OPTICAL IDENTIFICATIONS OF INTEGRAL / RXTE SOURCES WITH 1.5-METER OPTICAL TELESCOPE RTT150

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ABSTRACT

We present the first results of our project on optical identifications of INTEGRAL / RXTE hard X-ray sources by using scientific instrumentations of the 1.5-meter joint Russian-Turkish optical telescope RTT150. As the result of observations made in 2005 we have identified 6 new nearby (Z < 0.1) AGNs and two new intermediate polars.

1. INTRODUCTION

Since its launch in October 2002 INTEGRAL satellite (with its onboard instrumentations, [8]) has discovered many new hard X-Ray sources. Part of them are dust obscured sources and their detections were difficult or impossible by earlier space X-ray missions due to sensitivity limitations in the hard X-Ray range. Unfortunately, limited angular resolution of 2-3 arcmin of INTEGRAL is preventing direct identifications of many new sources on the sky, especially in the crowded fields in Galactic Center and Galactic Plane regions. RXTE satellite [3] has discovered and collected data of many X-Ray sources during 10 years in-orbit operations. But part of sources have not been identified yet [6]. INTEGRAL and RXTE X-sources are distributed over almost all-sky and this is allowing to use them for statistical studies.
Russian-Turkish 1.5-meter joint optical telescope is being equipped with modern photometric and spectroscopic instrumentations for observations of relatively faint optical sources. These instruments are:
CCD-photometer including UBVRcIc and u'g'r'i'z' filters sets and thermoelectrically cooled (-60 C) ANDOR CCD (www.andor.com) as the detector. Field of view is 8 x 8 arcmin (0.24"/pix, 2048 x 2048 pixels). Our experiences show that targets of R ~ 24th mag could be detected during 1-2 hours of total integrations at 1.0-1.5 arcsec seeing.
TFOSC instrument (TUBITAK FOSC) is the modified version of FOSC type instruments produced by Copenhagen University Astronomical Observatory (http:astroa.physics.metu.edu.tr/tug/tfosc.html). This instrument is allowing us to obtain direct images in 14x14 arcmin field of view (0.39"/pix) and low (5-15 A) resolution spectra of R~15-19 mag targets.
Here we present the first results of the program of optical identification of INTEGRAL / RXTE X-Ray sources based on RTT150 observations. Some of RTT150 data already were used in statistical analysis of nearby AGNs hard X-Ray luminosity functions [7].

2. SIX NEW NEARBY AGNS

In 2005 we have observed a number of sky fields around INTEGRAL / RXTE sources by using CCD photometer or Imaging mode of TFOSC instrument and have got deep images up to R ~ 23 mag. For the first series of observations, sources with relatively accurate positions determined by several X-Ray observatories (ROSAT, EINSTEIN, SWIFT, CHANDRA) were chosen. As the result of TFOSC spectroscopy of several targets within coordinates error boxes, six IGR and XSS sources studied were identified with AGNs in nearby galaxies [1]. For all these X-ray sources we found optical objects with bright emission lines of H-alpha, [O III], [N II] and line intensities ratio corresponding to active galactic nuclei. Study of deep images showed that in all cases we detected extended object around the AGN – their host galaxies. Angular sizes of galaxies at the sensitivity limits of images are ~ 10-20 arcsec which correspond to linear size of the galaxies ~ 10-20 Kpc.
Table 1 gives the main optical parameters of these AGNs. Optical fluxes of these AGNs are comparable with their X-Ray fluxes, LogL ~ 43-44.

Table 1. Main optical parameters of the six new AGNs.

Source	Rc, mag	Z	Ha, km/s	Type
XSSJ05055-2348	16.6	0.035	<700	Sy2
XSSJ16151-0943	14.8	0.065	1600	Sy1
IGRJ18559+1535	16.6	0.084	3200	Sy1
IGRJ19473+4452	17.2	0.053	<700	Sy2
IGRJ21277+5656	16.6	0.014	1600	Sy1
XSSJ21354-2720	15.8	0.067	1200	Sy1.5

Note to Table 1. IGR J18559+1535 was independently identified by [5] too.

3. TWO INTERMEDIATE POLARS

In the fields of IGRJ00234+6141 and XSSJ00564+4548 we have detected variable sources of Rc ~ 16.7 and 14.8 mag with periodical optical brightness oscillations of 9.5 (Fig.1) and 8 minutes, correspondingly [2]. Their spectra obtained by TFOSC instrument exhibit the intense hydrogen and helium emission lines (at Z = 0) typical of accretion disks around white dwarfs (Fig.2). Therefore, matter in IGRJ00234+6141 and XSSJ00564+4558 are most likely accreted from a normal star to polar cap of a white dwarf. Such systems have typical orbital periods of several hours (Fig.3). Short periods of 8-10 minutes are due to rotation of white dwarfs. We have concluded that IGRJ00234+6141 and XSSJ00564+4548 are, most probably, intermediate polars - weakly magnetized accreting white dwarfs.

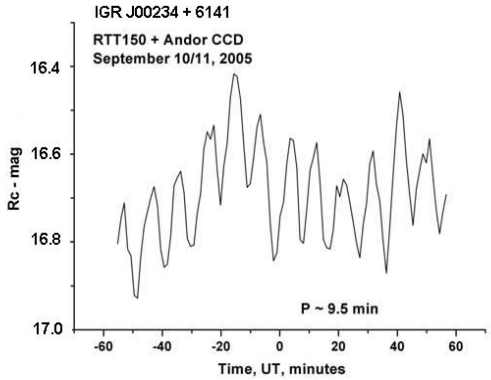

Fig.1. Part of optical light curve of IGRJ00234+6141 showing 9.5-min periodicity.

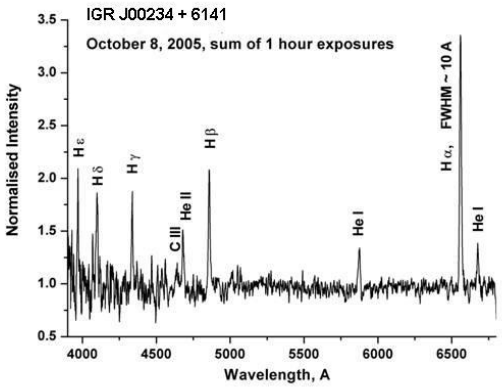

Fig.2. Optical spectrum of IGR J00234+6141 obtained by RTT150 in October 2005.

IGRJ00234+6141 was independently observed spectroscopically by [4] in January 2006 and they identified it as cataclysmic variable too.

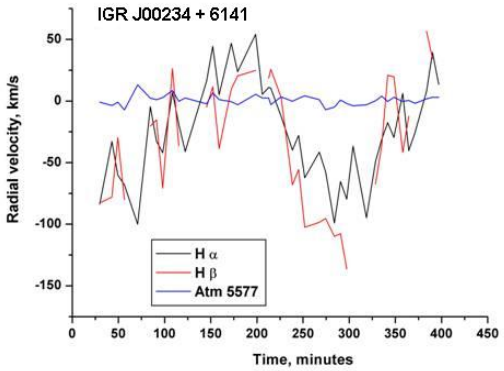

Fig.3. Emission lines radial velocity curve of IGRJ00234+6141 with periodical variations at the time scale of 4-4.5 hours, typical to orbital periods of close binary systems with accretion disks.

4. CONCLUSION

Scientific equipment of RTT150 is allowing us to identify optically INTEGRAL / RXTE sources and to study the main optical parameters of these sources. As the first step of this project we have identified six new nearby (Z<0.1) AGNs and two new intermediate polars.

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5. REFERENCES

1. Bikmaev I., Sunyaev R., Revnivtsev M., Burenin R., *Astron.Lett*., Vol.32, 221, 2006
2. Bikmaev I., Revnivtsev M., Burenin R., Sunyaev R., *Astron.Lett*., Vol.32, 588, 2006
3. Bradt H.V., Rotshild R.E., Swank J.H., *A&AS*, Vol.97, 355, 1993.
4. Halpern J.P.**,** Mirabal N., *ATel* 709, 2006.
5. Masetti N., Mason E., Bassani L., et al., *A&A*, Vol. 448, 547, 2006.
6. Revnivtsev M., Sazonov S., Jahoda K.,Gilfanov M., *A&A*, Vol. 418, 927, 2004.
7. Sazonov S., Revnivtsev M.,Krivonos R., Churazov E., Sunyaev R., *arXiv:astro-ph* /0608418, 2006
8. C.Winkler., T.J.-L.Courvoisier, G. Di Cocco, et al., *A&A*, Vol. 411, L1, 2003.