# BULGARIAN VIRTUAL OBSERVATORY. MULTICOLOR OBSERVATIONS OF OPEN CLUSTERS IN OUR GALAXY

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**Abstract:** Ca. 900 CCD frames in U,B,V,R,I on the 2-m RCC telescope and in B,V,R,I on the 60-cm telescope have been taken for 30 open clusters, including 7 bright clusters, 16 (8 x 2) probably double open clusters and 7 clusters in the anticenter of the Galaxy.
For photometric reduction Stetson's DAOPHOT and ALLSTAR program packages, implemented in MIDAS were used. Standards in several star clusters were used - the clusters M92 (mainly), NGC 7790, NGC 4147 an M67 and the improved standard sequences from the latest years have been taken.

## 1. INTRODUCTION:

Open clusters are physically related groups of stars held together by gravitational attraction. Originating from large cosmic gas and dust clouds, all member stars are of similar age and as all the stars in a cluster formed from the same diffuse nebula, they are all of similar initial chemical composition. Over 1600 open clusters are known in our Milky Way Galaxy (Dias 2002), and this is probably only a small percentage of the total population which is probably some factor higher. Nearly half of them have been observed so far in at least one photometric system and ca. 420 are comparatively well studied. The number of stars per cluster goes from several tens for the poorest objects, to several thousands for the most prominent clusters. According to ***WEBDA*** *(see below),* open clusters are of great interest for astrophysicists because of these properties:

**The stars are at the same distance**

This is true for most objects, because the effect of the cluster volume is smaller than the usual errors on magnitude determination and negligible in comparison with other effects like binarity and rotation. There is one cluster, namely the Hyades, for which a precise determination of the distances of the individual stars has been possible, thanks to the Hipparcos satellite.

**The stars have the same age**

This assumption is true for intermediate-age and old clusters, but is questionable for very young and extremely young open clusters. The problem arises from our lack of knowledge on how a molecular cloud contracts and which is the sequence of stellar formation. Which one of the low mass stars or the massive stars do form first? Obviously, in young clusters, the massive stars are already on the main sequence or even started their evolution away from the main sequence, while the low mass stars are still in a phase of contraction. This is a domain in which the contribution of star clusters to the understanding of the laws of star formation has been and will be fundamental.

**The stars have the same chemical composition**

So far, it has not been possible to prove the opposite and this is a good assumption. It implies that the material from which the stars formed was rather homogeneous. But the precise determination of the chemical composition is a difficult task and the uncertainties on the results are still rather large.

**The stars differ in their mass**

Open clusters usually contain stars over a large range of mass from more than 80 solar masses in the extremely young clusters, to stars less massive than 0.08 solar masses, i.e. the limit for brown dwarfs.

Therefore, comparing the "standard" Hertzshprung-Russel Diagram (HRD), derived from nearby stars with sufficiently well-known distances, or the theory of stellar evolution, with the measured CMD of star clusters, provides a considerably good method to determine the distance of star clusters. Comparing their HRD with stellar theory provides a reasonable way to estimate the age of star clusters. The theoretical study of stellar evolution has provided convincing evidence that the stars of a cluster are all roughly of the same age, and thus have formed within a short period of time on the cosmic time scale, i.e. their HRDs represent isochrones, or pictures of stars of all the same age. The result that all the cluster HRDs can be explained by the theory of stellar evolution gives convincing evidence for this theory.

***WEBDA*** is a site devoted to observational data on stars in galactic open clusters. It is intended to provide a reliable image of the available data and knowledge on these objects and to offer a wide access to the existing observations. This database has been conceived to bring at one place most data that could be useful to decide upon the membership of the stars and their physical characteristics, and store them with a coherent numbering scheme. In spite of the limitations due to the lower precision of some older data, the database is the best starting point for many astrophysical studies involving open clusters. Nowhere else are complete data collections to be found and one merit of the database is to give a clear report of the present observation status. The present database offers *astrometric data* in the form of coordinates, rectangular positions, and some proper motions, *photometric data* in the major system in which star clusters have been observed (UBV, uvby, Geneva, Vilnius, DDO and others), *spectroscopic data*, like spectral classification, radial velocities, rotational velocities. It contains also miscellaneous *types of data* like membership probabilities, orbital elements of spectroscopic binaries, periods of variability for different kinds of variable stars. List of interesting and peculiar stars have also been compiled. Finally a whole set of *bibliographic references* allows every one to locate the interesting publications on his or her favorite open clusters easily.

## *2. DESCRIPTION OF THE PROJECT*

Several years ago a joint project ***"Structure of the GALAXY*** " started, included astronomers from University of Bonn and Hoer List Observatory and Institute of Astronomy of the Bulgarian Academy of Sciences. The project itself includes three directions of investigations – selected open clusters in the direction of anticenter, bright open clusters and probably binary open clusters.

- Studied of selected open clusters in the direction of anticenter was devoted to add the available data for the spiral structure of our Galaxy. Here we studied seven such cluster.
- Some bright open clusters were chosen to complete “color – magnitude” diagrams and to determine their ages – this is the important parameter we are interested in(for example see Bica et al., 1993). For the larger clusters – i.e. such with large angular diameter mosaic from several frames in each color was used to cover all the field of the cluster. For all of them the central part with the brightest stars was investigated.

  A ***binary open star cluster*** could be defined as an object consisting of two open clusters. They can be basically described as: (i) binary physical systems with common origin formed together from one and the same Giant Molecular Cloud (GMC), having comparable age and chemical composition - this is a true binary cluster; (ii) binary physical systems arising from clusters formed in different part of the Galaxy and forming a pair with mutual gravitational capture - these clusters are expected to have different ages and chemical composition.

## 3. REALIZATION OF THE PROJECT:

For the period of 3 years - namely: end of 1996, 1997, 1998, 1999 in the project "Structure of the GALAXY..." the next basic steps have been finished:

1) Installed and tested CCD-camera ST-8 (Alexander fon Humboldt support) on the 2-m RCC telescope, latterly becomes as basic camera at 60-cm telescope at the Belogradchick observatory

2) Preliminary testing of the simple focal reducer on the 60-cm telescope

3) Ca. 900 CCD frames in U,B,V,R,I on the 2-m RCC telescope and in B,V,R,I on the 60-cm telescope have been taken for 30 open clusters from the program list, including 7 bright clusters, 16 (8 x 2) probably double open clusters and 7 clusters in anticenter.

For the reduction of the data some additional steps have been done:

4) Simple MIDAS procedures was created for determining of the SKY of the CCD frames - "@@ sky", full width of half maximum of star images - "@@ fwhm" etc.

5) Full complete of procedures for photometric calibration written in PASCAL.

Due to the bad self guiding of the telescopes, normally several 60-, 120-sec exposures have to be averaged for better S/N ratio:

6) All the frames have been SHIFTED to one position - usually the middle of the exposure times and AVERAGED. For the final image only the free regions have been subtracted

7) For all averaged images the AIRMASSES for the observations have been calculated

8) FWHM have been determined for all images of the clusters

9) All the frames have been REDUCED with DAOPHOT and ALLSTAR.

For photometric calibration the standards in several star clusters were used. The clusters M92 (mainly), NGC 7790, NGC 4147 an M67 were used and the improved standard sequences from the latest years have been taken:

a) Cristian et.al. (1985) - Standard sequences in M92, N4147, N7790, N7006, N2264, N2419 in B,V,R,I.

b) Odewahn et.al. (1992) - Improved standard sequences in N7790, N4147 and N7006 in B,V,R.

c) Majewski et al. (1994) - Standard sequences in M92, SA 57 and Hercules in U,B,V,R,I. As for the clusters itself, Stetson's DAOPHOT and ALLSTAR program packages in their MIDAS variants were used to analyze the standards and to construct the photometric calibration procedure.

d) Petrov et al. (2001) - CCD standards for U and I in the open cluster NGC 7790.

***Some important data for telescopes and CCD cameras equipment:***

1) 2-m RCC + CE200: Unbinned --> scale 0.31"/px; Binned x2 --> scale 0.31"/px

2) 2-m RCC + ST-8: Unbinned --> scale 0.12"/px; Binned x2 --> scale 0.24"/px;
Binned x3 --> scale 0.36 "/px

3) 60-cm + ST-8: Unbinned --> scale 0.21"/px; Binned x2 --> scale 0.42"/px;
Binned x3 --> scale 0.63"/px

***The next steps to be done:***

a) Implementation of the photometric calibration procedures in MIDAS
b) Repeated frames of the clusters of interest
c) Additional data for the clusters, observed in one date only
d) Making stable construction of the focal reducer for the 60-cm telescope

## 4. PRELIMINARY RESULTS:

The existence of star cluster pairs in our neighboring galaxies - Magellanic Clouds is established from several authors: Bhatia &, Hatzidimitriou (1988); Vallenariet al. (1998); Dieball & Grebel (2000); de Oliveira et al. (2000). Dieball (2002) proposed a catalog of binary and multiple cluster candidates in the Large Magellanic Cloud with 473 members. Amongst the more than 1600 open clusters in our Galaxy only one is well established double or binary cluster - *h & χ* Persei (NGC 869 and NGC 884), ***Fig.1***. Our Galaxy seems to show a lack of binary or multiple clusters when compared with the Magellanic Clouds. Whether this apparent lack of binary clusters in the Galaxy is real or not is a subject to discussion and several lists of binary open clusters candidates are proposed and studied by various authors: Lynga & Wramdemark (1984); Pavlovskaya & Filippova (1989); Tignanelli et al. (1990); Subramaniam et al. (1995); Loktin (1997); Muminov et al. (2000). One of the most complete and well studied list is the one of Subramaniam et al. (1995) with 18 candidates pairs, including the clusters NGC 1907 and NGC 1912 – see ***Fig.2*** (Kopchev & Petrov, 2006).

***Fig.1***: On left - h Persei, on right - □ Persei.
North is UP, East – to the left.

To answer of the two principle questions -

- Is the difference between our Galaxy and Magellanic Clouds co. binary open clusters is real?
- Are there another typical binary open clusters as “h and χ Persei” in our Galaxy?

we shall use the methods of extragalactic and stellar astronomy. One step is to define correctly "what binary open clusters are?". As working definition we accept "two clusters at distances ≤ 20 pc and with differences in the ages ≤ 10 Myr". Next steps are analyzing of :color-magnitude" diagrams and determining of the ages of the clusters.

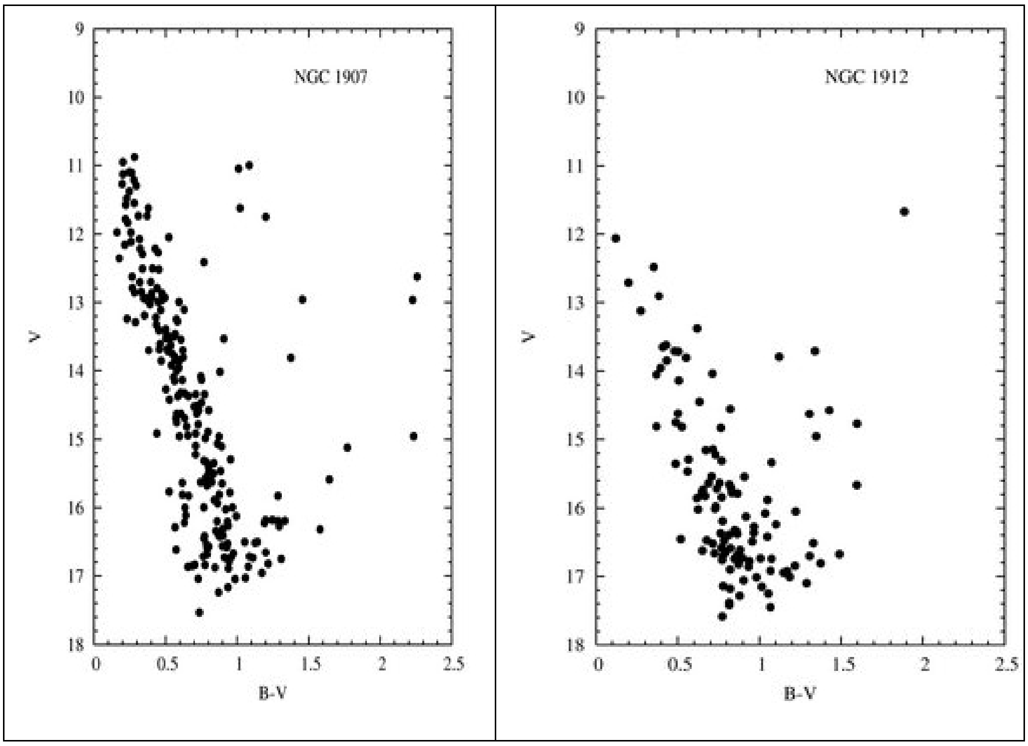


***Fig2:*** "Color – magnitude" diagrams for NGC1907-NGC1912 according to our observations.

The summary of our preliminary results are presented in ***Tabl.1***, where in the column are cluster's name, date of observation, Exposure times and numbers of frames, Airmass during the observations, Number of measured stars and FWHM of the frame.

***<u>Table1</u>: A list of all observations of OPEN CLUSTERS, sorted by objects:***

| Object | Date | Texp | Airmass | Stars | Object | Date | Texp | Airmass | Stars |
|---|---|---|---|---|---|---|---|---|---|
| bas10b | 98-09-28 | 120x3 | 1.04108 | 149 | n2251b | 98-02-28 | 60x2 | 1.21870 | 240 |
| bas10i | 98-09-29 | 120x3 | 1.03860 | 158 | n2251i | 99-01-22 | 60x2 | 1.2256 | 179 |
| bas10r | 98-09-29 | 120x3 | 1.03897 | 158 | n2251i | 98-02-28 | 30x2 | 1.21284 | 394 |
| bas10v | 98-09-28 | 120x3 | 1.04108 | 357 | n2251r | 99-01-22 | 60x2 | 1.2228 | 244 |
| | | | | | n2251r | 98-02-28 | 30x2 | 1.21368 | 399 |
| bas8b | 98-02-28 | 60x2 | 1.20956 | 247 | n2251u | 98-02-28 | 120x2 | 1.22278 | 123 |

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|---|---|---|---|---|
| bas8i | 99-01-22 | 120x2 | 1.2304 | 200 |
| bas8i | 98-02-28 | 30x2 | 1.20548 | 291 |
| bas8r | 99-01-22 | 120x2 | 1.2173 | 207 |
| bas8r | 98-02-28 | 30x2 | 1.20644 | 331 |
| bas8u | 98-02-28 | 120x2 | 1.21223 | 88 |
| bas8v | 99-01-22 | 120x2 | 1.2143 | 257 |
| bas8v | 98-02-28 | 30x2 | 1.20750 | 260 |
| | | | | |
| ber1b | 98-08-24 | 120x2 | 1.1078 | 48 |
| ber1b | 99-09-06 | 90x4 | 1.11194 | 168 |
| ber1i | 98-08-24 | 60x2 | 1.1117 | 650 |
| ber1i | 99-09-06 | 60x5 | 1.11746 | 757 |
| ber1r | 98-08-24 | 60x2 | 1.1095 | 845 |
| ber1r | 99-09-06 | 60x5 | 1.12008 | 506 |
| ber1u | 98-08-24 | 180 | 1.1068 | 86 |
| ber1u | 99-09-06 | 90x5 | 1.11490 | 20 |
| ber1v | 98-08-24 | 60x2 | 1.1087 | 569 |
| ber1v | 99-09-06 | 60x5 | 1.12281 | 348 |
| | | | | |
| col428b | 98-07-21 | 45x6 | 1.20102 | 605 |
| col428i | 98-07-18 | 20 | 1.01792 | xx |
| col428i | 98-07-18 | 120x2 | 1.01497 | 676 |
| col428i | 98-06-01 | 120x2 | .00363 | 818 |
| col428i | 98-07-21 | 60x4 | 1.01122 | 1398 |
| col428r | 98-07-18 | 20 | 1.01860 | |
| col428r | 98-07-18 | 120x2 | 1.01167 | 691 |
| col428r | 98-06-01 | 120x2 | 1.00557 | 714 |
| col428r | 98-07-21 | 30x6 | 1.01505 | 1368 |
| col428u | 98-07-21 | 60x6 | 1.02588 | 139 |
| col428v | 98-07-18 | 20 | 1.01938 | xx |
| col428v | 98-07-18 | 120x2 | 1.00869 | 502 |
| col428v | 98-06-01 | 120x2 | 1.00716 | 622 |
| col428v | 98-07-21 | 30x6 | 1.02077 | 1013 |
| | | | | |
| king14i | 99-01-19 | 120x2 | 1.40938 | 236 |
| king14i | 99-02-16 | 120x2 | 1.57241 | 271 |
| king14r | 99-02-16 | 120x2 | 1.55370 | 272 |
| king14r | 99-01-19 | 120x2 | 1.39471 | 325 |
| king14v | 99-02-16 | 120x2 | 1.53560 | 231 |
| king14v | 99-01-19 | 120x2 | 1.38464 | 636 |
| king14i | 98-07-21 | 120x2 | 1.14293 | 2077 |
| king14r | 98-07-21 | 120x2 | 1.14893 | 2334 |
| king14v | 98-07-21 | 120x2 | 1.15522 | 1845 |
| king14i | 99-01-22 | 120x2 | 1.1688 | 356 |
| king14r | 97-08-06 | 120 | 1.11893 | 405 |
| king14r | 99-01-22 | 120x2 | 1.1611 | 384 |
| | | | | |
| mrk50i | 98-07-20 | 120x2 | 1.09116 | 976 |
| mrk50r | 98-07-19 | 120x2 | 1.10283 | 831 |
| mrk50v | 98-07-19 | 120x2 | 1.10866 | 667 |
| | | | | |
| n146b | 97-08-06 | 120 | 1.10707 | 204 |
| n146i | 97-08-06 | 120 | 1.10496 | 440 |
| n146i | 99-01-22 | 120x2 | 1.2113 | 268 |
| n146i | 99-02-16 | 120x2 | 1.65777 | 273 |
| n146i | 98-07-21 | 120x2 | 1.14494 | 1819 |
| n146r | 97-08-06 | 120 | 1.11252 | 433 |
| n146r | 99-01-22 | 120x2 | 1.2034 | 252 |

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|---|---|---|---|---|
| n2251v | 99-01-22 | 60x2 | 1.2203 | 147 |
| n2251v | 98-02-28 | 30x2 | 1.21543 | 350 |
| | | | | |
| n6755b | 98-07-18 | 10x5 | 1.26107 | 863 |
| n6755b | 07-04-12 | 3x3x60 | Mosaic | |
| n6755i | 98-05-28 | 120x2 | 1.27693 | 2165 |
| n6755i | 98-07-19 | 120x2 | 1.27505 | 3446 |
| n6755i | 98-07-18 | 10x5 | 1.26107 | 6560 |
| n6755r | 97-08-04 | 120 | 2.11573 | 116 |
| n6755r | 98-05-28 | 120x2 | 1.29049 | 1571 |
| n6755r | 98-07-19 | 120x2 | 1.27606 | 3006 |
| n6755r | 98-07-18 | 10x5 | 1.25983 | 4199 |
| n6755r | 07-04-12 | 3x3x20 | Mosaic | |
| n6755u | 98-07-18 | 40x5 | 1.25912 | 383 |
| n6755v | 98-05-28 | 120x2 | 1.28556 | 1290 |
| n6755v | 98-07-19 | 120x2 | 1.27796 | 2171 |
| n6755v | 98-07-18 | 10x5 | 1.25902 | 3280 |
| n6755v | 07-04-12 | 3x3x40 | Mosaic | |
| | | | | |
| n6756b | 97-08-10 | 120x3 | 2.02622 | 152 |
| n6756b | 98-07-18 | 15x5 | 1.25319 | 1155 |
| n6756b | 07-03-15 | 300+240 | | |
| n6756i | 98-05-28 | 120x2 | 1.26883 | 1867 |
| n6756i | 98-07-19 | 120x2 | 1.27787 | 2694 |
| n6756i | 97-08-10 | 120x3 | 2.24511 | 458 |
| n6756i | 98-07-18 | 10x5 | 1.25480 | 4639 |
| n6756r | 97-08-10 | 120x2 | 2.11939 | 242 |
| n6756r | 98-05-28 | 120x2 | 1.26761 | 1452 |
| n6756r | 98-07-19 | 120x2 | 1.27375 | 1707 |
| n6756r | 98-07-18 | 10x5 | 1.25512 | 4313 |
| n6756r | 07-03-15 | 60+10 | | |
| n6756u | 98-07-18 | 60x5 | 1.25465 | 342 |
| n6756v | 98-05-28 | 120x2 | 1.26722 | 1104 |
| n6756v | 98-07-19 | 120x2 | 1.27070 | 1676 |
| n6756v | 98-07-18 | 10x5 | 1.25308 | 2775 |
| n6756v | 07-03-15 | 300+120 | | |
| | | | | |
| n6811b | 96-07-12 | 120 | 1.02756 | 950 |
| n6811b | 98-09-28 | 120x3 | 2.23456 | 140 |
| n6811i | 96-07-12 | 120 | 1.03535 | 592 |
| n6811i | 98-09-28 | 120x3 | 1.11427 | 249 |
| n6811r | 96-07-12 | 120 | 1.02276 | 752 |
| n6811r | 98-09-28 | 120x3 | 1.15683 | 247 |
| n6811v | 96-07-12 | 120 | 1.03109 | 764 |
| n6811v | 98-09-28 | 120x3 | 1.14288 | 247 |
| | | | | |
| n6819b | 96-07-13 | 120 | 1.04333 | 426 |
| n6819b | 98-09-28 | 150x4 | 1.00091 | 570 |
| n6819i | 96-07-13 | 120 | 1.05639 | 645 |
| n6819i | 98-09-28 | 150x4 | 1.00871 | 1055 |
| n6819r | 96-07-13 | 120 | 1.05187 | 868 |
| n6819r | 98-09-28 | 150x4 | 1.00548 | 1016 |
| n6819v | 96-07-13 | 120 | 1.04755 | 896 |
| n6819v | 98-09-28 | 150x5 | 1.00164 | 798 |
| | | | | |
| n6939b | 96-07-13 | 120x2 | 1.05840 | 145 |
| n6939b | 98-07-20 | 120x2 | 1.06836 | 1044 |
| n6939b | 99-09-06 | 45x5 | 1.10612 | 113 |

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|---|---|---|---|---|
| n146r | 99-02-16 | 120x2 | 1.63860 | 270 |
| n146r | 98-07-21 | 120x2 | 1.13057 | 1520 |
| n146v | 99-01-19 | 120 | 1.19164 | 161 |
| n146v | 97-08-06 | 120 | 1.10927 | 457 |
| n146v | 99-01-22 | 120x2 | 1.1957 | 215 |
| n146v | 99-02-16 | 120x2 | 1.61861 | 225 |
| n146v | 98-07-21 | 120x2 | 1.12620 | 1665 |
| | | | | |
| n433i | 98-09-25 | 120x3 | 1.05324 | 437 |
| n433r | 98-09-25 | 120x3 | 1.05095 | 355 |
| n433v | 98-09-25 | 120x3 | 1.04942 | 223 |
| | | | | |
| n609i | 98-09-26 | 120x2 | 1.08258 | 782 |
| n609r | 98-09-26 | 120x2 | 1.08397 | 328 |
| n609v | 98-09-26 | 120x2 | 1.08555 | 169 |
| | | | | |
| n1193i | 98-09-26 | 120x2 | 1.00353 | 140 |
| n1193r | 98-09-26 | 120x2 | 1.00241 | 635 |
| n1193v | 98-09-26 | 120x3 | 1.00136 | 401 |
| | | | | |
| n1348i | 98-09-27 | 120x3 | 1.01405 | 345 |
| n1348r | 98-09-27 | 120x3 | 1.01575 | 456 |
| n1348v | 98-09-27 | 120x3 | 1.01800 | 234 |
| | | | | |
| n1513i | 99-01-22 | 120x2 | 1.0075 | 246 |
| n1513r | 99-01-22 | 120x2 | 1.0073 | 244 |
| n1513v | 99-01-22 | 120x2 | 1.0073 | 238 |
| | | | | |
| n1545i | 99-01-22 | 120x2 | 1.0130 | 163 |
| n1545r | 99-01-22 | 120x2 | 1.0117 | 186 |
| n1545v | 99-01-22 | 120x2 | 1.0106 | 127 |
| | | | | |
| n1883b | 99-02-16 | 120 | 1.30261 | 48 |
| n1883i | 99-02-16 | 120x2 | 1.34898 | 227 |
| n1883r | 99-02-16 | 120x2 | 1.33115 | 187 |
| n1883v | 99-02-16 | 120x2 | 1.31419 | 170 |
| | | | | |
| n1907b | 98-02-28 | 60x2 | 1.03179 | 494 |
| n1907i | 99-01-22 | 60x2 | 1.1122 | 254 |
| n1907i | 99-03-14 | 120x2 | 1.10823 | 265 |
| n1907i | 98-02-28 | 30x2 | 1.02688 | 731 |
| n1907r | 99-01-22 | 60x2 | 1.1071 | 262 |
| n1907r | 99-03-14 | 120x2 | 1.07811 | 262 |
| n1907r | 98-02-28 | 30x2 | 1.02833 | 673 |
| n1907u | 98-02-28 | 120x2 | 1.03595 | 131 |
| n1907v | 99-03-14 | 120 | 1.07300 | 234 |
| n1907v | 99-01-22 | 60x2 | 1.1019 | 257 |
| n1907v | 98-02-28 | 30x2 | 1.02984 | 667 |
| | | | | |
| n1912b | 98-02-28 | 60x2 | 1.04335 | 217 |
| n1912i | 99-03-14 | 60 | 1.17850 | 182 |
| n1912i | 99-03-14 | 60 | 1.23169 | 180 |
| n1912i | 99-03-14 | 60 | 1.26382 | 191 |
| n1912i | 99-01-22 | 60x2 | 1.1429 | 201 |
| n1912i | 98-02-28 | 30x2 | 1.03725 | 431 |
| n1912i | 99-03-14 | 60x2 | 1.13180 | 207 |
| n1912r | 99-03-14 | 60 | 1.22250 | 206 |
| n1912r | 99-03-14 | 60 | 1.25428 | 170 |

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|---|---|---|---|---|
| n6939i | 96-07-13 | 120 | 1.06329 | 157 |
| n6939i | 98-07-20 | 120x2 | 1.06002 | 1203 |
| n6939i | 99-09-06 | 45x5 | 1.12214 | 288 |
| n6939r | 96-07-13 | 120 | 1.06508 | 191 |
| n6939r | 98-07-20 | 120x2 | 1.06259 | 1395 |
| n6939r | 99-09-06 | 45x5 | 1.11672 | 235 |
| n6939u | 99-09-06 | 60x3 | 1.10053 | 38 |
| n6939v | 96-07-13 | 120 | 1.0688 | 185 |
| n6939v | 98-07-20 | 120x2 | 1.06542 | 1269 |
| n6939v | 99-09-06 | 45x5 | 1.11136 | 183 |
| | | | | |
| n6996b | 98-07-20 | 45x6 | 1.00412 | 263 |
| n6996i | 98-07-18 | 20 | 1.02076 | xx |
| n6996i | 98-07-18 | 120x2 | 1.02389 | 1142 |
| n6996i | 98-06-01 | 120x2 | 2.65078 | 1869 |
| n6996i | 98-07-20 | 30x7 | 1.00161 | 1004 |
| n6996r | 98-07-18 | 20 | 1.02000 | xx |
| n6996r | 97-08-04 | 120x2 | 1.10429 | 769 |
| n6996r | 98-07-18 | 120x2 | 1.02812 | 1091 |
| n6996r | 98-06-01 | 120x2 | 2.75430 | 2172 |
| n6996r | 98-07-20 | 30x5 | 1.00212 | 758 |
| n6996u | 98-07-20 | 60x5 | 1.00587 | 76 |
| n6996v | 98-07-18 | 20 | 1.01933 | xx |
| n6996v | 98-07-18 | 120x2 | 1.03395 | 1137 |
| n6996v | 98-06-01 | 120x2 | 2.84409 | 1718 |
| n6996v | 98-07-20 | 30x6 | 1.00296 | 542 |
| | | | | |
| n7031i | 98-07-18 | 120 | 1.01963 | 805 |
| n7031r | 98-07-18 | 120x2 | 1.01786 | 503 |
| n7031v | 98-07-18 | 120 | 1.01559 | 260 |
| n7031b | 06-05-30 | 20x1 | | |
| n7031v | 06-05-30 | 10x1 | | |
| | | | | |
| n7086i | 98-07-18 | 120 | 1.01232 | 771 |
| n7086r | 98-07-18 | 120 | 1.01513 | 578 |
| n7086v | 98-07-18 | 120x2 | 1.02212 | 571 |
| n7086b | 06-05-30 | 25x1 | | |
| n7086v | 06-05-30 | 15x1 | | |
| | | | | |
| n7209b | 96-07-13 | 120 | 1.26969 | xx |
| n7209i | 96-07-13 | 120 | 1.24502 | xx |
| n7209r | 96-07-13 | 120 | 1.23291 | xx |
| n7209v | 96-07-13 | 120 | 1.25705 | xx |
| | | | | |
| n7243b | 96-07-13 | 120 | 1.24811 | xx |
| n7243i | 96-07-13 | 120 | 1.28330 | xx |
| n7243r | 96-07-13 | 120 | 1.27129 | xx |
| n7243v | 96-07-13 | 120 | 1.26010 | xx |
| | | | | |
| n7245b | 96-07-15 | 120 | 1.03667 | xx |
| n7245i | 96-07-15 | 120 | 1.04056 | xx |
| n7245r | 96-07-14 | 120 | 1.04235 | xx |
| n7245v | 96-07-15 | 120 | 1.03856 | xx |
| | | | | |
| n7261b | 96-07-15 | 120 | 1.05290 | xx |
| n7261i | 96-07-15 | 120 | 1.04855 | xx |
| n7261r | 96-07-15 | 120 | 1.04983 | xx |
| n7261v | 96-07-15 | 120 | 1.05923 | xx |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| n1912r | 99-01-22 | 60x2 | 1.1361 | 282 | | | | | |
| n1912r | 98-02-28 | 30x2 | 1.03907 | 562 | n7429i | 98-07-19 | 120x2 | 1.10129 | 655 |
| n1912r | 99-03-14 | 60x2 | 1.13258 | 218 | n7429r | 98-07-19 | 120x2 | 1.10773 | 590 |
| n1912r | 99-03-14 | 60x2 | 1.16972 | 187 | n7429v | 98-07-19 | 120x2 | 1.11485 | 403 |
| n1912u | 98-02-28 | 120x2 | 1.04844 | 81 | | | | | |
| n1912v | 99-01-22 | 60x2 | 1.1289 | 197 | | | | | |
| n1912v | 98-02-28 | 30x2 | 1.04094 | 375 | | | | | |
| n1912v | 99-03-14 | 60x2 | 1.12642 | 162 | | | | | |
| n1912v | 99-03-14 | 60x2 | 1.15565 | 177 | | | | | |
| n1912v | 99-03-14 | 60x2 | 1.21471 | 265 | | | | | |
| n1912v | 99-03-14 | 60x2 | 1.24500 | 260 | | | | | |

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