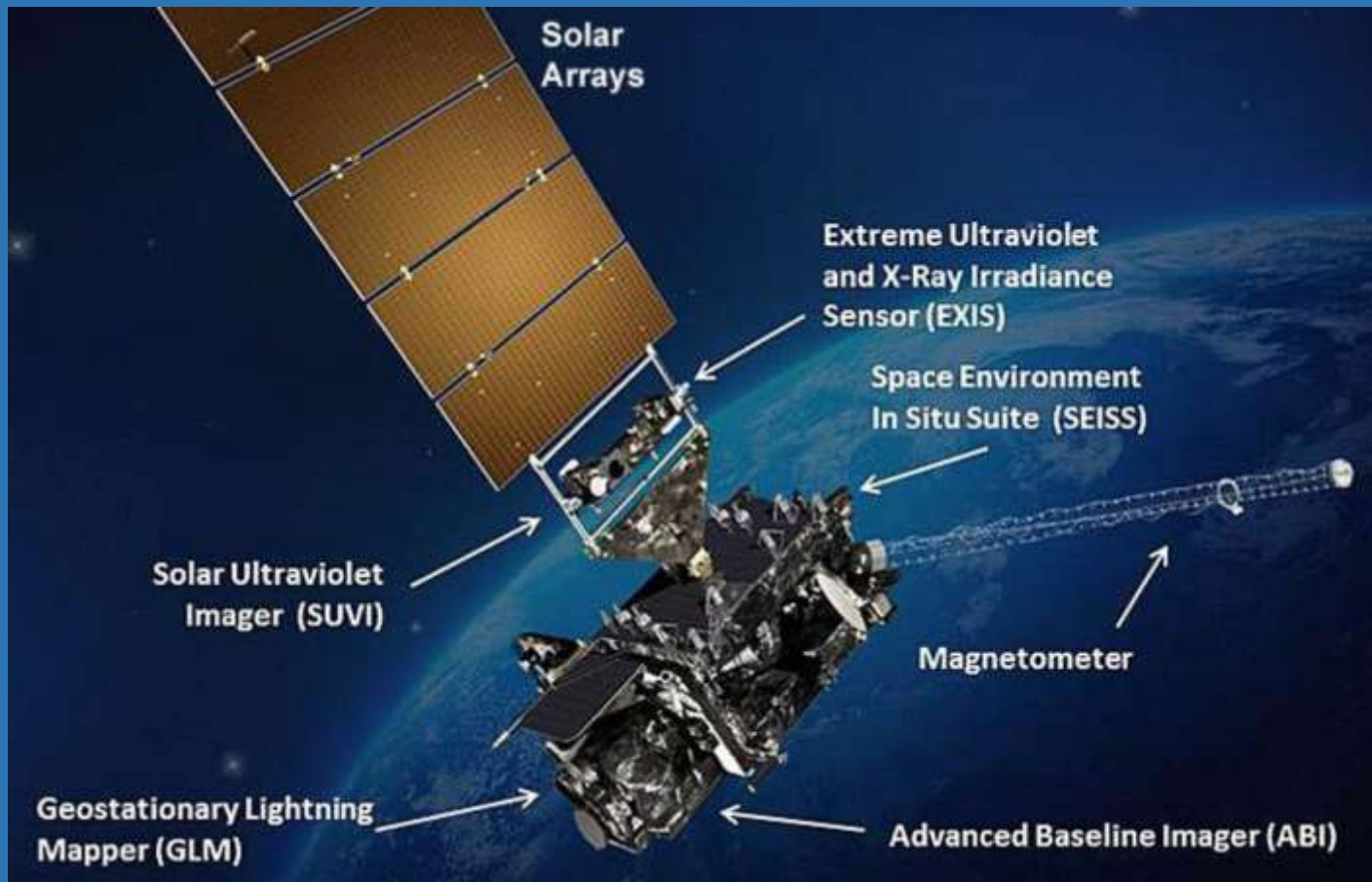


Satellieten in baan om aarde

GOES Geostationary Operational
Environmental Satellites

NOAA

GOES 16	<i>2016-11-19 East</i>
18	<i>2022-03-01 West</i>

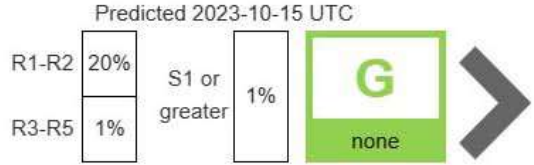


2023-10-15 Voorbeeld 3-Day forecast





SPACE WEATHER CONDITIONS on NOAA Scales



Solar Wind Speed: **403** km/sec Solar Wind Magnetic Fields: Bt **2** nT, Bz **-1** nT Noon 10.7cm Radio Flux: **148** sfu

SPACE WEATHER ENTHUSIASTS DASHBOARD



SPACE WEATHER CONDITIONS on NOAA Scales

24-Hour Observed Maximums



Latest Observed



Predicted 2023-10-15 UTC

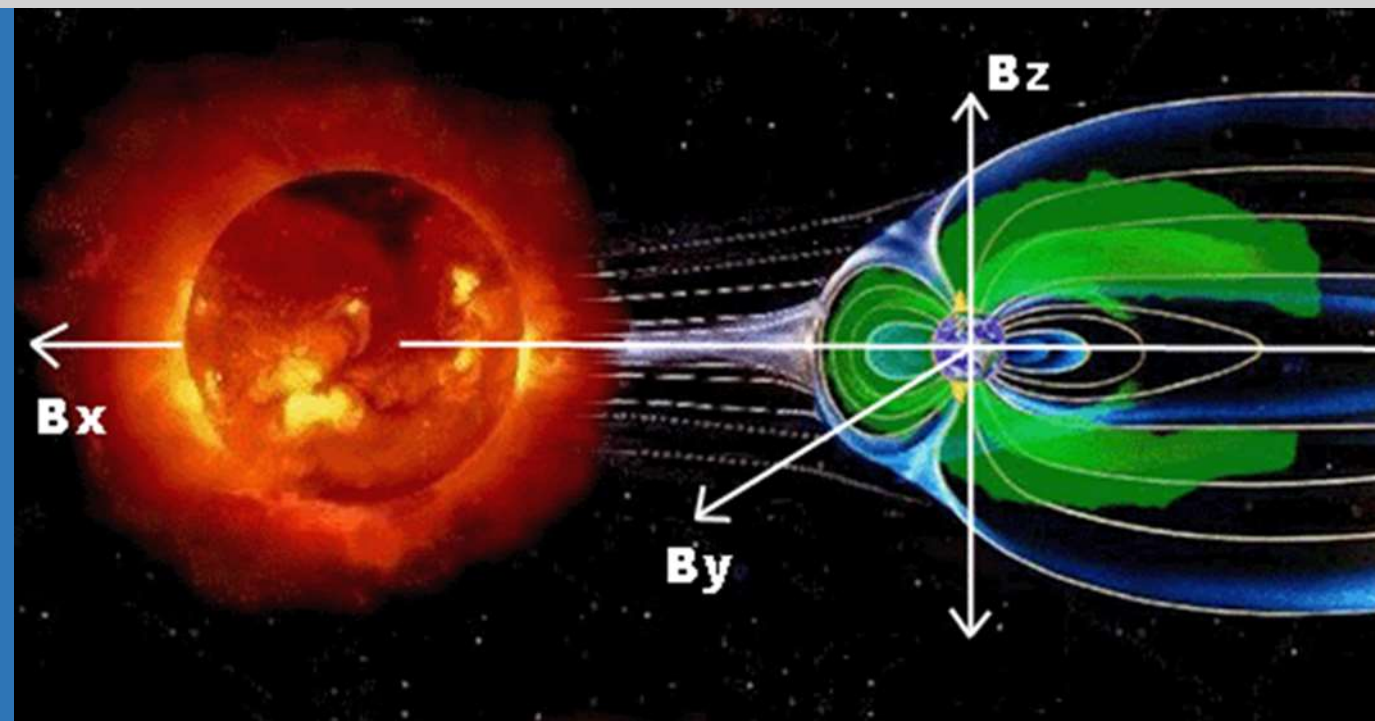
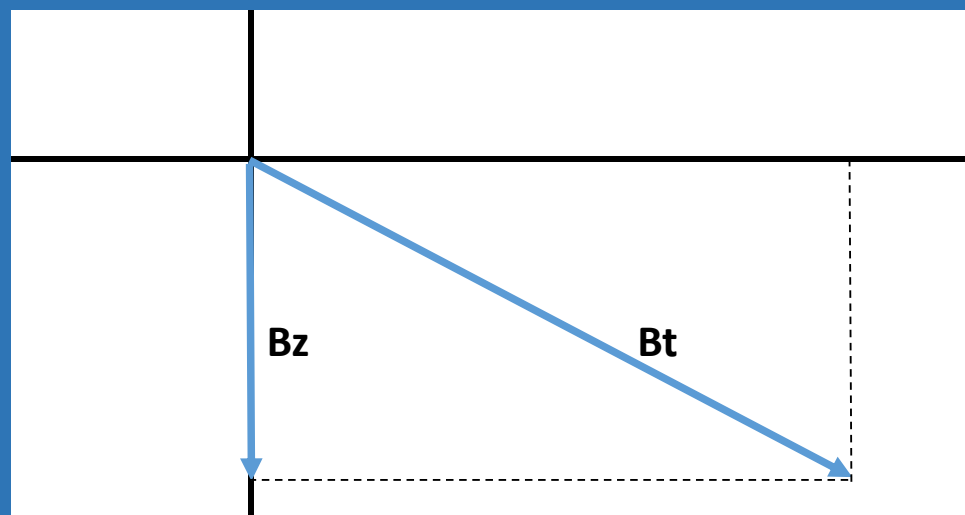


Solar Wind Speed: **403** km/sec

Solar Wind Magnetic Fields: Bt **2** nT, Bz **-1** nT

Noon 10.7cm Radio Flux: **148** sfu

SPACE WEATHER ENTHUSIASTS DASHBOARD

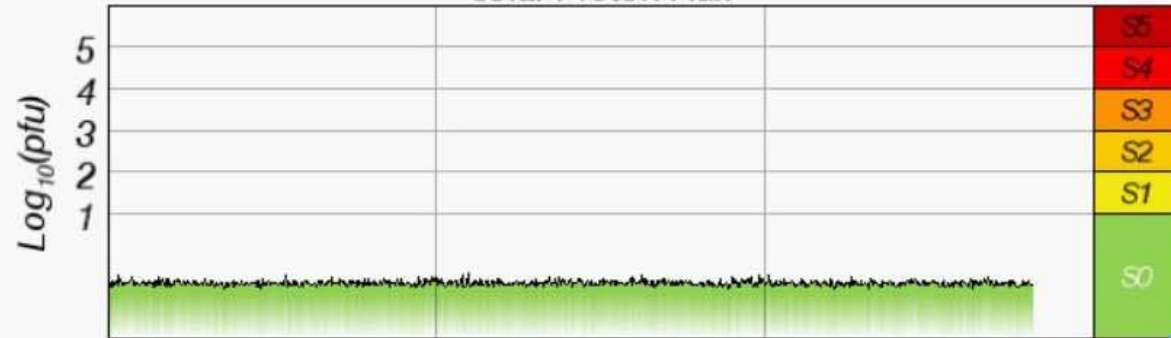


SPACE WEATHER OVERVIEW

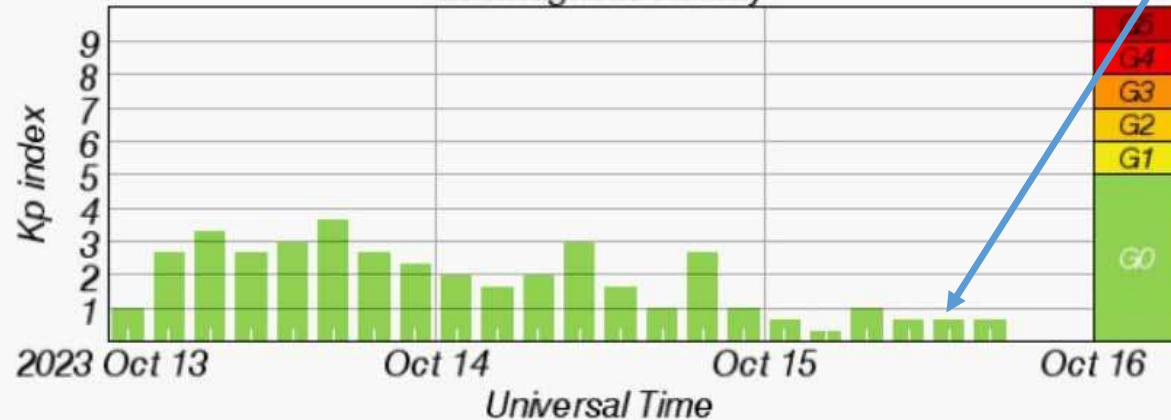
Solar X-ray Flux



Solar Proton Flux



Geomagnetic Activity



:Product: 3-Day Forecast

:Issued: 2023 Oct 15 1230 UTC

Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center

#

A. NOAA Geomagnetic Activity Observation and Forecast

The greatest observed 3 hr Kp over the past 24 hours was 3 (below NOAA Scale levels).

The greatest expected 3 hr Kp for Oct 15-Oct 17 2023 is 3.67 (below NOAA Scale levels).

NOAA Kp index breakdown Oct 15-Oct 17 2023

	Oct 15	Oct 16	Oct 17
00-03UT	0.67	1.67	2.67
03-06UT	0.33	1.67	2.67
06-09UT	1.00	1.33	3.67
09-12UT	0.67	1.33	2.67
12-15UT	2.67	1.67	1.67
15-18UT	2.33	1.33	1.67
18-21UT	2.33	1.33	2.67
21-00UT	2.33	1.33	3.00

Rationale: No G1 (Minor) or greater geomagnetic storms are expected. No significant transient or recurrent solar wind features are forecast.

B. NOAA Solar Radiation Activity Observation and Forecast

Solar radiation, as observed by NOAA GOES-16 over the past 24 hours, was below S-scale storm level thresholds.

Solar Radiation Storm Forecast for Oct 15-Oct 17 2023

	Oct 15	Oct 16	Oct 17
S1 or greater	1%	1%	1%

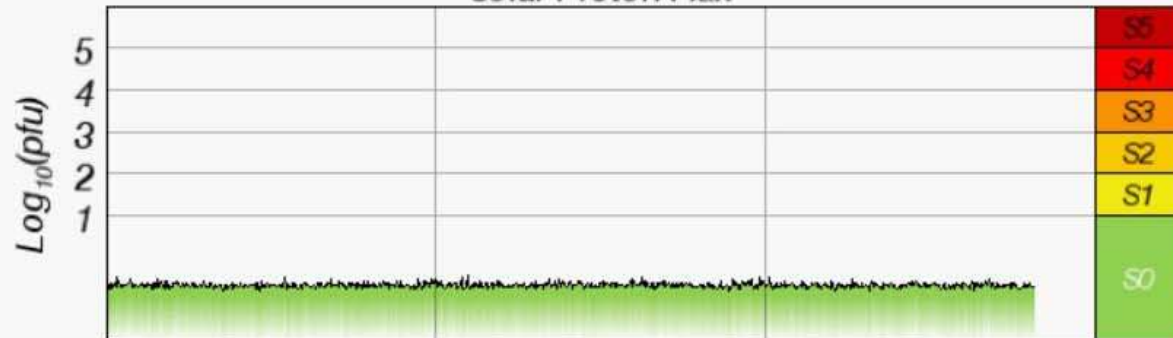
Rationale: No S1 (Minor) or greater solar radiation storms are expected. No significant active region activity favorable for radiation storm

SPACE WEATHER OVERVIEW

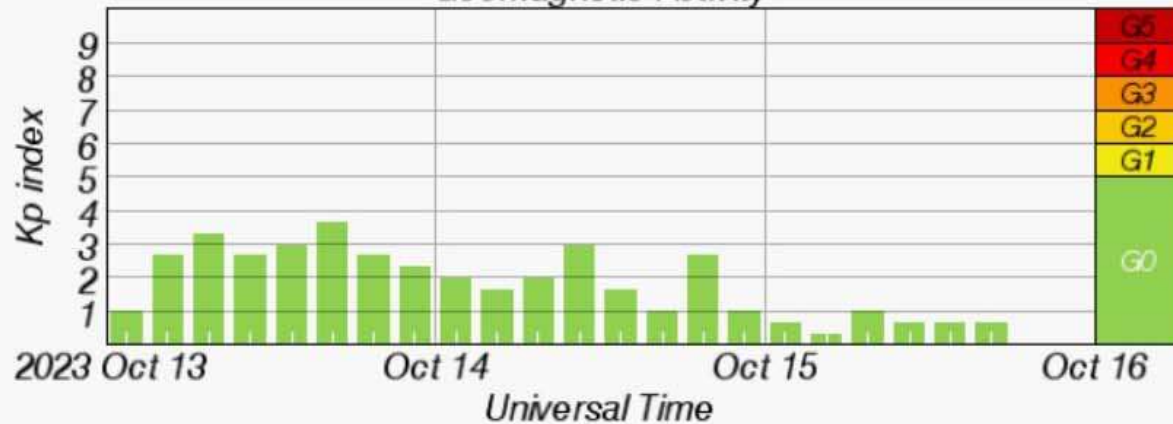
Solar X-ray Flux



Solar Proton Flux



Geomagnetic Activity



	Oct 15	Oct 16	Oct 17
00-03UT	0.67	1.67	2.67
03-06UT	0.33	1.67	2.67
06-09UT	1.00	1.33	3.67
09-12UT	0.67	1.33	2.67
12-15UT	2.67	1.67	1.67
15-18UT	2.33	1.33	1.67
18-21UT	2.33	1.33	2.67
21-00UT	2.33	1.33	3.00

Rationale: No G1 (Minor) or greater geomagnetic storms are expected. No significant transient or recurrent solar wind features are forecast.

B. NOAA Solar Radiation Activity Observation and Forecast

Solar radiation, as observed by NOAA GOES-16 over the past 24 hours, was below S-scale storm level thresholds.

Solar Radiation Storm Forecast for Oct 15-Oct 17 2023

	Oct 15	Oct 16	Oct 17
S1 or greater	1%	1%	1%

Rationale: No S1 (Minor) or greater solar radiation storms are expected. No significant active region activity favorable for radiation storm production is forecast.

C. NOAA Radio Blackout Activity and Forecast

No radio blackouts were observed over the past 24 hours.

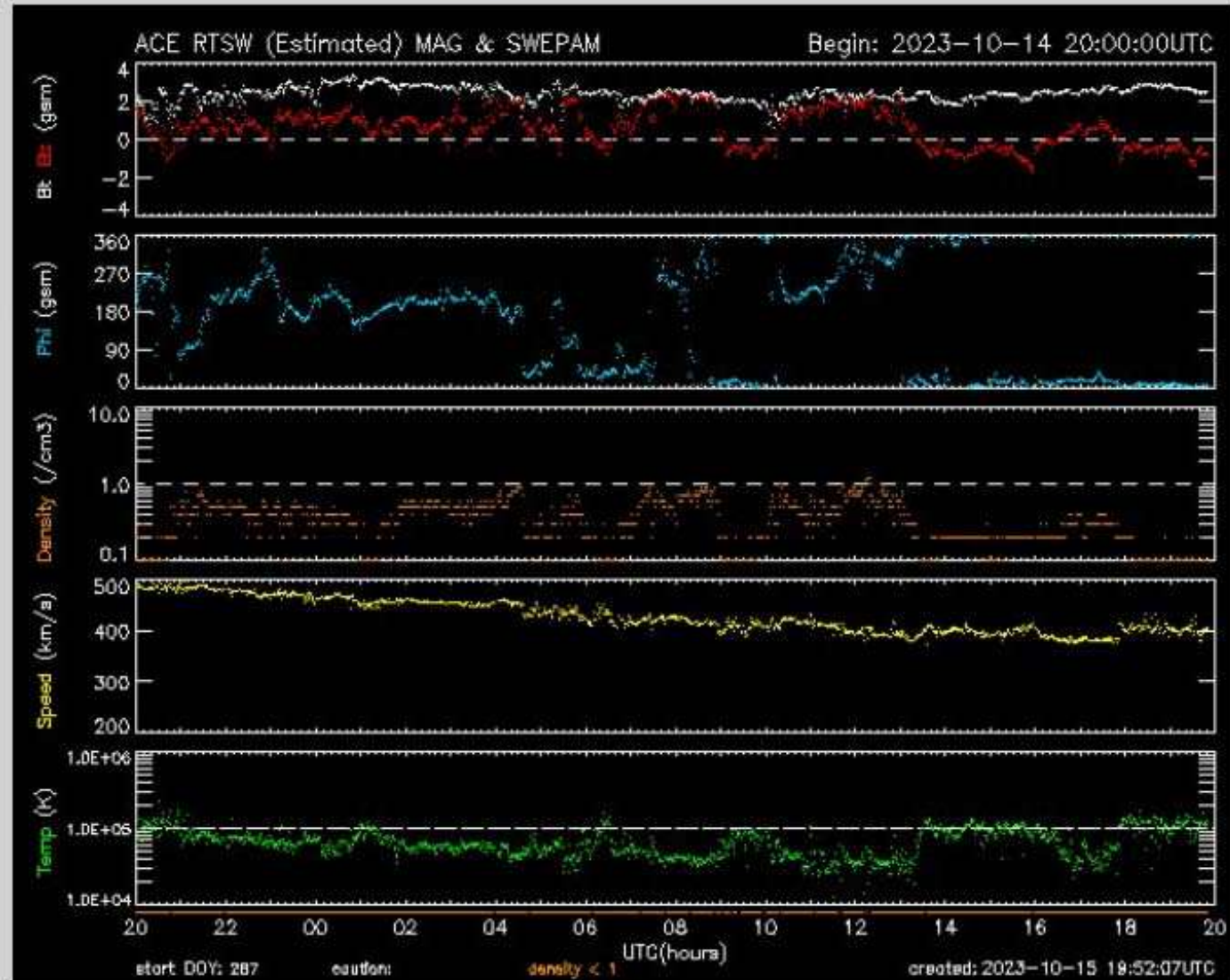
Radio Blackout Forecast for Oct 15-Oct 17 2023

	Oct 15	Oct 16	Oct 17
R1-R2	20%	20%	20%
R3 or greater	1%	1%	1%

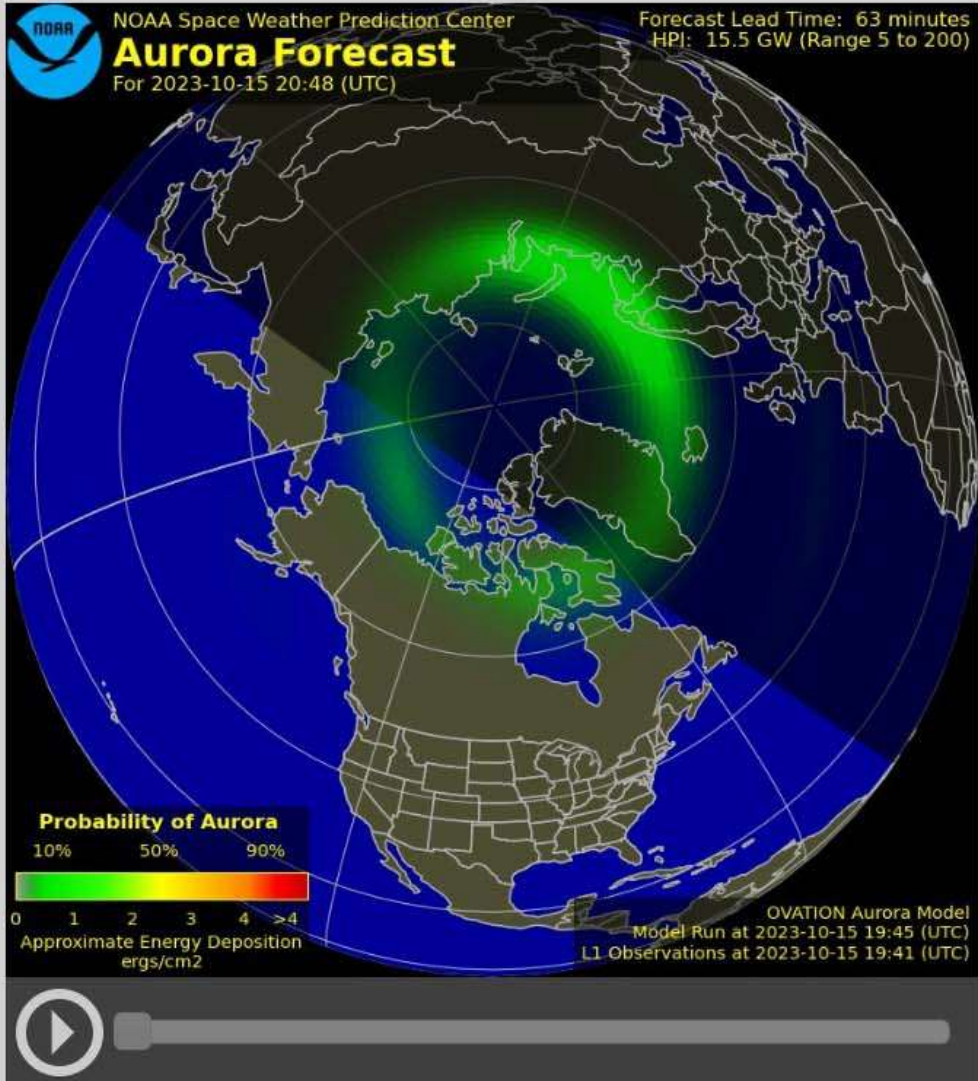
Rationale: There is a slight chance for R1-R2 (Minor-Moderate) radio blackouts over 15-17 Oct.

Solar Wind

ACE MAG AND SWEFAM



AURORA FORECAST



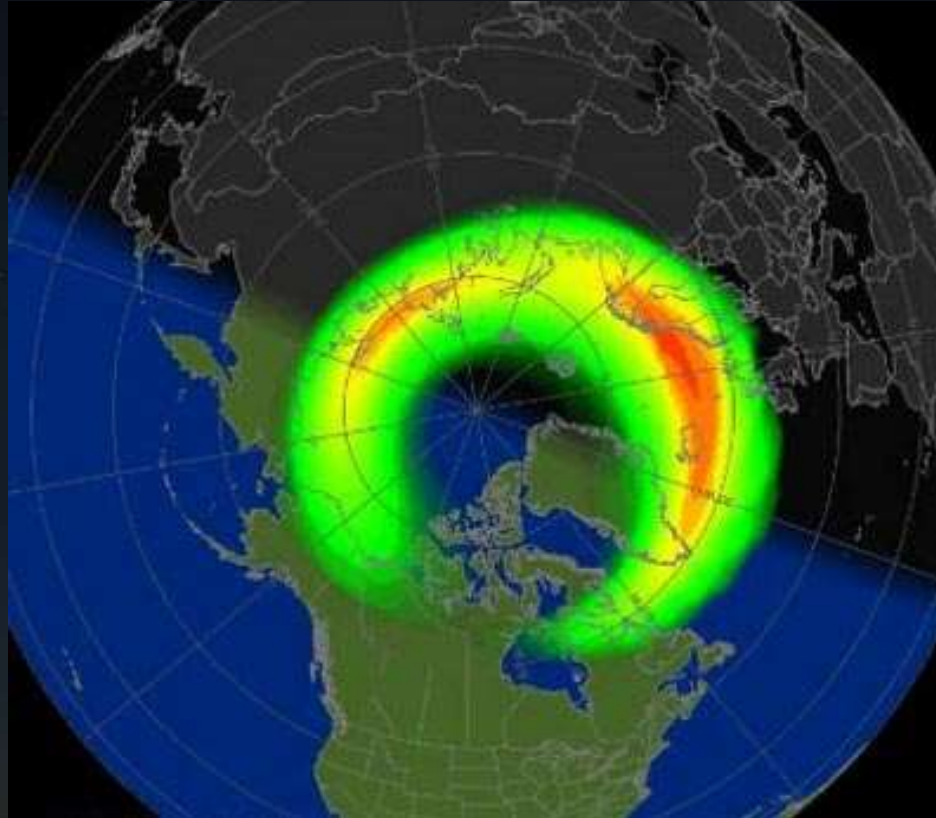
3-DAY SATELLITE ENVIRONMENT



Space Weather Prediction Center

Updated Time: 2023-10-15T19:49:00.000Z

Noorderlicht voorspellen

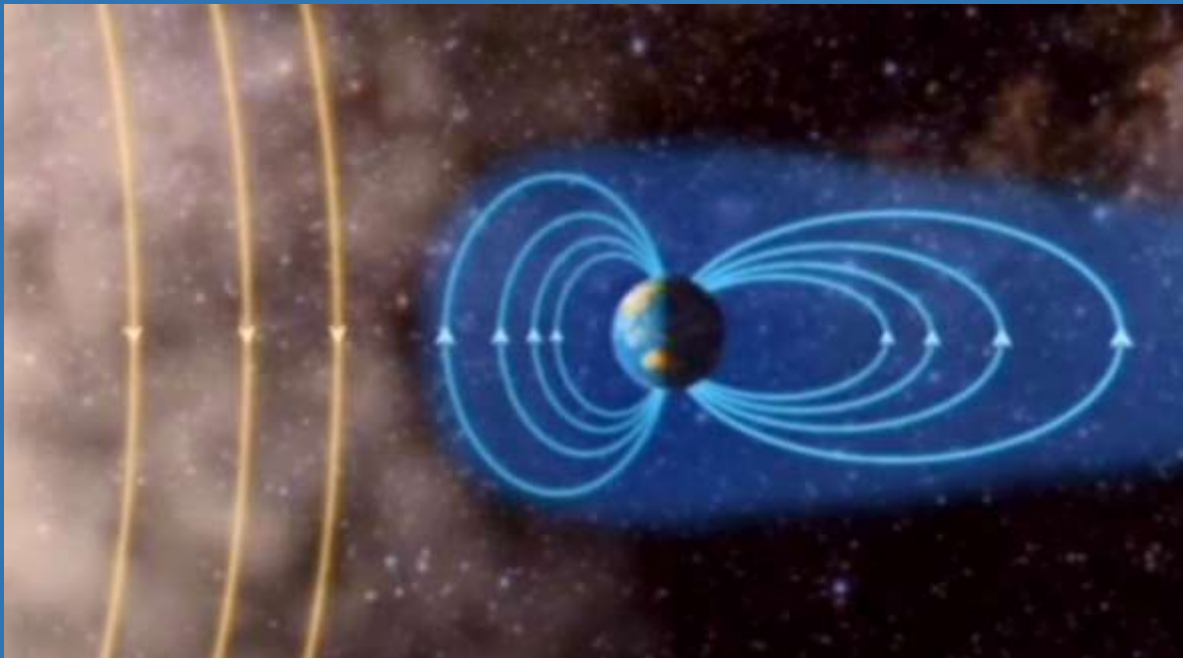


<https://www.swpc.noaa.gov/communities/space-weather-enthusiasts>
<https://www.spaceweatherlive.com/en/news.html>



Noorderlicht voorspellen

	Omgeving Poolcirkel		NL
• Zonnewind snelheid:	> 400	****	> 550
• Bt:	> 5	**	> 10
• Bz Negatief:	< -1	**	< -5
Langer dan 1 uur positief:		$-(2 \times B_z)^*$	
• Zonnewind dichtheid:	> 2	*	> 4



Noorderlicht voorspellen

	Omgeving Poolcirkel		NL
• Zonnewind snelheid:	> 400	****	> 550
• Bt:	> 5	**	> 10
• Bz Negatief:	< -1	**	< -5
Langer dan 1 uur positief:		-(2xBz)*	
• Zonnewind dichtheid:	> 2	*	> 4
• Datum rondom Equinox (Equinox Aurora):		* - ***	
• Gunstige trend snelheid/Bt/Bz/dichtheid:		* - **	
• Hoge Kp: Afgelopen 3 uur:	> 3	**	> 5
Afgelopen 12 uur:	> 2	***	> 4



SPACE WEATHER CONDITIONS on NOAA Scales

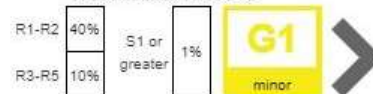
24-Hour Observed Maximums



Latest Observed



Predicted 2022-10-02 UTC



Solar Wind Speed: **476 km/sec**

Solar Wind Magnetic Fields: Bt **6 nT**, Bz **-5 nT**

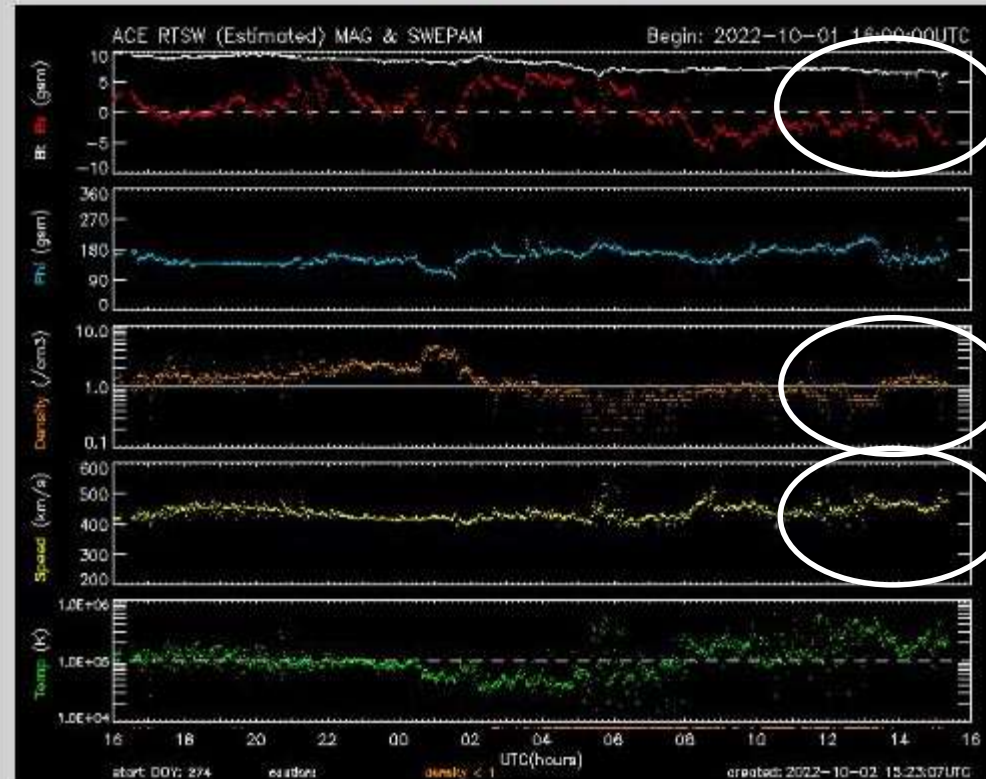
Noon 10.7cm Radio Flux: **148 sfu**

2022-10-02
15:22 UT

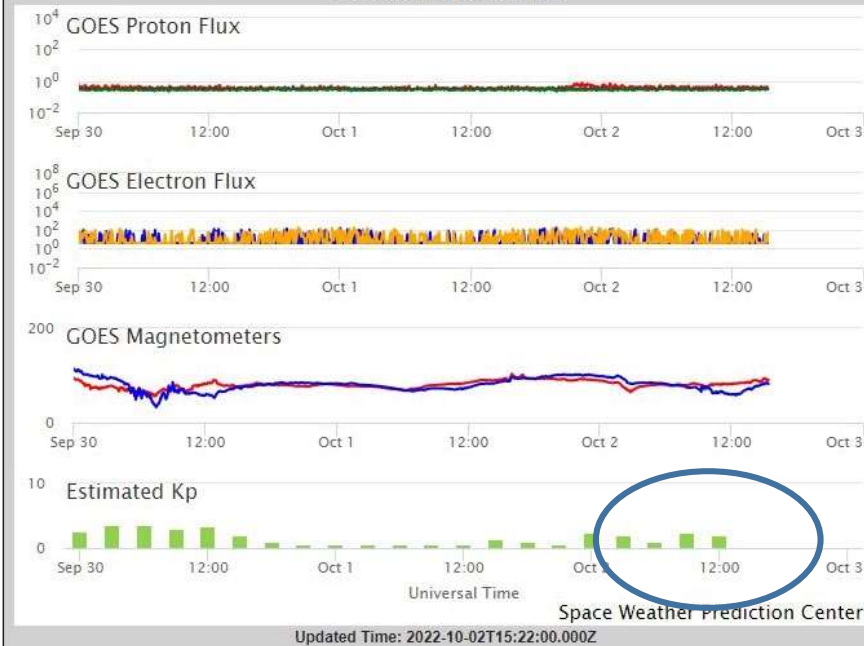
Solar Wind

Geospace

ACE MAG AND SWEPAM

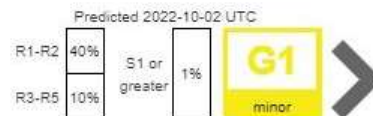


3-DAY SATELLITE ENVIRONMENT





SPACE WEATHER CONDITIONS on NOAA Scales



Solar Wind Speed: **476 km/sec**

Solar Wind Magnetic Fields: Bt **6 nT**, Bz **-5 nT**

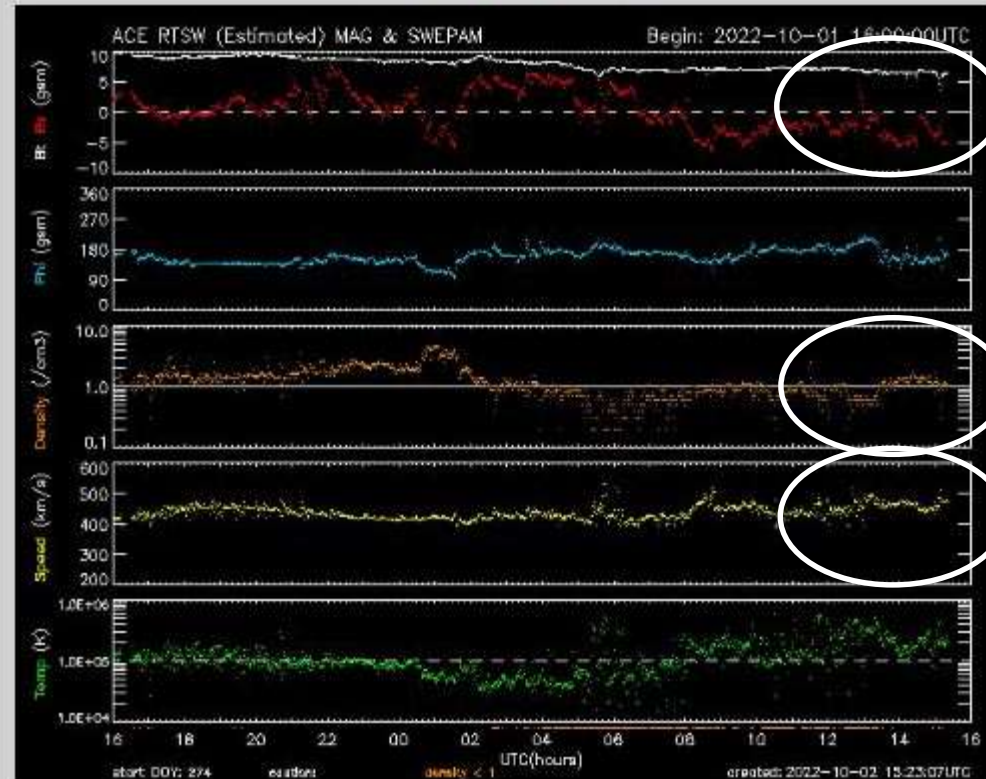
Noon 10.7cm Radio Flux: **148 sfu**

2022-10-02
15:22 UT

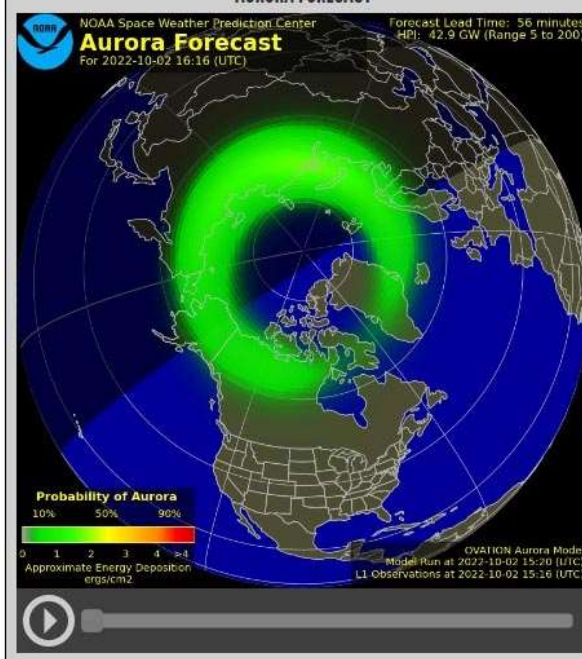
Solar Wind

Geospace

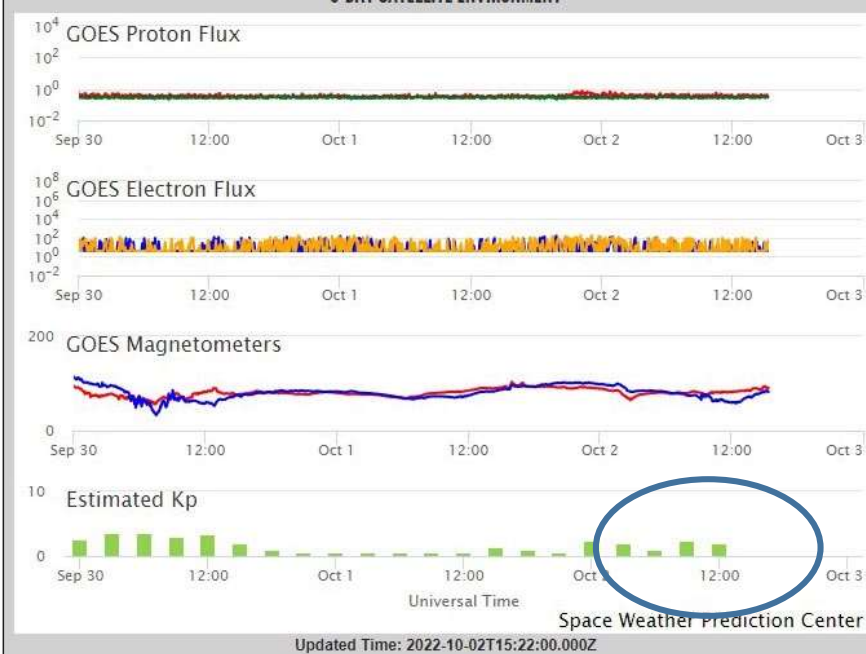
ACE MAG AND SWEPAM



AURORA FORECAST



3-DAY SATELLITE ENVIRONMENT



Noorderlicht NL 2023-02-27






SPACE WEATHER PREDICTION CENTER

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Monday, February 27, 2023 10:25:57 UTC

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SPACE WEATHER CONDITIONS on NOAA Scales

24-Hour Observed Maximums

R

S1

G3

none

minor

strong

Latest Observed

R

S

G1

none

none

minor

Predicted 2023-02-27 UTC

R1-R2 85%

S1 or greater 99%

R3-R5 15%

G3

strong

Solar Wind Speed: 458 km/sec

Solar Wind Magnetic Fields: Bt 20 nT, Bz -15 nT

Noon 10.7cm Radio Flux: 159 sfu

SPACE WEATHER ENTHUSIASTS DASHBOARD

SPACE WEATHER OVERVIEW

Solar X-ray Flux



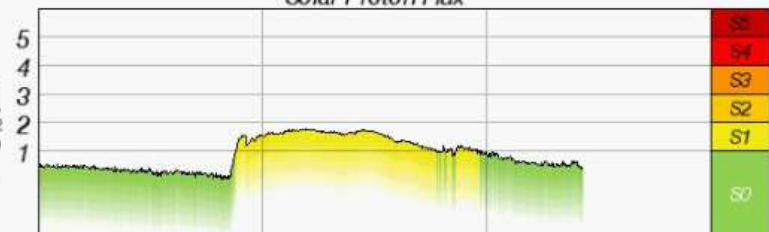
R5

R3

R1

R0

Solar Proton Flux



S5

S4

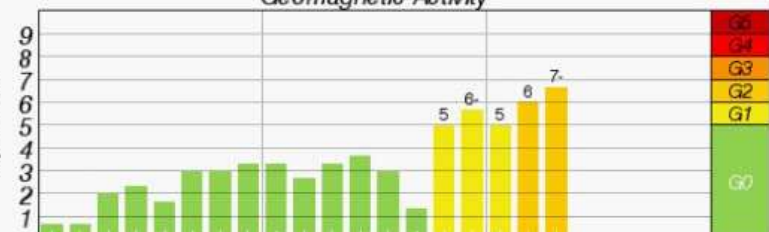
S3

S2

S1

S0

Geomagnetic Activity



G5

G4

G3

G2

G1

G0

:Product: 3-Day Forecast

:Issued: 2023 Feb 27 0030 UTC

Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center

#

A. NOAA Geomagnetic Activity Observation and Forecast

The greatest observed 3 hr Kp over the past 24 hours was 6 (NOAA Scale G2).

The greatest expected 3 hr Kp for Feb 27-Mar 01 2023 is 6.67 (NOAA Scale G3).

NOAA Kp index breakdown Feb 27-Mar 01 2023

	Feb 27	Feb 28	Mar 01
00-03UT	5.67 (G2)	5.67 (G2)	4.00
03-06UT	5.00 (G1)	5.00 (G1)	3.67
06-09UT	5.67 (G2)	4.33	3.00
09-12UT	4.67 (G1)	4.00	3.00
12-15UT	4.67 (G1)	4.00	2.67
15-18UT	4.33	3.00	2.67
18-21UT	5.00 (G1)	3.00	2.67
21-00UT	6.67 (G3)	3.67	3.00

Rationale: G3 (Strong) geomagnetic storms are likely on 27 Feb, and G2 (Moderate) storms are likely on 28 Feb, due to negative polarity CH HSS influences and CME effects.

B. NOAA Solar Radiation Activity Observation and Forecast

Solar radiation, as observed by NOAA GOES-16 over the past 24 hours, was above S-scale storm level thresholds.

Solar Radiation Storm Forecast for Feb 27-Mar 01 2023

	Feb 27	Feb 28	Mar 01
S1 or greater	99%	50%	25%

Rationale: Ongoing S1 (Minor) solar radiation storm conditions are expected to continue on 27 Feb.

Noorderlicht NL

2023-02-27

10:25 UTC

458 km/sec

Bt 20

Bz -15




SPACE WEATHER PREDICTION CENTER

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

Monday, February 27, 2023 17:04:37 UTC

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SPACE WEATHER CONDITIONS on NOAA Scales

24-Hour Observed Maximums

R

S1

G3

none

minor

strong

Latest Observed

R

S

G2

none

none

moderate

Predicted 2023-02-27 UTC

R1-R2 65%

S1 or greater

99%

G3

R3-R5 15%

strong

Solar Wind Speed: 836 km/sec

Solar Wind Magnetic Fields: Bt 9 nT, Bz -2 nT

Noon 10.7cm Radio Flux: 159 sfu

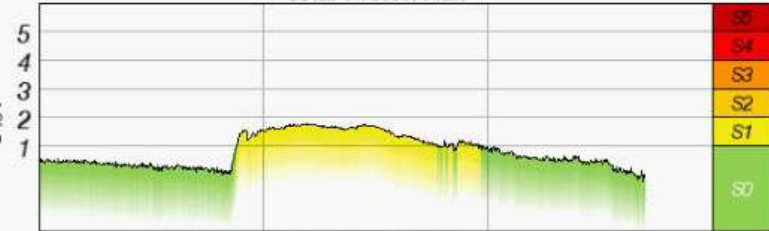
SPACE WEATHER ENTHUSIASTS DASHBOARD

SPACE WEATHER OVERVIEW

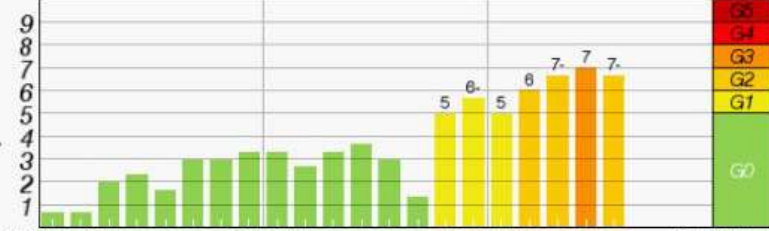
Solar X-ray Flux



Solar Proton Flux



Geomagnetic Activity



:Product: 3-Day Forecast

:Issued: 2023 Feb 27 1230 UTC

Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center

#

A. NOAA Geomagnetic Activity Observation and Forecast

The greatest observed 3 hr Kp over the past 24 hours was 7 (NOAA Scale G3).

The greatest expected 3 hr Kp for Feb 27-Mar 01 2023 is 7.00 (NOAA Scale G3).

NOAA Kp index breakdown Feb 27-Mar 01 2023

	Feb 27	Feb 28	Mar 01
00-03UT	5.00 (G1)	5.67 (G2)	4.00
03-06UT	6.00 (G2)	5.00 (G1)	3.67
06-09UT	6.67 (G3)	4.33	3.00
09-12UT	7.00 (G3)	4.00	3.00
12-15UT	4.67 (G1)	4.00	2.67
15-18UT	4.33	3.00	2.67
18-21UT	5.00 (G1)	3.00	2.67
21-00UT	5.00 (G1)	3.67	3.00

Rationale: The geomagnetic field is expected to be at active to severe storm levels (G3-Strong) on day one (27 Feb), unsettled to major storm levels (G2-Moderate) on day two (28 Feb) and unsettled to active levels on day three (01 Mar). Combined influence of the recurrent negative polarity CH HSS and effects from the 24 and 25 Feb CMEs is the source for these enhanced geomagnetic conditions.

B. NOAA Solar Radiation Activity Observation and Forecast

Solar radiation, as observed by NOAA GOES-16 over the past 24 hours, was above S-scale storm level thresholds.

Solar Radiation Storm Forecast for Feb 27-Mar 01 2023

	Feb 27	Feb 28	Mar 01
G1	15%	15%	5%

Noorderlicht NL

2023-02-27

17:04 UTC

836 km/sec

Bt 9

Bz - 2

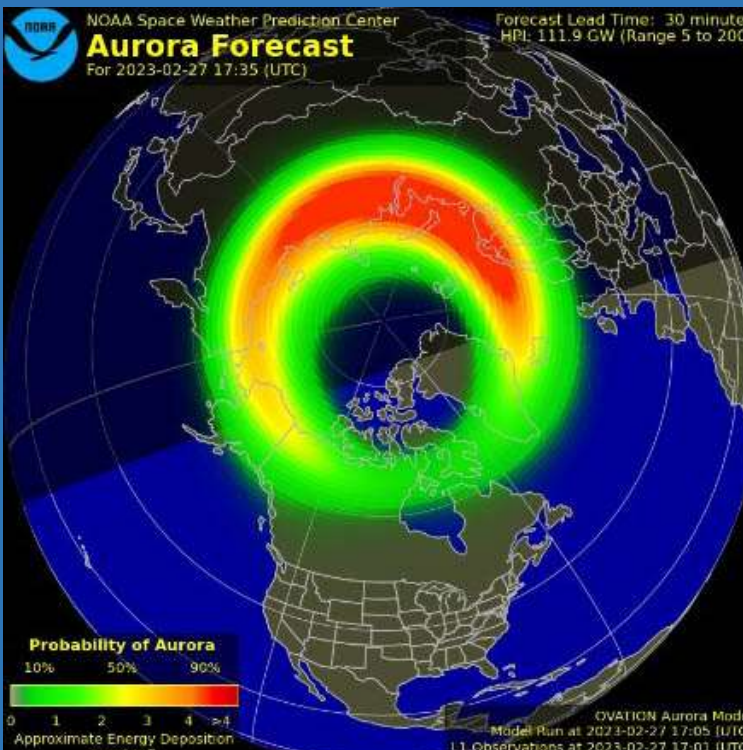
NOAA Space Weather Prediction Center

Aurora Forecast

For 2023-02-27 17:35 (UTC)

Forecast Lead Time: 30 minutes

HPI: 111.9 GW (Range 5 to 200)



Probability of Aurora

10% 50% 90%

0 1 2 3 4 >4

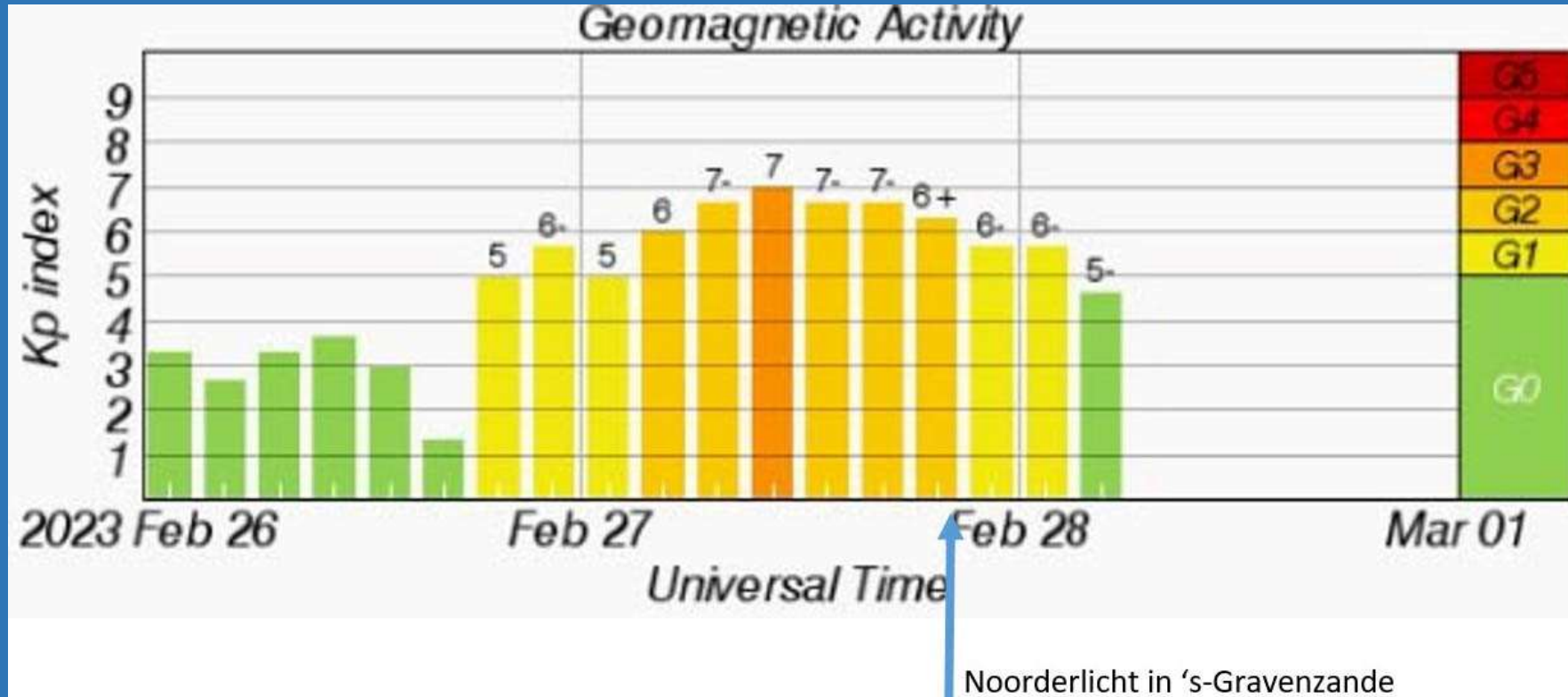
Approximate Energy Deposition ergs/cm2

OVATION Aurora Model

Model Run at 2023-02-27 17:05 (UTC)

L1 Observations at 2023-02-27 17:01 (UTC)

Noorderlicht NL 2023-02-27

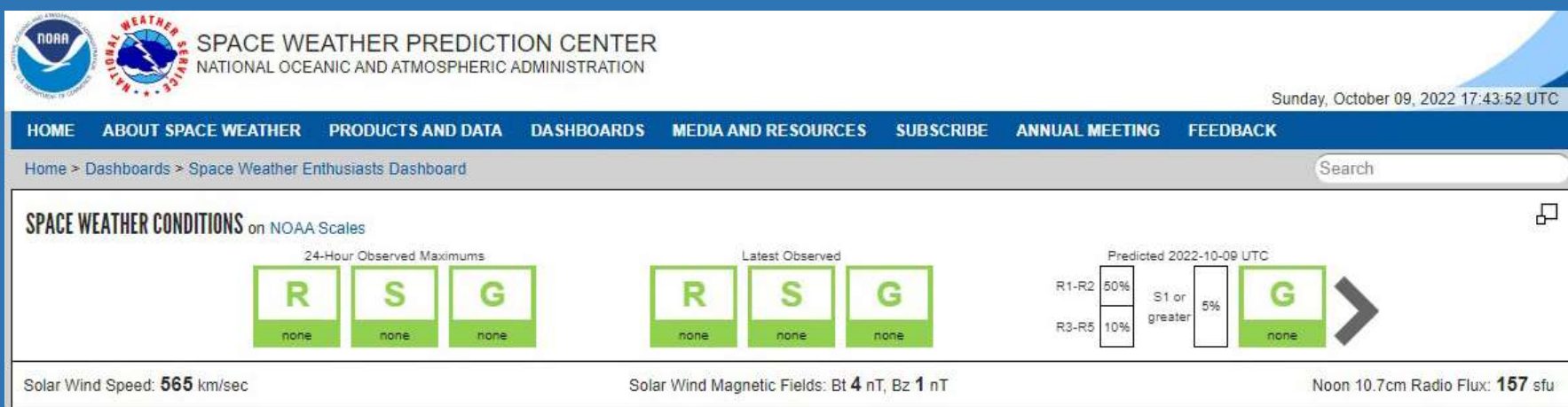


:Product: 3-Day Forecast: Issued: 2023 Feb 27 1230 UTC

The geomagnetic field is expected to be at active to severe storm levels (G3-Strong) on day one (27 Feb), unsettled to major storm levels (G2-Moderate) on day two (28 Feb) and unsettled to active levels on day three (01 Mar). Combined influence of the recurrent negative polarity CH HSS and effects from the 24 and 25 Feb CMEs is the source for these enhanced geomagnetic conditions.

2022-10-09 ARs 3112 & 3116





SPACE WEATHER ENTHUSIASTS DASHBOARD



Radio Blackout Forecast for Oct 09 2022:

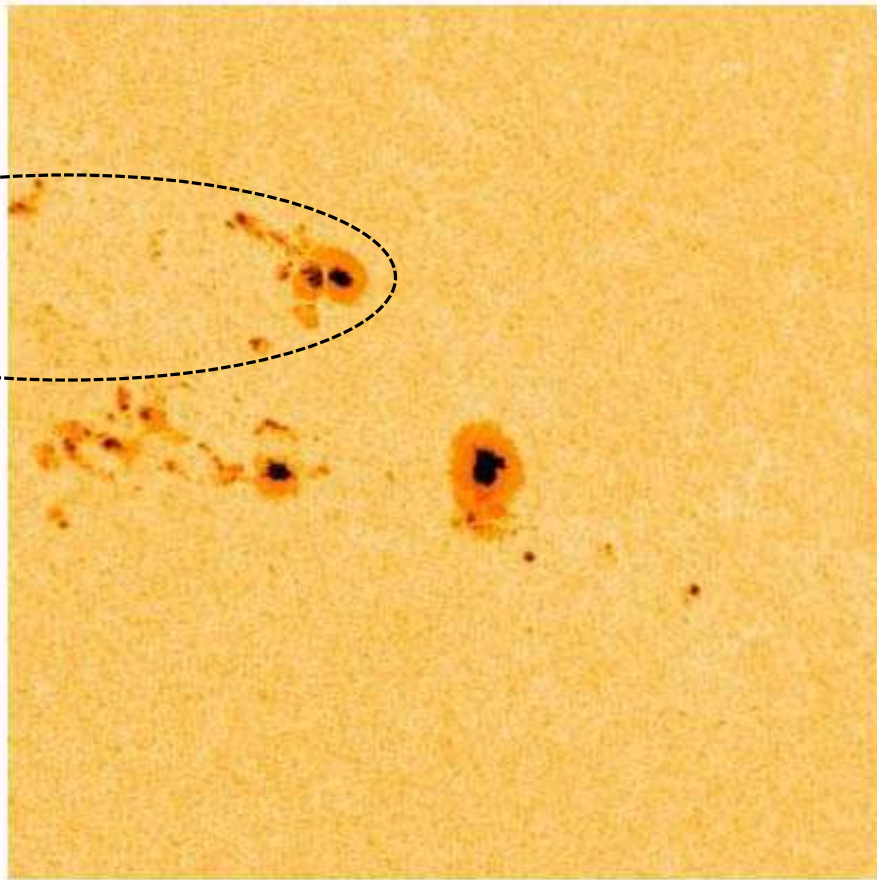
Oct 09
R1-R2 50%
R3 or greater 10%

Rationale: A chance for R1-2 (Minor-Moderate), with a slight chance for R3 (Strong), radio black-outs will persist through the forecast period mainly due to the configurations exhibited by regions 3112 and 3116.

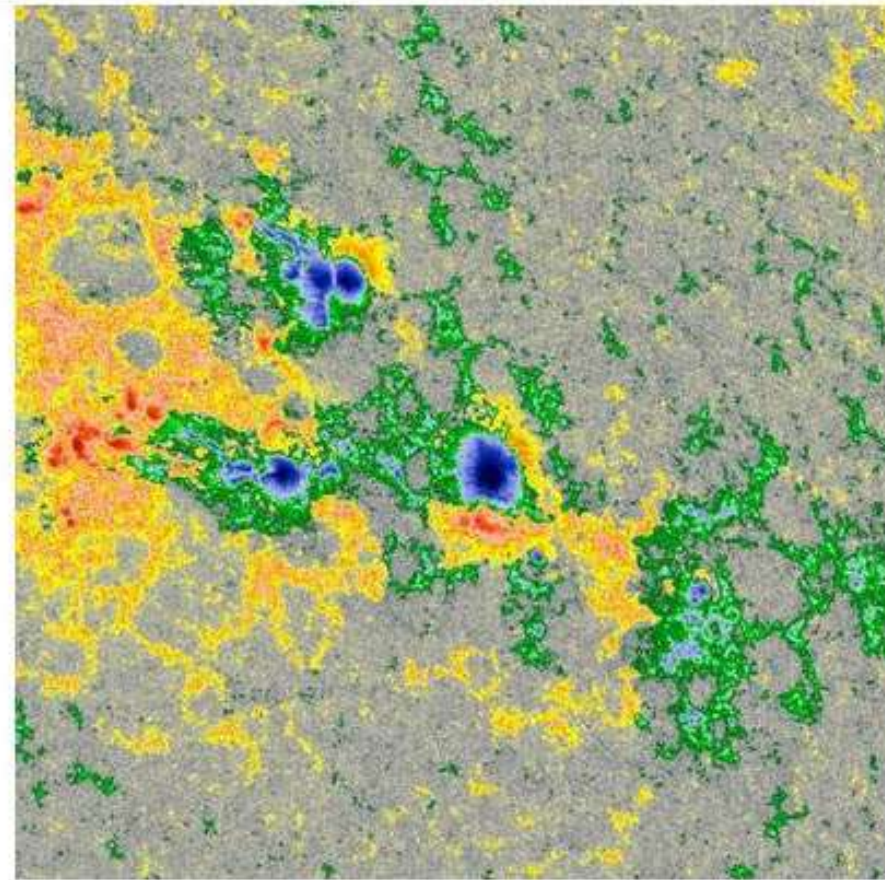
Region 3112

[i](#)

Number of sunspots	Size ?	Class Magn. ?	Class Spot ?	Location
14 ↓ -18	400 ↓ -70	β - δ	FKI	N22W28



3116

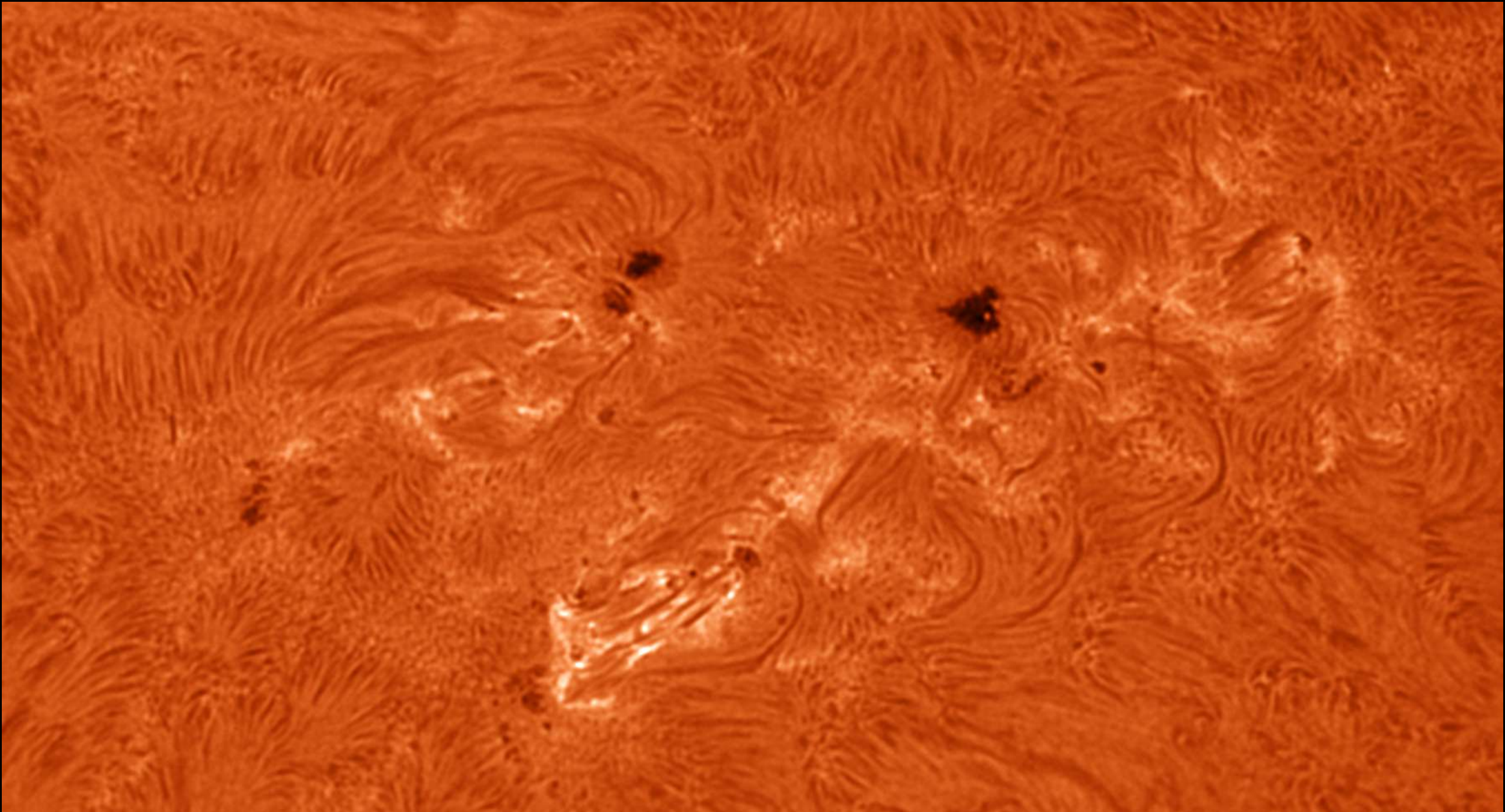


Solar flares on this day

C2.1 C3.3 C2.9 C2.0 C1.6 C2.9 C2.3 C3.9 C2.0 C3.6

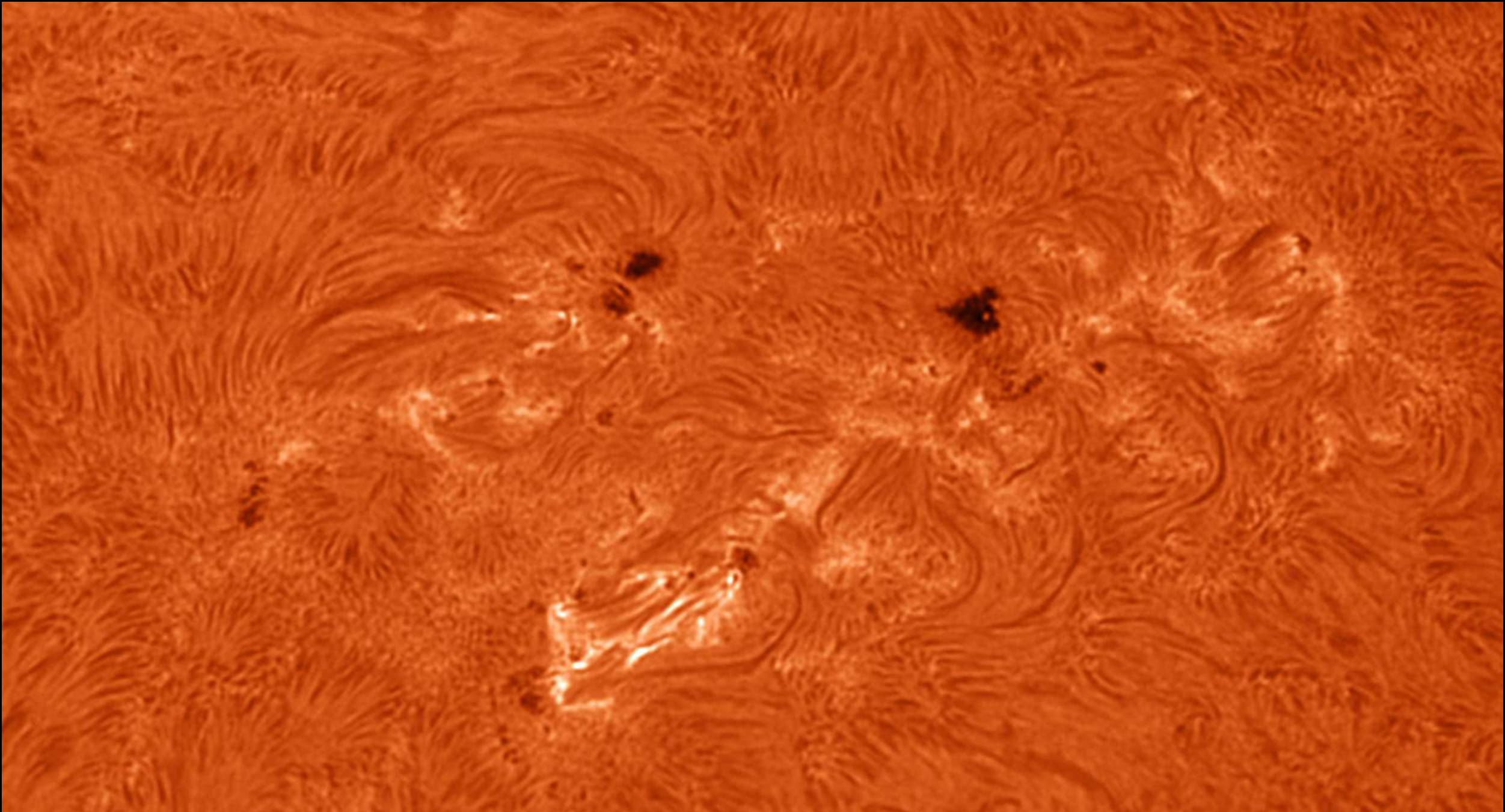
Solar flares

Region		Start	Maximum	End
3112	C2.1	02:08	02:25	02:35
3112	C3.3	08:05	08:13	08:20
3112	C2.9	08:20	08:25	08:30
3112	C2	09:15	09:21	09:30
3112	C1.6	10:17	10:24	10:27
3112	C2.9	10:27	10:34	10:46
3112	C2.3	10:58	11:01	11:06
3112	C3.9	14:10	14:27	14:56
3112	C2	18:37	18:47	19:03
3119	C3.6	21:46	21:57	22:05
3119	C4.2	22:11	22:16	22:24
3112	C3.6	23:43	23:57	00:03



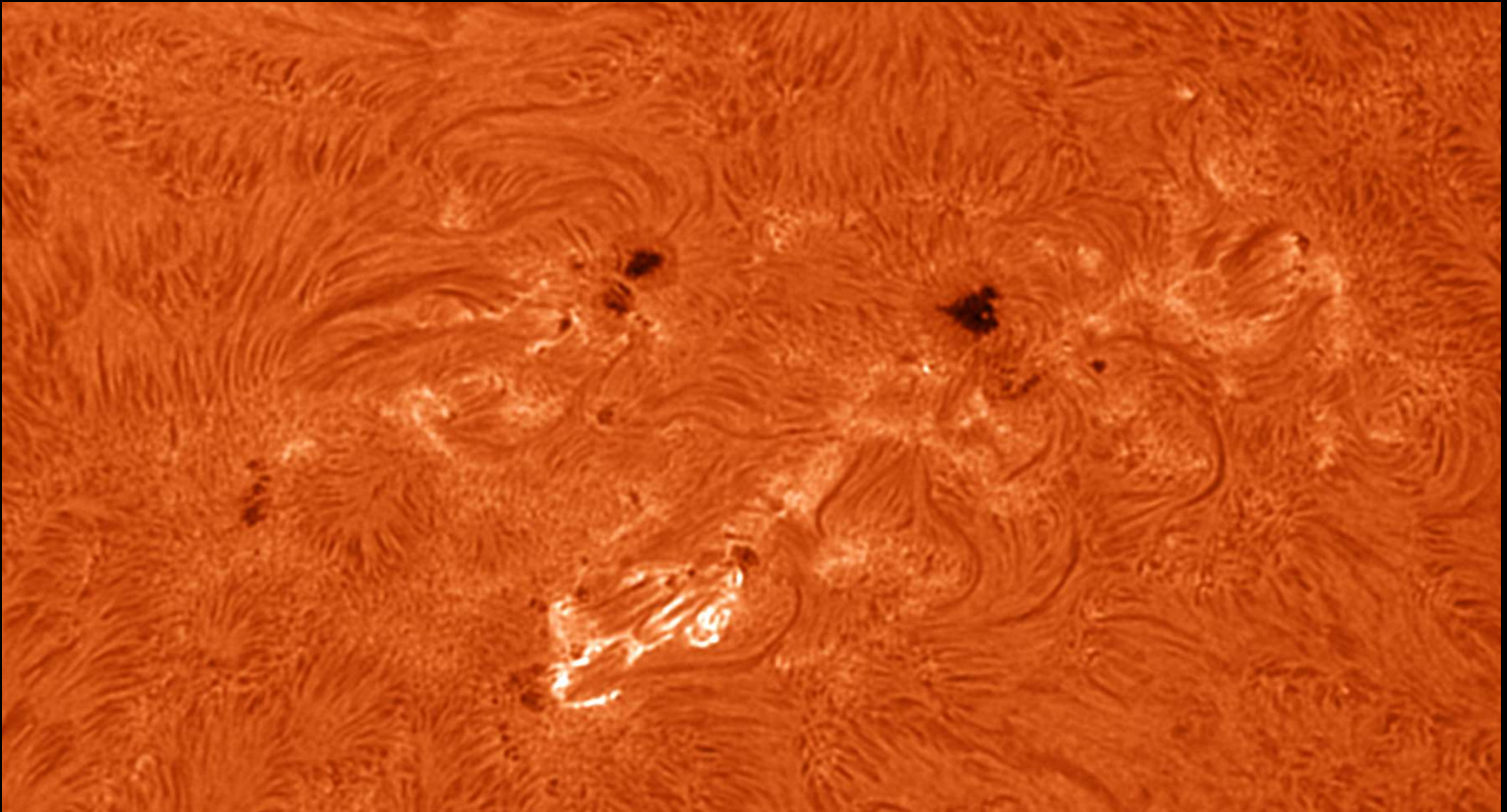
2022-10-09 Quark H α - valse kleuren

10:17 UT ARs 3112 & 3116



2022-10-09 Quark H α - valse kleuren

10:20 UT ARs 3112 & 3116



2022-10-09 Quark H α - valse kleuren

10:23 UT ARs 3112 & 3116





SPACE WEATHER CONDITIONS on NOAA Scales

24-Hour Observed Maximums



Latest Observed



Predicted 2024-03-25 UTC



Solar Wind Speed: 729 km/sec

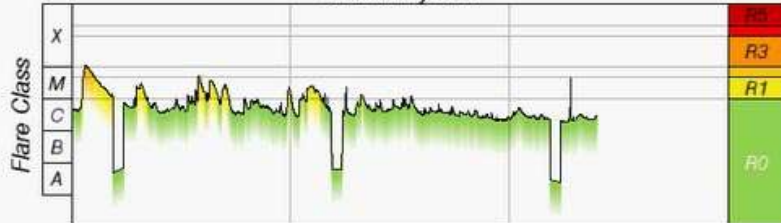
Solar Wind Magnetic Fields: Bt 12 nT, Bz 4 nT

Noon 10.7cm Radio Flux: 195 sfu

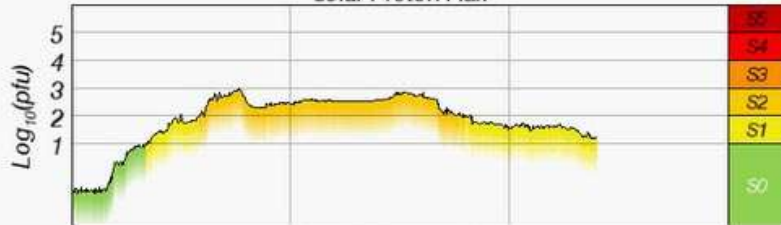
SPACE WEATHER ENTHUSIASTS DASHBOARD

SPACE WEATHER OVERVIEW

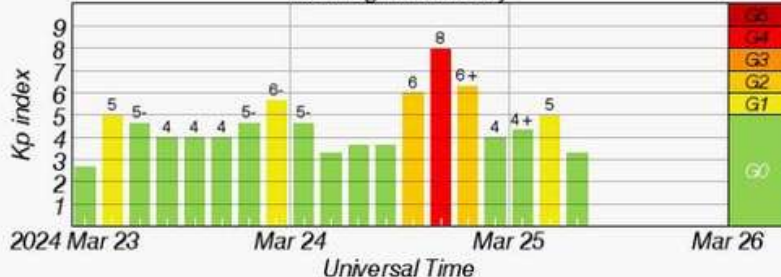
Solar X-ray Flux



Solar Proton Flux



Geomagnetic Activity



:Product: 3-Day Forecast

:Issued: 2024 Mar 25 0030 UTC

Prepared by the U.S. Dept. of Commerce, NOAA, Space Weather Prediction Center

#

A. NOAA Geomagnetic Activity Observation and Forecast

The greatest observed 3 hr Kp over the past 24 hours was 8 (NOAA Scale G4).

The greatest expected 3 hr Kp for Mar 25-Mar 27 2024 is 6.67 (NOAA Scale G3).

NOAA Kp index breakdown Mar 25-Mar 27 2024

	Mar 25	Mar 26	Mar 27
00-03UT	6.00 (G2)	5.00 (G1)	1.67
03-06UT	6.67 (G3)	4.00	1.33
06-09UT	6.00 (G2)	4.00	1.33
09-12UT	5.00 (G1)	3.67	1.33
12-15UT	4.00	3.00	1.33
15-18UT	3.00	2.33	1.33
18-21UT	3.00	2.33	1.67
21-00UT	4.00	3.33	1.67

Rationale: G1 (Minor) or greater (G3 Strong) geomagnetic storms are expected in response to CME passage.

B. NOAA Solar Radiation Activity Observation and Forecast

Solar radiation, as observed by NOAA GOES-18 over the past 24 hours, was above S-scale storm level thresholds.

Solar Radiation Storm Forecast for Mar 25-Mar 27 2024

	Mar 25	Mar 26	Mar 27
S1 or greater	99%	70%	50%

2024-03-24

Heavy Space Weather

Rationale: S1 (Minor) or greater solar radiation storms are expected as the space radiation event from March 23 continues to decay.

C. NOAA Radio Blackout Activity and Forecast

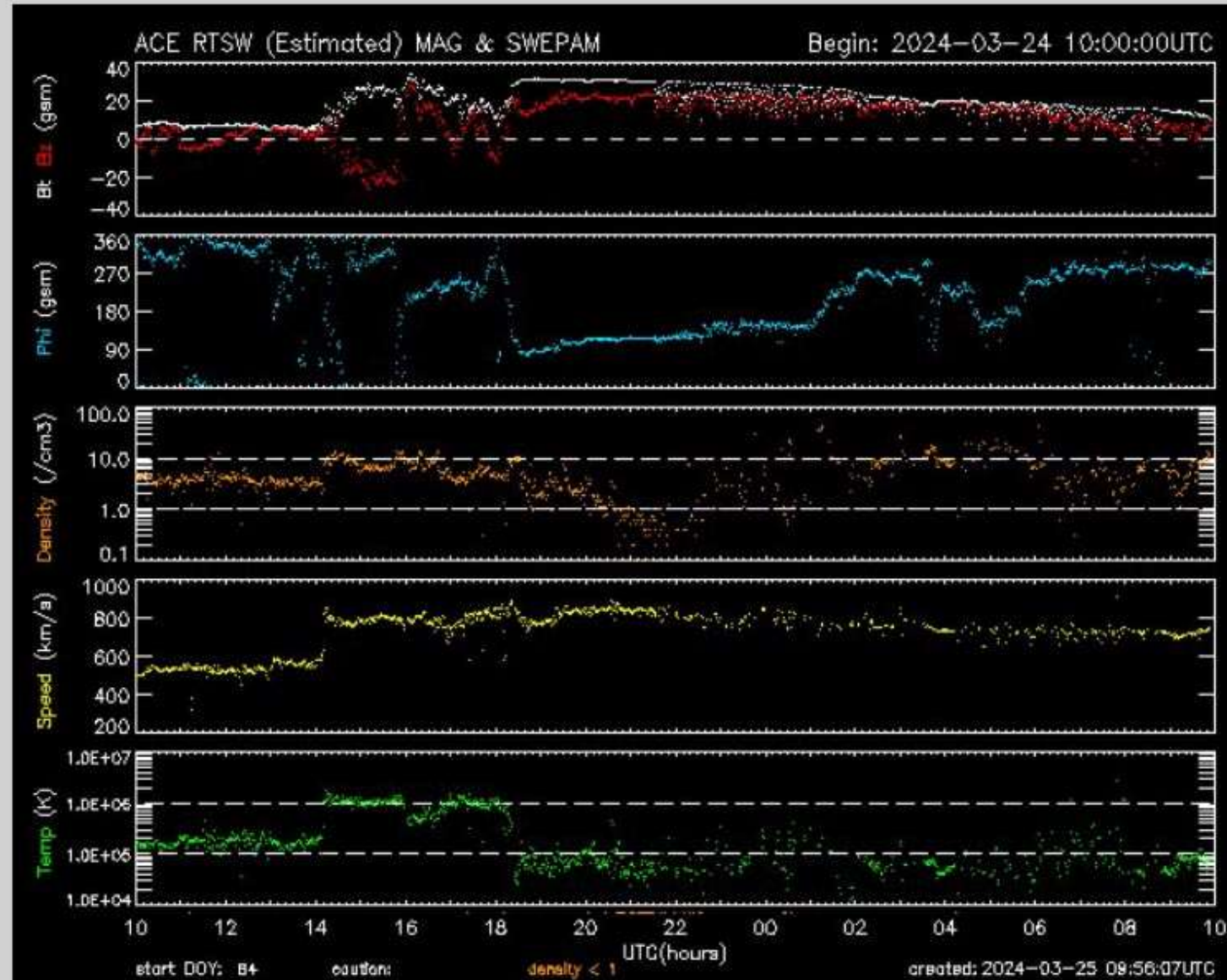
Radio blackouts reaching the R1 levels were observed over the past 24 hours. The largest was at Mar 24 2024 0218 UTC.

Radio Blackout Forecast for Mar 25-Mar 27 2024

	Mar 25	Mar 26	Mar 27
R1-R2	85%	85%	85%
R3 or greater	25%	25%	25%

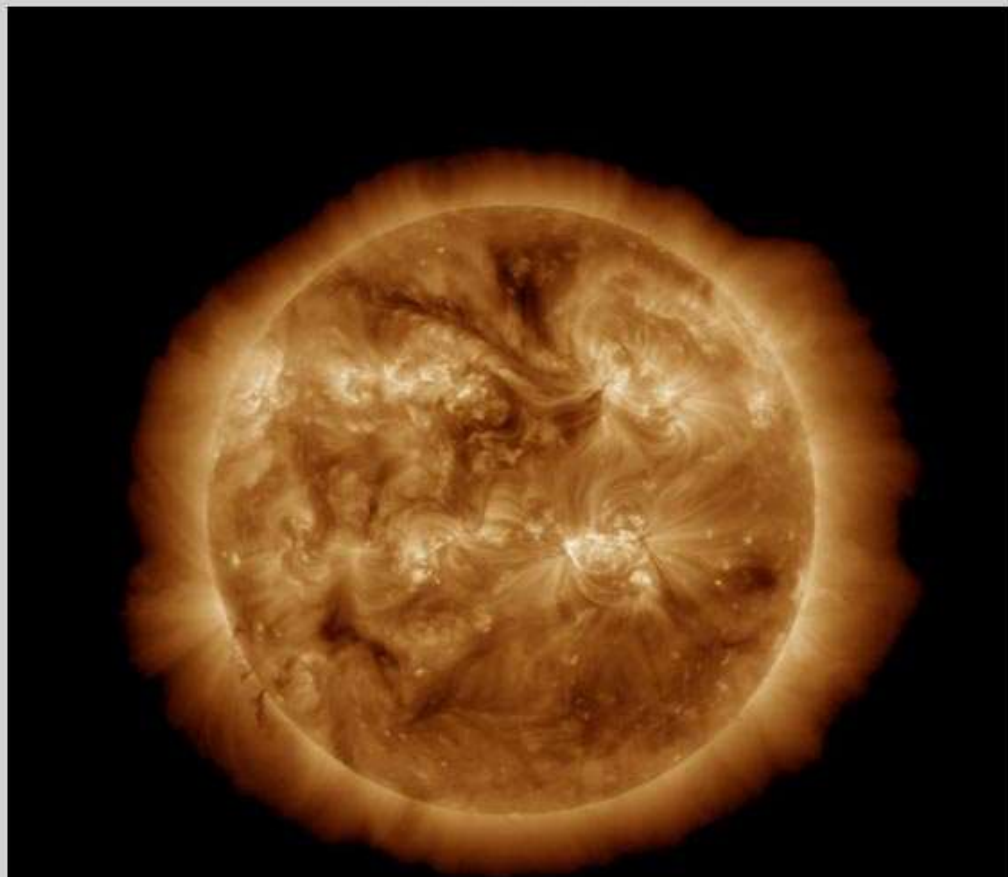
Rationale: R1-R2 (Minor-Moderate) or greater radio blackouts are expected, with a chance for an R3 (Strong) event from significant sunspot regions.

ACE MAG AND SWEPAM

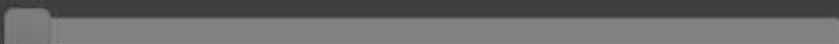


Solar

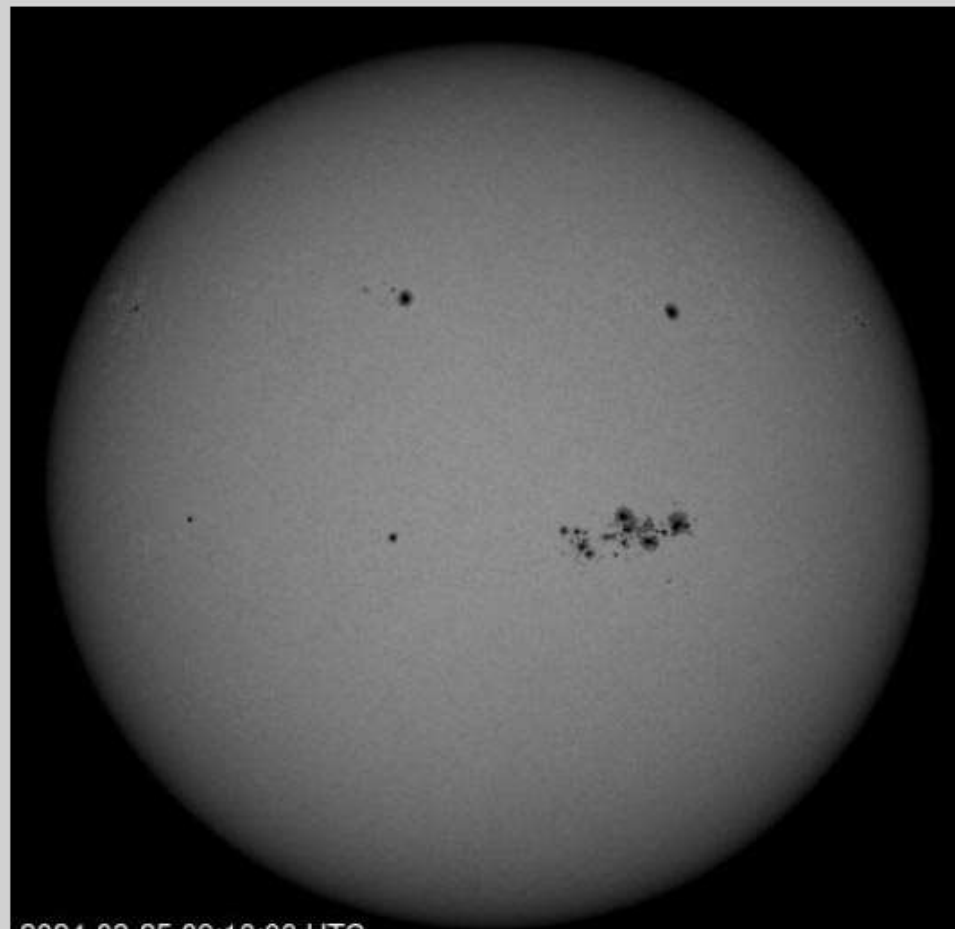
GOES SOLAR ULTRAVIOLET IMAGER



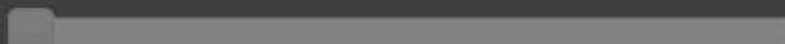
GOES-16 SUVI Composite 195 Angstroms 2024-03-25 09:44:03



SOLAR VISIBLE LIGHT



2024-03-25 09:10:00 UTC



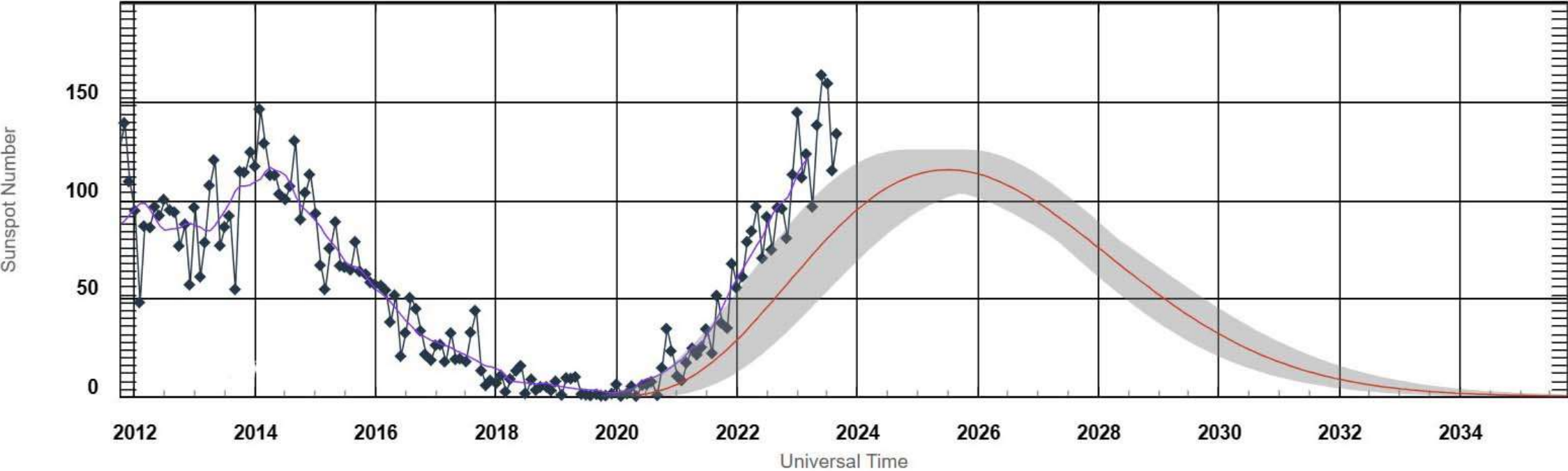


Solar Cycle

SUNSPOT NUMBER PROGRESSION

ISES Solar Cycle Sunspot Number Progression

Zoom:



◆ Monthly Values — Smoothed Monthly Values — Predicted Values ● Predicted Range

Add/Remove Error Bars... ▾

Space Weather Prediction Center

ISES Solar Cycle F10.7cm Radio Flux Progression



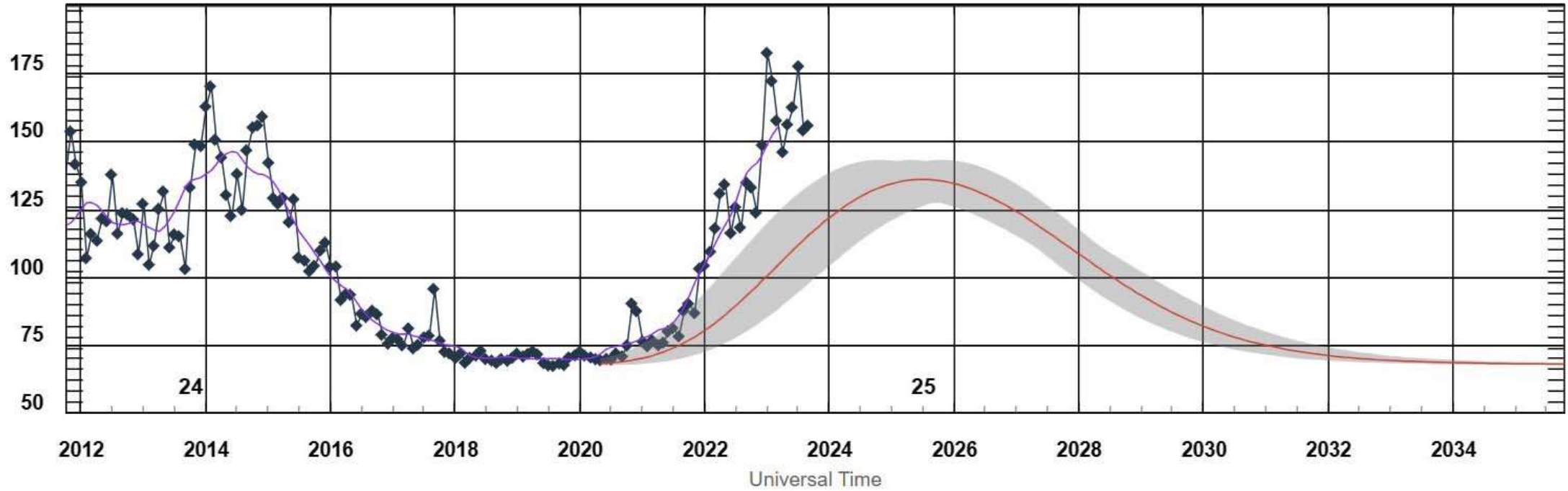
Zoom:

Default

All

Numbering On/Off

F10.7 Flux (solar flux units)



◆ Monthly Values — Smoothed Monthly Values — Predicted Values ● Predicted F10.7 Range

Add/Remove Error Bars... ▾

Space Weather Prediction Center

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WAM-IPE

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