Byurakan Astrophysical Observatory Plate Archive and its scientific usage

Areg Mickaelian
Byurakan Astrophysical Observatory (BAO)

Astroplate workshop
18-21 Mar 2014, Prague, Czech Republic

Overview

Byurakan Astrophysical Observatory

Telescopes and observational material

Observational programs accomplished in BAO

BAO Plate Archive

BAO Electronic Observational Database

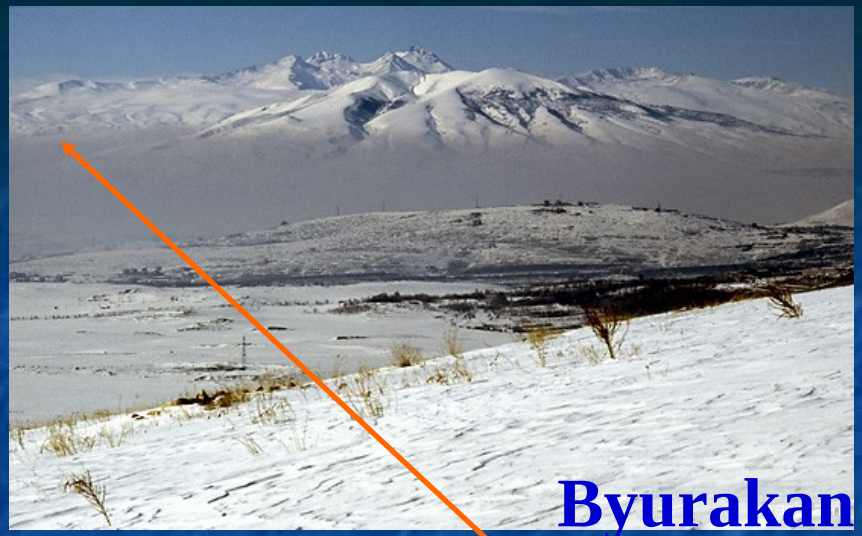
Digitization projects

Science projects based on BAO Plate Archive data

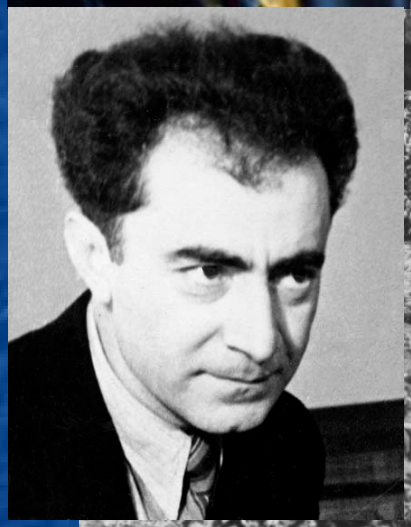
Armenian Virtual Observatory (ArVO), IVOA

Comparison of past and present observations

Armenia & BAO



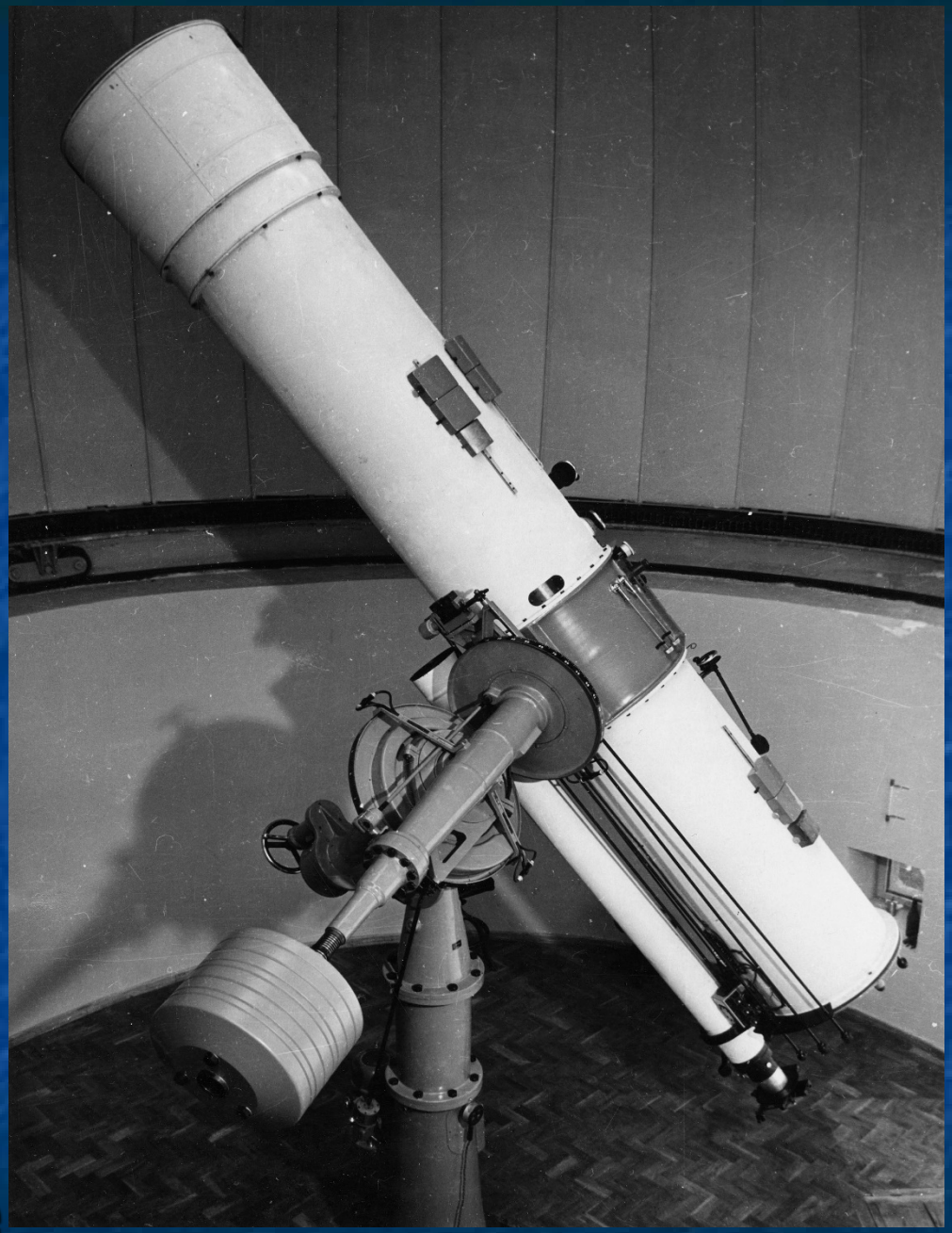
Southern slope of Mt. Aragatz,
near village Byurakan, 30km Northwest of Yerevan, founded in 1946



BAO. Ambartsumian's discoveries and theories, Markarian, Arakelian, and Kazarian galaxies, Shahbazian compact groups, T Tauri and flare stars, HH objects, SNe, FBS and SBS objects, IRAS sources

BAO telescopes & observational material

Telescope name	Size (cm)	Years	Observ. methods	Plates
5" double-astrograph	13	1947-1950	photometry	3000
6"	15	1947-1950	photometry	3000
8" Schmidt	20/20/31	1949-1968	photometry	4500
20" Cassegrain	51/800	1952-1991	electrophotometry	
10" tel.-spectrograph	25	1953-	spectra	
nebular spectrograph		1954-	spectra	
16" Cassegrain	41/400	1955-1991	electropolarimetry	
21" Schmidt	53/53/183	1955-1991	photometry	12000
40" Schmidt (AZT-10)	102/132/213	1960-1991	photom., spectra	7500
ZTA-2.6m	264/1016	1975-1991	photom., spectra	7000
All telescopes		**1947-1991**		**37000**

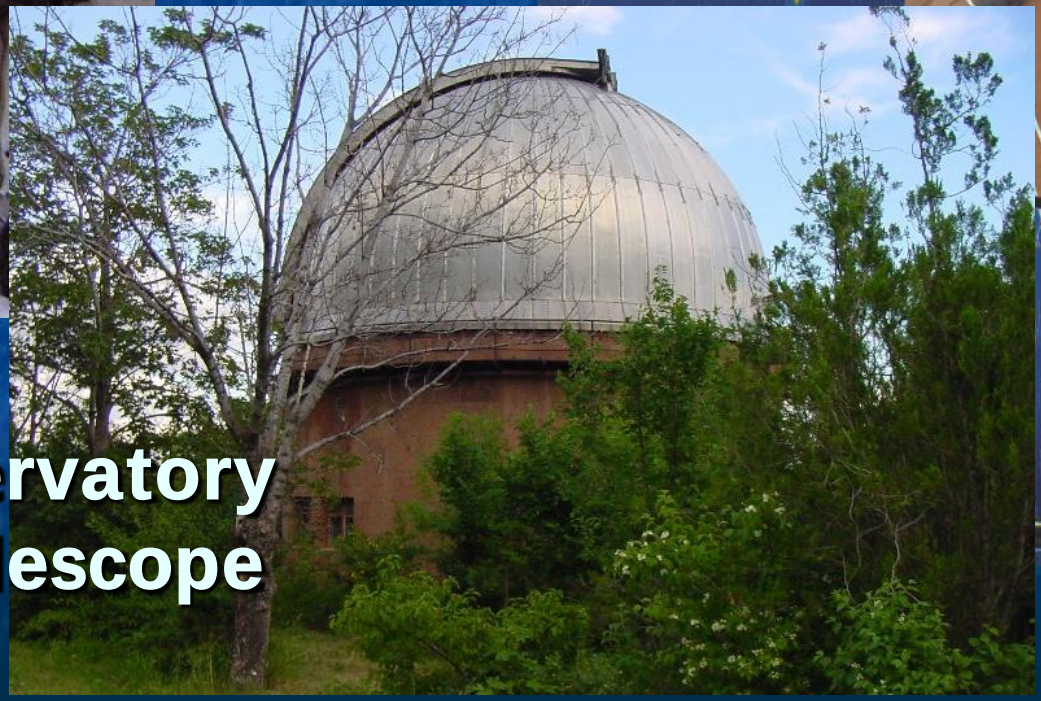


Byurakan Observatory
0.5m Schmidt telescope
1955-1991

Main observational projects

21” (0.5m) Schmidt telescope:

Polarization of cometary nebula NGC 2261
Nuclei of nearby Sa and Sb galaxies
Nuclei of nearby Sc galaxies
Search for flare stars in Pleiades
Search for flare stars in Orion
Search for flare stars in NGC 7000 (Cygnus)
Search for flare stars in Praesepe
Search for flare stars in Taurus Dark Clouds
Variability of Markarian galaxies
Monitoring of extragalactic supernovae in certain areas

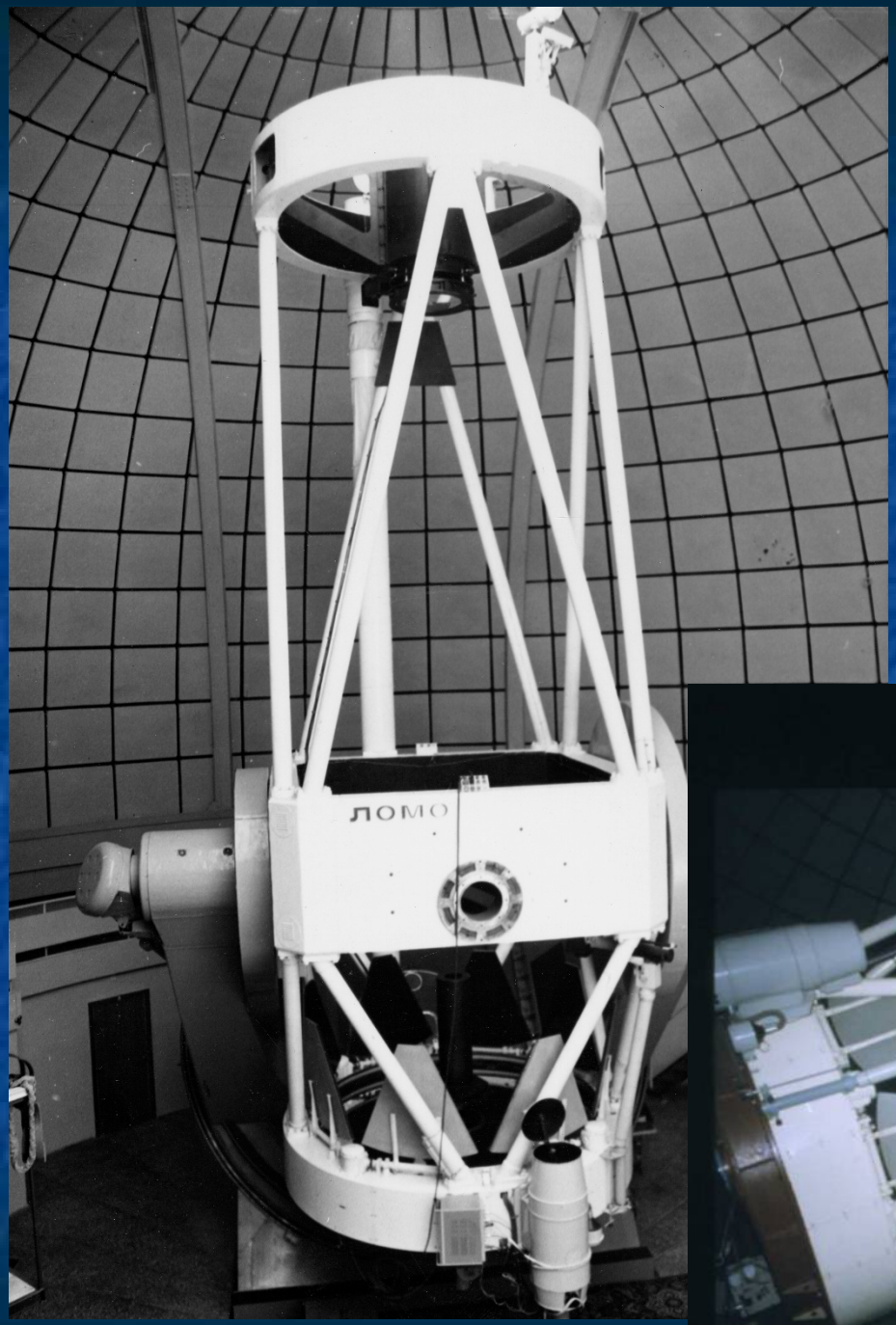


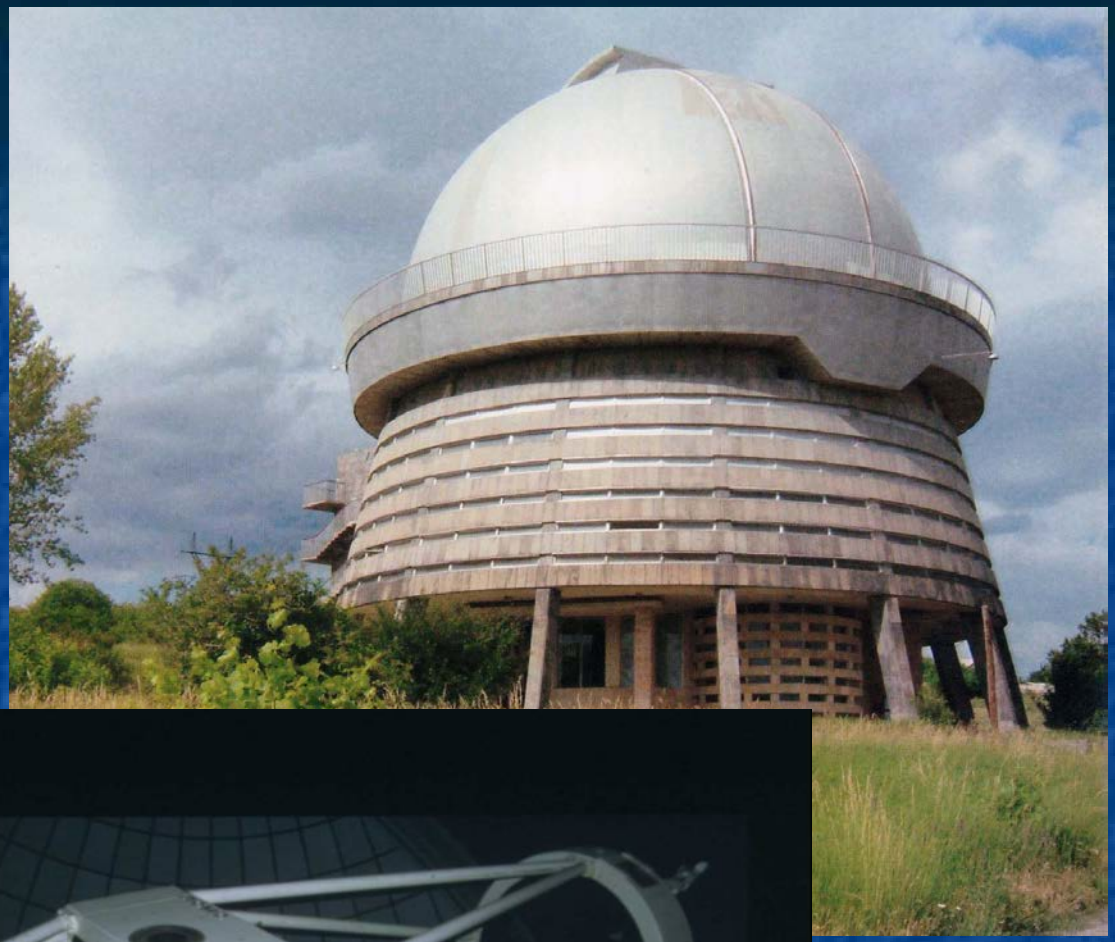
Byurakan Observatory
1m Schmidt telescope
1960-1991

Main observational projects

40” (1m) Schmidt telescope:

Detailed colorimetry of bright galaxies
First Byurakan Survey (FBS, Markarian survey)
Search for flare stars in Pleiades
Search for flare stars in Orion
Search for flare stars in NGC 7000 (Cygnus)
Search for flare stars in Praesepe
Search for flare stars in Taurus Dark Clouds
Second Byurakan Survey (SBS)
Extension of the FBS in the Galactic Plane





Byurakan Observatory
ZTA-2.6m telescope
1976-1991

Main observational projects

ZTA-2.6m telescope:

Morphological study of Markarian galaxies
Investigation of star clusters
Investigation of groups and clusters of galaxies
Spectroscopy FBS blue stellar objects
Spectroscopy FBS late-type stars
Spectroscopy SBS galaxies and stellar objects (BAO/SAO)
Direct images of the central regions of Markarian galaxies
Spectroscopy of T Tauri and flare stars
Spectroscopy of Byurakan-IRAS Galaxies (BIG objects)
Spectroscopy of ROSAT AGN candidates (BAO/HS/OHP/INAOE)

Byurakan Observatory: other telescopes

Yerevan State University (YSU) Observatory
0.2m telescope

Library of photographic plates – Plate Archive

Before observers kept plates and films at their offices! There was no rule for storage and preservation.

Plate Archive was organized in 1986, Head: J.A. Stepanian
Collected >20,000 plates and thousands of spectra on films; person in charge: G.B. Ohanian (1994-2009)
Persons in charge: S.K. Sinamyan (2009-2012), G.M. Paronyan (2012-), members of ArVO group

Digitization team: A.M. Mickaelian, K.S. Gigoyan, L.K. Erastova, L.A. Sargsyan, P.K. Sinamyan

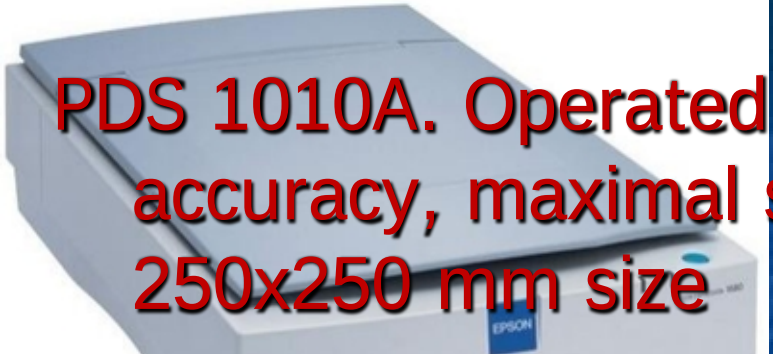
Electronic Plate Archive is now being created **> > >**

BAO Electronic Database
Observational projects

Dates / Julian dates
Telescope
Observing modes/methods
Instrument
Receiver
Emulsion
Filters
Seeing
Project name
Project PI
Observers

Targets / coordinates
Sky area
Surface
Scale
Spatial resolution
Spectral range
Spectral resolution
Limiting magnitude
Number of nights
Number of exposures
Links

Scanning possibilities



PDS 1010A. Operated with (old) PDP8 computer, 1mu accuracy, maximal speed of Stage motion 40 mm/sec, 250x250 mm size

EPSON Expression 1680 Pro & EPSON Perfection V750 3200 dpi resolution, 16 bit dynamic range, transparency mode (pos-neg), A4 size

Test scanning of DFBS plates with:

1995-1996:	PDS-1010 (Byurakan)
1995-2001:	Canon, HP, Epson scanners (Byurakan)
1996:	APM (Cambridge, UK)
1999:	MAMA (Paris, France)
2002-2003:	EPSON Expression 1680 Pro (Rome, Byurakan)
2003:	StarScan (USNO, Washington, DC, USA)

The First Byurakan Survey (FBS)

Authors:	*B.E.Markarian, V.A.Lipovetsky, J.A.Stepanian*
Years:	*1965-1980*
Instruments:	*102/132/213 cm Byurakan Schmidt telescope* *1.5° objective prism (1800 Å/mm at Hγ)*
Emulsions:	*Kodak IIA-F, IIa-F, 103a-F, II-F*
Spectral range:	*3400-6900 Å with a sensitivity gap near 5300 A*
Field:	*4.1° × 4.1° (plates: 16 × 16 cm)*
Scale:	*96.8 ″/mm*
Region of sky:	*$\delta \geq -15°$, $\|b\| > 15°$*
Total area:	*17,056 sq. degree (1139 fields, more than 1874 plates)*
Limiting magn:	*17^m-17.5^m ($\leq 18.5^m$)*
Main goal:	*selection of UV-excess galaxies*
Selected objects:	*UV gal, Sy, QSO, BLL, LINER, SB, HII, radiogalaxies, etc.*
Number of objs:	*1515*
Publication:	*15 lists (1967-1981), 2 catalogs (Mazzarella & Balzano 1986, Markarian et al. 1989)*

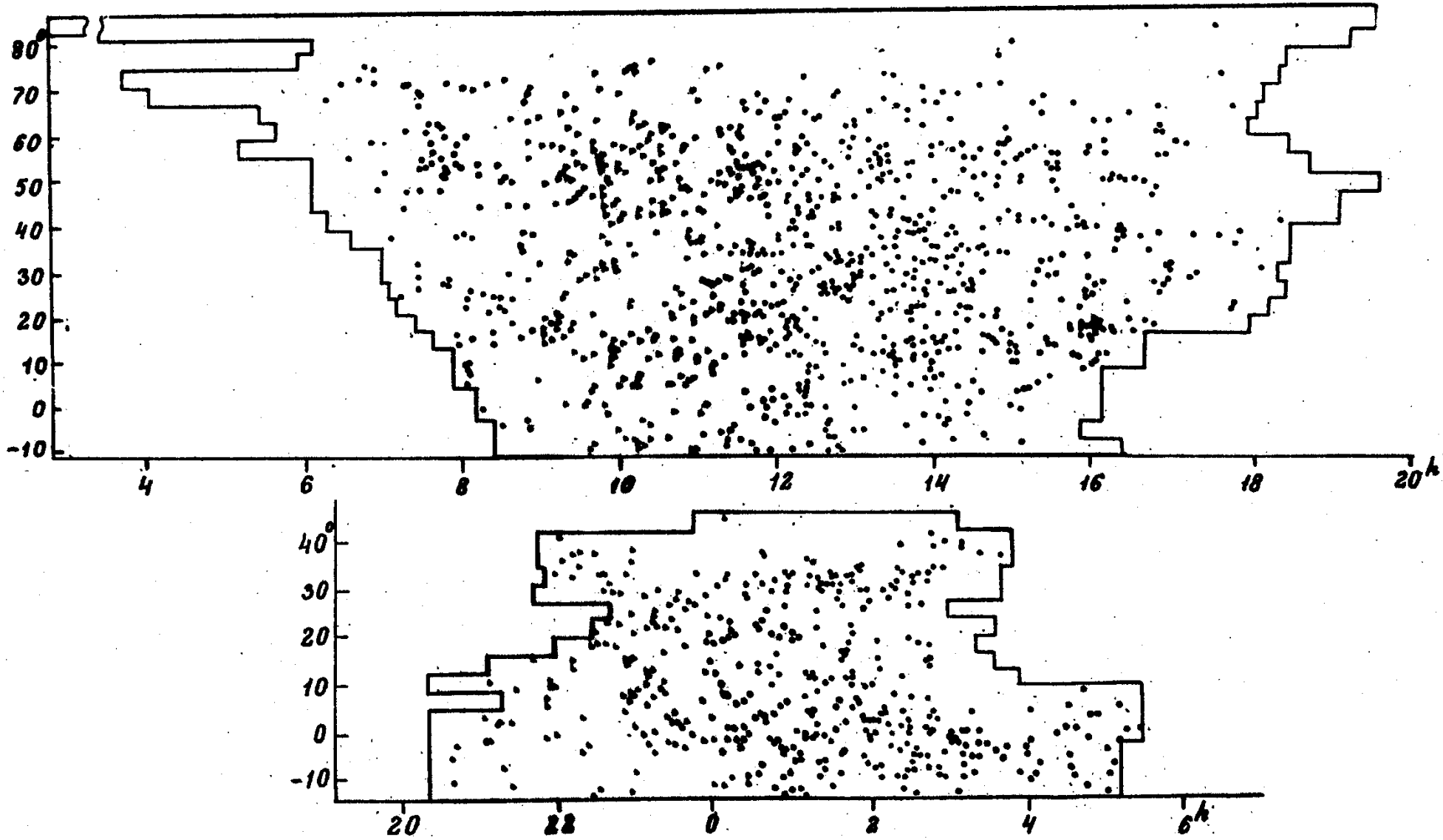


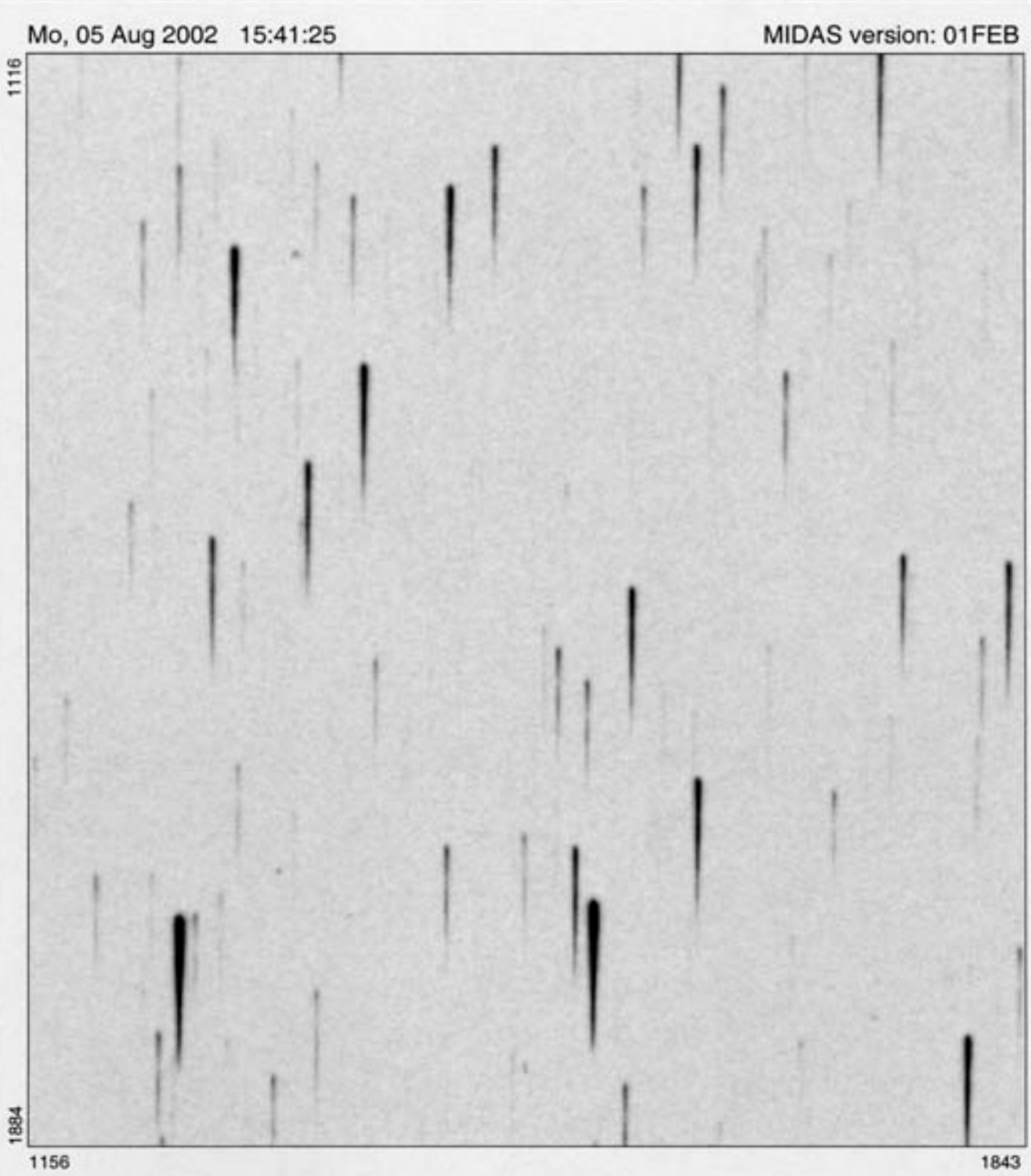
Fig. 1. Markarian galaxy distribution on the celestial sphere.

The Markarian Survey

- First systematic objective-prism survey
- The largest objective-prism survey of the Northern sky (17,000 sq. deg)
- New method of search for AGNs
- 1515 UVX galaxies: 181 Seyferts, 17 LINERs, 13 QSOs, 3 BLLs, 95 Starburst, 26 HII galaxies
- Classification of Seyferts: Sy1 & Sy2
- Definition of Starburst galaxies
- Other projects: FBS BSOs, RS, opt. ident. (BIG & BIS objects)

- *scanning*
- *astrometric solution*
- *extraction*
- *wavelength calibration*
- *density and flux calibration*
- *multiband (UBVR) photometry*
- *making up template spectra*
- *numerical classification*
- *DFBS catalog and database*
- *web page and user interface*

Collaboration between Byurakan Astrophys. Observ. (BAO, Armenia), La Sapienza Univ. di Roma (Italy), and Cornell Univ. (Ithaca, NY, USA)



Main features:

Pixel size 15.875μ or 1.542″

9601×9601 pixels each plate

180 MB file for each plate

107*pix* × 5*pix* spectra (1700μ length)

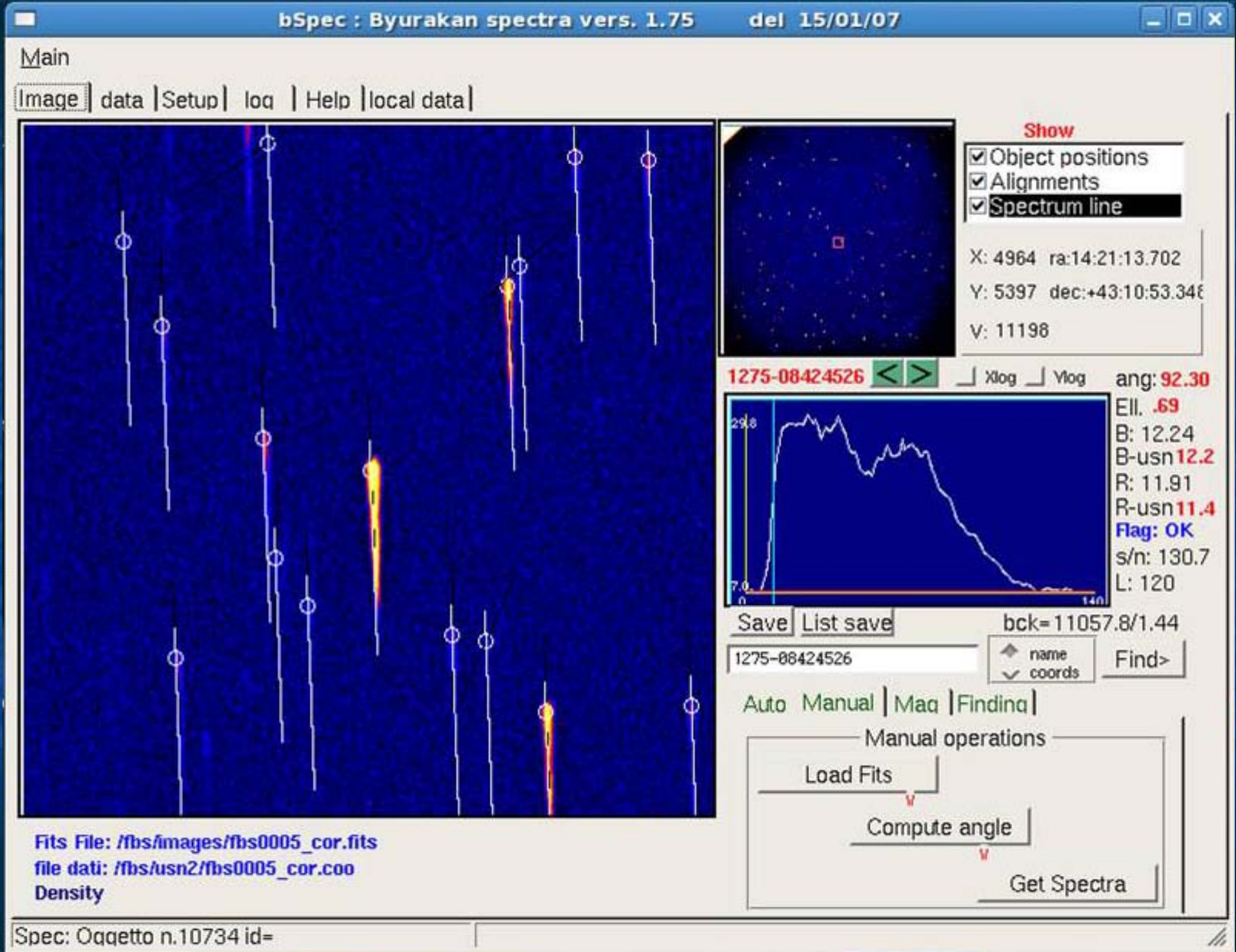
Astrometric solution ~1″ rms

Dispersion: 33A/pix (22-60 from B to R)

Photometric accuracy ~0.3m

1874 plates, ~400GB

40,000,000 spectra for 20,000,000 objects


bSpec : Byurakan spectra vers. 1.75 del 15/01/07
Main
Image
data
Setup
log
Help
local data
Show
Object positions
Alignments
Spectrum line
X: 4964 ra:14:21:13.702
Y: 5397 dec:+43:10:53.348
V: 11198
1275-08424526
Xlog
Ylog
ang: 92.30
Ell. .69
B: 12.24
B-usn 12.2
R: 11.91
R-usn 11.4
Flag: OK
s/n: 130.7
L: 120
Save
List save
bck=11057.8/1.44
1275-08424526
name
coords
Find>
Auto
Manual
Mag
Finding
Manual operations
Load Fits
Compute angle
Get Spectra
Fits File: /fbs/images/fbs0005_cor.fits
file dati: /fbs/usn2/fbs0005_cor.coo
Density
Spec: Oggetto n.10734 id=

First Byurakan Survey Database - Mozilla

File Edit View Go Bookmarks Tools Window Help

http://byurakan.phys.uniroma1.it/explore2.php?ra_in=21%3A32%3A03&dec_in=-12%3A

Home Bookmarks

DFBS archive

Digitized First Byurakan Survey

EXPLORE GET SPECTRA CREDITS

GET IMAGE TEAM

center

Ra 21:32:03

Dec -12:47:42

get Image

Options

Grid

Label

Position

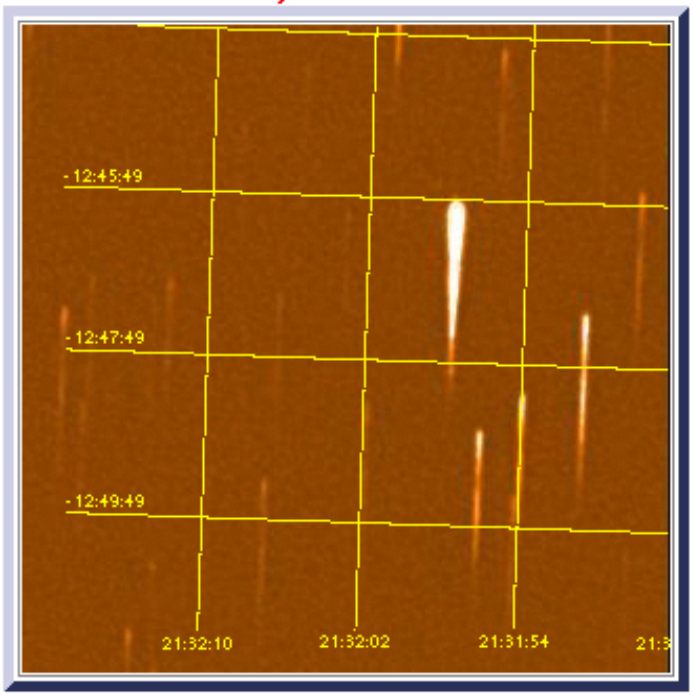
Compare with.

DSS1

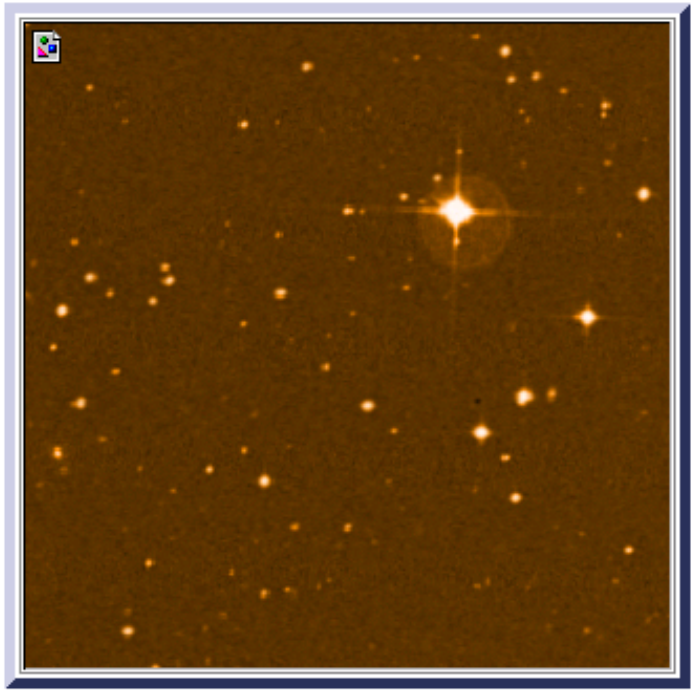
Image found in plate fbs1053

centered at (21:31:43.208, -12:45:22.17)

Byurakan field



DSS1



Help

Spectra selection

Document: Done (0.092 secs)

First Byurakan Survey Database - Mozilla

File Edit View Go Bookmarks Tools Window Help

http://byurakan.phys.uniroma1.it/getspectra.php

Home Bookmarks

DFBS archive

Digitized First Byurakan Survey

EXPLORE GET SPECTRA CREDITS

GET IMAGE TEAM

Query type

single

center

Ra 21:32:03

Dec -12:47:42

size: 10 amin

Radius Box

get spectra

options

Order by ra

and by dec

mag range

-7. ≤ R ≤ 17

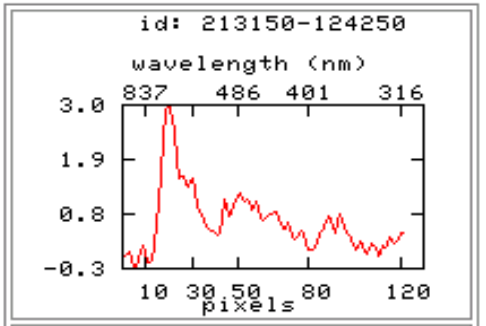
lines in table 50

Download as text file with inline spectra Go!

selected 31 of 31 records Download this table log file

Spectra List Table

#.	id.	ra(2000)	dec(2000)	B mag	R mag	B-R
1	213143-124622	21:31:43	-12:46:22	15.38	14.29	1.09
2	213148-124541	21:31:48	-12:45:41	14.85	14.10	0.75
3	213148-125004	21:31:48	-12:50:04	16.39	15.84	0.55
4	213150-124250	21:31:50	-12:42:50	15.16	14.17	0.99
5	213150-124437	21:31:50	-12:44:37	16.84	15.92	0.92
6	213150-124714	21:31:50	-12:47:14	13.10	12.46	0.64
7	213154-124814	21:31:54	-12:48:14	14.10	12.90	1.20
8	213154-124927	21:31:54	-12:49:27	16.02	13.96	2.06
9	213155-124419	21:31:55	-12:44:19	15.52	14.30	1.22
10	213155-124400	21:31:55	-12:44:00	15.53	14.31	1.22
11	213156-124841	21:31:56	-12:48:41	14.10	12.93	1.17
12	213157-124559	21:31:57	-12:45:59	10.42	11.04	-0.62
13	213158-124307	21:31:58	-12:43:07	16.24	16.07	0.17
14	213158-124534	21:31:58	-12:45:34	10.38	11.01	-0.63
15	213200-124549	21:32:00	-12:45:49	17.09	16.73	0.36

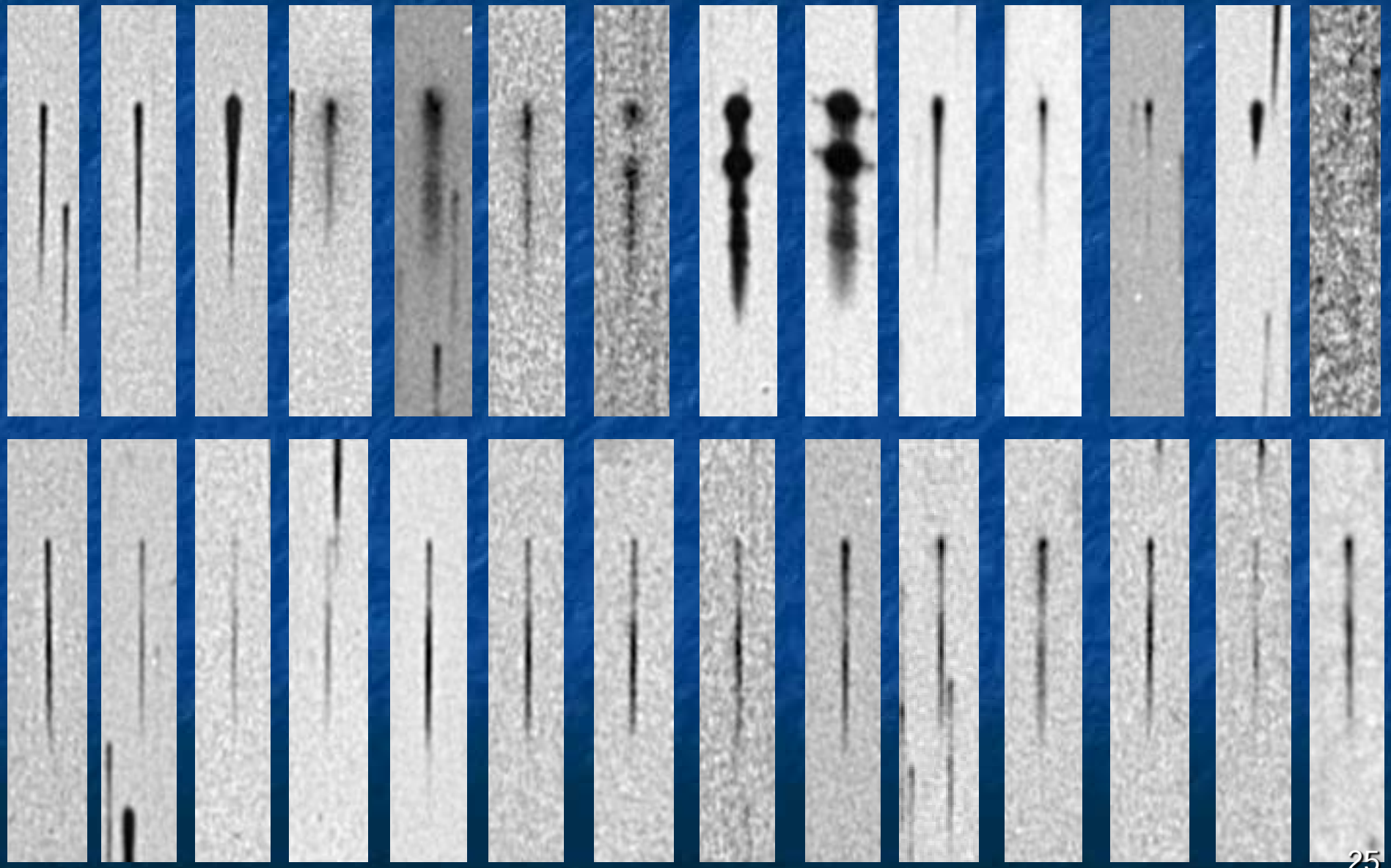


(J2000) ra:	21:31:50.273
(J2000) dec:	-12:42:50.61
R:	14.17
B:	15.16
Class:	U
Length:	110.0
Plate:	fbs1053

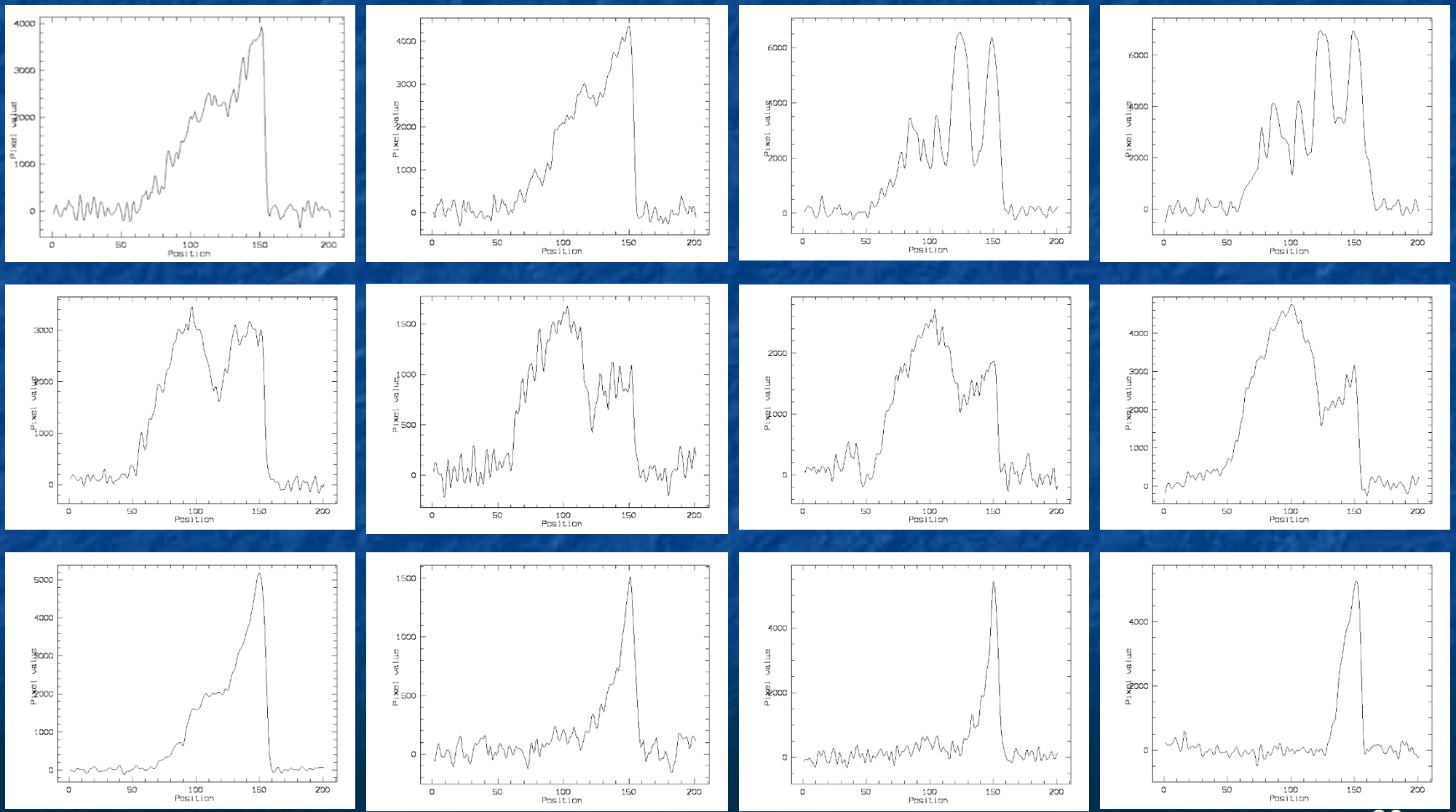
collect view collection

http://byurakan.phys.uniroma1.it/getSpec3.php?id=145...l10jg8r4u2g3m955ftr953&angoloMedio=&tmptable=spectmp

DFBS low dispersion spectra



DFBS low dispersion spectra



Other digitization projects:

Second Byurakan Survey (SBS)

Authors: *B.E.Markarian, J.A.Stepanian, L.K.Erastova, V.H.Chavushyan*
Years: *1978-1991*
Instruments: *102/132/213 cm Byurakan Schmidt, 1.5°, 3° & 4° prisms (1800 Å/mm, 900 Å/mm & 280 Å/mm at Hγ)*
Emulsions: *Baked Kodak IIIa-J, IIIa-J+GG495, IIIa-F+RG2, IV-N*
Spectral range: *3400-5300 Å, 4950-5400 Å, 6300-6950 Å*
Field: *4.1°× 4.1° (plates: 16×16 cm)*
Scale: *96.8 ″/mm*
Region of sky: *49°≤δ≤ 61°, |b| > 30° ($7^h43^m \le \alpha \le 17^h15^m$)*
Total area: *965 deg^2 (65 fields, 550 plates)*
Limiting magn: *18^m-20^m in V (completeness is $\le 17.5^m$)*
Main goal: *Extension of the FBS to fainter magnitude limits*
Methods: *UVX / emission lines / SED*

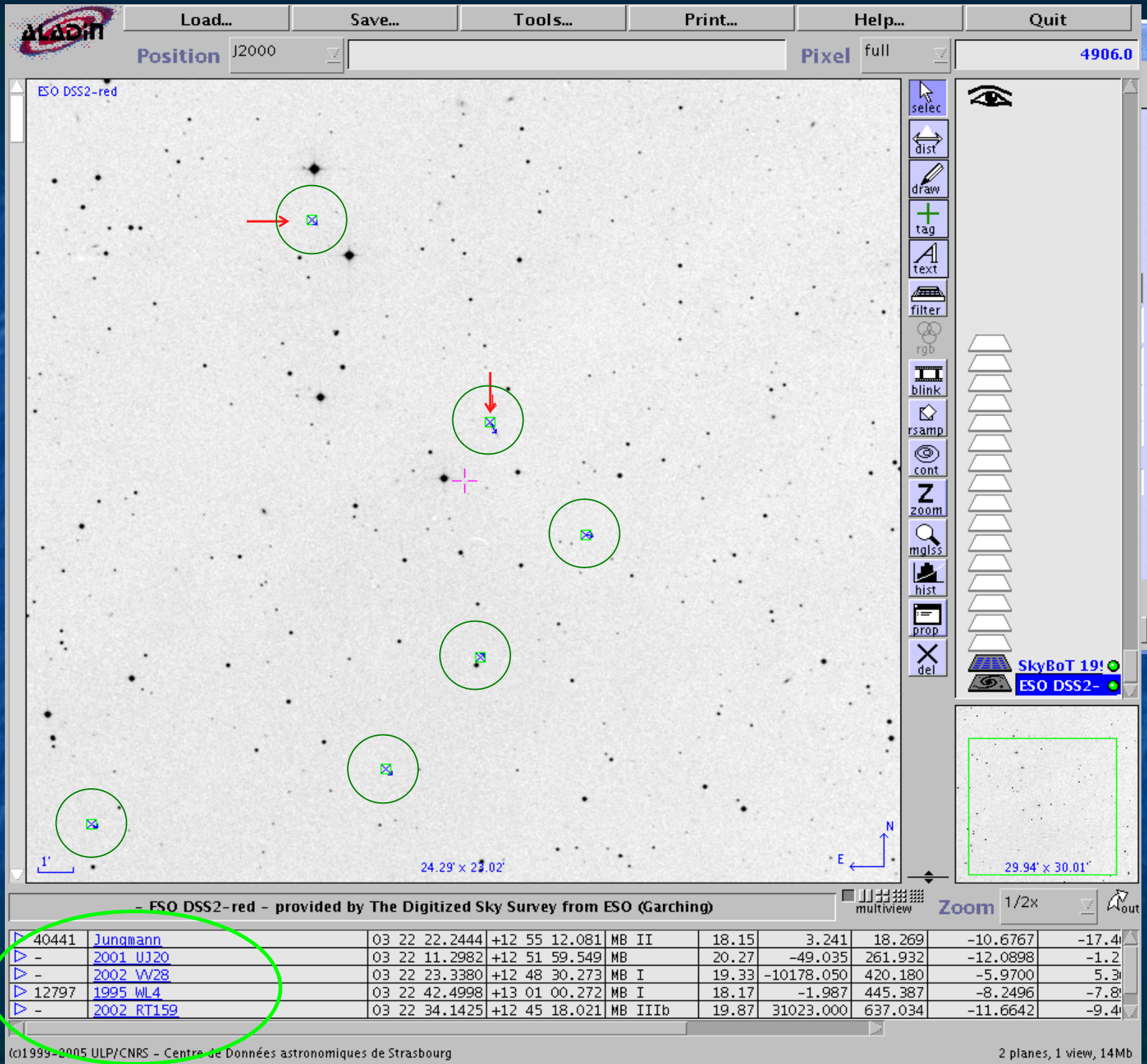
Digitization: *since 2003: 16 bit, 2400 dpi (10μ pixel size); 180 SBS plates*

Science projects based on BAO Plate Archive data

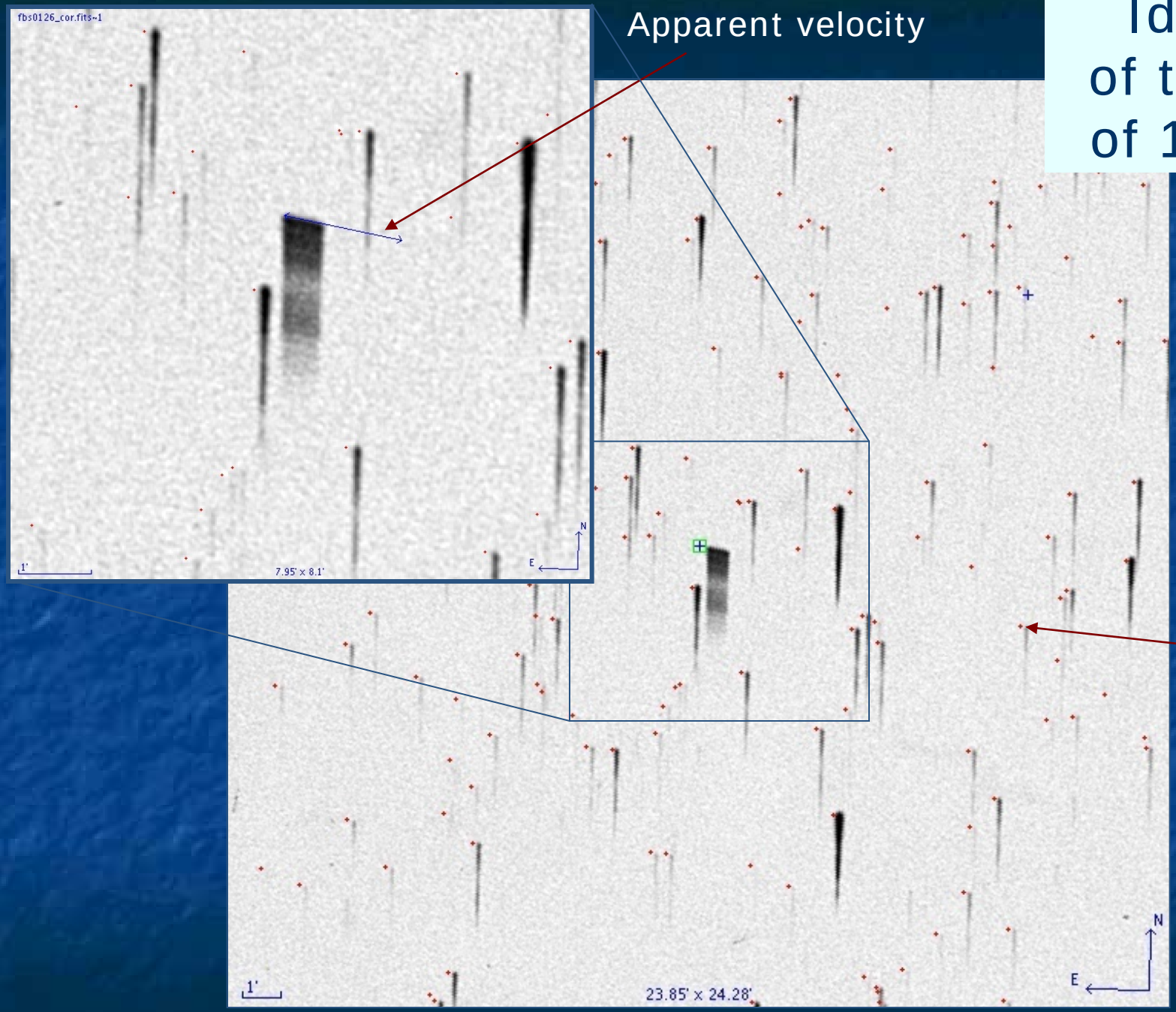
Search for Asteroids in the DFBS

Aladin and SKYBOTE

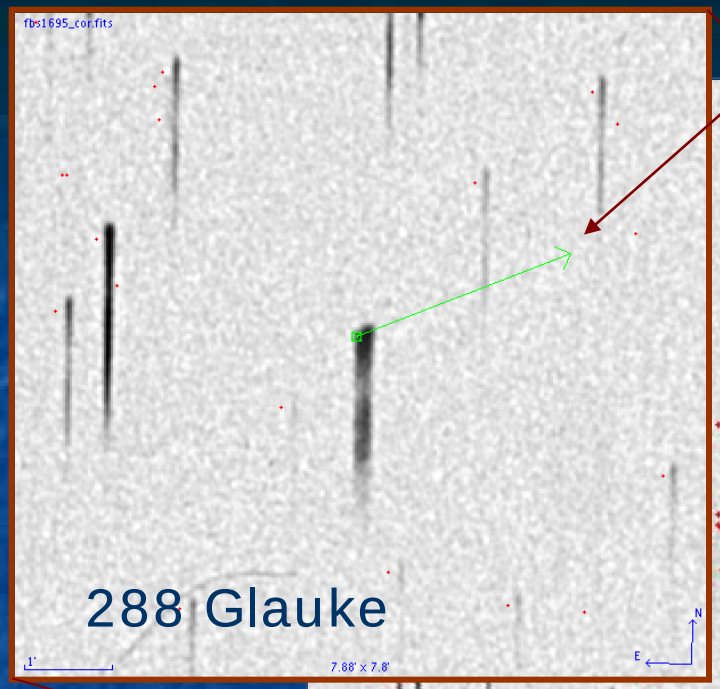
- the brightest asteroids (<15-16), which may be visible in the DFBS plates
- fast & slow asteroids with a division parameter, estimated as the motion of 3" during 20 minutes (the typical exposure time of a DFBS plate)
- extraction of all spectra of asteroids found in DFBS by SkyBote; group them into extended (fast asteroids) and star-like (slow asteroids)
- modeling of a template spectra of asteroids by means of the star-like spectra
- search for new candidate asteroids by similar spectra & comparison with DSS1/DSS2 fields for elimination of the stars
- spectral analysis of the asteroid spectra to get some physical parameters


Load...
Save...
Tools...
Print...
Help...
Quit
Position
J2000
Pixel
full
4906.0
ESO DSS2-red
selec
dist
draw
tag
text
filter
rgb
blink
rsamp
cont
zoom
mglss
hist
prop
del
SkyBoT 19
ESO DSS2-
1'
24.29' x 23.02'
N
E
29.94' x 30.01'
- ESO DSS2-red - provided by The Digitized Sky Survey from ESO (Garching)
multiview
Zoom
1/2x
out
40441 Jungmann 03 22 22.2444 +12 55 12.081 MB II 18.15 3.241 18.269 -10.6767 -17.4
- 2001 UJ20 03 22 11.2982 +12 51 59.549 MB 20.27 -49.035 261.932 -12.0898 -1.2
- 2002 VW28 03 22 23.3380 +12 48 30.273 MB I 19.33 -10178.050 420.180 -5.9700 5.3
12797 1995 WL4 03 22 42.4998 +13 01 00.272 MB I 18.17 -1.987 445.387 -7.8
- 2002 RT159 03 22 34.1425 +12 45 18.021 MB IIIb 19.87 31023.000 637.034 -11.6642 -9.4
Catalogs:
All VizieR
Surveys
Missions
SIMBAD
NED
SkyBot
Others..
(c)1999-2005 ULP/CNRS - Centre de Données astronomiques de Strasbourg
2 planes, 1 view, 14Mb

Identification of the spectrum of 104 Klymene



Identification of the spectrum of 288 Glauke

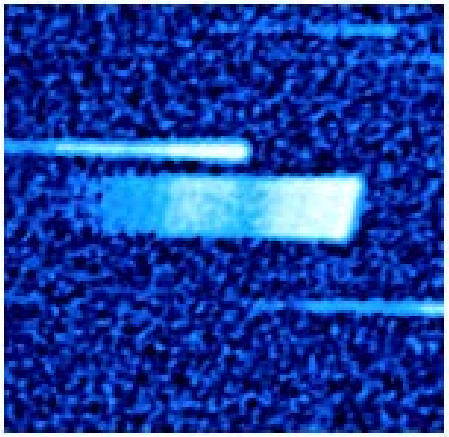


Apparent velocity

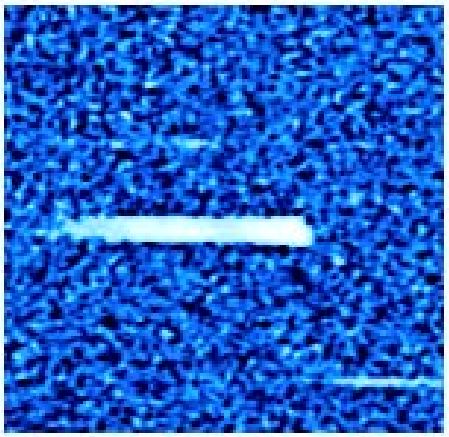
USNO stars (in red)

Spectra of asteroids in the DFBS

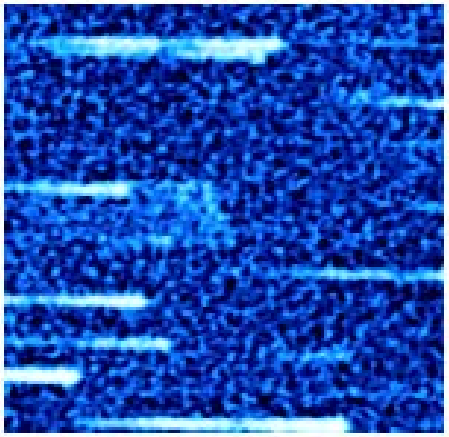
104 Klymene



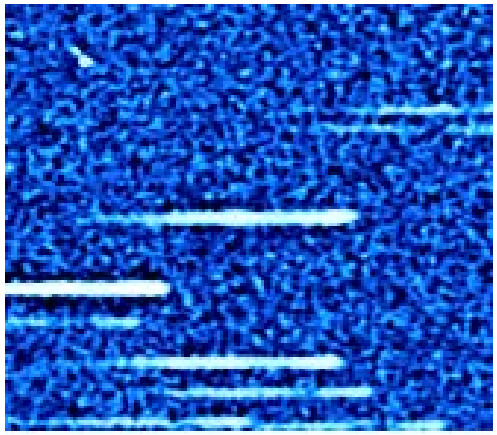
288 Glauke



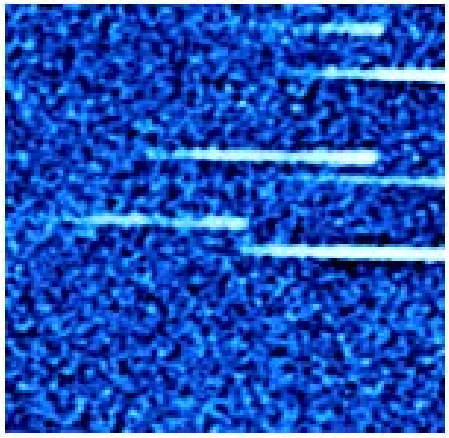
627 Charis



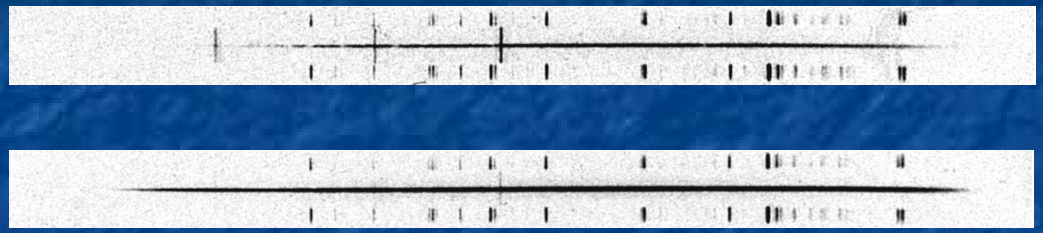
1323 Tugela

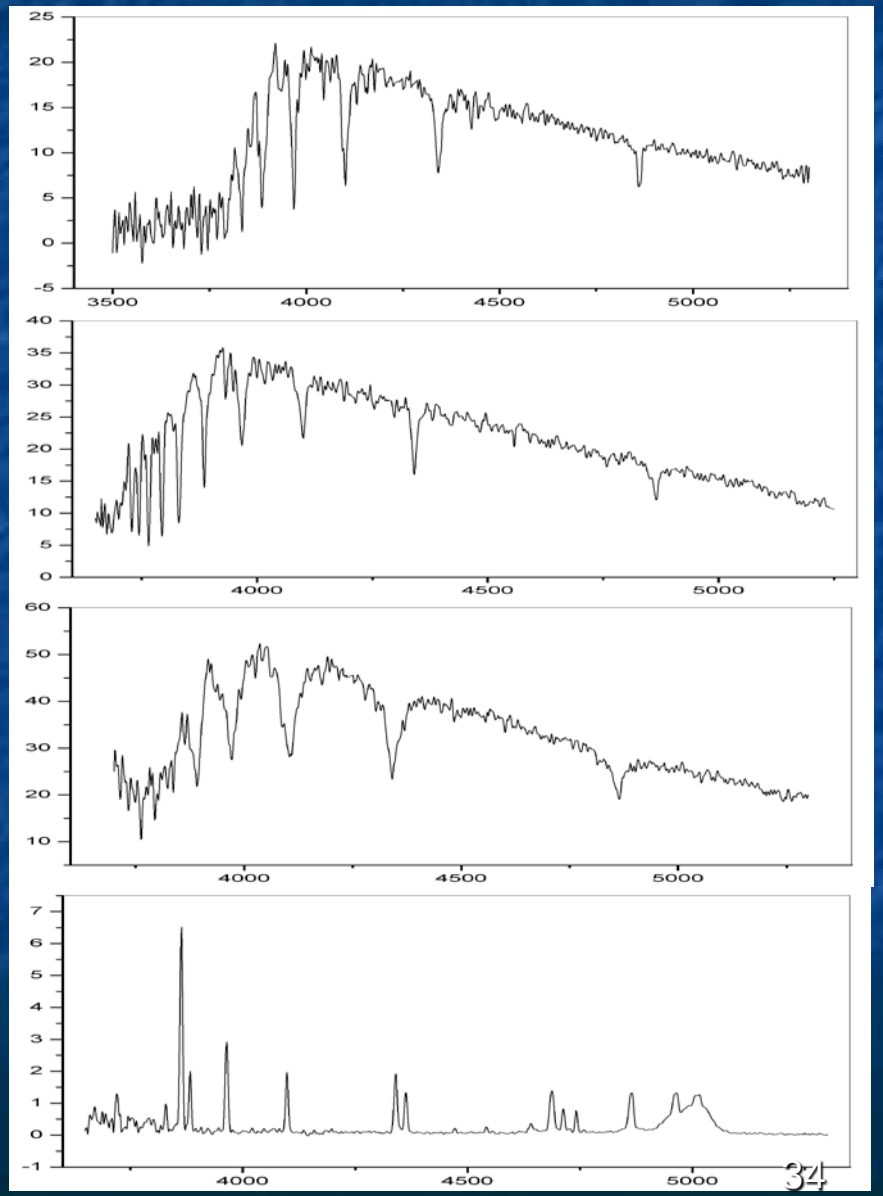


4713 Steel



Spectroscopic study of the FBS BSOs

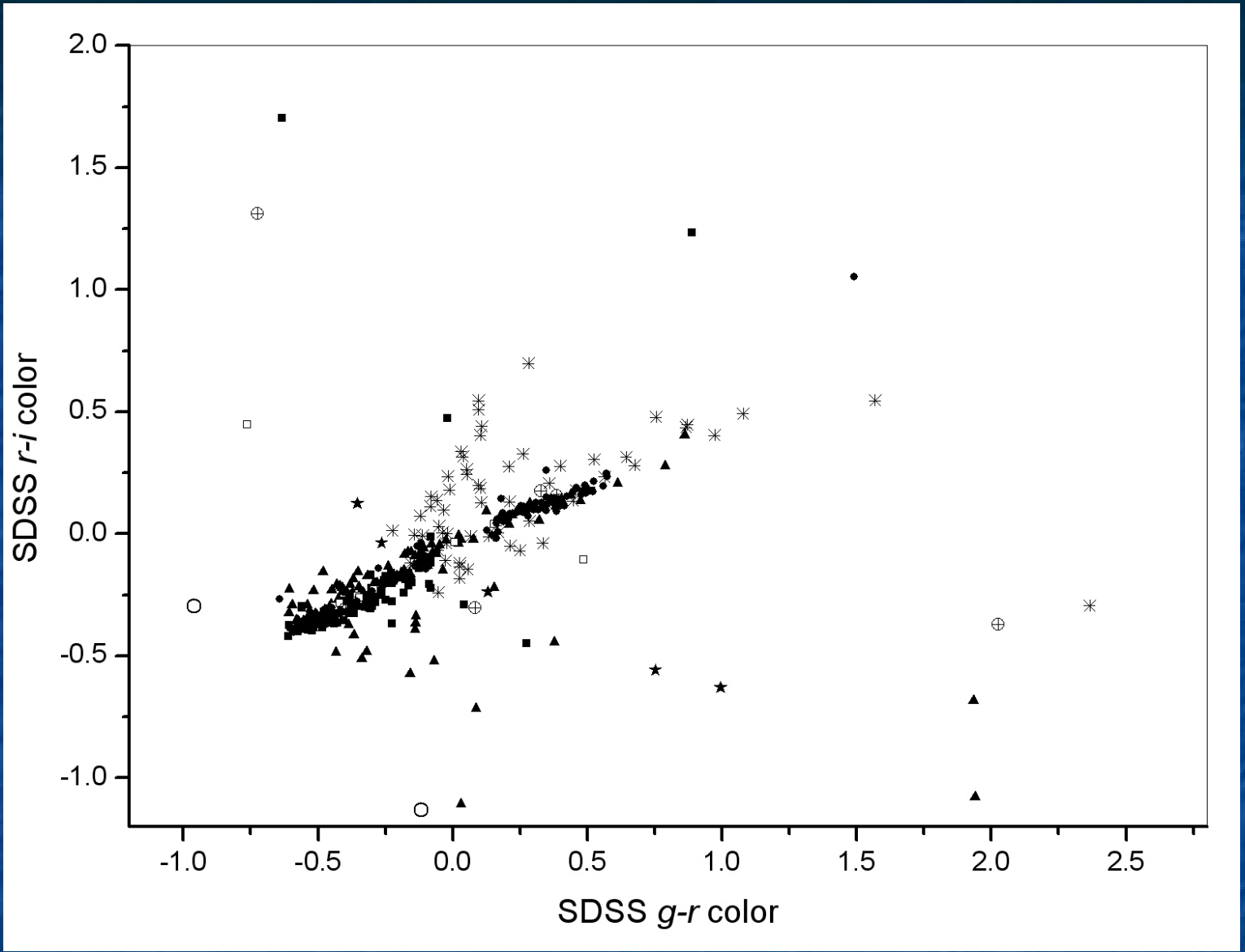




Scanning spectra: 1600 dpi,
16 bit, 650x21 pix sizes

~700 spectra have been digitized (FBS blue stellar objects & late-type stars), 101 published

A new PN (FBS 2323+421), 7 white dwarfs (DA, DAB, DZ), 78 hot subdwarfs, 9 HBB stars have been revealed.



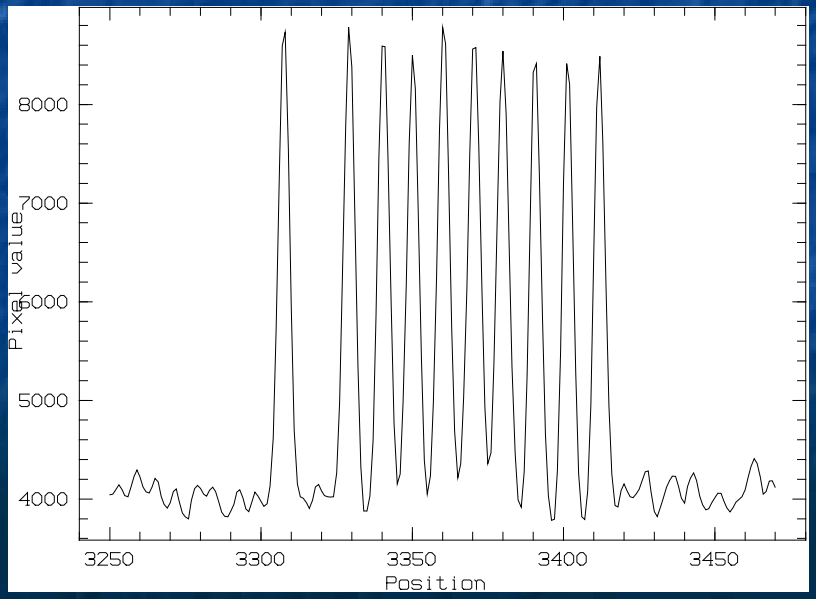
- Asterisks – extragalactic objects (AGN and Gal)
- Open circles – PNN
- Stars – CV
- Filled squares – WD
- Triangles – hot subdwarfs (sd)
- Open squares – HBB
- Earth symbols – MS stars
- Filled circles – unknown objects

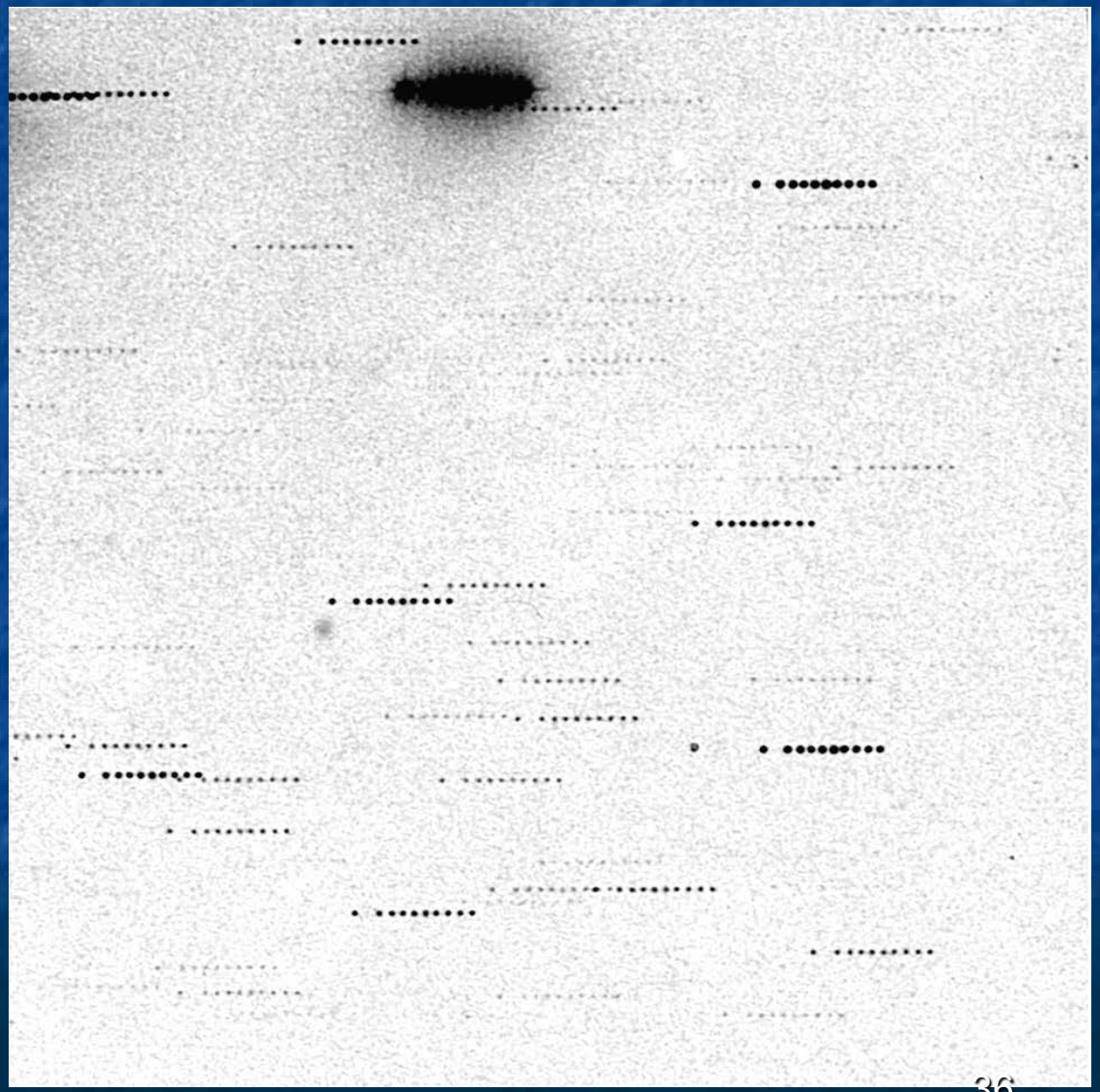
Sinamyan P.K., Mickaelian A.M. Astrophysics **49**, 333 (2006); **51**, 51 (2008); **51**, 226 (2008); **52**, 76 (2009)

Study of long-term variability of ON 231

Photographic chains for discovery of flare stars in stellar clusters

Coma: 189 plates with a total number of more than 1200 exposures in 1965-1976 with the Byurakan 21″ and 40″ Schmidt telescopes



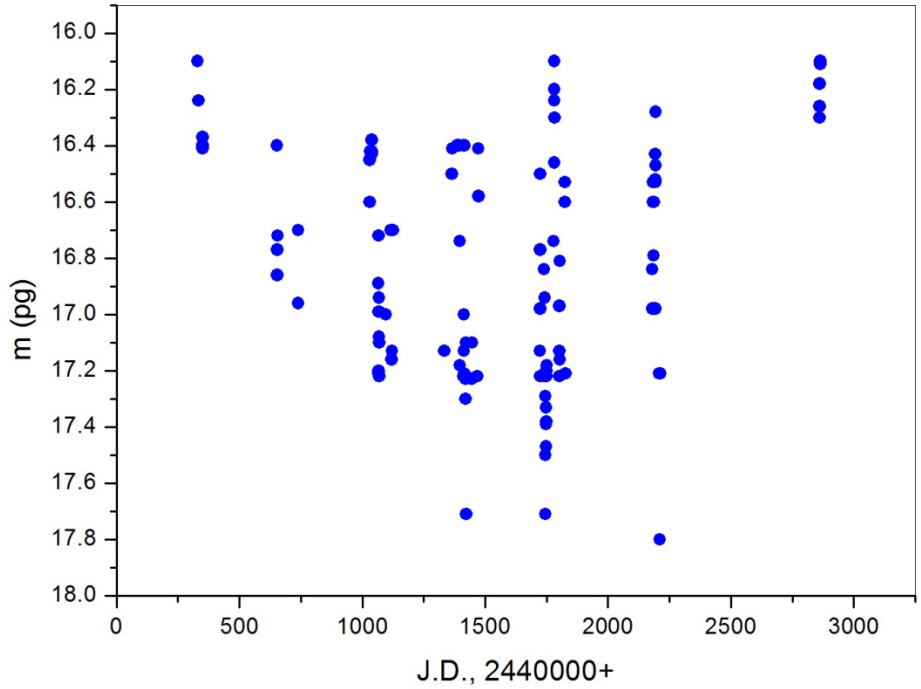


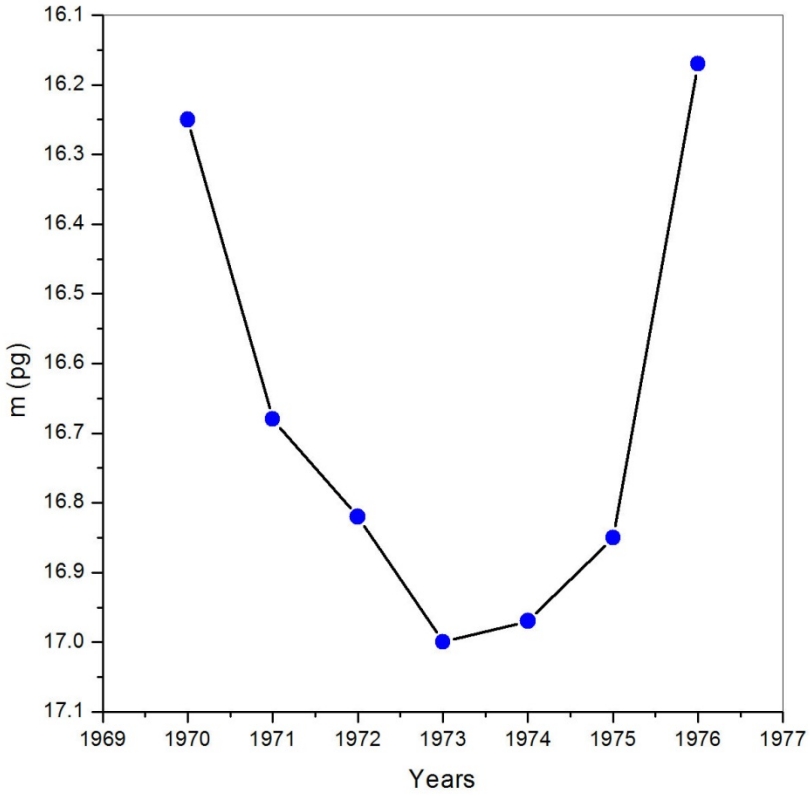
Study of long-term variability of ON 231

ON 231 (W Com, m=16.5, z=0.102)

- 1969-1976, L.K. Erastova, observations in Coma field (R.A.=12^h26^m, DEC=+25°55′) for study of the variations of the flare stars
- 187 plates with “chain” images (by a slight shifting of the plate for multiple images), BAO 0.5m and 1m Schmidt telescopes (5°×5° and 4°×4° fields, respectively)
- ON 231 was present in 141 of these plates with some 1200 total exposures All available plates were scanned
- Out of 141 plates with ON 231, useful measurements were done in about 80 ones
- A script was written under MIDAS for reduction of the plates and measurements
- The study of the variability was done by a comparison with the neighbouring standard stars, and the equivalent widths (EW) of the measured images (each point in the chains) were the main criteria for the comparison

Study of long-term variability of ON 231





Two other AGN in the field (will be studied later for possible variability):

FBQS J122424.3+243623 (z=0.218, a 87GB and ROSAT source)
FBQS J123014.1+251804 (z=0.135, a ROSAT source)

Other papers at Astroplate 2014

Roberto Nesci: ***AGB stars and the plate archives heritage***

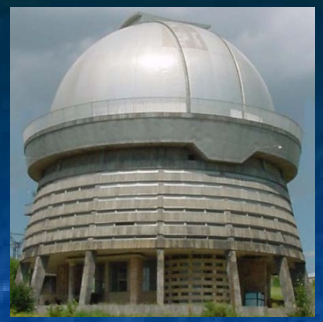
Variability of IRAS-selected AGB stars identified with the objective-prism plates of the FBS

Rene Hudec: ***Low Dispersion Spectroscopy (LDS) with astronomical photographic databases and surveys***

Applications in modern astrophysics (e.g. ESA Gaia project)


Astro Grid
ArVO
Armenian Virtual Observatory
Aus-VO
BRAVO
China-VO
CVO
VObs.it
esa
IVOA
VAO
VIRTUAL ASTRONOMICAL OBSERVATORY
France
vo-i
EURO VO
GERMAN ASTROPHYSICAL
GAVO
VIRTUAL OBSERVATORY
UKR VO
HVO
Hungarian Virtual Observatory
JVO
NOVA
RVO
NRF
National Research Foundation
SA3
South African Astroinformatics Alliance
SVO

BAO National Value project on Plate Archive



Creation of the project team: astronomers, technicians, computer scientists

Renovation of BAO Plate Archive area

Creation of BAO full electronic database; interactive electronic journals, etc.

Purchase of new scanning equipment

Digitization of plates by importance of scientific projects; ~ 10,000 plates during 2014-2015

Creation of interactive sky map for all BAO observations

New science projects based on BAO Plate Archive

Past and present observations

Numbers	Photographic era	Digital era
Telescopes	×	×
Wavelength coverage	0	×
Limiting magnitude	0	×
Spatial/spectral resolution	0	×
Total observing time	×	×
Number of exposures	×	0
Number of observed objects	×	×
Number of bytes	0	×
Time coverage	×	0
Sky coverage	×	×
Number of results	×	×
Number of finances	×	0