Ground-Based Astronomical Centers in Russia, It’s Facilities

V.V.Vlasyuk, SAO RAS
Main Astronomical Centers in Russia
Special Astrophysical Observatory of the Russian Academy of Sciences

- Total staff – about 400 persons, about 100 of them are scientists – astronomers, physisists, mathematician etc. Others are engineers and technician specialists.

- SAO RAS includes more than 20 laboratories and groups in optical and radioastronomical departments.

- Our scientific infrastructure costs about 2 Billions RUR, mean year budget – about 400 MRUR .

- SAO staff supports activity of 2 largest russian astronomical telescopes – 6-meter optical and 600-meter radio ones.

- Observatory was established in 1966, start of telescopes operation – 1976-1977.

- Status of our telescopes: national, they are operating under control of National Committee of Russian Telescopes.

- Main tasks of institute are support of ground-based astronomical studies with large telescopes, development of instrumentation, preparing of specialists: students, post-graduates etc.

- All the telescopes may be used and controlled via INTERNET – http://www.sao.ru
Main astronomical facilities in Russia:

1. Operating in a few astronomical organizations:
   SAO of RAS – largest optical (6-m) and radiotelescope (RATAN-600);
   Institute of astronomy or RAS – 2-m optical telescope Zeiss-2000;
   CrAO of RAS – 2.6-m optical telescope;
   Institute of Applied Astronomy - 3x32-m radiotelescopes

2. Current activity of these instruments are organized by local authorities under supervizing of National Programm Committee.

3. Some smaller instruments - optical telescopes with D<2m operates mostly under local programme commitees.
Equipment of the 6-Meter Telescope

Nasmyth focus F/31
Reserved for new equipment

Nasmyth focus F/31
Main stellar spectrograph, R=15000
Echelle spectrograph NES, R=6000

Primary focus F/4
Focal reducers SCORPIO
Speckle interferometer
Integral field spectrograph
Fast photometer MANIA

Main mirror: parabolic, D=6 m
RATAN-600- aerial view
Typical distribution of scheduled time between observing methods for the 6-m telescope
Spectral Camera with Optical Reducer for Photometrical and Interferometrical Observations

Modes of observation:
- Photometry in wide and narrow filters.
- Scanning Fabry-Perot interferometer
- long-slit spectroscopy
- spectropolarimetry
- slitless spectroscopy
- multi-slit spectroscopy (16 movable slits)
Focal reducer SCORPIO: multi-slit spectroscopy mode

Obtaining up to 16 spectra in 6-m field of view 3’x5’.
Limiting magnitudes – 23-24 m
at R=300-500 for 3-4 hours exposure
The main parameters of Nesmith Echelle Spectrometer

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
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<tbody>
<tr>
<td>Focus</td>
<td>Nasmith-2 F=1:30</td>
</tr>
<tr>
<td>Entrance slit</td>
<td>3 x 0.4&quot;, 0.6&quot;, 0.8&quot;</td>
</tr>
<tr>
<td>Collimator focus</td>
<td>7200 мм</td>
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<tr>
<td>Echelle grating</td>
<td>mosaic</td>
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<tr>
<td></td>
<td>600x300 mm with 37.7 gr/mm</td>
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<tr>
<td>Camera</td>
<td>Quartz Schmidt-Cassegrain, F=600 мм</td>
</tr>
<tr>
<td>Spectral range</td>
<td>300 – 1000 nm</td>
</tr>
<tr>
<td>Spectral resolution</td>
<td>R &gt; 60000</td>
</tr>
<tr>
<td>CCD</td>
<td>pixels</td>
</tr>
<tr>
<td></td>
<td>2048x2048 or 2048x4608</td>
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<tr>
<td></td>
<td>Δλ</td>
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<tr>
<td></td>
<td>300 – 680 nm</td>
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<tr>
<td>Readout noise</td>
<td>7e^-</td>
</tr>
<tr>
<td>Pre-slit units</td>
<td>Image slicers, Zeeman analyzer, iodine cell</td>
</tr>
<tr>
<td>View cameras</td>
<td>Field viewer, autoguiding cameras</td>
</tr>
</tbody>
</table>
NES + CCD 2Kx2K
2950÷6700 Å

NES frame (2Kx2K) and some of extracted orders
Small-size telescopes

1-meter and 60-sm instruments
RATAN-600: secondary mirrors and focal line

Quasi-simultaneous detection of radio-spectra in range from 0.6 to 30 GHz.
Crymean Astrophysical Observatory of RAS

Main instrument of the Observatory – 2.6-m Shajn optical reflector.
CrAO: other telescopes

Big Solar Telescope: Largest solar instrument

1.5-m reflector: photometry

RT-22 radiotelescope:
Peak Terskol Observatory (Institute of Astronomy of RAS&Academy of Science, Ukraine)

One highest observatories in Russia – at 3100 m above sea in Central Caucasus. Main instrument – 2-meter reflector.
Institute of Applied Astronomy of RAS (S-Petersburg)

Interferometrical complex of 3 32-meter dish radiotelescopes

Location at 3 places:
- near S-Petersburg,
- at Northern Caucasus, in Baikal Region.

Main tasks are:
- interferometry, astrometry, etc.

But telescopes may be used in separate regime in astrophysical studies.
Solar activity monitoring and it’s prognosis

Multi-wavelength monitoring of solar activity with 3-day prognosis for X and M class flashes

The example of positive prognosis for future solar activity.
Study of emission regions about local active galaxies (applicant – W. Keel, Alabama Univ., USA)

From left to right:
Data for galaxies SDSS 2201+11 and UGC7342:
HST data, 6-m IFP data, velocity field and velocity dispersion
SPECKLE-INTERFEROMETRY OF YOUNG MASSIVE STAR $\theta^1$Ori C

$\theta^1$ Orionis C
high-eccentricity binary system orbit

Y.Y. Balega team with MPIfR (Germany)
DISTRIBUTION OF GALAXIES IN THE LOCAL VOLUME

Distance to 250 galaxies

Velocity dispersion - 25 km/s

Mass of Local Group $1.9 \times 10^{12} M$

Mean matter density $\Omega_m = 0.08$ from the critical ones

I.Karachentsev, D.Makarov
Photometric observation of GRB970508 in SAO RAS: Zeiss-1000 & BTA-6m (V. Sokolov and Russian/Spain/India cooperation)

Photometry of optical transients

CCD images of the optical transient of GRB970508 (Zeiss-1000 and BTA)

Light curves of the optical transient of GRB970508 in B, V, Rc and Ic bands (Zeiss-1000 and BTA)
Deep photometry at 6-m telescope (program “Search of distant galaxies” by S. Dodonov (SAO))

Direct images of radiosource 3C441 field were taken in 11 filters (B, V, R, SED607, SED665, SED707, SED755, SED812, SED860, SED915, SED967) under seeing ~ 1 arcsec. Objects with $R_{AB} \sim 27^m$ were detected with S/N ratio ~5. (Программа “Поиск далёких галактик” Додонов С.Н.)
BRICS Countries’ Scientists Activity on SAO Telescopes in 2006-2016

1. Brasil – 6 nights (BTA, stellar spectroscopy)
2. India – 23 nights (BTA, SN, gamma-bursts, galaxies’s spectra + 30 days (RATAN-600, radiogalaxies study)
3. China – 11 nights (BTA, stellar spectroscopy)
4. South Africa – 5 night (BTA, spectra of galaxies)
Cooperation between SAO RAS and BRICS Institutions

1. India: Integrated Long Term Programme
   NCRA – National Center for Radioastronomy – Local Universe studies
   ARIES – Ariabata Research Institute – transients study

2. China: Agreement between SAO RAS and NAO CAS on Collaborative Astrophysical Studies and Development of Equipments: Spectrographs, CCD cameras etc. Agreement on Solar Physics between NAO CAS, SAO RAS and IZMIRAN.

3. South Africa: common programs on 6-meter and SALT telescopes.
CCD systems for the LAMOST project

Spectrograph LRS:
- Red channel:  CCD203 4096x4096 DD
- Blue channel:  CCD203 4096x4096 BI
What SAO plan to do in future?

1. Project of new medium-size optical/IR telescope

It’s parameters:
1. Main mirror diameter from 3 to 4 meters
2. FOV >1 degree
3. Active main mirror from astrositall and adaptive secondary mirror
4. Cassegrain for wide-field imaging: mosaics up to 20kx20k pixels (optical) and 8Kx8K (IR)

Nasmith foci for spectral instruments: integral field spectrograph and scanning Fabry-Perot interferometer, multi-object spectrograph for 1000 (?) objects.

Between main tasks for the new telescope: studying of transient phenomena, as GRBs, SN detection, neutrino events identification, deep wide-field sky surveys etc.

It is only preliminary projects which is in preparing now and should be agreed by government of Russia.
2. Small-sized telescopes – from 1 to 5

1. $D \sim 0.5$ m
2. FOV $\sim 1$ degree
3. Equipment – CCD photometers with large-field cameras. Tasks: square degree fields monitoring; photometry of bright objects.

Project now under consideration and can be realized in nearest future.

3. Upgrade of RATAN-600 antennae and instrumentation.

We hope to realize new facilities especially for solar studies within project of russian heliogeophysical complex.
Brief conclusion

1. Our instruments are in good condition and our staff members are able to provide modern astrophysical studies.

2. We open for wide international cooperation on different levels, like as:
   - cooperative studies on our telescopes
   - common scientific and engineering programs
   - preparing of young specialists: students and post-graduates

3. Our plans of instrumental development suppose possible participation in new observational programs.

4. SAO of RAS – as bridge in astronomy between Russia and BRICS countries.
Thanks for your attention

http://www.sao.ru