

Мрежа за наблюдения на Слънцето от България

д-р Росица Митева
Институт по астрономия с НАО-БАН
rmiteva@nao-rozhen.org



Кръжок към катедра
“Астрономия”, ФзФ-СУ

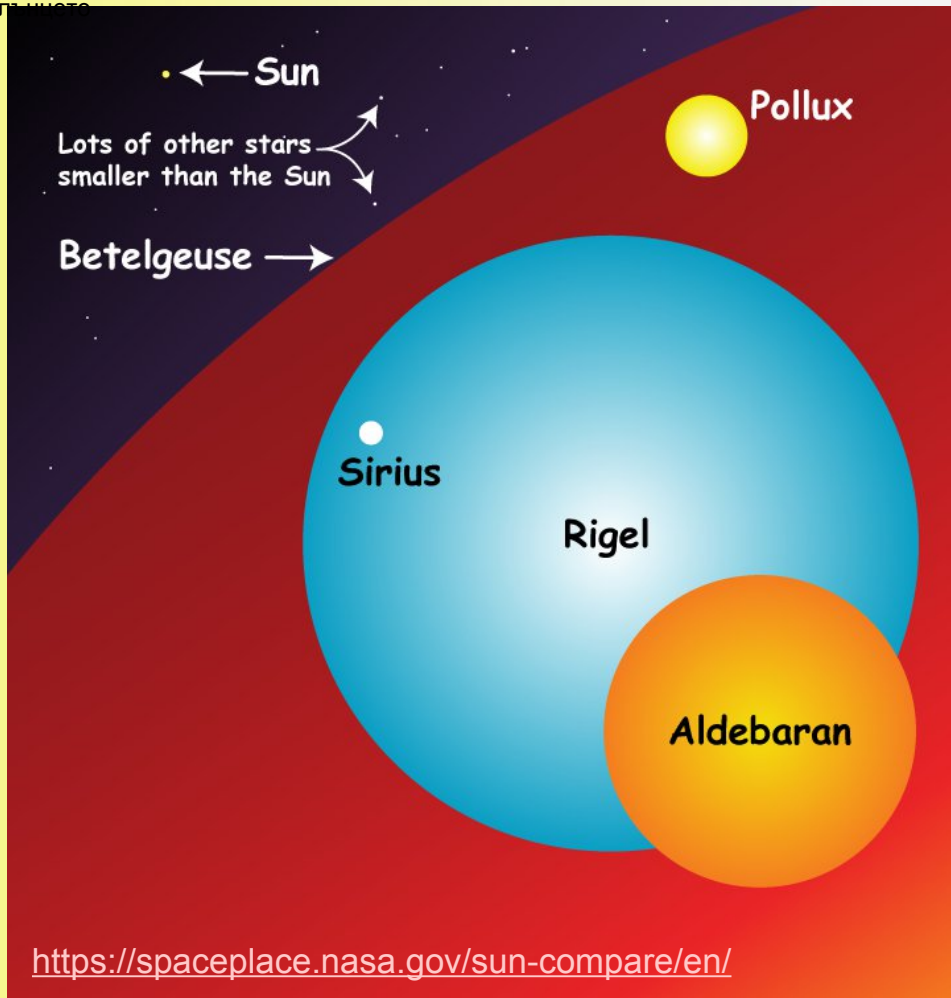
06.11.2025

Съдържание

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



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



Слънцето като звезда

Age	4.6×10^9 years
Mass	1.99×10^{30} kg (≈ 330 times of the Earth)
Diameter	1.38×10^8 m (≈ 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)

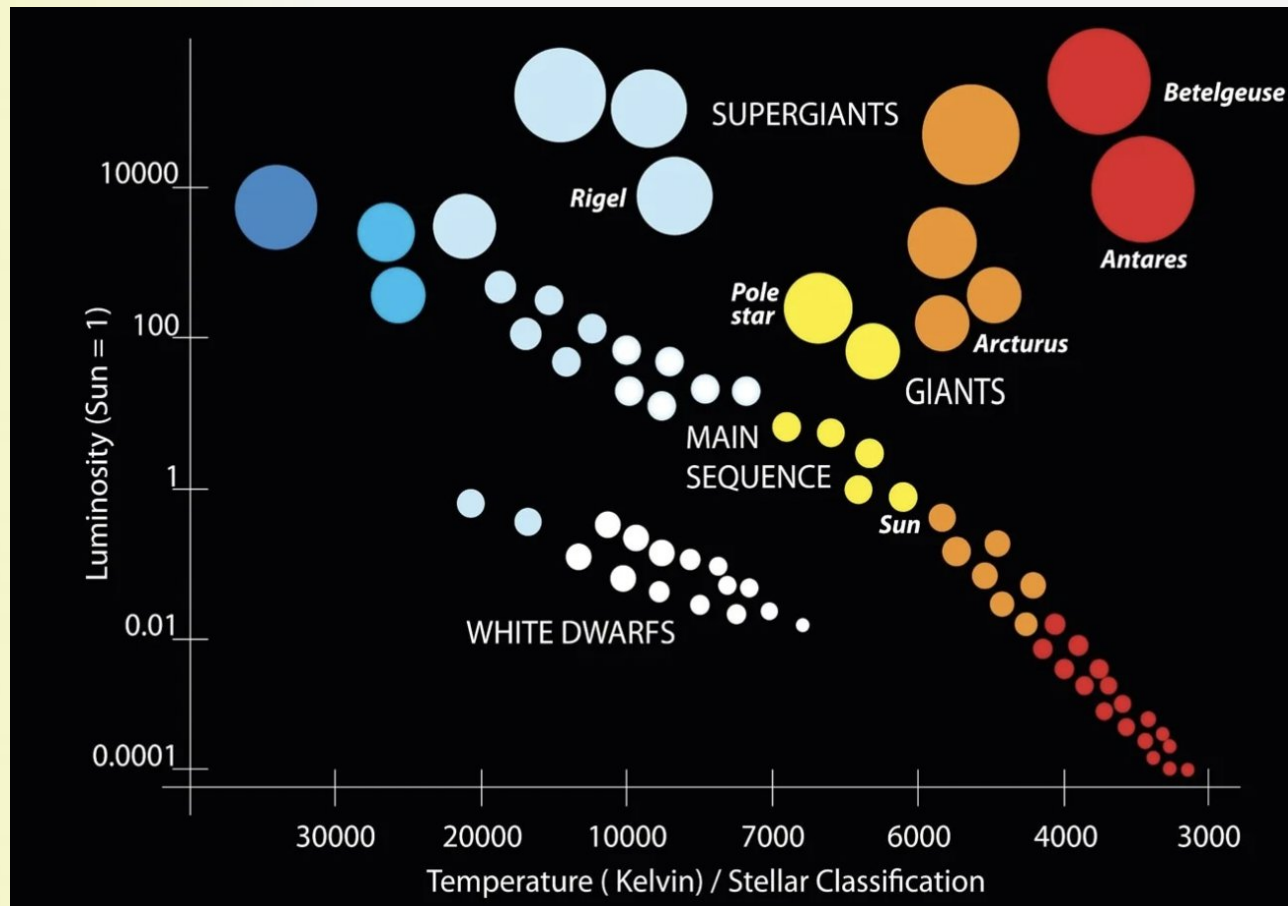
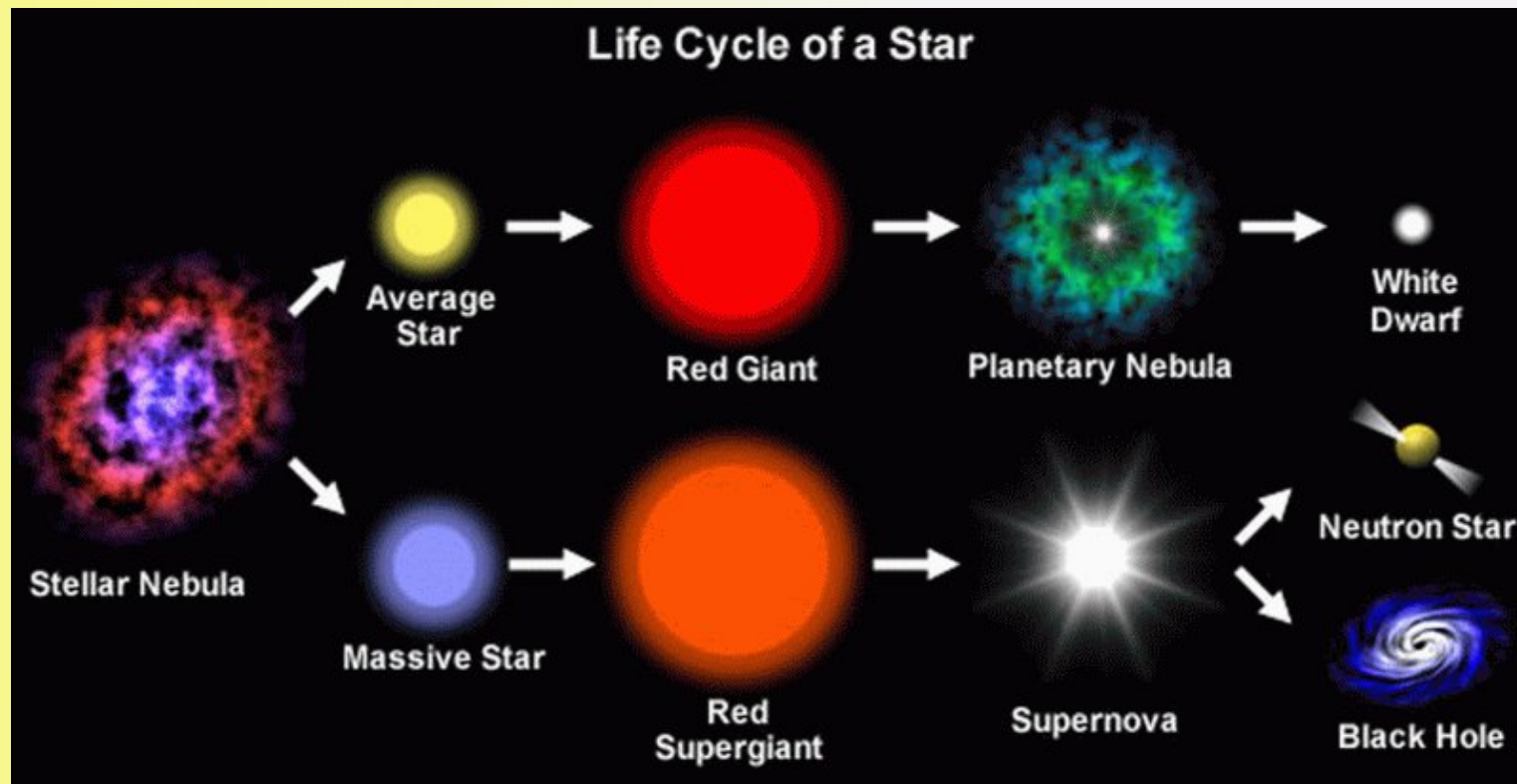
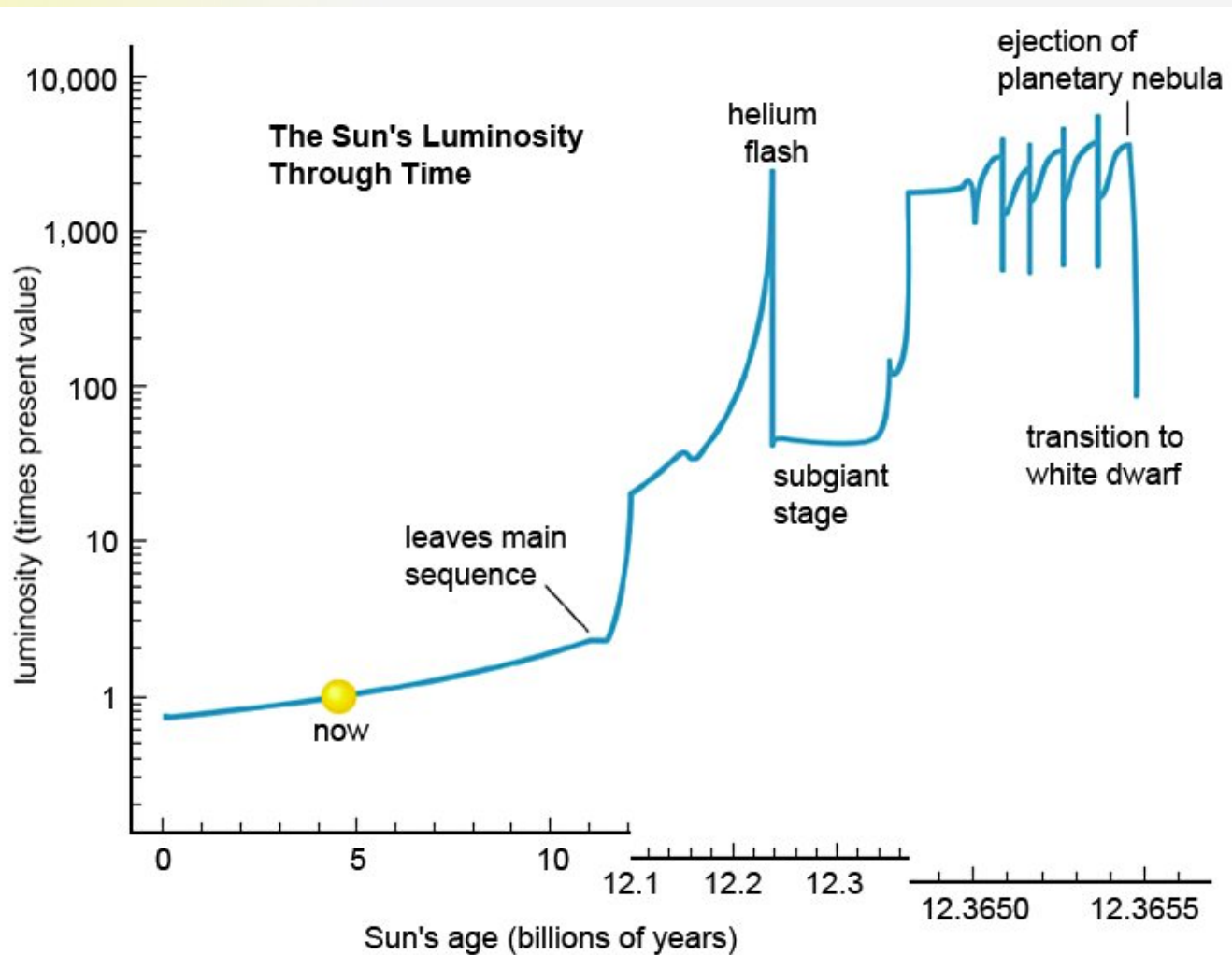


Схема на звездната еволюция



Светимост на Слънцето във времето



Слънцето: вътрешен строеж и атмосфера

ANATOMY OF THE SUN



Sunspots

Darker, cooler areas on the photosphere with concentrations of magnetic field

Prominence

Large structure, often many thousands of kilometres in extent

Granulation

Small, short-lived grainy features that cover the Sun, caused by thermal currents rising from below

Chromosphere

Layer above the photosphere, where the density of plasma drops dramatically

Photosphere

The visible 'surface' of the Sun

Transition region

Thin, irregular layer that separates the relatively cool chromosphere from the much hotter corona

Flare

Sudden release of energy in the form of radiation

Convective zone

Rapid heating of plasma creates currents of heated and cooled gas

Radiative zone

Energy created in the core diffuses slowly through the plasma

Core

Where the Sun generates its energy via thermonuclear reactions

Corona

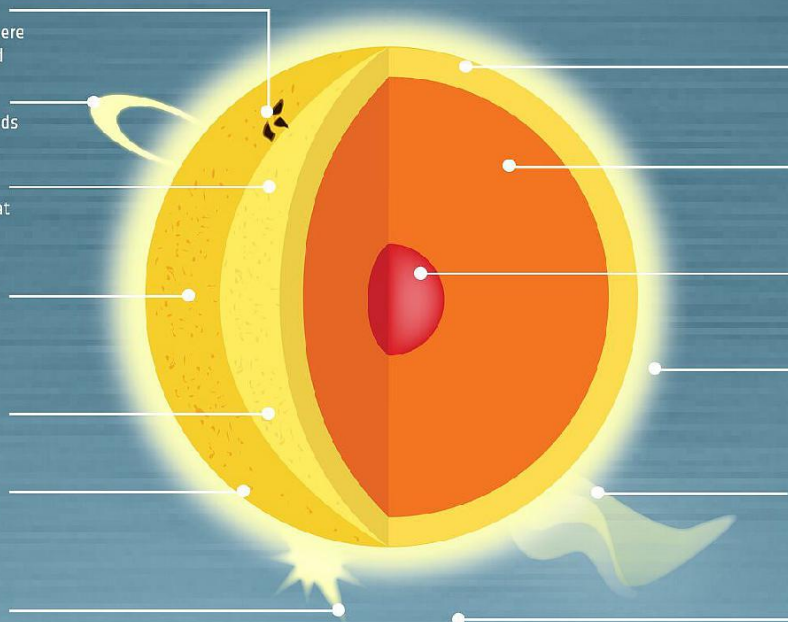
The Sun's outer atmosphere, which extends millions of kilometres into outer space

Coronal mass ejection

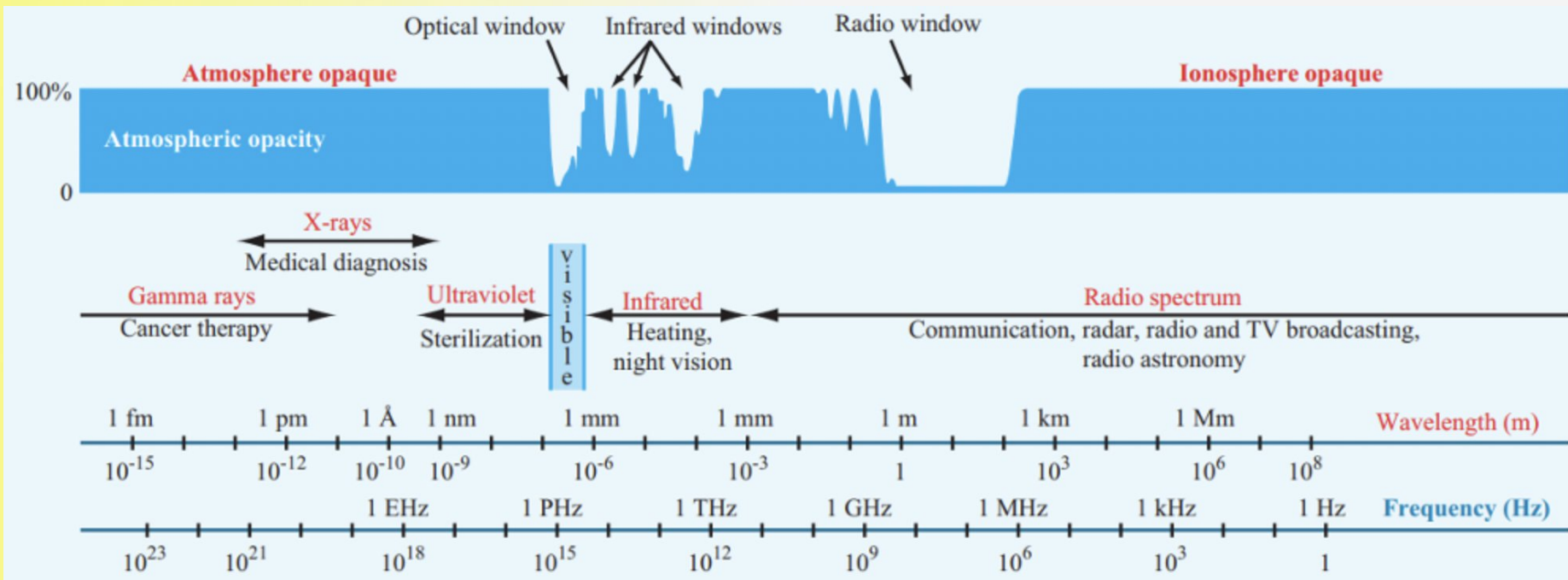
Vast eruption of billions of tonnes of plasma and accompanying magnetic fields from the Sun's corona

Solar wind

A continuous stream of charged particles released from the corona



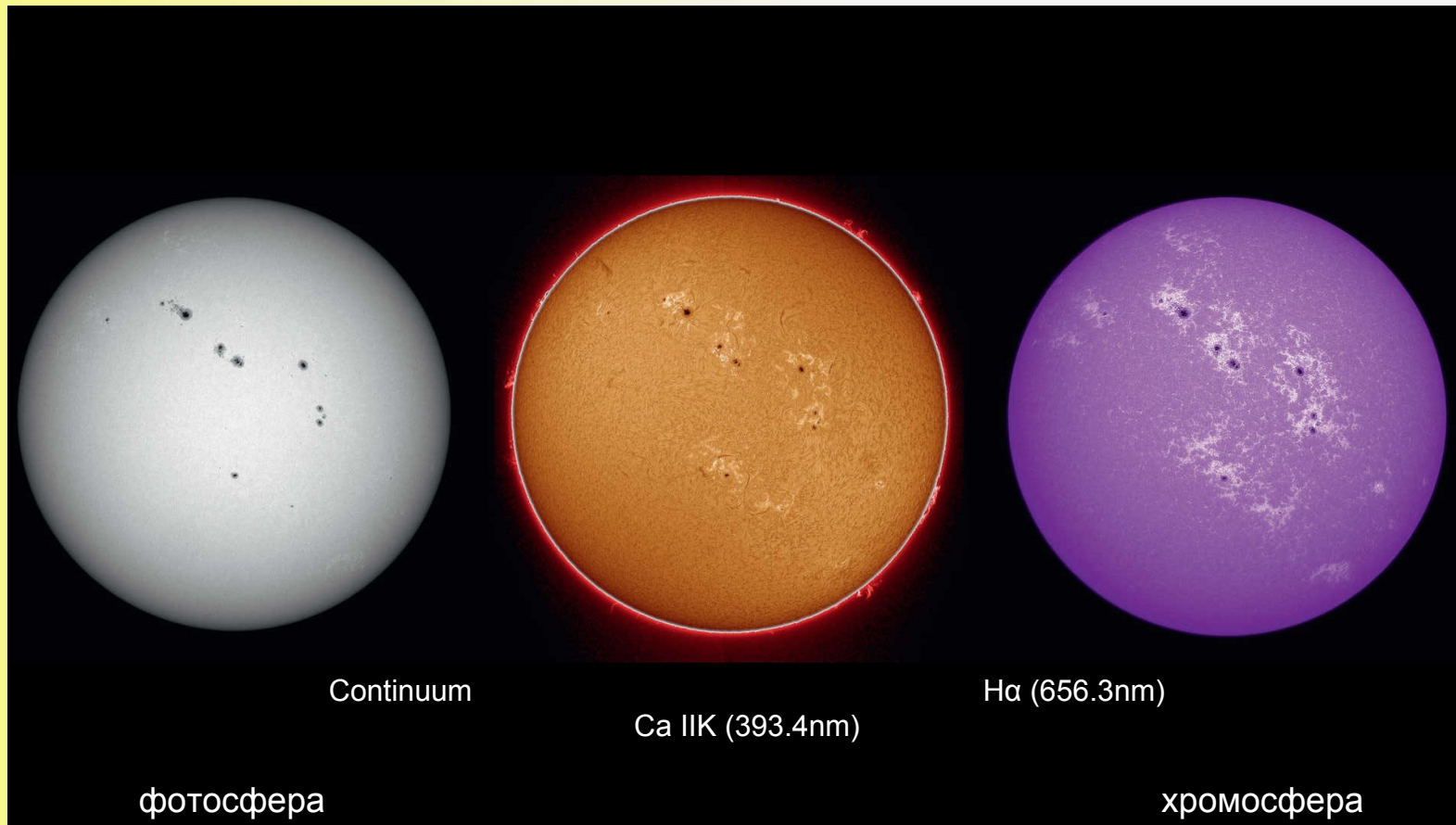
Наземни астрономически наблюдения



Credit: Microwave Radar and Radiometric Remote Sensing by Ulaby and Long

<https://www.nasa.gov/smallsat-institute/sst-soa/soa-communications/>

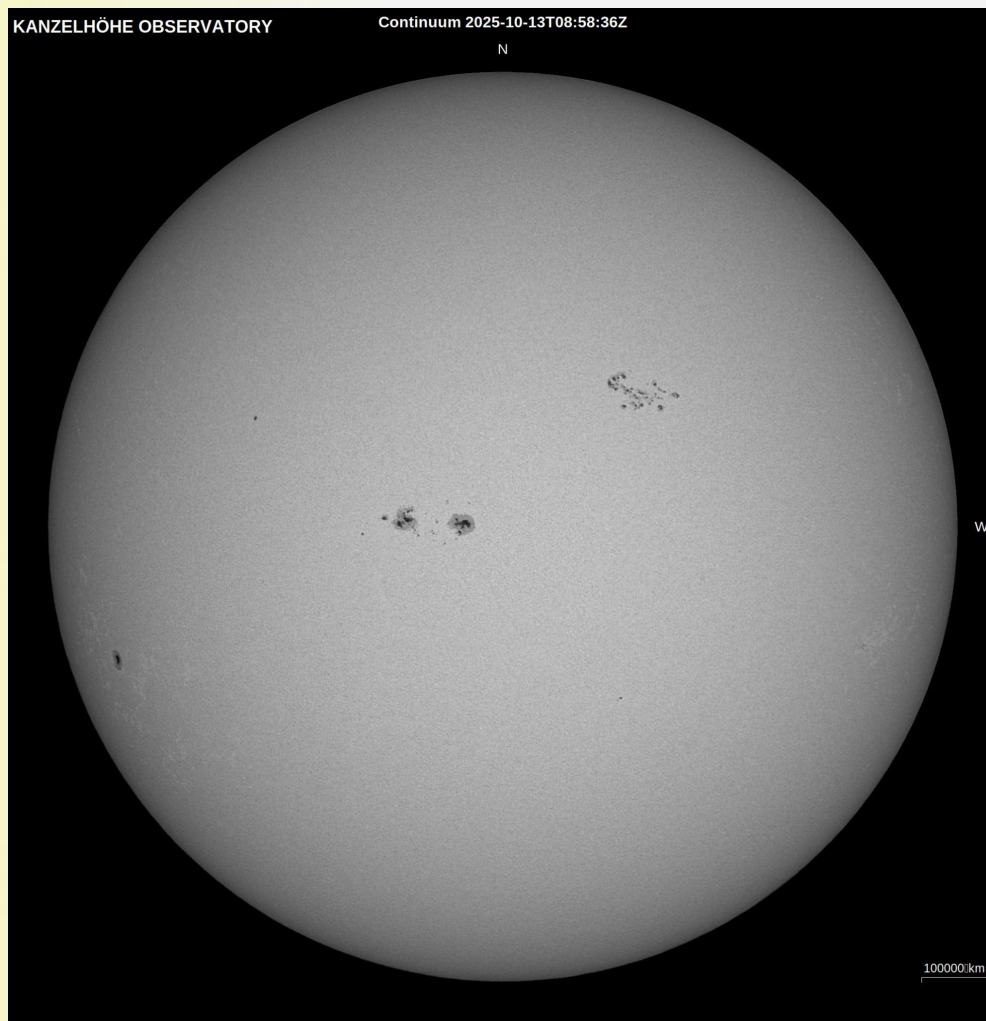
Наземни наблюдения на Слънцето



U. Dittler
<https://www.astroshope.eu/>

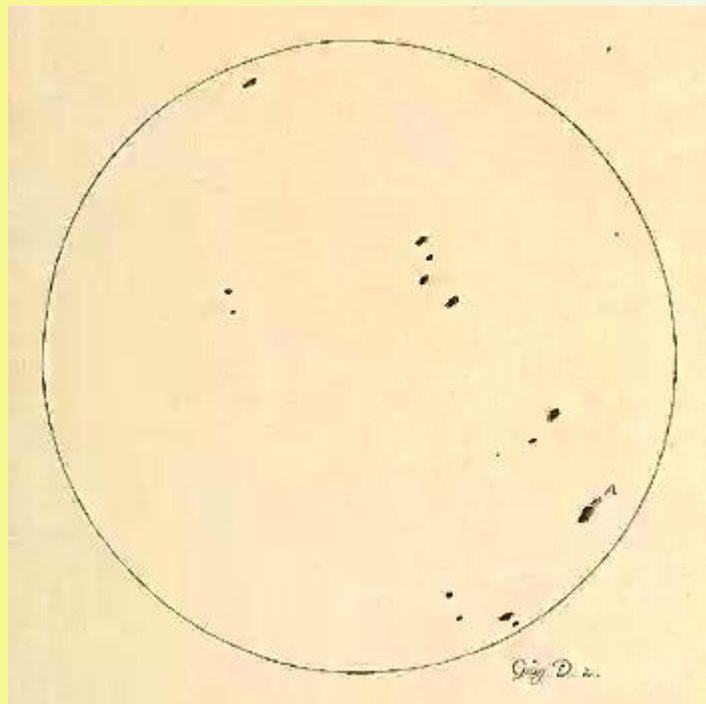
БГ-мрежа за наблюдения на
Слънцето

Бяла светлина

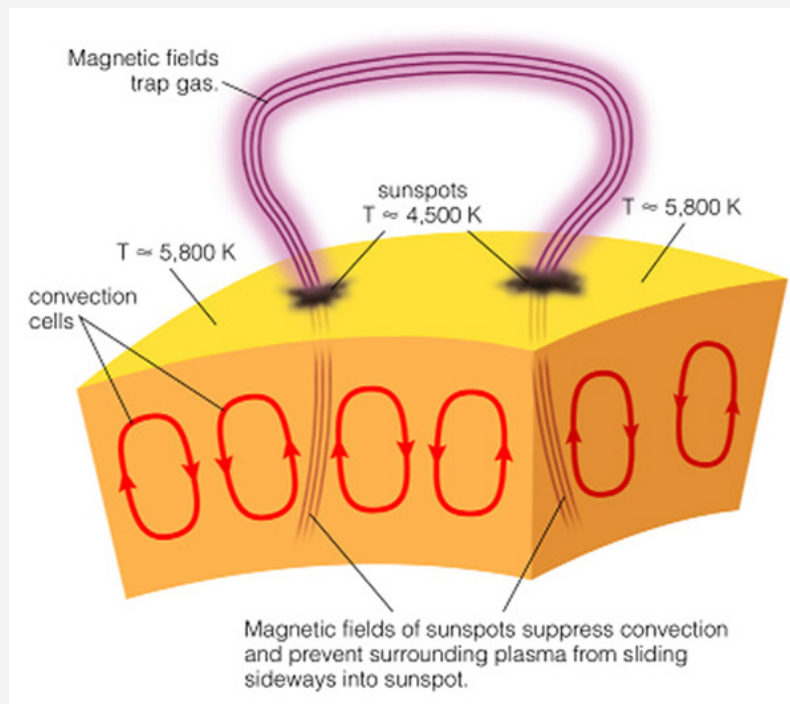


<https://cesar.kso.ac.at/synoptic/con-days.php?year=2025>

Слънчева активност: петна



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



<http://astronomy.nmsu.edu/>

БГ-мрежа за наблюдения на
Слънцето

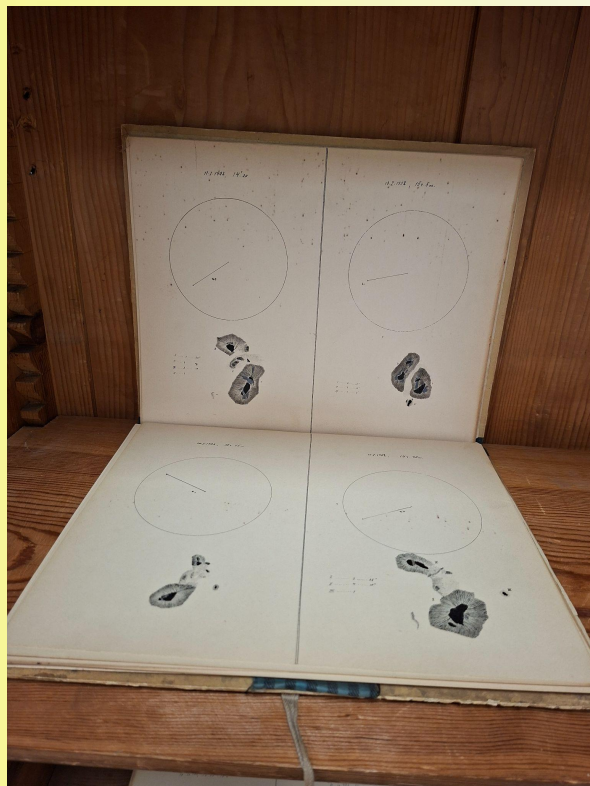
Слънчева активност: петна



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

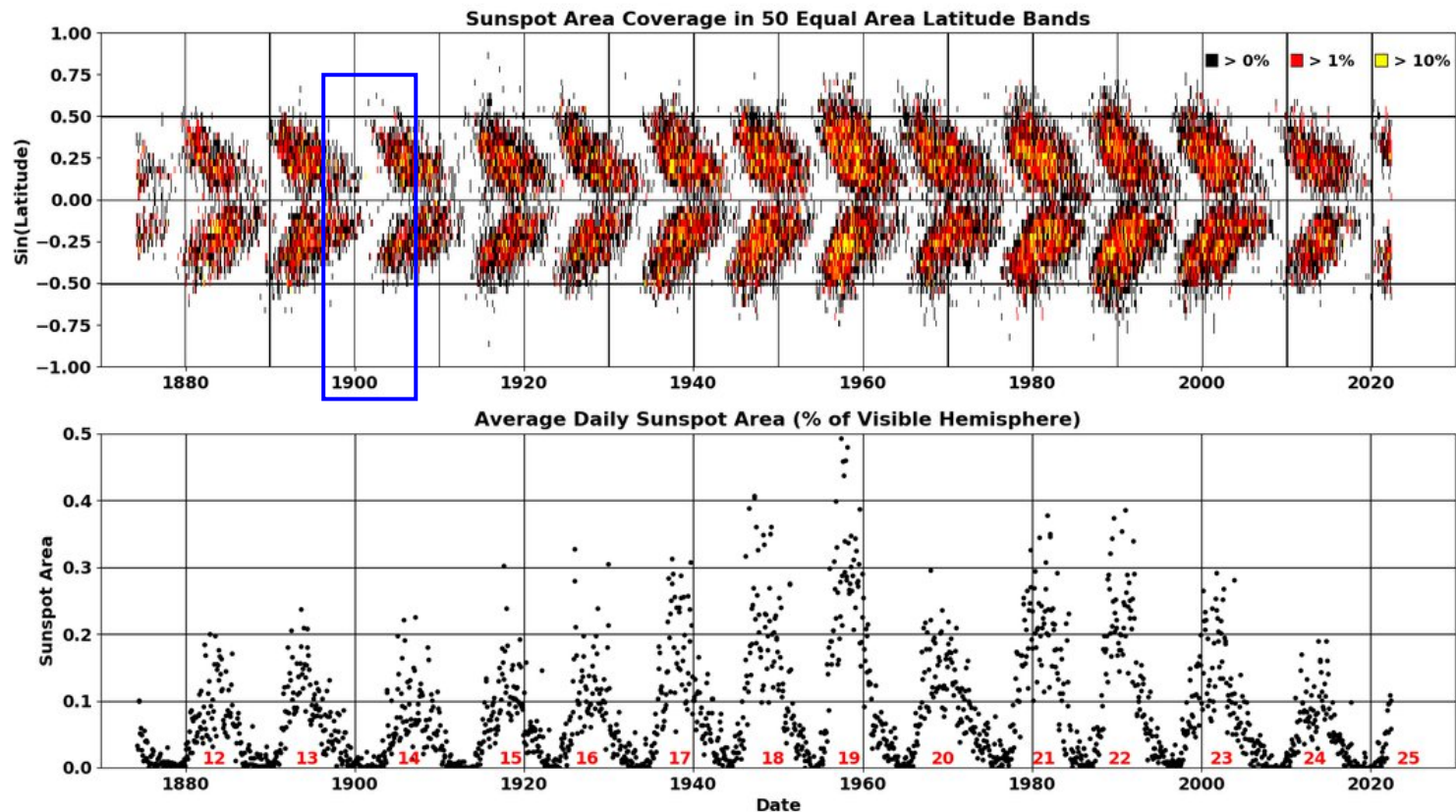


Слънчева активност: петна



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

Слънчев цикъл



Линия Ha

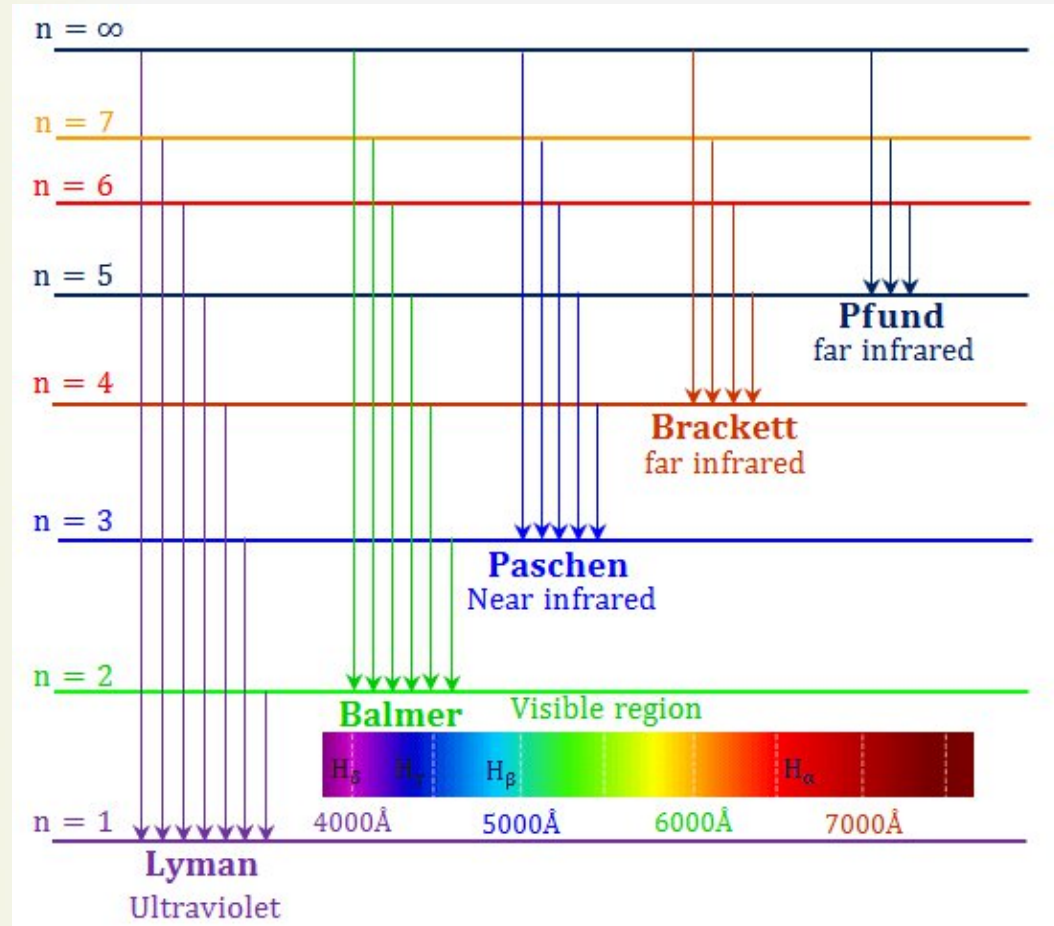
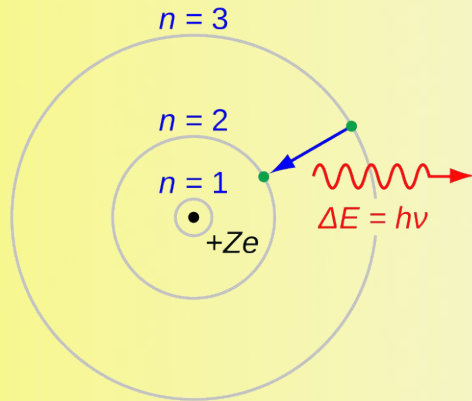
В модела на Бор за атома:

$n \geq 3 \rightarrow n=2$

- **Balmer- α /H α :** $n=3 \rightarrow n=2$ (656.28 nm)
- **Balmer- β /H β :** $n=4 \rightarrow n=2$
- **Balmer- γ /H γ :** $n=5 \rightarrow n=2$

$n \geq 2 \rightarrow n=1$

- **Lyman- α /Ly- α :** $n=2 \rightarrow n=1$



Линия Ha

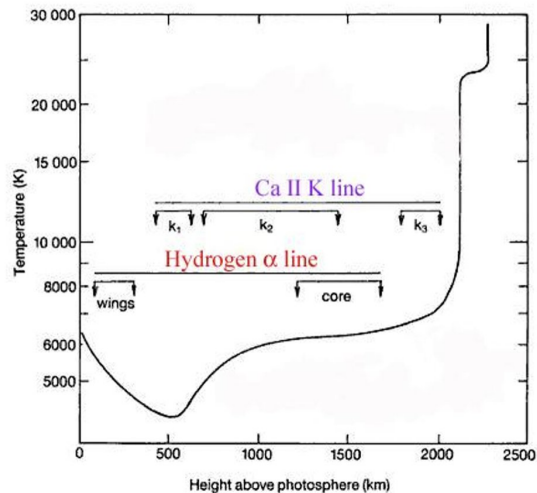
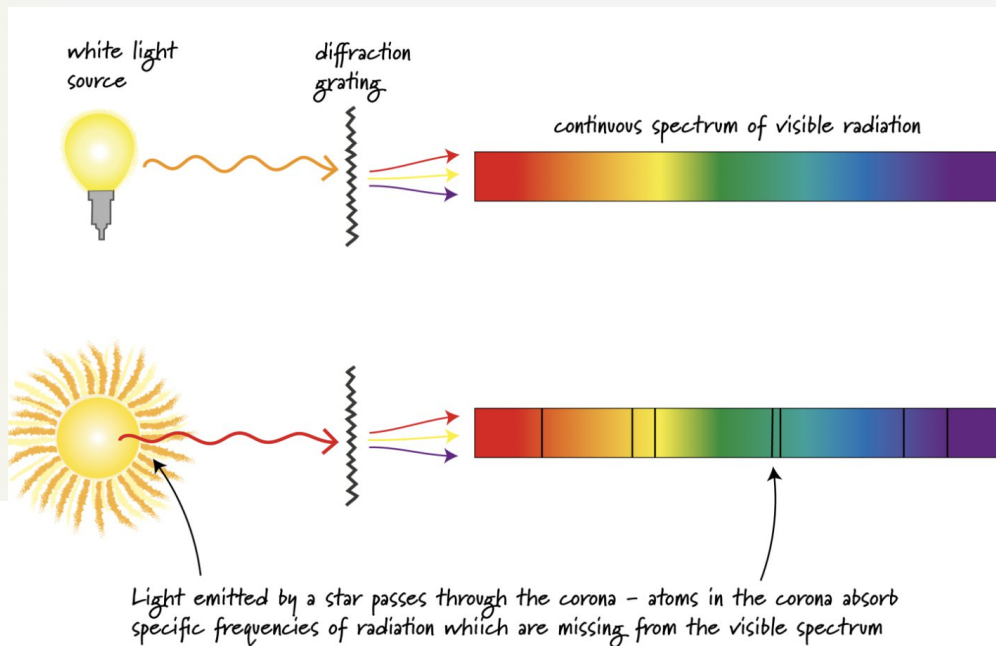


Figure 1. Graph showing the height above the photosphere of the Ca II K and hydrogen alpha line. Graph made from data gathered by (Vernazza et al. 1981).

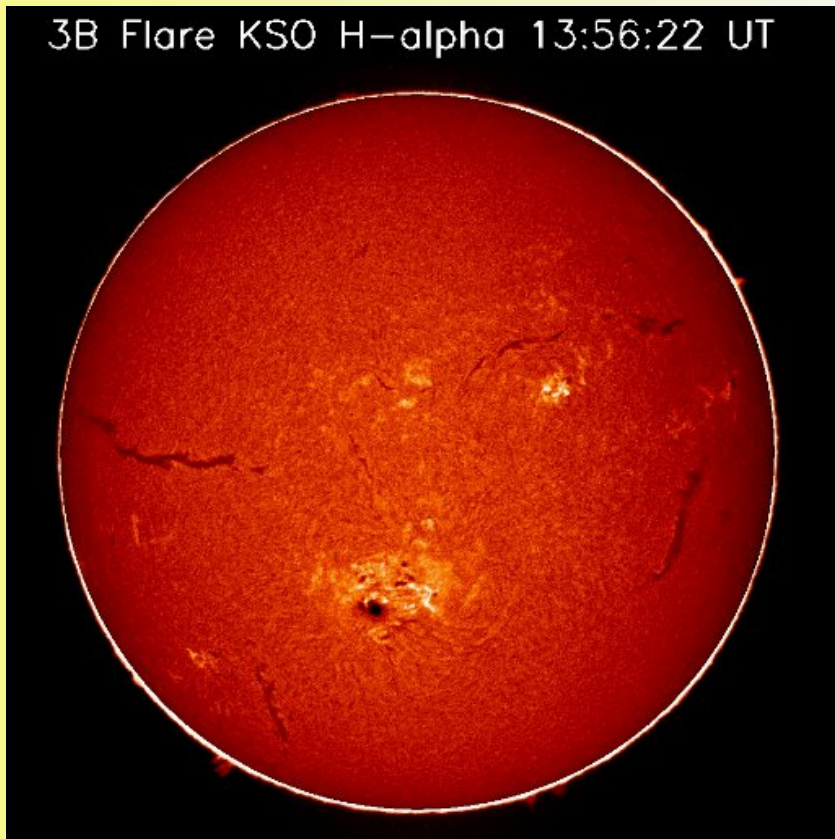


<https://www.briec.store/>

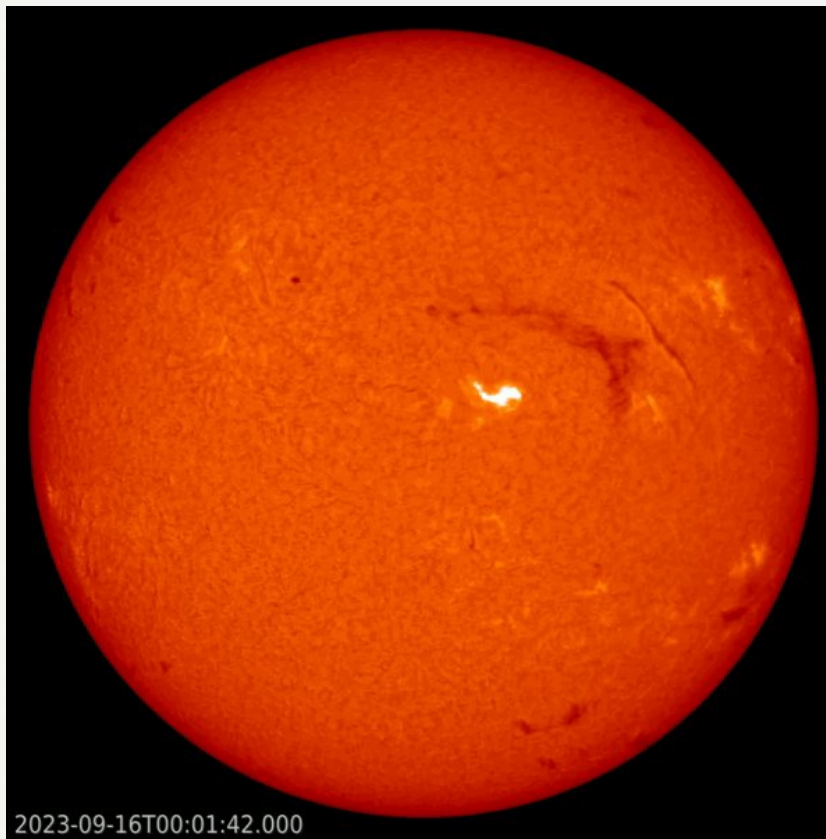
<https://www.ngdc.noaa.gov/stp/space-weather/solar-data/solar-imagery/chromosphere/calcium/meudon/documentation/Observing%20in%20Ca%20II%20K.pdf>

Слънчева активност: протуберанси/филаменти

3B Flare KSO H-alpha 13:56:22 UT



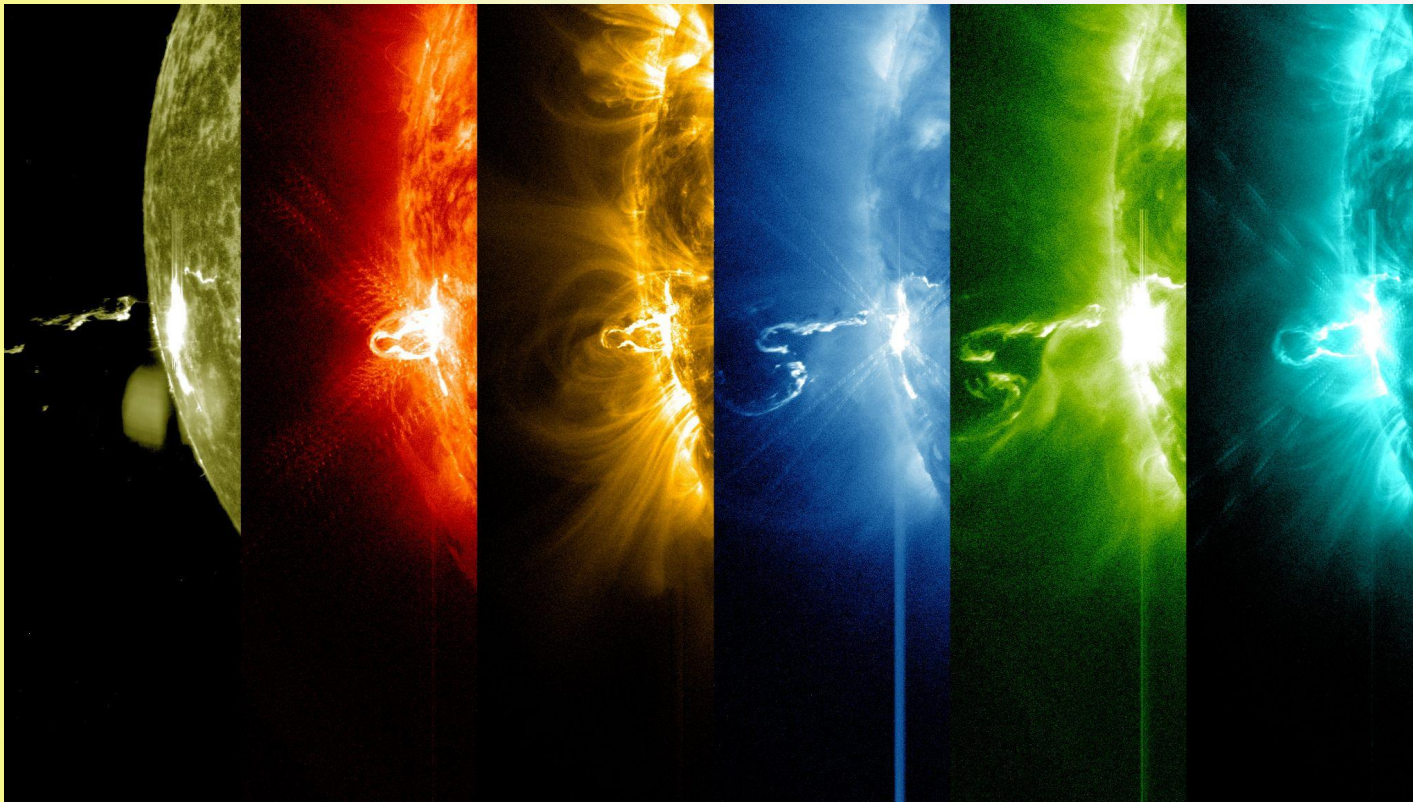
https://www.kso.ac.at/downloads/sonnenaufnahmen_en.php



2023-09-16T00:01:42.000

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

Слънчева активност: избухвания



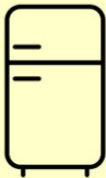
Classification	Peak flux range (W/m ²)
A	$< 10^{-7}$
B	$10^{-7} - 10^{-6}$
C	$10^{-6} - 10^{-5}$
M	$10^{-5} - 10^{-4}$
X	$> 10^{-4}$

Слънчева активност: избухвания

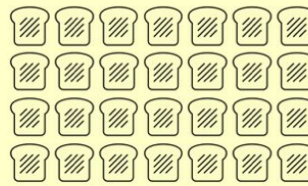
What can you
do with a
kilowatt hour?



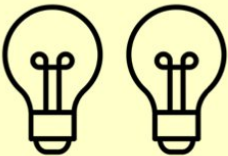
power a home for
50 minutes
(USA average)



run a modern fridge for
20 hours



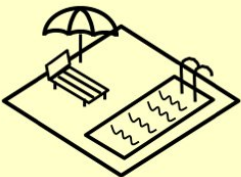
toast
89
slices of bread



power two 60 watt bulbs for
8.3 hours
nonstop



drive an electric car
3.6 miles



run a home pool pump for
2.8 hours
nonstop



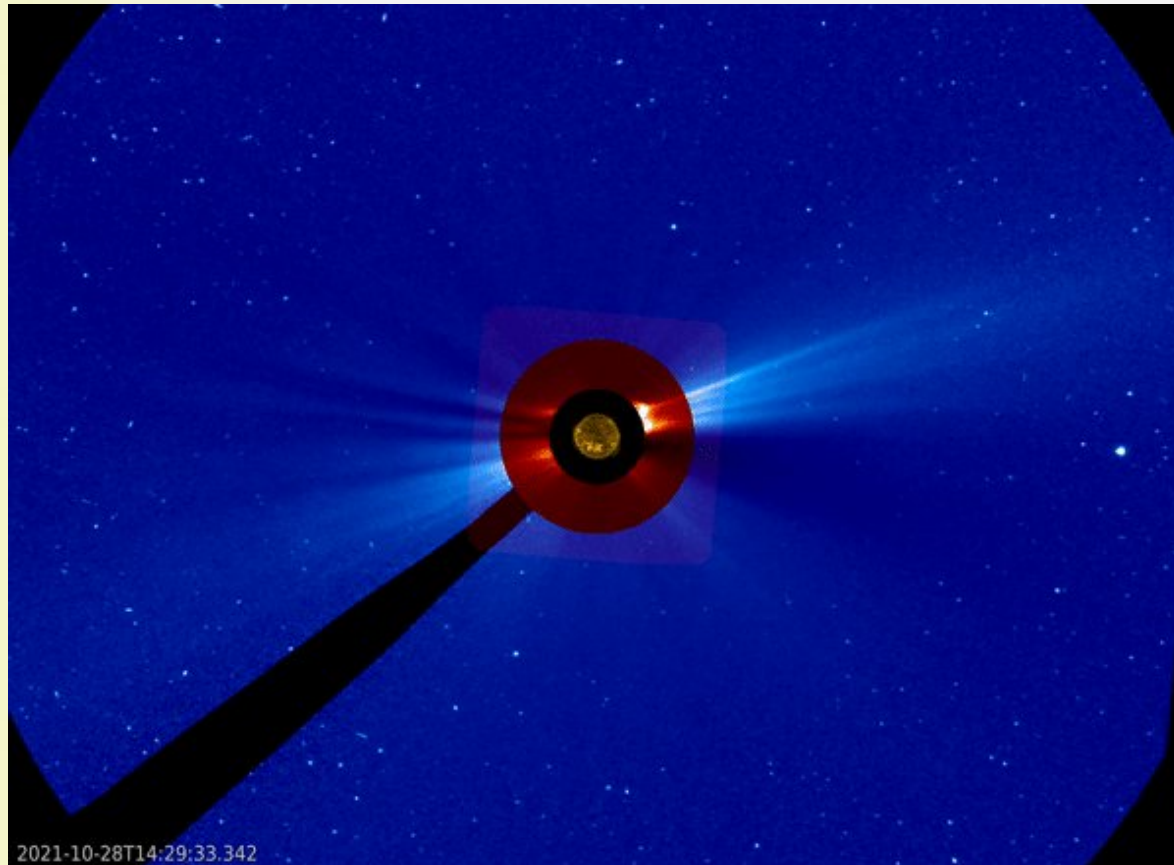
brew
12
pots of coffee

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	$> 10^{-4}$

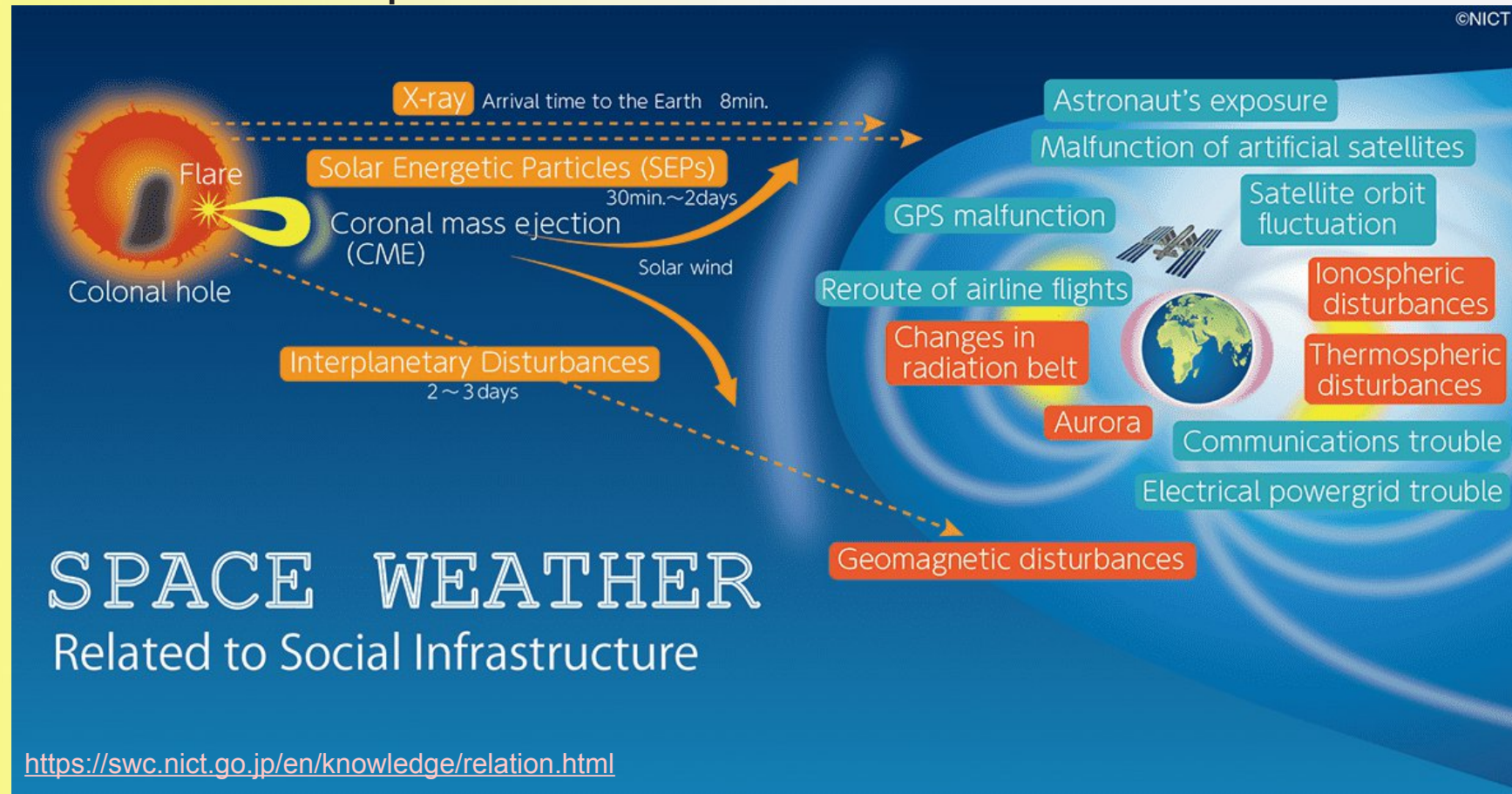
Най-мощното
регистрирано
избухване:
2003-11-04
~X40±5

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

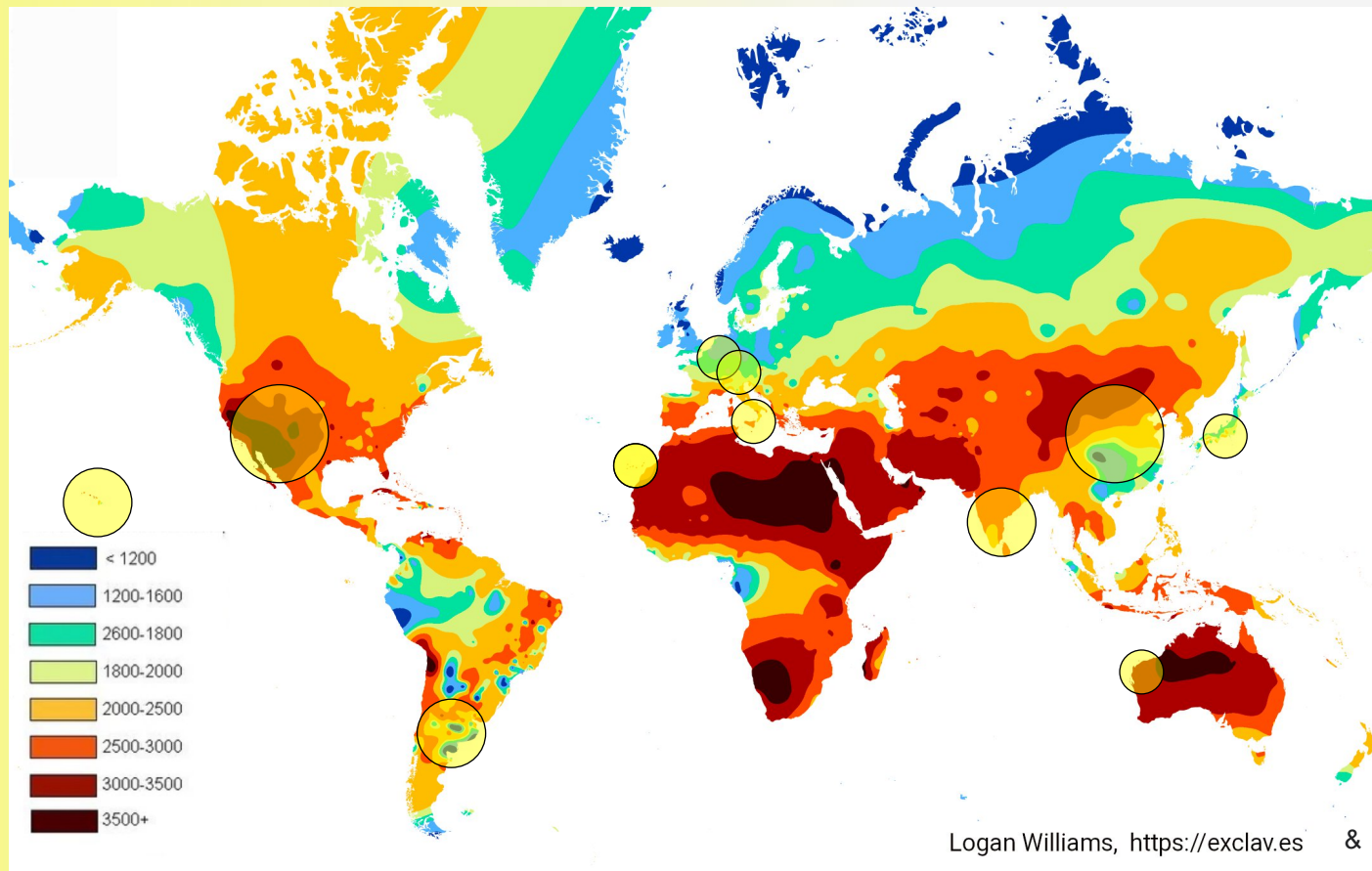
Слънчева активност: коронална маса



Космическо време



Наземни станции



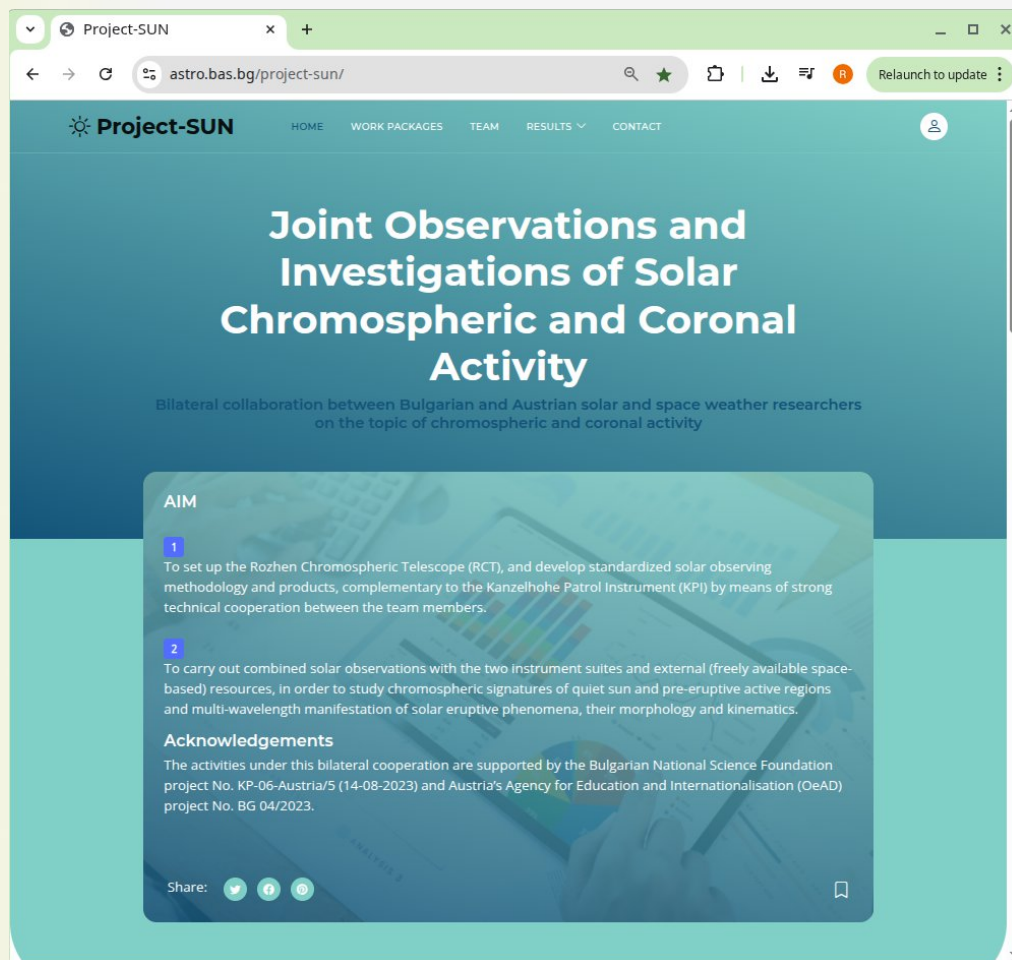
Първоначална идея

Научен проект за двустранно
сътрудничество с Австрия (2023-
2025) и Обсерваторията
Канцелхое

https://www.kso.ac.at/index_en.php

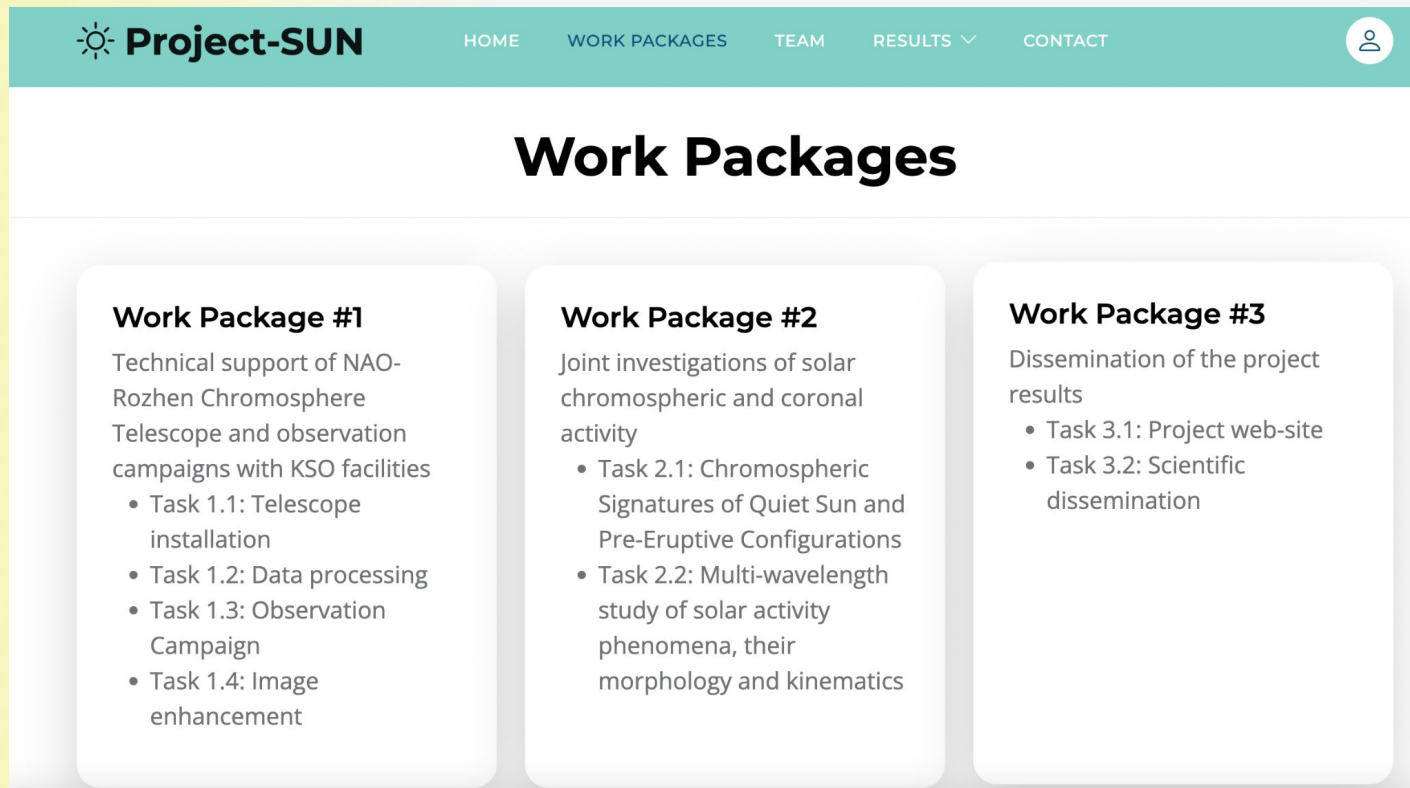
- Сътрудничество
- Научни наблюдения от
НАО-Рожен
- Научни изследвания
- Изграждане на апаратура

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



Тайно оръжие

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



The screenshot displays the 'Project-SUN' website. The header is teal with a sun icon and the text 'Project-SUN'. Navigation links include 'HOME', 'WORK PACKAGES', 'TEAM', 'RESULTS' (with a dropdown arrow), and 'CONTACT'. A user profile icon is in the top right. The main content area is white and titled 'Work Packages'. It features three white boxes with rounded corners, each containing a work package description and a list of tasks.

Project-SUN

HOME WORK PACKAGES TEAM RESULTS CONTACT

Work Packages

Work Package #1

Technical support of NAO-Rozhen Chromosphere Telescope and observation campaigns with KSO facilities

- Task 1.1: Telescope installation
- Task 1.2: Data processing
- Task 1.3: Observation Campaign
- Task 1.4: Image enhancement

Work Package #2

Joint investigations of solar chromospheric and coronal activity

- Task 2.1: Chromospheric Signatures of Quiet Sun and Pre-Eruptive Configurations
- Task 2.2: Multi-wavelength study of solar activity phenomena, their morphology and kinematics

Work Package #3

Dissemination of the project results

- Task 3.1: Project web-site
- Task 3.2: Scientific dissemination

Астрономическа обсерватория - Белоградчик



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

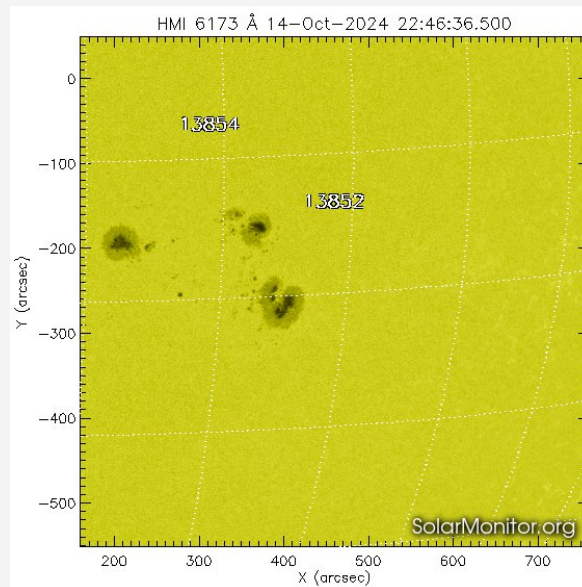
Energy rejection филтър E-325F90 на
DayStar, $D = 90 \text{ mm}$, монтиран off-axis пред
телескопа

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

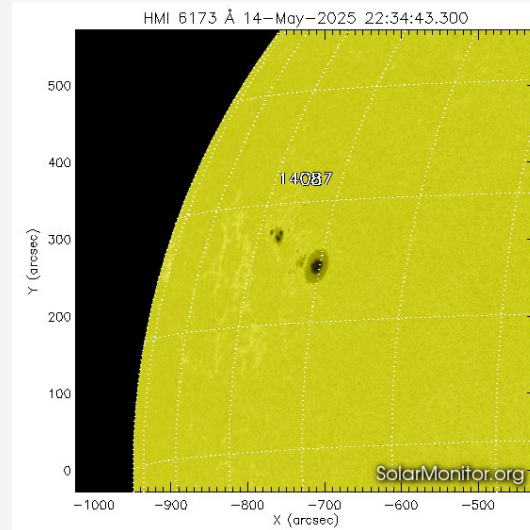
Слънчеви петна в бяла светлина: 2024-10-14



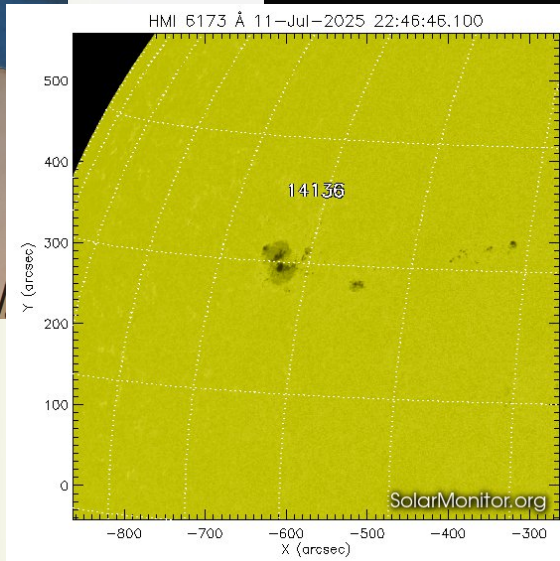
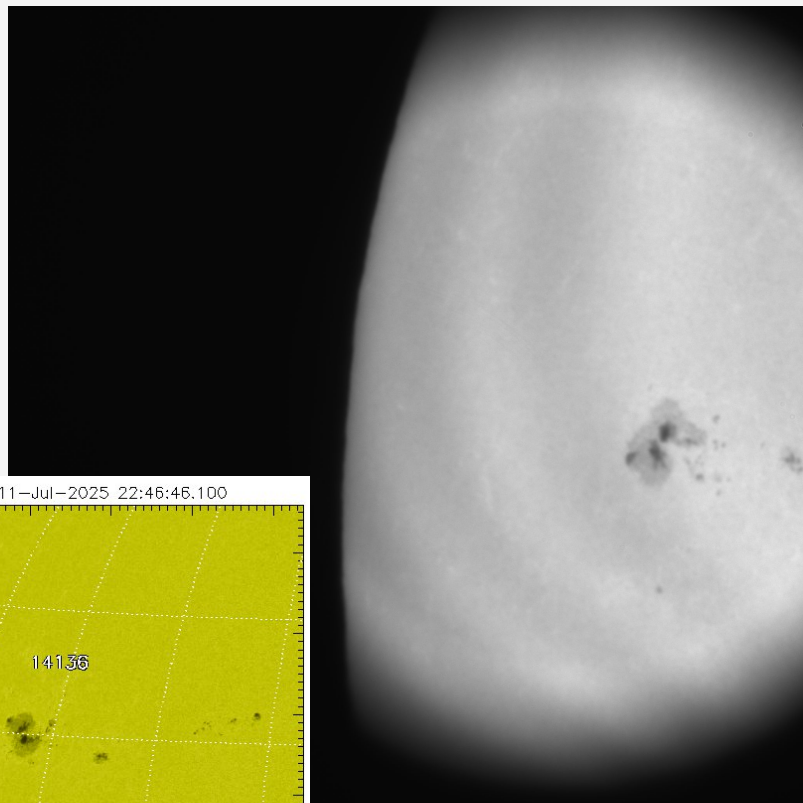
Наблюдение на слънчеви
петна:
бяла светлина (10:47 UT, 14
ms) с метализирано филио на
Baader - 70 mm



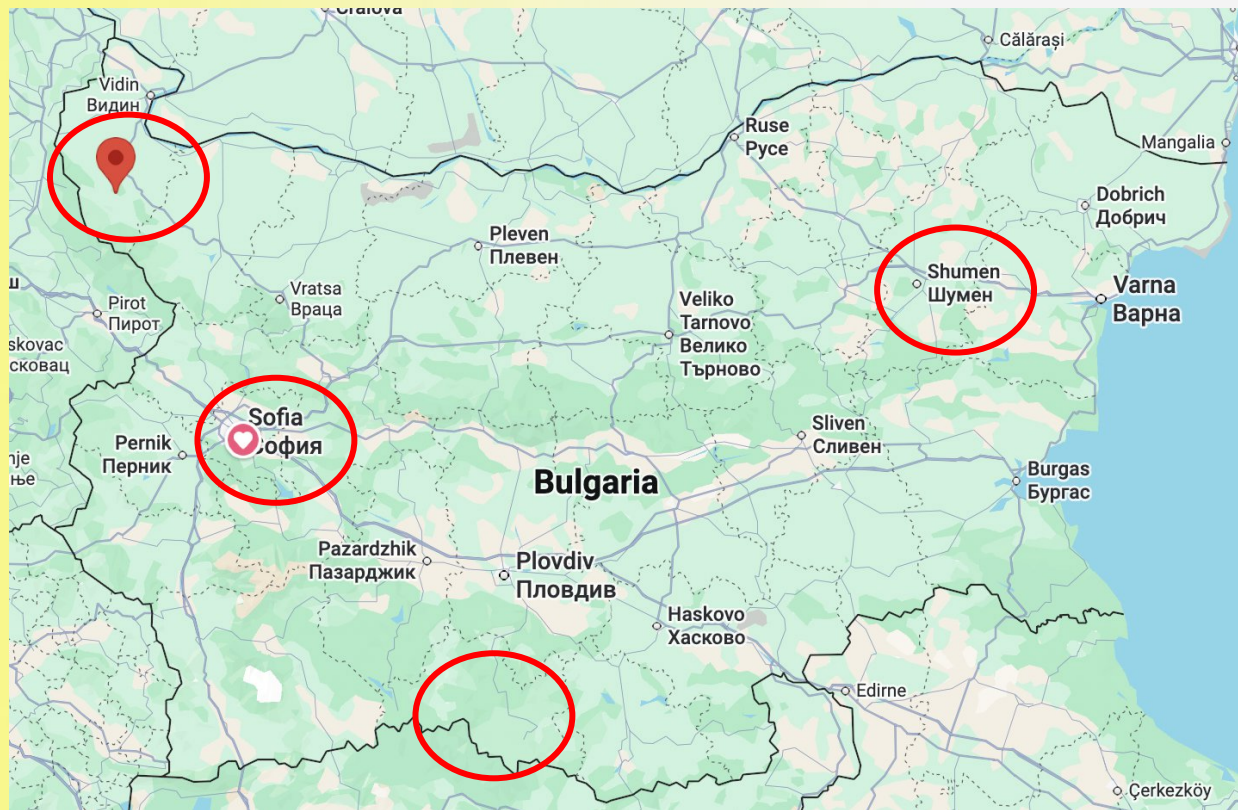
Слънчево избухване в H α : 2025-05-14



Наблюдения от Белоградчик



3 наблюдателни станции



Градски условия

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

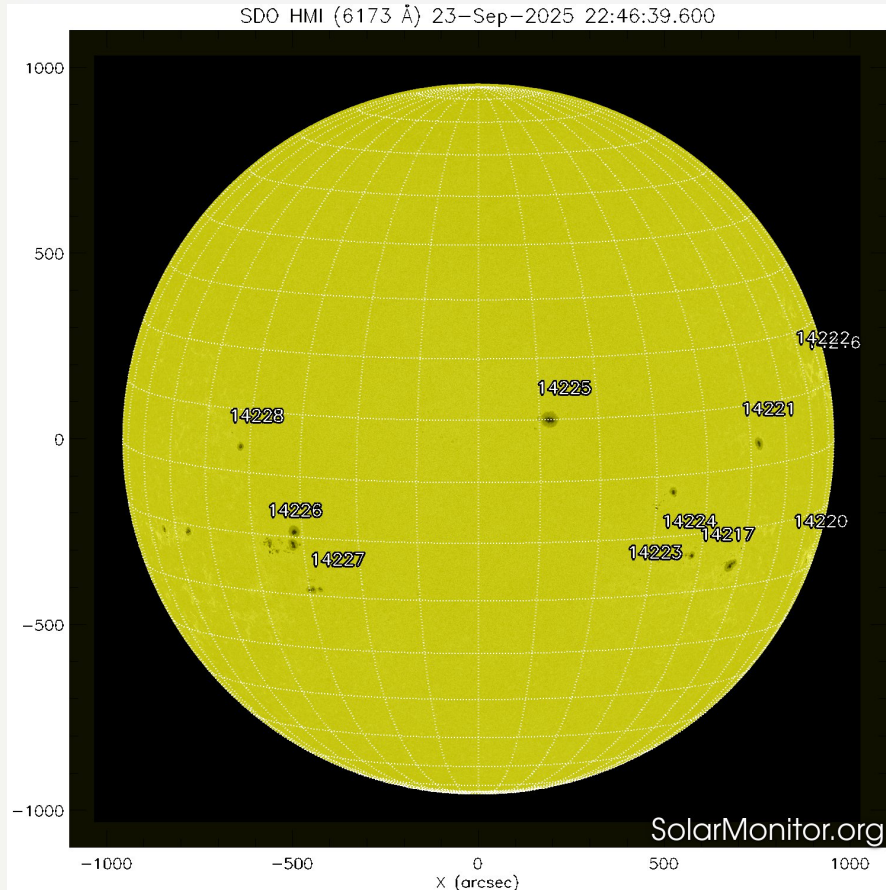
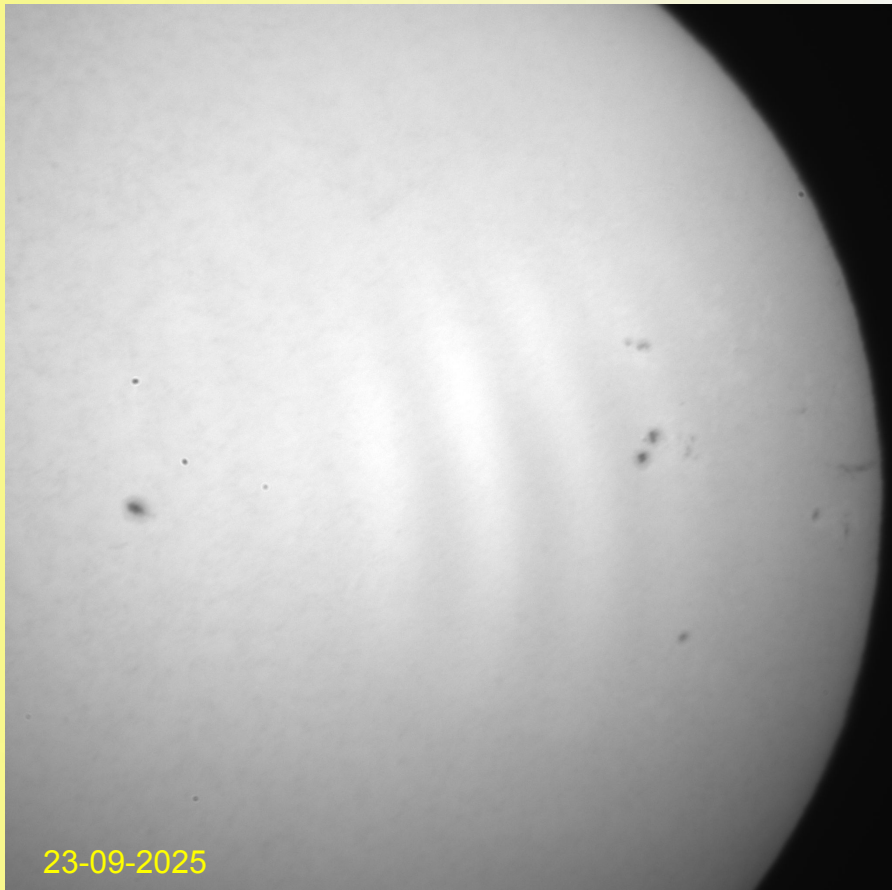
VI. Смолян?
любители-
астрономи?

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



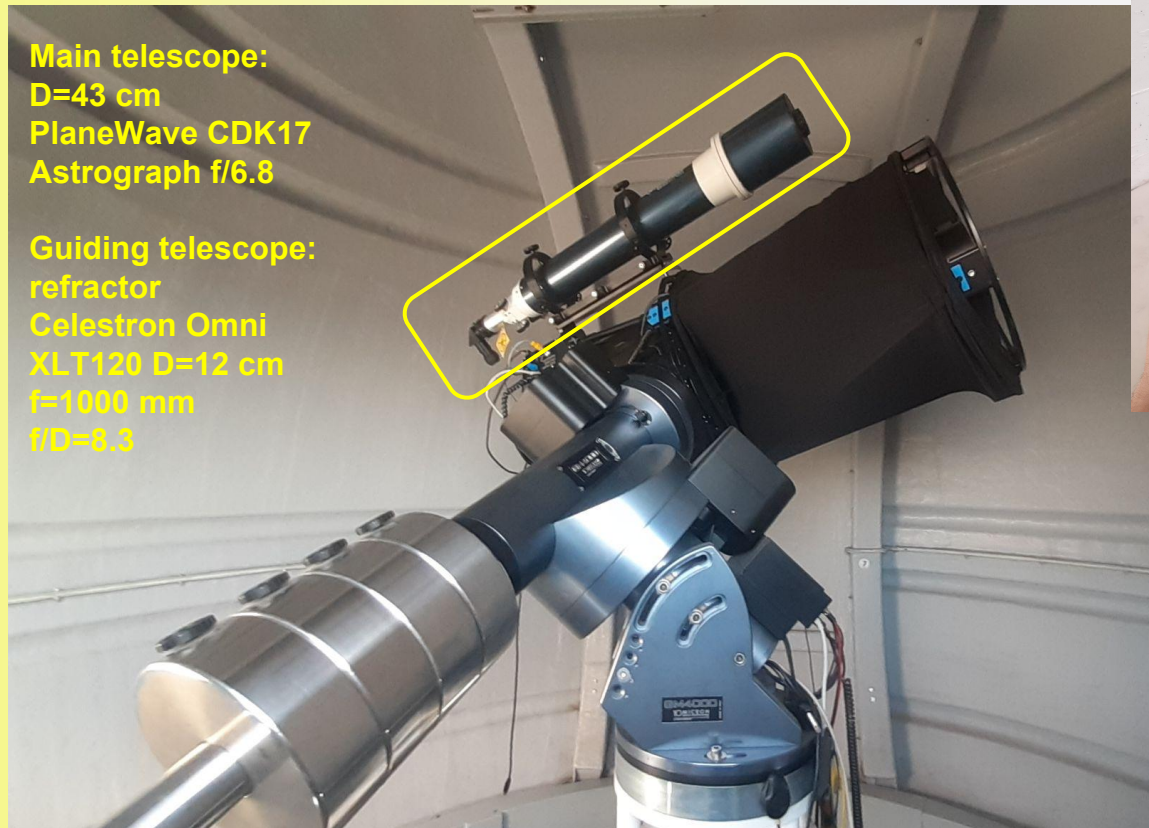
Наблюдения от Шумен



Обсерватория към частно училище “Св. Георги” - София

Main telescope:
D=43 cm
PlaneWave CDK17
Astrograph f/6.8

Guiding telescope:
refractor
Celestron Omni
XLT120 D=12 cm
f=1000 mm
f/D=8.3

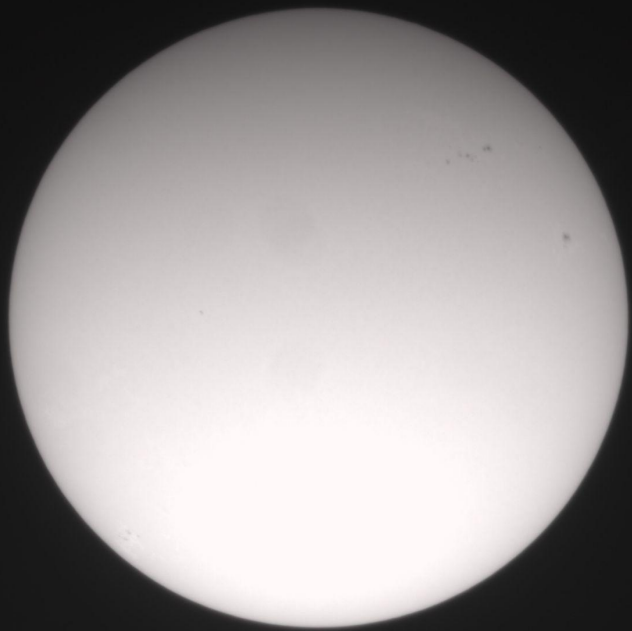


БГ-мрежа за наблюдения на
Слънцето

Наблюдения от София

2025-06-04

поляризационен филтър



Нови станции



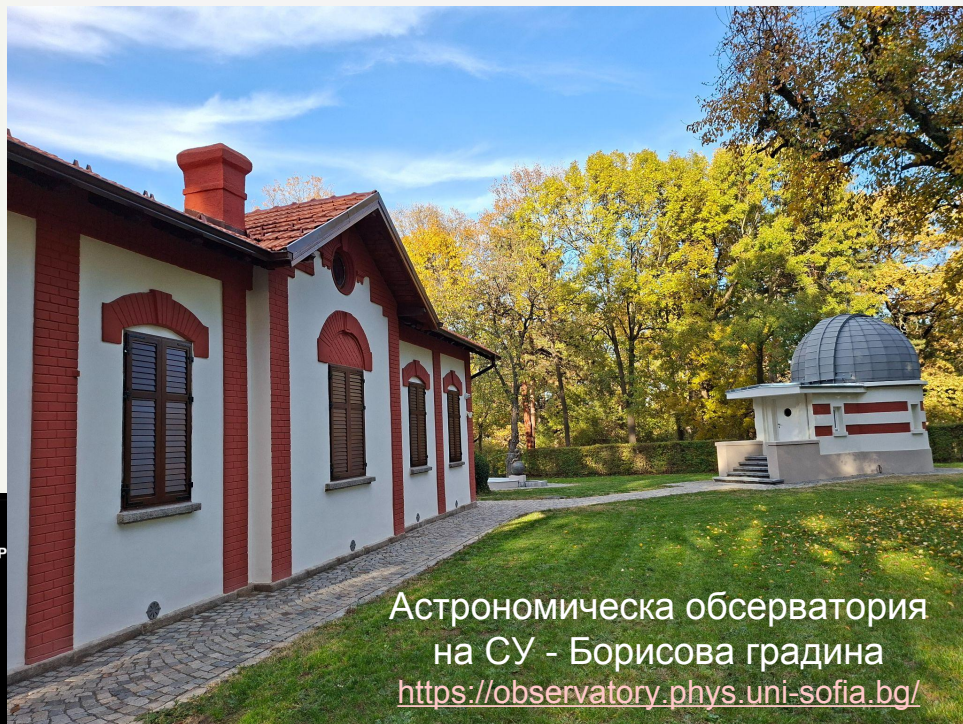
НАЧАЛО ЗА НАС ▾ ПОСЕЩЕНИЯ ▾ НАШИТЕ ПР

<https://planetarium-sm.org/bg>

ПОДГОТВЕТЕ СЕ ЗА

КОСМИЧЕСКО ПРЕЖИВЯВАНЕ

с технологии от ново поколение



Астрономическа обсерватория
на СУ - Борисова градина
<https://observatory.phys.uni-sofia.bg/>

- Научни задачи
слънчеви петна
филаменти
избухвания в $H\alpha$

- Обучение
студенти и докторанти (СУ, ШУ)

- Популяризация
Наблюдения

Изграждане на база данни -
отворена наука!

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

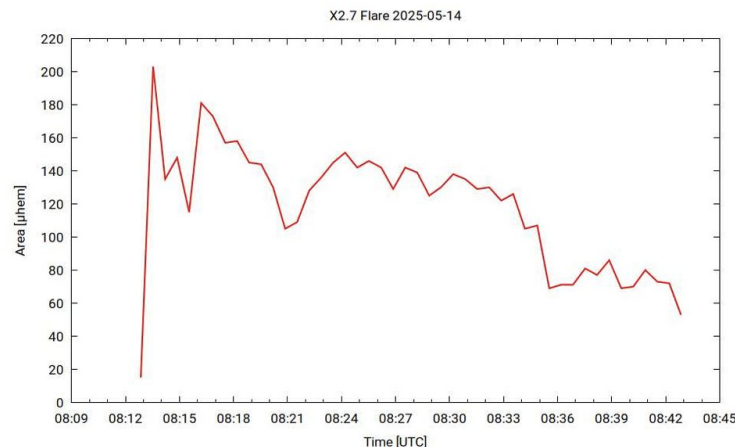


Fig. 8. The area of the optical flare in $H\alpha$ observed on 2025-05-14 at AO-Belogradchik. The area is given in millionths of the solar hemisphere, the time axis is only an approximation as the exact time information was not stored.

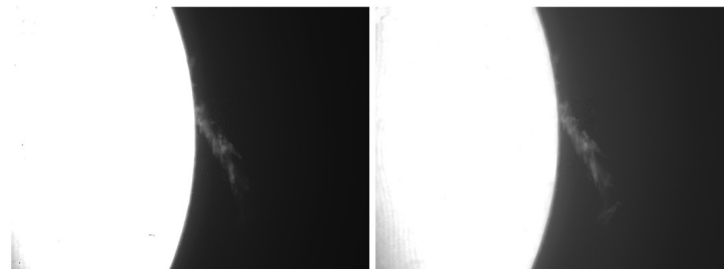


Fig. 4. $H\alpha$ images of a prominence in a close succession, observed from AO-Belogradchik on 2024-10-14 at 08:38 UT (exposure time 42 ms each).

Сътрудничество с радио наблюдения в България LOFAR-BG

<https://lofar.bg/>



- Ядро
- Отдалечени станции
- Международни станции

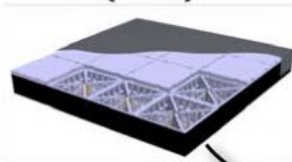
Нискочестотна антена
Low Band Antenna (LBA)
30-80 MHz

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

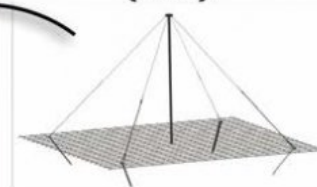
<https://science.astron.nl/>



**High-Band Antenna
(HBA)**

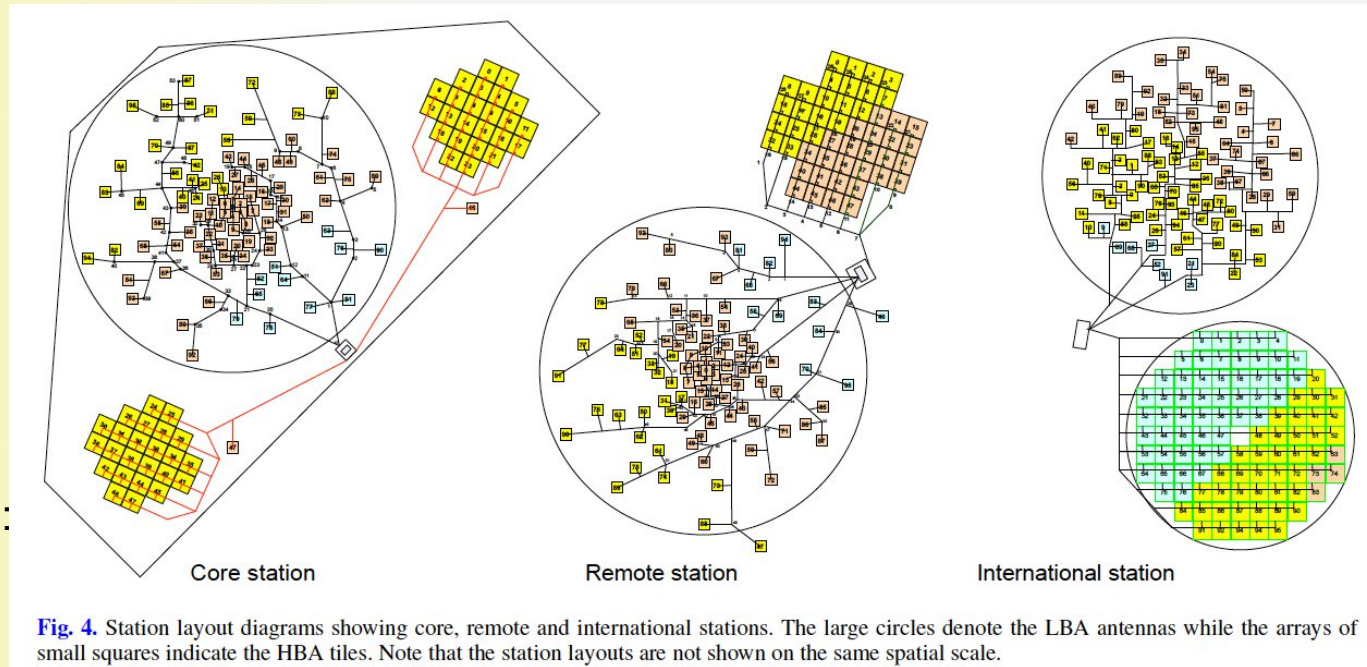


**Low-Band Antenna
(LBA)**



Международна станция: LOFAR-BG

<https://lofar.bg/>



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“

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



<https://lofar.bg/>

в близост до НАО-Рожен
2024/2025

Екип

ИАНАО-БАН

Р. Митева
П. Маркишки
М. Дечев
К. Козарев
Г. Латев



ШУ

Д. Марчев
С. Петров



Св. Георги - София

Х. Киров



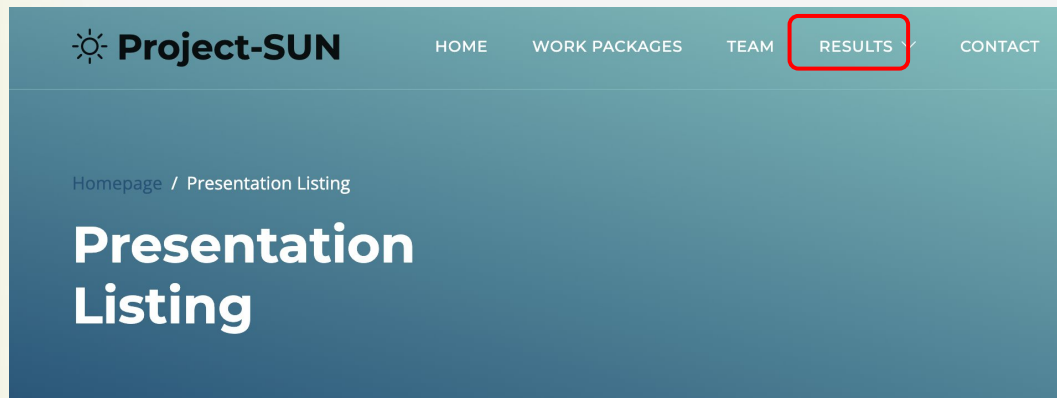
със съдействието на:
Werner Pötzi (Австрия)



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 JOURNEY AROUND THE SUN



Close approaches to the Sun

Feb 2021 - within 0.5 au*
Oct 2022 - within 0.3 au

Launch
9 February 2020 (EST)
10 February 2020 (GMT)

Earth gravity
assist manoeuvre
26 Nov 2021

First polar pass > 17° latitude
Mar 2025

First polar pass > 24° latitude
Jan 2027

First polar pass > 30° latitude
Apr 2028

Polar pass > 33° latitude
July 2029

Venus gravity
assist manoeuvre
26 Dec 2020
08 Aug 2021
03 Sep 2022
18 Feb 2025
24 Dec 2026
17 Mar 2028
10 Jun 2029
02 Sep 2030

300 million km

Maximum distance between
Earth and Solar Orbiter

16.5 min

Maximum time for a radio signal
to travel one way between Earth
and Solar Orbiter

22 orbits

around the Sun

Nov 2021

Start of main mission

Dec 2026

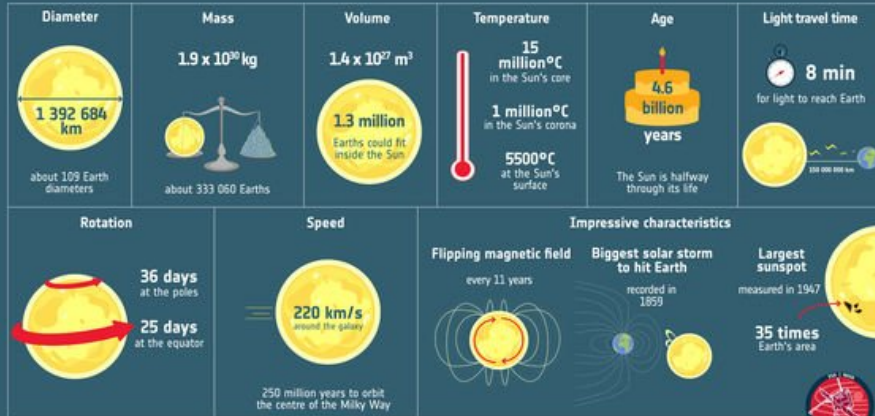
Expected start of extended
mission

*1 au = average distance between Sun and Earth (149 597 870 700 m)



#SolarOrbiter #WeAreAllSolarOrbiters

MEET THE SUN



#SolarOrbiter #WeAreAllSolarOrbiters

**Solar Orbiter
>2020**

<https://www.esa.int/>

2022-03-26 @ 0.32 AU

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