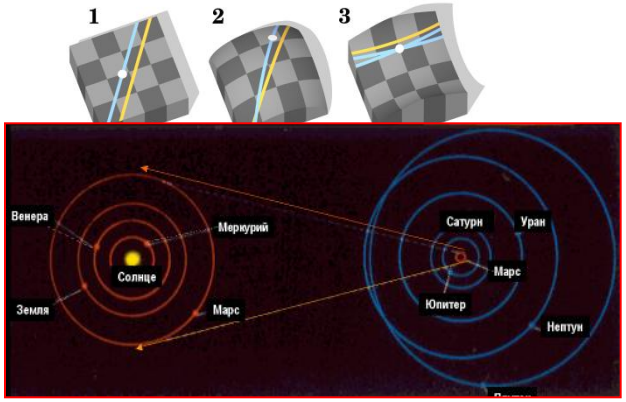
Optical identifications of X-Ray sources with RTT-150

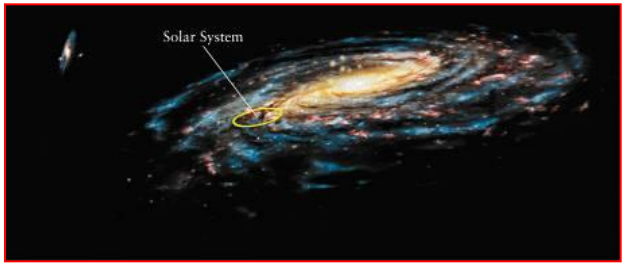
Ilfan Bikmaev
Department of Astronomy and Satellite Geodesy,
Kazan (Volga region) Federal University, Russia

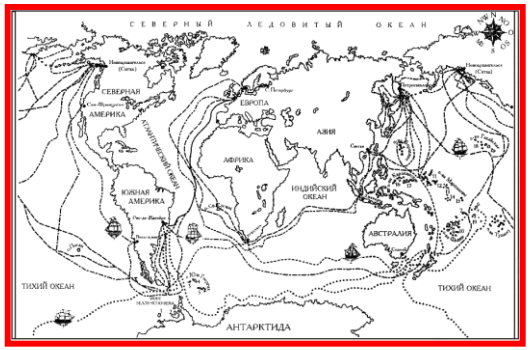
Kazan is the capital city of Republic of Tatarstan

Astronomical investigations are among leading scientific fields in Kazan University since its foundation in 1804 .

Prof. J. Littrow (Austria) was the first Astronomy Professor in Kazan University (1810). Nikolai Lobachevsky - founder of non-euclidean geometry (1829) and Ivan Simonov – only the astronomer among Russian teams of discoverers of Antarctica (1819-1821). Both they are the first students of Astronomy Department and later - Rectors of Kazan University (1827-1846 and 1846-1855)





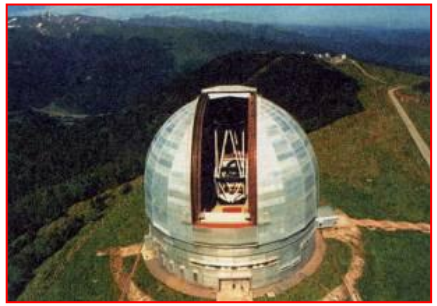


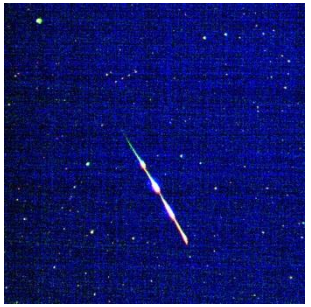
Competitive advantages of Kazan Federal University in experimental Astronomy - KFU has modern set of observational facilities for teaching and research studies – the Planetarium, Engelhardt Astronomical Observatory near Kazan, North-Caucasus astronomical Station near 6-m telescope of Russian Academy of Sciences, MEGATORTORA set of telescopes, 1.5-meter optical telescope in Turkey









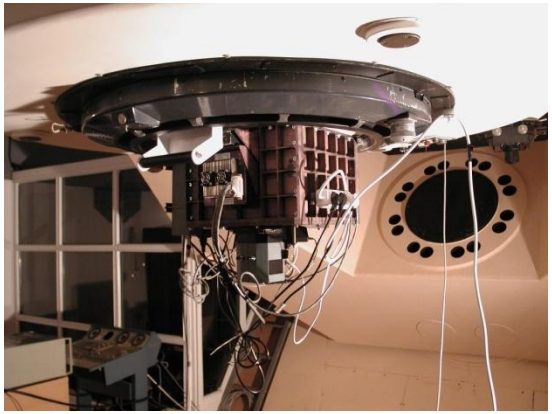


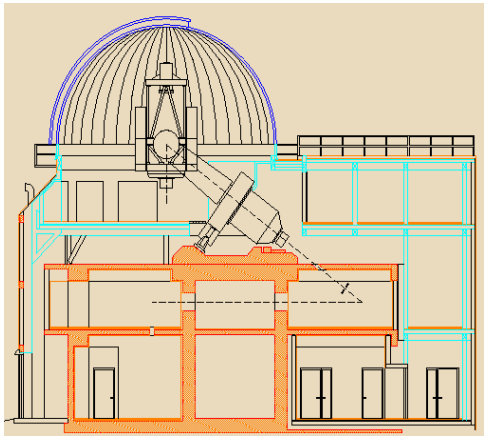



1.5-meter optical telescope RTT-150 (Russian-Turkish telescope with 150-cm mirror) – **International project (1995 – 2015 – 2028) with the partnership:**

- Kazan Federal University and Tatarstan Academy of Sciences (Kazan, Russia),
- Space Research Institute of Russian Academy of Sciences (Moscow, Russia),
- TUBITAK National Observatory (Antalya, Turkey)

Main scientific task of RTT-150 - optical identifications and search for X-ray sources detected by space Observatories - INTEGRAL, SWIFT, XMM-Newton, Chandra, RXTE, ROSAT, PLANCK, Spectrum-Roentgen-Gamma (2017 +).





Scientific equipments of RTT-150

1. TFOSC – TUBITAK Faint Object Spectrometer and Camera (F/5), 13x13 arcmin, 0.39 ” /pix, BVRI + SDSS filter sets, Limit R ~ 24 mag, + polyarimetry block (BVRI).

Spectral resolutions 5 - 15 A, Vlim ~20 mag

Echelle-mode (2-3 A), V lim~ 14 mag

3500-9000 A, N2 CCD (-100 C)

2. 2K x 2K, TE (-60 C) ANDOR CCD,

8 x 8 arcmin, 0.24 “/ pixel, BVRI +SDSS filter sets, accurate astrometry (0.05 “) and photometry (0.01 mag)

1K x 1K FAST (30 Hz) ANDOR CCD,

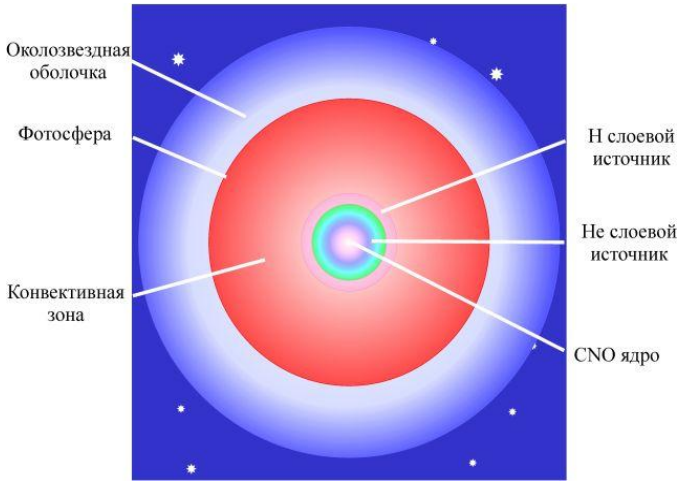
4 x 4 arcmin, 0.24 “/ pixel, BVRI +SDSS, fast photometry

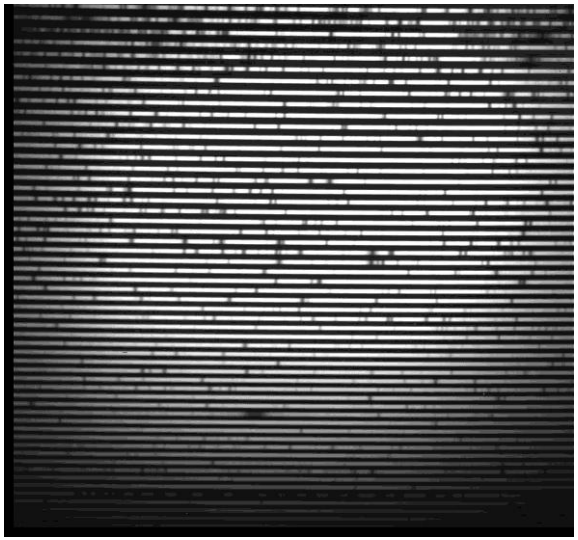
3. High-resolution (0.15 A) Coude-echelle spectrometer,

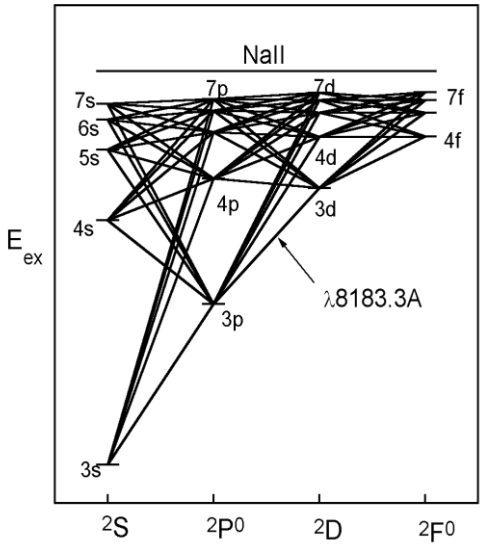
Detector - 2K x 2K ANDOR CCD, Vlim ~8 mag

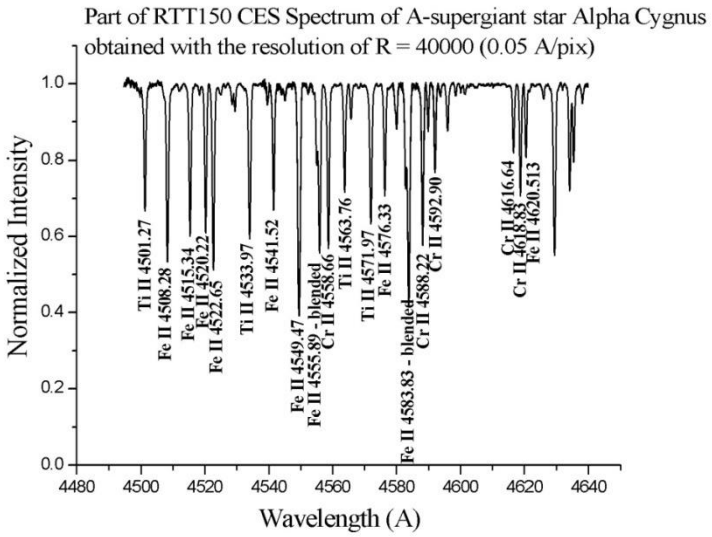
3900-8700 A

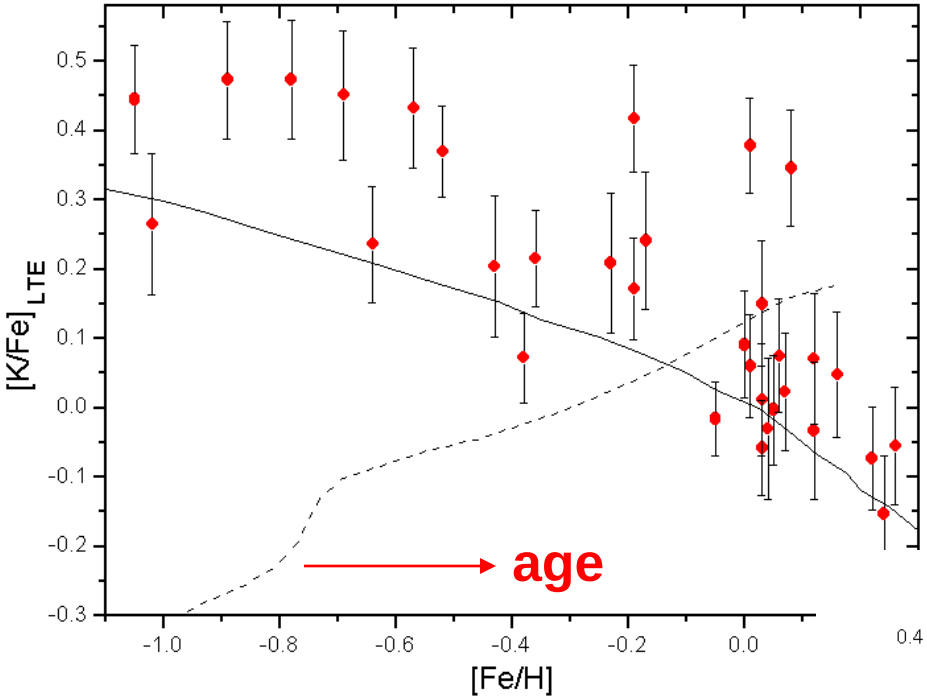
Leading Scientific School of Russian Federation - “Physics of Stellar Atmospheres”, created by Prof. Nail Sakhibullin in Kazan University . Non-LTE approach





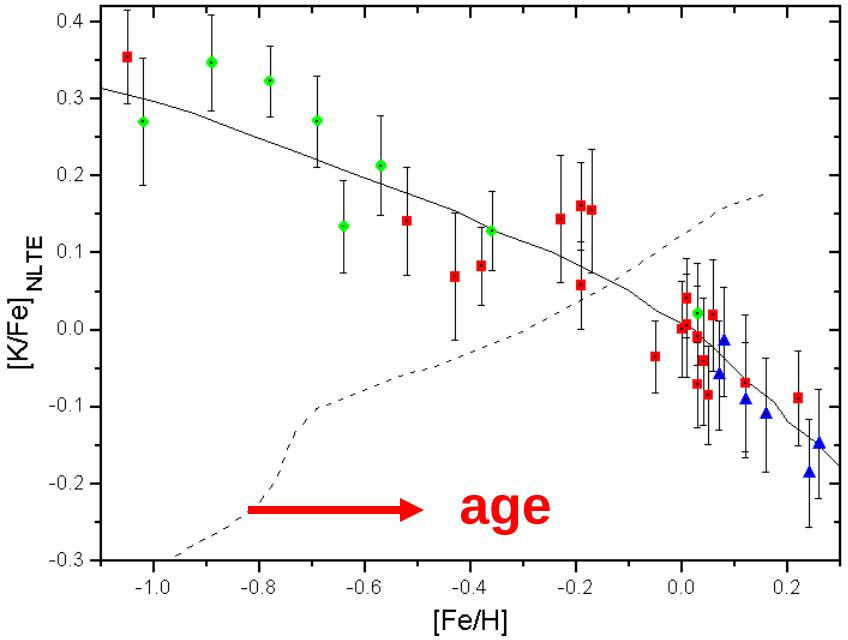




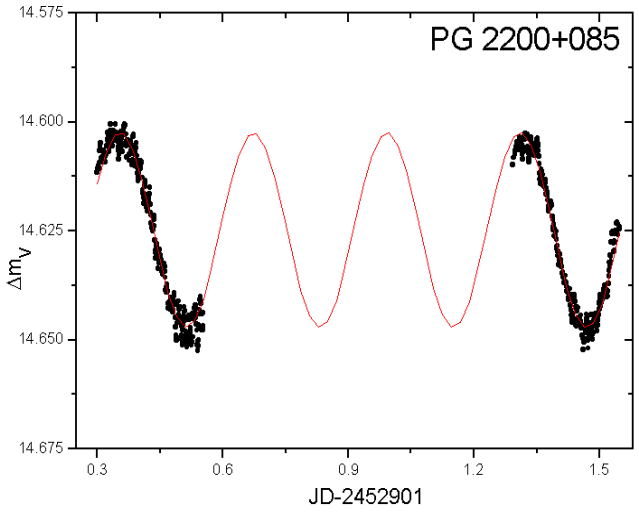


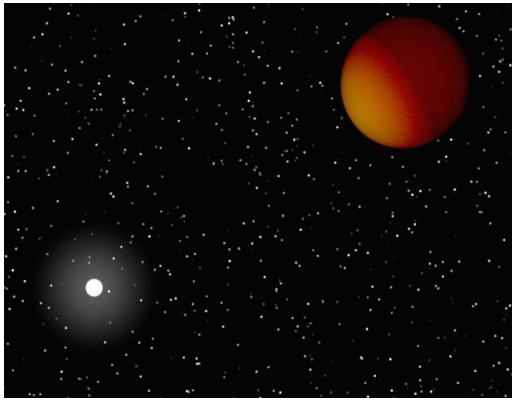
LTE potassium abundance

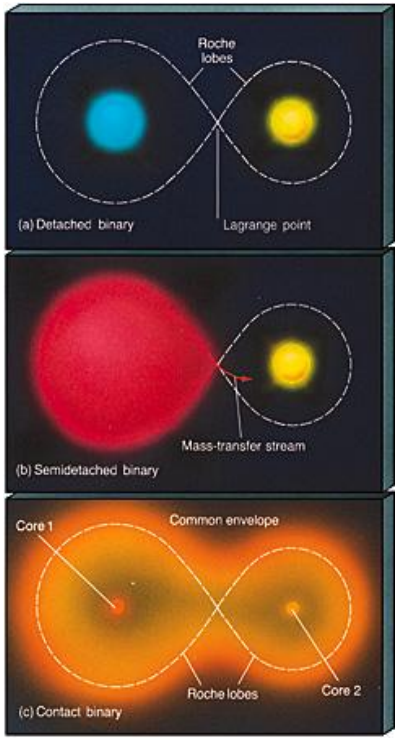
Non-LTE potassium abundance

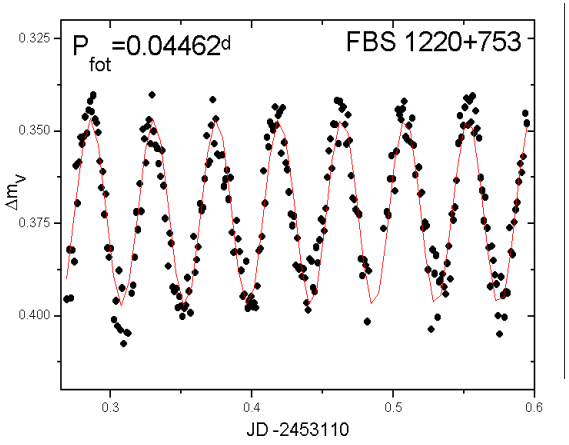


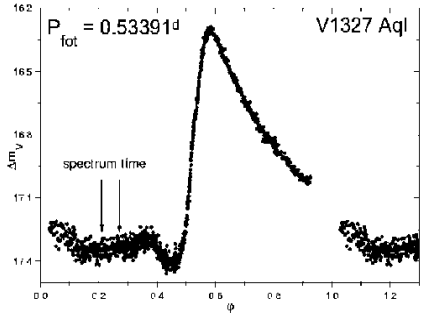
Illuminating atmospheres in close binary systems





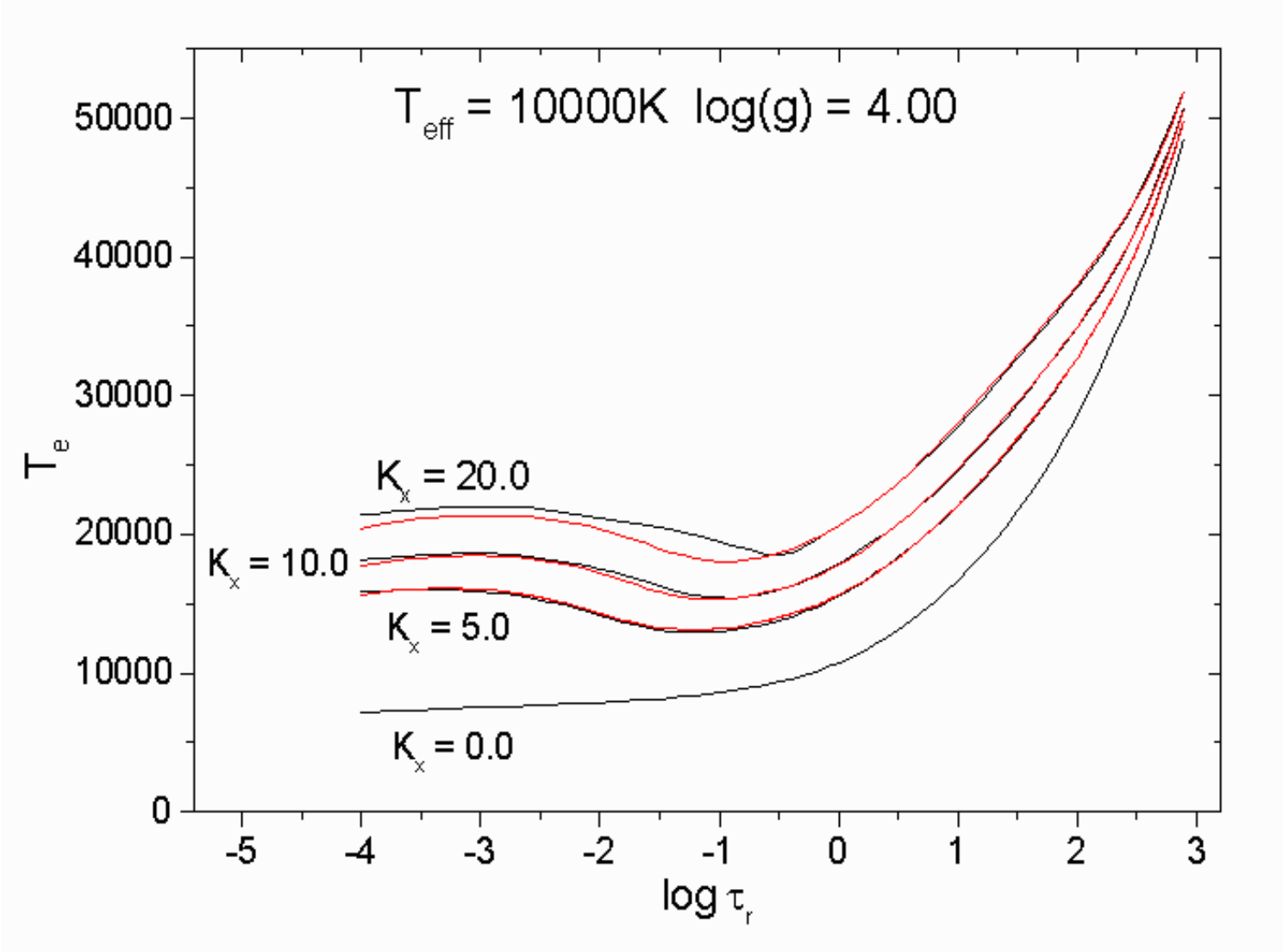




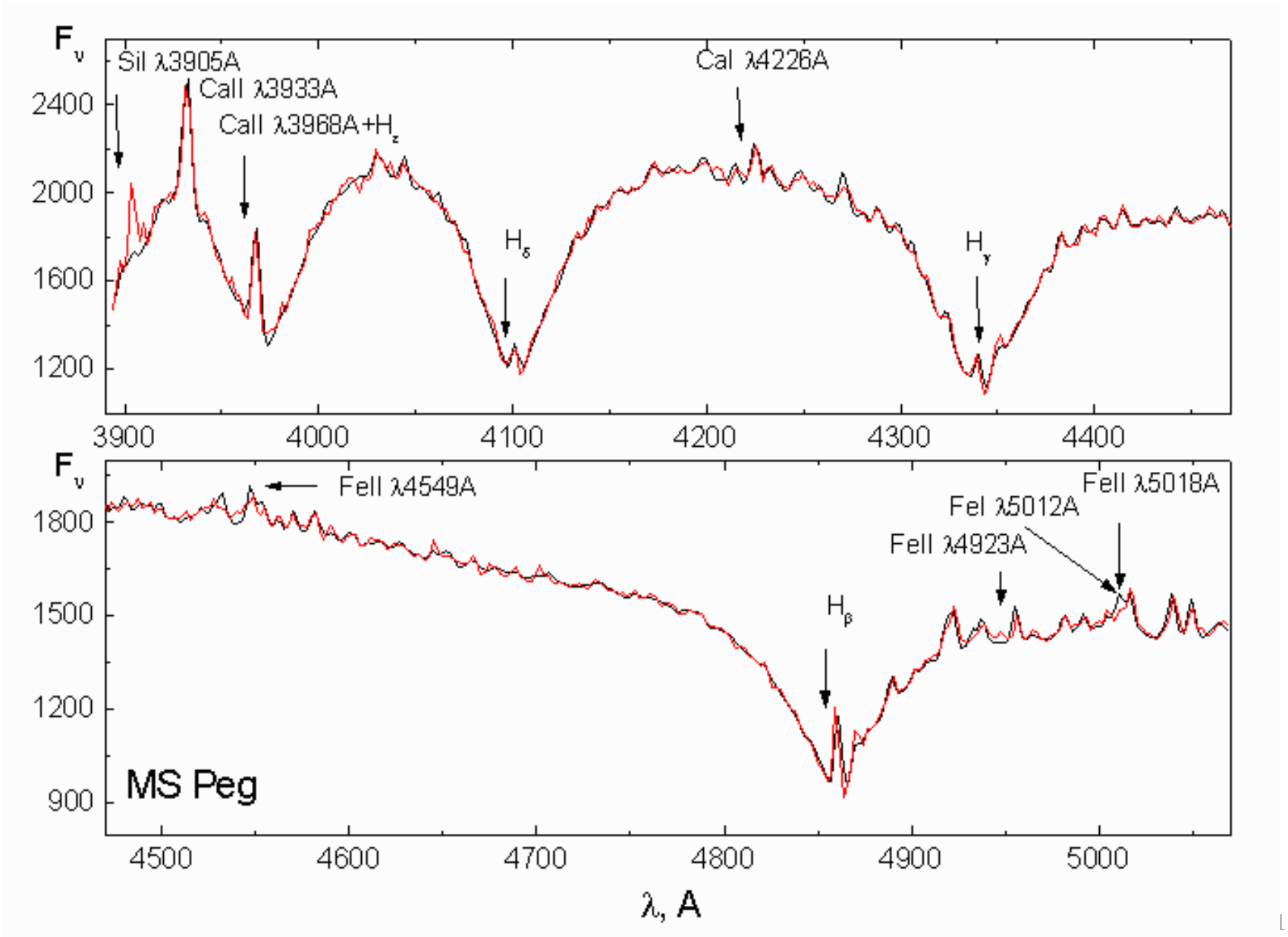


Object	Variation		Emission lines	P_{orb} day	Class
	m_V	V_l km/sec			
PG 1459-026	< 0.^{m}01	< 7.0	-	-	single sdB
PG 1505+074	< 0.^{m}01	<4.0	-	-	single sdB
PG 1520-050	< 0.^{m}03	<5.0	-	-	single sdO
PG 1632+088	< 0.^{m}01	<4.0	-	-	single sdB
PG 1701+359	< 0.^{m}02	<5.0	-	-	single sdB
PG 2300+166	< 0.^{m}01	<2.0	-	-	single sdB
PG 1524+439	< 0.^{m}04	<8.0	-	-	wide pair
WD 2151-015	< 0.^{m}02	< 5.0	+	-	wide pair
RBS 1032	< 0.^{m}04	< 10.0	+	-	X-ray galaxy
V1327 Aql	1.^{m}12	< 15.0	-	0.53391	RR Lyr

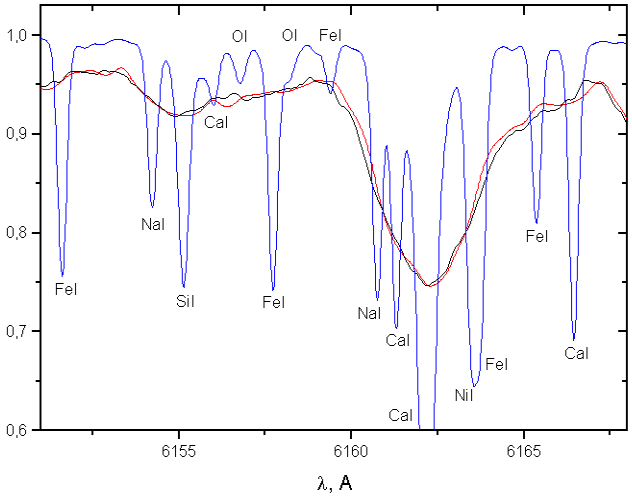
Modelling of the temperature distribution in the atmosphere of cool star illuminating by UV photons from companion (white dwarf) star

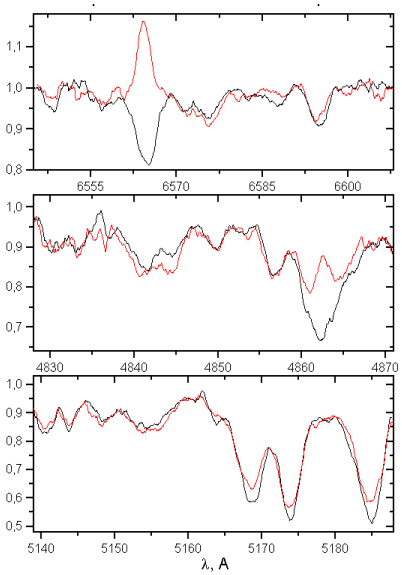


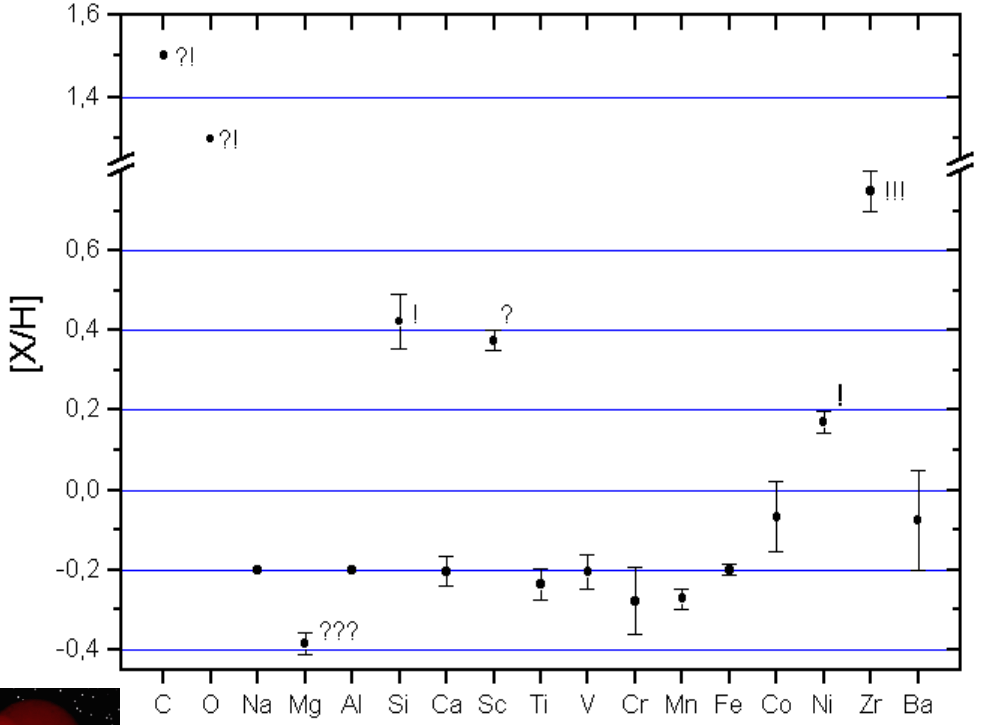
Comparison of observed (black) and calculated (red) spectra

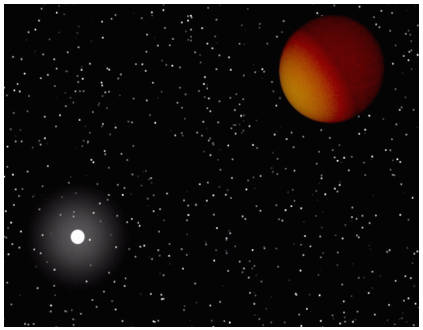


Modeling of high – resolution spectra of illuminated atmosphere and chemical composition determinations



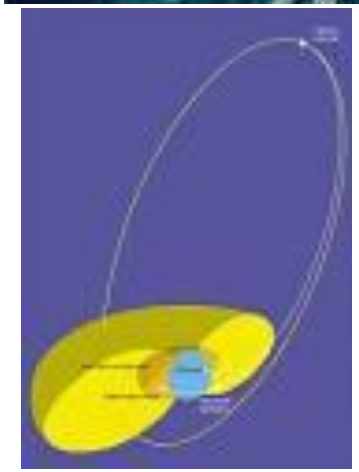






Scientific cooperation with orbital space Observatories

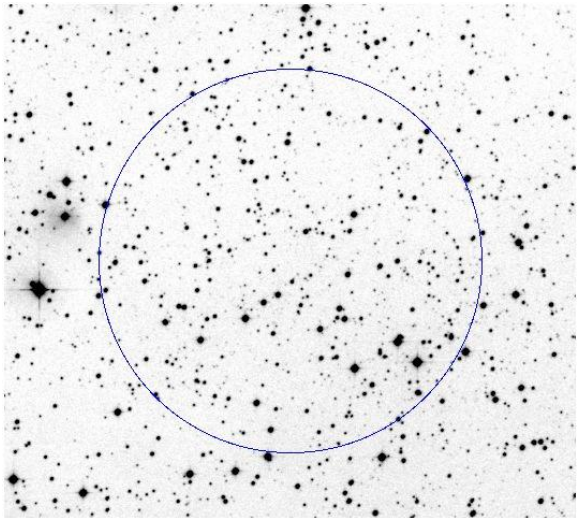
INTEGRAL Observatory has been launched in 2002 to high-altitude orbit by Russian PROTON rocket from Baikonur spaceport



INTErnational Gamma Ray Astrophysical Laboratory

Participants:
European countries + USA + RUSSIA

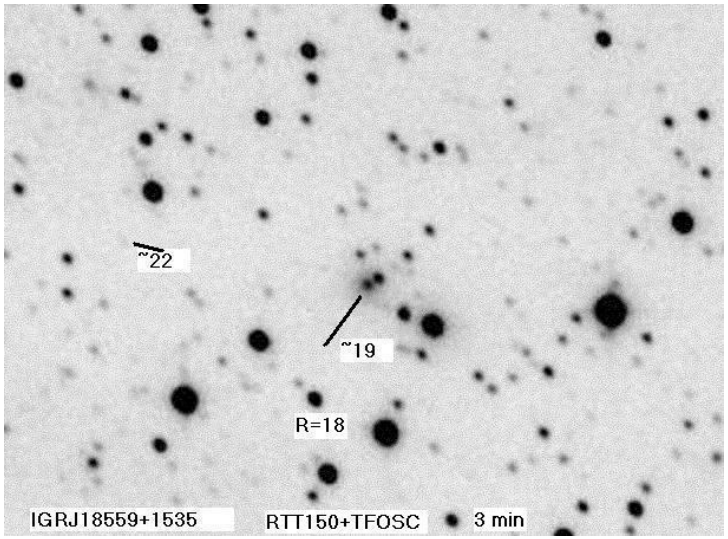
Why INTEGRAL needs ground optical support ?



angular resolution

INTEGRAL – 300 arcsec

RTT-150 one !
Arcsec resolution



The main technical problem of X-ray satellites – low angular resolution , preventing identification of discovered X-Ray sources with the real objects on the sky. Therefore X-ray observatories require the ground support from optical telescopes installed in best astro-climate sites – Observatories on the mountains

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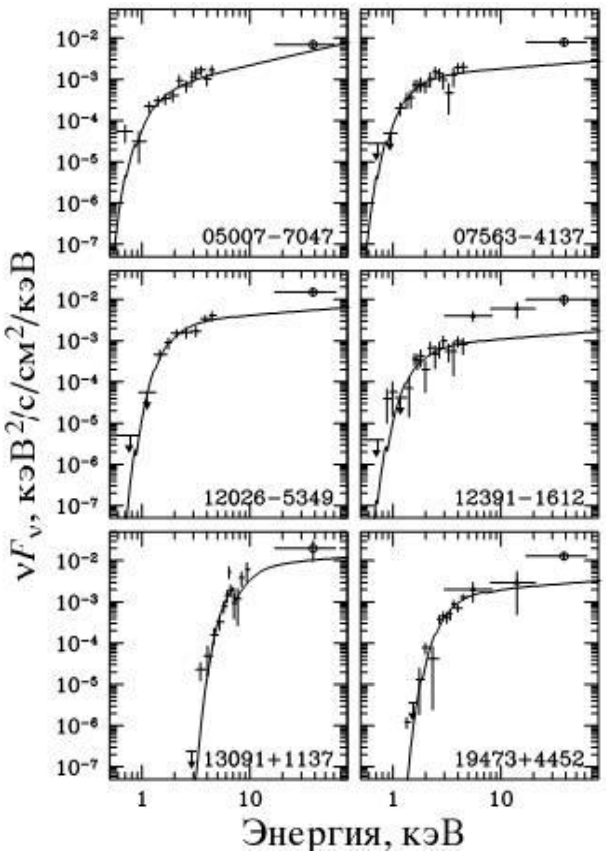
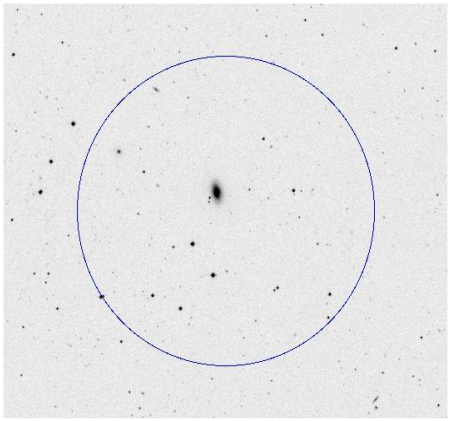
1.5-meter Russian-Turkish telescope meets fully above mentioned conditions and realize ground-based support of modern space Observatories

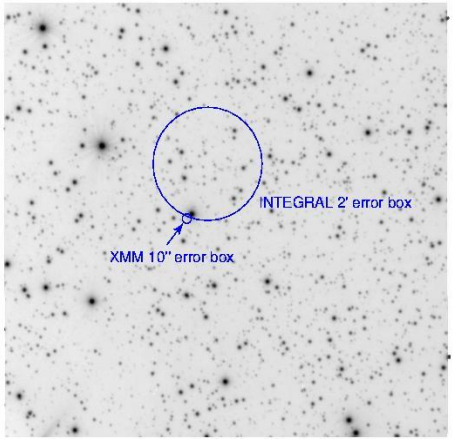
Optical identification of the new hard X-ray sources detected by INTEGRAL satellite

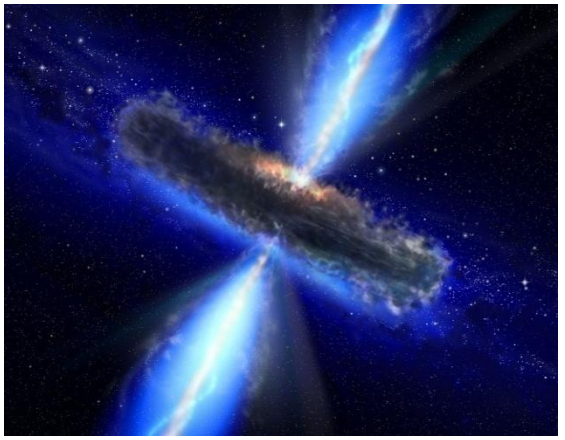
INTEGRAL catalogue contains of ~1000 sources, more than 200 objects have not optical identifications.

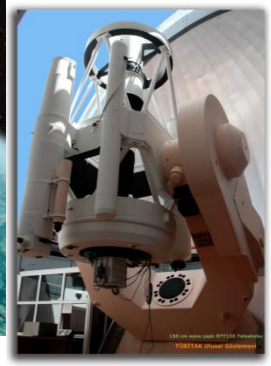
The main two groups among identified sources are close binary systems with compact objects (white dwarfs, neutron stars, black holes) and AGNs



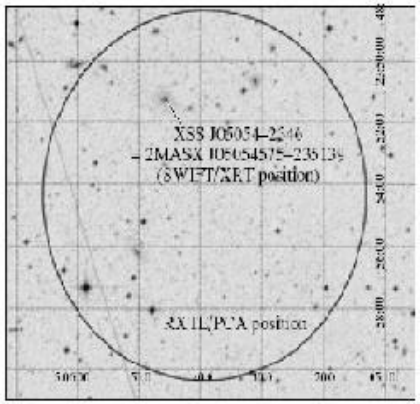


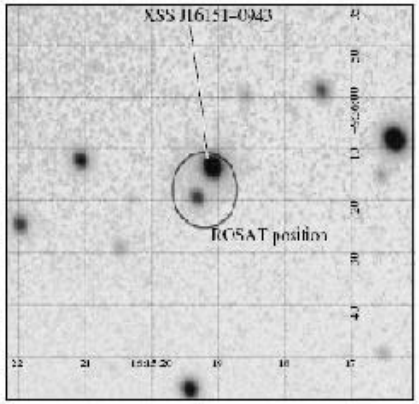


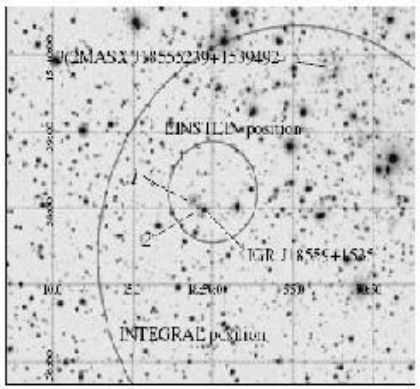


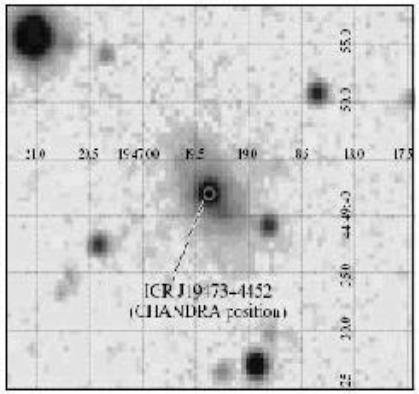


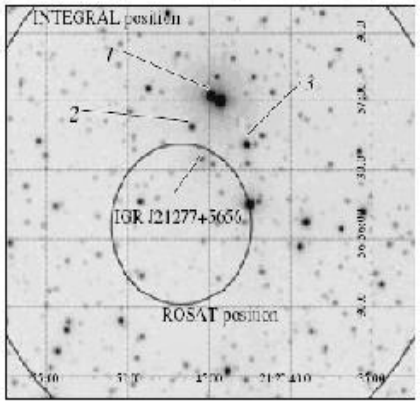
30 new AGNs have been identified during 2005 – 2016 by using RTT-150

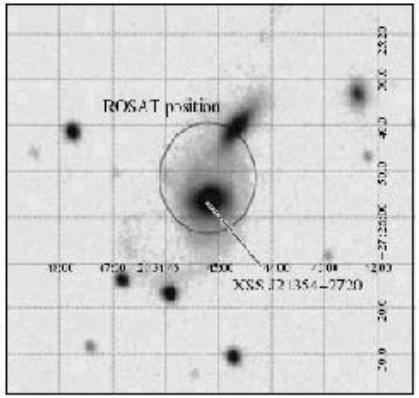


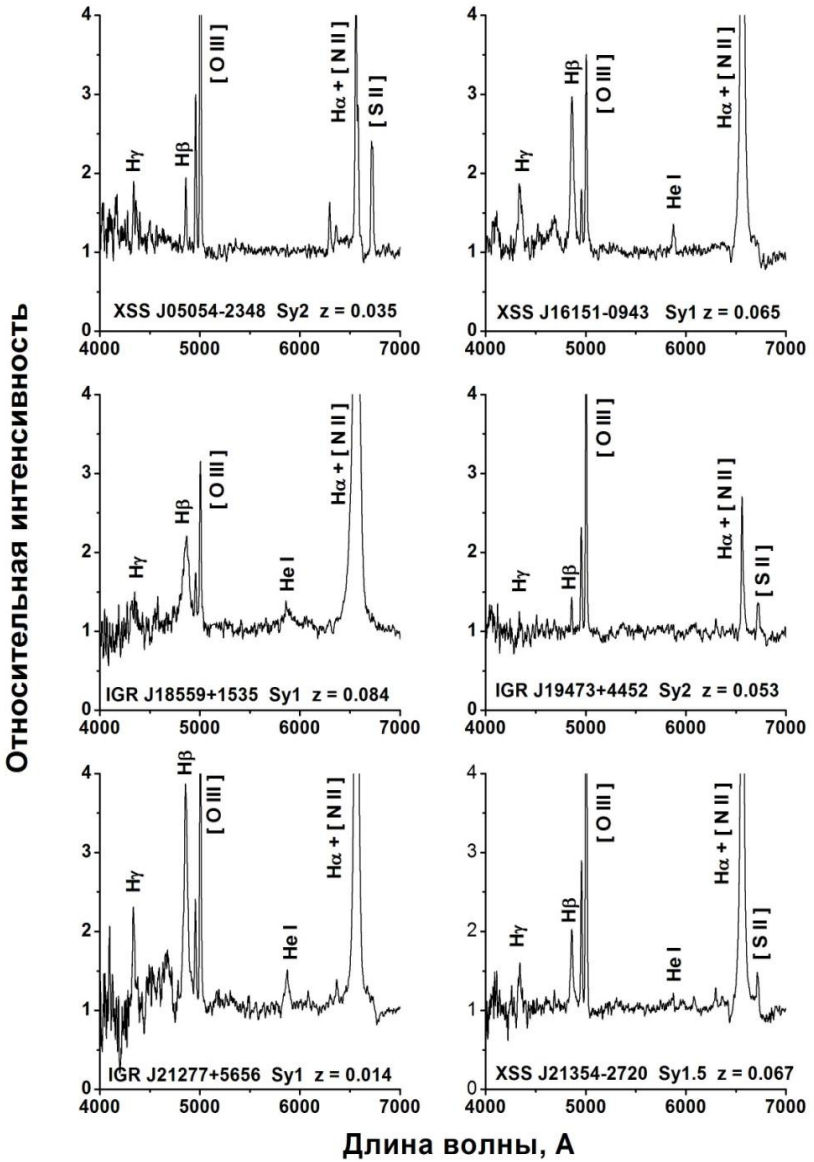






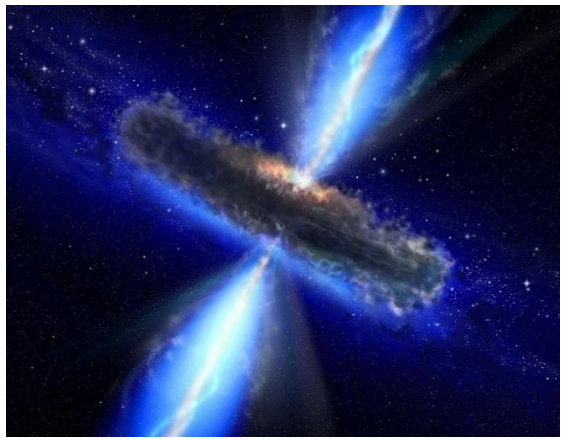


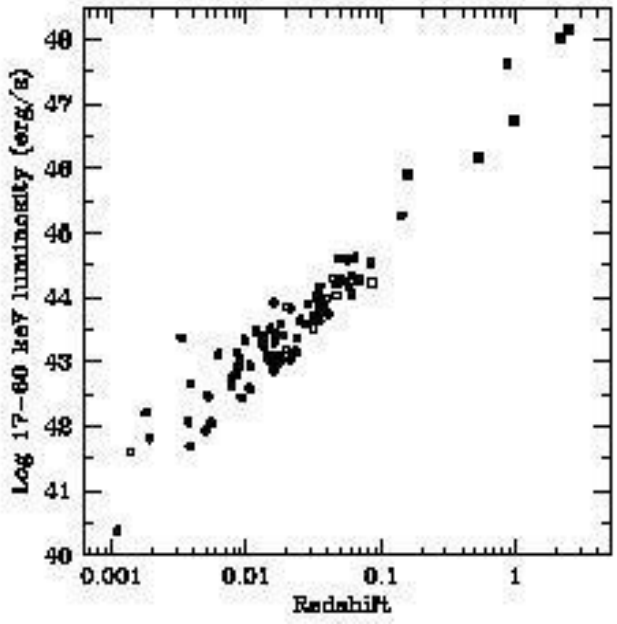




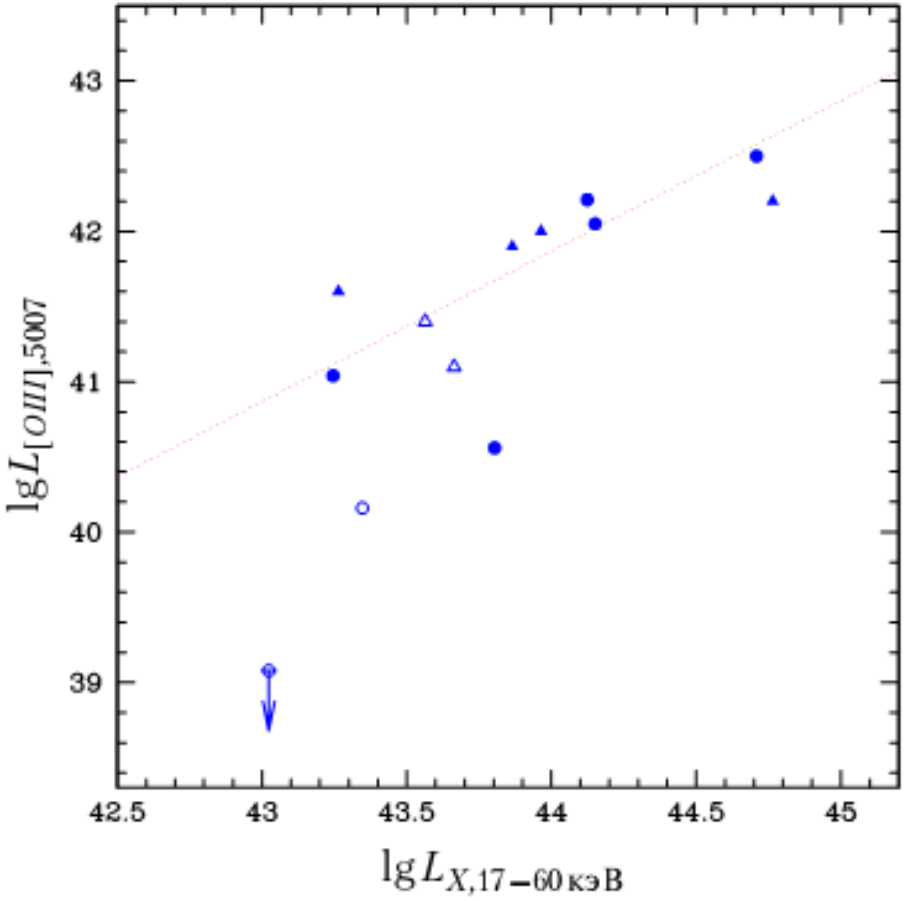
Classifications of identified AGNs – supermassive Black holes

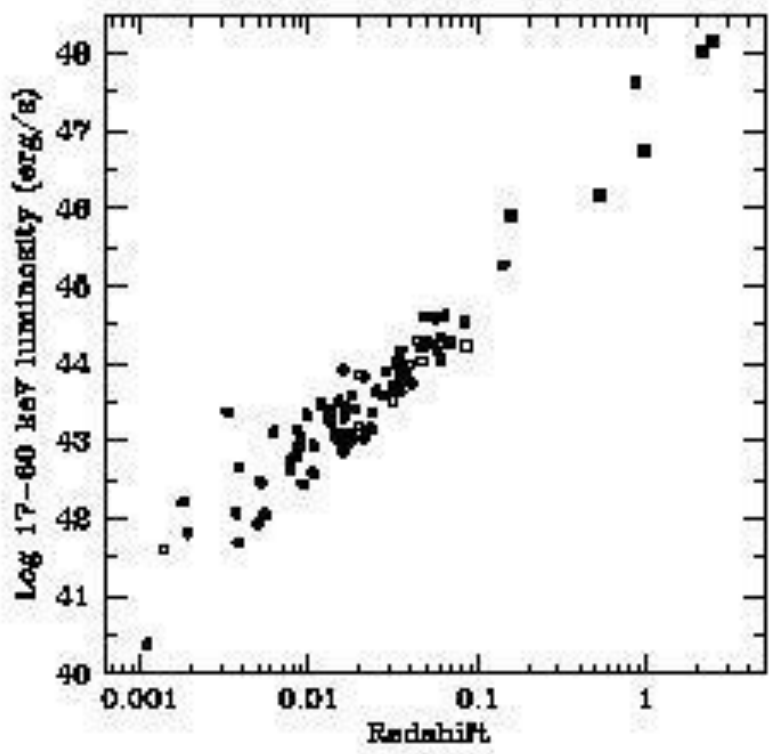
Название	R.A. (J2000)	Dec. (J2000)	R_c	z	$\lg L_{5500\ Å}$	$\lg L_{[OIII],\lambda5007}$	$\lg L_x$	$FWHM_{H_\alpha}$, км/с	Тип
XSS J05054−2348	05 05 45.7	−23 51 14	16.6	0.0351	42.84	41.1	43.6	<685	Sy2
XSS J16151−0943	16 15 19.1	−09 36 14	14.8	0.0650	44.08	42.0	43.9	1600	Sy1
IGR J18559+1535	18 56 00.6	+15 37 58	16.6	0.0838	44.32	42.2	44.7	3200	Sy1
IGR J19473+4452	19 47 19.4	+44 49 42	17.2	0.0532	43.42	41.4	43.5	<685	Sy2
IGR J21277+5656	21 27 45.4	+56 56 35	16.6	0.0144	43.45	41.6	43.2	1600	Sy1
XSS J21354−2720	21 34 45.1	−27 25 56	15.8	0.0670	43.68	41.9	43.8	1190	Sy1.5?



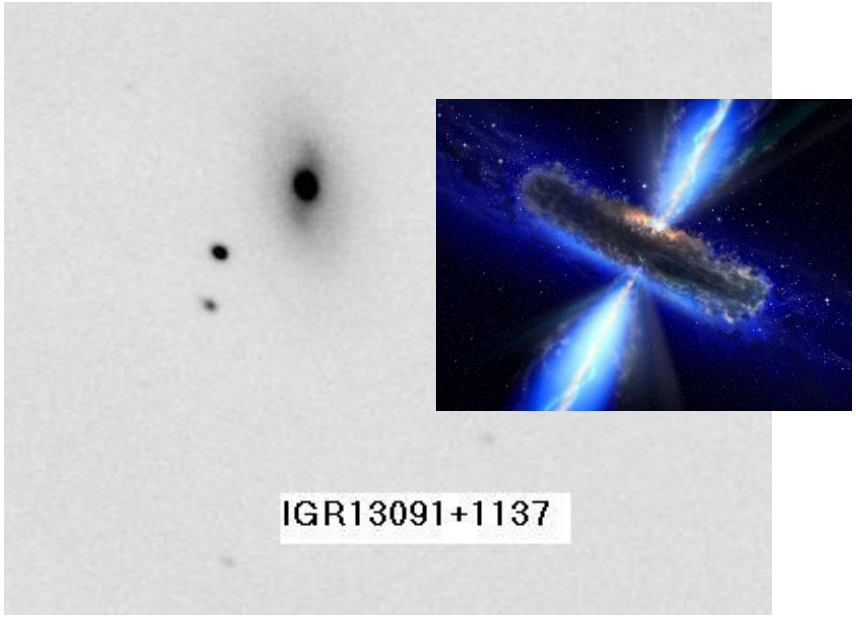


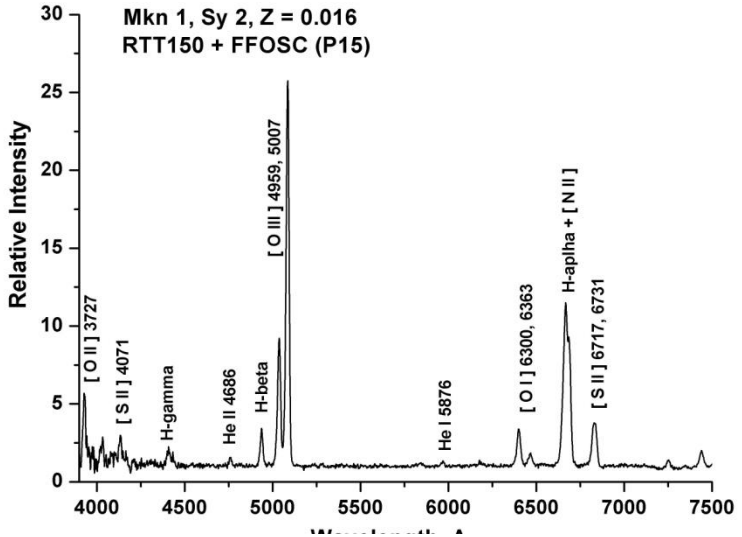
Optical luminosities based on [O III], 5007 A, line are in agreement with X-ray luminosities (Heckman et al., 2005), logLx = 2.13 + logL[OIII], but this relation is not valid for highly absorbed sources.

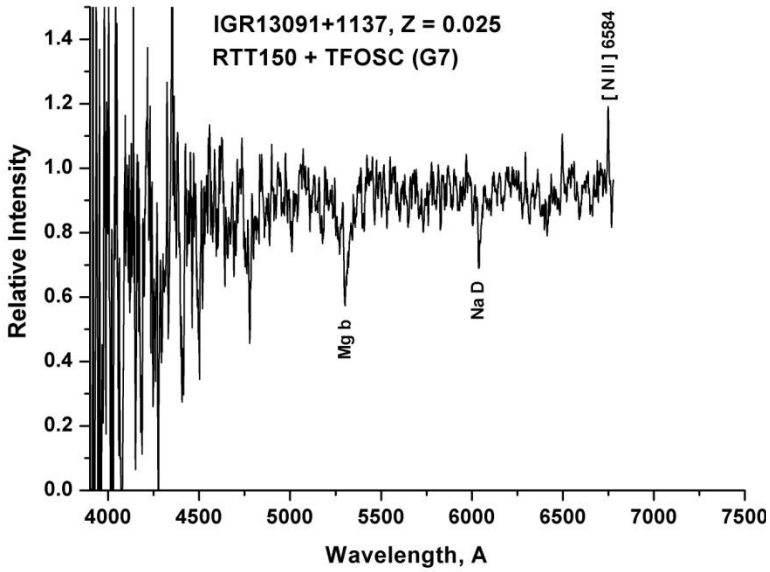


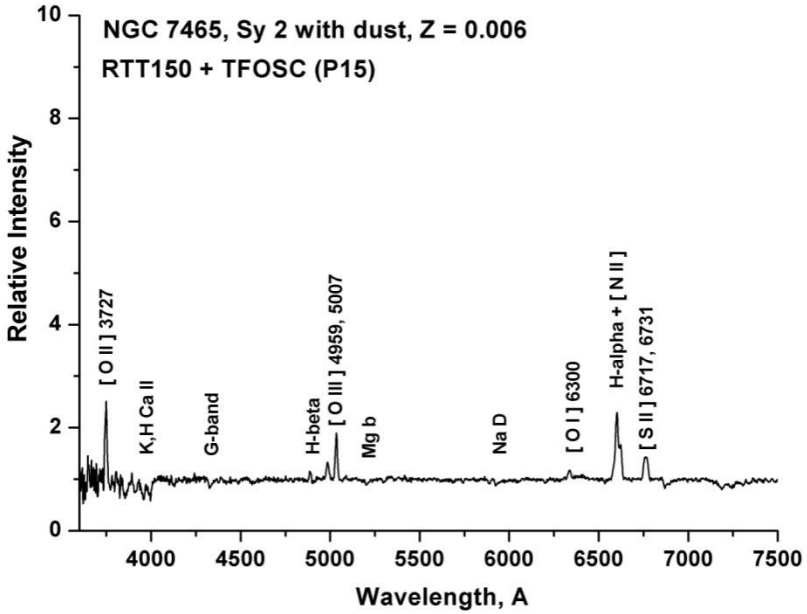


Optical spectra of absorbed AGNs, XBONGs. X-ray missions are needed !

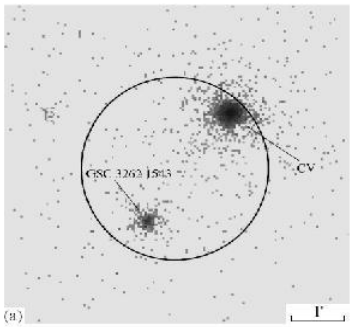


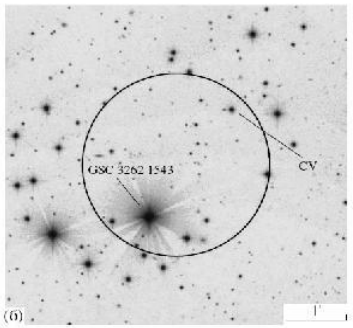


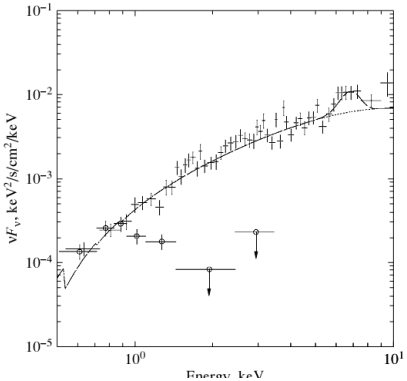


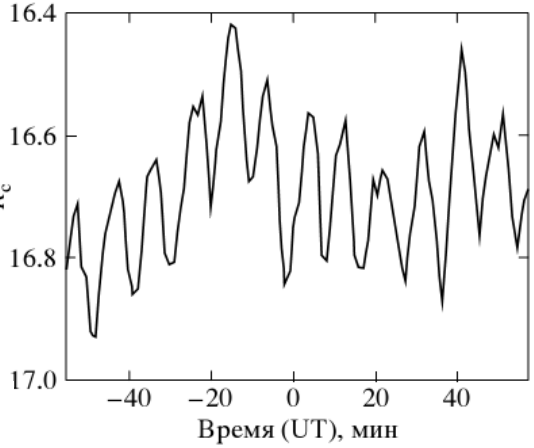


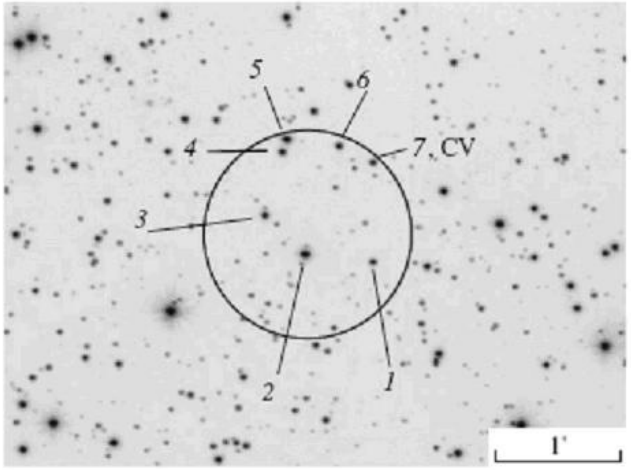
Optical identifications of intermediate polyars – IGRJ 00234+6141 and XSS 00564+4548

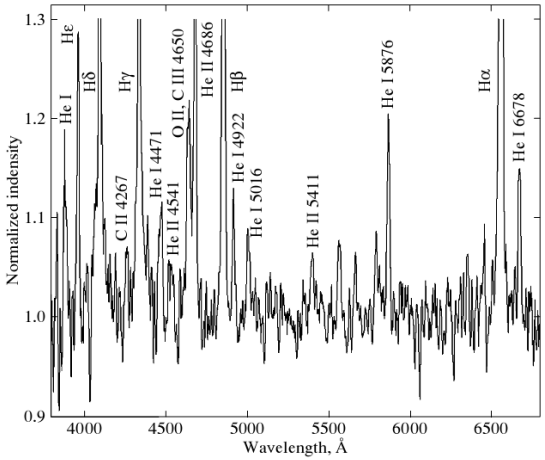


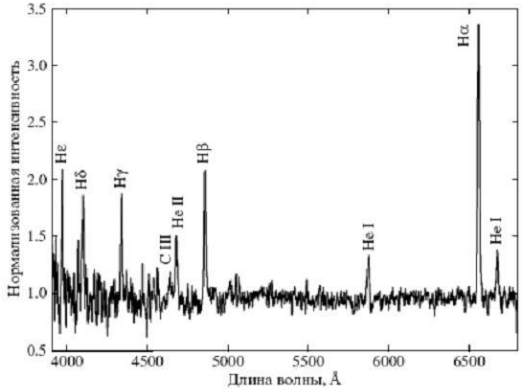


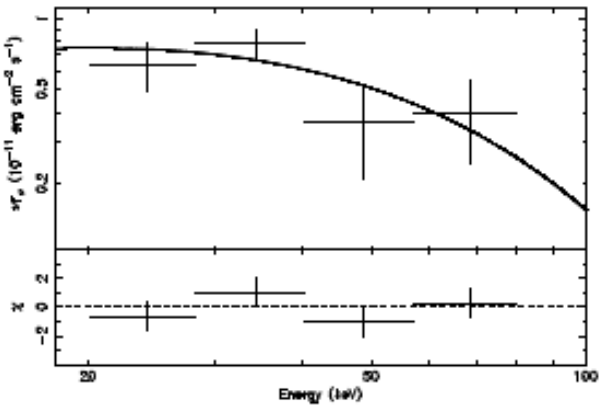


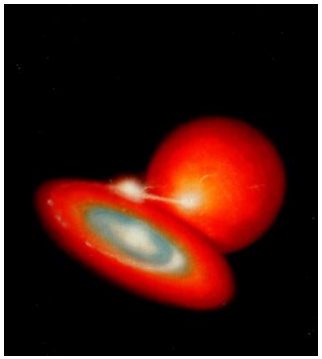


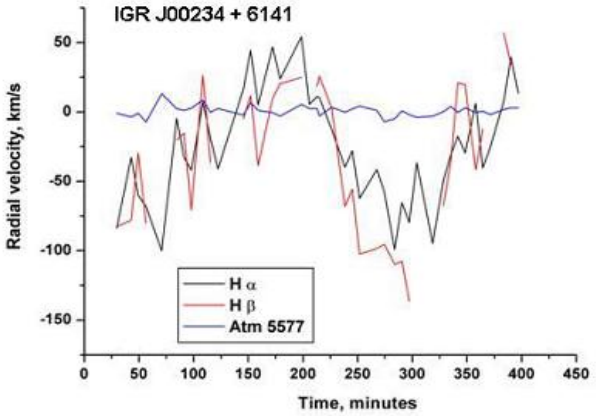












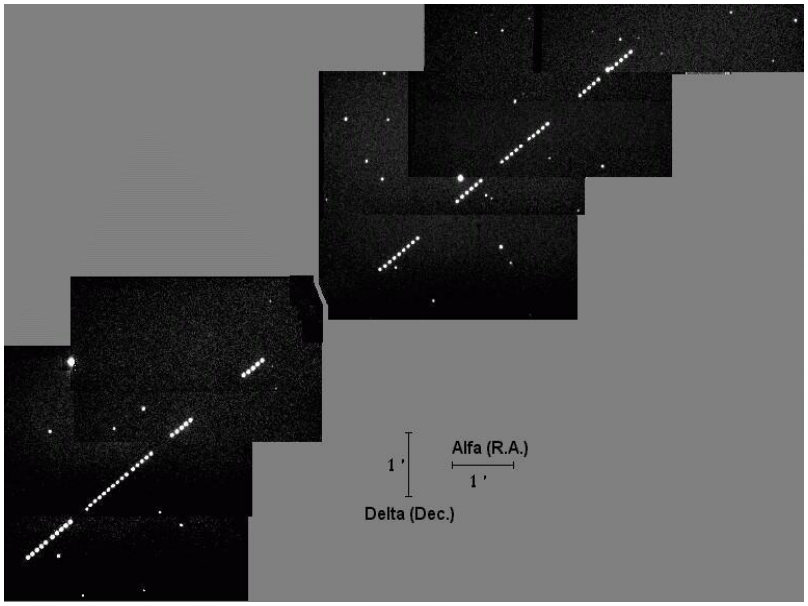
Minor Planet Observations.

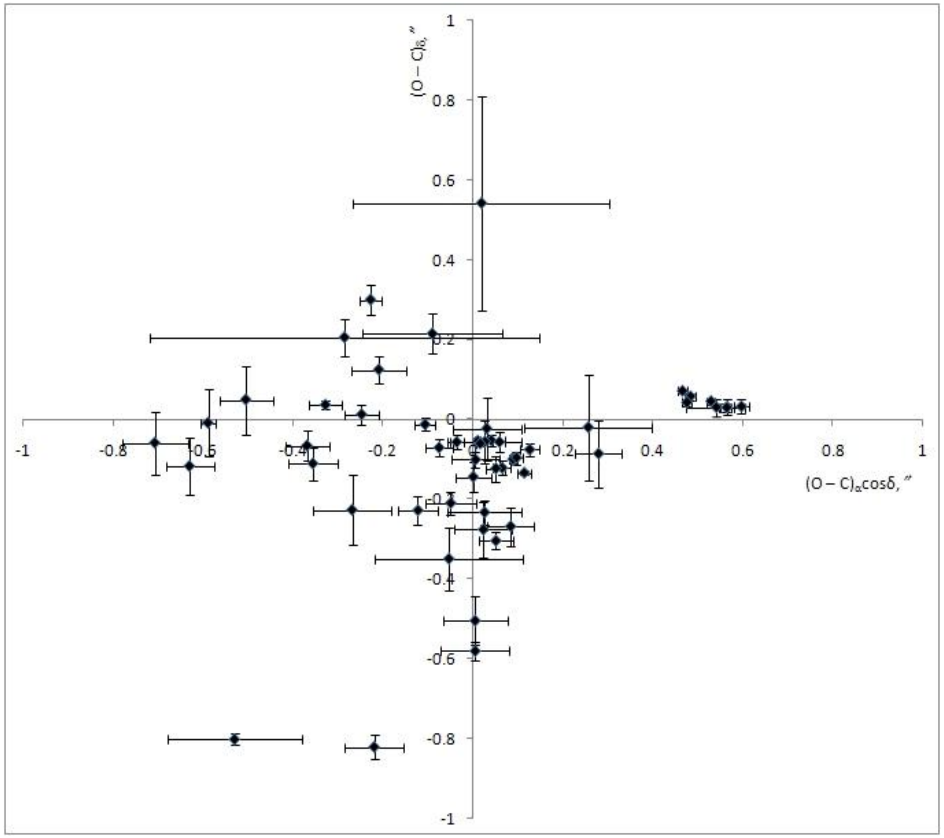
High precision (0.05 arcsec) astrometry permits to estimate and improve asteroid's masses

106 minor planets and 22 near Earth MP have been observed by RTT-150

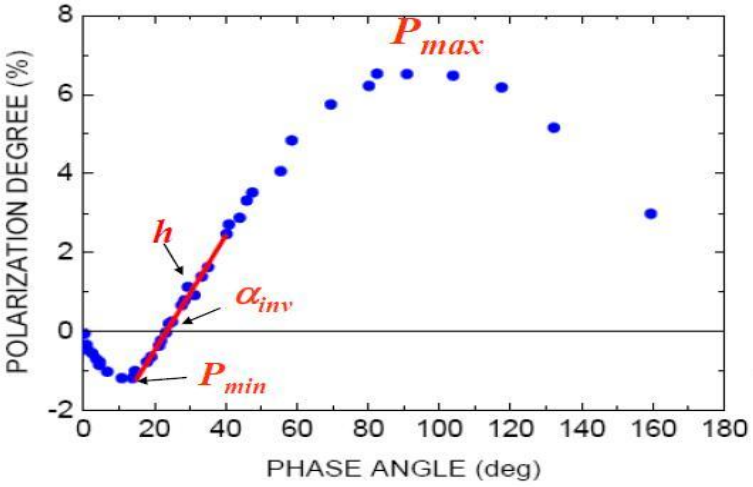
(O-C) diagram for observed Minor planets

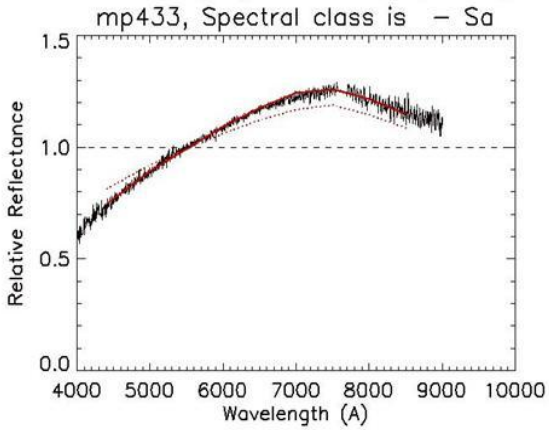
Astrometric catalogues with high accurate positions (0.005 arcsec) of reference stars (including proper motions) are needed,

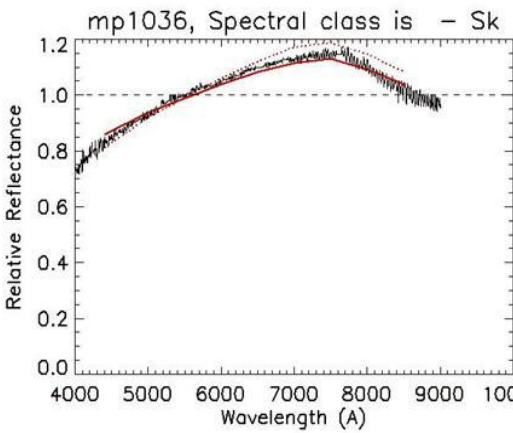


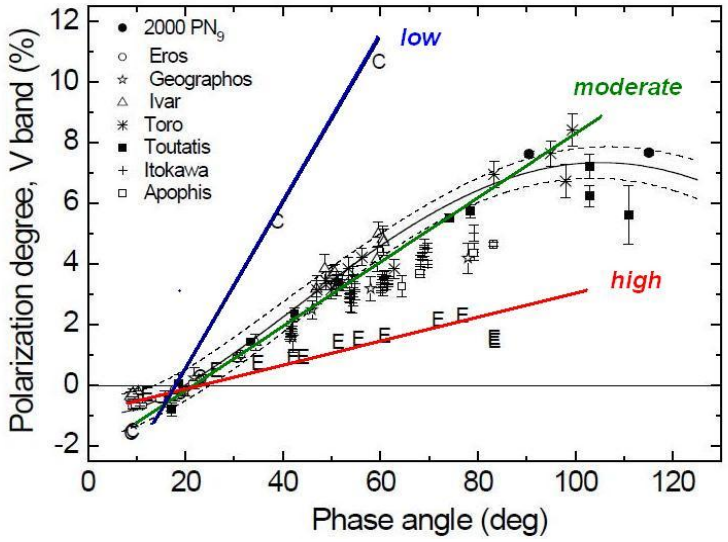


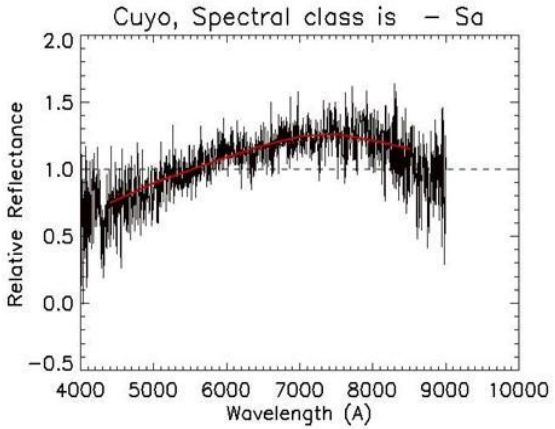
Minor planets polyarimetry and low-resolution spectroscopy at RTT-150

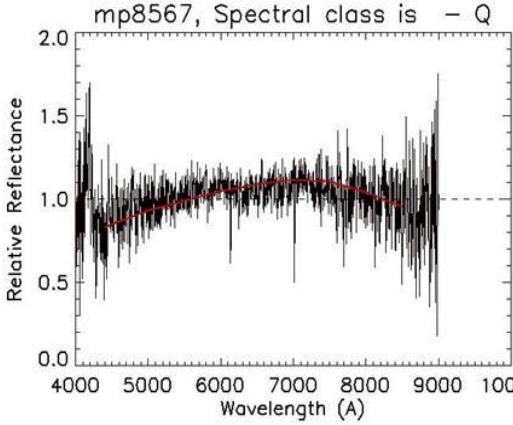






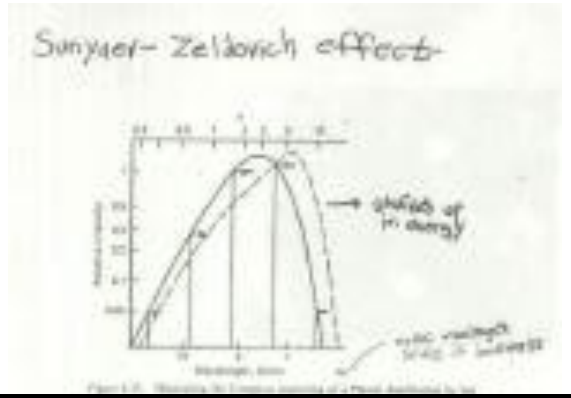


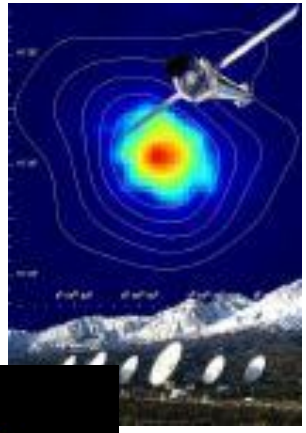


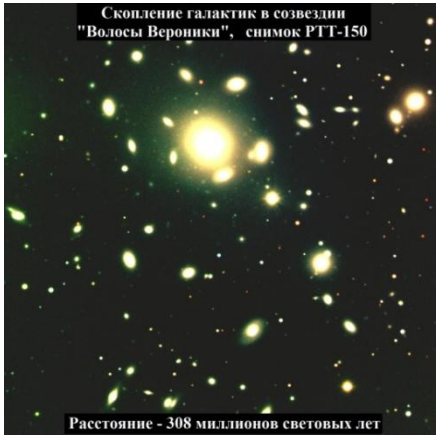


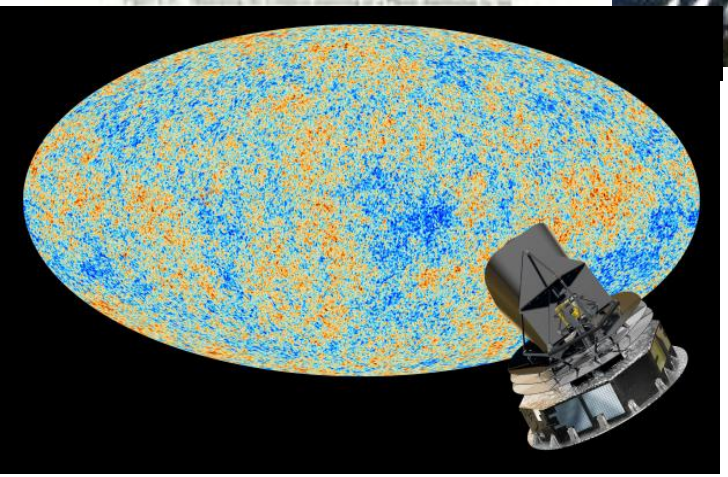
PLANCK space mission has detected 1600 clusters of galaxies (candidate to clusters of galaxies) based on Sunyaev – Zeldovich effect

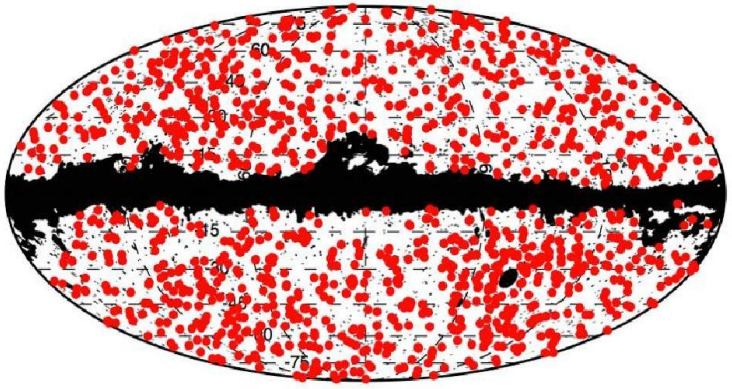
1200 objects are known clusters, but 400 clusters are new ones. Optical telescopes are needed to identify them.

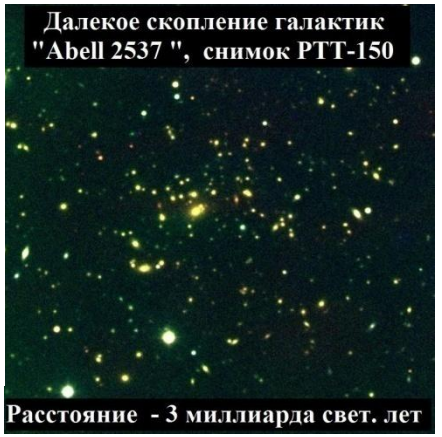




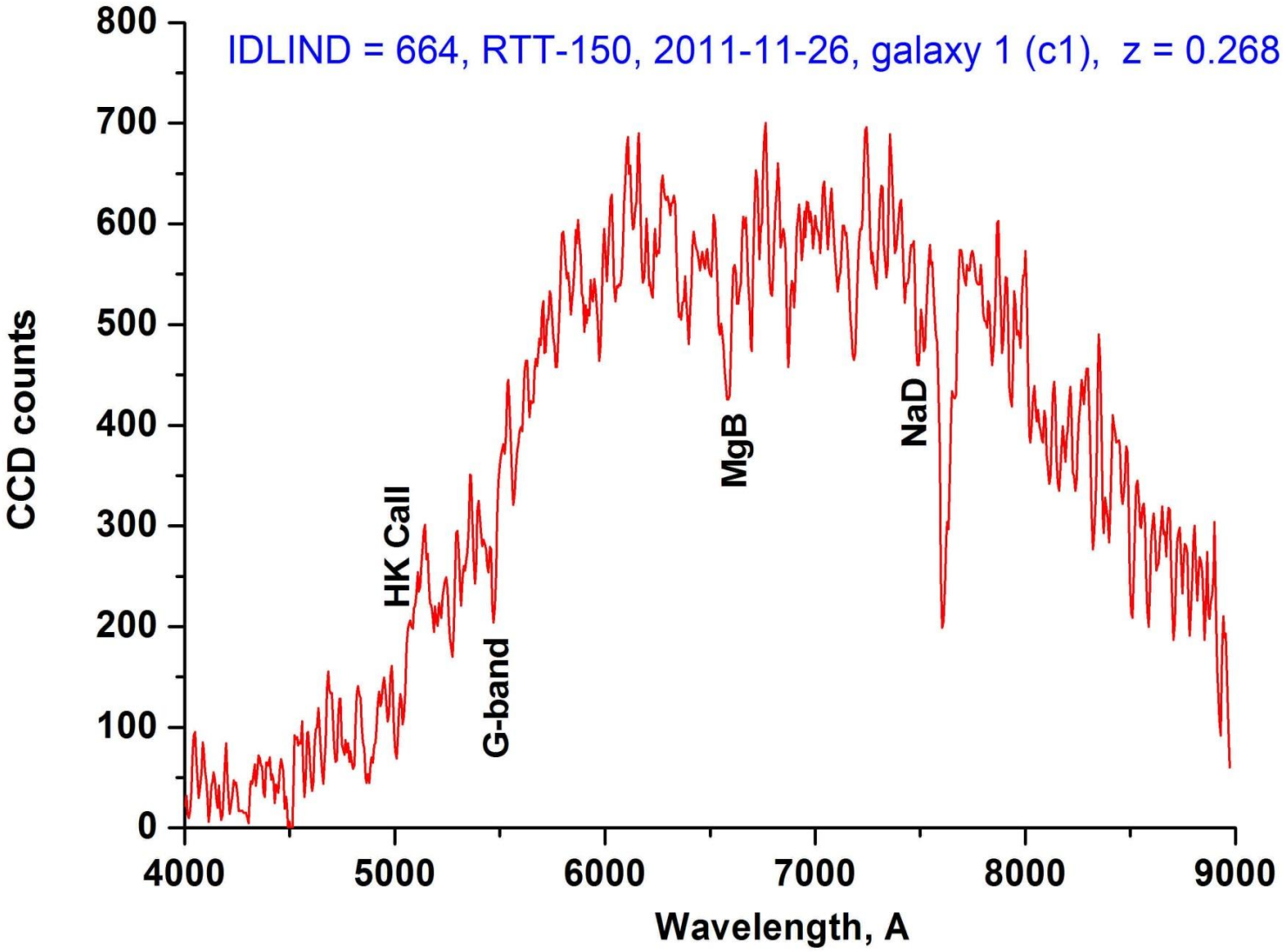








Optical identifications of clusters by Russian telescopes: RTT-150 and 6-m BTA
50 new galaxy clusters have been identified in z = 0.1 – 0.8 range in 120 fields.


IDLIND = 664, RTT-150, 2011-11-26, galaxy 1 (c1), z = 0.268
CCD counts
Wavelength, A
HK CaII
G-band
MgB
NaD
0
100
200
300
400
500
600
700
800
4000
5000
6000
7000
8000
9000

Examples of identified clusters at z ~ 0.4-0.7

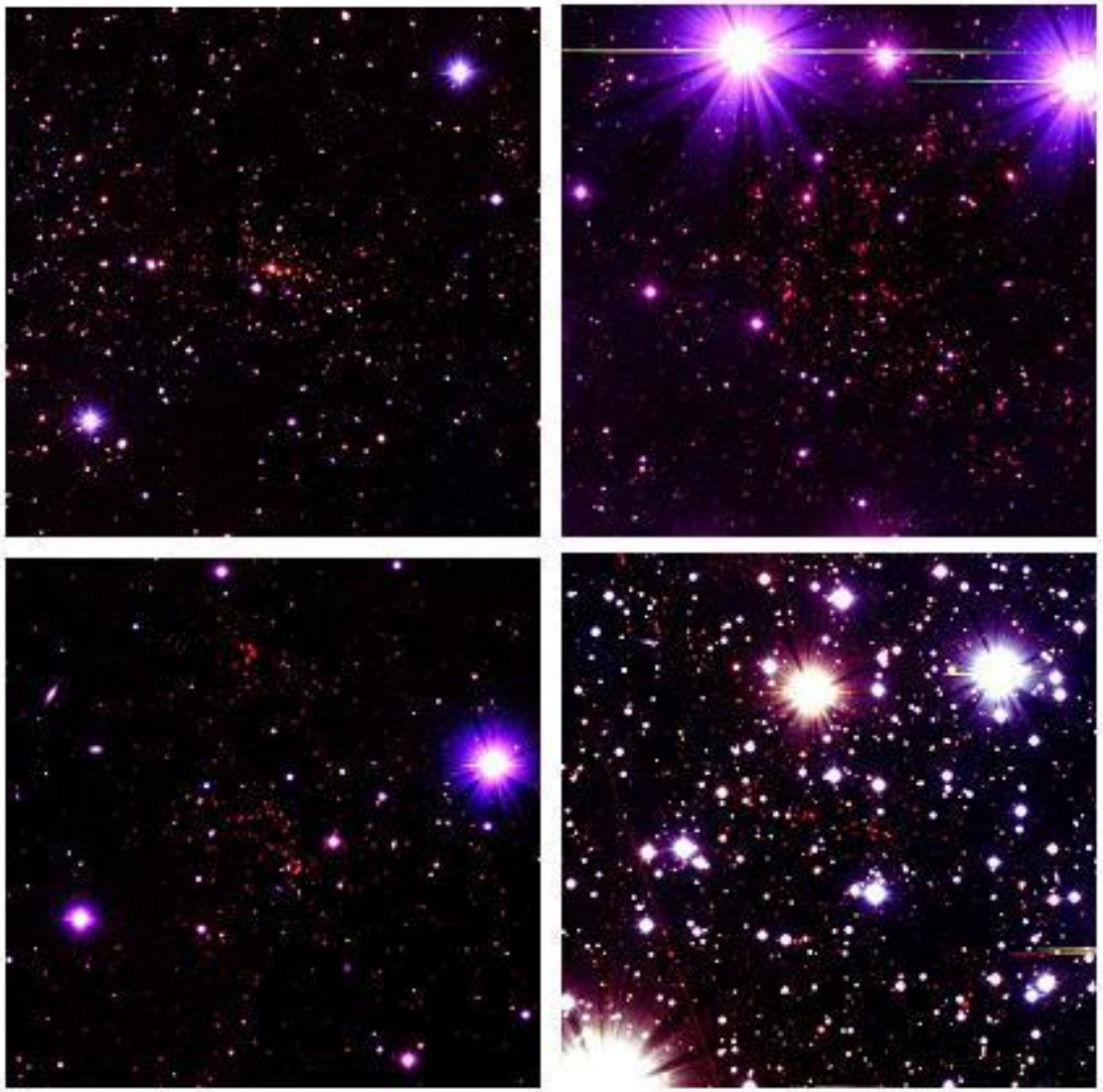


FIG. 2.— Pseudocolor ($g'r'i'$, RTT150) images of Planck clusters, with color map adjusted to emphasize red sequence of galaxies in the center of clusters. Upper left: G098.24-41.15, $z = 0.436$; upper right: G100.18-29.68, $z = 0.485$; lower left: G138.11+42.03, $z = 0.496$; lower right: G209.80+10.23, $z = 0.677$.

A&A 582, A29 (2015)
DOI: 10.1051/0004-6361/201424674

Astronomy & Astrophysics

Planck intermediate results. XXVI. Optical identification and redshifts of *Planck* clusters with the RTT150 telescope

Planck Collaboration: P. A. R. Ade[78], N. Aghanim[53], M. Arnaud[66], M. Ashdown[63,7], J. Aumont[53], C. Baccigalupi[77], A. J. Banday[85,11], R. B. Barreiro[59], R. Barrena[58], N. Bartolo[29,60], E. Battaner[86,87], K. Benabed[54,84], A. Benoit-Lévy[23,54,84], J.-P. Bernard[85,11], M. Bersanelli[32,47], P. Bielewicz[85,11,77], I. Bikmaev[19,2], H. Böhringer[71], A. Bonaldi[62], L. Bonavera[59], J. R. Bond[10], J. Borrill[14,80], F. R. Bouchet[54,84], R. Burenin[79,73,⋆],

A&A 581, A14 (2015)
DOI: 10.1051/0004-6361/201525787

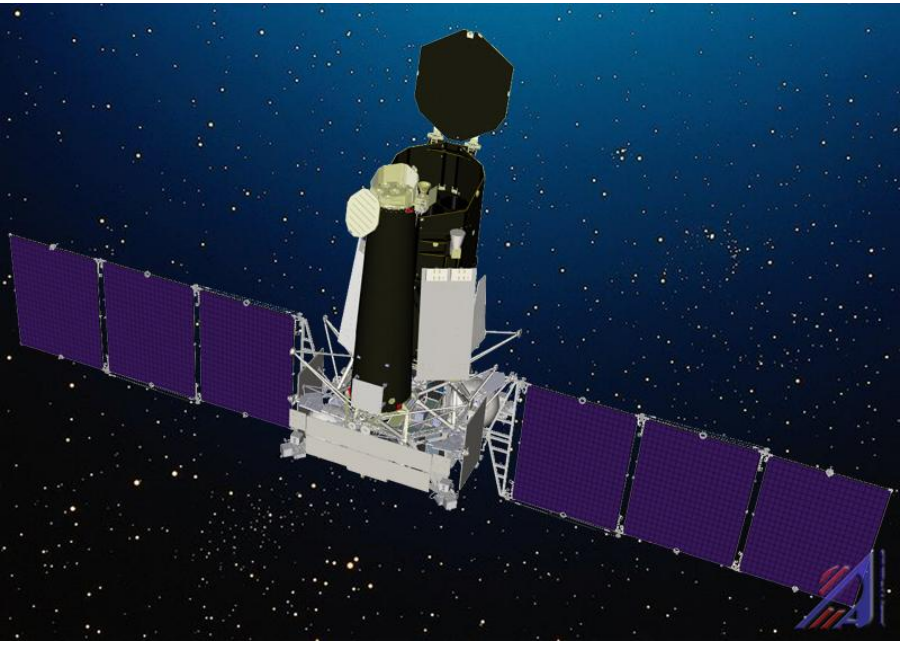
Astronomy & Astrophysics

Planck 2013 results. XXXII. The updated *Planck* catalogue of Sunyaev-Zeldovich sources⋆

Planck Collaboration: P. A. R. Ade[99], N. Aghanim[68⋆⋆], C. Armitage-Caplan[104], M. Arnaud[81], M. Ashdown[78,7], F. Atrio-Barandela[21], J. Aumont[68], H. Aussel[81], C. Baccigalupi[97], A. J. Banday[110,11], R. B. Barreiro[75], R. Barrena[74], M. Bartelmann[108,87], J. G. Bartlett[1,76], E. Battaner[113], K. Benabed[69,107], A. Benoît[66], A. Benoit-Lévy[29,69,107], J.-P. Bernard[110,11], M. Bersanelli[41,58], P. Bielewicz[110,11,97], I. Bikmaev[24,3], J. Bobin[81], J. J. Bock[76,12], H. Böhringer[88], A. Bonaldi[77], J. R. Bond[10], J. Borrill[16,101], F. R. Bouchet[69,107], M. Bridges[78,7,72], M. Bucher[1], R. Burenin[100,91], C. Burigana[57,39], R. C. Butler[57], J.-F. Cardoso[82,1,69], P. Carvalho[7], A. Catalano[83,80], A. Challinor[72,78,13], A. Chamballu[81,18,68],

Scientific cooperation with the future X-ray missions - Russian-German International project - "Spectrum-Roentgen-Gamma" orbital Observatory, 2017 - 2025

Big data and Catalogues (+ ground based telescopes) will play important role in the task of optical identifications of SRG X-Ray sources



SRG will detect in 1-30 KeV range much of X-Ray sources – close binary systems (1-2 mln), AGNs (3- 4 mln) , clusters of galaxies (100000).

RTT-150 will realize ground support observations in optical range of X-ray sources detected and discovered by SRG telescopes - ART-XC and e-Rosita.

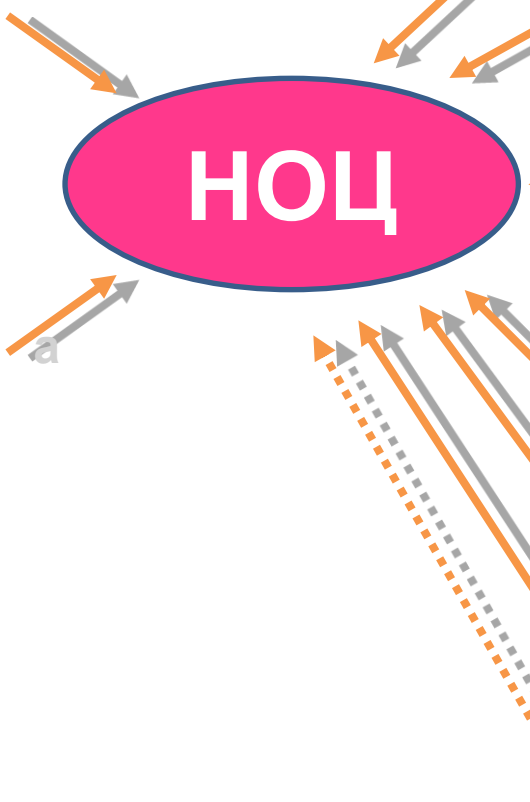
INITIATIVES OF EXCELLENCE

Astrophysics and Cosmology

KFU Departments

- Astronomy and Satellite Geodesy
  Prof. Ilfan Bikmaev

  Leading Scientific School of Russia
  Prof. Nail Sakhibullin
- Theory of relativity and gravitation
  Prof. Sergey Sushkov
- Advanced Mathematics and mathematic modelling
  Prof. Yuri Ignatiev



Russian and International partners

- IKI RAN , SAO RAS, MAO RAS, INASAN
- MSU Astr Inst.
- Institute of advanced studies, Barcelona, Spain
- Lisbon Technical University Lisbon, Portugal
- MAX PLANCK Institute for Astrophysics (Germany)
- California State University Fresno, California, USA