Мрежа за наблюдения на Слънцето *от България*

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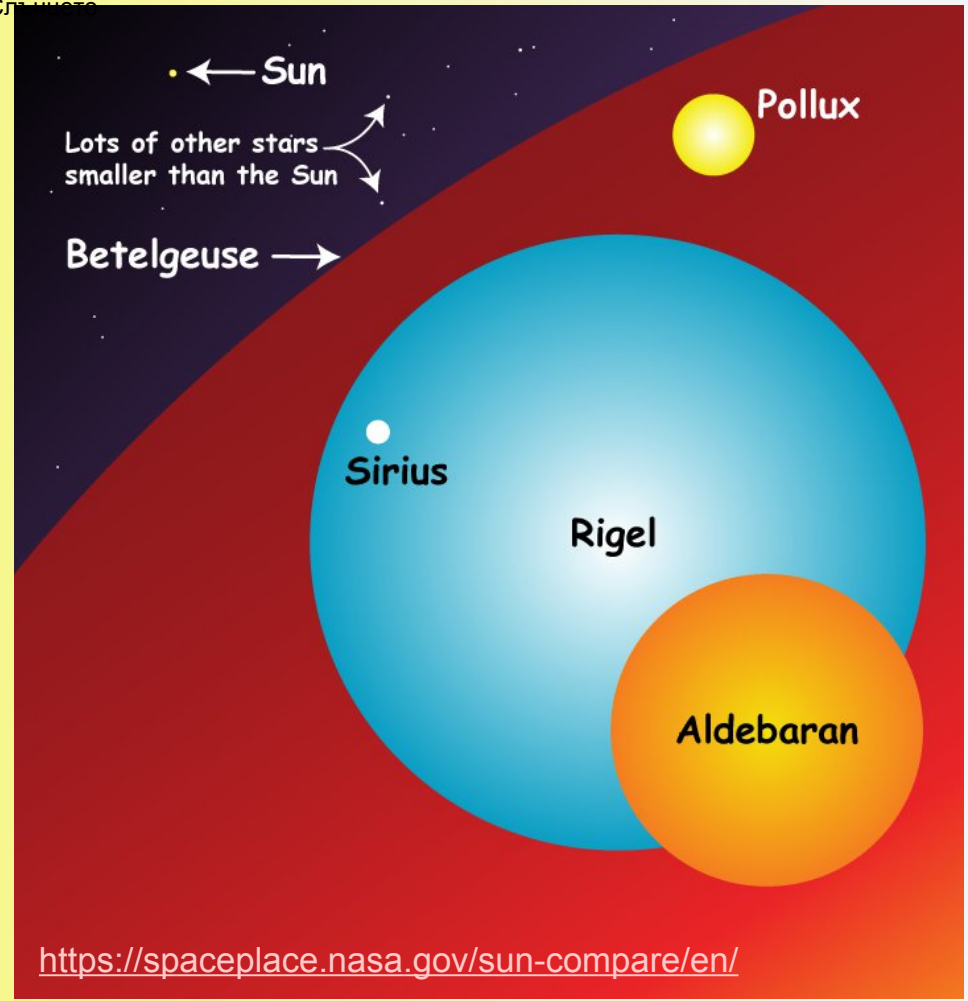
Кръжок към катедра “Астрономия”, ФзФ-СУ

06.11.2025

Съдържание

https://www.mdpi.com/2076-0760/6/3/95

- Слънцето като звезда
- Активност
- Космическо време
- Наземни наблюдения
- Мрежа от слънчеви станции в България
- Бъдещо развитие



https://spaceplace.nasa.gov/sun-compare/en/

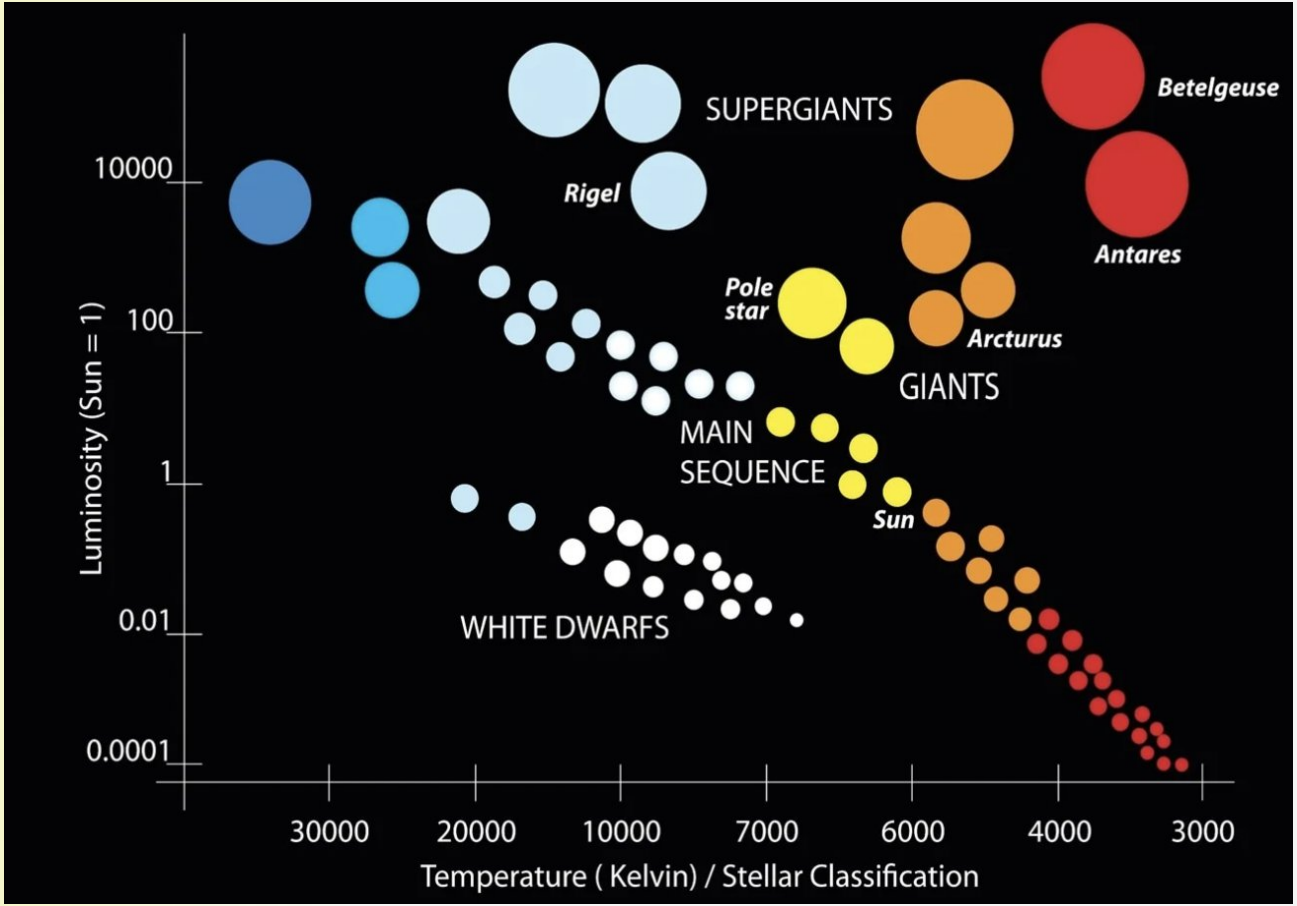
Слънцето като звезда

Age	4.6×10^9 years
Mass	1.99×10^{30} kg ($\approx$ 330 times of the Earth)
Diameter	1.38×10^8 m ($\approx$ 110 times of the Earth)
Surface gravity	274 m s^{-2}
Surface Temperature	5800 K
Equatorial rotation period	24.5 days
Escape velocity at surface	618 km s^{-1}
Luminosity	3.86×10^{26} W
Average density	1.41 g cm^{-3}
Spectral type	G2 V
Absolute magnitude	+ 4.83
Apparent magnitude	- 26.74

https://arxiv.org/abs/2206.02478

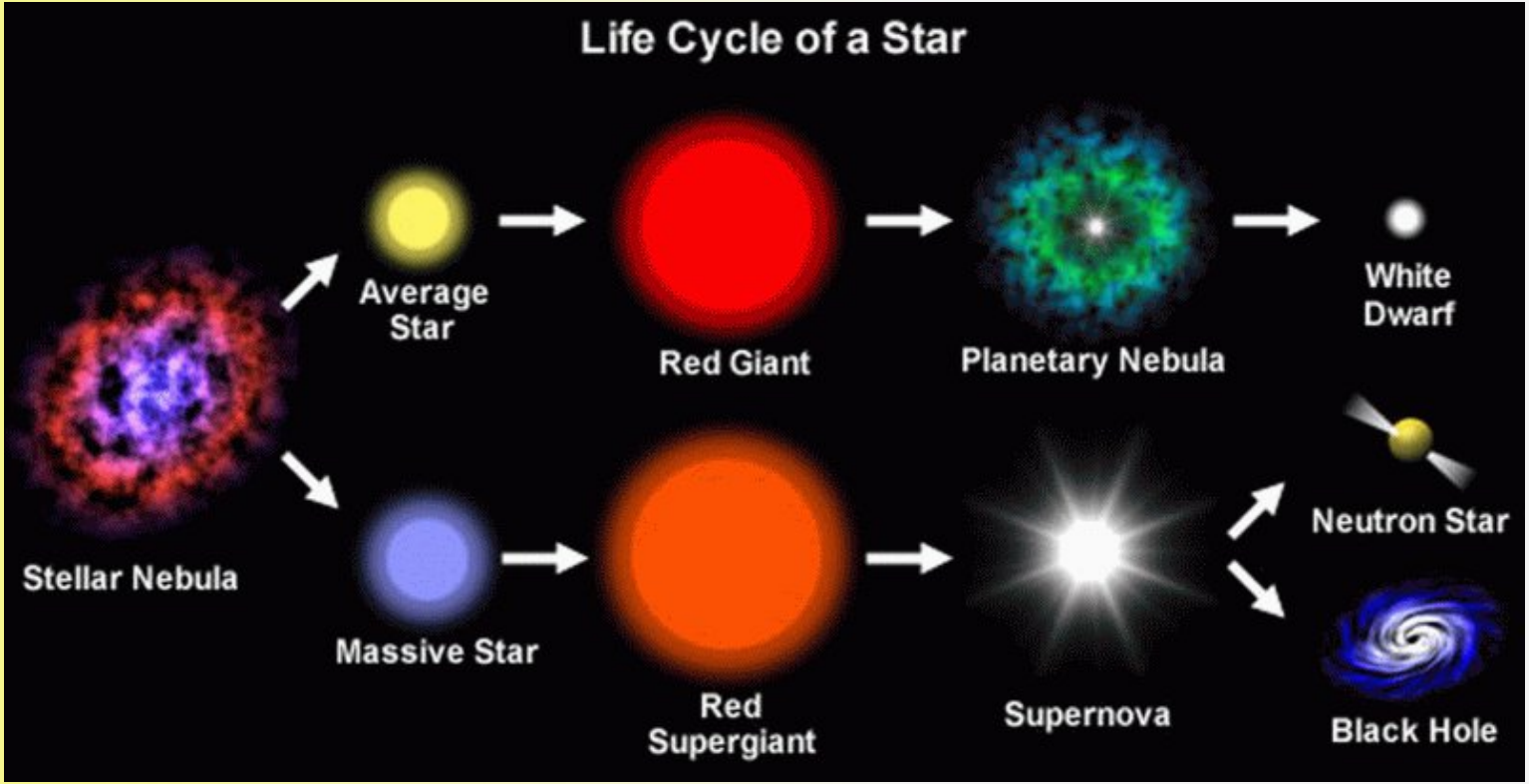
Betelgeuse (Orion)
Rigel (Orion)
Aldebaran (Taurus)
Pollux (Gemini)
Sirius (Canis Major)

Диаграма на Х-Р (цвят - светимост)



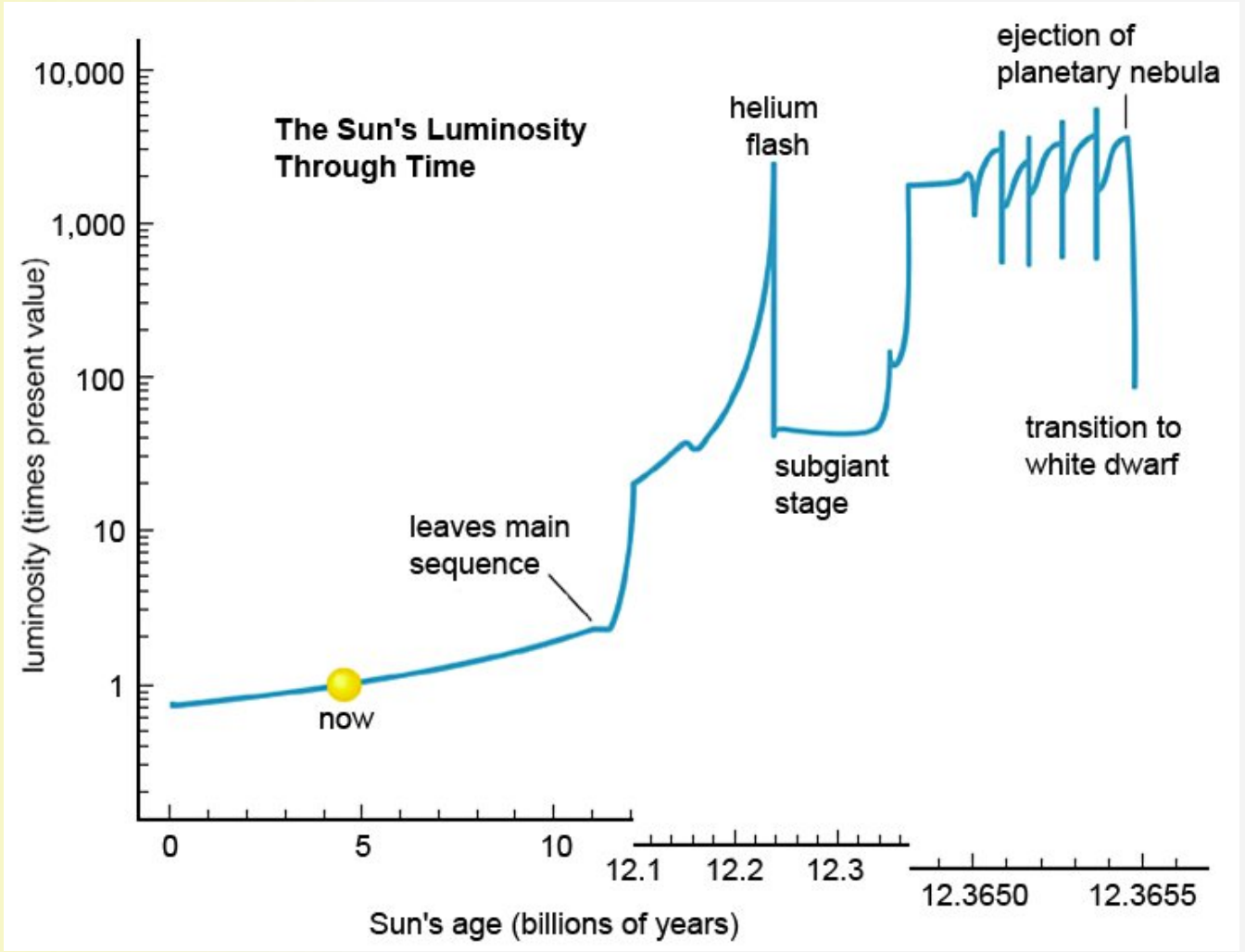
https://www.azoquantum.com/Article.aspx?ArticleID=436

Схема на звездната еволюция



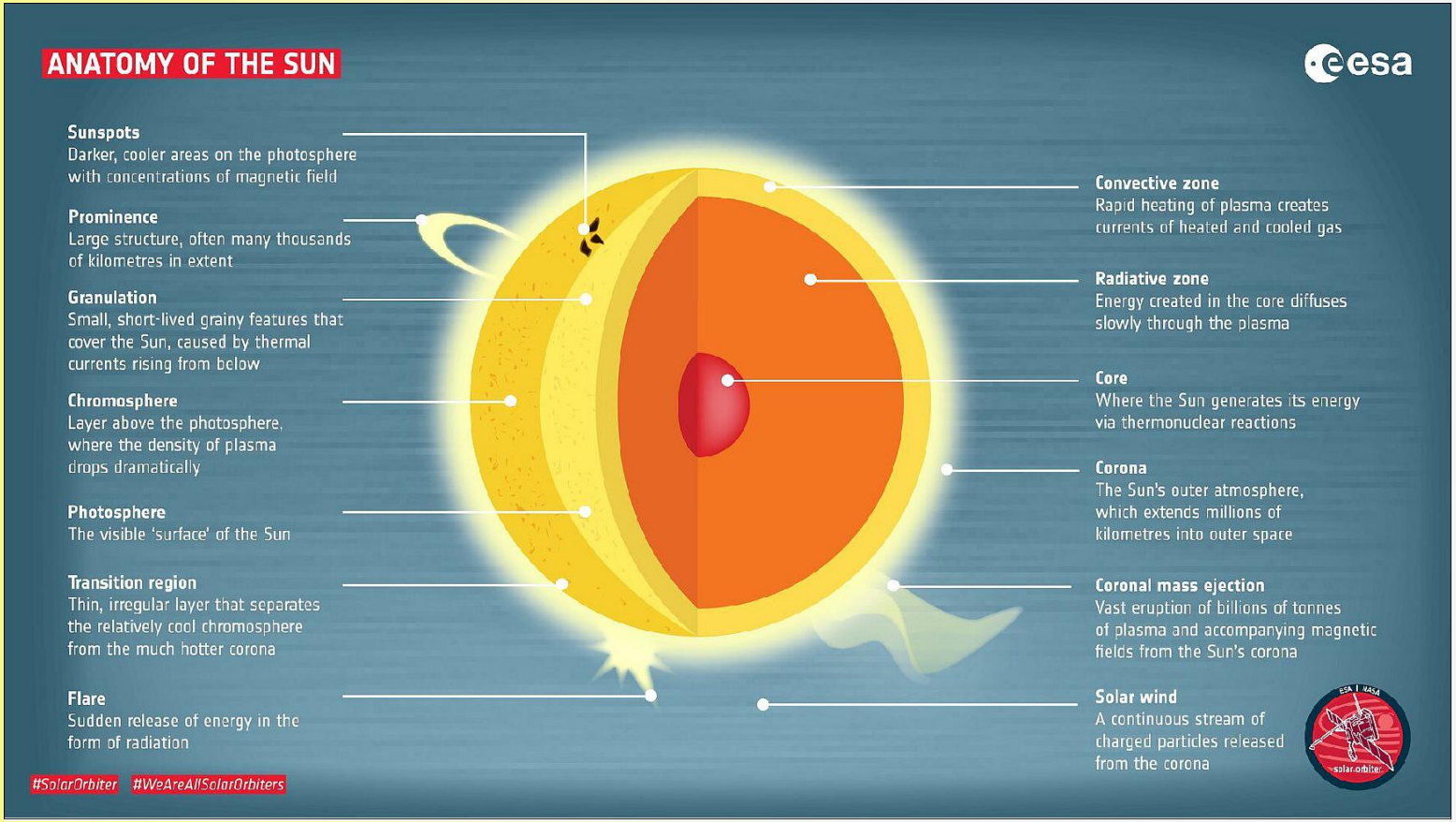
https://cesar.esa.int/

Светимост на Слънцето във времето

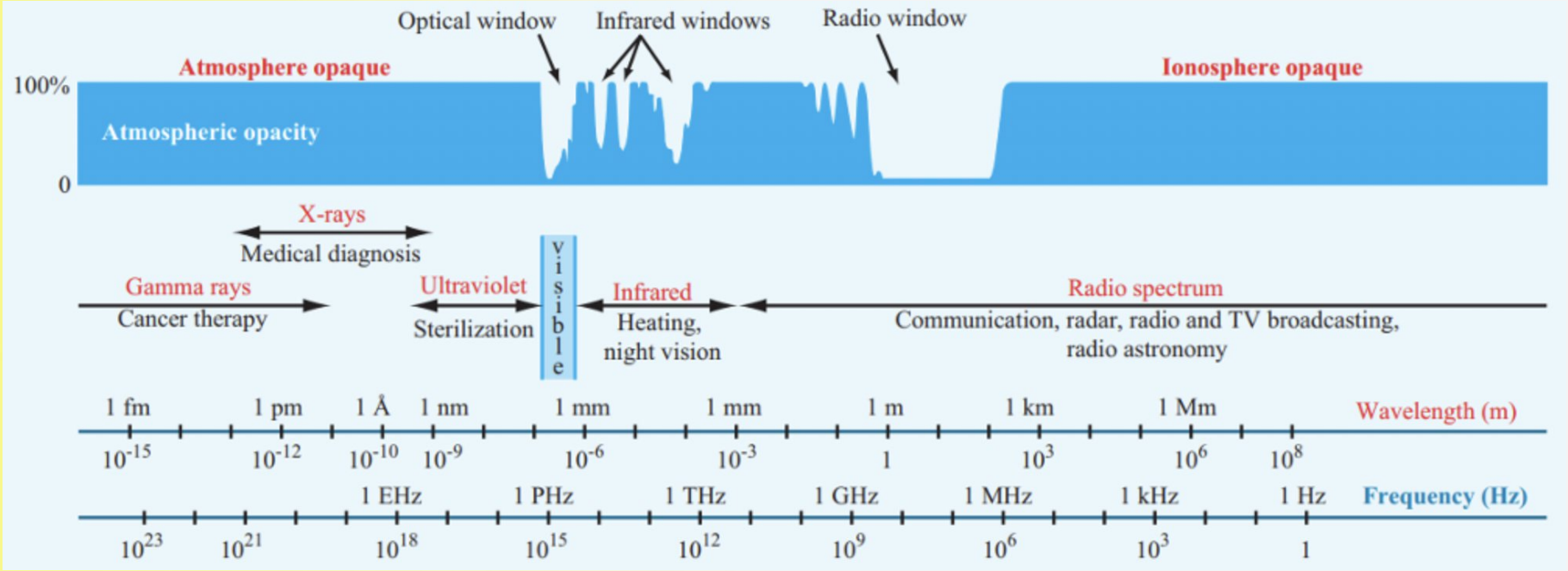


https://faculty.wcas.northwestern.edu/infocom/The%20Website/end.html

Слънцето: вътрешен строеж и атмосфера

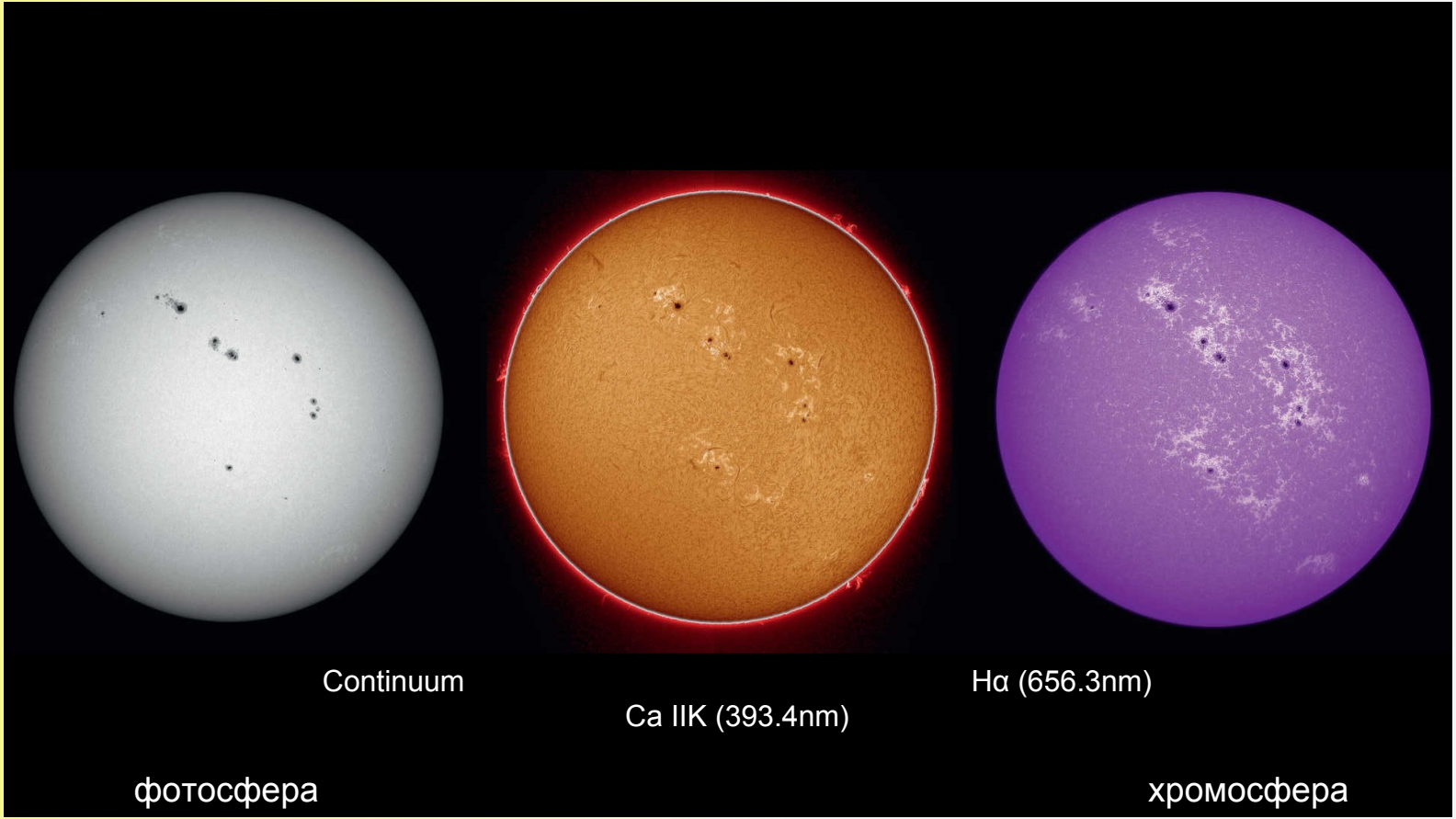


Наземни астрономически наблюдения



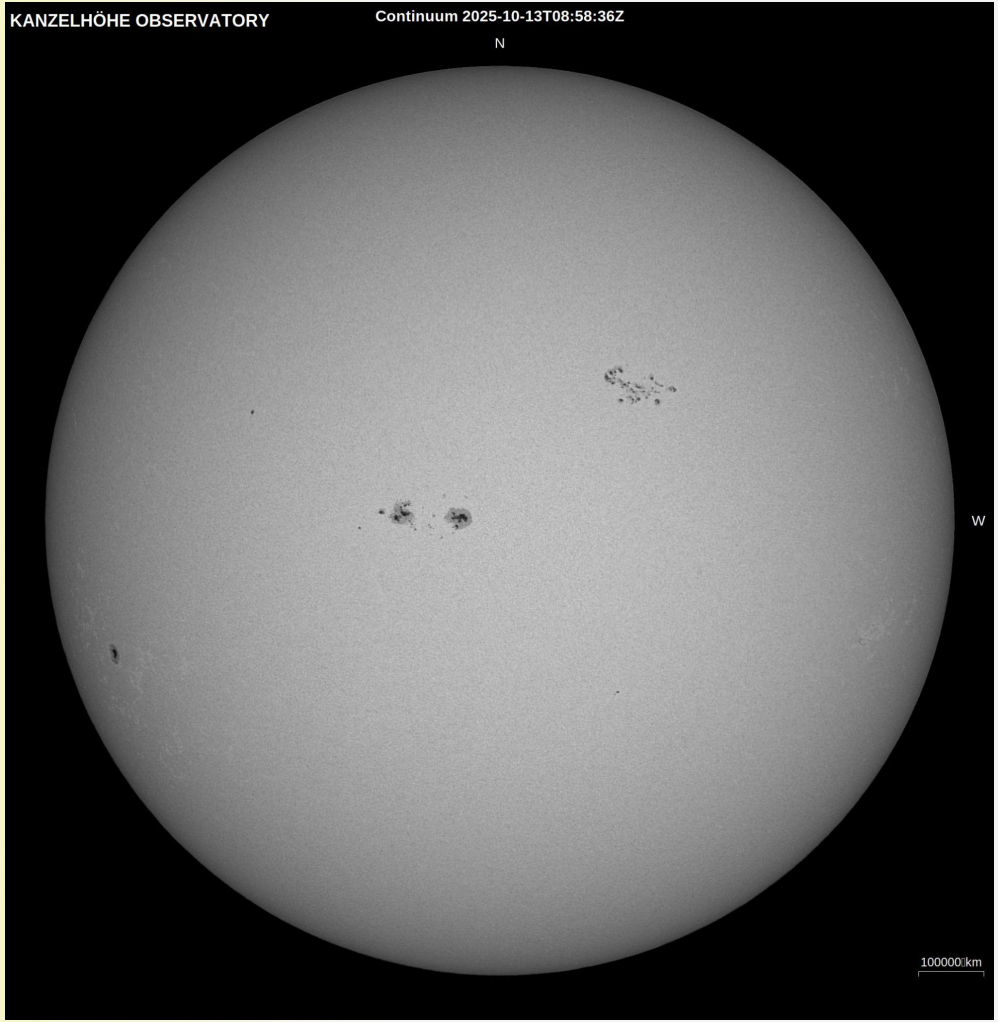
Credit: Microwave Radar and Radiometric Remote Sensing by Ulaby and Long
https://www.nasa.gov/smallsat-institute/sst-soa/soa-communications/

Наземни наблюдения на Слънцето



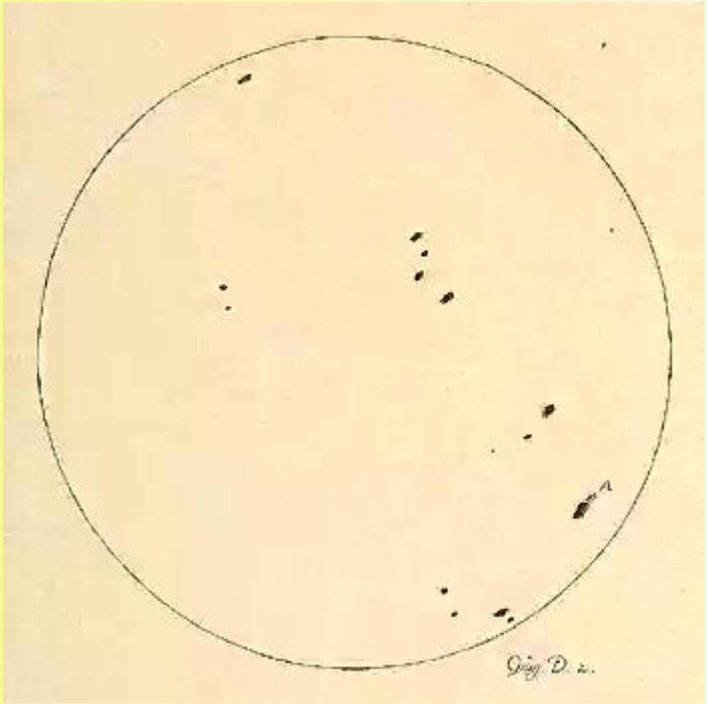
U. Dittler
https://www.astroshop.eu/

Бяла светлина

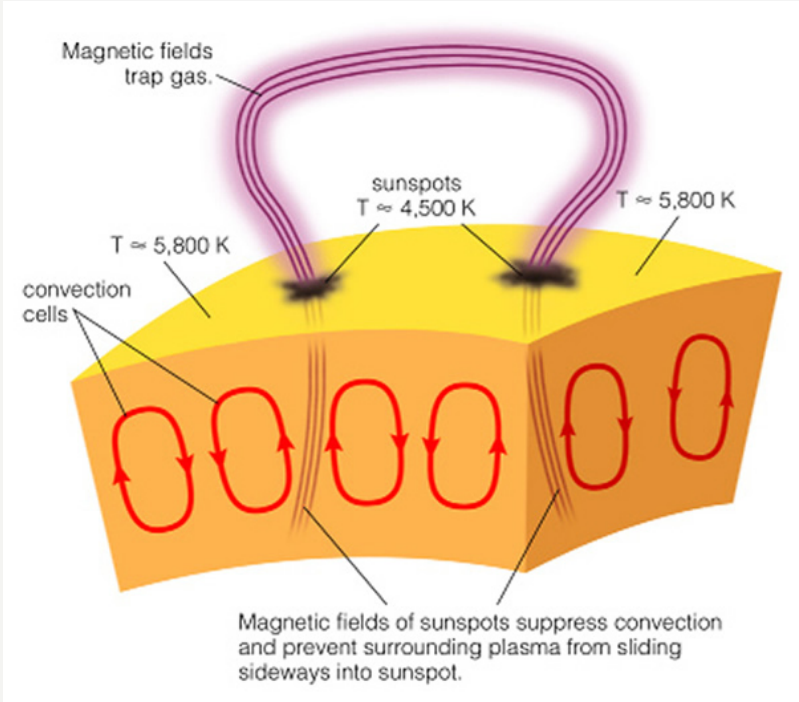


https://cesar.kso.ac.at/synoptic/con_days.php?year=2025

Слънчева активност: петна



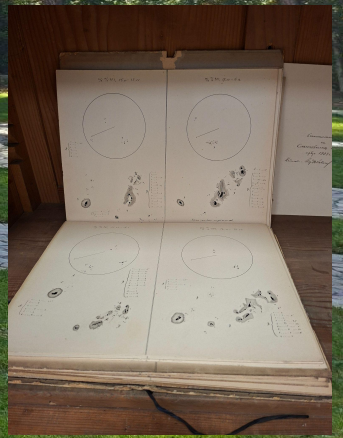
https://galileo.library.rice.edu/sci/observations/sunspot_drawings.html



http://astronomy.nmsu.edu/

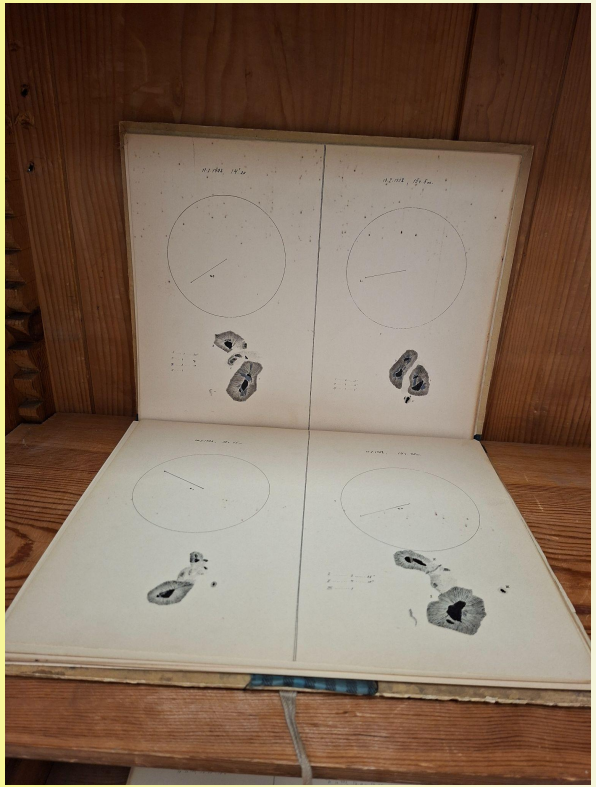
БГ-мрежа за наблюдения на Слънцето

Слънчева активност: петна



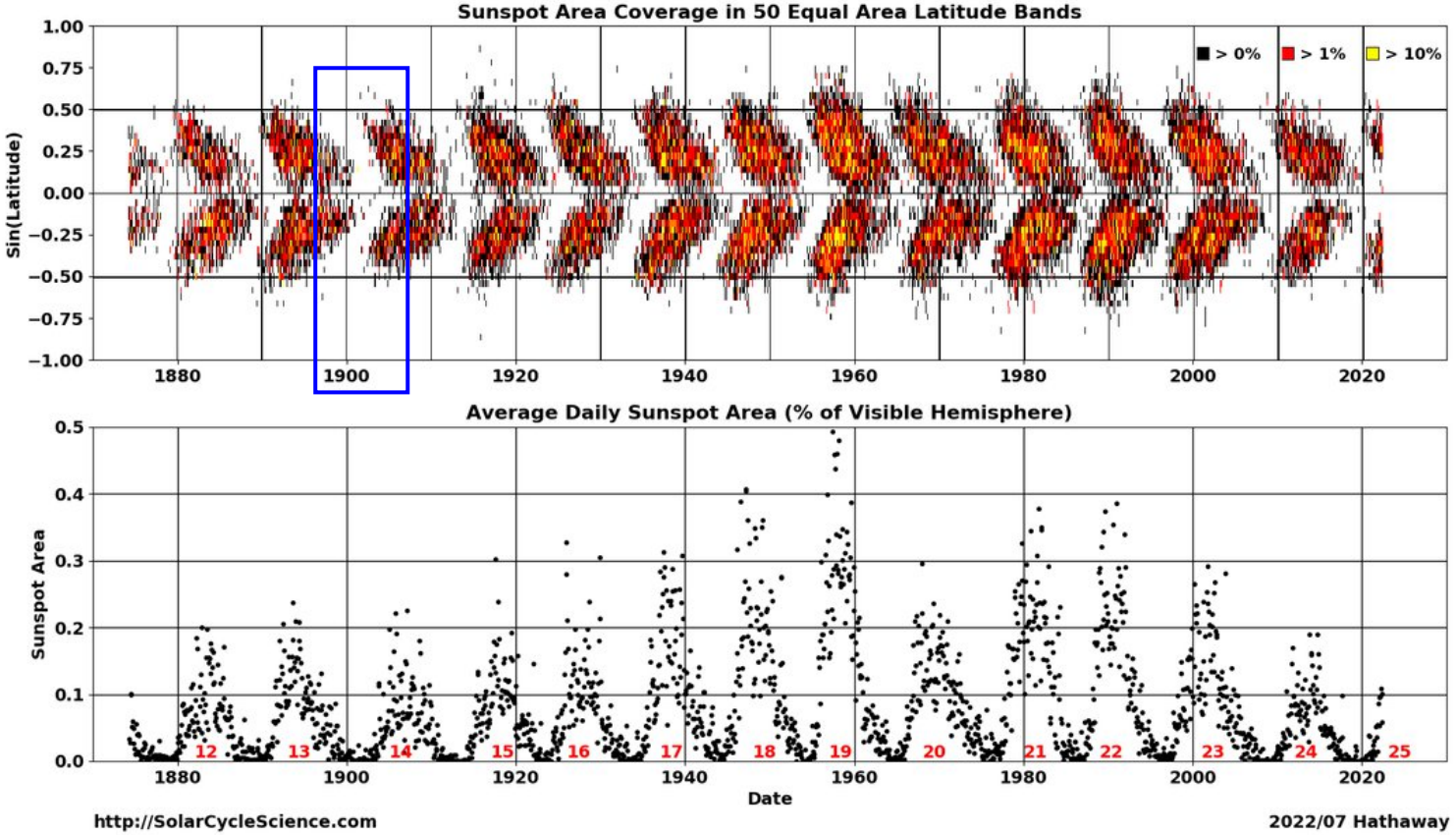
Първи професионални наблюдения от България: АО/СУ - Борисова градина

Слънчева активност: петна



Първи професионални наблюдения от България: АО/СУ - Борисова градина

Слънчев цикъл



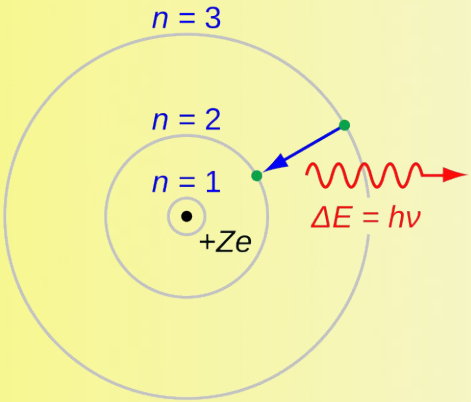
Линия Hα

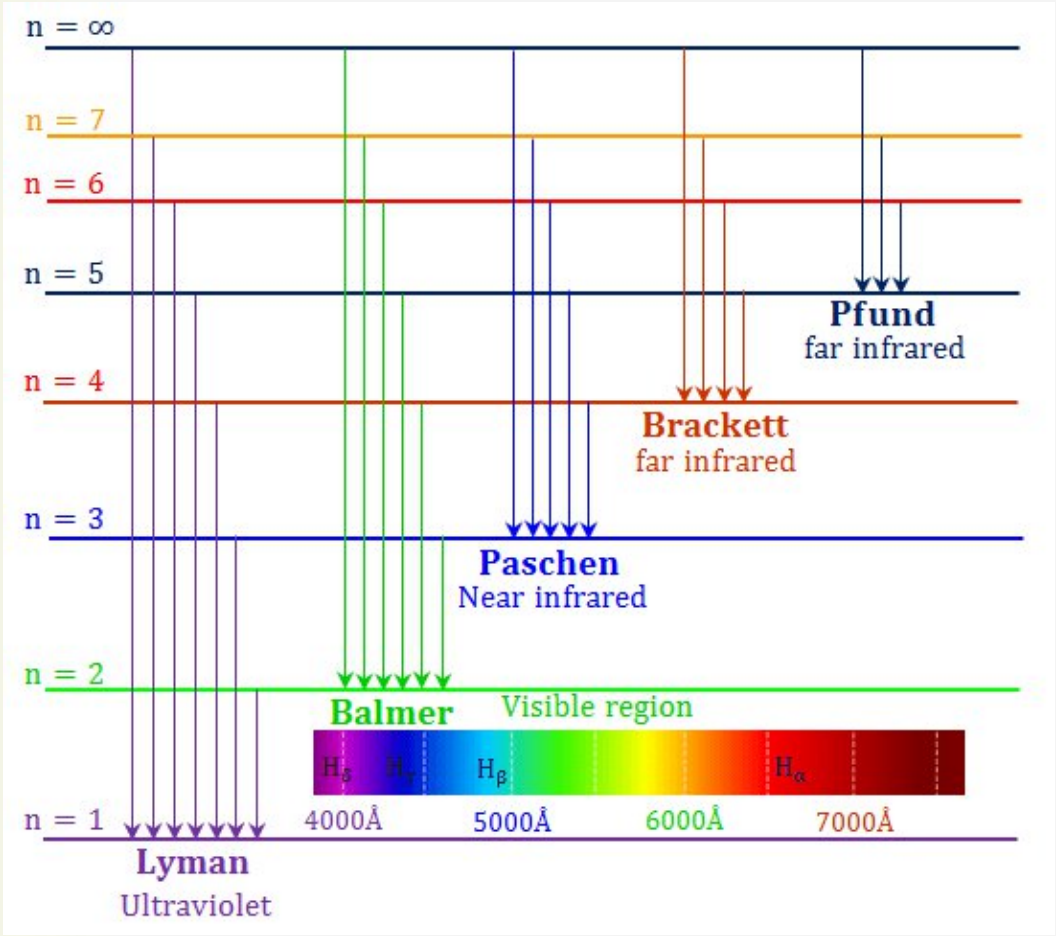
В модела на Бор за атома:
n>=3 -> n=2

- **Balmer-α/Hα: n=3 -> n=2 (656.28 nm)**
- Balmer-β/Hβ: n=4 -> n=2
- Balmer-γ/Hγ: n=5 -> n=2

n>=2 -> n=1

- Lyman-α/Ly-α: n=2 -> n=1

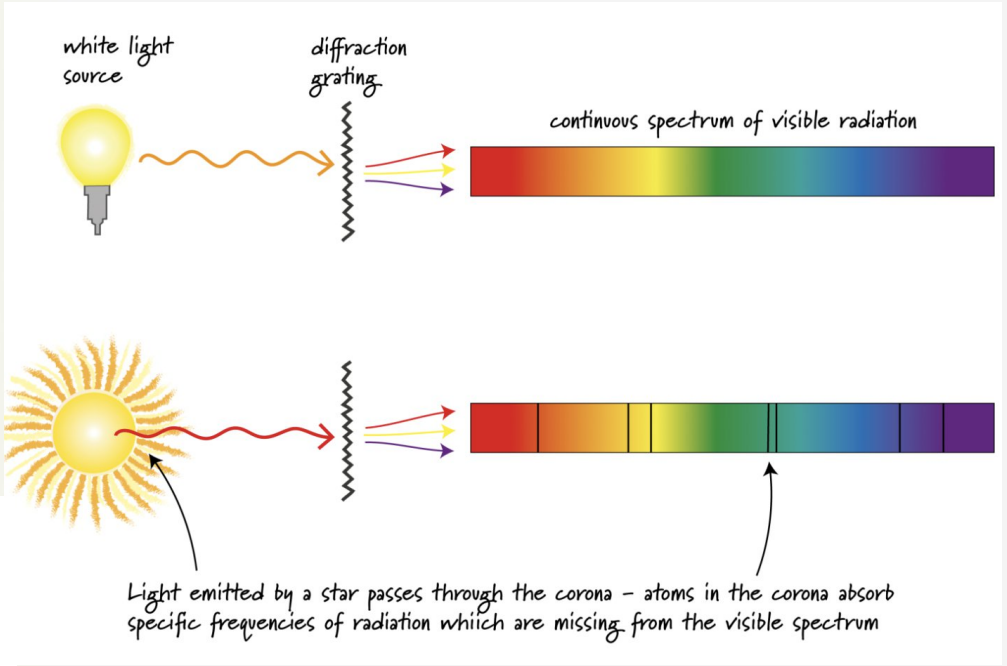




https://en.wikipedia.org/

https://www.priyamstudycentre.com/2019/02/hydrogen-spectrum.html

Линия Hα



https://www.briec.store/

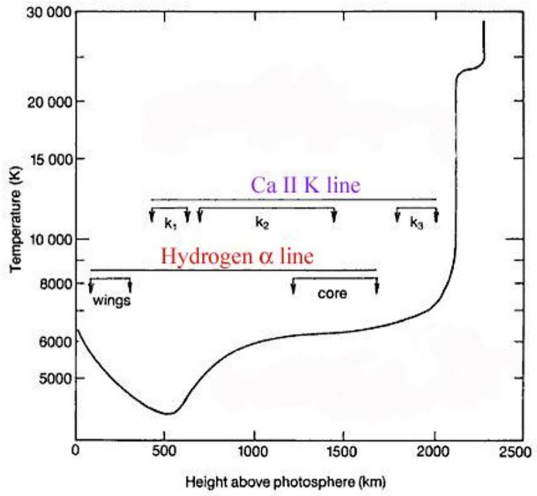
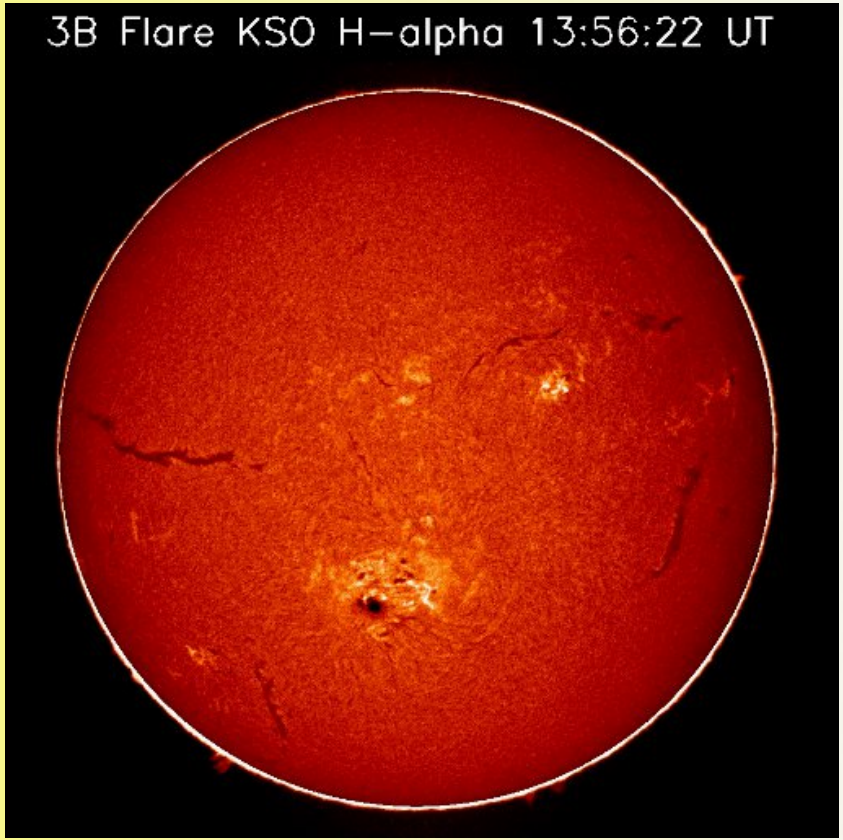


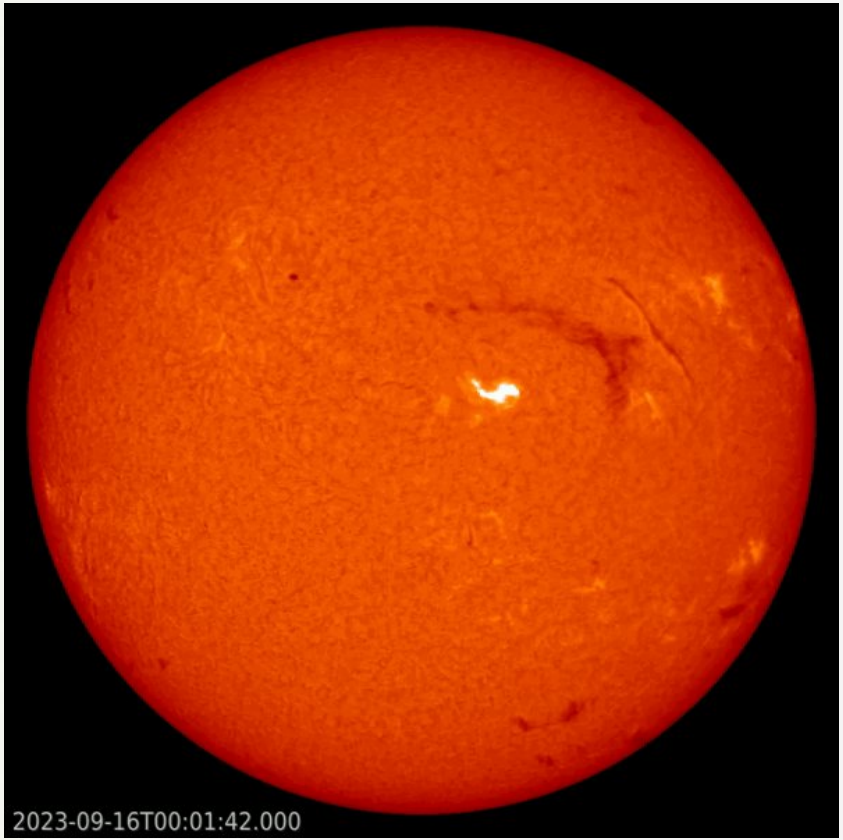
Figure 1. Graph showing the height above the photosphere of the Ca II K and hydrogen alpha line. Graph made from data gathered by (Vernazza *et al.* 1981).

https://www.ngdc.noaa.gov/stp/space-weather/solar-data/solar-imagery/chromosphere/calcium/meudon/documentation/Observing%20in%20Ca%20II%20K.pdf

Слънчева активност: протуберанси/филаменти

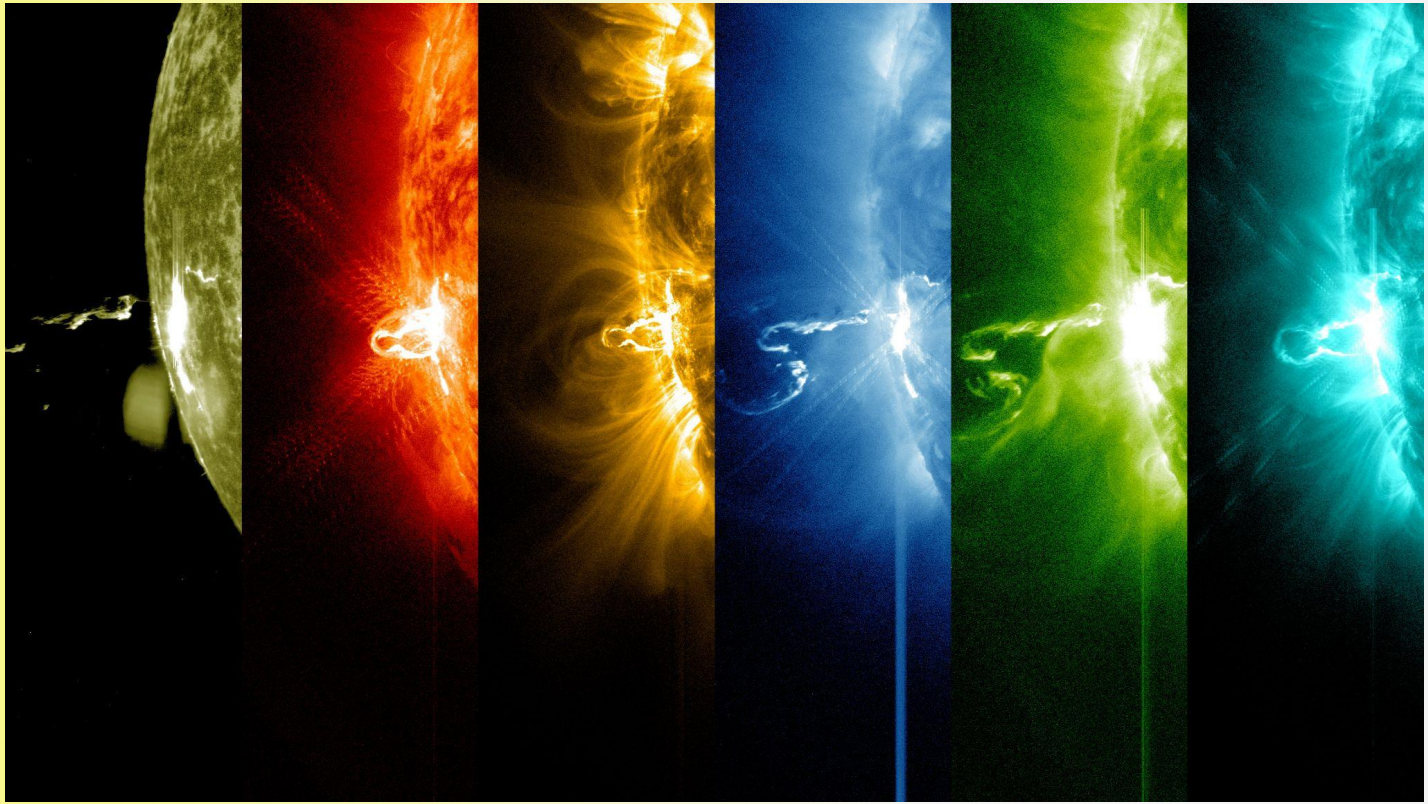


https://www.kso.ac.at/downloads/sonnenaufnahmen_en.php



NSO/GONG network https://www.stce.be/news/665/welcome.html

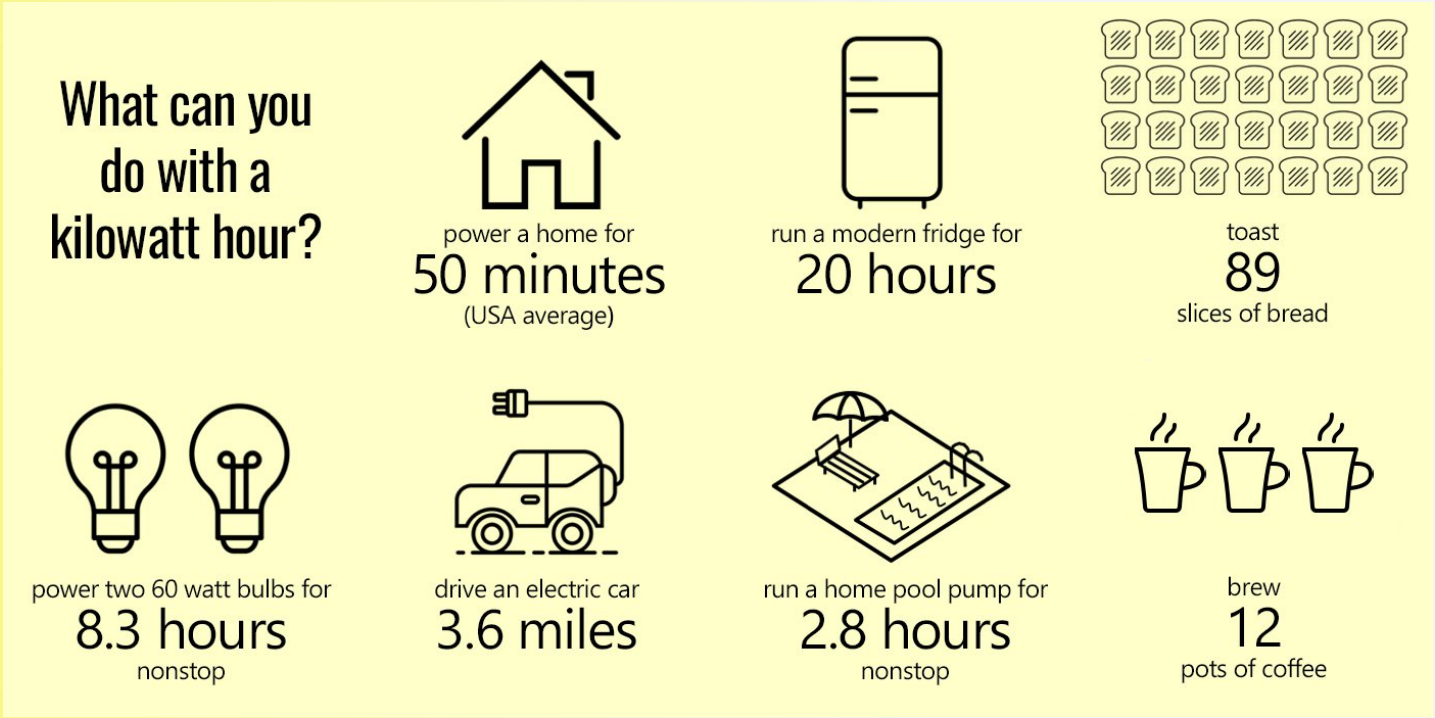
Слънчева активност: избухвания



NASA/SDO, 2014-02-14

Classification	Peak flux range (W/m^2)
A	$< 10^{-7}$
B	$10^{-7} – 10^{-6}$
C	$10^{-6} – 10^{-5}$
M	$10^{-5} – 10^{-4}$
X	$> 10^{-4}$

Слънчева активност: избухвания



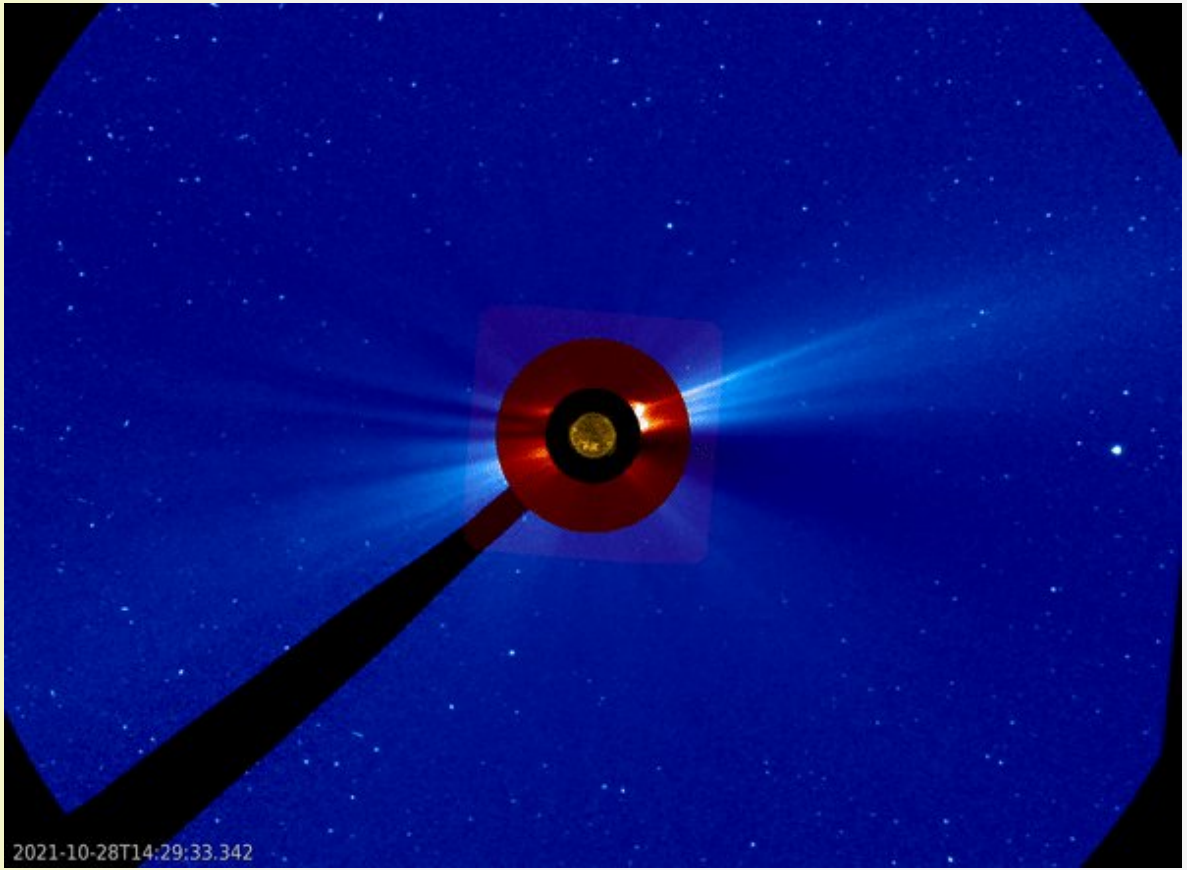
Classification	Peak flux range (W/m^2)
A	$< 10^{-7}$
B	$10^{-7} – 10^{-6}$
C	$10^{-6} – 10^{-5}$
M	$10^{-5} – 10^{-4}$
X	$> 10^{-4}$

Най-мощното регистрирано избухване:
2003-11-04
~X40±5

10^32 erg/10^25 J/
10^19 kWh

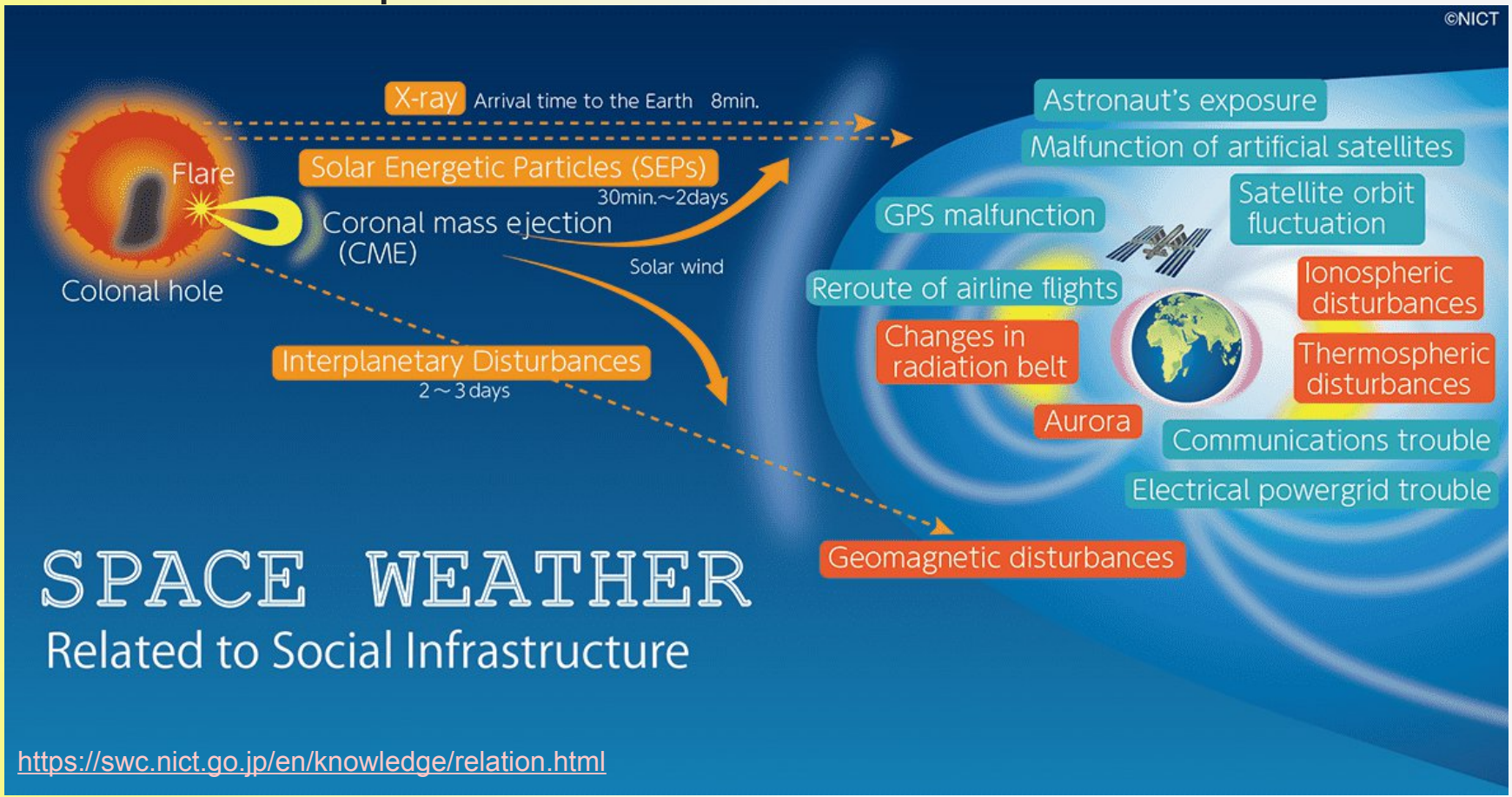
https://www.freeingenergy.com/what-is-a-kilowatt-hour/

Слънчева активност: коронална маса



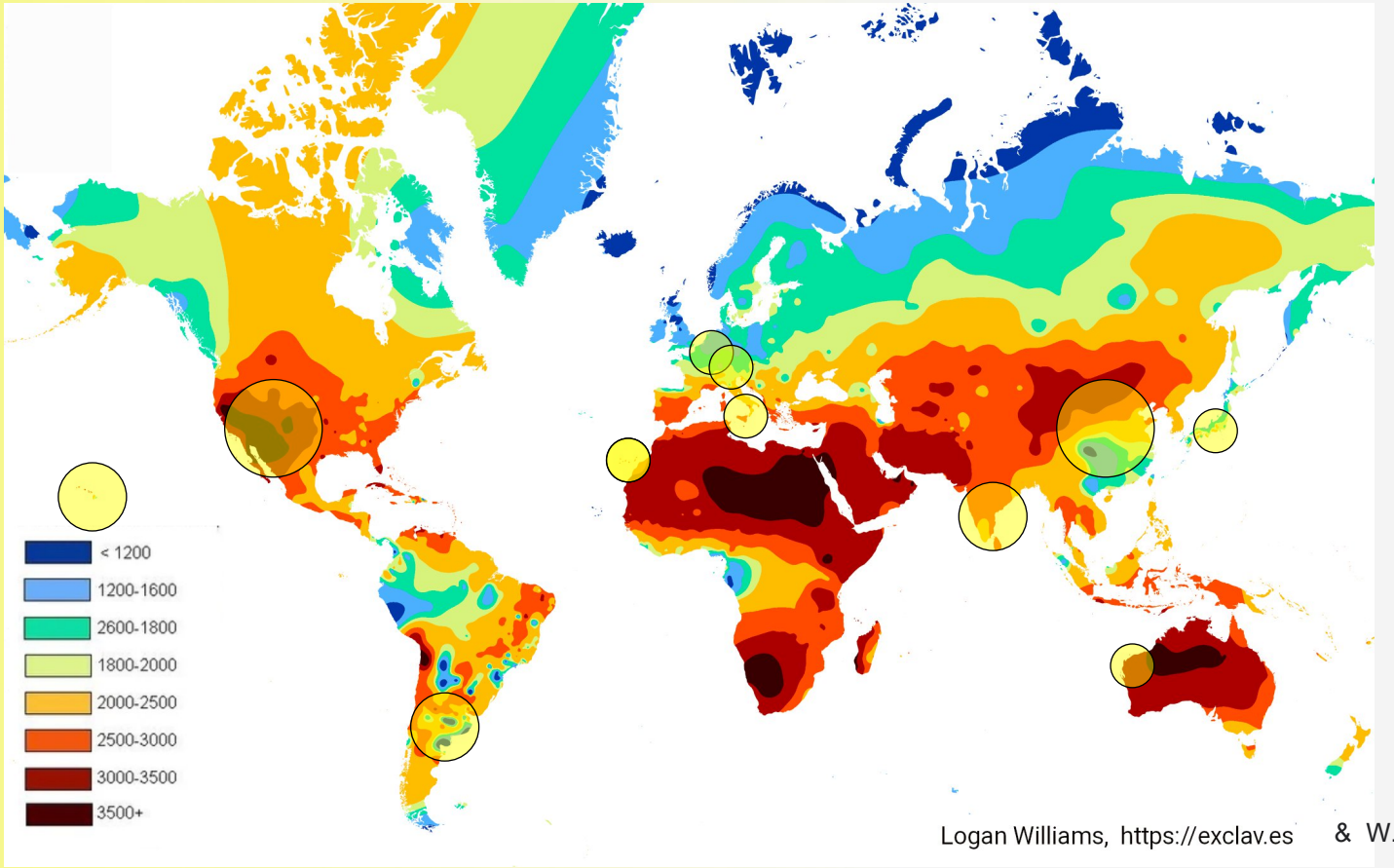
SOHO/ESA/NASA

Космическо време



https://swc.nict.go.jp/en/knowledge/relation.html

Наземни станции



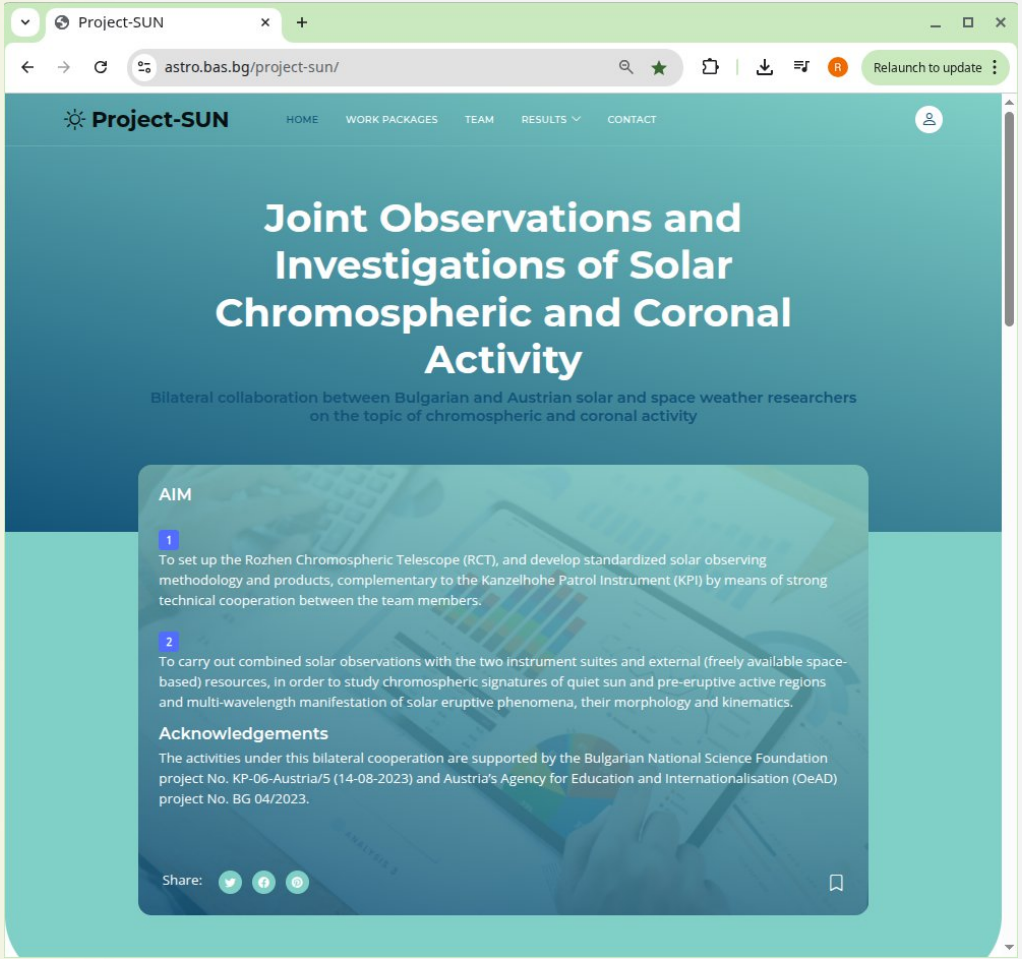
Logan Williams, https://exclav.es & W. Poetzi

https://astro.bas.bg/project-sun/

Първоначална идея

Научен проект за двустранно сътрудничество с Австрия (2023-2025) и Обсерваторията Канцелхое
https://www.kso.ac.at/index_en.php

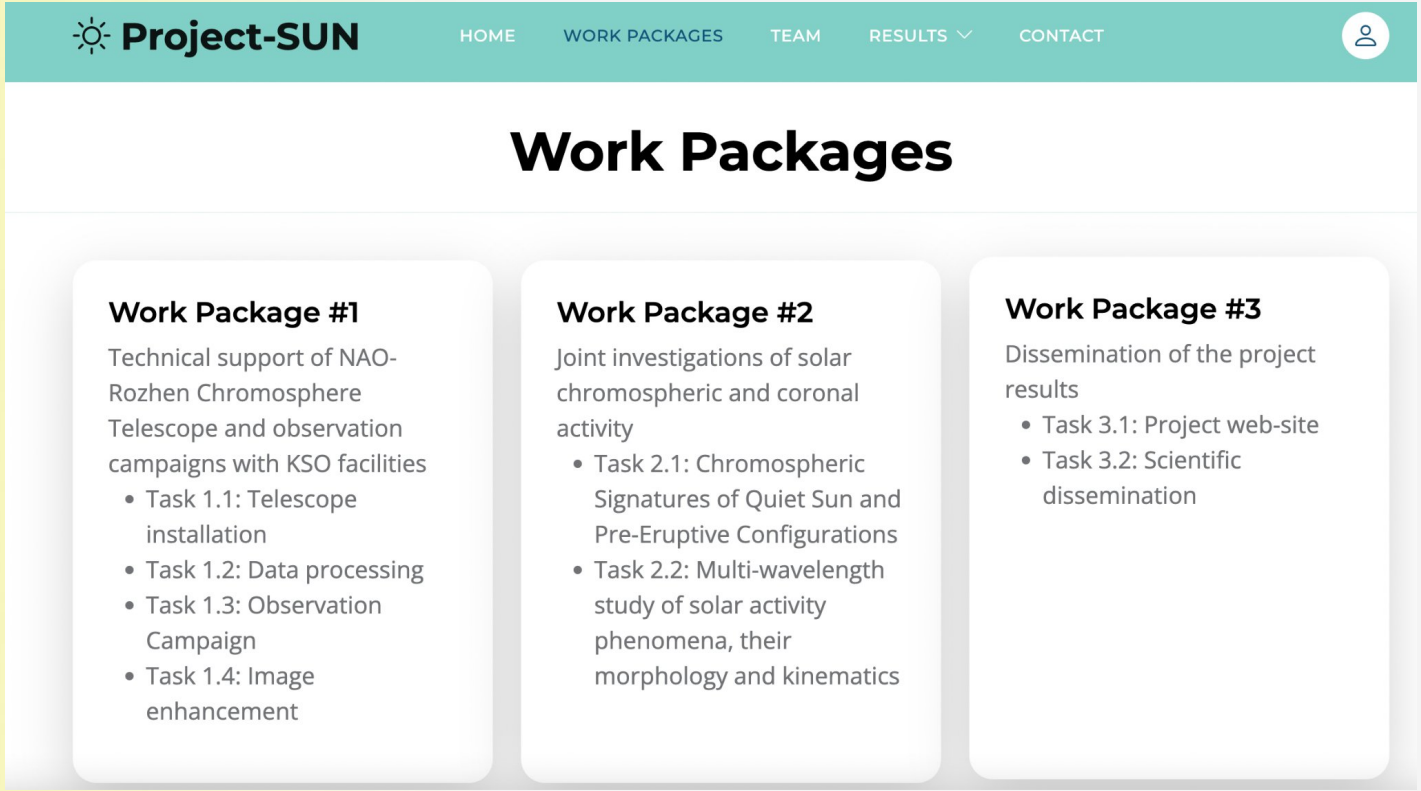
- Сътрудничество
- Научни наблюдения от НАО-Рожен
- Научни изследвания
- Изграждане на апаратура



https://astro.bas.bg/project-sun/

Тайно оръжие

Екипът изказва специални благодарности на Пенчо Маркишки за оказаната помощ и всеотдайна работа!!



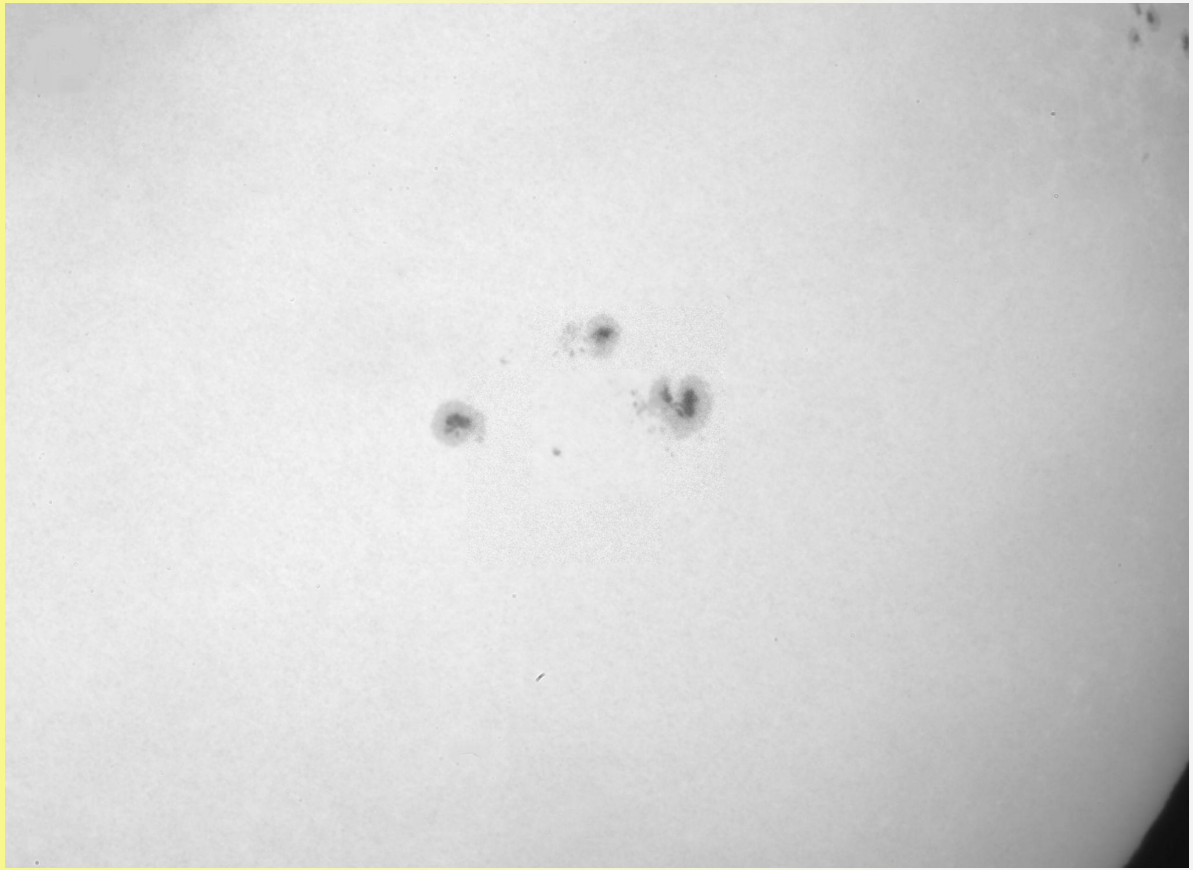
Астрономическа обсерватория - Белоградчик

Шмит-Касегрен телескоп C11 на производителя Celestron, D = 279 mm, фокусно разстояние f = 2800 mm, f/10, управлява се с екваториална монтировка Advanced VX

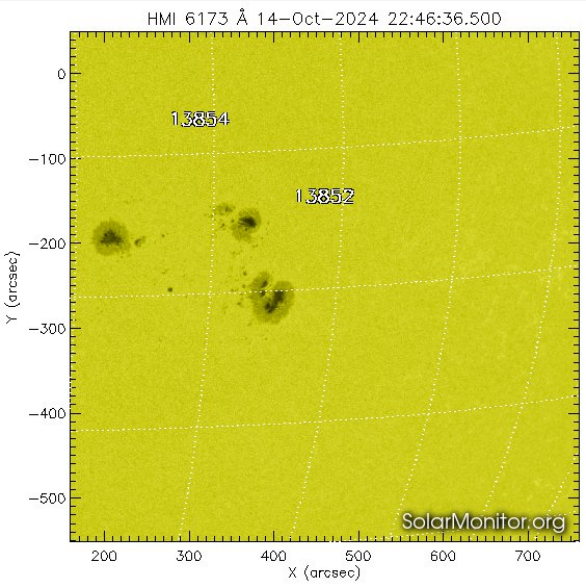
Energy rejection филтър E-325F90 на DayStar, D = 90 mm, монтиран off-axis пред телескопа

Филтър Hydrogen Alpha Quantum на DayStar (FWHM< 0.5 Å, f/30, температурно стабилизиран) и камера Common Vision SP-12401M-USB, монтирани в прекия фокус на

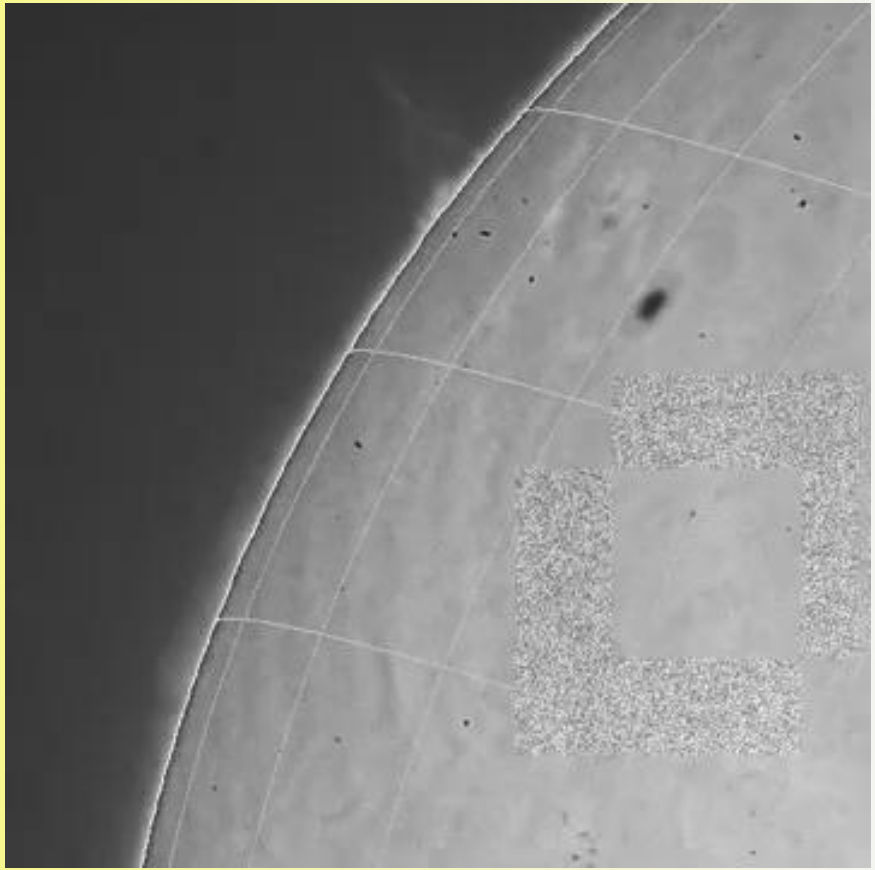
Слънчеви петна в бяла светлина: 2024-10-14

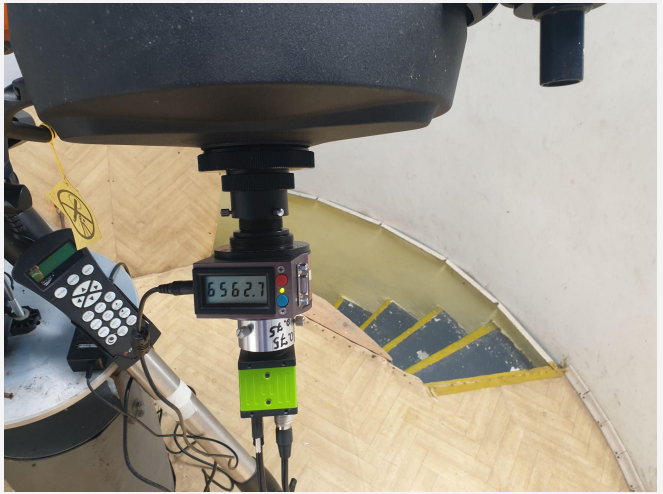


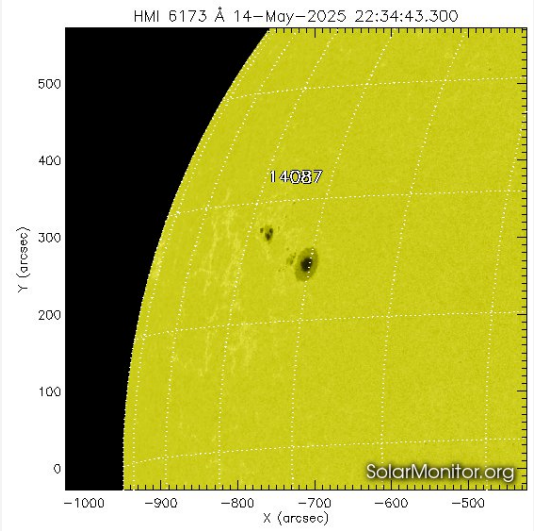
Наблюдение на слънчеви петна:
бяла светлина (10:47 UT, 14 ms) с метализирано филио на Baader - 70 mm



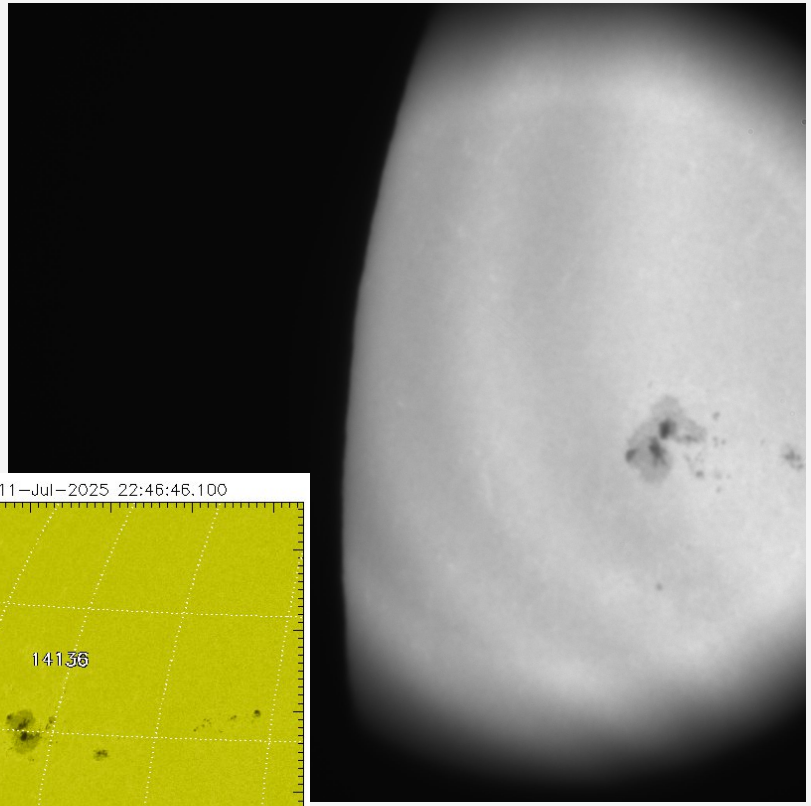
Отвънчево избухване в Hα: 2025-05-14

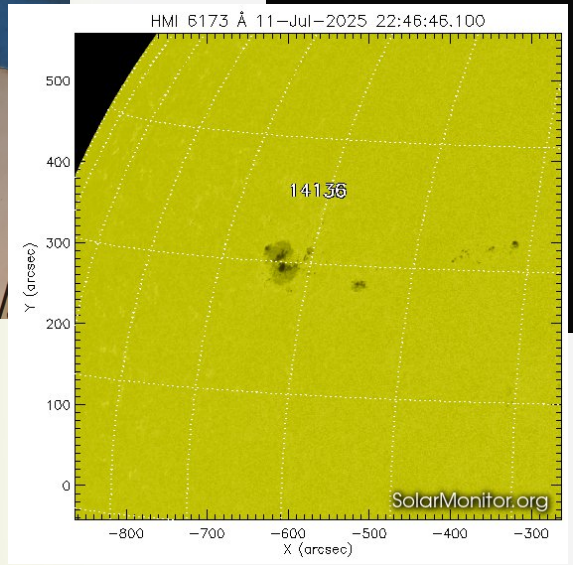




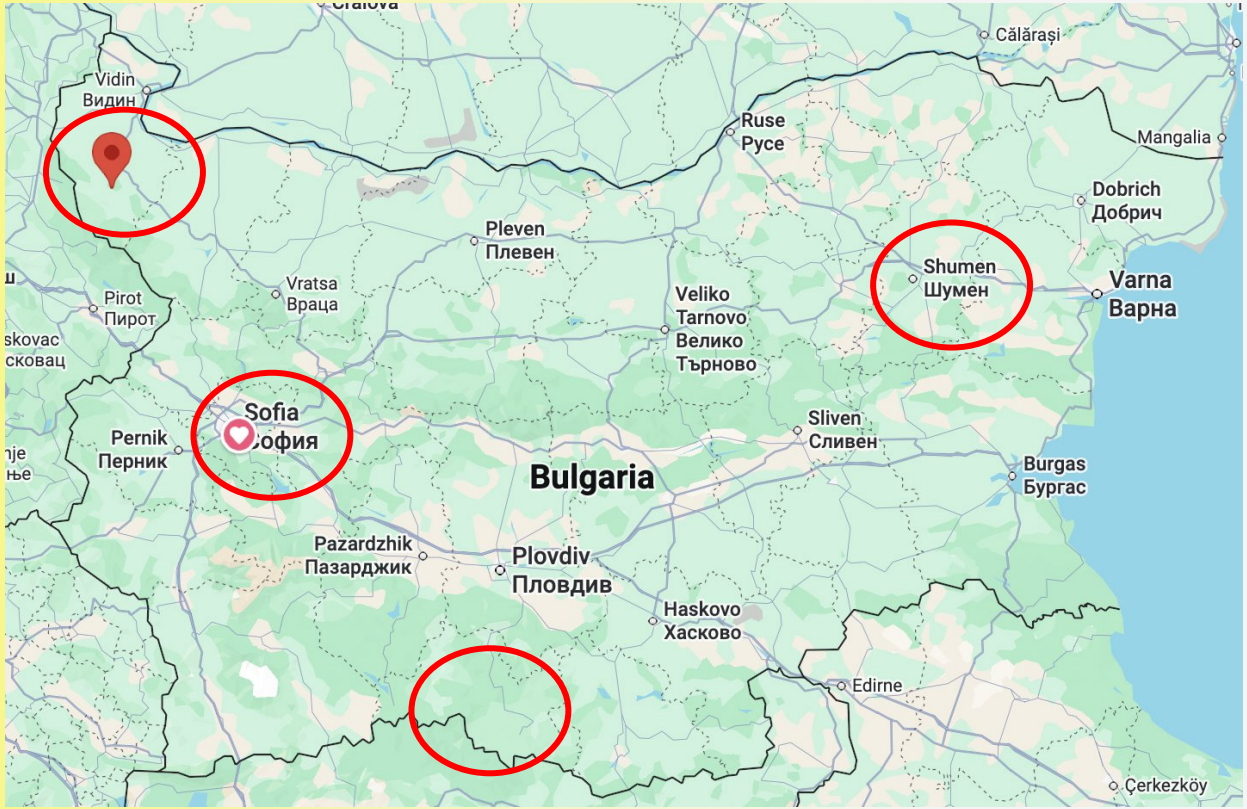


Наблюдения от Белоградчик





3 наблюдателни станции



https://www.google.com/maps/

Градски условия

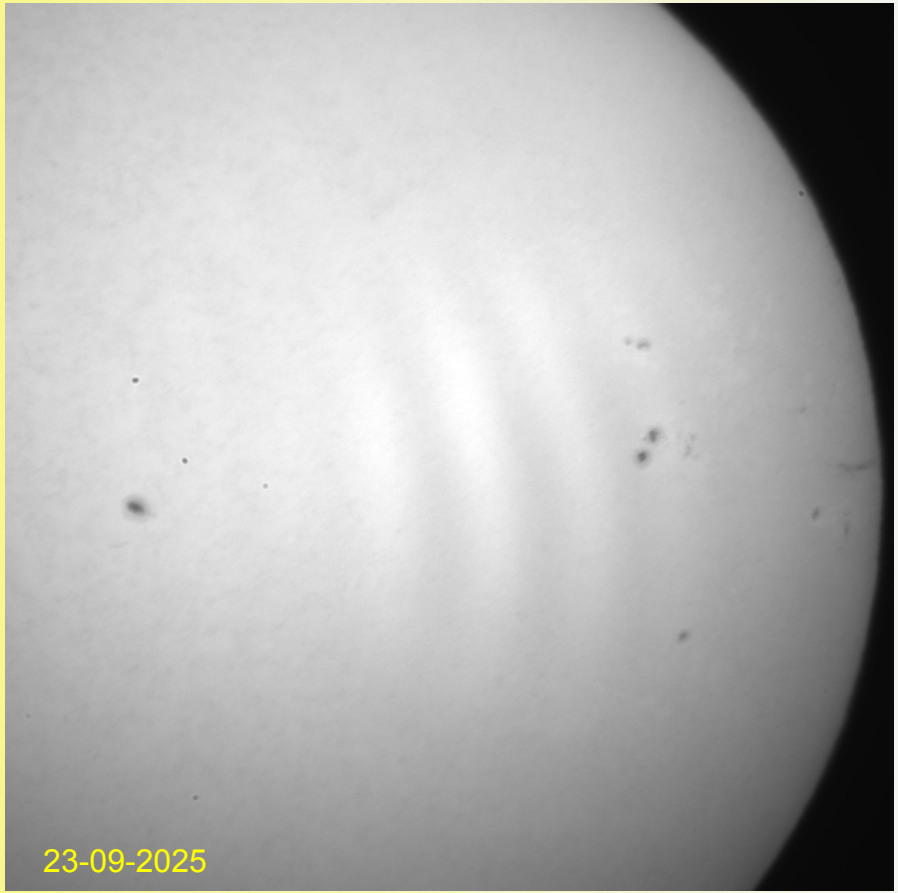
I. Белоградчик ~520 m
I. Шуменско плато ~500 m
I. София (x2?) ~600 m

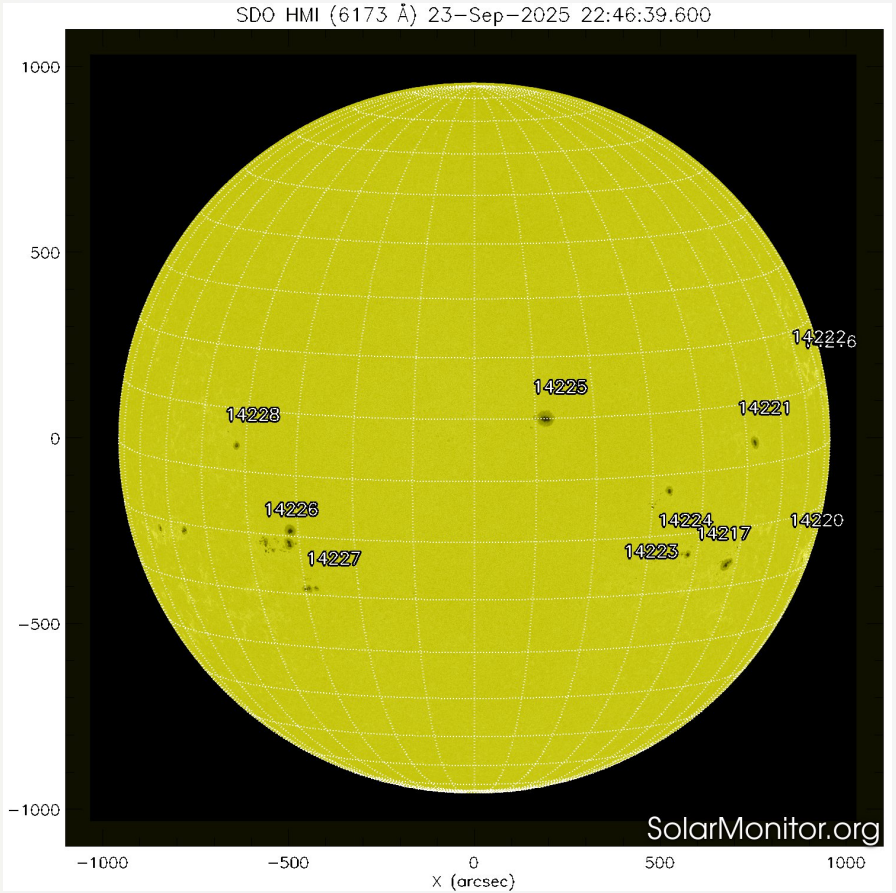
VI. Смолян? любители-астрономи?

Астрономически център към Шуменски университет

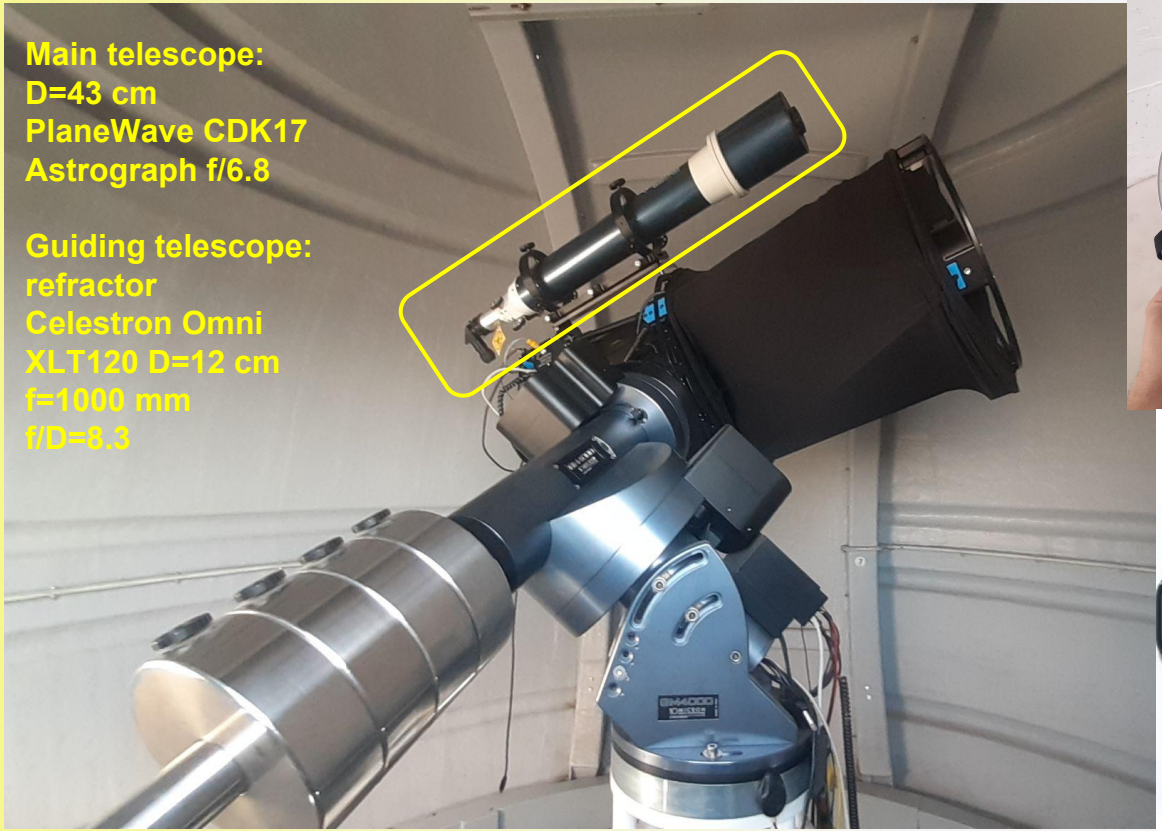
- Telescope: Coronado ST 40/400 PST Personal Solar Telescope OTA, D = 40 mm, focal ratio: f/10
- Mount/guiding: azimuthal, ‘HelioFind’ automatic Sun-guiding system
- Camera: NexImage 5 CCD camera
- Filter: integrated H-alpha

Наблюдения от Шумен



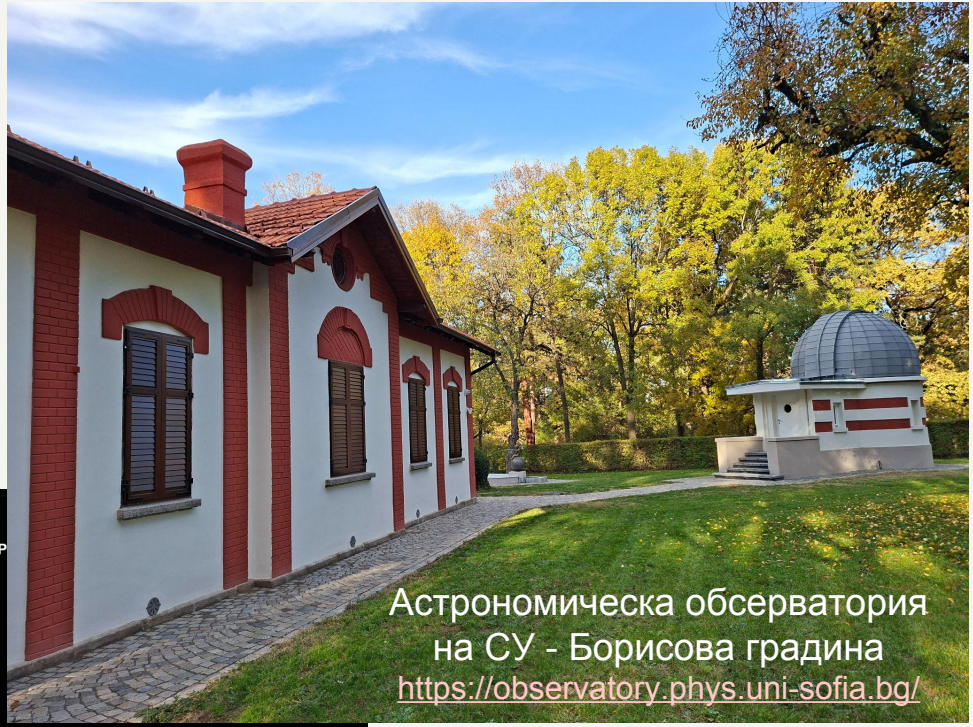


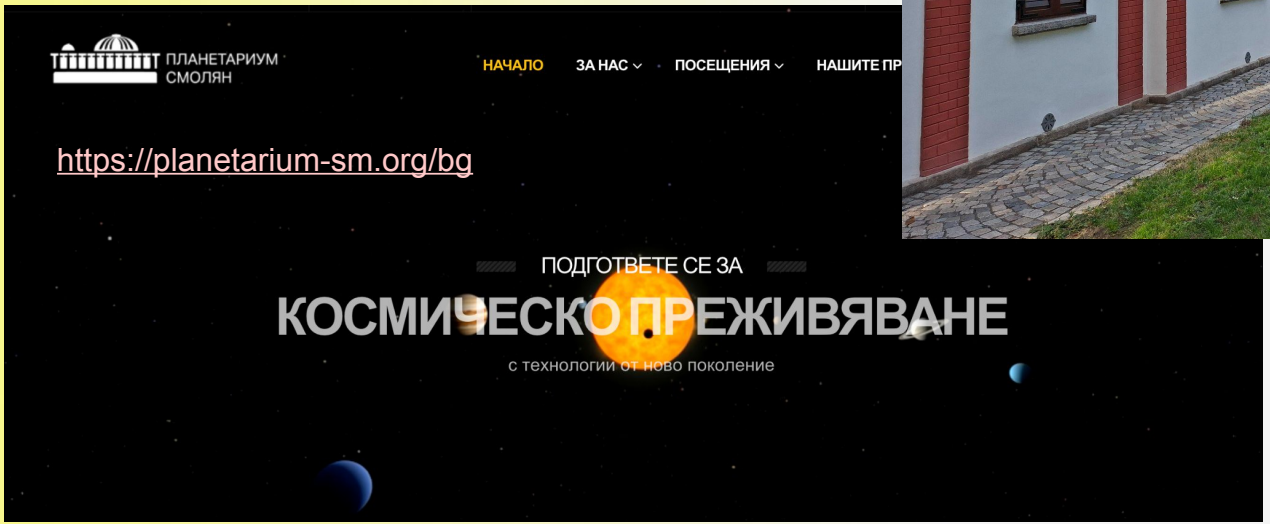
Обсерватория към частно училище “Св. Георги” - София



Наблюдения от София

Нови станции





БГ-мрежа за наблюдения на Слънцето

- Научни задачи

слънчеви петна
филаменти
избухвания в Hα

- Обучение

студенти и докторанти (СУ, ШУ)

- Популяризация

Наблюдения

Изграждане на база данни - отворена наука!

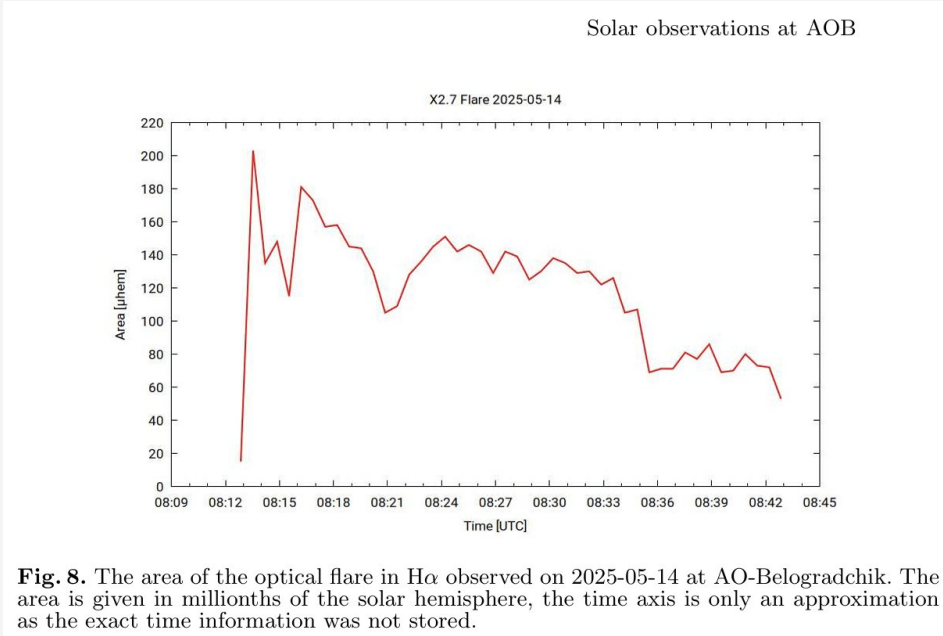


Fig. 8. The area of the optical flare in Hα observed on 2025-05-14 at AO-Belogradchik. The area is given in millionths of the solar hemisphere, the time axis is only an approximation as the exact time information was not stored.

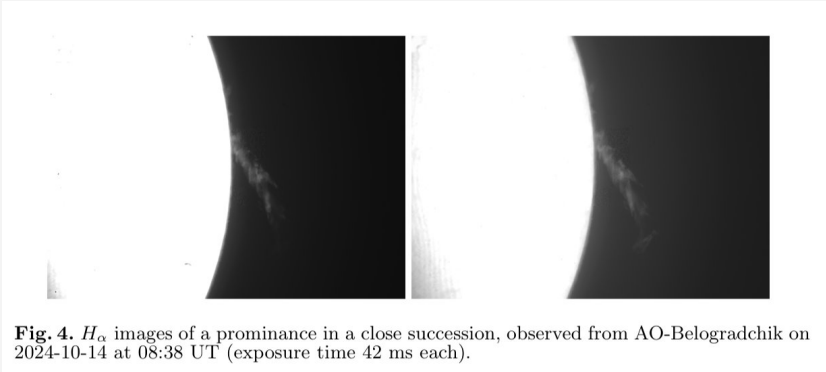


Fig. 4. H_α images of a prominance in a close succession, observed from AO-Belogradchik on 2024-10-14 at 08:38 UT (exposure time 42 ms each).

https://astro.bas.bg/AIJ/issues/n43/PMarkishki.pdf

Сътрудничество с радио наблюдения в България

LOFAR-BG

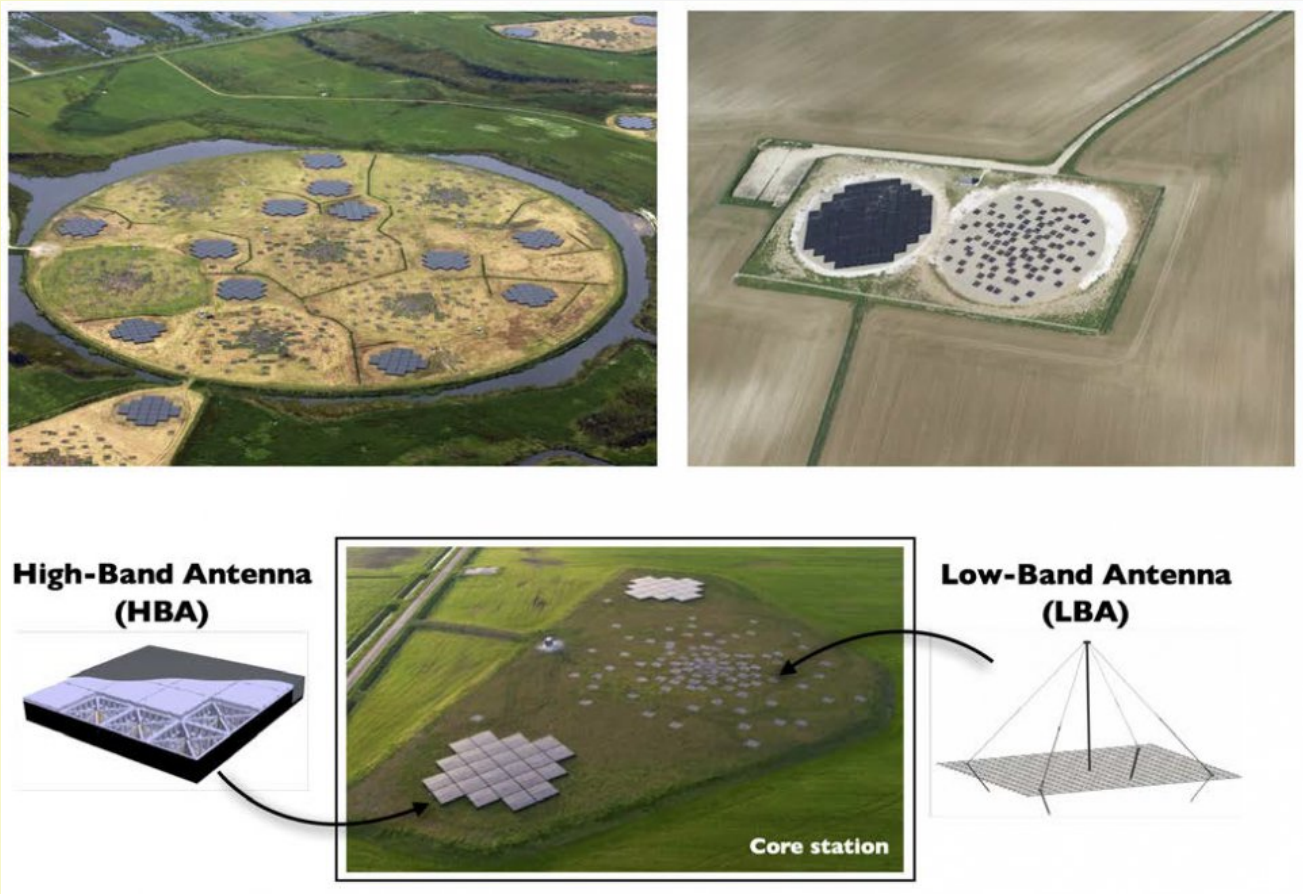
https://lofar.bg/

- Ядро
- Отдалечени станции
- Международни станции

Нискочестотна антена
Low Band Antenna (LBA)
30-80 MHz

Високочестотна антена
High Band Antenna (HBA)
120-240 MHz

https://science.astron.nl/



Международна станция: LOFAR-BG
https://lofar.bg/

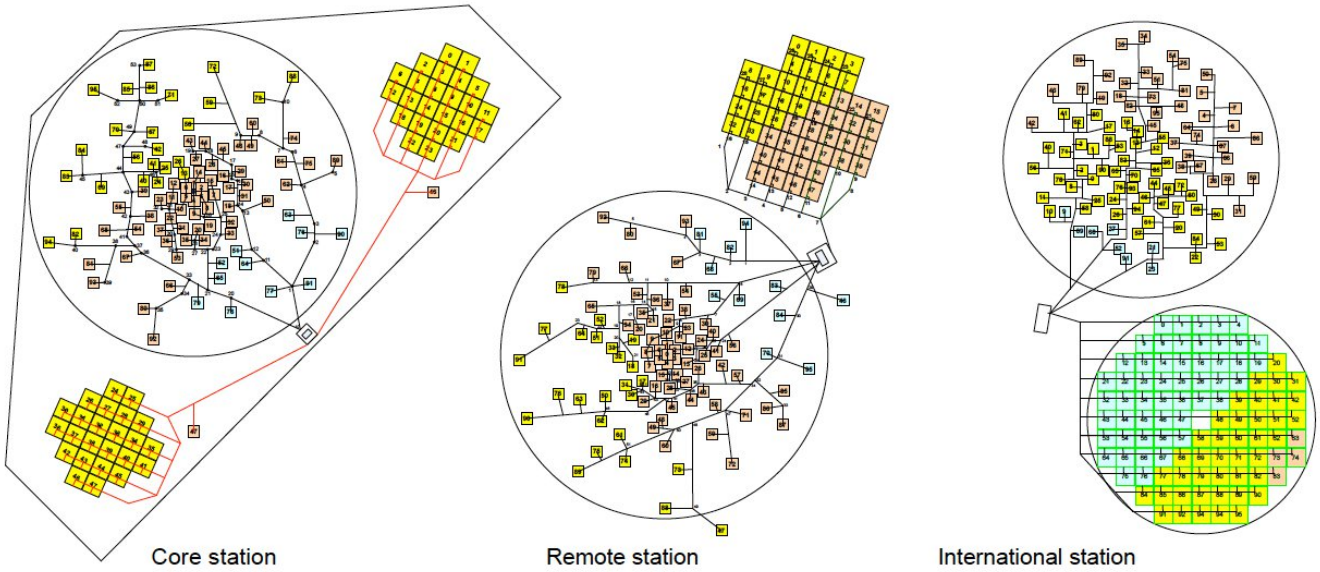


Fig. 4. Station layout diagrams showing core, remote and international stations. The large circles denote the LBA antennas while the arrays of small squares indicate the HBA tiles. Note that the station layouts are not shown on the same spatial scale.

https://doi.org/10.1051/0004-6361/201220873

Национален консорциум за управление на проекта:

- Институт по астрономия с НАО-БАН
- Катедра „Катедра Радиокомуникации и видеотехнологии“ на Технически университет-София
- Катедра „Астрономия“ на СУ „Св. Климент Охридски“
- Катедра „Астрономия“ на ШУ „Епископ Константин Преславски“

БГ-мрежа за наблюдения на Слънцето

https://lofar.bg/

в близост до НАО-Рожен
2024/2025

Екип

ИАНАО-БАН

Р. Митева

П. Маркишки

М. Дечев

К. Козарев

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Св. Георги - София

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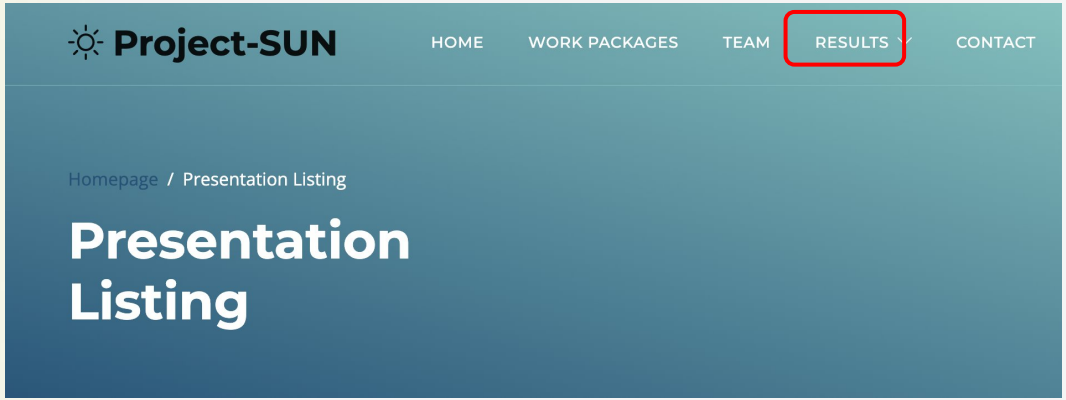
със съдействието на:

Werner Pötzi (Австрия)

https://astro.bas.bg/project-sun/

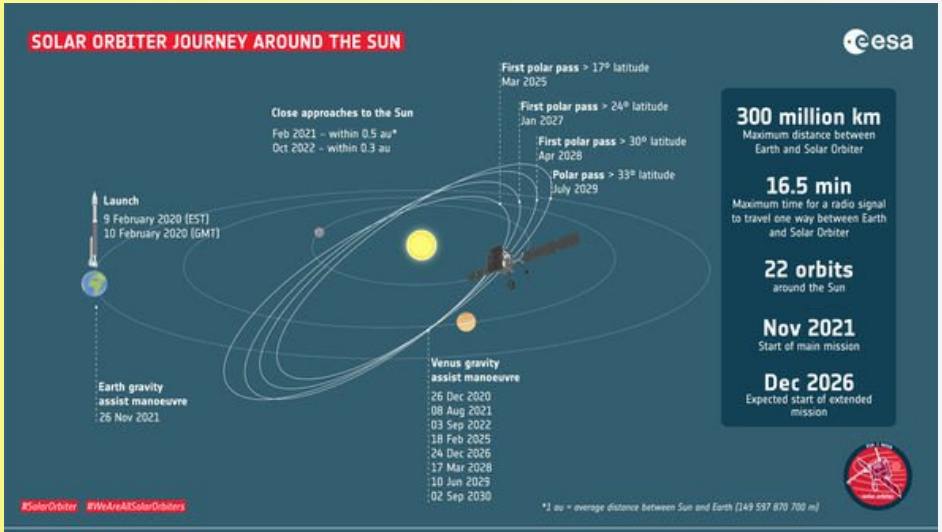
Благодарности: проекти

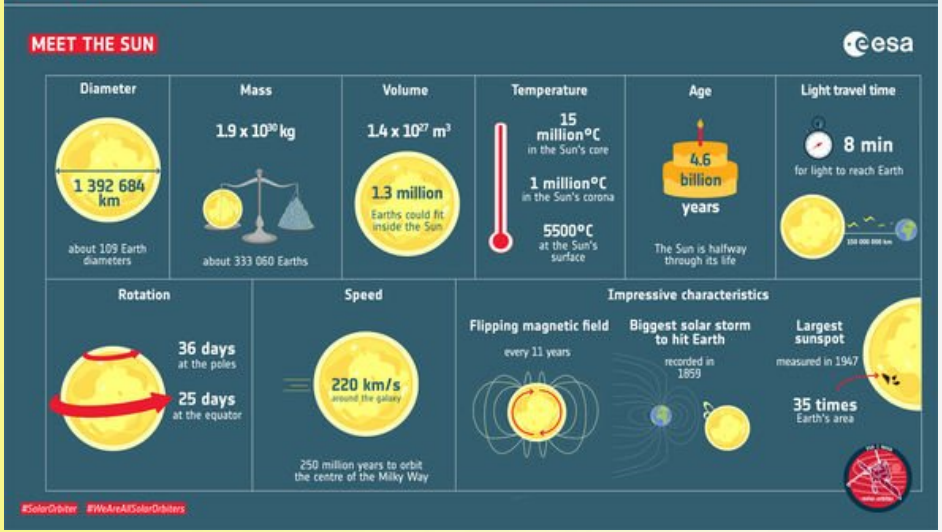


(1) Двустранно сътрудничество България-Австрия ‘Joint Observations and Investigations of Solar Chromospheric and Coronal Activity’, финансиран от ФНИ проект No. КП-06-Австрия/5 (14-08-2023) & Austria’s Agency for Education and Internationalisation (OeAD) project No. BG 04/2023

(2) RACIO финансиран от МОН (Националната пътна карта за научна инфраструктура) https://naukamon.eu/regionalen-astronomicheski-czentar-za/

(3) LOFAR-BG финансиран от Националната пътна карта за научна инфраструктура (2020-2027), координирана от Министерството на образованието и науката на България (договори D01-389/18.12.2020, D01-177/29.07.2022, D01-362/14.12.2023, D01-110/30.06.2025). https://lofar.bg/bg/





Solar Orbiter
>2020
https://www.esa.int/

2022-03-26 @ 0.32 AU

https://www.youtube.com/watch?v=L00J3hZCdFs&ab_channel=SciNews