OGLE Collection of Star Clusters.
New Objects in the Magellanic Bridge and the Outskirts of the Small Magellanic Cloud

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ABSTRACT

The Magellanic System (MS) encompasses the nearest neighbors of the Milky Way, the Large (LMC) and Small (SMC) Magellanic Clouds, and the Magellanic Bridge (MBR). This system contains a diverse sample of star clusters. Their parameters, such as the spatial distribution, chemical composition and age distribution yield important information about the formation scenario of the whole Magellanic System. Using deep photometric maps compiled in the fourth phase of the Optical Gravitational Lensing Experiment (OGLE-IV) we present the most complete catalog of star clusters in the Magellanic System ever constructed from homogeneous, long time-scale photometric data. In this second paper of the series, we show the collection of star clusters found in the area of about 360 square degrees in the MBR and in the outer regions of the SMC. Our sample contains 198 visually identified star cluster candidates, 75 of which were not listed in any of the previously published catalogs. The new discoveries are mainly young small open clusters or clusters similar to associations.

Key words: Catalogs – Galaxies: star clusters: general – Surveys
1. Introduction

The Magellanic System (MS) provides an excellent astrophysical laboratory for studying the structure and evolution of stellar systems (Skowron et al. 2014, Piatti et al. 2015, Jacyszyn-Dobrzeniecka et al. 2016). Star clusters are one of the tools for such studies. However, a complete collection of star clusters is needed to conduct such a research derived from homogeneous observational data, preferably from a single photometric survey. For more details of the scientific rationale of this research, see the Introduction in Sitek et al. (2016, hereafter referred to as Paper I).

To date, the largest catalog of extended objects in the Magellanic System was prepared by Bica et al. (2008) as a compilation of all the previously published catalogs. The important contribution to this sample was taken from the OGLE-II star clusters catalogs (Pietrzyński et al. 1998, 1999). These catalogs, however, covered only the central parts of the LMC and SMC: 5.8 and 2.5 square degrees (Udalski et al. 1997) respectively – only 1.5–2% of the area observed toward these regions during the current OGLE-IV phase (Udalski, Szymański and Szymański 2015). The Magellanic Bridge has never been systematically observed at such scale before, both in terms of the area, time range and cadence. The MBR coverage in the OGLE-IV is 185 square degrees.

This paper presents the second part of the star cluster collection based on the OGLE-IV data. The central part of the SMC has already been observed or analyzed by many other projects (Piatti and Bica 2012, Piatti 2016). Thus, we decided to start our exploration from the outer parts of the galaxy. We have also analyzed the whole area of the MBR covered by the OGLE-IV survey.

2. Observations and Data Reduction

The photometric data of the SMC and MBR fields analyzed in this paper are based on the images gathered during the first five years (2010–2015) of the fourth phase of the OGLE project (Udalski, Szymański and Szymański 2015).

We have used the “deep photometric maps” – catalogs of all objects detected on the deep images of all observed fields. For details we refer the reader to Paper I. For all 120 observed SMC fields (which were analyzed in this paper) and 132 MBR fields, the number of the stacked images used for the deep images is between 55 and 100 (86 on average), depending on the overall number of good seeing individual images in the I-band available for any given field. For the V-band, which is observed less frequently, the deep images were constructed from 2 to 100 individual images with the mean value of 13. For comparison, the reference images for 41 OGLE-III SMC fields (Udalski et al. 2008) were constructed using 4–15 images.

The star detection limit of the deep photometric maps of the SMC and MBR reaches $I \approx 23.5$ mag and $V \approx 24$ mag. The maps are complete to about 22–23 mag in the $I$-band and 22.5–23.5 mag in the $V$-band, depending on the location
Fig. 1. Histograms of brightness (*left panels are* $I$-band and *right panels are* $V$-band) for two OGLE-IV subfields SMC714.22 (*top panels*) and MBR122.22 (*bottom panels*).

and crowding of the field. These limits are determined from the histograms of the mean magnitudes of the stars by estimating the value where the numbers start to deviate from the systematic growth (Fig. 1). All the details about observations, data reductions and construction of the deep photometric maps can be found in Paper I.

### 3. Search for Clusters

The method used in this paper is well established. The first automated search of star clusters was performed by Zaritsky *et al.* (1997) and has been used ever since. We used Zaritsky’s method with small modifications which are described in Paper I (Section 3). Here, we present the analysis of the fields located outside the central part of the SMC and the MBR (Fig. 2).

The examined area of 353 square degrees contains 252 OGLE-IV fields (each field has 32 subfields what gives 8064 single subfields). All analyzed fields are shown in Fig. 2 as black polygons. The 10 gray polygons mark the central SMC fields which have not been analyzed here. The list of all analyzed SMC and MBR fields and their central coordinates are available on the OGLE Web page together with other supplementary information.

Exemplary density maps are presented in Figs. 3 and 4 for both MBR and SMC subfields, respectively. As in Paper I, we constructed a false-color composition of images taken in the $I$- and $V$-bands (Fig. 5) and plotted a photometric map of the region $400 \times 400$ pixels ($1.7 \times 1.7$) around each star cluster candidate detected by our algorithm (see an example in Fig. 6).

Maps presented in Fig. 6 were made for the same object named OGLE-MBR-CL-0033 which is presented in Fig. 5 and shown on the density map in Fig. 3.

[http://ogle.astrouw.edu.pl]
Fig. 2. OGLE-IV fields in the SMC and MBR region. All outer black polygons were analyzed in this paper. Red and blue dots mark the location of newly discovered and the previously known star clusters, respectively (see Section 4).

Fig. 3. Stellar density maps of the MBR118.11 subfield for two different cell sizes. The field contains new cluster: OGLE-MBR-CL-0033, which is located around (630,2680).
Fig. 4. Stellar density maps of a subfield SMC738.05 with object OGLE-SMC-CL-0242 located around (1335,1090). This is a new candidate for star cluster.

Fig. 5. Color image of the subfield MBR118.11. The white square (1\'7 × 1\'7) is enlarged in the right panel, clearly showing the cluster OGLE-MBR-CL-0033 which is a new object.
For all regions found by our algorithm to be denser than the median value for a given subfield we made a visual inspection, as described in Paper I. For all objects which passed the visual inspection based on six different images, the reliability index was assigned: 34% cluster candidates received the maximum value of 1, 28% – 0.9, 17% – 0.8, 12% – 0.7 and 9% – 0.6. This index depends on the quantity of images the object was identified on. The object received the reliability index equal 1 if it was found on every image. The index was reduced by 0.1 each time the object was not found on the image from the inspected group. Object which was found only on two from six images was rejected. All pictures (images in the V- and I-bands, color images and a photometric map) of the accepted star clusters are shown on the Web page (Section 4).

All the centroids were calculated in XY coordinates of the field and then converted to the equatorial coordinates. The estimation of the approximate size of star cluster candidate was made using Kernel Density Estimation (KDE) contour line at half maximum value (see an example in Fig. 6. right panel). The calculations are the same as in Paper I. Table 1 presents the cluster parameters for the new objects and Table 2 for the already known objects.

4. The OGLE Collection of Star Clusters in the Outer Regions of the SMC and in the MBR

We have found 198 star clusters in the outer regions of the SMC and in the MBR. Among these, we have found 35 new star clusters in the 185 square degrees area of the MBR and 40 new star clusters in the 168 square degrees area of the outer
regions of the SMC, based on observations collected by the OGLE-IV survey. Their on-sky locations are shown in Fig. 1 with red dots. The remaining 123 objects were identified in previously published catalogs – 121 objects were listed in the Bica catalog and two objects in Piatti (2017). They are marked in Fig. 1 with blue dots. As some extended objects cannot be unambiguously classified, we have performed a cross-match of our sample to both star clusters and associations from the Bica et al. (2008) catalog. Some of their A-type objects (associations) were found by our algorithm as clusters (the classification is shown in column 6 in Table 2). Almost all previously known objects located in the area of the analyzed OGLE fields were detected by our algorithm, proving its effectiveness and the completeness of the sample. There were eight Bica objects (three star clusters and five clusters similar to associations) which were not detected by our algorithm. Those which have Bica C-type were on the edge of a subfield, and those classified as CA by Bica are not visible in our data. There was also one cluster from Piatti (2017), Field16-02, which was found on the edge of our subfield but rejected after visual inspection. All undetected objects are listed in Table 3.

All discovered cluster candidates were numbered according to the OGLE-IV naming scheme, which was presented in Paper I. The name is constructed as OGLE-MBR-CL-NNNN for the Magellanic Bridge and OGLE-SMC-CL-NNNN for the Small Magellanic Cloud, where NNNN is an object number. To make the numbering consistent with the OGLE-II catalog (Pietrzyński et al. 1998), we started it with 0239 for the SMC. The MBR was not observed during previous OGLE phases so for the MBR we started numbering with 0001.

Table 1 presents the OGLE collection of new candidates for star clusters. Column 1 contains the OGLE identification number, column 2 shows the field name, in columns 3 and 4 we list the equatorial coordinates (J2000) of the cluster center, column 5 contains the size of the cluster (radius) in arcseconds and the last column contains the reliability index.

Table 2 presents the OGLE collection of star clusters, which were already known. We cross-matched our detections with the Bica catalog of star clusters as well as with the catalog of associations (both are part of the Bica et al. 2008). Column 1 contains the OGLE identification number, column 2 shows the field name. Columns 3 and 4 give our estimations of the center equatorial coordinates (J2000). Column 5 shows our estimation of the size in arcseconds (radius), in column 6 we list the cross-identification of extended objects. Column 7 contains the object type from Bica et al. (2008): C – ordinary cluster, CN – cluster in nebula, CA – cluster similar to association, A – ordinary association, AC – association similar to cluster. Some of the objects have more than one name or type because of problems with unambiguous cross-identification. Data in Tables 1 and 2 show exactly the same parameters as in Paper I to make our collection self consistent.
| OGLE-IV name         | OGLE-IV field   | RA     | DEC     | R_kde [°] | reliability |
|----------------------|-----------------|--------|---------|-----------|-------------|
| OGLE-MBR-CL-0001     | MBR100.32       | 1°46′02″68 | −69°42′29″9 | 32        | 0.7         |
| OGLE-MBR-CL-0002     | MBR101.04       | 1°50′17″42 | −71°53′28″1 | 49        | 0.7         |
| OGLE-MBR-CL-0003     | MBR101.05       | 1°48′33″32 | −71°38′22″0 | 50        | 0.7         |
| OGLE-MBR-CL-0004     | MBR101.06       | 1°47′25″41 | −71°51′11″4 | 48        | 0.7         |
| OGLE-MBR-CL-0005     | MBR101.15       | 1°46′01″10 | −71°19′14″9 | 43        | 0.8         |
| OGLE-MBR-CL-0006     | MBR101.28       | 1°53′12″39 | −70°45′09″7 | 29        | 0.9         |
| OGLE-MBR-CL-0007     | MBR102.15       | 1°44′09″39 | −72°31′21″2 | 36        | 0.9         |
| OGLE-MBR-CL-0008     | MBR102.20       | 1°51′37″98 | −72°23′22″4 | 34        | 0.7         |
| OGLE-MBR-CL-0009     | MBR103.10       | 1°52′44″33 | −73°55′34″7 | 24        | 1           |
| OGLE-MBR-CL-0010     | MBR103.13       | 1°47′29″34 | −73°53′39″5 | 37        | 0.9         |
| OGLE-MBR-CL-0011     | MBR103.13       | 1°45′54″59 | −73°46′50″0 | 44        | 0.8         |
| OGLE-MBR-CL-0012     | MBR103.16       | 1°41′06″00 | −73°49′00″9 | 22        | 0.9         |
| OGLE-MBR-CL-0013     | MBR103.25       | 1°40′39″05 | −73°43′05″8 | 27        | 1           |
| OGLE-MBR-CL-0014     | MBR104.21       | 1°47′29″66 | −74°42′54″8 | 33        | 1           |
| OGLE-MBR-CL-0015     | MBR104.26       | 1°54′37″56 | −74°32′42″9 | 36        | 0.9         |
| OGLE-MBR-CL-0016     | MBR104.26       | 1°54′46″63 | −74°29′04″3 | 27        | 0.9         |
| OGLE-MBR-CL-0017     | MBR104.31       | 1°43′28″27 | −74°31′45″7 | 42        | 0.8         |
| OGLE-MBR-CL-0018     | MBR104.31       | 1°43′50″47 | −74°22′12″1 | 38        | 0.8         |
| OGLE-MBR-CL-0019     | MBR104.32       | 1°40′29″43 | −74°26′05″3 | 31        | 1           |
| OGLE-MBR-CL-0020     | MBR105.25       | 1°35′04″87 | −76°11′19″6 | 21        | 0.9         |
| OGLE-MBR-CL-0021     | MBR108.13       | 2°03′13″01 | −73°16′49″3 | 25        | 0.9         |
| OGLE-MBR-CL-0022     | MBR109.03       | 2°08′40″16 | −74°57′28″7 | 45        | 0.7         |
| OGLE-MBR-CL-0023     | MBR109.04       | 2°06′38″84 | −74°45′17″0 | 21        | 0.6         |
| OGLE-MBR-CL-0024     | MBR109.06       | 2°00′45″78 | −74°45′07″6 | 35        | 0.8         |
| OGLE-MBR-CL-0025     | MBR109.11       | 2°07′38″63 | −74°29′42″8 | 32        | 1           |
| OGLE-MBR-CL-0026     | MBR109.18       | 2°12′11″91 | −74°10′23″2 | 28        | 0.6         |
| OGLE-MBR-CL-0027     | MBR109.31       | 2°02′12″63 | −73°59′32″5 | 31        | 0.9         |
| OGLE-MBR-CL-0028     | MBR112.01       | 2°28′02″11 | −73°02′53″4 | 23        | 0.8         |
| OGLE-MBR-CL-0029     | MBR113.08       | 2°31′30″69 | −73°59′26″9 | 21        | 1           |
| OGLE-MBR-CL-0030     | MBR113.09       | 2°29′53″33 | −73°49′10″8 | 25        | 1           |
| OGLE-MBR-CL-0031     | MBR117.27       | 2°39′28″54 | −71°19′02″7 | 36        | 0.6         |
| OGLE-MBR-CL-0032     | MBR118.06       | 2°34′08″09 | −73°42′14″6 | 19        | 0.8         |
| OGLE-MBR-CL-0033     | MBR118.11       | 2°41′03″58 | −73°15′12″4 | 17        | 1           |
| OGLE-MBR-CL-0034     | MBR119.06       | 2°36′38″95 | −74°58′21″0 | 24        | 0.6         |
| OGLE-MBR-CL-0035     | MBR123.29       | 2°54′42″98 | −73°22′17″4 | 28        | 0.9 *       |
| OGLE-SMC-CL-0239     | SMC738.01       | 1°40′38″72 | −73°43′03″6 | 28        | 1           |
| OGLE-SMC-CL-0240     | SMC738.02       | 1°37′02″76 | −73°28′18″6 | 27        | 0.8         |

*Object OGLE-MBR-CL-0035 was detected on the edge of the known association ICA65ne.
| OGLE-IV name     | OGLE-IV field | RA          | DEC          | R_{KDE} [\text{\arcsec}] | reliability |
|------------------|---------------|-------------|--------------|---------------------------|-------------|
| OGLE-SMC-CL-0241 | SMC738.03     | 1\textdegree36\text{\arcmin}24\text{\arcsec}26 | −73\textdegree36′30″8     | 37                        | 0.9         |
| OGLE-SMC-CL-0242 | SMC738.05     | 1\textdegree31\text{\arcmin}13′45      | −73\textdegree41′35″3     | 26                        | 1           |
| OGLE-SMC-CL-0243 | SMC735.07     | 1\textdegree27′35″51         | −73\textdegree33′32″2     | 44                        | 0.9         |
| OGLE-SMC-CL-0244 | SMC738.07     | 1\textdegree27′41″17         | −73\textdegree35′49″0     | 48                        | 0.6         |
| OGLE-SMC-CL-0245 | SMC738.10     | 1\textdegree37′15″96         | −73\textdegree22′53″8     | 37                        | 0.9         |
| OGLE-SMC-CL-0246 | SMC738.11     | 1\textdegree36′19″48         | −73°21′49″5                | 44                        | 0.8         |
| OGLE-SMC-CL-0247 | SMC738.14     | 1\textdegree28′57″40         | −73\textdegree14′55″7     | 38                        | 1           |
| OGLE-SMC-CL-0248 | SMC738.14     | 1\textdegree29′49″16         | −73°25′48″7                | 45                        | 0.8         |
| OGLE-SMC-CL-0249 | SMC738.14     | 1\textdegree29′36″38         | −73°13′39″7                | 38                        | 0.8         |
| OGLE-SMC-CL-0250 | SMC738.16     | 1\textdegree24′33″75         | −73°14′21″2                | 44                        | 0.9         |
| OGLE-SMC-CL-0251 | SMC738.16     | 1\textdegree24′38″61         | −73°12′57″6                | 47                        | 0.9         |
| OGLE-SMC-CL-0252 | SMC739.08     | 1\textdegree40′30″50         | −74°26′04″9                | 28                        | 1           |
| OGLE-SMC-CL-0253 | SMC739.25     | 1\textdegree23′11″37         | −74°12′06″0                | 37                        | 0.7         |
| OGLE-SMC-CL-0254 | SMC739.25     | 1\textdegree22′52″99         | −74°11′28″5                | 50                        | 0.7         |
| OGLE-SMC-CL-0255 | SMC739.28     | 1\textdegree34′30″37         | −73°56′59″9                | 31                        | 1           |
| OGLE-SMC-CL-0256 | SMC740.09     | 1\textdegree36′41″78         | −75°51′15″0                | 24                        | 1           |
| OGLE-SMC-CL-0257 | SMC740.24     | 1\textdegree21′30″56         | −75°33′15″2                | 39                        | 1           |
| OGLE-SMC-CL-0258 | SMC734.24     | 1\textdegree06′44″77         | −74°49′58″5                | 32                        | 1           |
| OGLE-SMC-CL-0259 | SMC735.24     | 1\textdegree01′50″99         | −76°06′38″4                | 27                        | 0.8         |
| OGLE-SMC-CL-0260 | SMC735.31     | 1\textdegree02′36″01         | −75°49′22″7                | 34                        | 0.6         |
| OGLE-SMC-CL-0261 | SMC728.01     | 1\textdegree01′51″09         | −76°06′35″2                | 23                        | 0.9         |
| OGLE-SMC-CL-0262 | SMC730.10     | 1\textdegree26′31″46         | −70°16′09″4                | 23                        | 0.9         |
| OGLE-SMC-CL-0263 | SMC722.14     | 0\textdegree28′02″60         | −76°21′12″3                | 19                        | 1           |
| OGLE-SMC-CL-0264 | SMC706.16     | 0\textdegree18′22″14         | −71°27′02″2                | 18                        | 1           |
| OGLE-SMC-CL-0265 | SMC708.08     | 0\textdegree25′17″91         | −73°52′10″6                | 39                        | 1           |
| OGLE-SMC-CL-0266 | SMC708.11     | 0\textdegree18′56″07         | −73°57′37″4                | 52                        | 0.7         |
| OGLE-SMC-CL-0267 | SMC708.17     | 0\textdegree26′32″81         | −73°38′07″2                | 53                        | 0.6         |
| OGLE-SMC-CL-0268 | SMC708.28     | 0\textdegree19′48″95         | −73°18′05″7                | 34                        | 1           |
| OGLE-SMC-CL-0269 | SMC714.01     | 0\textdegree34′48″90         | −74°42′18″5                | 52                        | 1           |
| OGLE-SMC-CL-0270 | SMC714.13     | 0\textdegree26′04″88         | −74°24′59″5                | 50                        | 0.9         |
| OGLE-SMC-CL-0271 | SMC714.19     | 0\textdegree33′27″41         | −74°21′42″3                | 36                        | 1           |
| OGLE-SMC-CL-0272 | SMC721.23     | 0\textdegree36′31″49         | −74°55′46″7                | 39                        | 1           |
| OGLE-SMC-CL-0273 | SMC721.32     | 0\textdegree33′27″97         | −74°21′45″5                | 41                        | 0.9         |
| OGLE-SMC-CL-0274 | SMC724.02     | 1\textdegree11′23″08         | −71°10′00″4                | 47                        | 0.9         |
| OGLE-SMC-CL-0275 | SMC724.09     | 1\textdegree13′18″32         | −70°50′45″7                | 40                        | 1           |
| OGLE-SMC-CL-0276 | SMC724.16     | 1\textdegree00′46″51         | −70°47′12″8                | 40                        | 1           |
| OGLE-SMC-CL-0277 | SMC724.24     | 1\textdegree02′20″76         | −70°29′08″4                | 37                        | 0.8         |
| OGLE-SMC-CL-0278 | SMC731.09     | 1\textdegree27′30″34         | −71°19′26″5                | 36                        | 0.9         |
### Table 2

#### Already known star clusters

| OGLE-IV name          | OGLE-IV field | RA      | DEC      | $R_{KDE}$ [$\degr$] | name                          | cluster type |
|-----------------------|---------------|---------|----------|---------------------|-------------------------------|--------------|
| OGLE-MBR-CL-0036      | MBR100.23     | $1^h48^m01^s75$ | $-70^\circ00'13''1$ | 20 | BS196 | C |
| OGLE-MBR-CL-0037      | MBR101.16     | $1^h42^m29^s05$ | $-71^\circ16'52''8$ | 17 | HW85 | C |
| OGLE-MBR-CL-0038      | MBR102.05     | $1^h47^m56^s36$ | $-73^\circ07'38''7$ | 35 | BS198 | CA |
| OGLE-MBR-CL-0039      | MBR103.01     | $1^h56^m44^s64$ | $-74^\circ13'09''9$ | 23 | NGC796,L115,WG9,ESO30SC6 | C |
| OGLE-MBR-CL-0040      | MBR103.02     | $1^h52^m57^s31$ | $-74^\circ14'56''7$ | 29 | BS207 | C |
| OGLE-MBR-CL-0041      | MBR103.03     | $1^h50^m20^s50$ | $-74^\circ21'10''3$ | 28 | L114,WG4,ESO30SC5 | C |
| OGLE-MBR-CL-0042      | MBR103.03     | $1^h50^m55^s38$ | $-74^\circ10'43''3$ | 38 | WG5se | CA |
| OGLE-MBR-CL-0043      | MBR103.07     | $1^h42^m23^s53$ | $-74^\circ10'24''7$ | 42 | HW86 | C |
| OGLE-MBR-CL-0044      | MBR103.10     | $1^h53^m48^s21$ | $-73^\circ56'09''3$ | 25 | BS212 | C |
| OGLE-MBR-CL-0045      | MBR103.10     | $1^h53^m34^s18$ | $-74^\circ00'26''7$ | 38 | BS210 | A |
| OGLE-MBR-CL-0046      | MBR103.10     | $1^h53^m12^s57$ | $-73^\circ58'39''6$ | 45 | WG6 | C |
| OGLE-MBR-CL-0047      | MBR103.21     | $1^h49^m30^s93$ | $-73^\circ43'57''0$ | 52 | L113,ESO30SC4 | C |
| OGLE-MBR-CL-0048      | MBR103.29     | $1^h48^m01^s05$ | $-73^\circ07'55''7$ | 23 | BS198 | CA |
| OGLE-MBR-CL-0049      | MBR103.32     | $1^h42^m53^s16$ | $-73^\circ20'13''6$ | 21 | WG1 | C |
| OGLE-MBR-CL-0050      | MBR104.17     | $1^h57^m16^s53$ | $-74^\circ42'32''0$ | 31 | BS218 | A |
| OGLE-MBR-CL-0051      | MBR104.22     | $1^h45^m14^s28$ | $-74^\circ41'23''3$ | 30 | WG2/BS195 | CA/A |
| OGLE-MBR-CL-0052      | MBR104.28     | $1^h49^m43^s75$ | $-74^\circ36'55''3$ | 26 | WG3 | CA |
| OGLE-MBR-CL-0053      | MBR104.28     | $1^h49^m25^s56$ | $-74^\circ39'11''5$ | 26 | BSBD3/BDDS2 | CN/AN |
| OGLE-MBR-CL-0054      | MBR104.28     | $1^h49^m52^s27$ | $-74^\circ28'49''0$ | 45 | BS202 | A |
| OGLE-MBR-CL-0055      | MBR104.28     | $1^h50^m18^s00$ | $-74^\circ21'34''3$ | 20 | L114,WG4,ESO30SC5 | C |
| OGLE-MBR-CL-0056      | MBR104.31     | $1^h43^m50^s16$ | $-74^\circ34'16''7$ | 41 | BS192 | CA |
| OGLE-MBR-CL-0057      | MBR104.31     | $1^h43^m53^s64$ | $-74^\circ32'25''2$ | 36 | BS193 | C |
| OGLE-MBR-CL-0058      | MBR109.03     | $2^h08^m19^s40$ | $-74^\circ48'11''2$ | 35 | WG16 | AC |
| OGLE-MBR-CL-0059      | MBR109.03     | $2^h07^m44^s30$ | $-74^\circ45'44''4$ | 41 | BS228 | AC |
| OGLE-MBR-CL-0060      | MBR109.04     | $2^h06^m50^s82$ | $-74^\circ41'31''4$ | 32 | ICA11 | A |
| OGLE-IV name                  | OGLE-IV field | RA             | DEC             | $R_{KDE}$ ["] | name           | cluster type |
|------------------------------|---------------|----------------|-----------------|----------------|----------------|--------------|
| OGLE-MBR-CL-0061             | MBR109.08     | $2^h14^m38^s91$| $-74^\circ21^\prime30^\prime4$ | 22             | BSBD4         | C            |
| OGLE-MBR-CL-0062             | MBR109.11     | $2^h08^m13^s12$| $-74^\circ31^\prime48^\prime3$ | 34             | WG17          | A            |
| OGLE-MBR-CL-0063             | MBR109.11     | $2^h07^m47^s97$| $-74^\circ26^\prime31^\prime8$ | 26             | BS229         | C            |
| OGLE-MBR-CL-0064             | MBR109.11     | $2^h07^m40^s03$| $-74^\circ37^\prime47^\prime1$ | 34             | WG15          | C            |
| OGLE-MBR-CL-0065             | MBR109.12     | $2^h05^m40^s86$| $-74^\circ23^\prime00^\prime1$ | 36             | BS226         | C            |
| OGLE-MBR-CL-0066             | MBR109.13     | $2^h04^m45^s46$| $-74^\circ30^\prime57^\prime6$ | 22             | WG14          | C            |
| OGLE-MBR-CL-0067             | MBR109.13     | $2^h04^m02^s81$| $-74^\circ28^\prime46^\prime9$ | 38             | BS223         | C            |
| OGLE-MBR-CL-0068             | MBR109.14     | $2^h09^m38^s09$| $-74^\circ33^\prime30^\prime8$ | 20             | WG11          | C            |
| OGLE-MBR-CL-0069             | MBR109.15     | $1^h59^m59^s09$| $-74^\circ22^\prime57^\prime5$ | 45             | WG10          | AC           |
| OGLE-MBR-CL-0070             | MBR109.18     | $2^h11^m49^s50$| $-74^\circ06^\prime59^\prime0$ | 31             | BS235         | C            |
| OGLE-MBR-CL-0071             | MBR109.19     | $2^h10^m40^s97$| $-74^\circ09^\prime20^\prime6$ | 27             | BS233         | CA           |
| OGLE-MBR-CL-0072             | MBR109.19     | $2^h11^m12^s23$| $-74^\circ16^\prime44^\prime9$ | 21             | BS234         | AC           |
| OGLE-MBR-CL-0073             | MBR109.24     | $1^h59^m47^s87$| $-74^\circ16^\prime30^\prime4$ | 34             | BS220         | A            |
| OGLE-MBR-CL-0074             | MBR109.25     | $1^h56^m55^s40$| $-74^\circ15^\prime20^\prime6$ | 30             | BS216/BS217   | C/A          |
| OGLE-MBR-CL-0075             | MBR109.25     | $1^h56^m44^s78$| $-74^\circ13^\prime08^\prime1$ | 24             | NGC796,L115,WG9,ESO30/SC6/BS215 | C/A |
| OGLE-MBR-CL-0076             | MBR109.25     | $1^h56^m35^s44$| $-74^\circ16^\prime58^\prime3$ | 25             | WG8           | AC           |
| OGLE-MBR-CL-0077             | MBR109.28     | $2^h09^m20^s82$| $-74^\circ01^\prime38^\prime3$ | 24             | BS232/BS231   | C/A          |
| OGLE-MBR-CL-0078             | MBR109.30     | $2^h02^m44^s28$| $-73^\circ56^\prime16^\prime0$ | 22             | WG13          | C            |
| OGLE-MBR-CL-0079             | MBR110.30     | $2^h04^m21^s20$| $-74^\circ59^\prime01^\prime8$ | 34             | ICA6          | A            |
| OGLE-MBR-CL-0080             | MBR113.06     | $2^h19^m28^s70$| $-74^\circ11^\prime45^\prime4$ | 31             | BS243         | A            |
| OGLE-MBR-CL-0081             | MBR113.08     | $2^h31^m11^s50$| $-73^\circ55^\prime51^\prime0$ | 28             | ICA57         | A            |
| OGLE-MBR-CL-0082             | MBR113.10     | $2^h27^m16^s01$| $-73^\circ45^\prime38^\prime6$ | 40             | IDK2w,ICA45   | A            |
| OGLE-MBR-CL-0083             | MBR113.10     | $2^h27^m28^s38$| $-73^\circ58^\prime29^\prime4$ | 31             | BS245         | CA           |
| OGLE-MBR-CL-0084             | MBR113.10     | $2^h28^m22^s51$| $-73^\circ48^\prime05^\prime4$ | 28             | ICA49/ICA48   | A/A          |
| OGLE-MBR-CL-0085             | MBR113.16     | $2^h14^m50^s33$| $-73^\circ57^\prime10^\prime9$ | 31             | BS240/ICA34   | C/A          |
| OGLE-IV name | OGLE-IV field | RA          | DEC          | $R_{K_{S}}$ [$^\circ$] | name | cluster type |
|-------------|--------------|-------------|--------------|------------------------|------|--------------|
| OGLE-MBR-CL-0086 | MBR113.16 | 20214°34'80'' | −73°58'56''6 | 28 | BS239/ICA34 | CA/A |
| OGLE-MBR-CL-0087 | MBR123.26 | 19°01'33'52'' | −73°25'08''5 | 24 | ICA71 | A |
| OGLE-MBR-CL-0088 | MBR128.03 | 19°10'22'86'' | −73°30'07''5 | 18 | BS247 | AC |
| OGLE-MBR-CL-0089 | MBR128.15 | 19°01'33'27'' | −73°25'08''2 | 24 | ICA71 | A |
| OGLE-MBR-CL-0090 | MBR141.07 | 19°34'26'41'' | −71°40'50''2 | 47 | NGC1466,SL1,LW1,ESO54SC16,KMHK1 | C |
| OGLE-MBR-CL-0091 | MBR160.11 | 19°55'36'02'' | −77°39'15''5 | 17 | L116,ESO13SC25 | C |
| OGLE-SMC-CL-0279 | SMC738.06 | 19°29'27'77'' | −73°31'56''5 | 27 | B164 | C |
| OGLE-SMC-CL-0280 | SMC738.06 | 19°29'34'82'' | −73°33'29''4 | 34 | GHK24/GHK29/GKH22/GHK51/NGC602,L105,ESO29SC43,H-A68 | C/C/C/DAN |
| OGLE-SMC-CL-0281 | SMC738.06 | 19°29'14'50'' | −73°32'02''1 | 36 | SGGH-cluster-A | C |
| OGLE-SMC-CL-0282 | SMC738.08 | 19°42'53'34'' | −73°20'15''3 | 25 | WG1 | C |
| OGLE-SMC-CL-0283 | SMC738.12 | 19°34'41'19'' | −73°16'27''2 | 29 | H86-213 | C |
| OGLE-SMC-CL-0284 | SMC738.13 | 19°31'08'83'' | −73°24'51''1 | 41 | L107,H-A69 | AC |
| OGLE-SMC-CL-0285 | SMC738.13 | 19°30'49'89'' | −73°25'45''2 | 43 | B165 | C |
| OGLE-SMC-CL-0286 | SMC738.13 | 19°30'33'40'' | −73°25'20''7 | 46 | BS186 | A |
| OGLE-SMC-CL-0287 | SMC738.16 | 19°25'25'86'' | −73°22'58''1 | 46 | BS282/L104/H-A67 | C/ANDAN |
| OGLE-SMC-CL-0288 | SMC738.16 | 19°24'30'28'' | −73°24'41''9 | 46 | H86-211 | C |
| OGLE-SMC-CL-0289 | SMC738.16 | 19°24'09'76'' | −73°09'27''2 | 62 | HW81 | CN |
| OGLE-SMC-CL-0290 | SMC738.16 | 19°24'25'25'' | −73°10'31''2 | 46 | HW82 | C |
| OGLE-SMC-CL-0291 | SMC738.16 | 19°24'25'37'' | −73°10'30''4 | 57 | BS176/HCD99-1 | C/C |
| OGLE-SMC-CL-0292 | SMC738.21 | 19°34'25'56'' | −72°52'21''8 | 45 | L110,ESO29SC48 | C |
| OGLE-SMC-CL-0293 | SMC738.22 | 19°31'01'36'' | −72°51'03''1 | 28 | BS187 | CA |
| OGLE-SMC-CL-0294 | SMC739.20 | 19°33'12'46'' | −74°10'02''7 | 24 | L109,ESO29SC46 | C |
| OGLE-SMC-CL-0295 | SMC739.29 | 19°31'11'93'' | −73°53'35''6 | 45 | B166 | C |
| OGLE-SMC-CL-0296 | SMC740.03 | 19°30'38'30'' | −76°03'15''3 | 28 | L106,ESO29SC44 | C |
| OGLE-SMC-CL-0297 | SMC740.18 | 19°34'55'99'' | −75°33'17''1 | 38 | NGC643,L111,ESO29SC50 | C |
| OGLE-IV name          | OGLE-IV field | RA      | DEC      | $\delta_{\text{KDE}}$ | name     | cluster type |
|----------------------|---------------|---------|----------|------------------------|----------|--------------|
| OGLE-SMC-CL-0298     | SMC740.18     | 1°35′58″27″ | −75°27′26″00″ | 23                     | L112     | C            |
| OGLE-SMC-CL-0299     | SMC740.31     | 1°22′44″71″ | −75°00′30″4″  | 39                     | HW79     | C            |
| OGLE-SMC-CL-0300     | SMC737.14     | 1°31′38″99″ | −71°56′49″4″  | 29                     | L108     | C            |
| OGLE-SMC-CL-0301     | SMC737.17     | 1°43′52″43″ | −71°44′51″9″   | 31                     | BS190    | CA           |
| OGLE-SMC-CL-0302     | SMC737.21     | 1°35′11″61″ | −71°44′15″5″   | 37                     | BS188    | C            |
| OGLE-SMC-CL-0303     | SMC737.32     | 1°30′11″16″ | −71°20′19″7″   | 27                     | BS184    | CA           |
| OGLE-SMC-CL-0304     | SMC736.01     | 1°42′27″76″ | −71°16′47″8″   | 20                     | HW85     | C            |
| OGLE-SMC-CL-0305     | SMC736.02     | 1°41′40″48″ | −71°09′53″2″   | 30                     | HW84     | C            |
| OGLE-SMC-CL-0306     | SMC734.08     | 1°22′49″14″ | −75°00′04″9″   | 41                     | HW79     | C            |
| OGLE-SMC-CL-0307     | SMC734.12     | 1°12′04″82″ | −75°11′40″1″   | 38                     | HW66,ESO29SC36 | C |
| OGLE-SMC-CL-0308     | SMC717.25     | 0°48′50″91″ | −69°52′08″7″   | 40                     | L38,ESO51SC3 | C |
| OGLE-SMC-CL-0309     | SMC716.10     | 0°58′58″01″ | −68°54′54″0″   | 23                     | ESO51SC9  | C            |
| OGLE-SMC-CL-0310     | SMC710.26     | 0°47′24″56″ | −68°55′15″1″   | 25                     | L32,ESO51SC2 | C |
| OGLE-SMC-CL-0311     | SMC706.12     | 0°26′52″99″ | −71°32′56″6″   | 46                     | NGC121,K2,L10,ESO50SC12 | C |
| OGLE-SMC-CL-0312     | SMC703.01     | 0°12′57″34″ | −73°29′30″6″   | 30                     | L2       | C            |
| OGLE-SMC-CL-0313     | SMC703.05     | 0°03′47″83″ | −73°28′43″4″   | 24                     | L1,ESO28SC8 | C |
| OGLE-SMC-CL-0314     | SMC715.28     | 0°22′42″73″ | −75°04′33″8″   | 23                     | L5,ESO28SC16 | C |
| OGLE-SMC-CL-0315     | SMC761.02     | 2°38′48″59″ | −72°56′43″6″   | 16                     | AM-3,ESO28SC4 | C |
| OGLE-SMC-CL-0316     | SMC707.01     | 0°28′31″18″ | −73°00′40″4″   | 50                     | BS2      | C            |
| OGLE-SMC-CL-0317     | SMC707.03     | 0°24′57″18″ | −73°01′48″4″   | 40                     | B4       | CA           |
| OGLE-SMC-CL-0318     | SMC707.09     | 0°27′44″16″ | −72°46′46″9″   | 46                     | K7,L11,ESO28SC22 | C |
| OGLE-SMC-CL-0319     | SMC707.11     | 0°24′44″77″ | −72°47′45″0″   | 50                     | K3,L8,ESO28SC19 | C |
| OGLE-SMC-CL-0320     | SMC707.17     | 0°31′03″58″ | −72°20′21″1″   | 37                     | HW5      | C            |
| OGLE-SMC-CL-0321     | SMC707.29     | 0°21′30″47″ | −71°56′03″5″   | 35                     | BOLOGNA-A | C            |
Table 2
Concluded

| OGLE-IV name     | OGLE-IV field | RA       | DEC       | $R_{KDE}$ ["] | name                        | cluster type |
|------------------|---------------|----------|-----------|----------------|-----------------------------|--------------|
| OGLE-SMC-CL-0322 | SMC708.03     | 0°19'19"65 | −74°06'23"3′ | 36             | B1                          | C            |
| OGLE-SMC-CL-0323 | SMC708.04     | 0°18'25"79 | −74°19'07"0′ | 22             | L3,ESO28SC13               | C            |
| OGLE-SMC-CL-0324 | SMC714.31     | 0°24'39"57 | −73°45'11"7′ | 45             | K5,L7,ESO28SC18            | C            |
| OGLE-SMC-CL-0325 | SMC708.10     | 0°21'31"25 | −73°45'27"1′ | 45             | K1,L4,ESO28SC15            | C            |
| OGLE-SMC-CL-0326 | SMC708.18     | 0°23'03"83 | −73°40'09"5′ | 37             | K4,L6,ESO28SC17            | C            |
| OGLE-SMC-CL-0327 | SMC708.19     | 0°21'27"97 | −73°44'54"1′ | 41             | K1,L4,ESO28SC15            | C            |
| OGLE-SMC-CL-0328 | SMC708.23     | 0°12'55"25 | −73°29'27"9′ | 29             | L2                          | C            |
| OGLE-SMC-CL-0329 | SMC708.29     | 0°18'23"44 | −73°23'40"5′ | 36             | HW1                         | CA           |
| OGLE-SMC-CL-0330 | SMC714.12     | 0°28'39"66 | −73°23'55"6′ | 51             | B6                          | C            |
| OGLE-SMC-CL-0331 | SMC714.16     | 0°19'18"10 | −73°34'26"2′ | 25             | B2                          | C            |
| OGLE-SMC-CL-0332 | SMC714.22     | 0°25'26"81 | −73°04'30"9′ | 40             | K6,L9,ESO28SC20            | C            |
| OGLE-SMC-CL-0333 | SMC724.03     | 1°10'43"92 | −71°16'50"2′ | 51             | BS144                       | A            |
| OGLE-SMC-CL-0334 | SMC724.07     | 1°02'01"10 | −71°01'11"5′ | 40             | B111                        | C            |
| OGLE-SMC-CL-0335 | SMC724.09     | 1°13'03"80 | −70°57'46"1′ | 35             | HW67                        | C            |
| OGLE-SMC-CL-0336 | SMC724.12     | 1°07'41"73 | −70°56'08"4′ | 26             | HW56                        | C            |
| OGLE-SMC-CL-0337 | SMC724.31     | 1°04'24"97 | −70°20'32"3′ | 26             | L73                         | C            |
| OGLE-SMC-CL-0338 | SMC731.08     | 1°30'11"68 | −71°20'17"5′ | 33             | BS184                       | CA           |
| OGLE-SMC-CL-0339 | SMC731.15     | 1°16'24"75 | −71°19'36"1′ | 33             | HW73                        | C            |
| OGLE-SMC-CL-0340 | SMC731.16     | 1°14'54"34 | −71°32'32"6′ | 48             | NGC458,K6,L9,ESO51SC26     | C            |
| OGLE-SMC-CL-0341 | SMC731.16     | 1°14'44"48 | −71°20'54"3′ | 38             | L95                         | C            |
| OGLE-SMC-CL-0342 | SMC731.20     | 1°24'55"87 | −71°11'13"5′ | 26             | IC1708,L102,ESO52SC2       | C            |
| OGLE-SMC-CL-0343 | SMC731.27     | 1°26'42"70 | −70°46'58"8′ | 24             | B168                        | C            |
| OGLE-SMC-CL-0344 | SMC739.05     | 1°29'52"83 | −74°50'48"2′ | 28             | Field12-01                 | -            |
| OGLE-SMC-CL-0345 | SMC734.21     | 1°13'42"75 | −74°45'14"4′ | 28             | Field16-01                 | -            |
Table 3
Undetected objects form Bica et al. (2008) and Piatti (2017)

| Name     | Bica type | Comment |
|----------|-----------|---------|
| BS6      | CA        | not visible edge |
| H86-197  | C         | not visible edge |
| BS127    | CA        | not visible edge |
| HW20     | C         | edge |
| B44      | C         | edge |
| BS173    | CA        | not visible edge |
| BS1      | CA        | not visible edge |
| BS189    | CA        | not visible edge |
| Field16-02 | –     | edge |

The OGLE star cluster collection, the list of all analyzed SMC and MBR fields and all the graphical materials are available on the OGLE web page:

[http://ogle.astrouw.edu.pl](http://ogle.astrouw.edu.pl)

5. Conclusions

We have presented a catalog of star clusters in the Magellanic Bridge and the outer regions of the Small Magellanic Cloud based on the OGLE-IV deep photometric maps. We found a total of 198 star clusters, including 75 new objects which were not listed in any of the previous catalogs, 121 clusters listed in Bica et al. (2008) and two clusters listed in Piatti (2017). For all of them the equatorial coordinates and cross-identification with the Bica et al. catalog are provided. The detection method presented in this paper is very effective. With our algorithm we found more than 95% of previously known clusters in this characteristic sparse region of the SMC and in the whole MBR, increasing the total number of these objects by 40%. This paper is the second of a series of publications. In the next one we will present clusters found in the central regions of the LMC and SMC, thus concluding the complete collection of star clusters in the whole Magellanic System observed by the OGLE survey.

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REFERENCES

Bica, E., Bonatto, C., Dutra, C.M., and Santos, J.F.C. 2008, *MNRAS*, 389, 678.
Jacyszyn-Dobrzeniecka, A., et al. 2016, *Acta Astron.*, 66, 149.
Piatti, A.E., and Bica, E. 2012, *MNRAS*, 425, 3085.
Piatti, A.E., et al. 2015, *MNRAS*, 450, 552.
Piatti, A.E., et al. 2016, *MNRAS*, 460, 383.
Piatti, A.E. 2017, *ApJ*, 834, L14.
Pietrzyński, G., Udalski, A., Kubiak, M., Szymański, M. K., Woźniak, P., and Żebruń, K. 1998, *Acta Astron.*, 48, 175.
Pietrzyński, G., and Udalski, A. 1999, *Acta Astron.*, 49, 165.
Skowron, D.M., et al. 2014, *ApJ*, 795, 108.
Sitek, M., et al. 2016, *Acta Astron.*, 66, 255, Paper I.
Udalski, A., Kubiak, M., and Szymański, M.K. 1997, *Acta Astron.*, 47, 319.
Udalski, A., Szymański, M.K., Soszyński, I., and Poleski, R. 2008, *Acta Astron.*, 58, 69.
Udalski, A., Szymański, M.K., and Szymański, G. 2015, *Acta Astron.*, 65, 1.
Zaritsky, D., Harris, J., and Thompson, I. 1997, *AJ*, 114, 1002.