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Star Clusters in Irregular Galaxies in the Local Group

Eva K. Grebel

MPI für Astronomie, Königstuhl 17, D-69117 Heidelberg, Germany

Abstract. I summarize our knowledge of star clusters and associations in irregular galaxies other than the Magellanic Clouds in the Local Group. Surveys affording complete area coverage at high angular resolution are still lacking. Confirmed globular clusters are known only in NGC 6822 and WLM. Very few dIrrs contain populous or sparse open clusters. There is a pronounced deficiency of intermediate-age and young clusters. Apart from parent galaxy mass, the lack of interactions may be a key reason for the lack of cluster formation in the dIrrs. All dIrrs have one or several short-lived OB associations in the star-forming regions in their centers.

1. Introduction

While star clusters in extragalactic systems are most abundant in giant ellipticals, also lower-mass galaxies such as spirals and irregulars may harbor star clusters with a range of ages. Irregular galaxies are excellent sites for the study of cluster formation and evolution in low-mass environments without spiral density waves and allow us to extend comparative studies of correlations between star cluster content and host galaxy properties to star-forming low-mass galaxies. In this review I concentrate on star clusters in Local Group irregulars (excluding the Magellanic Clouds, which are reviewed by Da Costa, these proceedings).

The Local Group has a zero-velocity surface radius of ~ 1.2 Mpc (Courteau & van den Bergh 1999), within which 36 galaxies are located. Twelve of these are irregular galaxies, i.e., gas-rich galaxies irregular in shape and with recent star formation. They range from $\sim 10^{10}$ to $\sim 10^{8}$ $M_{\odot}$ in mass. Apart from the Large Magellanic Cloud (LMC) they are all dwarf irregular galaxies (dIrrs). The more massive irregulars usually show solid-body rotation (with occasional differential rotation in their outer parts), while dIrrs at the low-mass end tend not to have measurable rotation. In fact, at the low-mass end a transition to gas-poor dwarf spheroidal (dSph) galaxies may be taking place.

Local Group irregulars are sufficiently close to allow us to resolve their star clusters into individual stars, making it possible to carry out isochrone-based age determinations, to determine detailed spectroscopic abundances, structural parameters, internal dynamics, etc. Their proximity also enables us to correlate recent star cluster formation sites with gas content and star formation history (e.g., Fukui's review; these proceedings). Furthermore, here we can obtain a fairly complete census of their cluster content, since even sparse clusters and individual OB associations are detectable. This gives us the unique opportunity to study the full range of cluster properties in these low-mass, nearby galaxies.

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2. Cluster types

Before discussing the properties of clusters in nearby dIrr galaxies, I briefly summarize the characteristics and definitions for the different types of star clusters.

2.1. Globular clusters

Globular clusters are centrally concentrated, spherical systems with masses of $10^4 \lesssim M\,[\mathrm{M}_\odot] \lesssim 10^{6.6}$ and tidal radii ranging from ~ 10 to ~ 100 pc. They are bound, long-lived objects, whose lifetimes may extend beyond a Hubble time if external destructive forces are absent. In irregulars, bulge and disk shocks play no significant role in the destruction of globular clusters, and dynamical friction is reduced in comparison to massive spirals and ellipticals. Internal relaxation effects are likely the main agent of destruction.

In 12 of the 36 Local Group galaxies globular clusters have been detected. including the irregular galaxies LMC, SMC, NGC 6822, and WLM. One of the most massive, most luminous ($M_V = -10\overset{\mathrm{m}}{.}55$) globular clusters is the old, metal-rich, elliptical globular Mayall II in M31. In contrast, the faintest ($M_V \sim 0\overset{\mathrm{m}}{.}2$), least massive globular currently known is AM-4, a distant old Galactic halo globular. The globular clusters in irregulars lie in between these two extremes.

2.2. Open clusters

Open clusters have masses of $10^3 \lesssim M\,[\mathrm{M}_\odot] \lesssim 10^5$ and radii of 1 to 20 pc. While most Milky Way open clusters survive for only ~200 Myr (Janes, Tilley, & Lyngå 1988), there are also long-lived open clusters with ages of several Gyr (Phelps, Janes, & Montgomery 1994; Phelps, these proceedings). The oldest open clusters and the youngest globular clusters in the Local Group overlap in age. The distinction between massive open clusters and low-mass globular clusters is somewhat arbitrary. Bound objects that survive for more than 10 Gyr are generally called globulars even though they be more akin to sparse open clusters. Open clusters were identified in ~ 40% of the Local Group galaxies.

Loose, extended open clusters are dominant in spiral galaxies like the Milky Way, while the Magellanic Clouds and several other dIrrs contain a large number of blue, compact, populous clusters with typical tidal radii < 70 pc. In contrast to the short lifetimes of the Milky Way open clusters, the populous Magellanic Clouds clusters have typical lifetimes of at least 1 Gyr (Hodge 1988).

2.3. Super Star Clusters

Super star clusters are young populous clusters exceeding several 10^4 $\mathrm{M}_\odot$ within a radius of 1–2 pc. Some may be progenitors of globular clusters. The most massive super star clusters are found in interacting and starburst galaxies or as nuclear star clusters near the centers of massive galaxies. Only a few, comparatively low-mass super star clusters are known in the Local Group. The most massive one, R136, is located in the giant H II region 30 Doradus in the LMC. No super star clusters are have been identified in the Local Group dIrrs.

2.4. Associations

The most common result of large-scale star formation are associations, which appear to be the major contributors to a galaxy's field population. Found in

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all Local Group galaxies with current star formation, associations are extended, unbound, coeval groups of stars with radii of $\lesssim$ 100 pc. They disperse on time scales of ~100 Myr. Often they are embedded in hierarchical structures of similar age such as stellar aggregates (~250 pc radius) and star complexes (~600 pc radius; Efremov, Ivanov, & Nikolov 1987). Associations appear to be present in all types of galaxies during and after episodes of star formation. Both open clusters and associations generally have initial mass functions consistent with a Salpeter slope for high and intermediate-mass stars (Massey, Johnson, & DeGioia-Eastwood 1995a; Massey et al. 1995b; Hunter 2001).

3. Local Group Dwarf Irregulars With Confirmed Globular Clusters

3.1. NGC 6822

NGC 6822, a barred dIrr galaxy (type Ir VI–V, distance 500 kpc), is a possible Milky Way companion. The bar and young star-forming regions are embedded in a large elliptical halo of old and intermediate-age stars (Letarte et al. 2002). The stellar component lies within an extended, flattened, diagonal H I "disk". The highest concentrations of the H I distribution coincide in part with the stellar bar and surrounding star-forming regions, but also show an asymmetric off-set to the northwest of the stellar component (de Blok & Walter 2000).

The star-formation rate of NGC 6822 is $\gtrsim 0.04$ $M_\odot$ yr^{-1} (Gallagher et al. 1991; Wyder 2001). It was either relatively constant throughout the dIrr's lifetime or increased slowly over the past few Gyr (Wyder 2001). The bar shows a higher star formation rate. A recent increase in the star formation rate during the past ~ 200 Myr (Hodge 1980; Gallart et al. 1996) may be due to interaction with a possibly infalling, massive H I cloud (de Blok & Walter 2000).

At least 31 star cluster candidates have been identified in NGC 6822 (Hubble 1925; Hodge 1977). Five of these have since been shown to be luminous stars or H II regions (Wilson 1992; Chandar, Bianchi, & Ford 2000), and the nature of several other candidates is not yet clear. A comprehensive study of the cluster content of NGC 6822 is underway (Chandar, Bianchi, & Romaniello 2001).

There is only one old globular cluster in NGC 6822: (Hubble VII). Integrated spectroscopy and resolved HST photometry yield an age of ~ 11 Gyr, [Fe/H] ~ −2.0 dex, and a mass of ~ 10^6 $M_\odot$ (Cohen & Blakeslee 1998; Chandar et al. 2000; Wyder, Hodge, & Zucker 2000a).

The other clusters resemble young populous Magellanic Cloud clusters (e.g., Hubble VI and VIII), or are sparser and fainter. Hubble VIII has a metallicity of ~ −1 dex (Cohen & Blakeslee 1998) and is ~ 1.5 Gyr old (Wyder et al. 2000a). Hodge's cluster C21 has an age of ~ 200 Myr (Chandar et al. 2000) in good agreement with Hodge's (1980) estimate based on the most luminous star in this cluster. Hubble VI is 70 Myr old (Wyder et al. 2000a) and fairly metal-poor (~ −1.5 dex; Chandar et al. 2000). Chandar et al. suggest that the clusters in NGC 6822 may be on average 0.5 dex more metal-poor than SMC clusters of the same age. On the other hand, the young field population of NGC 6822 has a metallicity of ~ −0.5 dex (Muschielok et al. 1999), which might imply that Hubble VI is exceptional in its metallicity. The masses of the populous clusters are of order of 10^4 to 10^5 $M_\odot$ (Chandar et al. 2000; Wyder et al. 2000a). Hodge (1980) estimates the ages of 16 of the other cluster candidates

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to be mainly between 50 and 150 Myr. Considering that their disruption time scales are likely considerably longer, this indicates an enhancement in the recent cluster formation rate. Hubble VIII is the second oldest cluster known to date in NGC 6822, which may imply a cluster age gap similar to the one in the LMC.

The half-light radii of 2.0, 2.2, and 5.6 pc of Hubble VI, VII, and VIII, respectively, are comparable to the half-light radii of globular clusters in the inner part of the Milky Way in contrast to star clusters in the Magellanic Clouds, whose half-light radii are on average three times larger than in the Milky Way (Wyder et al. 2000a). This appears to contradict the suggestion that cluster radii become larger in low-density environments (van den Bergh 1991) and with increasing Galactocentric distance (van den Bergh, Morbey, & Pazder 1991).

17 OB associations have been identified in NGC 6822 (Hodge 1977; Wilson 1992). This number is likely a lower limit since the ≥ 110 H II regions (Hodge, Kennicutt, & Lee 1988) may contain additional OB associations (O'Dell, Hodge, & Kennicutt 1999). Wilson (1992) finds a median diameter of 90 pc for the OB associations, a median age of $8 \cdot 10^6$ years, and a median mass of 500 $M_\odot$.

Hodge (1980) estimates the cluster formation rate to be one cluster per $6 \cdot 10^6$ years, and the OB association formation rate to be $0.7 \cdot 10^6$ years. The latter is comparable to the LMC, but the former is only ~ 0.005 of the LMC cluster formation rate, two orders of magnitude below what one would expect if the cluster formation rate scales primarily with parent galaxy luminosity.

3.2. WLM or DDO 221

WLM is a barred dIrr (type Ir IV-V) at a distance of 950 kpc from the Sun ($\sim$ 840 kpc from M31). WLM formed half of its stars in the period from 12 to 9 Gyr after an initially more quiescent period (Dolphin 2000). Its present-day star-formation rate is 0.0011 $M_\odot$ yr^{-1} (Hodge & Miller 1995) and began to increase about 2 Gyr ago (Dolphin 2000). WLM contains one luminous globular cluster (Humason, Mayall, & Sandage 1956; Ables & Ables 1977) at a distance of approximately 550 pc from its center, but no further globular clusters were detected (Minniti & Zijlstra 1997; detection limit I = 19.5 mag), nor are there any intermediate-age clusters known (Hodge et al. 1999). A young populous cluster named C3 was identified in one of the most luminous H II regions in WLM (Hodge & Miller 1995; Hodge et al. 1999).

WLM is the faintest dIrr ($M_V = -14.4$ mag) containing a globular cluster and indeed the only dIrr fainter than -16 mag known to contain a globular (Hodge et al. 1999). This results in a specific frequency of 1.7, while the typical specific frequency in irregulars is 0.5 ± 0.2.[1]

The globular cluster's luminosity ($M_V \sim -8.8$ mag) exceeds that of average Milky Way globular clusters. Resolved HST photometry of its stellar content reveals that this cluster may be as old as Galactic halo globulars and formed prior to the bulk of the old field population (Dolphin 2000). Its metallicity of ~ -1.5 dex resembles that of the WLM field giants. The cluster is elongated,

[1]The specific frequency S_N is the number of globulars, N_{GC}, normalized by parent galaxy luminosity; $S_N = N_{GC} \cdot 10^{0.4(M_V+15)}$ (Harris & van den Bergh 1981).

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has a core radius of 4.6 ± 0.6 pc similar to massive Milky Way globulars, and a large but uncertain tidal radius (130 ± 60 pc; Hodge et al. 1999).

4. Local Group Dwarf Irregulars Without Known Globular Clusters

4.1. IC 10

IC 10 is a starbursting dIrr (type Ir IV), whose distance from the Milky Way is uncertain (~ 0.5 to ~ 1 Mpc). Adopting the distance of 660 kpc of Sakai, Madore, & Freedman (1999) results in $M_V = -16.3$ mag for WLM. IC 10 is embedded in an irregular H I envelope that is seven times more extended than its optical body. The outer H I halo is counterrotating with respect to the central H I concentration. An infalling H I cloud may provide the trigger for the currently ongoing starburst (Wilcots & Miller 1998) and unusually high Wolf-Rayet star fraction (Massey & Armandroff 1995). The current star formation rate of IC 10 is ~ 0.7 $M_\odot$ yr^{-1} (Mateo 1998), the highest of all Local Group galaxies.

In this unusual dIrr no globular clusters have been detected. But recent HST imaging covering roughly one third of the actively star-forming regions of IC 10 led to the discovery of 13 OB associations and clusters (Hunter 2001). Most of these objects have ages ranging from 3 to 300 Myr and masses of a few thousand $M_\odot$. Two clusters may be older (350 Myr to 1 Gyr). Typical half-light radii range from 1.5 to 6.6 pc. Only two clusters may qualify as low-mass populous clusters. The "primary mode of star formation" in IC 10 appears to be the formation of OB associations (Hunter 2001).

4.2. IC 1613

IC 1613 is a dIrr galaxy of type Ir V with $M_V = -15.3$ mag, ~ 500 kpc from M31. Its star formation rate has been 0.00035 $M_\odot$ yr^{-1} over the past ~ 350 Myr. 400 to 900 Myr ago is was 50% higher (Cole et al. 1999). No globular clusters or even rich populous clusters were detected in IC 1613. Hodge (1978) found 43 cluster candidates and 20 candidate OB associations on photographic plates. Hodge concluded that ~ 2 OB associations are formed every 10^6 years, two times the rate in the LMC. The OB associations in both galaxies tend to appear in groups ($\sim$ 60% of the total). Georgiev et al. (1999) searched multi-color CCD data, reclassified the OB association boundaries, and added seven new ones. Using color-magnitude diagrams, they found ages ranging from 5 to 20 Myr for nine associations. Using HST images covering 16% of the area of IC 1613, Wyder, Hodge, & Cole (2000b) showed that out of 23 cluster candidates present in their images, only five are possible sparse open clusters while the remainder are either asterisms or background galaxies. They conclude that the comparable area in the LMC contains 80 times more clusters.

4.3. DDO 210 or Aquarius

DDO 210 is a dIrr of type Ir V in the outskirts of the Local Group (distance 950 kpc). This metal-poor (~ -1.9 dex), faint ($M_V = -10.9$ mag) galaxy experienced a low star formation rate of 0.3 to $0.44 \cdot 10^{-4}$ $M_\odot$ yr^{-1} in its outer and inner regions, respectively, and a recent increase to $1.1 \cdot 10^{-4}$ $M_\odot$ yr^{-1} in its center, while the star formation rate dropped in its stellar halo (Lee et al. 1999).

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The central region of DDO 210 contains recent star formation and possibly OB associations, though the latter are not discussed in the literature. Greggio et al. (1993) suggested the presence of a globular cluster, but this does not seem to be confirmed in recent work (Lee et al. 1999; Gallagher, priv. comm.).

4.4. Phoenix

The dIrr/dSph transition-type galaxy Phoenix is at a distance of $\sim$ 400 kpc from the Milky Way. This low-luminosity ($M_V = -9.8$ mag) galaxy has a low star formation rate ($\leq 10^4$ $M_\odot$ yr^{-1}) and seems to be in the process of losing its H I through ram-pressure stripping (St-Germain et al. 1999; Gallart et al. 2001). It contains a central association of blue stars (Canterna & Flower 1977), which extends perpendicularly to the major axis of Phoenix. The age of this association is $\sim$ 100 Myr. Older associations are present as well (Martínez-Delgado, Gallart, & Aparicio 1999). Martínez-Delgado et al. identify two out of the three globular cluster candidates of Canterna & Flower (1977) as background galaxies. They find three additional cluster candidates, all of which are very red and have magnitudes fainter than average Galactic globulars. Deeper HST imaging, already scheduled, will reveal the nature of these objects.

4.5. Pegasus Dwarf Irregular (PegDIG) or DDO 216

PegDIG, a dIrr of type Ir V with $M_V = -12.3$ mag is a possible dIrr/dSph transition galaxy at a distance of $\sim$ 410 kpc from M31. It is currently forming stars at a low rate ($3 \cdot 10^{-4}$ $M_\odot$), but had higher star formation rates in the past (Gallagher et al. 1998). Ivanov (1996) identified three OB associations in the central regions of PegDIG, which have mean diameters of 50 pc. Hoessel & Mould (1982) found three star cluster candidates, whose red colors indicate that they are likely intermediate-age or old objects. One of these clusters is resolved in the HST images of Gallagher et al. (1998) and is of intermediate age with a prominent red clump ($>$ 2 Gyr). Its diameter is $\sim$ 40 pc, and its stellar density is low. The red colors of the other two may imply that they are background galaxies (Gallagher et al. 1998) or young embedded regions (Sandage 1986).

4.6. Leo A or DDO 69

Leo A, another dIrr of type V and $M_V = -11.5$ mag, has a distance of $\sim$ 690 kpc from the Milky Way and is dominated by intermediate-age and young populations (Tolstoy et al. 1998). Its present-day star formation rate is $\sim 3 \cdot 10^{-5}$ $M_\odot$ yr^{-1} (van den Bergh 2000). No star clusters have been identified. Demers et al. (1984) describe two possible OB associations in the central regions of this galaxy, one of which has a distance-corrected diameter of $\sim$ 100 pc.

4.7. LGS 3 or Pisces

The dIrr/dSph transition type galaxy LGS 3 ($M_V = -10.5$ mag) has a distance of $\sim$ 280 kpc from both M31 and M33 (Miller et al. 2001). Its time-averaged star formation rate is $5 \cdot 10^{-5}$ $M_\odot$ yr^{-1}. While neither globular clusters nor rich star clusters were found in this object, Miller et al. (2001) found 13 young, sparse clusters and associations with typical diameters of 2 to 5 pc in the central region of this dIrr. Their HST images cover approximately half of the regions with recent star formation. The age of one of the sparse clusters is $\sim$ 800 Myr.

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4.8. Sagittarius Dwarf Irregular (SagDIG)

SagDIG, a distant (~ 1.1 Mpc) and metal-poor (~ −2.2 dex) dIrr (Momaney et al. 2002) of type Ir V contains a number of associations in its star-forming central regions, but no clusters. The youngest identified association has an age of ~ 20 Myr and a size of 180 pc (Momaney et al. 2002). Slightly older stellar populations in the central regions also show a clumpy distribution (Lee & Kim 2000; Momaney et al. 2002). The star formation rate of this low-luminosity galaxy ($M_V = -11.7$ mag) is low ($\sim 7 \cdot 10^{-5}$ $M_\odot$ yr^{-1}; van den Bergh 2000).

Table 1. Star Clusters in the Local Group

Galaxy	Type	D_{Sp} [kpc]	M_V [mag]	N_{GC}	S_N	[Fe/H] [dex]	N_{OC}
M31	Sb I-II	0	−21.2	~600	2:	−2.5, 0.4	many
Galaxy	S(B)bc I-II	0	−20.9	~160	0.7	−2.5, 0.4	>1000
M33	Sc II-III	220	−18.9	$\gtrsim$54	1.5:	−3.0, −0.8	> 600
LMC	Ir III-IV	50	−18.5	~13	0.5	−2.3, −1.2	$\gtrsim$4000
SMC	Ir IV/IV-V	63	−17.1	1	0.1	−1.4	$\gtrsim$2000
NGC 6822	Ir IV-V	500	−16.0	1	0.4	−2.0	~20
WLM	Ir IV-V	840	−14.4	1	1.7	−1.5	≥1
IC 10	Ir IV:	250:	−16.3	0	0	—	$\gtrsim$13
IC 1613	Ir V	500	−15.3	0	0	—	$\gtrsim$5
Phe	dIrr/dSph	405	−12.3	[4:]	[48:]	—	?
PegDIG	Ir V	410	−11.5	0	0	—	$\lesssim$3
LGS 3	dIrr/dSph	280	−10.5	0	0	—	$\lesssim$13
NGC 205	Sph	60	−16.4	$\gtrsim$8	$\gtrsim$2.2	−1.9, −1.3	≥2
NGC 185	Sph	170	−15.6	$\gtrsim$6	$\gtrsim$3.4	−2.5, −1.2	some
NGC 147	Sph	100	−15.1	≥4	$\gtrsim$3.6	−2.5, −1.9	?
Sgr	dSph(t)	28	−15.0:	≥4	≥4:	−2.0, −0.4	0
For	dSph	138	−13.1	5	22.8	−2.2, −1.8	0

Notes: Only galaxies in which star clusters have been detected are listed. Galaxy types (Col. 2) and M_V (Col. 4) were taken from Courteau & van den Bergh (1999). D_{Sp} denotes the distance to the nearest spiral galaxy (M31 or Milky Way, Col. 3). N_{GC} and N_{OC} (Cols. 5 & 8) denote the number of globular clusters and open clusters, respectively. Note that the globular cluster suspects in Phoenix are highly uncertain. S_N (Col. 6) is the specific globular cluster frequency. When two values are listed in Col. 7 (metallicity), these indicate the most metal-rich and most metal-poor globular clusters. For references, see text and Grebel (1999).

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5. Final thoughts

Star formation in the irregular galaxies in the Local Group tends to occur in short-lived associations, clustered in space and in time. These regions tend to be found near the centers of the irregulars, where sufficiently high gas densities can be more easily sustained.

Massive star clusters are rare in Local Group irregulars. With the exception of WLM, the cut-off parent galaxy luminosity for the formation of globular clusters is at $M_V < -16$ mag. Yet, as already noted by Hodge, cluster formation does not *scale* with parent galaxy luminosity. Instead, it appears to be favored in interacting galaxies (such as the Magellanic Clouds) and/or galaxies with pronounced bars. A starburst in a low-mass galaxy does not necessarily lead to the formation of populous clusters (see IC 10), although the more massive irregulars that possess star clusters also show higher star formation rates than the comparatively quiescent low-mass dIrrs.

Rather than an LMC-like age gap (which appears to exist in NGC 6822), we generally find a pronounced deficiency of massive young and intermediate-age clusters. Considering the low tidal field strengths and absence of shear, the lack of massive clusters at younger ages cannot be explained by destruction-induced selection effects. Instead, it seems to indicate significantly different formation conditions in the early Universe, directly related to one of the key questions driving this Symposium: Under which conditions can globular clusters form? The case of WLM, in which the globular cluster may be older than the bulk of the old field population, is particularly interesting in this respect.

Desiderata for future observational work include spatially complete, high-resolution surveys of irregular galaxies to complete the census of clusters and associations and their properties.

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Discussion

Y. Fukui: Is there any correlation between H I (or CO) and star formation activity in these dwarf galaxies?

E. Grebel: Yes. Recent star formation activity and the location of H II regions both show a good spatial correlation with H I concentrations (and, to the extent measured, with CO clouds). This is shown in greater detail in studies, e.g., by Hodge, by Wilson, and by Young and their collaborators. It is also seen that older stellar populations show little evidence for such correlations, in good agreement with the results of your CO surveys in the Magellanic Clouds.

D. Minniti: It is interesting that there are extended H I halos around IC 10 and NGC 6822. Are there surveys around high-velocity clouds (HVCs) or compact HVCs to search for new dIrr galaxies?

E. Grebel: We have surveyed a number of compact HVCs for an associated stellar component. While we detected star-like objects whose colors and magnitudes are consistent with being red giants at the assumed distance, these objects do not show a spatial concentrations at the location of the compact HVCs. Instead, their large-scale distribution and number density appears to be consistent with their being unresolved background galaxies at $z > 0.2$.

C. Gallart: About the list of galaxies without clusters you gave, have actually targeted searches for clusters been made? With Mario Pedreros I present a poster on the dIrr galaxies Sextans A and B. In Sex A we have a very likely cluster candidate, which starts to be resolved in red (older than 1 Gyr) stars.

J. Gallagher: Using sub-arcsec WIYN data and superb VLT images we also have searched for cluster candidates in Local Group dIrrs. We do not see an obvious globular cluster candidate in DDO 210, and few candidates are seen in other cases. Even so, clusters can be hard to study and to find. E.g., the central cluster in the PegDIG, which is difficult even with HST. Also, confusion of stars on top of background galaxies always presents difficulties.

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Miss Star Cluster (Eva Grebel) admires one of the 95 posters.

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