10th OPTICON Gaia Science Alerts Workshop, Catania, Italy
December 18-20, 2019

Observational capabilities of the Shamakhy Observatory

Nariman Ismailov

N.Tusi Shamakhy Astrophysical Observatory of Azerbaijan National Academy of Sciences (ShAO of ANAS)

Settlement Y.Mammadaliyev, Shamakhy, Azerbaijan, AZ 5626

Short information on the ShAO

Shamakhy Astrophysical Observatory named after Nasireddin Tusi of Azerbaijan National Academy of Sciences (ShAO of ANAS)

Established in 17 November 1959 on the mount Pirqulu in altitude 1500 m

Distance from Baku 140 km;

In November 2019, we celebrated the 60th anniversary of ShAO.

The geographical coordinates

$\lambda=48^{0}35'04''$ E,

$\varphi=40^{0}46'20''$ N

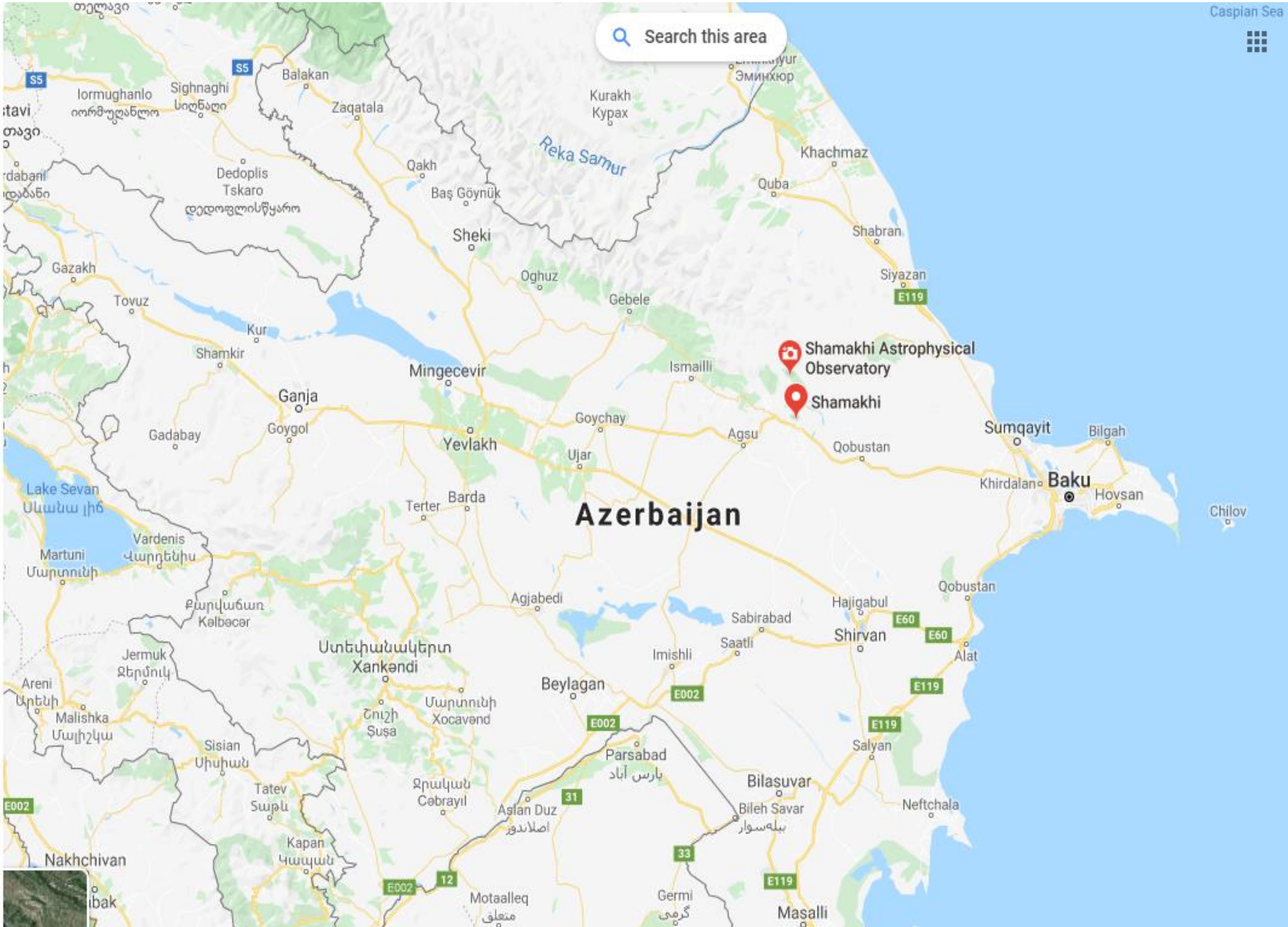
located in the North-East of the Great Caucasus Mountains, in the South Caucasus

Number of clear nights reaches 150-200 per year;

Scientific research fields :

1. **Non-stationary processes occurring in various type of variable stars, active galactic nucleus and their nature,**
2. **Dynamics and Physics of Active Structures in Solar Atmosphere, Solar-Earth Relations,**
3. **Solar System Physics (Planets& Satellites, Comets, Asteroids, their Structure, Physics and Evolution).**

In addition, are being researches the history of astronomy, theoretical studies, ionosphere synthesis of high-frequency radio signals and their dependence on different cosmic air factors (solar activity, magnetic storms, etc.) and other fields.



Search this area
Caspian Sea
Balakan
Zaqatala
Iormughanlo
Sighnaghi
Dedoplis
Tskaro
Kurakh
Кура́х
Reka Samur
Khachmaz
Quba
Qakh
Baş Göynük
Sheki
Shabran
Siyazan
Oghuz
Gebele
Gazakh
Tovuz
Kur
Shamkir
Mingecevir
Ismailli
Shamakhi Astrophysical Observatory
Shamakhi
Ganja
Goygol
Gadabay
Goychay
Agsu
Qobustan
Sumqayit
Bilgah
Yevlakh
Ujar
Khirdalan
Baku
Hovsan
Lake Sevan
Terter
Barda
Azerbaijan
Chilov
Vardenis
Martuni
Agjabedi
Qobustan
Kəlbəcər
Hajigabul
Sabirabad
Shirvan
Saatli
Imishli
Alat
Jermuk
Xankəndi
Areni
Beylagan
Xocavənd
Malishka
Şuşa
Sisian
Parsabad
Salyan
Bilasuvar
Tatev
Cəbrayıl
Aslan Duz
Bileh Savar
Neftchala
Kapan
Nakhchivan
Motaalleq
Germi
Masalli
S5
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E60
E002
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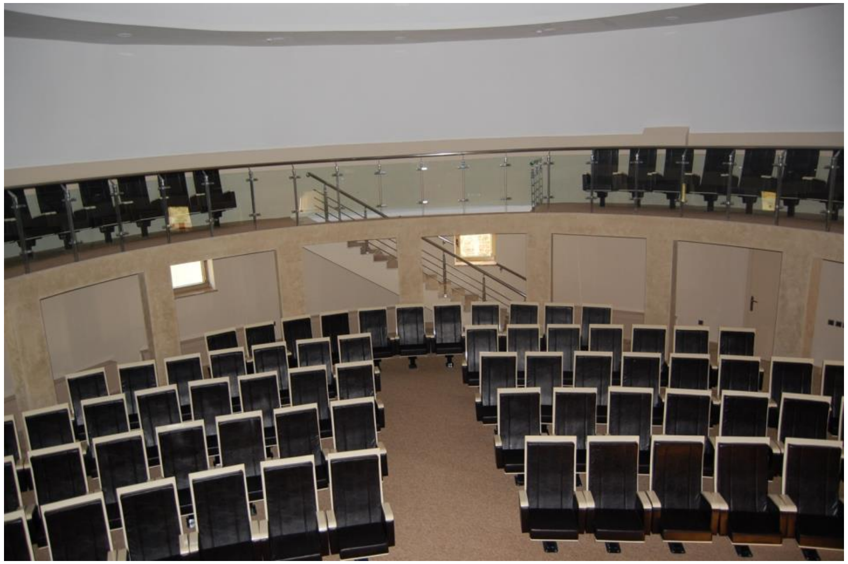
33
12

ShAO after repair and upgrade
2011-2014

Old

Present



You can see the exhibit stone from the original piece of iron meteorite that fell on the territory of Azerbaijan in 1954.




Structure of ShAO

Director of ShAO – prof. Namig Dzhalilov

The Baku city Branch of the ShAO ,
Observatory and Administrative building in Shamakhy

Departments:

1. Space Plasma and Heliogeophysical Problems
2. Theoretical Astrophysics and Cosmology
3. Binary Stars and Eruptive processes
4. Physics of Stellar atmospheres and magnetism
5. Galaxies and Starformation processes
6. Planets and Small Celestial Bodies
7. Astronomical Devices and Innovative Technologies
8. Information, Communication Technology and Organization
9. Education (master , PhD and post-doctoral levels)
10. Public Relations

2 m telescope (Carl-Zeiss)

λ=48°35' 50″E, φ=40°46' 51″N

mounted at 1966 in altitude 1435 m on the mount Pirgulu

Focuses:

Coude F=72 m, A=1/36, 3'x3‘, 2,8″/mm

Cassegrain 29.5 m, A=1/14.75 , 7'x7‘, 7″/mm

direct focus 9 m; A=1/4.5, 6'x6‘-21x21’, 23″/mm

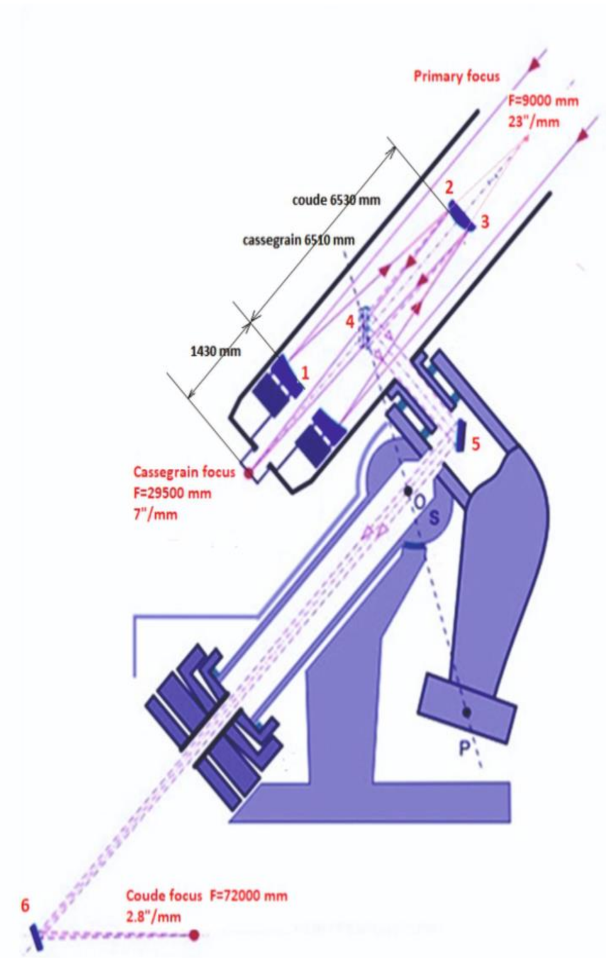
In 2012 it was improved and modernized hydraulic and electric control by a Czech company “Project Soft” .

At this moment used mainly Cassegrain focus together with different spectrographs, and CCD cooled with liquid nitrogen and Peltye systems

Possible various spectral resolution

From R=1500 ….up to 56000 in Cassegrain

Limit magnitude 17 mag for 1 hr exposition with S/N relation 30-50 with low resolution.



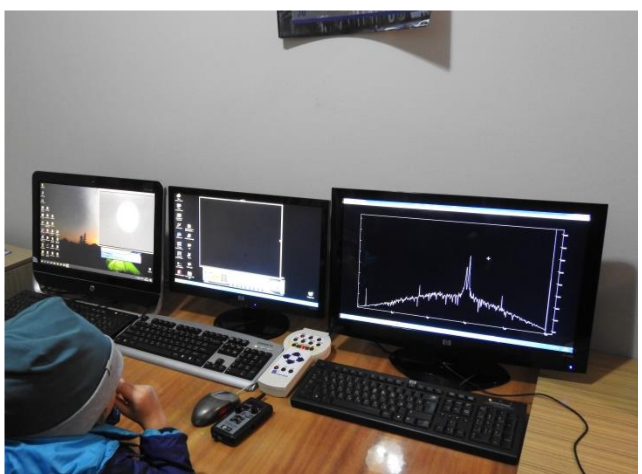
2 m-lik teleskopun optik sxemi

2 m telescope

Outward of the telescope

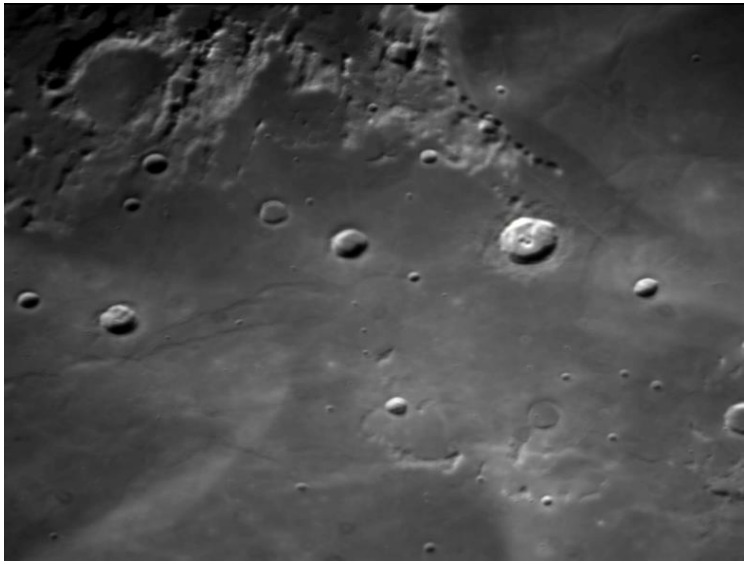
CCD Camera on the focus Cassegrain

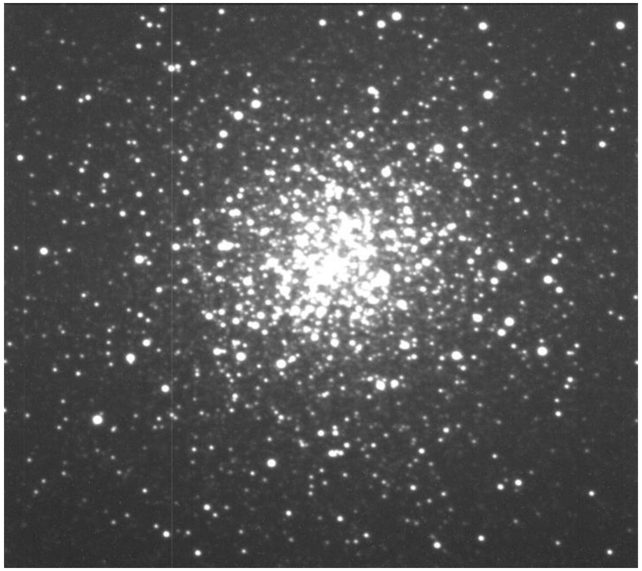
Observer room

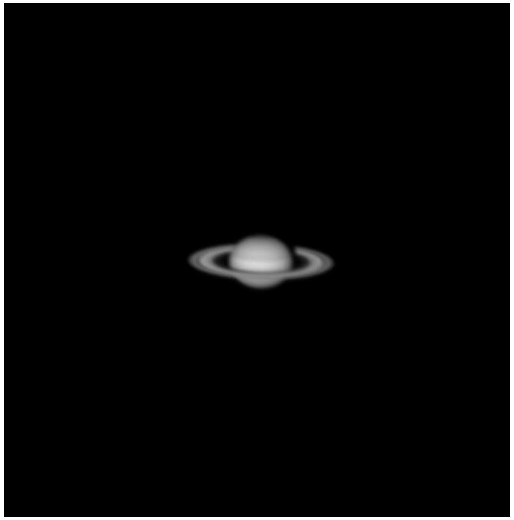


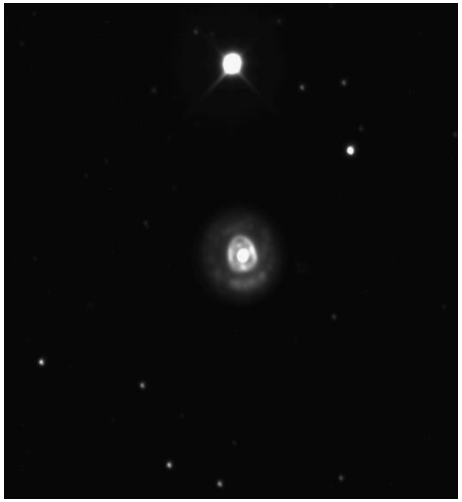
View of the telescope

Some images from 2 m telescope



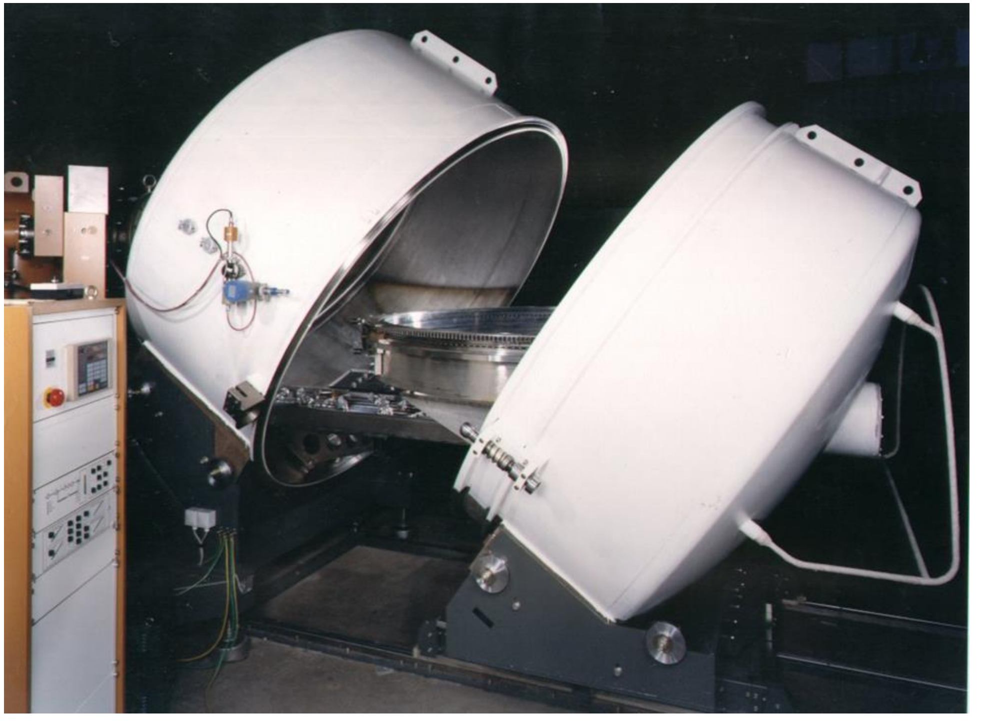






Vacuum camera

There is a vacuum plant for updating the aluminum layer on the surface of telescope mirrors. The maximum allowable mirror size for aluminizing is 2.2 m

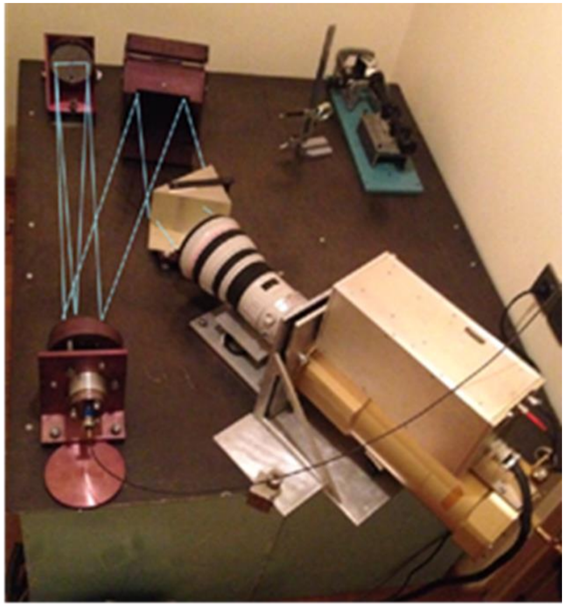


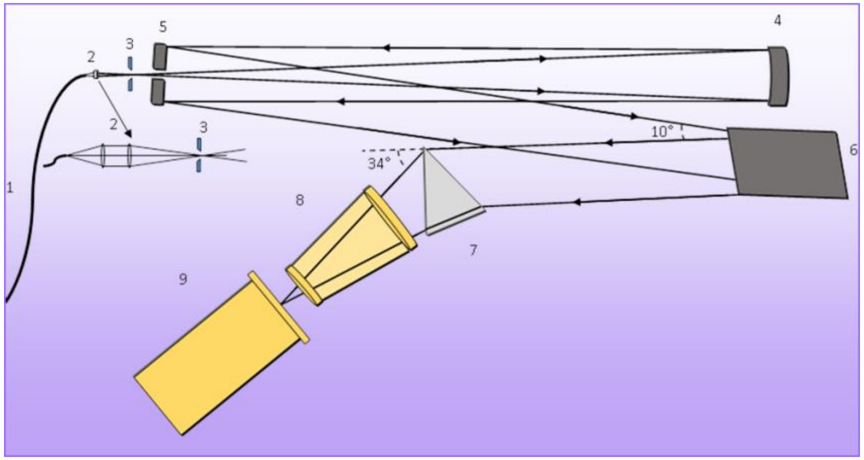
Spectrographs at the 2 m telescope

№	spectrometry	CCD	Spectral range, Å	R	S/N	Limit mag in 1 hr exposition
1	Classic UAGS CCD Andor 2048x2048	2048x2048 1 px=13.5 μ (-100°)	3800-9000	1500 2400 20000	100	17
2	Optic Fibre Echelle Spectrograph CCD STA4150A 4000x4000	4000x4000 1px=15μm (-100°)	3800-9000	56000	200	6
		4000x4000 1px=30μm (-100°)	3800-9000	28000	100	9.6
3	Kanberra Classic 2x2 prism spektrograph CCD FLI 4000x4000	FLI 4000x4000 1px=9μm (-50°)	3800-9000	D=90 Å/mm R=2680 for Hgamma	200	15

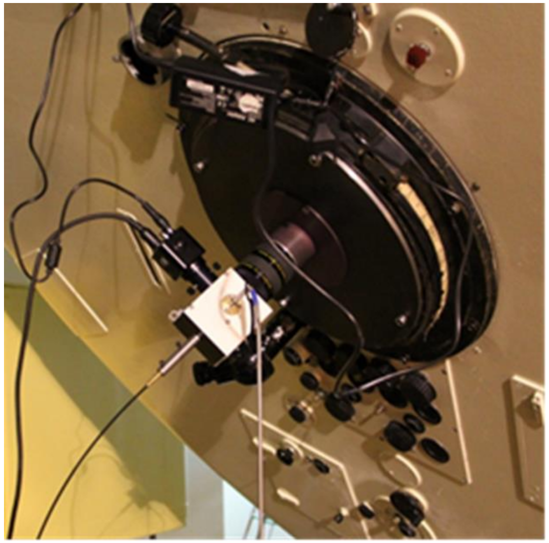
Echelle Spectrograph ShAFES

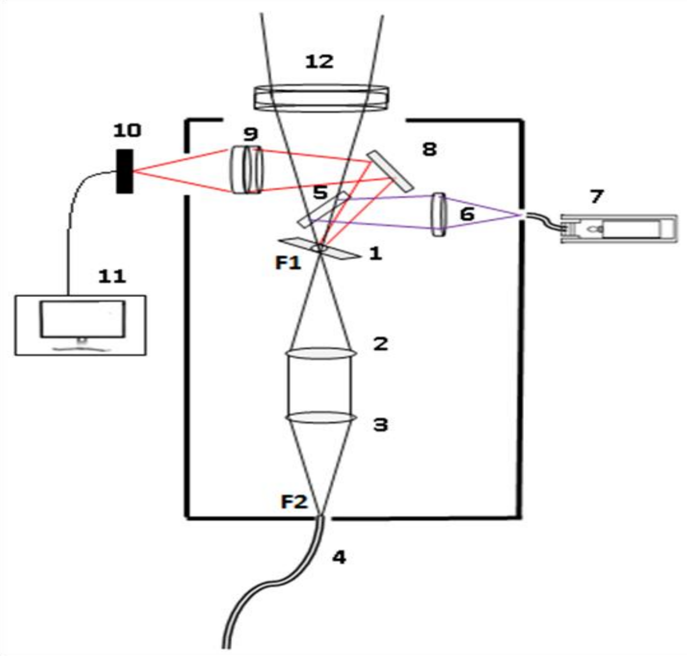
Stationary part



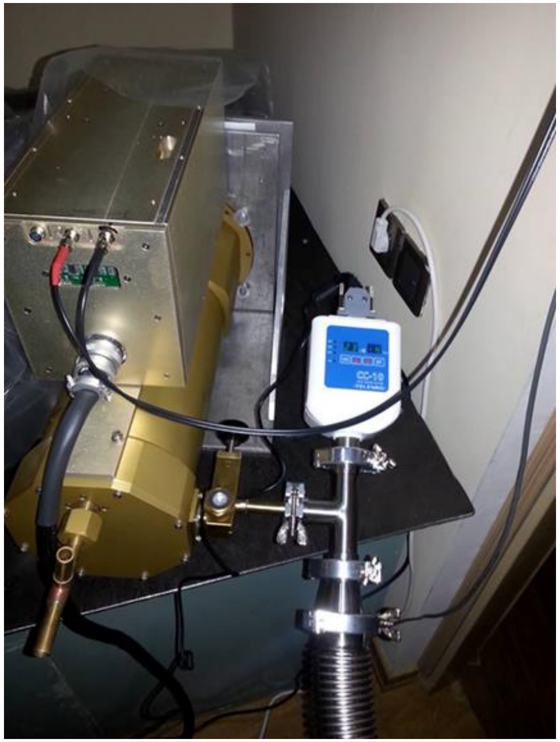


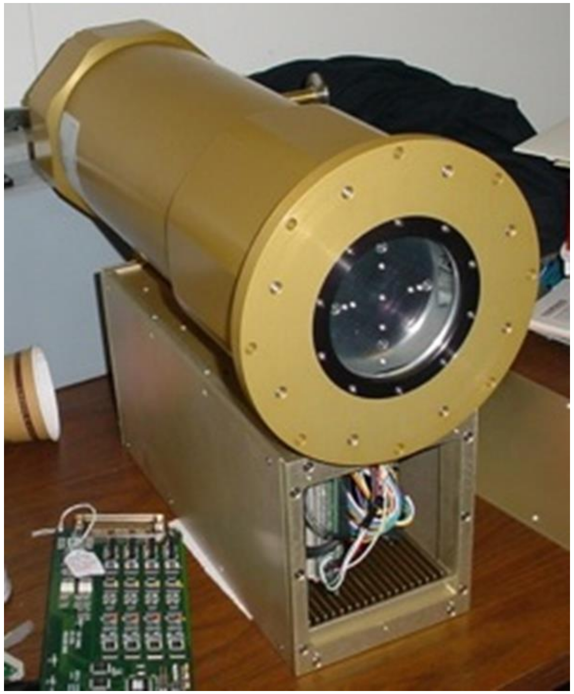
Plant at the focus point

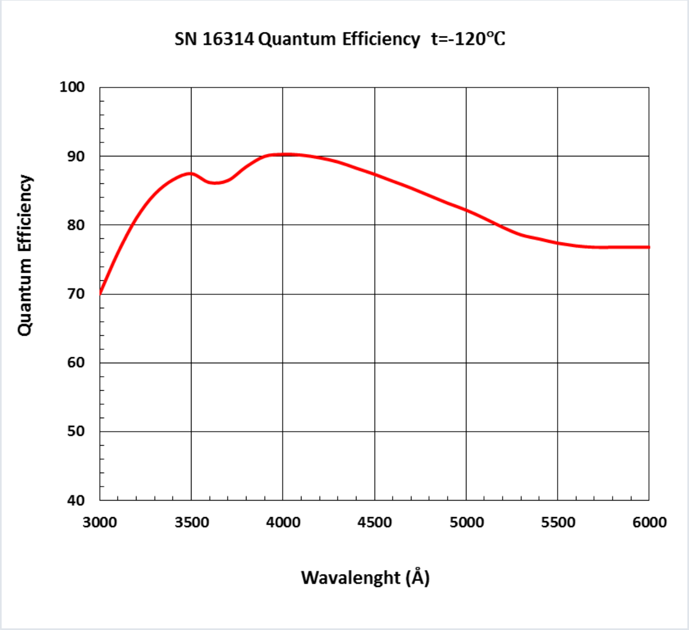




CCD

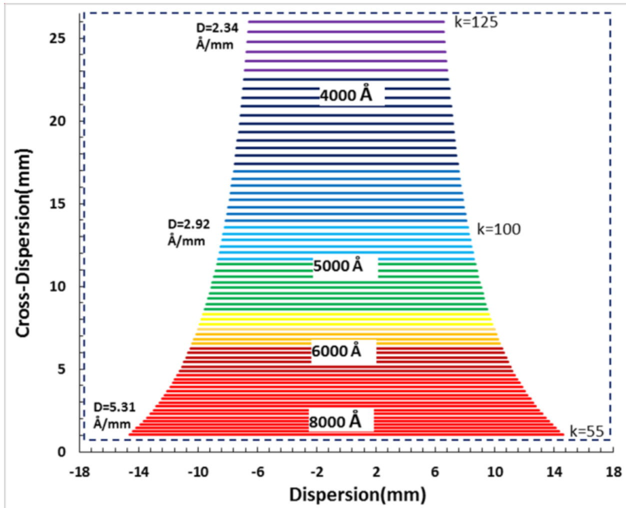


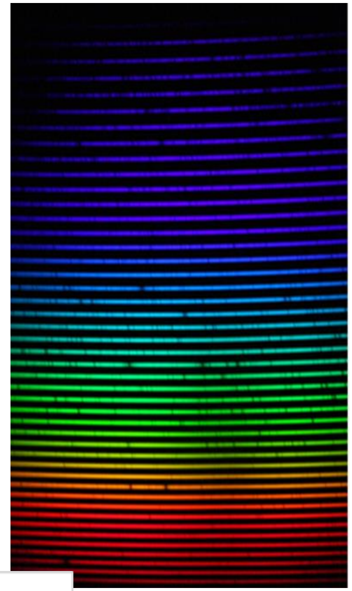




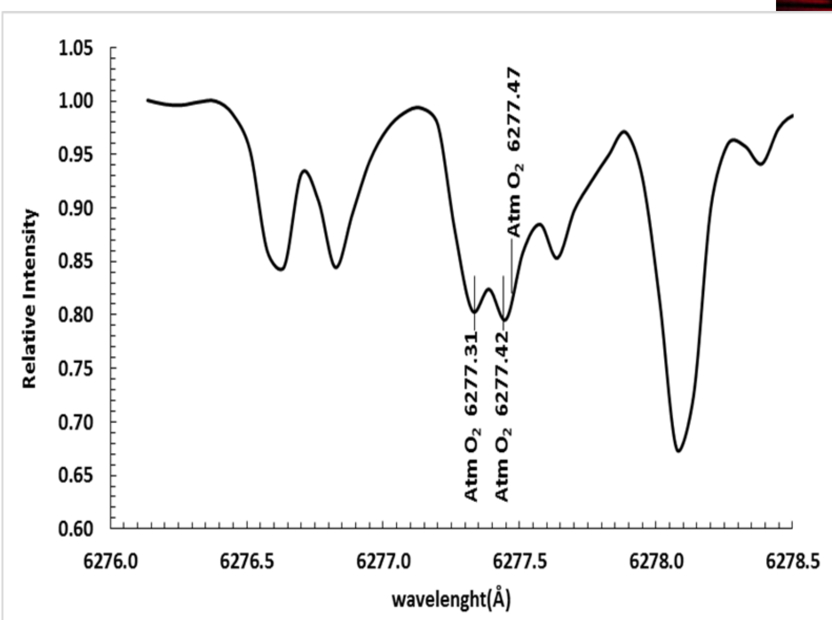
USA-Associates, Inc., Model- STA4150A,
ser.№1634,
Cooled by liquid nitrogen- -110÷ -145°C, l
Working mode -120°C, camera capasity-3 l,
Size: 4096x4096 px., 1 px size: 15 µ,

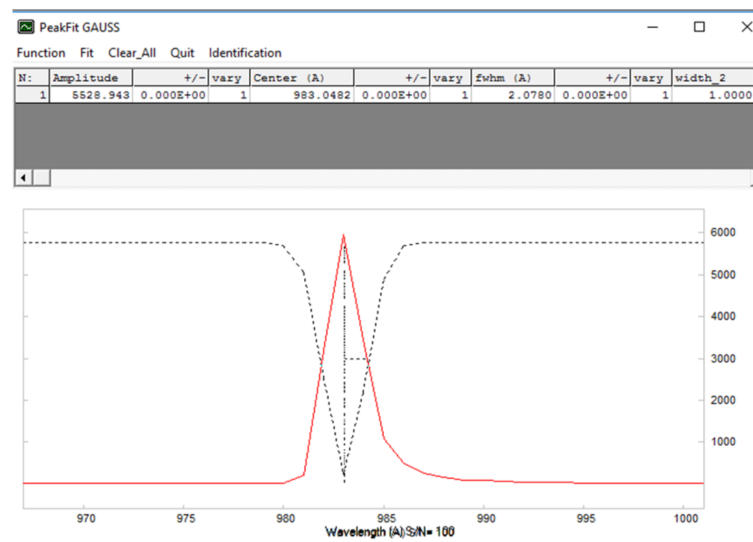
Simulated spectrum



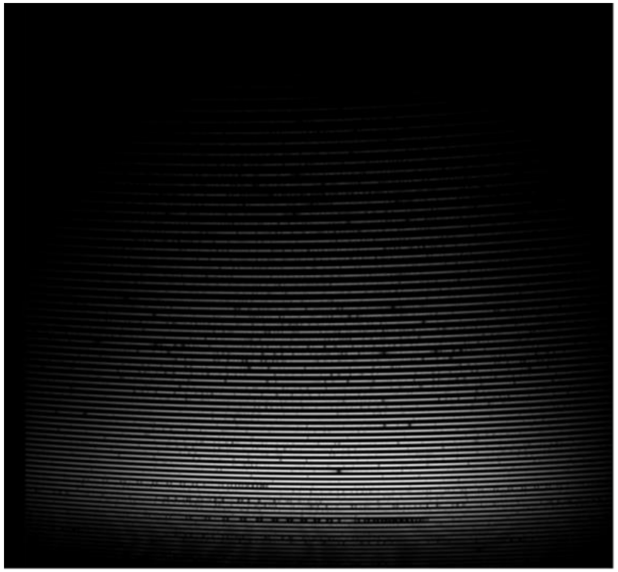


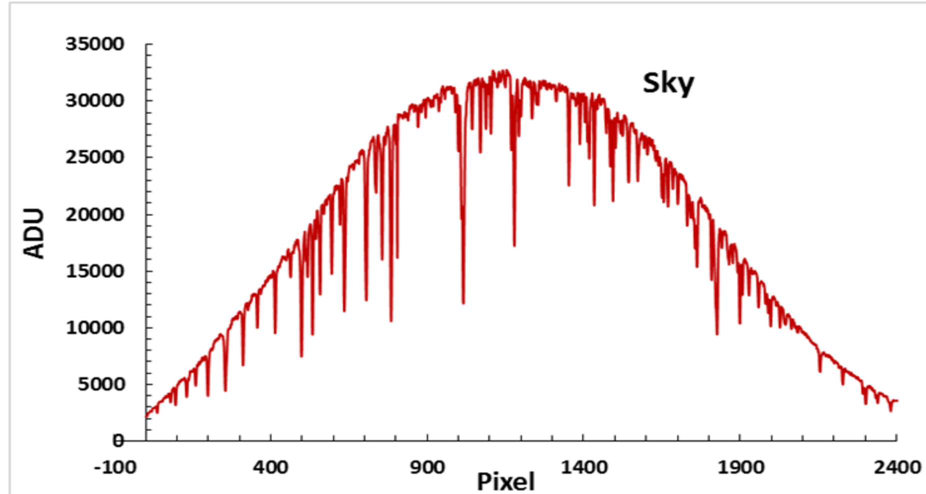
İnstrumental profil:
0.12Å---Hα
0.102Å---5500Å
0.090Å---Hβ
0.08Å-----Hγ

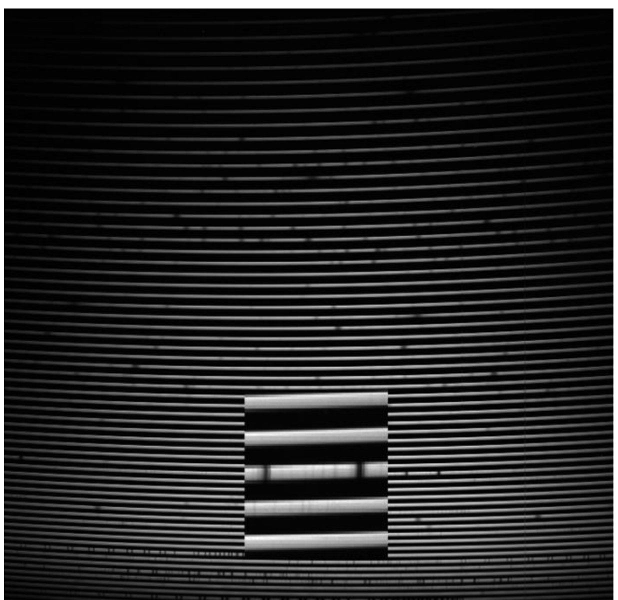


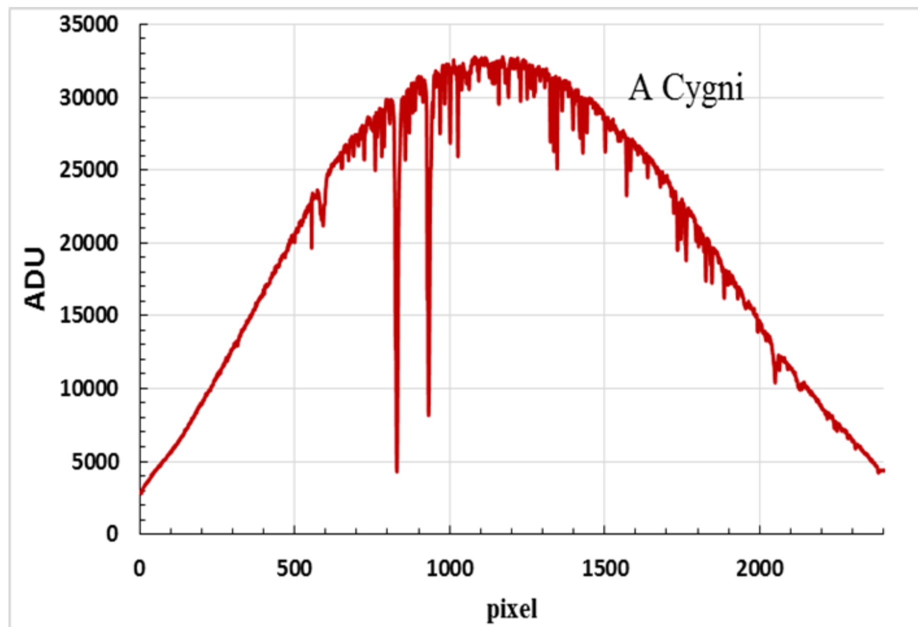


CCD image, sky and α Cyg spectrums

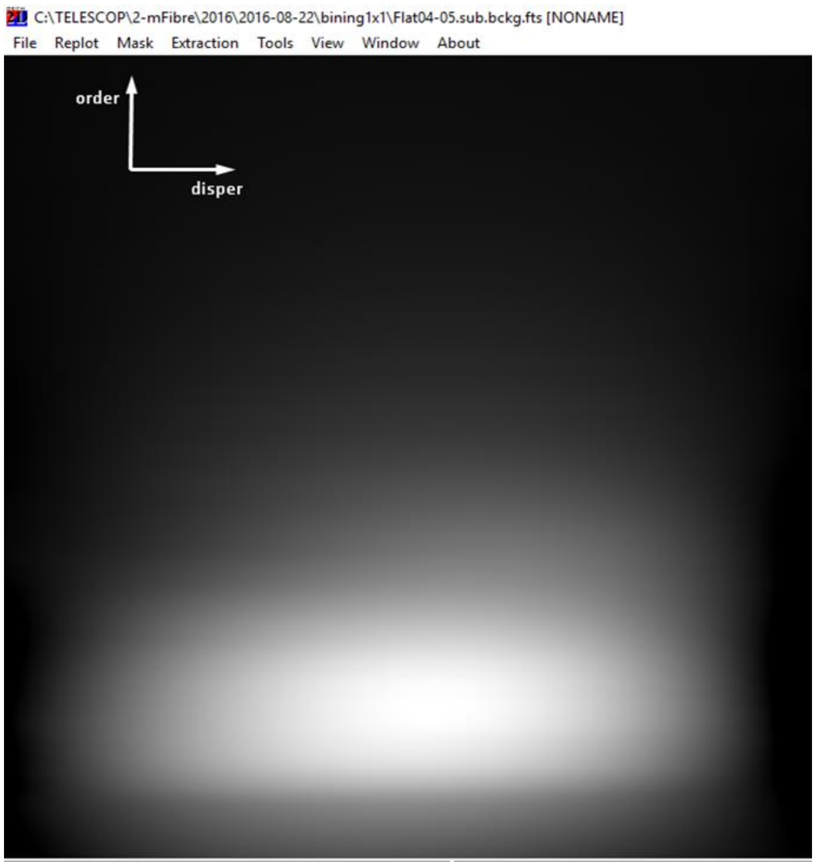


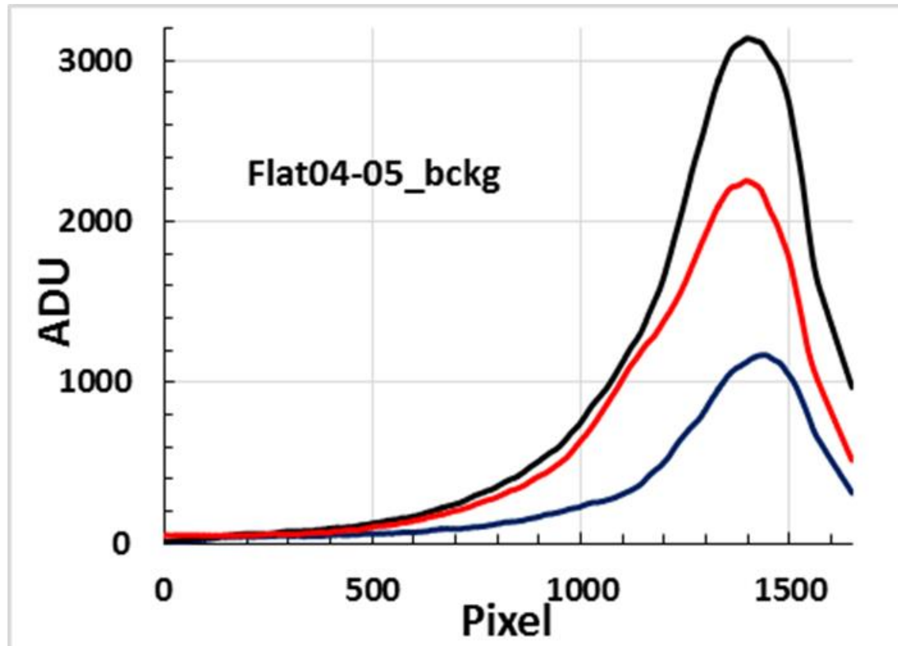




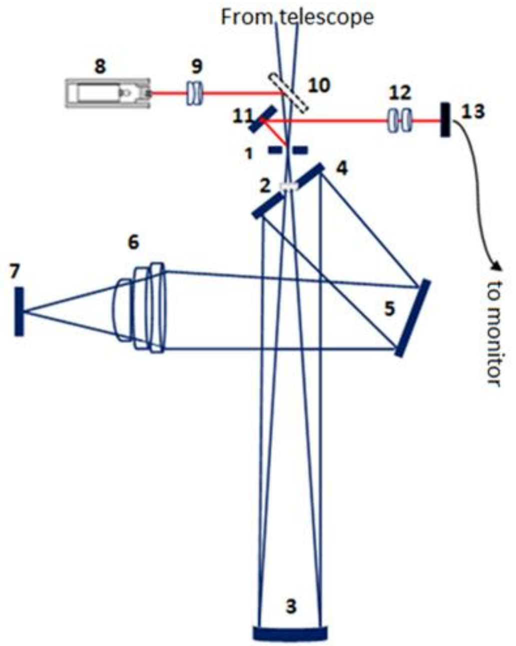


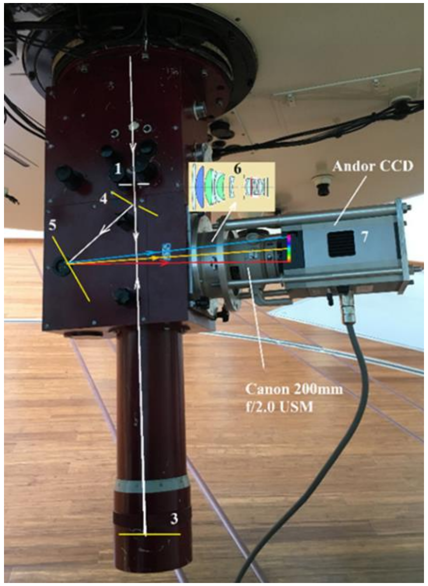
Scatter light background





Classic UAGS+ANDOR



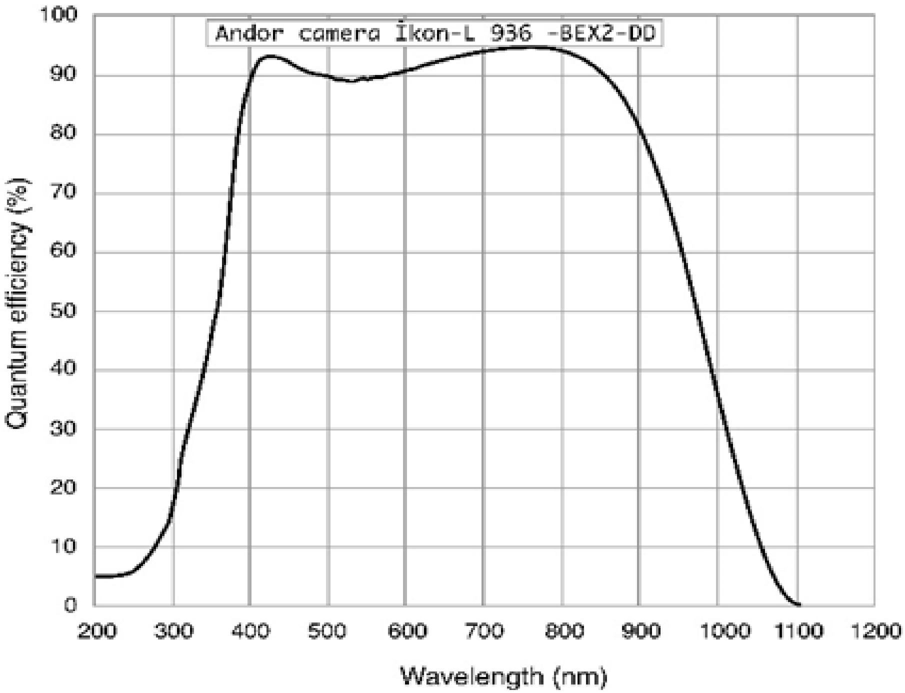


λ 3800-8000 Å 144 Å/mm, 75 Å/mm
λ 3800-5300 Å 25 Å/mm
λ 5000-8000 Å 30 Å/mm

F=200 mm, aperture f/2

Objective
Canon EF

CCD Andor



Five step cooling system

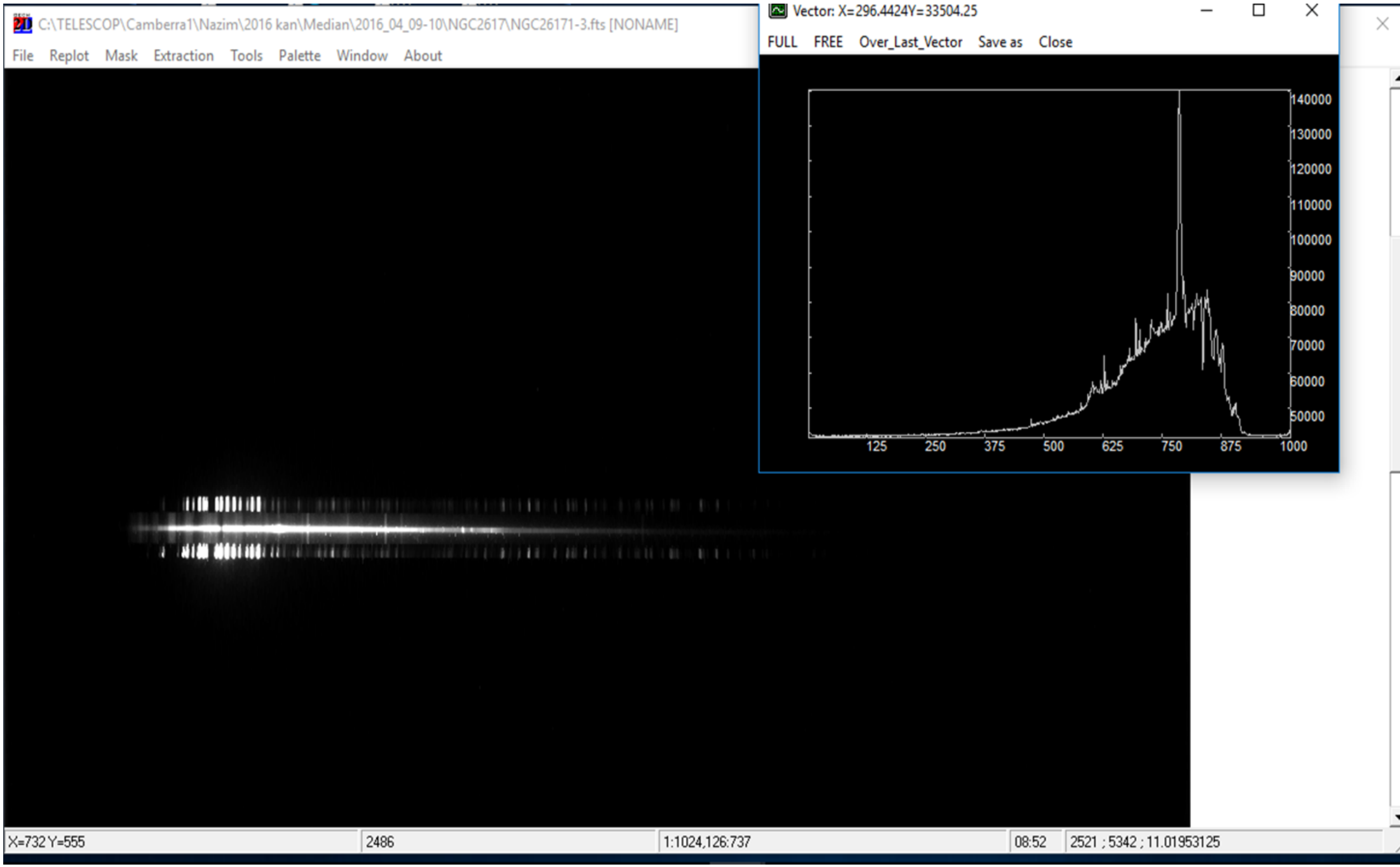
Air -80°C

Water+air -100°C

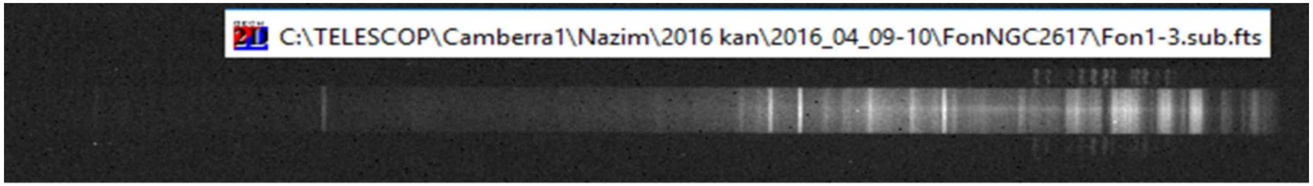
"Andor" (ikonL-936-BEX2-DD) : Size- 2048x2048 px (1 px= 13.5 μ)

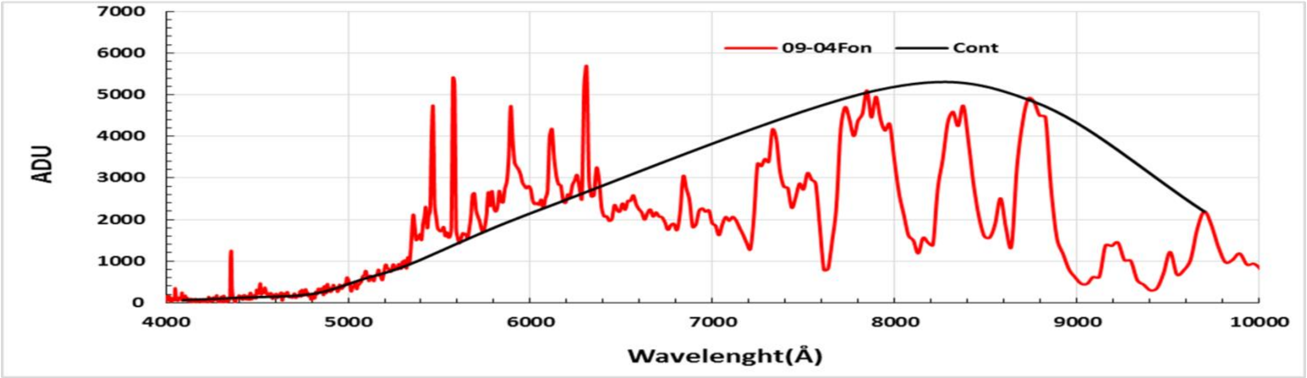
Example

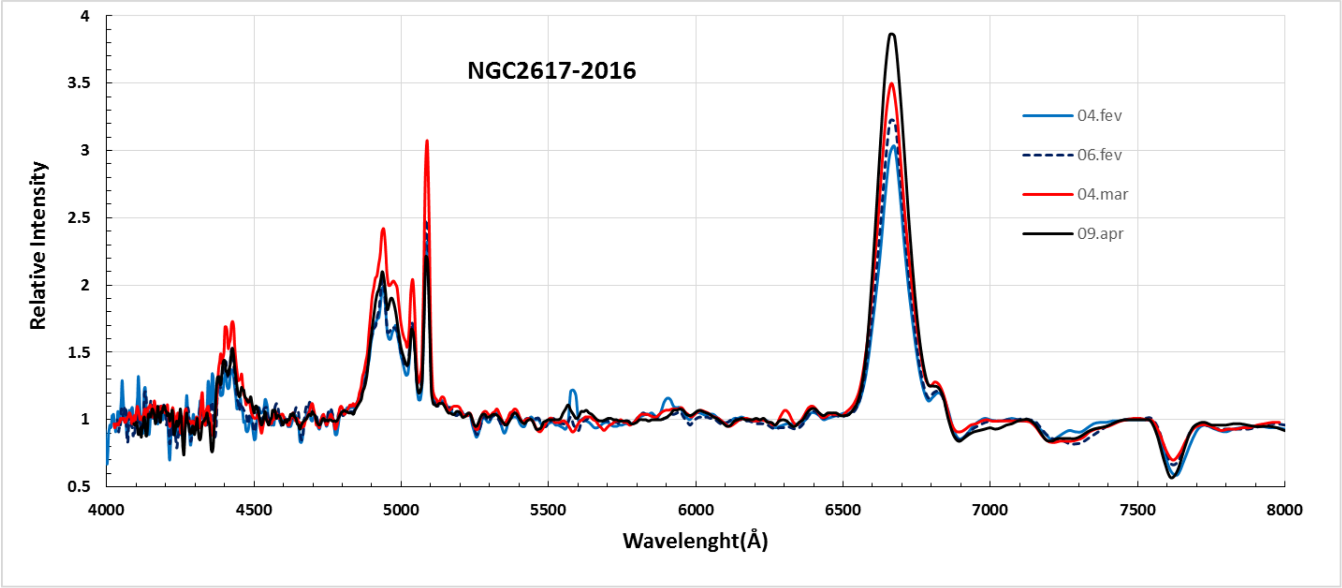
2x2 prism Kanberra spectrograph



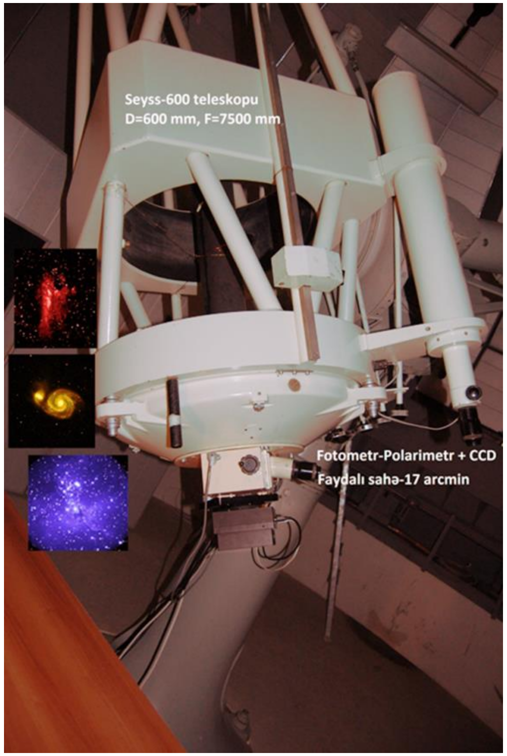
Spectrum NGC 2617







Zeiss 600


Seyss-600 teleskopu
D=600 mm, F=7500 mm
Fotometr-Polarimetr + CCD
Faydalı sahə-17 arcmin

60 cm Cassegrain, λ=48° 35' 50″ E, φ=40° 46' 51″ N

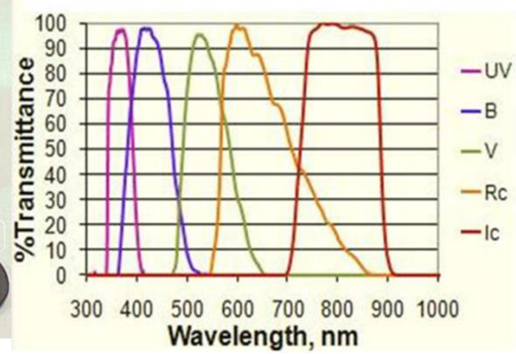
Carl-Zeiss

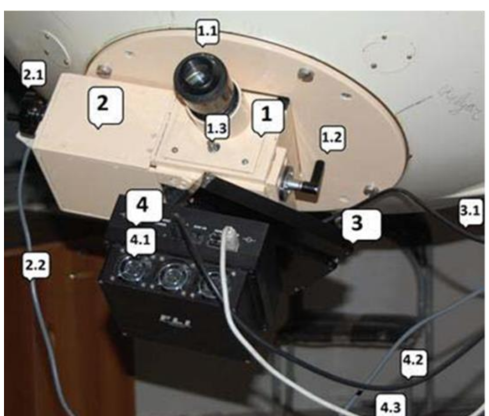
1. Fekv=7500 mm, f/12.5, 17’x17’, 27.5 "/mm

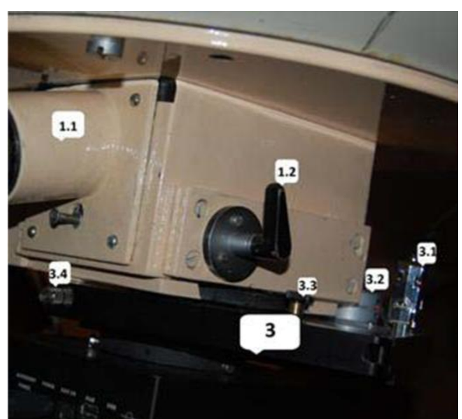
2. Fekv=4680 mm, f/7.8, 27’x27’, 44”/mm (with Celeron adapter 0.6)

Photometer BVRIcRc + Halpha

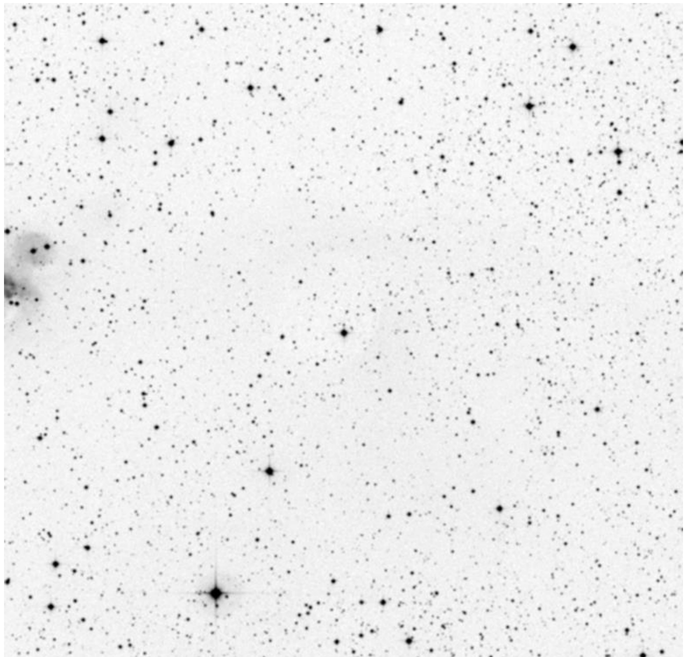
CCD FLI 4kx4k, 9µm

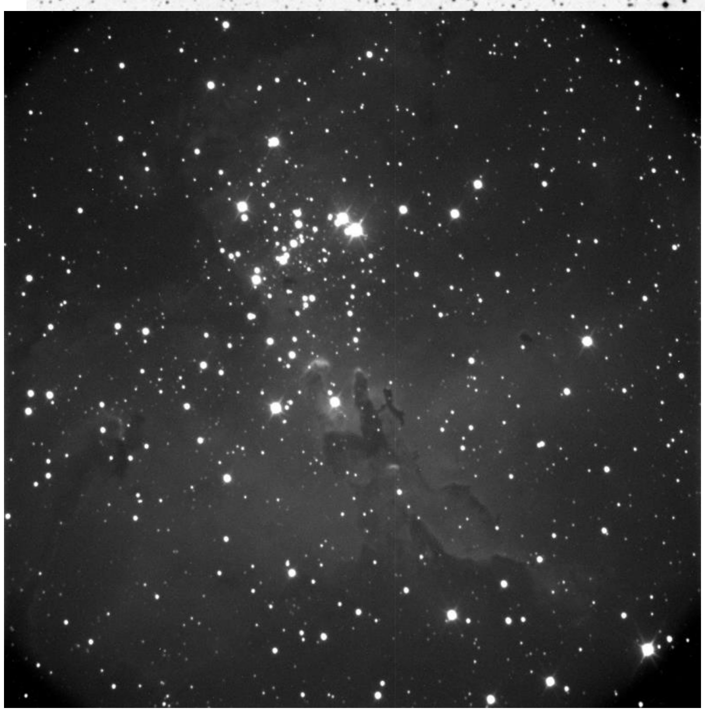


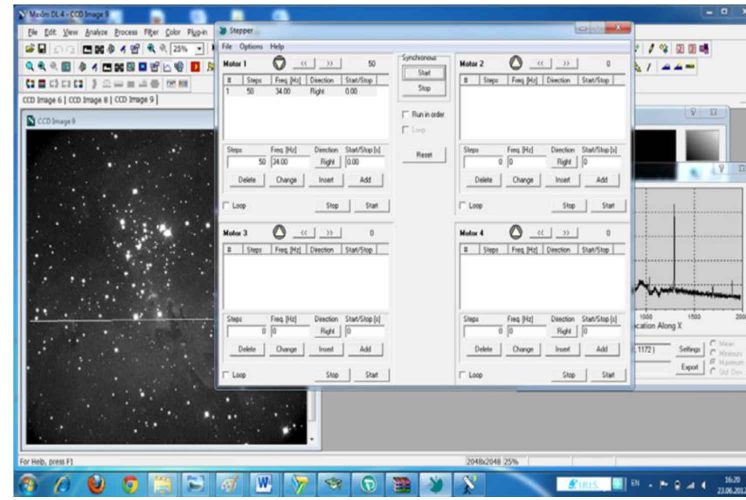


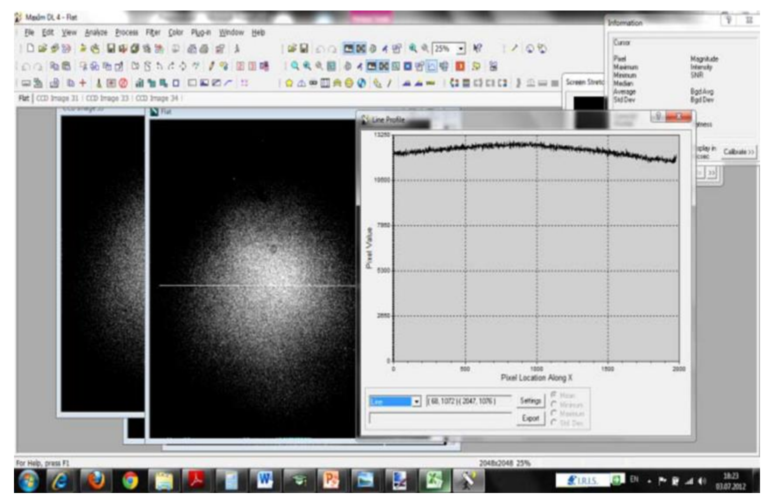


MaxDel 6

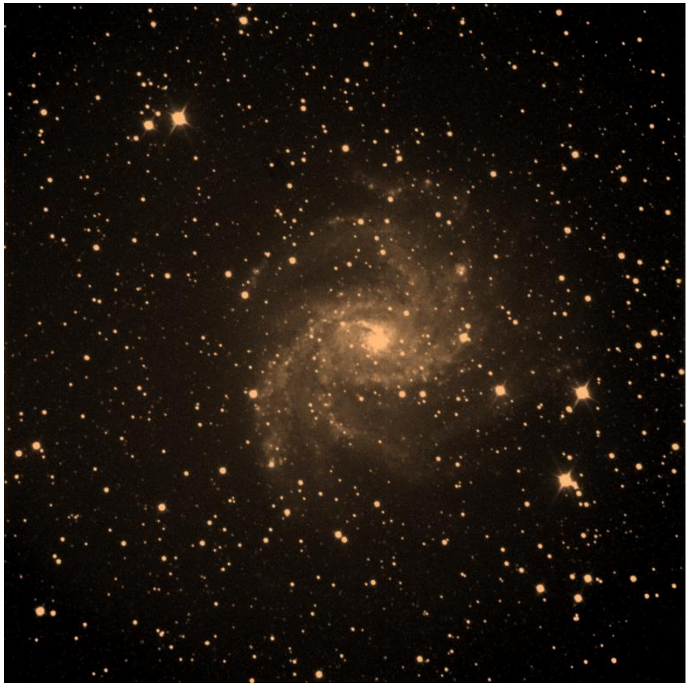




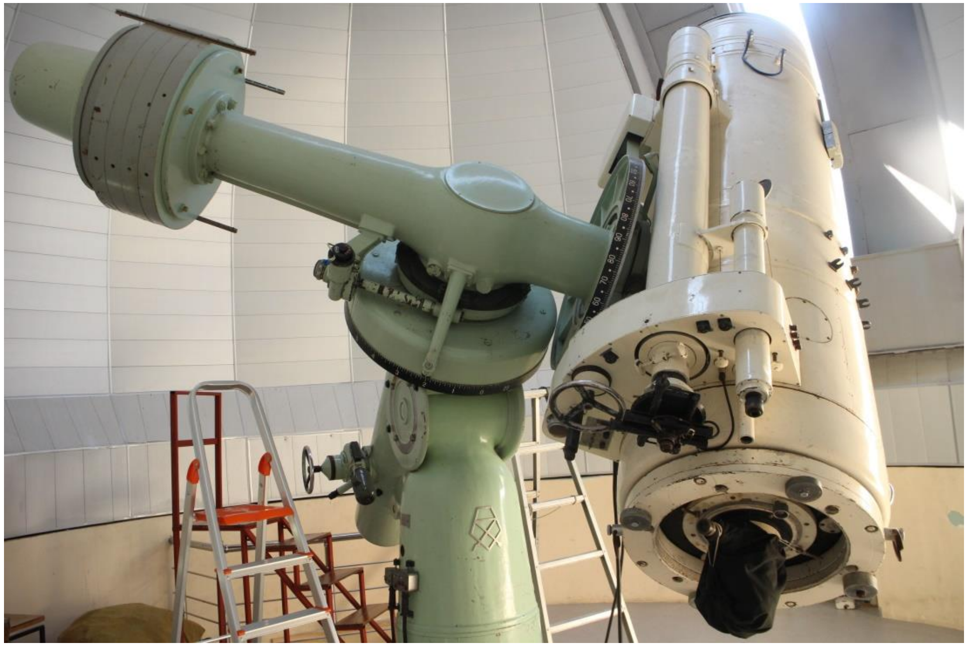


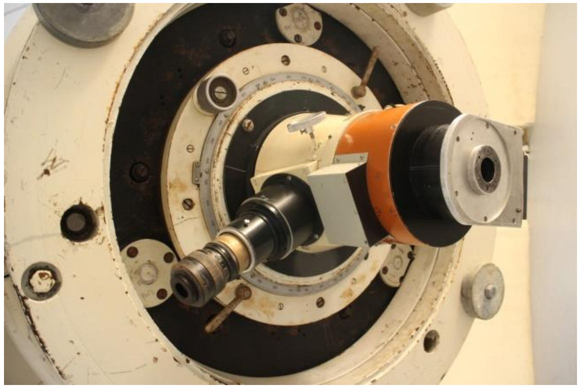


M67, M51, NGC 6946



70 cm AZT-8





35 cm, AST 452

Smidt-Maksutov system
Field 4°x4°,
Linear size of field   12 x12 cm,
Objective prism
Spectrum 1000 A/mm
CCD?

Astronomical Journal of Azerbaijan

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International relations - active

There are scientific relation between various astronomical centers of Russia, Ukraine, in a weak form of Europe. The following are the names of organizations with which scientific relations are maintained.

- Pushkov Institute of Terrestrial Magnetism, Ionosphere and Radio Wave Propagation Russian Academy of Sciences (IZMIRAN)
- Special Astrophysical Observatory of the Russian Academy of Sciences (Russia)
- Sternberg Astronomy Institute of Lomonosov Moscow State University (MSU, Russia);
- Kazan Federal University Astrophysics Department (Russia);
- Astrophysics Dpt of St Petersburg University (Russia);
- Taras Shevchenko National University of Kyiv (Ukraine);
- Kharkiv National University (Ukraine);
- Odessa Astronomical Observatory of ONU (Ukraine);
- Ilia State University (Georgia);
- Pulkovo Observatory of Russian Academy of Sciences;

International relations –weak form

- University of Hawaii (USA);
- Rabin Medical Center (Israel);
- Tel Aviv University (Israel);
- The Space Research and Technology Institute of the Bulgarian Academy of Sciences (Bulgaria);
- Université de Montréal (Canada);
- Nicolaus Copernicus University in Toruń (Poland);
- Akdeniz University (Turkey);
- Center for the Study of Space Weather and Cosmic Rays (Israel)
- Institute of Ionosphere (Kazakhstan)
- Istambul University, Turkey
- Katholieke Universiteit Leuven (Belgium);
- The Austrian Academy of Sciences (Austria);

Scientific grants and collaboration programs

- Science Development Found under President of Azerbaijan, 2011, 2015, 2018 (Russian-Azerbaijan)
- Support program of National Academy of Sciences, 2016-2017
- Partner of HORIZON 2020 collaboration program, 2019
- GRANDMA international campaign of transient objects (Kilonova) observations (photometric and spectral)

We are open for collaboration in the framework of OPTICON GAIA Science Alert program:

http://shao.az

ismailovnshao@gmail.com

Example of researches:
Photometry of TTS and Herbig Ae/Be stars
DN Tau (type CTTS) by Ismailov and Alishov (2018)

It is shown that the seasonal changes in the brightness of the star in the V-band are 0.5 -1.0 mag. The annual average brightness show a long-term cycle with a characteristic time of about 25 years. The variability of the brightness of the star, with various characteristic times is also observed, what indicated about existence of different mechanisms of brightness variation.

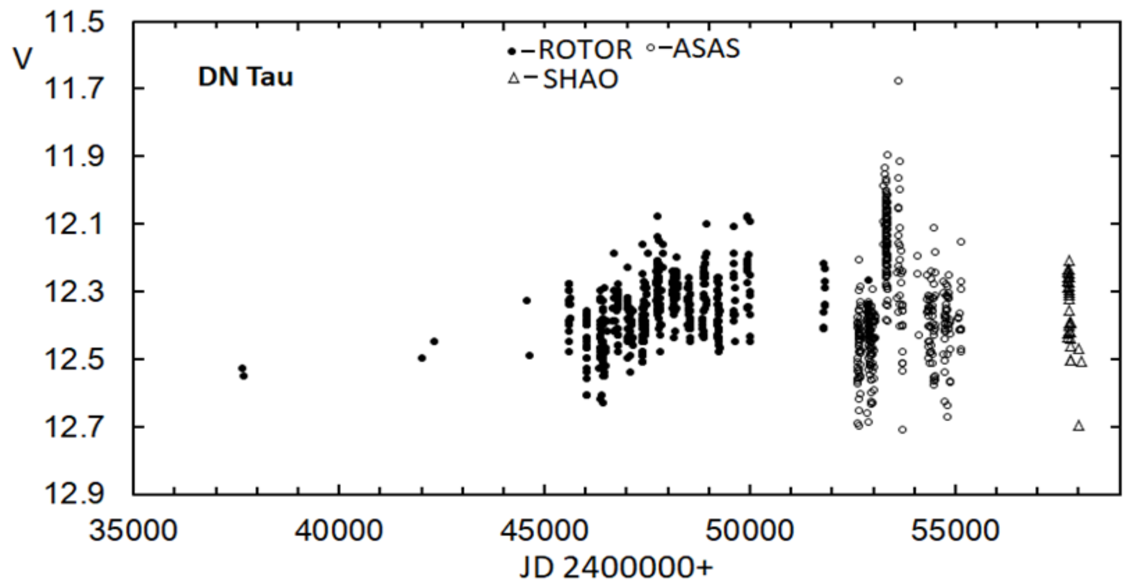
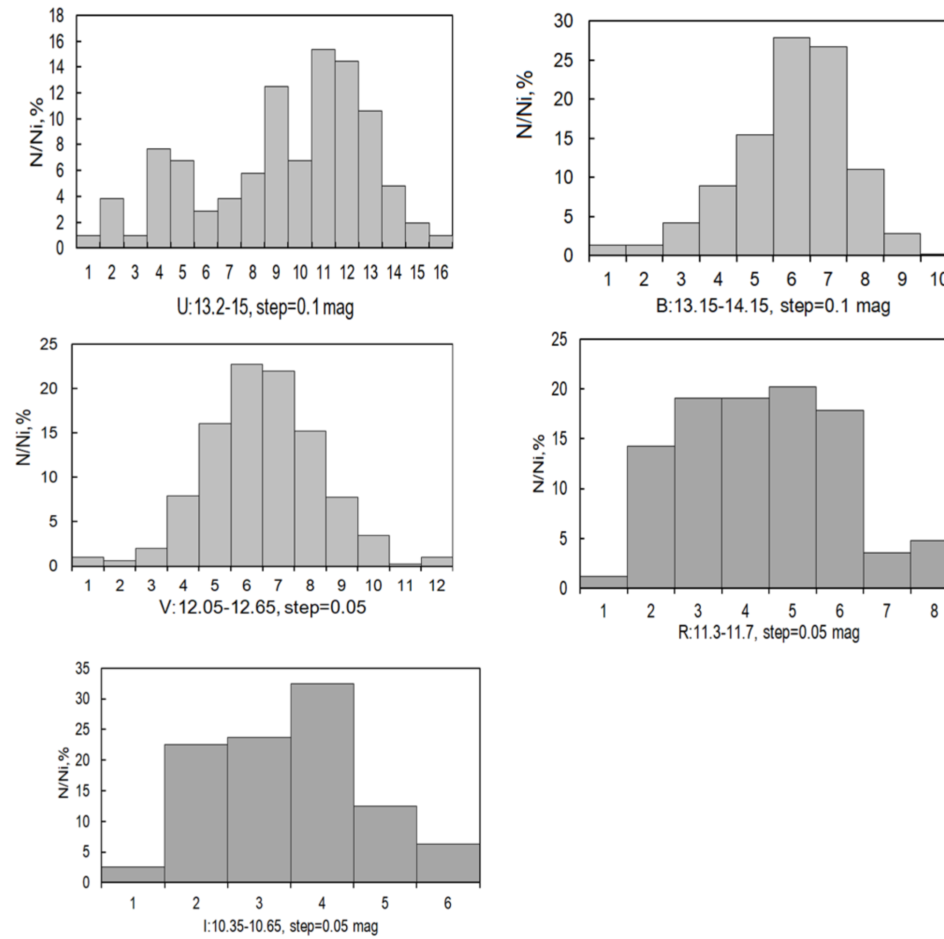


Fig.2. The master light curve of the star DN Tau. Dark cycles, is from ROTOR program data,(800 points)(light circles – ASAS (384 points), triangles,- ShAO (38 points).

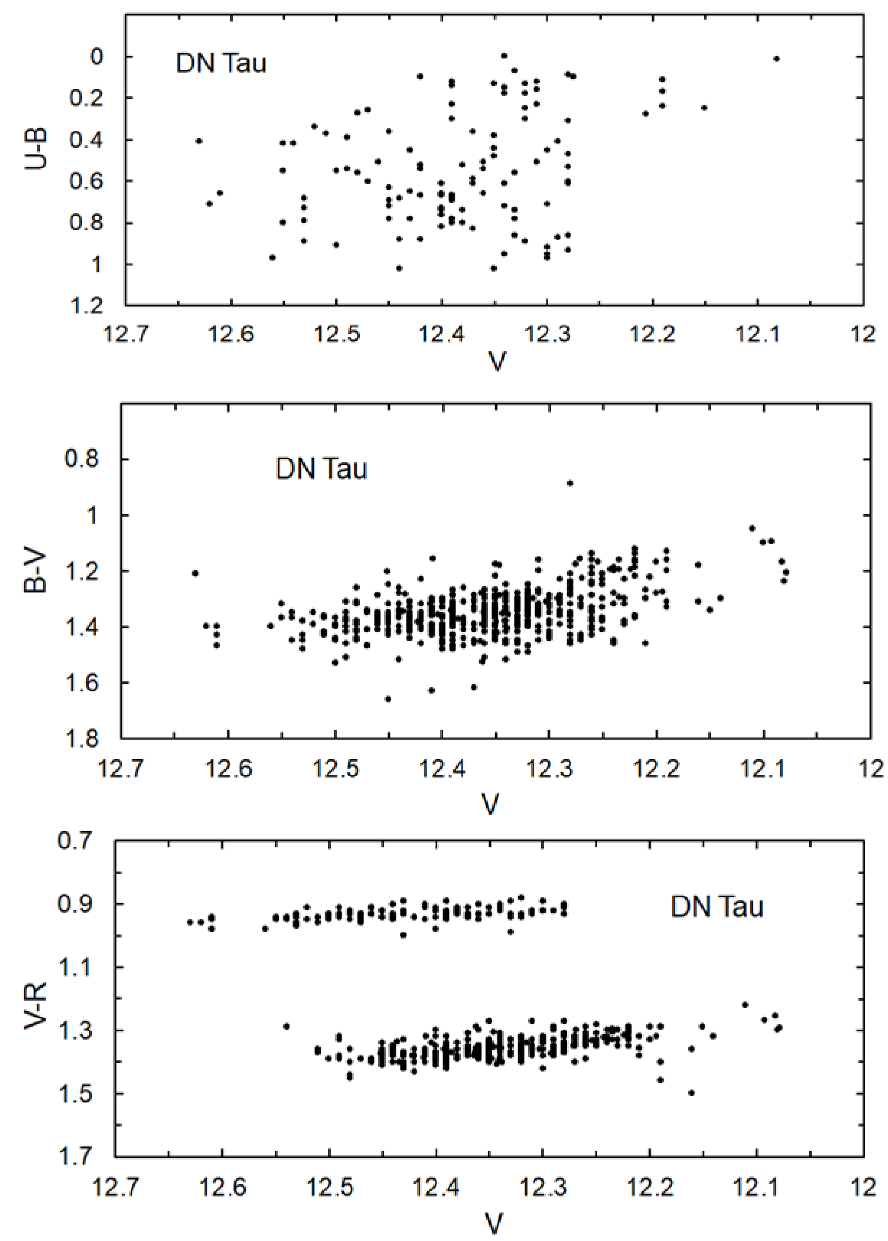
Brightness distribution (on the data ROTOR)

Figure 3. The brightness distribution in UBVRI bands of DN Tau.



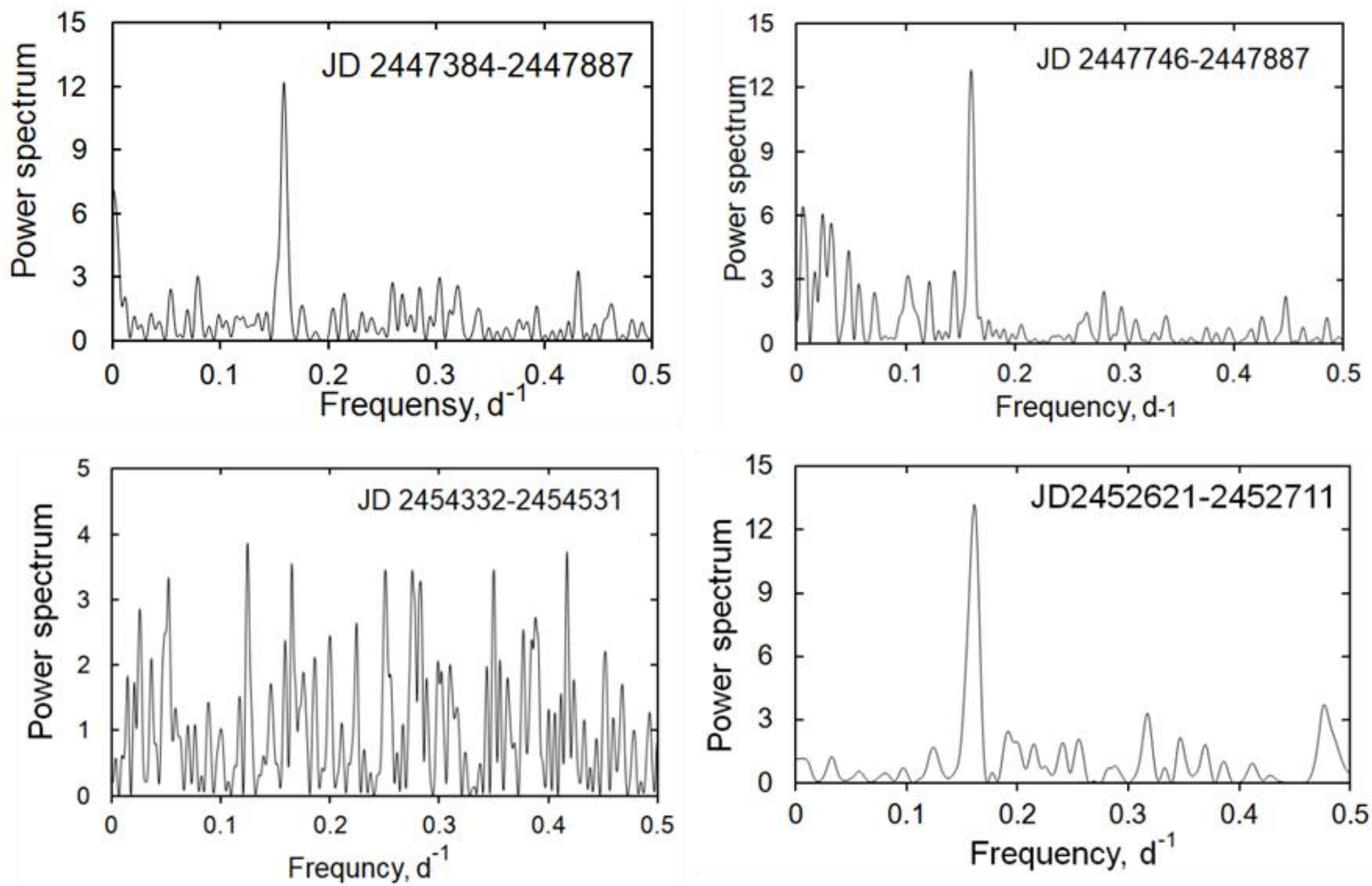
In the U and B bands, the brightness distribution has an asymmetrical form due to flare activity. In the R and I bands, the brightness distribution of the star in a large interval remains stable. It testifies that the contribution of the circumstellar disc of the star in change is insignificant and main variability mechanism is associated with the stellar surface.

Fig.4. The diagrams of color-indexes U-B, B-V and V-R versus V-brightness.



An analysis of the star's light curve by different seasons allows to detecting clearly the 6-day period of brightness variability, defined previously by other authors. The distinction in the value of period for different seasons on a few tenths of days. For average value of the period by all seasons was obtained P = 6.231 ± 0.089 days.

Fig.5. Examples of power spectrum for different groups, for V-band brightness values. In all the figures, the presence of the 6-day period is well detected.



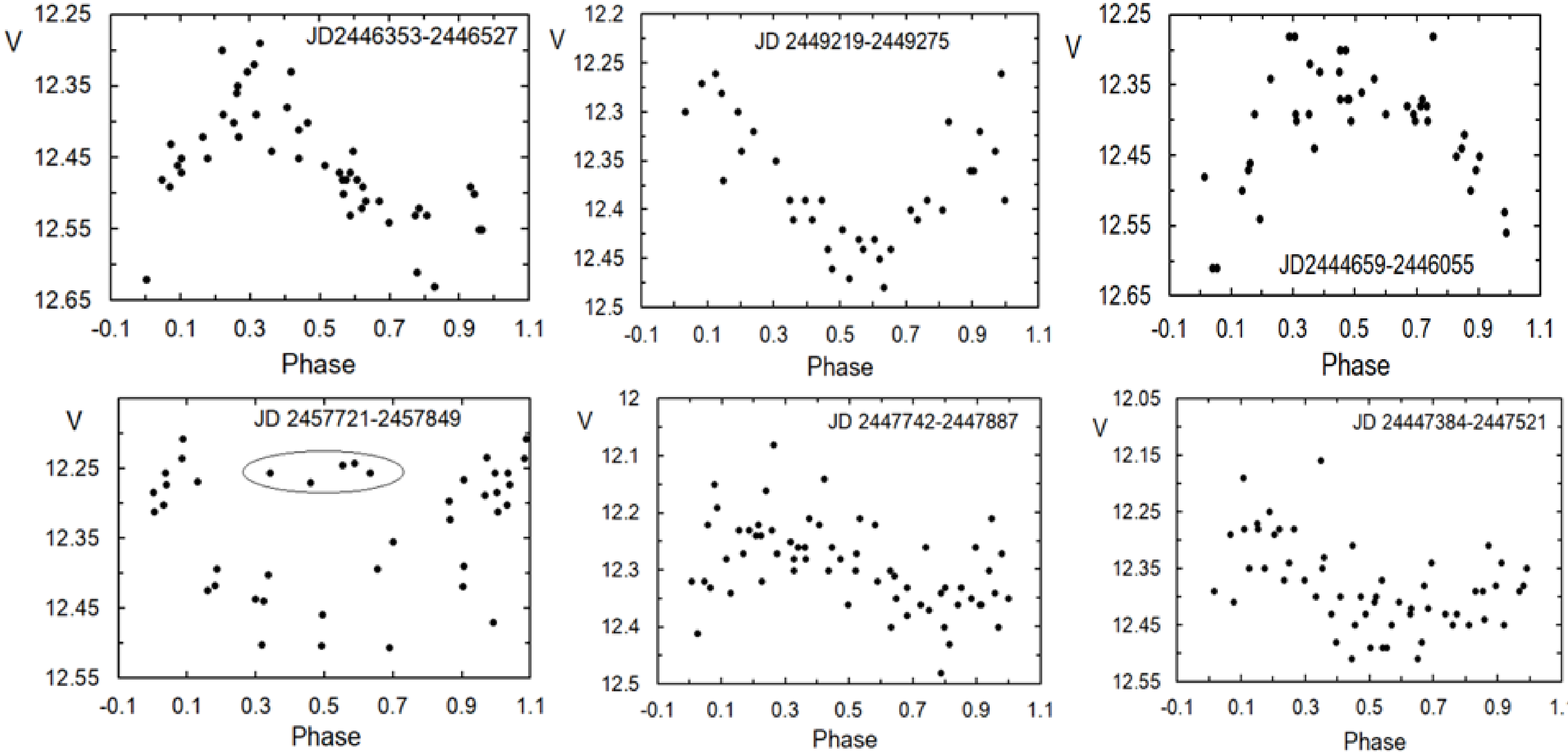
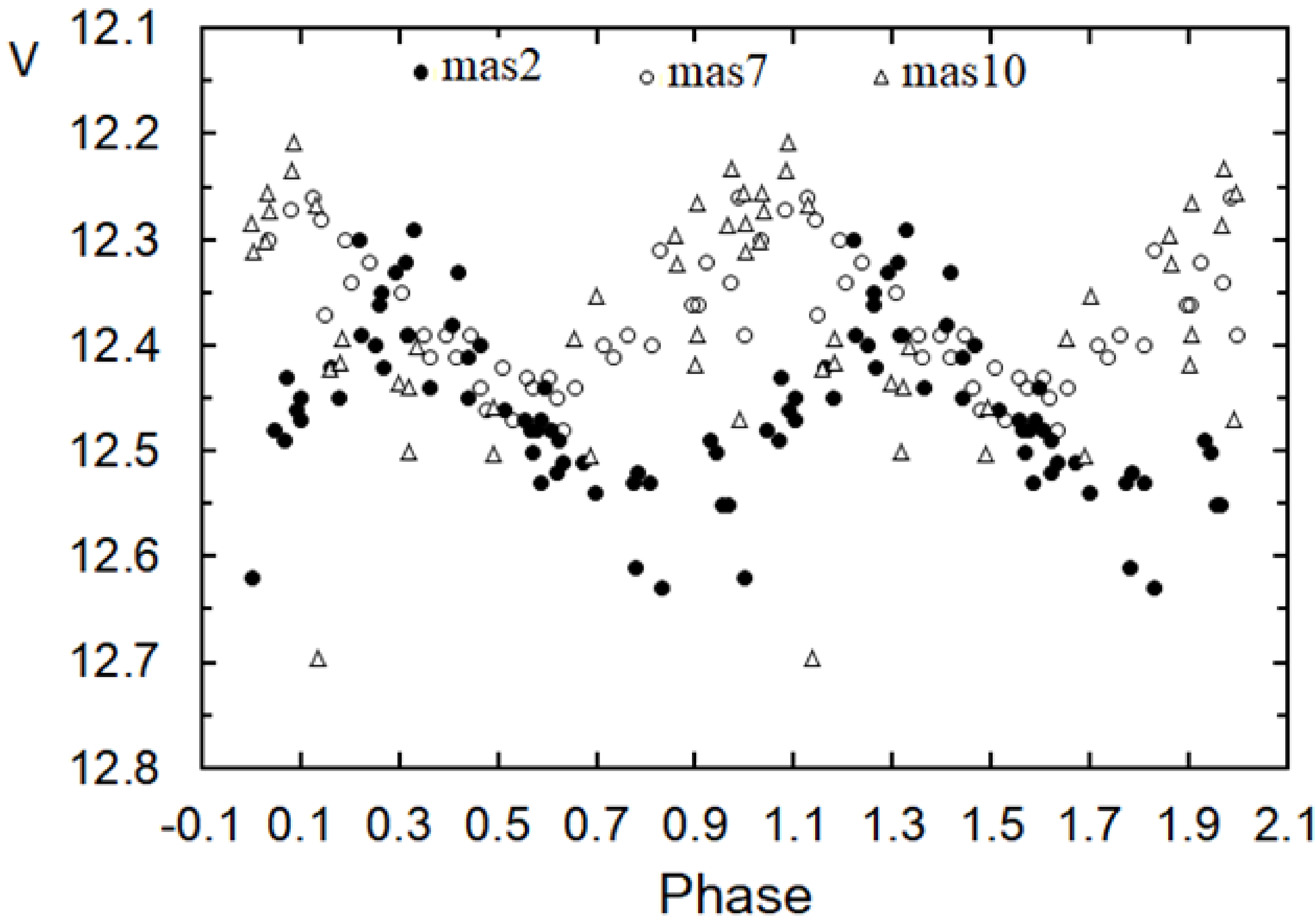


Fig.6. Phase lights curves, obtained for different seasons of observations. Bottom left panel was obtained according to our observations, where points are selected contour significantly deviating from phase curve.



Pic.9. Phase V - light curves for groups of mas2 (black dots), mas7 (circles) and mas10 (triangles) , where the groups numbers are corresponding to numbers, given in the first column of the table.5.

Conclusions

- The period of 6.3 days, previously determined by different methods, is confidently stand out in separate seasons of photometric observations;
- The periods obtained in different years differ each from other by several tenth days. Such difference of the period values, apparently is not an error in period definition, but occurs as a result of real physical processes. Such a change, for example, could occur, when spots are migrated on the surface of the star by latitude, at differential rotation of the star's atmosphere, analogically to solar;
- it is revealed that a period is changing at least for 0.3 days. In literature, various values of the rotation velocity vsini of the star are given - from 12.3 km/s to 8.1 km/s , and on the latest data by spectropolarimetric method was obtained 9 ± 1 km/s and for angle i = 35 ± 10°. If we assume, that various values of the period are observed due to differential rotation in the atmosphere and migration of spots by latitude, then at angle of inclination of the axis 35° and in difference of periods by $\Delta P = 0.6$ days upper limit for differences of rotation velocity relative to the equator would be only ~2 km/s.
- It was shown, that phase light curve, for the period of 6.3 days show a significant shift by separate seasons. Maximum shift in phases is about 0.7P. The cause of such phase shifts can be occurred by appearing of star spots in different seasons, in various stellar longitudes.

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Thank you for attention

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