Fifty Star Cluster Candidates toward the Galactic Bulge from VVV and *Gaia*

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Globular clusters (GCs) are the oldest and most massive star clusters in the Galaxy, and are preferentially destroyed in the central bulge. Most of the dynamical processes that affect GC survival (bulge shocking, dynamical friction, tidal disruption, evaporation, etc.) are maximized in the Galactic bulge. That is why the bulge has been called the elephant graveyard of the Milky Way (Minniti et al. 2017a). It is in the bulge where we expect to find GCs in different stages of evolution: normal GCs, clusters in process of disruption, as well as the debris of already destroyed GCs.

Searching for these objects in the innermost regions of the Milky Way is very difficult due to the high foreground and background contamination, and to the extreme extinction and crowding. Large surveys like 2MASS (Skrutskie et al. 2006), Glimpse (Benjamin et al. 2005), VVV (Minniti et al. 2010), and *Gaia* DR2 (*Gaia* Collaboration et al. 2018), have recently allowed the discovery of numerous new GCs in these inner regions. These newly found GCs are mostly faint and small, although a couple of large ones have also been identified lately (like VVV-GC05—Minniti et al. 2017d, and FSR1758—Cantat-Gaudin 2018; Barba et al. 2019). The recent compilation of 10,000 star clusters by Bica et al. (2019) comprises the most complete and up to date list, including a number of new GC discoveries by different teams (e.g., Froebrich et al. 2007; Borissova et al. 2014; Minniti et al. 2017a, 2017b, 2017c; Camargo 2018; Ryu & Lee 2018, etc.).

Herewith we have extended our previous bulge GC searches following the procedures described by Minniti et al. (2017a, 2017b, 2017c), adding a couple of additional steps to target more distant objects. Considering the high foreground contamination and in order to discard nearby sources, we used the matched VVV-*Gaia* catalogs of Kammers et al. (2019),

with distances (Bailer Jones et al. 2018). Also, we rejected sources with proper motions consistent with the mean motion of the Galactic disk for the different fields. We then built red giant density maps and identified the over-densities with sizes typical for GCs. Finally, we checked the optical and near-IR color–magnitude diagrams for each individual object, selecting the ones with red giant branches tighter than their surrounding fields. While in most targets a clear red clump is present, in a few cases there is also a concentration of RR Lyrae stars and/or a blue horizontal branch can be observed.

The fifty new candidate GCs are listed in Table 1. We give their IDs, positions, mean field extinction values A_{Ks} (Schlafly & Finkbeiner 2011), and the number of RR Lyrae within 3 arcmin of the cluster center. As a caveat, we cannot discard the possibility that some of these GC candidates could be open clusters or mere background fluctuations instead of real GCs. These objects must be individually confirmed as such using additional information (like proper motions, radial velocities, chemical abundances, presence of RR Lyrae variable stars, etc.), as discussed for example by Minniti et al. (2018), and Palma et al. (2019). These new GC candidates are interesting cases for a variety of follow-up studies.

Table 1. New VVV-*Gaia* GC Candidates in the Galactic Bulge

ID	R.A.(J2000)	Decl.(J2000)		N_{RRL}	Comment[a]
Minni 85	18:02:25	−28:43:52	0.233	1	
Minni 86	18:15:26	−30:15:56	0.073	1	
Minni 87	18:13:48	−27:57:23	0.141	4	BHB
Minni 88	18:21:10	−28:14:23	0.113	1	
Minni 89	17:47:59	−21:24:34	0.301	0	
Minni 90	18:16:46	−34:19:41	0.050	0	BHB
Minni 91	17:54:14	−36:09:08	0.172	3	BHB
Minni 92	18:01:04	−36:58:28	0.086	0	BHB
Minni 93	18:09:04	−37:50:36	0.041	0	
Minni 94	17:15:03	−31:48:46	0.314	1	
Minni 95	18:14:22	−21:53:04	0.728	1	
Minni 96	18:14:10	−21:39:17	0.951	0	
Minni 97	18:12:34	−20:49:01	1.155	0	
Minni 98	18:10:45	−22:32:20	0.953	0	
Minni 99	18:14:35	−22:01:11	0.704	1	

ID	R.A.(J2000)	Decl.(J2000)	N_{RRL}	Comment[a]
Minni 100	18:08:58	−23:47:08	1.113	1
Minni 101	17:34:56	−33:37:54	2.116	2
Minni 102	17:24:04	−36:14:54	3.087	0
Minni 103	17:27:41	−37:50:40	0.869	0
Minni 104	17:32:18	−37:58:18	0.482	1
Minni 105	17:28:56	−37:41:25	1.049	0
Minni 106	17:32:59	−36:44:30	0.454	1
Minni 107	17:34:26	−37:01:29	0.484	0
Minni 108	17:31:03	−37:17:26	0.798	0
Minni 109	17:29:08	−38:17:56	0.689	0
Minni 110	17:32:45	−37:41:21	0.571	0
Minni 111	17:31:41	−37:49:38	0.587	0
Minni 112	17:32:24	−36:20:43	0.650	2
Minni 113	17:35:34	−35:50:08	0.709	0
Minni 114	17:38:07	−35:44:44	0.460	1
Minni 115	17:37:11	−34:35:37	0.688	1
Minni 116	17:34:54	−33:38:24	2.128	2
Minni 117	17:35:34	−34:55:39	0.807	0
Minni 118	17:41:00	−34:51:51	0.533	0
Minni 119	17:34:58	−33:39:33	2.145	0
Minni 120	17:18:59	−34:02:42	0.778	0
Minni 121	17:17:53	−34:26:09	0.767	0
Minni 122	17:33:31	−36:57:19	0.454	1
Minni 123	17:38:10	−34:51:09	0.622	0
Minni 124	18:05:06	−25:17:25	1.048	2
Minni 125	18:08:37	−24:34:19	0.666	1
Minni 126	18:10:22	−23:14:38	0.736	1
Minni 127	18:08:05	−23:49:27	1.104	1
Minni 128	17:25:34	−38:31:40	0.607	0
Minni 129	17:09:06	−37:40:42	0.946	0
Minni 130	17:20:53	−40:02:01	0.546	0
Minni 131	17:16:50	−40:00:34	0.852	0
Minni 132	16:59:22	−39:11:31	0.829	0
Minni 133	17:08:13	−42:51:00	0.896	0
Minni 134	16:46:41	−42:40:06	0.929	0
Minni 135	15:40:36	−56:22:45	1.345	0

Note.

[a]BHB indicates the possible presence of a blue horizontal branch.

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