ASTRONOMY & ASTROPHYSICS
SUPPLEMENT SERIES

JANUARY II **1998**, PAGE 145

*Astron. Astrophys. Suppl. Ser.* **127,** 145-152 (1998)

# The Hamburg/RASS Catalogue of optical identifications*

**N. Bade[1], D. Engels[1], W. Voges[2], V. Beckmann[1], Th. Boller[2], L. Cordis[1], M. Dahlem[1,3], J. Englhauser[2], K. Molthagen[1], P. Nass[1,2], J. Studt[1], and D. Reimers[1]**

[1] Hamburger Sternwarte, Gojenbergsweg 112, D-21029 Hamburg, Germany
[2] Max-Planck-Institut für extraterrestrische Physik, D-85740 Garching, Germany
[3] ESTEC, Astrophysics Division, Postbus 299, NL-2200 AG Noordwijk, The Netherlands

Received February 13; accepted April 25, 1997

**Abstract.** We present the Hamburg/RASS Catalogue of optical identifications (HRC). The catalogue contains optical information about objects inside the error circles of ROSAT All-Sky Survey (RASS) sources. The information was gathered from objective prism and direct plates taken by the Hamburg Quasar Survey (HQS). The plates enable an effective selection of several X-ray emitting classes of objects, as there are galaxies, AGN, QSOs, galaxy clusters and several types of galactic stars, in particular M dwarfs, hot white dwarfs and cataclysmic variables. In the current state (November 1996) the HRC contains information about 3847 X-ray positions and covers about 8480 $\deg^2$ of the high galactic latitude ($|b| > 20°$) northern sky. For 81.2% of the X-ray sources a plausible optical counterpart is given. The counterparts of the remaining sources are probably faint ($B > 18.5$) AGN and galaxy clusters. The HRC is available electronically together with finding charts taken from the digitized direct HQS plates.

**Key words:** X-ray sources: general — galaxies — stars

## 1. Introduction

About 80 000 X-ray sources with a detection likelihood $\geq 10$ were found during the ROSAT All-Sky Survey (Voges et al. 1996b, 1997a), from which the 18 811 brightest sources were compiled in the ROSAT Bright Source Catalogue (RASS-BSC) (Voges et al. 1996a,b). Cross-correlation with Galactic and extragalactic catalogues compiled in the SIMBAD and NED database showed that more than 65% of the objects are objects previously unknown. The identification of these objects, and more to come with the release of additional catalogues, is a challenge, as the X-ray data alone provide only limited insight into their nature. Digitized optical sky surveys play a major role in this effort to provide candidates for optical counterparts to the X-ray sources. Despite the relatively small error radii ($< 20''$) of the RASS positions, often more than one candidate is present and follow-up optical spectroscopy is needed to determine the nature of the candidates.

The need of ample telescope time for follow-up spectroscopy can be alleviated considerably by using the information provided by (digitized) objective prism plates. The low-dispersion spectra allow to draw conclusions on the nature of the optical candidates and provide in many cases unambiguous identifications of the X-ray sources. Therefore, digitized plates of the objective prism survey for bright QSOs and direct plates at the Hamburger Sternwarte (Hagen et al. 1995) were used to provide identifications for X-ray sources from the RASS. The identification process covers currently $\sim$ 8480 $\deg^2$ of the high galactic latitude northern sky (337 fields from the Hamburg Quasar Survey (HQS, Hagen et al. (1995), each with an area of $5\overset{\circ}{.}5 \times 5\overset{\circ}{.}5$), and with the present paper we release a first catalogue containing optical counterparts for 3847 X-ray sources from the RASS-BSC.

Use of the identifications has been made already to study the RASS content of AGN. From follow-up spectroscopy of 550 counterparts classified as AGN candidates we found a confirmation rate $\geq$95% (Bade et al. 1992a). Subsequently, samples of new ROSAT detected emission-line AGN (Bade et al. 1995; Cordis et al., in preparation), and BL Lac objects (Bade et al. 1994; Nass et al. 1996) were analyzed.

In the present paper we describe the identification technique (Sect. 2), we discuss the classification criteria (Sect. 3) and present the Hamburg/RASS Catalogue of optical identifications (HRC) (Sect. 4). In the remaining

*Send offprint requests to*: N. Bade; e–mail: nbade@hs.uni-hamburg.de

* Based on observations from the German-Spanish Astronomical Center, Calar Alto, operated by the Max-Planck-Institut für Astronomie, Heidelberg, jointly with the Spanish National Commission for Astronomy.

sections the reliability of the identifications and the completeness of the catalogue are discussed, and statistics on its content are presented.

## 2. Identification technique

### *2.1. The digitized database of Schmidt plates*

The HQS provides objective prism plates for 567 fields of the northern high galactic latitude sky with $|b| > 20°$ and direct plates for most of them. In many cases two prism plates per field are available. The field size of the plates is $5\overset{\circ}{.}5 \times 5\overset{\circ}{.}5$ and the spectra have a non-linear dispersion with 1390 Å/mm at H$\gamma$. The Kodak IIIa-J emulsion is used, giving a wavelength coverage of $\approx 2000$ Å between the atmospheric UV-limit at $\approx 3400$ Å and the emulsion sensitivity cut-off at 5400 Å. The limiting magnitude for the spectral plates is $B \approx 18.5$ mag but can differ between the worst and the best plates up to 1 magnitude. The upper brightness limit due to saturation is reached between $12 < B < 14$ for the objective prism plates. The direct plates have a limit of $B \approx 20$.

The plates are digitized with a PDS microdensitometer. To fasten the digitization process the prism plates are scanned with low resolution, providing density spectra consisting typically of $15 - 20$ pixels. Interesting spectra can be rescanned individually with a tenfold higher resolution. The left part of Fig. 1 shows a cut of the digitized spectral plate around the position of an arbitrary RASS source, and the right part presents the digitized spectrum in high and low resolution.

The digitized spectral plates are calibrated in the Johnson $B$-band with photometric sequences from the Guide Star Photometric Catalogue (Lasker et al. 1988) and faint sequences from various sources. Down to $B \approx 18$ the photometric accuracy varies in the range $0.2-0.5$ mag depending on the sequences available. Below $B \approx 18$ the quality of the calibration degrades gradually. The calibration of extended optical sources (galaxies) yields brightnesses systematically too faint often more than 1 mag. The HRC marks such brightnesses with an "e" for extended after the magnitude. The digitized direct plates provide coordinates with an accuracy of $\leq 2''$ and images with moderate to good resolution $(2'' - 4'')$.

### *2.2. The identification process*

The identification process is performed in several steps. Originally the positions of X-ray sources were provided by the first processing of the survey data (RASS I, Voges et al. 1992a). This system collected all RASS sources in great circle strips 2° wide passing through the ecliptic poles. Data from neighbouring strips were combined to create a RASS X-ray source file for each HQS field. Correlations with stellar positions from the SIMBAD catalogue revealed that the RASS I positions have a $1\sigma$-error of $20''$ (Voges 1992). For the search of counterparts we adopted an error circle with radius $R = 40''$ or $R = 2\sigma + 20''$, whichever is larger and where $\sigma$ is the standard deviation of the X-ray position as given by the first RASS processing. In order to account for the larger positional error of the spectra in dispersion direction the error circle was enlarged by 200 $\mu$m $(2.3'')$ in this direction (forming an ellipse).

The selection of optical counterparts is made field by field. The first step is the registration of all optical sources inside the X-ray error circle. The method of registration was changed in 1995 to extract the full information from the spectral plates down to their limit. Prior to 1995 all spectra inside the error circle were automatically selected from the digitized low-resolution spectral database and rescanned with higher resolution. Then, objects from the direct plates, too faint to be visible on the spectral plates, were added. Since 1995 the automatic selection was made on the direct plates and scans with high resolution were made at the transformed positions. This procedure has the advantage to provide additional density spectra with low signal to noise for objects which failed to enter the digitized low resolution spectral database.

The classification of the optical sources is made basically with the high resolution objective prism spectra. These spectra are displayed on a video screen and are classified interactively. Only galaxies and galaxy clusters are mainly recognized due to their appearance on the direct plates. The classification criteria are described in Sect. 3 and a detailed description of the catalogue is given in Sect. 4.

### *2.3. Adjustment to the second RASS processing*

The RASS-BSC is based on a second processing of the RASS data, yielding $\sim 80\,000$ sources (RASS-II). The main differences in the second data processing as compared to the first are as follows. The photons were not collected in strips but rather merged in 1378 sky-fields of size $6\overset{\circ}{.}4 \times 6\overset{\circ}{.}4$, taking full advantage of the increasing exposure towards the ecliptic poles. Neighbouring fields overlap by at least $0\overset{\circ}{.}23$, in order to ensure detection of sources at the field boundaries, which was a problem in the first processing. The candidate list for the maximum-likelihood analysis was enlarged by lowering the threshold values for the two preceding source detection algorithms, and the acceptance criteria were changed to allow very soft and very hard sources to be included. These might have been rejected previously if the likelihood in the broad energy band was too low. The calculation of the spline-fitted background map was improved, resulting in more accurate count rates. Finally a new aspect solution was incorporated; this reduced drastically the number of sources with erroneous positions and morphology.

In order to ensure the quality of the source detection process a visual inspection of all RASS-BSC sources was performed (Voges et al. 1997a). While the total number of

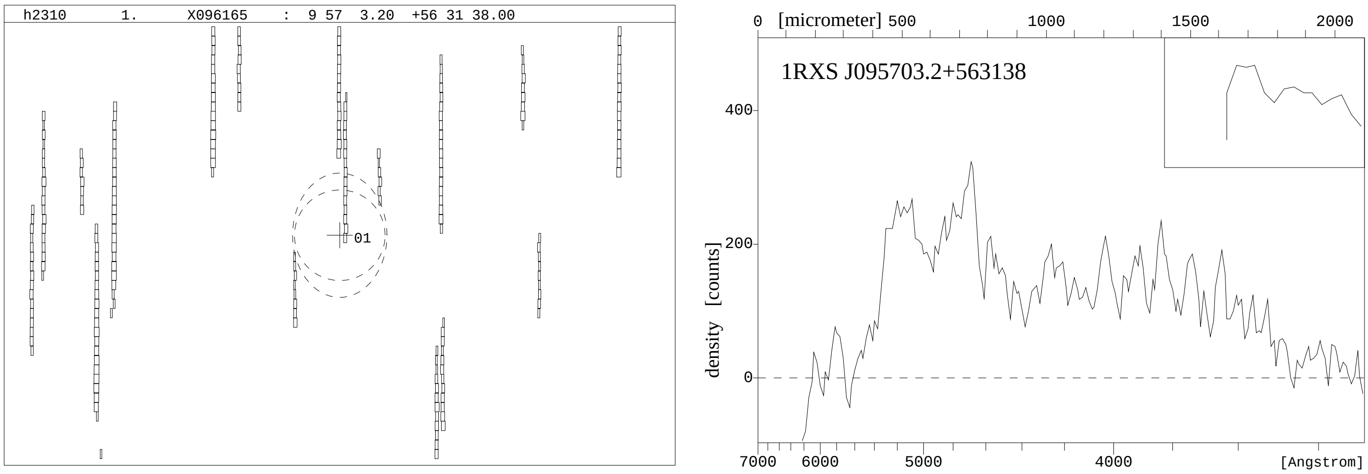


**Fig. 1.** Digitized objective prism spectrum of `1RXS J095703.2+563138`. The left image shows a part of the digitized objective prism plate (low resolution scan) around the X-ray position. The right image displays the spectrum from the high-resolution and low-resolution (inset) scan

**Table 1.** Classification codes with contents

| Code | Objects | Number | Fraction | Comments |
|---|---|---|---|---|
| 1 | AGN/QSO | 1574 | 40.9% | |
| 2 | Galaxies | 138 | 3.6% | extended optical image, contain some AGN |
| 3 | Galaxy clusters | 113 | 2.9% | |
| 5 | M-dwarfs | 155 | 4.0% | |
| 6 | White Dwarfs | 31 | 0.8% | |
| 7_1 | K Stars | 136 | 3.5% | can also contain some stars of early M type |
| 7_2 | F or G Stars | 4 | 0.1% | Classification needs further support from high resolution spectra |
| 7_3 | CVs | 16 | 0.4% | |
| 7_4 | Bright Stars | 956 | 24.9% | |
| 8 | Unidentified | 619 | 16.1% | Majority consists probably of optically weak AGN and clusters |
| 0 | Empty | 105 | 2.7% | empty on objective prism and direct HQS IIIa-J plates |

sources increased from 50 000 (RASS-I) to 80 000 (RASS-II) there are only a few sources in the RASS-BSC, which were not already detected as RASS-I sources. Typical error radii for RASS-II sources are $\sigma = 17''$. Due to the relatively large error circles ($\geq 40''$) adopted for the identification of RASS-I sources, the error circles of the corresponding RASS-II sources usually fall within the RASS-I error circles. We then only updated our catalogue with the new X-ray positions. Checks were made, if the criteria leading to a particular classification were altered by the new X-ray data. Finally, a few sources were discarded from the final catalogue because the error circles of the two RASS processings do not overlap.

## 3. Identification criteria

The basic criterion for the classification of optical counterpart candidates is the appearance of the high-resolution density spectra. A small collection of typical spectra are shown in Fig. 2. In some of the brighter density spectra emission lines (cf. classification CV, QSO in Fig. 2) and absorption features (stars of spectral type FG, K and M, some WDs) can be distinguished, and the shape of the continuum can be derived (cf. blue continua of AGN, WDs). Extended direct images help to identify galaxies which often show featureless spectra (cf. galaxy, blue galaxy). At lower densities, near the plate limit, only basic colour information is available and we classify the spectra in “extreme blue and weak (EBL – WK)”, “blue and weak (BLUE – WK)” and “red and weak (RED – WK)” spectral categories. We associate the blue spectra with X-ray emitting AGN, while the red and weak spectra are considered as unidentified sources. To identify the most plausible counterpart, we required the candidate to have in addition to an acceptable positional distance to the X-ray source to have a $\log(f_X/f_B)$ value consistent with its object class (Stocke et al. 1991).

For the final evaluation and the determination of the most plausible optical counterpart all obtainable information is put together: sky positions from the direct plates, classifications and optical magnitudes (or upper limits) from the spectral plates, hardness ratios and X-ray to

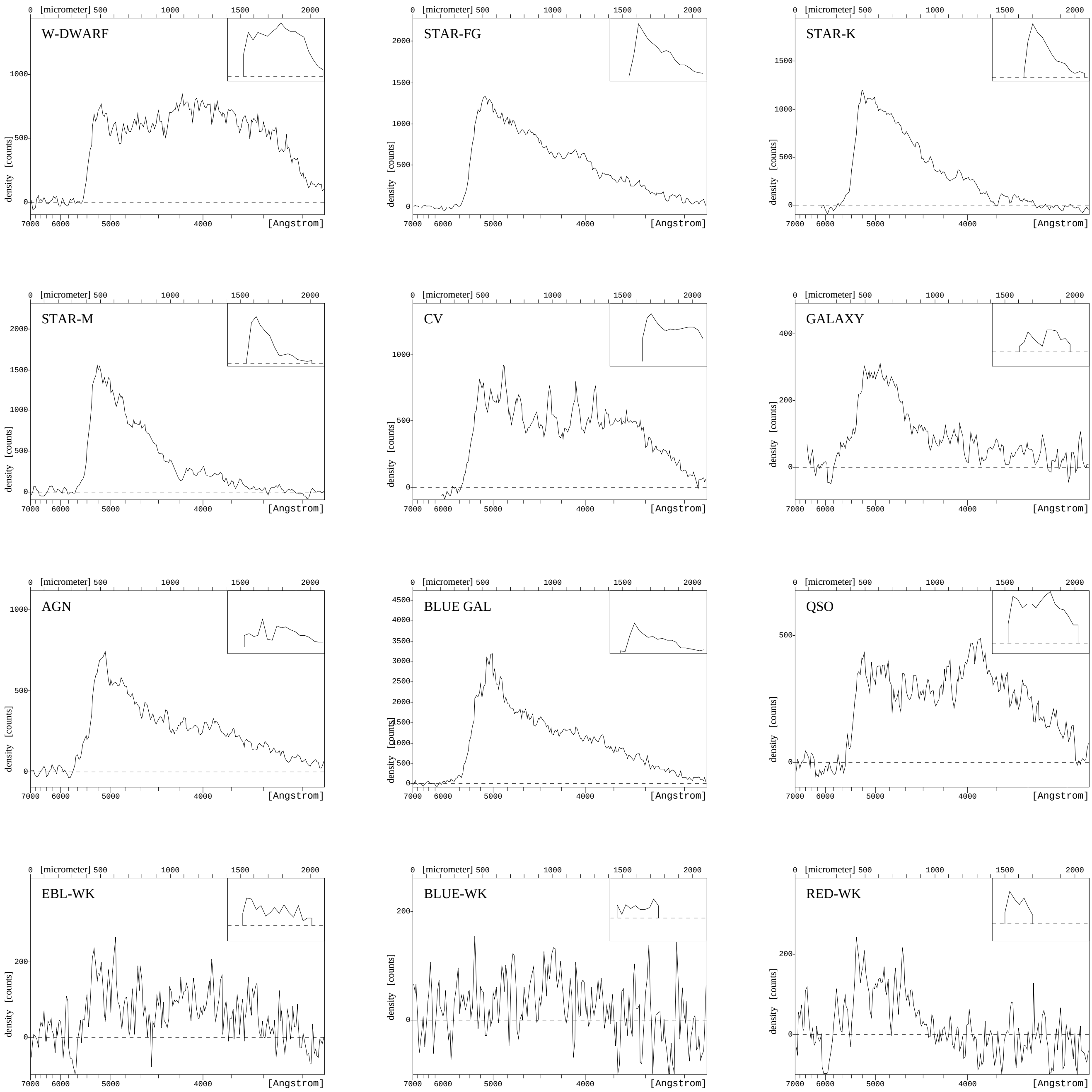


**Fig. 2.** Examples of high resolution objective prism spectra for several important object classes. The inset in the upper right of each panel contains the low resolution spectrum. The object classes `GALAXY` and `BLUE GAL` are only given if the direct image is extended

optical flux ratios ($\log(f_X/f_B)$). For white dwarfs (WDs) and some kinds of cataclysmic variables (CVs) information about the softness of the X-ray spectrum (from the hardness ratios) is useful for their classification. Information about the extent of X-ray sources is also helpful for identifying some object classes (e.g. clusters of galaxies). Based on this information and applying various classification criteria (Bade et al. 1992b) a final classification code is determined, and an entry in a "master catalogue of identifications" is constructed.

The classification is coded by a two or three-digit number. The first digit identifies the class of objects, with "1" to "3" identifying extragalactic objects, and "5" to "7" stellar objects (Table 1). A third digit is present for classes that could be subdivided, e.g. the stars. The second digit describes the reliability of the classification:

"0" "highly probable", the proposed counterpart fulfills all requirements of its class and no other plausible counterpart is found in the X-ray error circle.

"1" "probable", the proposed counterpart fulfills the requirements of its class, but there are some limitations. Either the objective prism spectrum is not typical, or small conflicts with the X-ray information (spectral or spatial information, distance to X-ray position) are present or there is another (considerably less) plausible counterpart in the error circle.

"2" "possible", the proposed counterpart fulfills some requirements of its class, but there are doubts arising from insufficient objective prism data, conflicting X-ray data (e.g. extended emission for an AGN) or another neighbouring plausible counterpart.

In Table 2 the portion of the reliability classes is tabulated for the relevant object classes.

**Table 2.** Percentage of the reliability classes in the object classes

| Object class | "highly probable" | "probable" | "possible" |
|---|---|---|---|
| AGN/QSO | 70.4% | 20.3% | 9.2% |
| Galaxies | 39.1% | 48.6% | 11.6% |
| Galaxy clusters | 23.9% | 42.5% | 33.6% |
| M-dwarfs | 68.4% | 23.2% | 8.4% |
| White Dwarfs | 90.3% | 3.2% | 6.5% |
| K Stars | 30.9% | 23.5% | 44.9% |
| F or G Stars | 25.0% | 50.0% | 25.0% |
| CVs | 81.3% | 18.8% | 0.0% |
| Bright Stars | 64.3% | 31.6% | 4.2% |

### *3.1. Object classes*

The following classes of objects were defined (Table 1):

– QSO/AGN (Class 1). This is the most frequent classification. Their objective prism spectra show a blue continuum and occasionally emission lines (Fig. 2). Other objects with similar spectra, which can be confused with QSO/AGN, are faint ($B$ >17) hot subdwarfs or white dwarfs. They are generally ruled out because of an unlikely high $\log(f_X/f_B)$-ratio. White dwarfs also have very soft X-ray spectra, often without hard photons above 0.4 keV, which is untypical (but not impossible) for AGN. Another class with objective prism spectra potentially similar to QSO/AGN are cataclysmic variables. Follow-up spectroscopy has shown that the fraction of CVs among the QSO/AGN candidates is below 1%.

– Galaxies (Class 2). This classification is given, if the counterpart is clearly extended on the direct plates (Fig. 3) and the objective prism spectrum shows no AGN characteristics. Objective prism spectra are taken without slit. Therefore features in objective prism spectra of extended objects are smeared out, which hinders a classification of such spectra. Follow-up spectroscopy of members of this class shows that they are X-ray luminous early-type galaxies and partly Seyfert 1 galaxies with $z < 0.1$. Some galaxies might be members of unrecognized distant galaxy clusters.

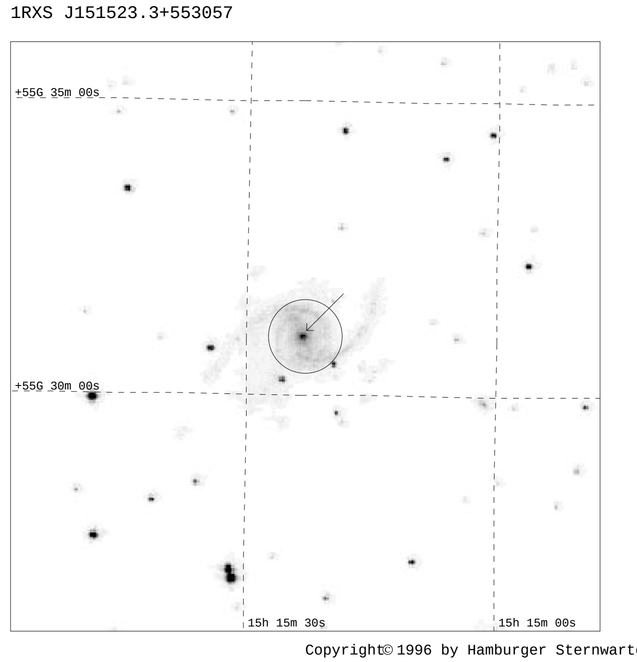


**Fig. 3.** Example for a finding chart taken from the ftp-Server with an optical counterpart classified as GALAXY (Code 20)

– Galaxy clusters (Class 3). This class of X-ray sources is identified mainly by their appearance on the direct plates. The prism spectra of galaxies in clusters are inconspicuous and of little help. Often hard X-ray spectra, as inferred from the hardness ratios, and information that the X-ray source is extended, helps to increase the plausibility of the identification. For redshifts $z > 0.35$ the 4000 Å break of the cluster galaxies is shifted out of the sensitive range of the KODAK III-aJ emulsion. Therefore the detection probability of such galaxy clusters is very low on HQS Schmidt plates.

– M-dwarfs (Class 5). These are frequent counterparts of RASS sources and are easy to identify, because of the presence of strong TiO absorption in the spectra (Fig. 2). Comparison of their positions on the Palomar Sky Survey I and on our direct plates reveal frequently proper motions. As the HQS Schmidt plates were taken within the last ten years, identification problems due to large proper motions are negligible compared to the use of POSS I.

– White dwarfs (Class 6). The current version of the HRC contains 31 WDs. They are relatively bright ($B$ <17), have very blue density spectra, often with weak and broad Balmer absorption lines (DA) (Fig. 2) and have in general very soft X-ray spectra.
– Stars (Class 7). This class contains several subgroups indicated by the third digit. "1" as third digit stands for stars of spectral class K. They have rather red continua and a Ca II absorption line (Fig. 2). Due to their typical $\log(f_{\rm X}/f_B)$ ratios main sequence stars are usually saturated on the objective prism plates, if they were detected by the RASS. In particular for partly saturated stars the inclusion of some M or K dwarfs to this subclass cannot be excluded. "2" as third digit stands for stars of spectral type F and G. Only few X-ray sources were identified with this subclass. These identifications need further support by more detailed optical spectra since most of the known X-ray emitting F or G stars are optically brighter than the saturation limit of the HQS plates. The next subgroup are the cataclysmic variables (CVs) with the third digit "3". They are rare on the high galactic latitude sky, but nevertheless CVs with strong emission lines are easily detected in the objective prism spectra (Fig. 2). Optically weak CVs near the plate limit show similar spectra as AGN and can therefore been mixed up with this class. X-ray sources identified with saturated spectra have the third digit "4". The objective prism plates saturate in the range $12 < B < 14$, so that for many X-ray sources the only classification criterion is the positional coincidence with the X-ray source and the lack of other plausible candidates. Among them unrecognized M-dwarfs (Class 5) and white dwarfs (Class 6) can hide, although the WDs would need an untypical flat X-ray spectrum to get lost in the identification process.
– Unidentified (Class 8). This class comprises all X-ray sources for which no plausible counterpart was assigned, although objects were found on the Schmidt plates inside the error circle. But the corresponding objective prism spectra were unclassifiable or we did not find a plausible counterpart or, in a very few cases, more than one plausible counterpart was found. Several subclasses were defined, but we kept only one. The third digit "3" designates X-ray sources for which we found a single candidate on the direct plate too faint to show a spectrum. In general, they turn out to be members of the "QSO/AGN" class.
– Empty fields (Class 0). These X-ray sources do not have an optical counterpart neither on the spectral plate nor on the direct plate. Often the HQS direct plate are just not deep enough and optical counterparts are found on the Palomar Sky Survey. Nevertheless, these sources often have a high $\log(f_{\rm X}/f_B)$-ratio and were successfully used for an efficient search for BL Lac objects (Nass et al. 1996).

## 4. Availability of the catalogue

Until November 1996 10 800 X-ray sources from RASS I have gone through the identification process on the HQS Schmidt plates. The HRC was compiled with these data and a correlation with the RASS-BSC. The HRC contains for each X-ray source the X-ray position and the error circle, the positions of the optical candidates and their offsets from the X-ray position. For each optical candidate its optical brightness and a classification is given, if possible. The most likely optical counterpart is marked, if possible, and an identification code is given. The current version of the HRC with 3847 entries is available via anonymous ftp (`ftp.hs.uni-hamburg.de`) in the subdirectory `pub/outgoing/rass-id`. A README file explains the structure of the catalogue.

Finding charts were prepared from the digitized direct plates and are available as compressed Postscript-files on the ftp-server as well. For the work with the HRC they are considered to be superior to finding charts obtained from the digitized POSS I, because of differences in colour and of the epoch of observation. Since only the red plates of the POSS are currently digitally available, the wavelength overlap with the KODAK IIIa-J emulsion is small. In addition the epochs of the POSS and the HQS plates are $30 - 40$ years apart from each other, making proper motions of nearby stars a significant problem for the assignment of catalogue entries to images on the POSS plates. Nevertheless, we recommend to use POSS I plates as well, because they are in general more sensitive and provide additional colour information.

## 5. Reliability of the identifications

The reliability of the classification varies due to a number of constraints. Basically, the object classes are defined by features of the objective prism spectra and the direct images, and are therefore not coincident with common definitions. Also the object classes do not need to be complete in themselves. For example, although, the class "QSO/AGN" contains most of the quasars and Seyfert 1 galaxies, part of them will be found among "galaxies", and many of the fainter optical counterparts are still unidentified. To make a more quantitative completeness test we have correlated the HRC with the most recent Véron-Cetty and Véron AGN catalogue (Véron-Cetty & Véron 1996)[1] and found 539 coincidences. 481 of them were recognized on our plates as AGN candidates, 2 were empty fields, 16 classified as galaxies, 3 as clusters of galaxies and for 37 AGN

[1] It should be noted that such a correlation is not an independent completeness test. The Véron-Cetty and Véron AGN catalogue is not complete and we have already contributed more than 200 new AGN to this catalogue which are partly members of the HRC. In addition the Véron-Cetty and Véron AGN catalogue also contains entries with controversial classifications.

no classification was possible based on the HQS Schmidt plates.

Among stars, the assignments of spectral types are fuzzy with respect to the usual Morgan-Keenan classification. Early M-dwarfs may have a classification as M-dwarf (Class 5) or as K-star. Similarly there is a gradual transition between the F and G star subclass and the K-star subclass.

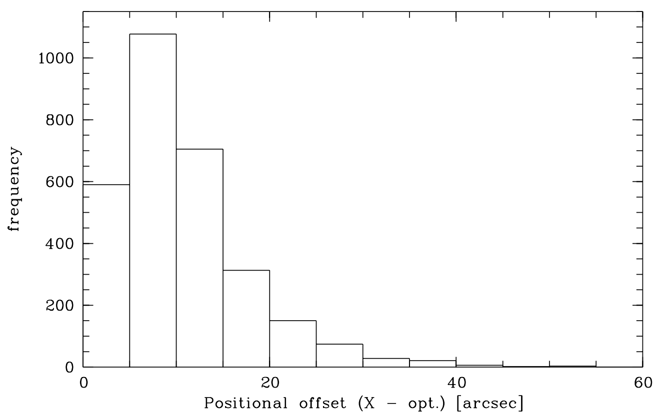


**Fig. 4.** Histogram of the offset between the RASS II X-ray position and the position of the counterpart for all identified X-ray sources

In principle, the catalogue is also affected by confusion. There could be objects inside the error circle which can be X-ray emitters from their optical classification, but actually are not the real counterparts in these specific cases. Except for bright stars the surface densities of the potential X-ray emitting object classes are so low, that this problem is negligible. This confusion was also discussed in Bade et al. (1995) and we refer the reader to this paper for more details. A recalculation of the numbers given in Bade et al. (1995) for the 3847 HRC positions with an error radius of 20″ let us expect less than 1 serendipitous QSO in the HRC, but up to 8 "bright stars" with $B < 12$. Since the average error radius is smaller, these values are upper limits. Therefore some of the "bright star" classifications (Code 7) can be erroneous. Note that for many of them the plausibility of the identification cannot be checked, because saturation inhibits an estimate of the spectral type. Another possible source of contamination is proper motion of nearby galactic X-ray emitters. For our identification project we used nearly exclusively plates taken within five years of the X-ray RASS observations. Even with proper motions of several arcseconds per year this problem is negligible.

## 6. Completeness of the HRC and statistical tests

The Hamburg/RASS catalogue of optical identifications covers about 8 480 deg$^2$ of the extragalactic northern sky

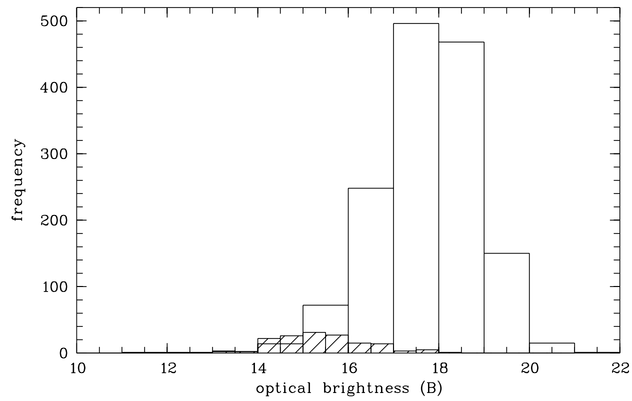


**Fig. 5.** Distribution of optical brightness $B$ for AGN candidates and M dwarfs (hashed). $B$ was derived from the objective prism plates for all plotted objects. Optical brightness values $B > 20$ are probably erroneous. On average AGN are weaker than M dwarfs but there is a small overlap

and should therefore provide a representative overview of the RASS-BSC content in the optical brightness region accessible by the HQS objective prism and direct plates. The distribution of the offsets between the optical and the X-ray positions shows that in most cases (90.4%) the offsets are below 20″ (see Fig. 4). The mean offset is 10.2″ (median 9″) which is considerably below the value of 20″ given by Voges (1994). However, it should be pointed out that Fig. 4 contains only the X-ray sources with a proposed optical counterpart. The positional offset is also a classification criterion, and possibly for some X-ray sources the optical counterpart was not found because of a comparatively large offset.

The completeness of the catalogue can be judged from the class of still unidentified objects (Codes "8" and "0"). These classes comprise together 18.8% of the catalogue. In the vast majority of these cases the optical counterpart must be faint ($B \geq 18.5$) and we do not expect a significant population of stars at these faint magnitudes. As shown in Fig. 5 very few M-stars were found at $B > 17$ and they already have the largest $\log(f_X/f_B)$-ratios among main-sequence stars. Thus we expect the catalogue to be fairly complete for stellar sources from the main sequence.

The optical counterparts to the unidentified sources are therefore almost certainly extragalactic objects, and among these mostly AGN. If the $\log N - \log S$ relation of the RASS − BSC is taken and folded with the $\log(f_X/f_B)$ distribution from Bade et al. (1995) 46.5% AGN with $B > 18.5$ and 9.7% with $B > 20$ are expected. The optically weak galaxy clusters and BL Lac objects are not included in this estimate. Further support for the proposed association of the bulk of unidentified sources with optically faint extragalactic objects is illustrated in Fig. 6. The fraction of unidentified X-ray sources or sources with empty error circles on the HQS Schmidt plates decreases with increasing X-ray count rate limit, and the

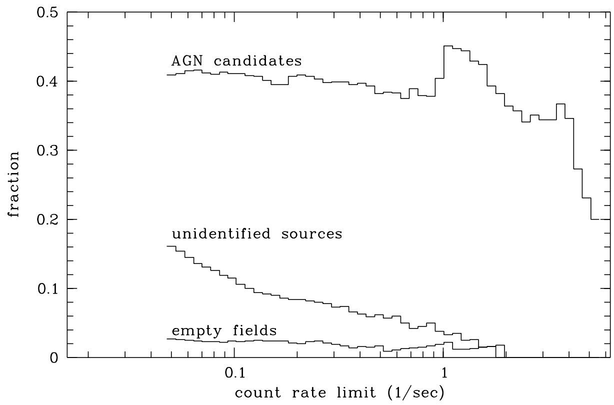


**Fig. 6.** Number of three object classes in relation to the total number of X-ray sources above a given X-ray count rate limit

unidentified X-ray sources disappear for high count rates. The portion of AGN candidates remains nearly constant, only for the highest count rates the galactic X-ray emitters are more abundant. This flat distribution stands in contrast to observational results (Stocke et al. 1991) that the portion of AGN rises continuously with decreasing count rate limit. In addition X-ray selected AGN show cosmological evolution in the sense that they are more abundant in ancient times (Hasinger et al. 1993; Boyle et al. 1994) which would even increase the number of X-ray faint AGN.

The HRC allows a convenient compilation of X-ray emitting object samples with substantial size for subsequent follow-up studies. Since the HRC is limited in its completeness (mainly due to its optical brightness limit) investigations aiming at flux-limited samples, cannot depend solely on the HRC. The current version of the HRC was produced by correlation of RASS I identifications with the RASS-BSC. The identification of RASS sources with objective prism plates is an ongoing project. Updates resulting from this work will be posted on our WEB page (`http://www.hs.uni-hamburg.de`).

*Acknowledgements.* The ROSAT project is supported by the Ministerium für Bildung, Wissenschaft, Forschung und Technologie (BMBF/DARA) and by the Max-Planck-Gesellschaft (MPG). We thank Hans Hagen for contributions to the software development of this project. This research has made use of the NASA/IPAC Extragalactic Database (NED) which is operated by the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration. D.R. wishes to thank in particular the former President of the University of Hamburg, Dr. Peter Fischer-Appelt, without whose support in a critical phase of the HQS the present project would never have become real. This work has been funded by the Deutsche Forschungsgemeinschaft under Re 353/22-1 to 4 and by the BMBF under DARA 50 0R 96016.

## References

Bade N., Engels D., Fink H., et al., 1992a, A&A 254, L21
Bade N., Dahlem M., Engels D., Reimers D., Voges W., 1992b, MPE-Report 235, 377
Bade N., Fink H.H., Engels D., 1994, A&A 286, 381
Bade N., Fink H.H., Engels D., et al., 1995, A&AS 110, 469
Boyle B.J., Shanks T., Georgantopoulos I., Stewart G.C., Griffiths R.E., 1994, MNRAS 271, 639
Hagen H.-J., Groote D., Engels D., Reimers D., 1995, A&AS 111, 195
Hasinger G., Burg R., Giacconi R., et al., 1993, A&A 275, 1
Lasker B.M., Sturch C.R., et al., 1988, ApJS 68, 1
Nass P., Bade N., Kollgaard R.I., et al., 1996, A&A 309, 419
Stocke J. T., Morris S. L., Gioia I., et al., 1991, ApJS 76, 813
Véron-Cetty M.-P., Véron P., 1996, ESO Sci. Rep. No. 17
Voges W., 1992, in Proceedings on European International Space Year Meeting, ESA ISY-3, p. 9
Voges W., 1994, in Basic Space Science, Haubold H.J., Onuora L.I. (ed.) p. 212
Voges W., Gruber R., Paul J., et al., 1992, in Proceedings on European International Space Year Meeting, ESA ISY-3, p. 223
Voges W., Boller Th., Dennerl K., et al., 1996a, MPE-Report 263, 637
Voges W., Aschenbach B., Boller Th., et al., 1996b, IAU Circ. 6420
Voges W., Aschenbach B., Boller Th., et al., 1997a (to be submitted A&AS)
Voges W., Aschenbach B., Boller Th., et al., 1997b, to be published in the Proceedings of the IAU symposium 179 on "New Horizons from Multi-Wavelength Sky Surveys"