

IDENTIFICATION OF INTEGRAL SOURCES WITH ASTRONOMICAL ARCHIVAL PLATES

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ABSTRACT

The ESA INTEGRAL satellite (International Gamma Ray Laboratory) launched in October 2002 continues to deliver valuable data about the gamma-ray sky. The first 2 years of INTEGRAL public and Core Program data have revealed 209 sources and this number is expected to increase to about 500 in the future [1].

1. IDENTIFICATION OF SOURCES

Only a fraction of these sources are either known sources or have been identified and classified already. From the 56 newly by INTEGRAL detected sources (IGR sources), only ~20% have already firm classification, mostly with Cataclysmic variables (CVs), AGN, High Mass X-ray Binaries, Low Mass X-ray Binaries, Black Hole Candidates, and Anomalous X-ray Pulsars [1]. One of the methods applied in the past is the identification by spectroscopy, which proved recently some new and interesting identification of INTEGRAL gamma-ray sources such as newly detected symbiotic and cataclysmic variables [2][3].

2. LIMITATIONS OF RECENT METHOD

Although successful, this method has some limitations. First, it can be hardly applied for particular types of transients and recurrent transients. Secondly, it requires access to dedicated large aperture telescopes and spectrographs. Moreover, it can be laborious in the case of large error box and crowded field. And in some specific cases, only the spectral information alone is sometimes, not enough for reliable classification of the objects.

3. THE PROPOSAL

In this proposal, we propose an alternative method how to identify the still non-classified INTEGRAL gamma

ray sources and newly detected INTEGRAL sources in the future (and of other high energy satellites in general). This method is based on the fact that (1) many of gamma-ray sources identified and classified so far do have optical counterparts, in many cases brighter than magnitude 18, and (2) a significant fraction of these sources is variable both in gamma-rays as well as in optical wavelengths.

4. MOTIVATION

The INTEGRAL satellite focus on the Galactic Center region as well as on Galactic Plane Scans (GPS). Numerous new gamma-ray sources have been found in these regions by INTEGRAL, and only a fraction of these sources was successfully identified. The identification of INTEGRAL sources indicates that most of them have variable optical counterpart brighter than mag 18.

The recent progress in classification of newly detected INTEGRAL sources has indicated that the fraction of Cataclysmic Variables and Symbiotic Stars in larger than originally expected. These sources are usually optically bright with magnitudes 10 ... 18 and can be easily and effectively studied at optical wavelengths by ground-based telescopes or, alternatively, by archival databases as described in this contribution.

5. SUITABLE DATABASES

Among the nearly 3 million astronomical archival plates in the various astronomical plate archives [8], the Sonneberg Field Patrol and Leiden/Johannesburg Franklin Adams Plates have been identified as suitable databases for identification and analysis of INTEGRAL sources. They both provide numerous data for regions along the Galactic Plane.

6. SONNEBERG FIELD PATROL

Northern regions along the Galactic Plane (but also other fields) are covered by numerous (typically

50...500) astrograph plate of the Sonneberg Field Patrol originated by Prof. Cuno Hoffmeister. Typical Field of View (FOV) of one plate is 10 x 10 deg and the typical limiting magnitude is B~17. The distribution of the plates in galactic coordinates (Fig. 1) is consistent with the coverage of INTEGRAL IBIS instrument (Fig. 2). This is valid also for the Leiden plate collection described in the next section. In exceptional cases, also low-dispersion spectral plates are available in this archive.

7. LEIDEN/JOHANNESBURG F.A. PLATES

These plates were taken in Johannesburg by the high quality Franklin Adams refractor [10] in years 1923-1952 within the project originated by Prof. E. Hertzsprung and are stored in Leiden. The plates cover selected fields along the southern Galactic plane as well as the Galactic centre (Fig. 1). The typical number of plates in one field is 300...400, the FOV is 10 x 10 degrees and the typical limiting magnitude 17.

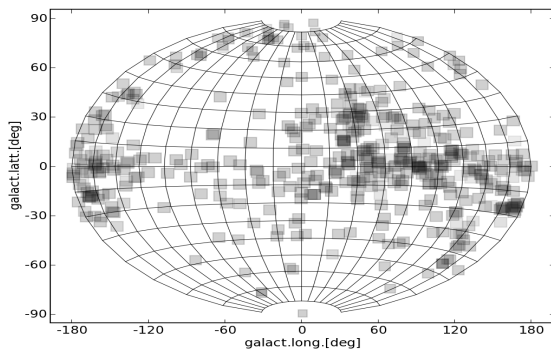


Fig. 1. Distribution of Sonneberg Field Patrol Fields and Franklin Adams Fields in Galactic coordinates. The densely covered fields are darker.

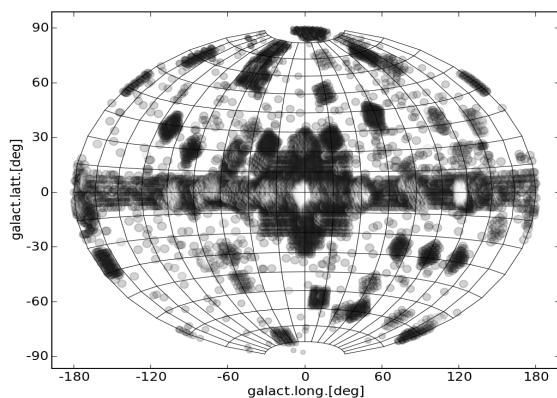


Fig. 2. The coverage of INTEGRAL IBIS in galactic coordinates for revolutions 1 - 430.

8. THE PROPOSED ANALYSIS

Using the data material mentioned here, the optically identified INTEGRAL sources with objects brighter than mag 17 can be investigated for long-term changes covering 10 ... 50 years.

In addition, these data can be used to search for new optical identifications of non-classified INTEGRAL sources on hand of their optical variability.

9. ADDITIONAL PROSPECTS

In addition, there are numerous additional prospects in using of astronomical archival plates for the analyses described in this paper, such as analyzing the light curves for flares and flaring activity (similar to those found on astronomical plates from the Bamberg Observatory southern sky patrol for polar TV Col [7]). Another prospects are as follows: trying to fit the flare profiles, trying to look for possible periodicities and recurrences, study of colors and color changes with time, with consequent physical discussions and interpretations. Correlations with other objects, with related conclusions toward physical processes and physical models. Recently, the study using the Sonneberg Observatory sky patrol plates has enabled to detect and to investigate the so far unknown brightening of blazar OJ287, contributing to the improved model parameters and enabling precise prediction of future activity of the object [4]. In addition, novel algorithms have been designed and developed recently to allow easy computer based detections of new, flaring and variable objects on digitized astronomical archival plates [5][6]. This can have a serious positive impact on astrophysical works with astronomical plates in general as the previous extended studies which have led e.g. to the discovery of large amplitude flares from AGN [9] required considerable and time consuming efforts.

10. GALACTIC CENTRE

A particular interest will be devoted to region close to Galactic Centre where the INTEGRAL satellite coverage is large (Fig. 2) and where numerous high energy sources are located and new sources are continuously discovered. This area is also covered by archival plates at particular observatories (e.g. Leiden, Franklin Adams plates taken in Johannesburg), see Fig. 1.

11. CONCLUSIONS

A new cost-effective method for classification and optical identification of INTEGRAL sources has been proposed.

This method can be applied both to detailed analyses of already identified sources as well as to identification of non-classified new sources. Dedicated software programs are in design and development.

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