SOLAR OBSERVATIONS IN BULGARIA AND COLLABORATIONS IN SPACE WEATHER RESEARCH

MOMCHIL DECHEV (1)
ROSITSA MITEVA (1)
PENCHO MARKISHKI (1)
GEORGI LATEV (1)
SUSAN W. SAMWEL (2)

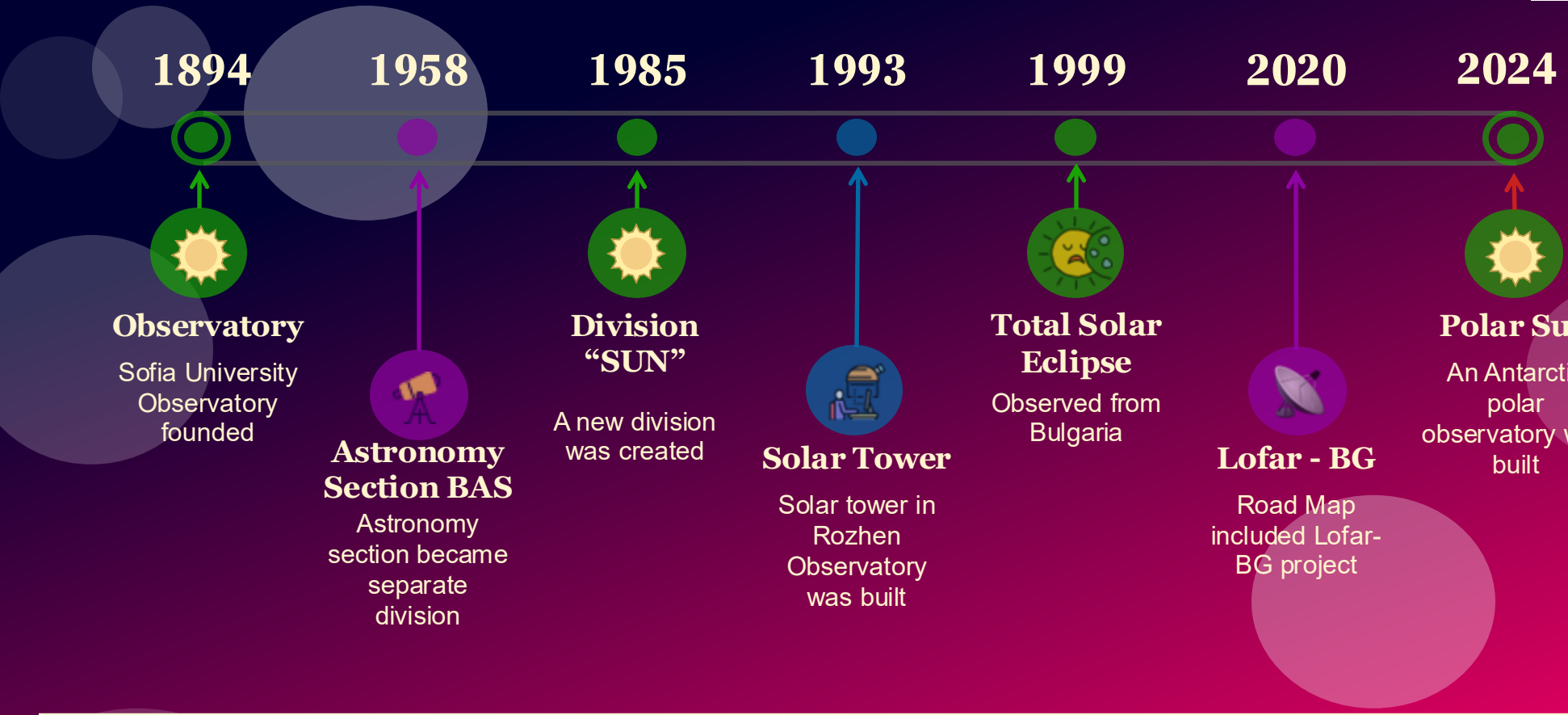
(1) Institute of Astronomy and NAO, BAS, Bulgaria
(2) National Research Institute of Astronomy and Geophysics, (NRIAG), Egypt

ACAG9 October 13–16, 2025 · Helwan, Cairo, Egypt (NRIAG)

Outline

1. Introduction & Historical Context
2. Core Research Domains
3. International Collaborations & Projects
4. Observational Infrastructure
5. Recent Observational Results
6. Future Directions & Major Initiatives

Very Brief History



Domains of Research

Solar Activity

- New indirect index of the solar activity
- Activity of the solar prominences
- Distribution and large-scale motions of the solar filaments
- Flares

Solar Eclipses

- Faint H-alpha emission in the solar corona
- Corona polarization
- Rapid Changes in the Visible Wavelength of the Corona

Space Weather

- Geoeffective active regions
- SEP events
- Geomagnetic storms
- Impact on satellites

Radio Sun

- Radio bursts
- Machine learning, automatic feature recognition

Bulgarian-Egyptian project

On space weather effects At near Earth environment - from remote observations And in situ particle forecasting to impacts on satellites

(finished, 2022-2024)

Work packages

1. SEP events - Estimating the fluences of the different energetic particles; SEP forecasting of selected events; Development, validation and operational application of new SEP forecasting methods

2. **Solar events** - Remote observations and in depth data analysis by performing monitoring the origins of SEP events in optical and radio wavelengths; Data analysis and deduction of physical parameters of the solar eruption

3. Impact on satellites - Qualitative and quantitative evaluation of satellite risks caused by space weather events; Investigating the different effects of hazardous energetic particles on a GEO spacecraft

Publications:

Universe 2023, 9(4), 179 (15pp.)
https://doi.org/10.3390/universe9040179

Astron. Soc. “Rudjer Bošković” No 25, 2023, 125-135
https://astro.bas.bg/conf_proc/book_XIIIBSAC.pdf

Atmosphere, 2023, 14(12)
https://doi.org/10.3390/atmos14121744

Astronomy, 2023, 2(3), 165-179
https://doi.org/10.3390/astronomy2030012

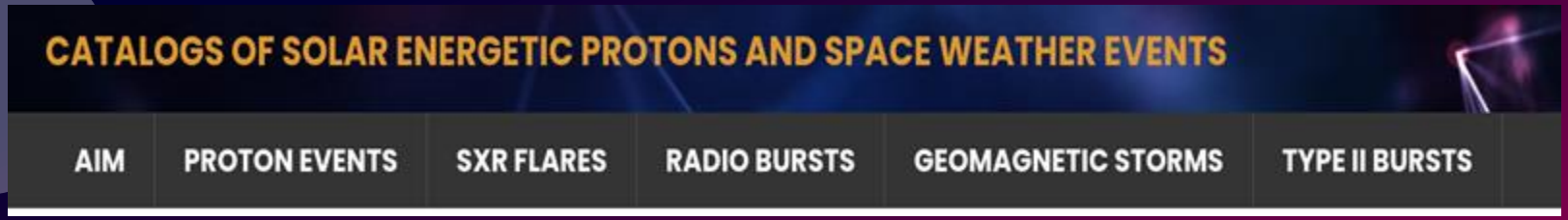
Proceedings SES 2023, 67-70
http://space.bas.bg/SES/archive/SES%202023_DOKLADI/PROCEEDINGS%20SES%202023.pdf

Bulgarian-Serbian project

Active Events on the Sun.Catalogs of Proton Events and Electron Signatures In X-Ray, UV and Radio Diapason.

(2023-2025)

Bg-PI: M. Dechev
Rs-PI: Z. Simic



The Catalog list the proton events from SOHO/ERNE instrument presented separatly in solar cycles SC23 (1996-2008) and SC 24 (2009-2017).

The Catalog utilizes the highest tempporal resolutionas provided, namely 1 min.

Results from the final SEP catalog are available here:

Miteva et al. Atmosphere (2024)
Preliminary results from the catalog are published here:
Miteva et al. SES-Proceedings (2023)
Miteva et al., Bulgarian Astronomical Journal, Vol. 33, pp. 99-108 (2020)

Bulgarian-Austrian project

Joint Observations and Investigations of Solar Chromospheric and Coronal Activity (2023-2025)

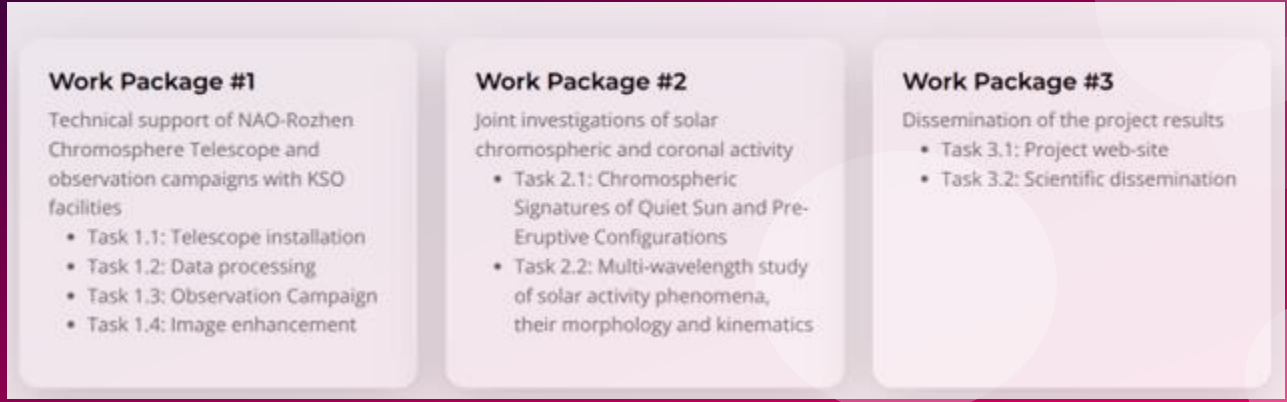
Bg-PI: R. Miteva
At-PI: W. Poetzi

1. Parameter study of geoeffective active regions (completed, 2024)

https://doi.org/10.3390/atmos15080930

2. Confined M-class flares in solar cycles 23&24 (completed, 2025)

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



Bulgarian-Austrian project

Observatory Kanzelhöhe in Austria

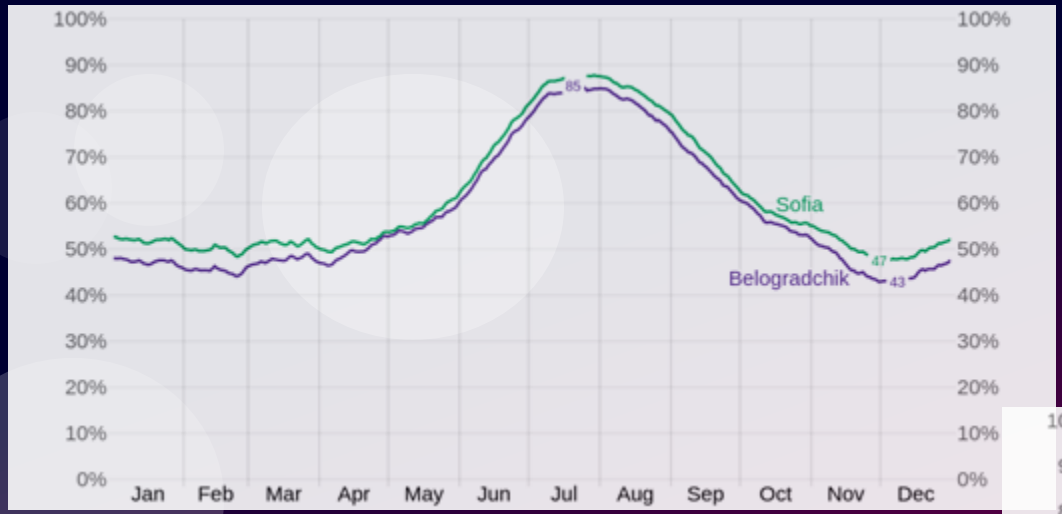
Long tradition in Solar observations (since 1944)

Very experienced staff (scientific and technical)

Long data archive

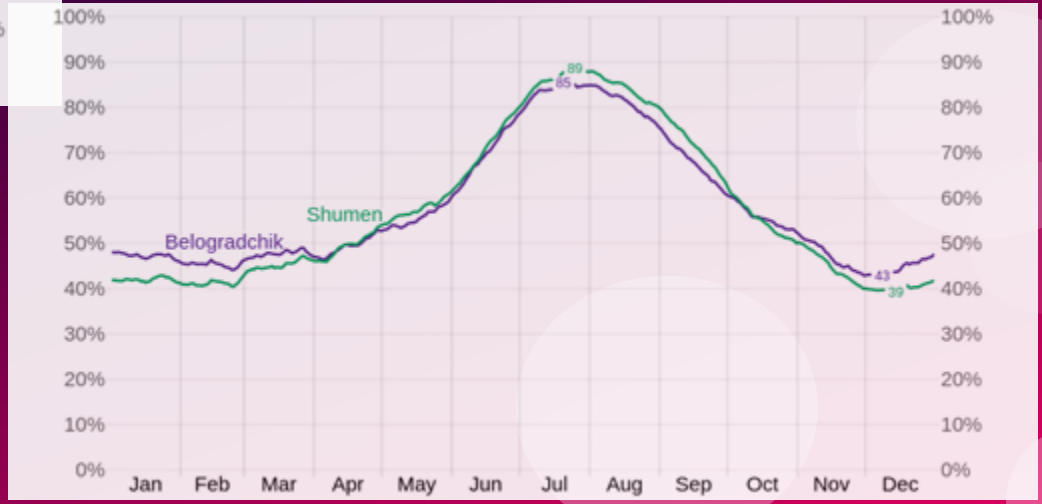
365(6) days per year

Some Weather Considerations



Up to 20% clouds - clear

The clearer part of the year in Belogradchik begins around June 7 and lasts for 3.5 months, ending around September 23.



Instrumentation: Telescope – Belogradchik Observatory

Celestron Schmidt-Cassegrain telescope
SC 279/2800 C11 OTA

Aperture (mm)	279
Focal length (mm)	2800
Aperture ratio (f/d)	10

For filter f/d = 1/30 is needed ⇒

1) enlarge focal length;
2) reduce aperture;

Reduce aperture advantages:
- less heat;
- less light – camera exposure time still very short;
- cheaper optical components;
- f/l for filter is better;
- resolution still largeenough for seeing conditions;

Instrumentation: Filter, Camera – Belogradchik Observatory

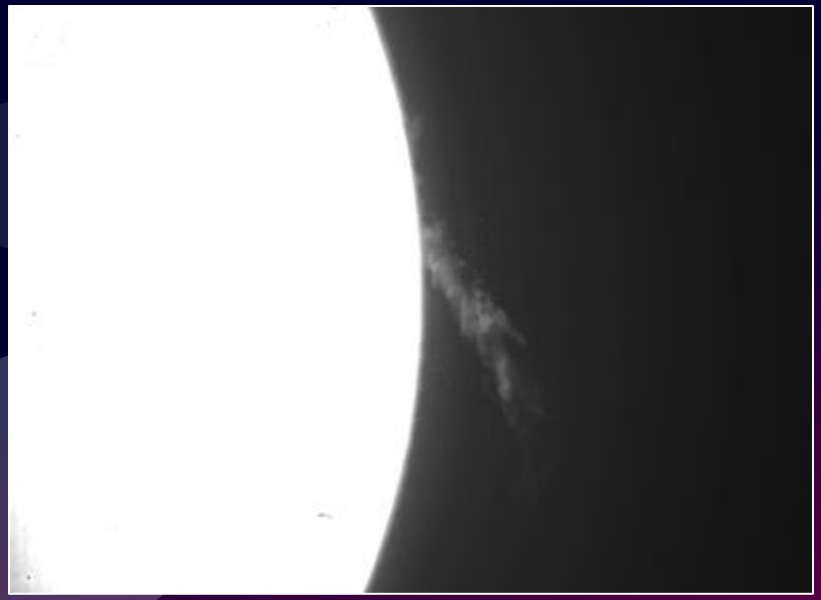
Hydrogen Alpha Quantum 1.25 DayStar

(FWHM) < 0.5Å
filter's wavelength output (accurate to 0.1Å) and red /blue wing shift buttons
Temperature stabilized

Common Vision Spark Series, SP-12401M-USB

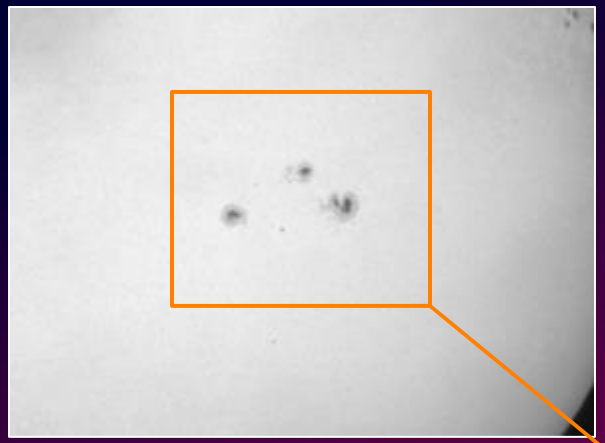
Light Spectrum	Visible + NIR
Resolution	12.4 MP
Resolution WxH	4112 x 3008 px
Frame rate	23 fps

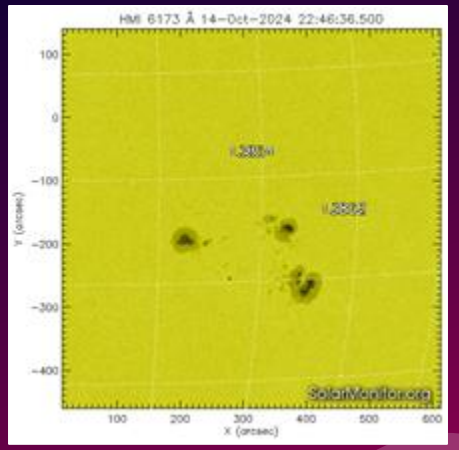
Bulgarian-Austrian project

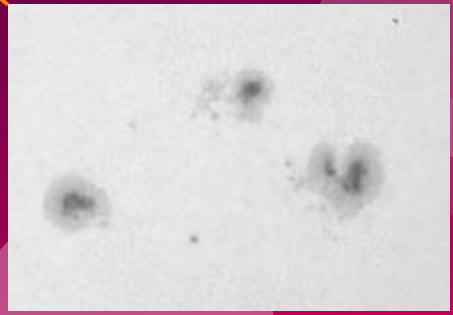


Overexposed image shows prominence at limb. Structures are visible. Relatively good contrast.

First tests – Belogradchik Observatory



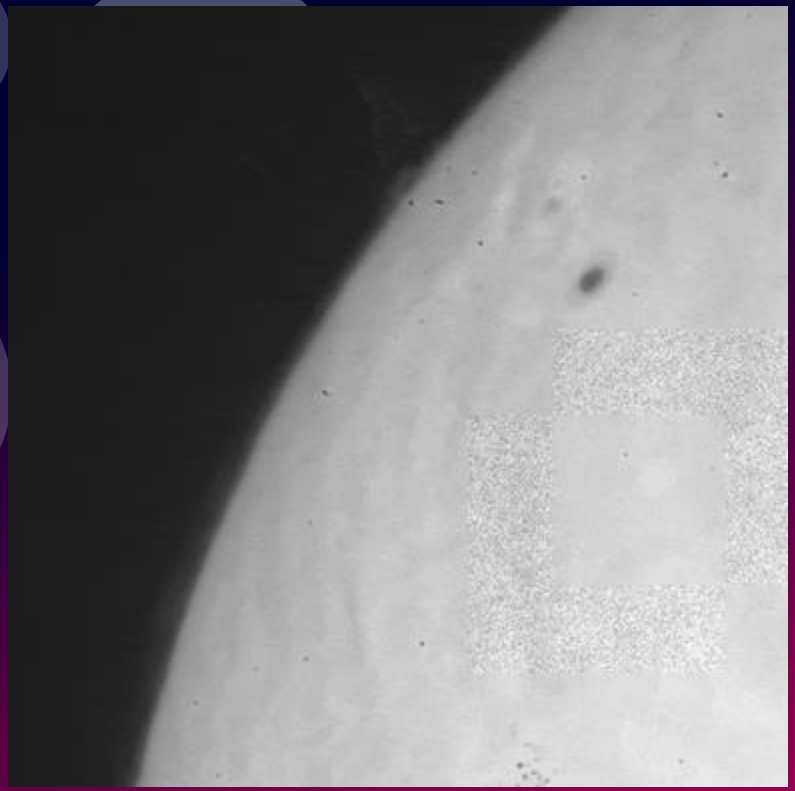




Solar spot group on 2024-10-11 and the same group in Solar Monitor. Resolution is sufficient to resolve details. Seeing conditions were bad (wiggly limb), but umbra and penumbra well separated

2024-10-14

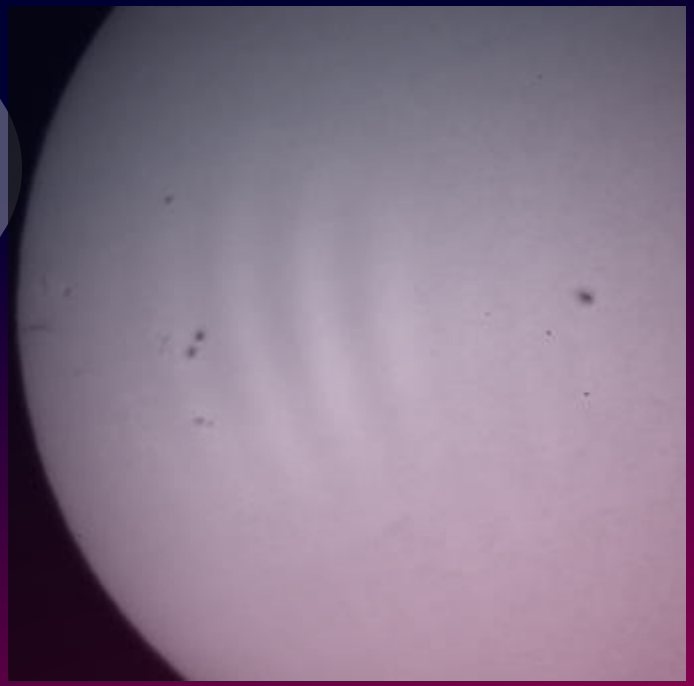
First tests – Belogradchik Observatory



2025-05-14

X2.7 flare

First tests – Shumen University Observatory



Instrumentation and test image on 2025-09-23

The second station, AO-Shumen University, is located on the Shumen plateau (at about 500 m elevation). The instrumentation used (Fig. 2, left) is as follows:

- 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

The image was taken after a three-fold extension of the focal length to 1200 mm using a projection eyepiece.

The image also shows a weak, but recognizable interference pattern, with numerous sunspot groups.

Bulgarian-Austrian project

First tests – Shumen St. George school Observatory

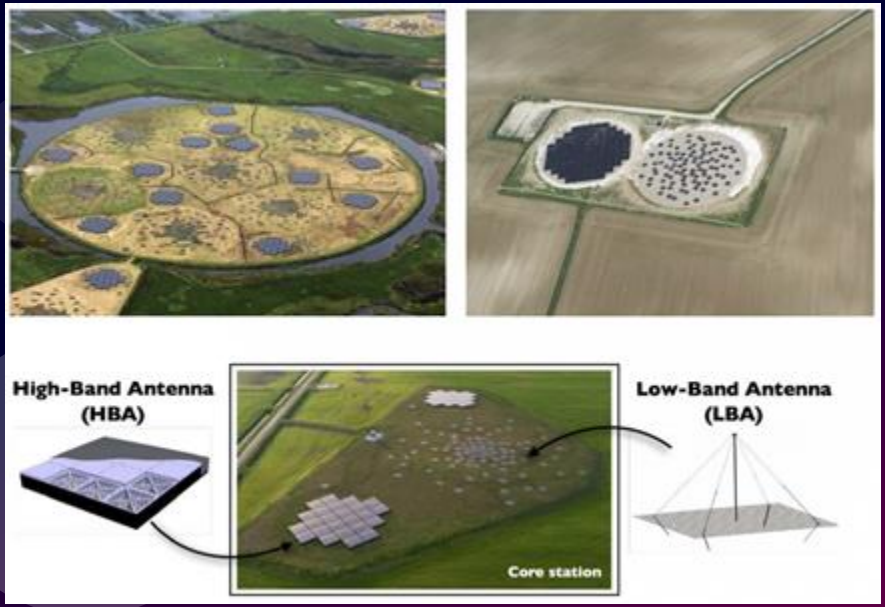
Instrumentation and test image from St. George school and preschool observatory on 2025-06-04.

The Instrumentation to be used at St. George School and Preschool-Observatory:

- Guiding telescope: Refractor Celestron Omni XLT 120, D = 120 mm, f = 1000 mm, focal ratio: f/8.3
- Mount/guiding: 10Micron
- Camera: Atik Horizon Color CMOS Panasonic MN34230, chip size: 17.6 x 13.3 mm (22 mm diagonal), pixel size: 3.8 µm, pixel area: 4644 x 3506
- Filter: various metallized filters, glass and special film, for example AstroSolar Photo Film OD 5 from Baader

Several sunspot groups are visible at the western limb. According to the Solar Monitor database these are ARs 14100 (upper) and 14099 (lower)

Lofar-BG



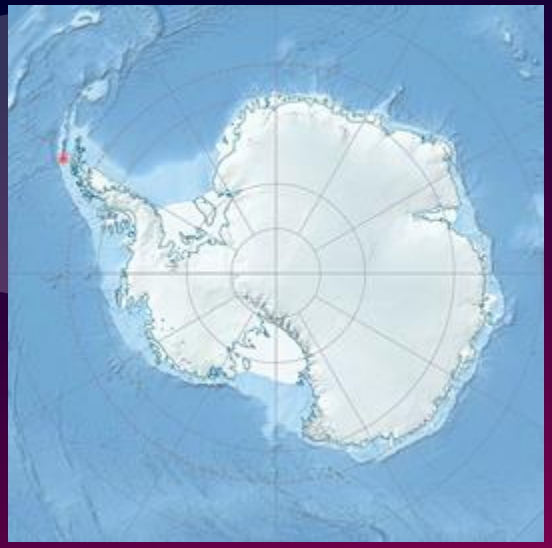
LOFAR is a multi-functional, highly innovative, pan-European distributed low-frequency radio telescope, operating between 10 and 240 MHz. It was developed by the Dutch Institute for Radio Astronomy (ASTRON) with the goal of exploring the early, distant Universe, solar activity, and the terrestrial atmosphere.

Top left: the Superterp core of LOFAR. Top right: The Chilbolton UK LOFAR station. Bottom: a core station with schematics of the HBA and LBA antennas. Credit: ASTRON

BG Polar Astronomical Observatory

The Influence of Solar Activity on Antarctic Ionospheric Dynamics and High-Energy Particle Fluxes

POLAR ASTRONOMICAL OBSERVATORY BULGARIA



1. Study of the effects of solar flares on the ionospheric D-layer using VLF observations of distant terrestrial sources.
2. Study of the properties of Type II and Type III solar radio bursts at HF radio frequencies between 75-750 MHz.
3. Observations of secondary cosmic ray fluxes in the area of the Bulgarian Antarctic Base using particle detectors.
4. Observations of disturbances in the Earth's magnetic field in the area of the Bulgarian Antarctic Base, caused by solar eruptions in interplanetary space.

Acknowledgements

Bilateral project: Bulgaria-Austria https://astro.bas.bg/project-sun/
'Joint observations and investigations of solar chromospheric and coronal activity' (2023-2025) Bulgarian National Science Foundation project No. KP-06-Austria/5 (14-08-2023) and Austria's Agency for Education and Internationalisation (OeAD) project No. BG 04/2023

شكرًا لك

Thank You for Your Attention!