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Catalogue of cataclysmic binaries, low–mass X–ray binaries and related objects (Sixth edition)

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Abstract. The catalogue lists coordinates, apparent magnitudes, orbital parameters, stellar parameters of the components and other characteristc properties of 318 cataclysmic binaries, 47 low–mass X–ray binaries and 49 related objects with known or suspected orbital periods together with a comprehensive selection of the relevant recent literature. In addition the catalogue contains a list of references to published finding charts for 394 of the 414 objects. A cross–reference list of alias object designations concludes the catalogue. Literature published before 30 June 1997 has, as far as possible, been taken into account.

Key words: Catalogs — novae, cataclysmic variables — binaries: close

1. Preface to the 6th Edition

Seven and a half years after the publication of the previous (5th) edition of the *Catalogue of Cataclysmic Binaries, Low–Mass X–Ray Binaries and Related Objects* (Ritter 1990, hereafter R90), and almost four years after the deadline of an updated list of cataclysmic binaries published in 1995 (Ritter and Kolb 1995, hereafter RK95), the amount of new literature and the number of new objects to be included have again grown so much that it seems worthwhile to publish an updated edition. The philosophy and the purpose of this catalogue (now in its 6th edition) have been outlined in the preface to the 3rd edition (Ritter 1984, hereafter R84) and will not be repeated here. Rather let us briefly recall some of the developments which, over the past seven and a half years, have had (and still have) a major impact on this catalogue:

– First, we have seen the successful launch and operation of a number of satellites, e.g. of Rosat, Ginga, ASCA, EUVE, GRO, and XTE, which have led to the detection of many new sources or even new classes of compact binaries (e.g. AM Her stars and supersoft X–ray sources by Rosat or EUVE, X–ray transients (Black Hole candidates) by Ginga and GRO), or to new insights concerning previously known sources (e.g. the detection of kHz X–ray oscillations in low–mass X–ray binaries by XTE observations).
– Second, we have seen the publication of *A Catalog and Atlas of Cataclysmic Variables* by Downes and Shara (1993), and most recently of its updated 2nd edition by Downes, Webbink and Shara (1997), both of which are now the primary sources for accurate coordinates and finding charts for cataclysmic variables.
– Third, since the publication of the 5th edition of this catalogue four new issues of the *Name List of Variable Stars* have appeared (the 70th by Kazarovets and Samus (1990), the 71st by Kazarovets, Samus and Goranskij (1993), the 72nd by Kazarovets and Samus (1995), and finally the 73rd by Kazarovets and Samus (1997)). These lists provide the definitive variable names which are also used as primary names in this catalogue. We note in passing that the catalogue by Downes, Webbink and Shara (1997) does not yet include the designations provided by the 73rd *Name List.*
– Fourth, we note the increasing contribution of amateur astronomers in the field of cataclysmic variables. Equipped with CCD photometers, amateur astronomers are now in a position to do photometry of moderate time resolution of rather faint objects, even with telescopes of rather small apertures. Such photometry is for example adequate to track down the superhump periods of presumed SU UMa-type stars, or to determine the orbital periods of eclipsing binaries. Results of these amateur activities, which can be found on the Web page of the Variable Star Network (VSNET) at `http://www.kusastro.kyoto-u.ac.jp/vsnet`, have also been incorporated in this compilation.

Compared with the 5th edition, the number of objects listed has almost doubled. The current version of this catalogue provides tabulated data and references for 414 ob-

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jects (318 cataclysmic binaries, 47 low–mass X–ray binaries and 49 related objects).

The fact that on the one hand the number of objects, the number of references per object and the length of the *Who's Who?* section are steadily increasing, and that on the other hand the total length of the catalogue must remain within acceptable limits, makes it necessary to drop some of the information given in previous editions. This is done by suppressing essentially all those references already given in RK95 (for the cataclysmic variables), or in the 5th edition (R90) (for the other objects). Since the previous three editions (R84, Ritter 1987, hereafter R87, and R90) are published in an easily accessible journal, all the information is still available. Earlier references are only repeated if they are required for cross–reference (see below). Accordingly the 6th edition provides:

- the table sections for all three object classes (cataclysmic binaries, low–mass X–ray binaries and related objects) in full;
- for each catalogued object a selection of references to the literature, published either after 1 September 1993 (the deadline of RK95) for cataclysmic binaries, or after 31 December 1989 (the deadline of R90) for the other objects. Earlier references are only included if they are needed for cross–reference, or in cases where there have been few or no new publications of relevance;
- a list of selected references to published finding charts. Additional references may be found in previous editions;
- the *Who's Who?* section, a cross–reference list of alias names of the objects catalogued.

Thus the catalogue is complete and self–contained in the table sections and in giving cross–references to alternative object designations. With respect to the bibliography given in the reference sections and to the references to published finding charts it is essentially a supplement to RK95 in the case of cataclysmic binaries, and to R90 in the case of the other objects.

We should also like to mention three major changes which we are introducing with this edition, and which, so we hope, will make the catalogue even more valuable:

- First, for better readability we now use upper and lower case characters instead of upper case only as in previous editions.
- Second, in order to save space, we have changed the style of referencing. We use shorter abbreviations for the major journals (e.g. ApJ instead of Astrophys. J.) and in case of references with more than five authors we quote only the name of the lead author, followed by "et al." and the number of authors in parenthesis.
- Third, as we have already done in RK95, we provide now limited information about where the values given in the tables are taken from. How this is done is explained in the *Introduction*.

Every effort has been made to avoid errors and to keep the lists up to date. Nevertheless, the authors are well aware of the fact that also this edition will contain errors and may be incomplete with regard to the criteria stated in the preface to the 3rd edition (R84). It is certainly incomplete with respect to the references quoted. However, it should be stressed that no attempt has been made to provide a complete bibliography. Rather, the aim is to give a selection of references that should allow the user to find his way through the literature addressing mainly the binary properties of the objects in question.

In addition to this version , i.e. the print version, of the catalogue a fully machine–readable one is available from the CDS via anonymous ftp to `cdsarc.u-strasbg.fr (130.79.128.5)`, via `http://cdsweb.u-strasbg.fr/Abstract.html`, or from the MPA Web page at `http://www.mpa-garching.mpg.de/Binary/ukolb/ed6.html`.

For the current version of this catalogue, literature published before 30 June 1997 has, as far as possible, been taken into account.

2. Introduction

The objects listed in this catalogue are subdivided into three main object classes, i.e. into **Cataclysmic Binaries**, **Low–Mass X–Ray Binaries** and **Related Objects**. The defining characteristics of the three object classes used here are the following:

Cataclysmic Binaries are semi–detached binaries consisting of a white dwarf primary (or a white dwarf precursor) and a low–mass secondary which is filling its critical Roche lobe. The secondary is not necessarily unevolved. It may even be a highly evolved star as for example in the case of the AM CVn–type stars. A more detailed description of the main characteristics of these objects may be found in Warner (1995).
In addition, we list among the cataclysmic binaries also the supersoft binary X–ray sources, because these too are semi–detached binaries containing a white dwarf, though one in a state of sustained nuclear burning. More information about these objects can be found in Greiner (1996).

Low–Mass X–Ray Binaries are semi–detached binaries consisting of either a neutron star or a black hole primary, and a low–mass secondary which is filling its critical Roche lobe. Observationally they are distinguished from the luminous, massive X–ray binaries by the following main properties: in general the spectra of the low–mass X-ray binaries (at maximum light) are devoid of normal stellar absorption features. The ratio of their X–ray to optical luminosities is much larger than unity (typically it ranges from $\sim 10^2$ to $\sim 10^4$). A more detailed description of the main characteristics of these objects may be found in the review articles in Lewin, van Paradijs and van den Heuvel (1995).

Related Objects are detached binaries consisting of either a white dwarf or a white dwarf precursor primary and of a low–mass secondary. The secondary may also be a highly evolved star. Further information may be found e.g. in Ritter (1986), Bond (1989), or de Kool and Ritter (1993).

With one possible exception (HD 49798) we do not list among the related objects detached binaries containing a neutron star, or, for the lack of known objects, a black hole. Thus we explicitly exclude binary radio pulsars from our compilation because these are adequately documented elsewhere (e.g. in the Princeton pulsar list (Taylor, Manchester and Lyne 1993) and its updates, available via anonymous ftp at `pulsar.princeton.edu`).

According to the subdivision in these three object classes the catalogue contains three major sections, hereafter referred to as *catalogue sections*. Each of the three catalogue sections is further subdivided into a *table section (TS)*, where a few characterizing parameters of the object are tabulated, and into a *reference section (RS)*, where a selection of references is given. Within each of the table sections, the objects are listed in order of decreasing orbital period. In the corresponding reference section, however, the objects are listed in lexigraphical order.

The quantities listed in the table section and the corresponding abbreviations used in the table headings are described in a separate *Description* section which precedes the three catalogue sections.

In contrast to the previous editions we provide now limited information about where the values given in the tables are taken from. This is done as follows: at the end of a reference from which a given quantity, say `XYZ`, was taken, this quantity is given in parenthesis, i.e. as `(XYZ)`. The quantities for which this is done are: the periods (`Orb.Per.`, `2. Per.`, `3. Per.`, `4. Per.`), the spectral types (`Spectr1`, `Spectr2`), the mass ratio (`M1/M2`), the orbital inclination (`Incl`), the masses (`M1`, `M2`), and, where appropriate, the radii (`R1`, `R2`) and the eccentricity (`e`).

The catalogue is supplemented by a list giving references to published *finding charts (FC)* of the objects. In this separate section, which follows the three catalogue sections, the objects of all three classes are merged and listed in lexigraphical order. The full form of abbreviated references is given at the end of the section.

Note that beginning with the *Table of Contents* we provide internal page numbers which are given at the bottom of each page. In the following the page numbers quoted always refer to these internal page numbers. The reason for using internal page numbers is that they are of great help for finding the information about a particular object in this catalogue. For this, pages 2 to 11 contain two lists of the objects catalogued. The first list gives the objects in lexigraphical order, the second one in order of increasing right ascension. For each object, both lists give three page numbers: the first one referring to the table section *(TS)*, the second one to the corresponding reference section *(RS)* and the third one to the list giving references to the finding charts *(FC)*. An asterisk following the name of the object indicates that the object is also known under other designations which can be found in the *Who's Who ?* section at the end of the catalogue.

The *Who's Who?* section is a cross–reference list of alias names of the objects catalogued. In order to keep this list short, the full list of alternative object names appears only once for each object and is to be found under the standard name used in this catalogue. If an object is sought under one of its alternative names, reference to the standard name is given. Wherever possible the variable name given in the 4th edition of the *General Catalogue of Variable Stars* (Kholopov et al. 1985a, 1985b, 1987) or in the *Name Lists of Variable Stars* (up to and including the 73rd list (Kazarovets and Samus (1997), and references therein) is used as the standard name here. This section includes also a list of references to various catalogue acronyms that appear in this compilation. However, references to catalogue acronyms which have already been given in previous editions are not repeated here. A more complete list of this kind may be found in *The First Dictionary of the Nomenclature of Celestial Objects* by Fernandez, Lortet and Spite (1983), its supplements Lortet (1986a,b), and Lortet and Spite (1986), in the *Second Reference Dictionary of the Nomenclature of Celestial Objects* by Lortet, Borde and Ochsenbein (1994), or online via the CDS at `http://vizier.u-strasbg.fr/cgi-bin/Dic`, or from the ADC at `http://adc.gsfc.nasa.gov/adc/`.

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