BUCHAREST SOLAR STATION AT SIXTY YEARS

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Abstract. Sixty years ago in Romania started the solar observations at Bucharest Observatory – this event actually was the beginning of the Romanian Astrophysics research.
We make a remember of the beginning of the Bucharest Solar Station, the past activity, and the latest solar observations in the light of the last equipment acquisitions.

Key words: Solar observations – History of astronomy.

1. FROM IGY TO IHY

The story began with the activities linked to the International Geophysical Year (IGY), when the scientists understood the necessities of a new era. The new spatial era started once with the highest solar maximum known until now. The scientist understood that the solar activity is responsible for the Earth magnetic field variations and they paid attention to the adequate astronomical instruments setup. In this historical context, an international network of observatories, having similar standard instruments, was initiated and worked until 1990 year. World wide data centers specialized for chromospheric or photospheric observations started their role in data centralisation and standardisation. These types of activities, solar patrol and solar phenomena database build up, constituted undoubtedly a solid base for the solar physics and spatial era developments.

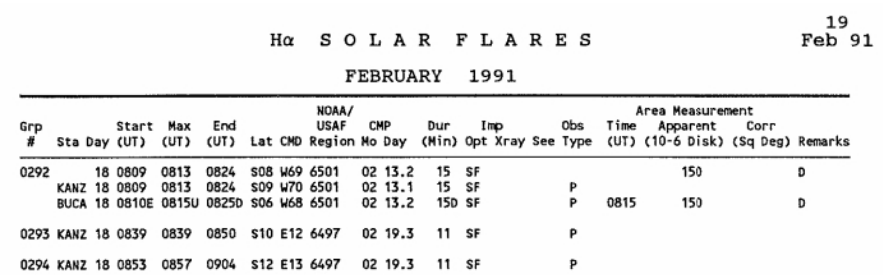
In Romania, Professor Călin Popovici, recently elected as academician postmortem, initiated the solar and spacecraft survey observations. The first and single solar station was settled up at the Bucharest Observatory, now belonging to the Astronomical Institute of Romanian Academy. The systematic solar observations began in Bucharest in 1956, through the setting up of a solar working group in 1955 (Popovici, 1969). Bucharest Solar Station occupied a strategic place also in the old international network (code name BUCA), providing solar photospheric and chromospheric data monthly bulletins for the meridian GMT+2, at lat. $44^o45'$, long. $26^o06'$, altitude 81 m. First solar photosphere observations have been performed at the Prin-Merz double Astrograph 380/6000 mm, and later a five meters diameter solar dome was built and the specific instruments and equipment was purchased for the solar photosphere

and chromosphere surveyance.

A Zeiss (1957) 130/1950 mm refractor (*lunette A*) has been used at daily, visual and photographic observations of the photosphere for sunspot relative number determination, sunspot group coordinates and evolution, and sunspot groups' area. The storage of data has been done on paper support and plates of 130×180 mm. The cadence was 1 or 2 plates/day and 1 diagram/day, with an approximate number of 240 observational days per year. The sunspot data monthly bulletins were sent to data centers in Pulkovo (1957–1968), Zürich (1957–1982), Freiburg (1957–1968), and later to Bruxelles (1983–1997).

In 1958, a new Zeiss refractor 110/1650 mm (*lunette B*) was purchased and equipped with a Halle Lyot-Ohmann filter (0.5 $\mathring{A}$ pass-band). It has been used for chromospheric patrol observations, visual (sunspot draw) and photographic (storage: 35 mm film) until 1997. The cadence of the patrol observations: photos at 1–5 min, 2–3 hours/day, approximate 6–31 days/month, between 1956–1997. The filaments activation and flares occurrence were monitored daily. Monthly telegrams were sent to four data centers: Boulder Colorado, Meudon, Moscow (1958–1997), Pulkovo (1958–1997).

The solar features observed at Bucharest Observatory were published in: *Solar Geophysical Data* (USA), *Quarterly Bulletin of Solar Activity* (Japan), *Solnechnye Dannye* (Russia), *Observations Solaires* (Bucharest, Romanian Academy Publishing House, 1956–1997). The Fig. 1 displays an extract from *Solar Geophysical Data* Bulletin (Boulder, Colorado, `http://www.ngdc.noaa.gov/stp/solar/sgd.html`) where our observation telegrams were included and Bucharest solar station appeared under the code name of 'BUCA' after the French name of our town.



Hα S O L A R F L A R E S 19 Feb 91

FEBRUARY 1991

Grp #	Sta	Day	Start (UT)	Max (UT)	End (UT)	Lat	CMD	NOAA/ USAF Region	CMP Mo	CMP Day	Dur (Min)	Imp Opt	Imp Xray	Obs See	Obs Type	Area Measurement Time (UT)	Area Measurement Apparent (10-6 Disk)	Area Measurement Corr (Sq Deg)	Remarks
0292		18	0809	0813	0824	S08	W69	6501	02	13.2	15	SF					150		D
	KANZ	18	0809	0813	0824	S09	W70	6501	02	13.1	15	SF			P				
	BUCA	18	0810E	0815U	0825D	S06	W68	6501	02	13.2	15D	SF			P	0815	150		D
0293	KANZ	18	0839	0839	0850	S10	E12	6497	02	19.3	11	SF			P				
0294	KANZ	18	0853	0857	0904	S12	E13	6497	02	19.3	11	SF			P				

Fig. 1 – A *Solar Geophysical Data* Bulletin extras from 1991.

Observations Solaires Bulletin (Bucharest, Romanian Academy Publ.House, 1956–1997), published in French language, was the main own journal that published the events data registered during the solar patrol observations at Bucharest Observatory. This bulletin was actually a solar catalog containing data of our archives (pho-

tographic plates and films). *Observations Solaires*, with one yearly issue, published our data on sunspots group evolution, the observed H_{alpha} flares and prominence and filament activations.

These two instruments were involved in the following observational programs: daily solar patrol, other observations during the International Geophysical Year (1957–1968), the international Quiet Sun Years (IQSY, 1964-1965), the Proton Flare Project (PFP, 1967), Rapid Variations of the Solar Magnetic Fields (KAPG, 1966-1974), and INTERCOSMOS (1964-1977).

Fig. 2 – The equipment between 1999-2004.

In 1999, we have purchased ST-7 CCD camera, with the characteristics: 765×510 pixels and 8.4 μm (Fig. 2). In this way the chromospheric refractor was modified for CCD observations. This change did not permit full disk observations (the field of view was 0.6×0.4 from the solar disk) and, consequently, the solar patrol program could not be continued. Therefore, we have performed only observational campaigns for active regions and filament captures in H_{alpha}, between 2001 and 2004. In 2004, the old Halle Lyot-Ohmann filter ceased its activity, after the Venus transit observations, and the solar dome entered in a long period of restoration.

The new horizons opened by the International Heliophysical Year (2006–2007) constituted a good moment to remember the heritage and celebrate fifty years of Romanian Solar Physics, that actually were fifty years from the starting of astrophysics researches in Romania (Dumitrache and Popescu, 2005). It was the time to refresh the solar astronomical instruments for a new era of space weather observations and new issues of the scientific community. The space era gave us unbelievable new scientific data and results, the opportunity to observe the Sun in many wavelengths, but the chromospheric observations in H_{alpha} are still preserved only for the ground

based observations.

2. NEW EQUIPMENT

The new era of solar observations is about to begin at the Bucharest Solar Station. After many attempts, we were able to purchase new equipments (Fig. 3).

Fig. 3 – The solar observations equipment in 2016.

In this way, the refractor for photospheric observations, Zeiss 130/1950 mm (1957), was equipped with a Herschel Prism 2" Baader Cool Ceramic P(hoto) and a Skyris 274 CCD. This camera, with 1600×1200 pixels and with 4.4 μm pixel size, has the ability to catch 0.38 from the solar disk. A Baader UV/IR-cut 1.25" was added too.

The Zeiss refractor 110/1650 mm for chromospheric observations was equipped with a new Solar Observer H_{alpha} Filter S-1.5 (0.3 $\AA$), purchased in 2006, and with an Atik 4000 monochrome CCD, with 2048×2048 pixels having a size of 7.4 μm.

During the year 2016 we have performed many tests in H_α wave length, as well as in white light. For the moment, our instruments did not allowed us to obtain full disk images: the field of view (FOV) is 0.49 from the Sun disk, at the *lunette B*, and 0.38 from the full disk, at the *lunette A*.

3. CAMPAIGNS OF OBSERVATIONS IN 2016

During the year 2016 we have focused on campaigns of observations in H_{alpha} and later also in white light, after we did several tests. On these occasions we wrote the IDL codes necessary to visualize and calibrate our data. For all astronomical observations we had to overcome the difficulties arising from the location of the observatory in the middle of a very polluted town. The Bucharest Observatory of the Astronomical Institute of the Romanian Academy was build in 1908 on a 2.8 ha land in the Carol I Park.

We summarize here the most important campaigns we have conducted this year. A complex composed by two sigmoid filaments were registered for two days at Bucharest Observatory, between 17 and 18 March 2016. They are positioned in a shape of "U" letter near the active region AR12519, region that did not release any flare during these two days (Fig. 4). However a dark surge on the disk appeared at the active region border, on 17 March 2016.

We had as targets also few active regions and we note here the NOAA active regions 12565 (Fig. 5–9) and 12585 (Fig. 10–13). AR12565 released few flares we have registered, while AR12585 was a very calm with no important flares.

We have tested the CCD Atik4000 properties and the complex of the instruments. One of these tests is displayed in Fig. 14, where the acquisition of the images have been taken in bin2, in order to compare the differences between these and those taken at full resolution.

Fig. 4 – The sigmoid filaments observed on 17 and 18 March 2016.

The following white light images were acquired with a Skyris274 CCD, at a resolution of 0.6 arcseconds/pixel.

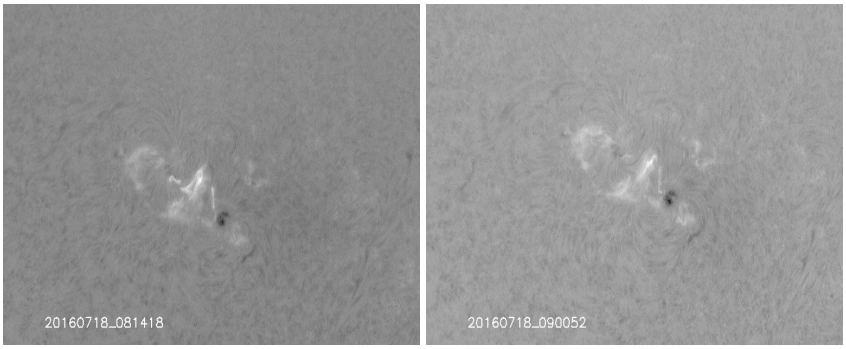


Fig. 5 – AR 12565: flare observed on 18 July 2016, in H_α.

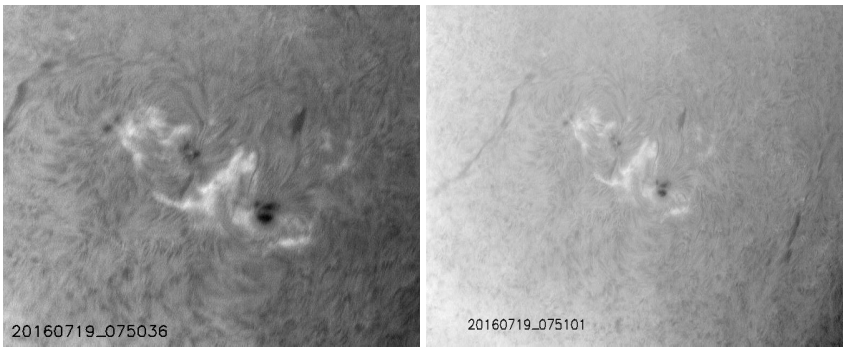


Fig. 6 – H_α observations of AR 12565, on 19 July 2016.

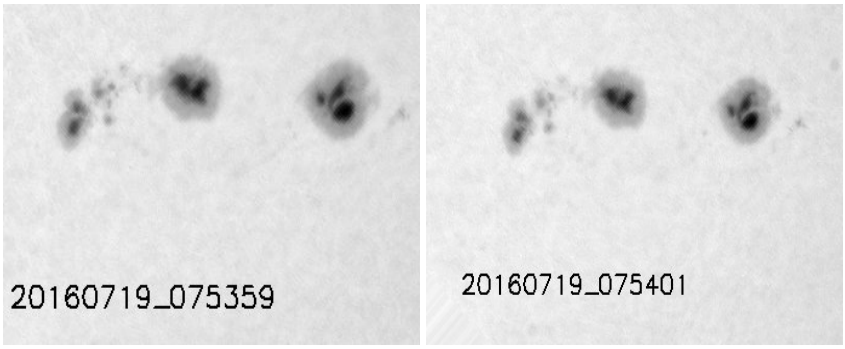


Fig. 7 – AR 12565 in white light, observed on 19 July 2016.

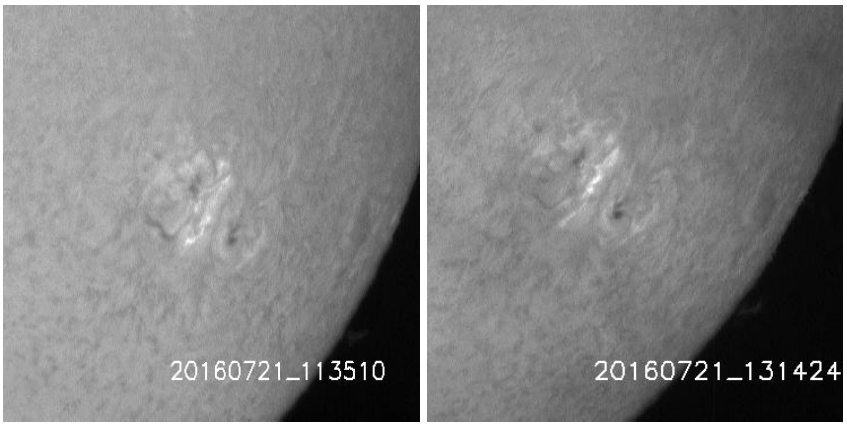


Fig. 8 – AR 12565: The flare observed on 21 July 2016, in H_α.

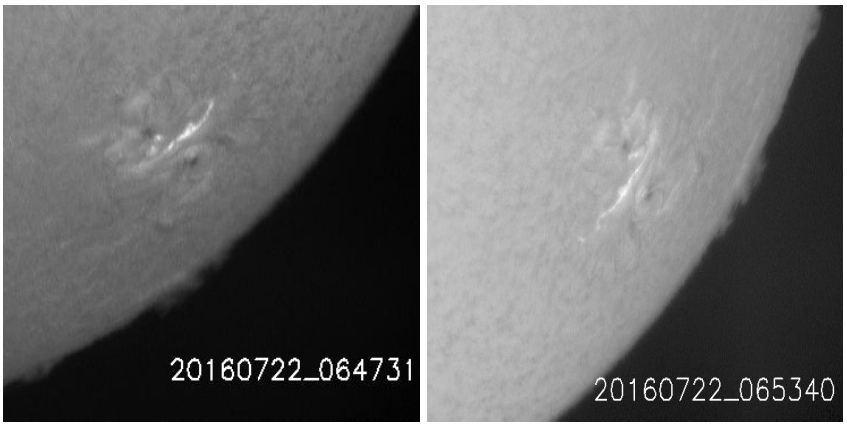


Fig. 9 – AR 12565: flare observed on 22 July 2016, in H_α.

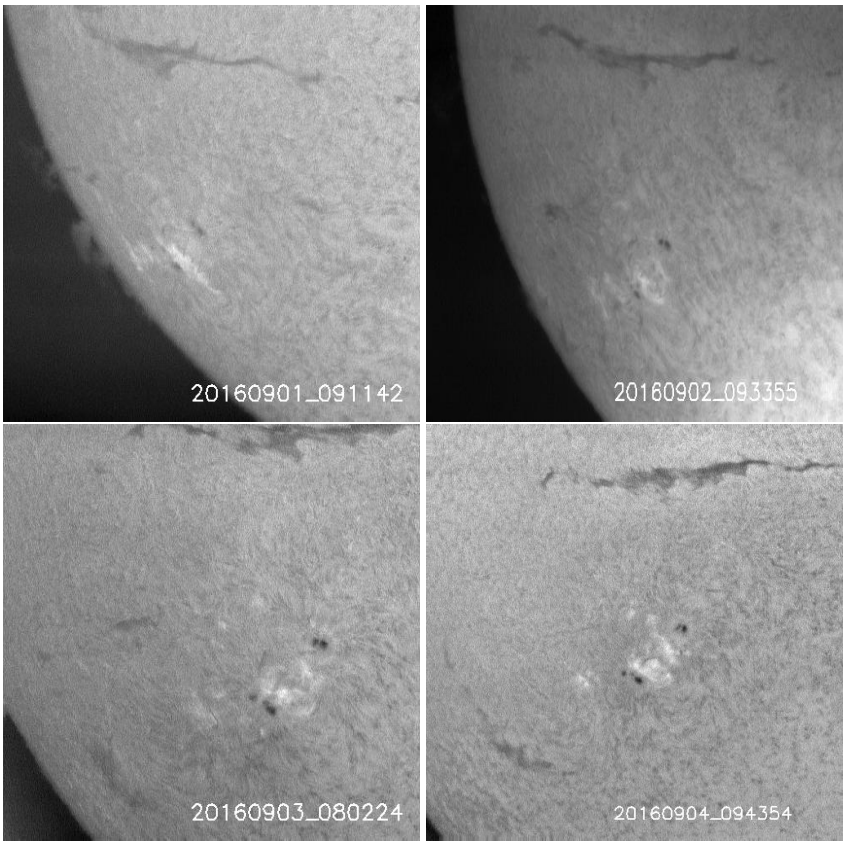


Fig. 10 – H_α observations of NOAA AR12585.

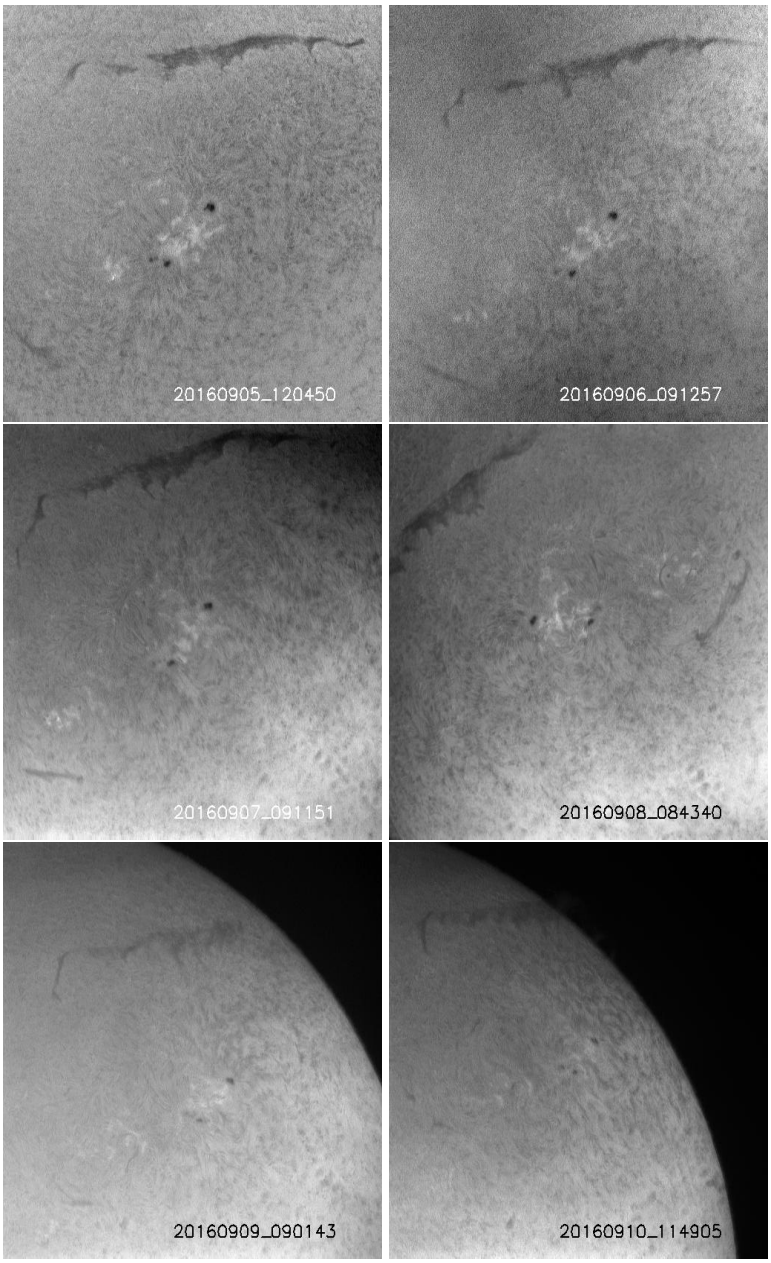


Fig. 11 – H_α observations of NOAA AR12585.

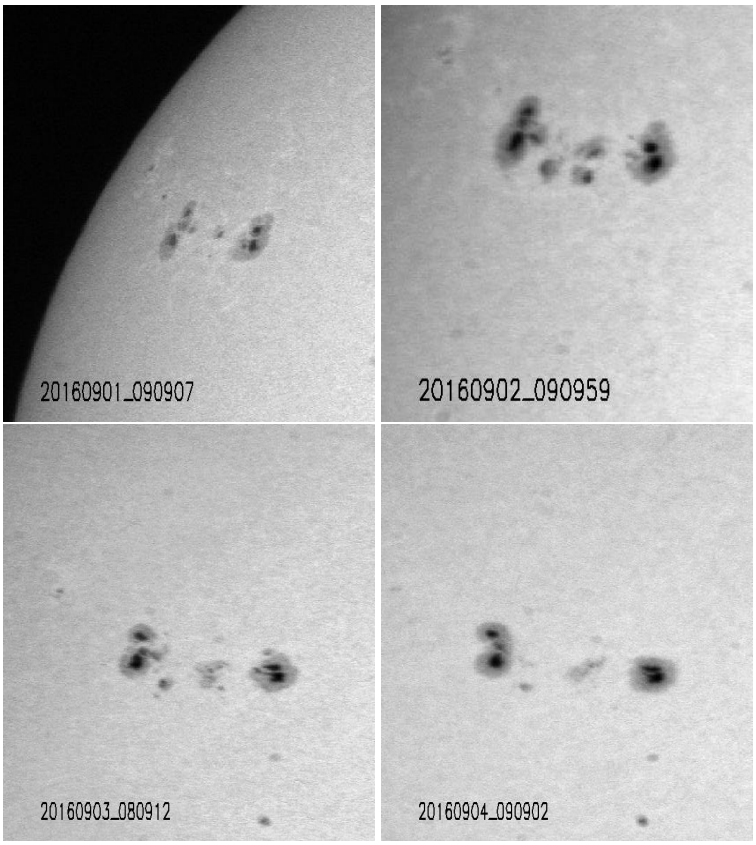


Fig. 12 – White light observations of NOAA AR12585.

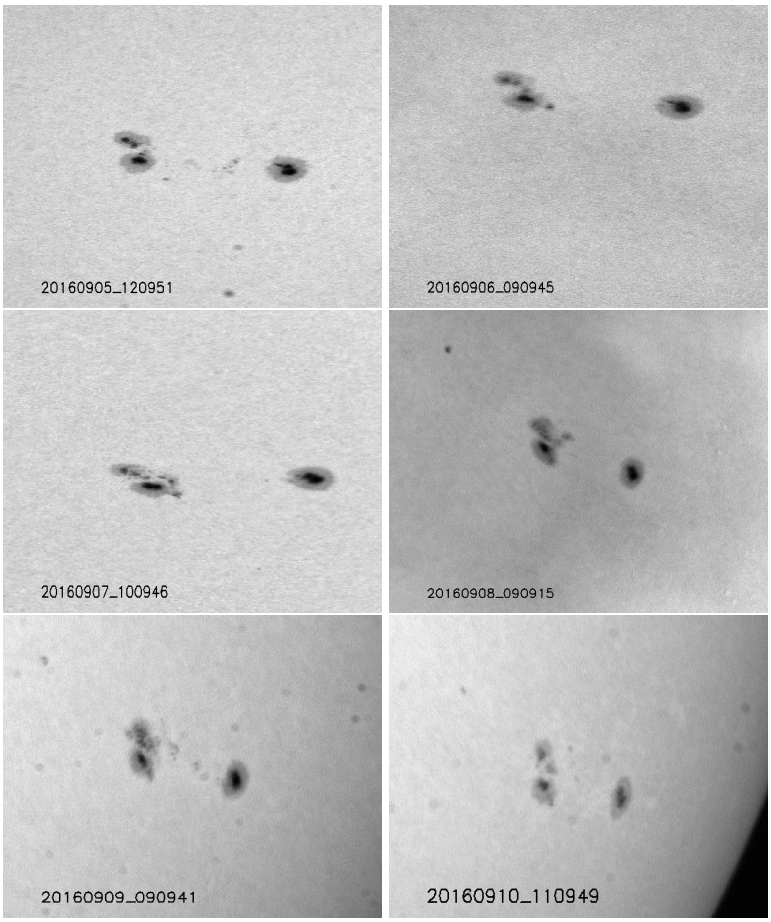


Fig. 13 – White light observations of NOAA AR12585.

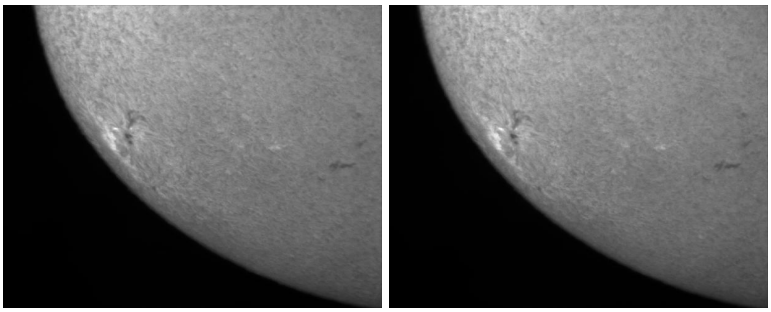


Fig. 14 – AR 12599 images in H_α, with bin2 CCD registration.

4. EPILOG

Our next plans are to install a focal reducer on the lunette of 130/1950 mm that, together with Atik 4000 CCD, will give full disk images in white light, and to purchase a new CCD Atik 11000 for a lunette Zeiss 80/1200 mm for chromospheric observations. The use of the refractor of 110/1650 mm will be tested for white light full disk observations without a focal reducer, thus taking into account its use for photospheric observations. All these configurations are compliant with ESA standards for the resolutions of the images.

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