STATISTICAL STUDY OF SOME GROUPS OF GALAXIES

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Abstract

In this paper, we apply a clustering technique on de Carvalho et al. catalog of compact groups of galaxies (2005) to test the physical reality of each group. The method is applied on the groups that contain five members only to classify the relation between each two galaxies in the same group and if they belong to the group or not.

The results showed that most of the members are real members in groups while some groups (36 groups) contain one or more attribute discordant galaxies and 20 groups contain 2 sub-groups.

Introduction:

The majority of the galaxies in the universe tend to aggregate in groups (Tully 1987). Groups of galaxies range from loose groups to compact groups. The loose groups of galaxies contain less number of galaxies than clusters. The compact groups of galaxies are so dense with separation distances of a galaxy’s diameter. The first observed compact groups were Stephan’s Quintet (1877) and Seyfert’s Sextet (1948).

Searching for compact groups has been started by Shakbazyan in 1973, after she has found a group of 17 faint red objects which were thought to be a cluster of stars (Shakbazyan 1957). The first systematic search for compact groups of galaxies was held by Rose (1977) by setting criteria that the number of galaxies is 3 or more with a total surface equals or brighter than 17.5 mag arcsec−2. He has found a total number of 205 compact groups of galaxies. The second systematic search was held by Hickson (1982) after adopting different criteria that the number of galaxies is 3 or more with 3 mag difference from the brightest member, the total surface brightness is equal to or brighter than 26.0 mag arcsec−2 and the isolation criterion by setting a large circle that is 3 times a small circle passing through the centers of the galaxies in the group to isolate the members of the same group from the field. He has found 100 compact groups of galaxies (HCGs). Studies on HCGs showed that 8 groups have galaxies with a discordant redshift (Hickson et al. 1992).

Other searching techniques were introduced using different criteria (Prandoni et al. 1992, Garcia et al. 1995, Barton et al. 1996, Iovino et al. 1999, Allam & Tucker 2000, Lee et al. 2000, Focardi & Kelm 2002, de Carvalho et al. 2005, Deng et al. 2007, McConnachie et al. 2009 and Diaz-Gimenez et al. 2012).

The paper is organized as follows: section 2 describes the data used and method while section 3 describes the results obtained and discussion.
Data and Method:-

The Data:-
In 2005, de Carvalho et al. searched the Digitalized Palomar Observatory sky survey (DPOSS) for compact groups of galaxies, within an area of 6260 deg. sq. including the northern and a part of the southern sky. They adopted the following criteria:
1. \( N \geq 4 \) with magnitude difference \( \leq 2 \)
2. \( R_{\text{isol}} \geq 3R_{\text{gr}} \)
3. \( \mu_{\text{gr}} < 24.0 \text{ mag arcsec}^{-2} \)
4. \( |b| > 40^\circ \) to avoid stars contamination

Where \( N \) is the number of galaxies in a group, \( R_{\text{gr}} \) is the angular diameter of the smallest circle, \( R_{\text{isol}} \) is the angular diameter of the greatest circle, \( \mu_{\text{gr}} \) is the mean surface brightness in the \( r \) band and \( b \) is the galactic latitude.

They found a total of 459 groups of galaxies with 4 or more members.

The Method:-
We applied the clustering technique which we choose because of its simplicity and direct calculations on the groups that contain 5 members from de Carvalho et al catalog (2005). Before we start, we assume that galaxies in the same group are not connected and we try to find if their physical attributes will show any similarity.

Galaxies in the same group are supposed to have similar properties that connect them together. The method uses the physical attributes of the galaxies in each group to test the relation between all galaxies in the same group and knowing if galaxies are real member or should be discarded from the group. By calculating the astrophysical Euclidean separation coefficient between each two galaxies, one can find the similarities and dissimilarities between the galaxies.

We use a Hierarchical clustering method which is UPGMA (Unweighted Pair Group Method using Arithmetic Average) method, Romesburg (1984). The UPGMA method is an Agglomerative clustering that starts with galaxies as being individual clusters and merges galaxies with similar attributes by averaging similarities of each two galaxies and forms a tree-like structure in a bottom-up way which can be cut off at any level.

The method starts with a data matrix which contains the galaxies in one column and their attributes that we think show similarities if the galaxies are from the same group in one row. The second step is to build the resemblance matrix by using a clustering method and calculating the resemblance coefficient to find if there is a similarity or dissimilarity between different galaxies’ attributes.

We then calculate the resemblance coefficient to obtain the value of dissimilarities between each two galaxies. The larger value of the Euclidean coefficient, the more dissimilar are the galaxies that means that they don’t belong to the same group, and the smaller the value, the more similar and connected are the galaxies which concludes that they lie in the same group.

The astrophysical Euclidean coefficient for \( n \) attributes is calculated as:

\[
e_{jk} = \sqrt{n} \sum_{i=1}^{n} \left( X_{ij} - X_{ik} \right)^2
\]

Where \( j \) and \( k \) are two galaxies and \( i \) is the attribute.

Calculating the average Euclidean coefficient as:

\[
e_{av} = \frac{\sum e_i}{N}
\]
With the following criteria used by Sabry et al. (2009) and Sabry et al. (2012), one can define the separation between each two galaxies:

1. If $e_{jk} < e_{av} - \sigma$
   The galaxies are regarded as a Twin (T)

2. If $e_{jk} < e_{av}$
   The galaxies are regarded as a Pair (P)

3. If $e_{av} \leq e_{jk} \leq e_{av} + \sigma$
   The galaxies are regarded as a Member (M)

4. If $e_{jk} > e_{av} + \sigma$
   The galaxies have a discordant attribute and are regarded as an Attribute Discordant (AD)

We calculated the astrophysical Euclidean coefficient of each two members in the same group using the total magnitude of the group in the r band and the g-r color index.

Results:

The following tables show the results as follows:
Column (1): the galaxy symbol (G), column (2): the total magnitude of the first galaxy in the r band, column (3): the total magnitude of the second galaxy in the r band, column (4): the g-r color index of the first galaxy, column (5): the g-r color index of the second galaxy, column (6): the Astrophysical Euclidean coefficient between every 2 galaxies in the group, column (7): the average astrophysical Euclidean coefficient in each group, column (8): the standard deviation in each group, column (9): the classification of every two galaxies regarding each other and column (10): the comments.

| Group 085756+383340 | Galaxies | $(r)_i$ | $(r)_j$ | $(g-r)_i$ | $(g-r)_j$ | $e_{ij}$ | $e_{av}$ | $\sigma$ | Comments |
|---------------------|----------|---------|---------|----------|----------|--------|--------|--------|----------|
| $G_{12}$            | 16.601   | 16.791  | 0.016   | 0.558    | 0.574338 | 0.713594 | 0.319102 | P       | $G_{12}$ make a pair. |
| $G_{13}$            | 16.601   | 17.223  | 0.016   | 0.303    | 0.68502  |         |         | P       | $G_{13}$ make a pair. |
| $G_{14}$            | 16.601   | 17.377  | 0.016   | 0.195    | 0.796377 |         |         | M       | $G_{14}$ make a pair. |
| $G_{15}$            | 16.601   | 17.898  | 0.016   | 0.381    | 1.34738  |         |         | AD      | $G_{15}$ make a pair. |
| $G_{23}$            | 16.791   | 17.223  | 0.558   | 0.303    | 0.501646 |         |         | P       | $G_{23}$ make a twin. |
| $G_{24}$            | 16.791   | 17.377  | 0.558   | 0.195    | 0.689322 |         |         | P       | $G_{24}$ make a pair. |
| $G_{25}$            | 16.791   | 17.898  | 0.558   | 0.381    | 1.121061 |         |         | AD      | $G_{25}$ make a pair. |
| $G_{34}$            | 17.223   | 17.377  | 0.303   | 0.195    | 0.188096 |         |         | T       | $G_{34}$ make a twin. |
| $G_{35}$            | 17.223   | 17.898  | 0.303   | 0.381    | 0.679492 |         |         | P       | $G_{35}$ make a pair. |
| $G_{45}$            | 17.377   | 17.898  | 0.195   | 0.381    | 0.553206 |         |         | P       | $G_{45}$ make a pair. |

| Group 091524+213038 | Galaxies | $(r)_i$ | $(r)_j$ | $(g-r)_i$ | $(g-r)_j$ | $e_{ij}$ | $e_{av}$ | $\sigma$ | Comments |
|---------------------|----------|---------|---------|----------|----------|--------|--------|--------|----------|
| $G_{12}$            | 16.941   | 17.717  | 0.622   | 0.313    | 0.835259 | 0.519267 | 0.348545 | M       | $G_{12}$ make a pair. |
| $G_{13}$            | 16.941   | 17.751  | 0.622   | 0.539    | 0.814241 |         |         | M       | $G_{13}$ make a pair. |
| $G_{14}$            | 16.941   | 17.806  | 0.622   | 0.529    | 0.869985 |         |         | AD      | $G_{14}$ make a pair. |
| $G_{15}$            | 16.941   | 17.952  | 0.622   | 0.183    | 1.102199 |         |         | AD      | $G_{15}$ make a twin. |
| $G_{23}$            | 17.717   | 17.751  | 0.313   | 0.539    | 0.228543 |         |         | P       | $G_{23}$ make a pair. |
| $G_{24}$            | 17.717   | 17.806  | 0.313   | 0.529    | 0.233617 |         |         | P       | $G_{24}$ make a pair. |
| $G_{25}$            | 17.717   | 17.952  | 0.313   | 0.183    | 0.268561 |         |         | P       | $G_{25}$ make a pair. |
| $G_{34}$            | 17.751   | 17.806  | 0.539   | 0.529    | 0.055902 |         |         | T       | $G_{34}$ may have a discordant attribute. |
| $G_{35}$            | 17.751   | 17.952  | 0.539   | 0.183    | 0.408824 |         |         | P       | $G_{35}$ make a pair. |
| $G_{45}$            | 17.806   | 17.952  | 0.529   | 0.183    | 0.375542 |         |         | P       | $G_{45}$ make a pair. |
### Group 092831+634736

| Galaxies | (r)_i | (r)_j | (g-r)_i | (g-r)_j | e_i | e_av | σ | Comments |
|----------|-------|-------|---------|---------|-----|-------|---|----------|
| G12      | 16.639| 16.85 | 0.464   | 0.605   | 0.253775 | 0.504881 | 0.251499 | P | G12 make a pair. |
| G13      | 16.639| 16.979| 0.464   | 0.642   | 0.383776 |         |      | P | G13 make a pair. |
| G14      | 16.639| 17.278| 0.464   | 0.437   | 0.63957   |         |      | M | G23 make a twin. |
| G15      | 16.639| 17.616| 0.464   | 0.375   | 0.981045 |         |      | AD | G24 make a pair. |
| G23      | 16.85 | 16.979| 0.605   | 0.642   | 0.134201 |         |      | T | G34 make a pair. |
| G24      | 16.85 | 17.278| 0.605   | 0.437   | 0.459791 |         |      | P | G45 make a pair. |
| G25      | 16.85 | 17.616| 0.605   | 0.375   | 0.799785 |         |      | AD |               |
| G34      | 16.979| 17.278| 0.642   | 0.437   | 0.362527 |         |      | P |               |
| G35      | 16.979| 17.616| 0.642   | 0.375   | 0.690694 |         |      | AD |               |
| G45      | 17.278| 17.616| 0.437   | 0.375   | 0.343639 |         |      | P |               |

### Group 094316+392308

| Galaxies | (r)_i | (r)_j | (g-r)_i | (g-r)_j | e_i | e_av | σ | Comments |
|----------|-------|-------|---------|---------|-----|-------|---|----------|
| G12      | 16.98 | 18.002| 0.393   | -0.025  | 1.104178 | 0.747002 | 0.407185 | M | G23 make a pair. |
| G13      | 16.98 | 18.061| 0.393   | 0.543   | 1.091357 |         |      | M | G24 make a pair. |
| G14      | 16.98 | 18.201| 0.393   | 0.408   | 1.221092 |         |      | AD | G25 make a pair. |
| G15      | 16.98 | 18.382| 0.393   | 0.055   | 1.442168 |         |      | AD | G34 make a twin. |
| G23      | 18.002| 18.061| -0.025  | 0.543   | 0.571056 |         |      | T | G35 make a pair. |
| G24      | 18.002| 18.201| -0.025  | 0.408   | 0.47654  |         |      | P | G45 make a pair. |
| G25      | 18.002| 18.382| -0.025  | 0.055   | 0.38833  |         |      | P | G1 may have a discordant attribute. |
| G34      | 18.061| 18.201| 0.543   | 0.408   | 0.194487 |         |      | T |               |
| G35      | 18.061| 18.382| 0.543   | 0.055   | 0.58411  |         |      | P |               |
| G45      | 18.201| 18.382| 0.408   | 0.055   | 0.396699 |         |      | P |               |

### Group 101328-005522

| Galaxies | (r)_i | (r)_j | (g-r)_i | (g-r)_j | e_i | e_av | σ | Comments |
|----------|-------|-------|---------|---------|-----|-------|---|----------|
| G12      | 16.78 | 18.002| 0.062   | 0.507   | 1.300503 | 0.916366 | 0.508782 | M | G23 make a twin. |
| G13      | 16.78 | 18.148| 0.062   | 0.324   | 1.392863 |         |      | M | G24 make a twin. |
| G14      | 16.78 | 18.187| 0.062   | 0.795   | 1.586486 |         |      | AD | G25 make a pair. |
| G15      | 16.78 | 18.381| 0.062   | -0.139  | 1.613568 |         |      | AD | G34 make a pair. |
| G23      | 18.002| 18.148| 0.507   | 0.324   | 0.234105 |         |      | T | G35 make a pair. |
| G24      | 18.002| 18.187| 0.507   | 0.795   | 0.3423   |         |      | T | G1 may have a discordant attribute. |
| G25      | 18.002| 18.381| 0.507   | -0.139  | 0.748971 |         |      | P |               |
| G34      | 18.148| 18.187| 0.324   | 0.795   | 0.472612 |         |      | P |               |
| G35      | 18.148| 18.381| 0.324   | -0.139  | 0.518322 |         |      | P |               |
| G45      | 18.187| 18.381| 0.795   | -0.139  | 0.953935 |         |      | AD |               |

### Group 111622+420044

| Galaxies | (r)_i | (r)_j | (g-r)_i | (g-r)_j | e_i | e_av | σ | Comments |
|----------|-------|-------|---------|---------|-----|-------|---|----------|
| G12      | 16.061| 17.13 | 0.026   | 0.258   | 1.093885 | 0.818999 | 0.449043 | M | G23 make a twin. |
| G13      | 16.061| 17.251| 0.026   | -0.193  | 1.209984 |         |      | M | G24 make a twin. |
| G14      | 16.061| 17.394| 0.026   | 0.295   | 1.359871 |         |      | AD | G25 make a pair. |
| G15      | 16.061| 17.738| 0.026   | 0.055   | 1.677251 |         |      | AD | G34 make a pair. |
| G23      | 17.13 | 17.251| 0.258   | -0.193  | 0.46695  |         |      | P | G35 make a pair. |
| G24      | 17.13 | 17.394| 0.258   | 0.295   | 0.26658  |         |      | T | G45 make a pair. |
| G25      | 17.13 | 17.738| 0.258   | 0.055   | 0.640994 |         |      | P | G1 may have a discordant attribute. |
| G34      | 17.251| 17.394| -0.193  | 0.295   | 0.50852  |         |      | P |               |
| G35      | 17.251| 17.738| -0.193  | 0.055   | 0.54651  |         |      | P |               |
| G45      | 17.394| 17.738| 0.295   | 0.055   | 0.419447 |         |      | P |               |
| Galaxies | $(r_1)$ | $(r_2)$ | $(g-r)_1$ | $(g-r)_2$ | $e_1$ | $e_2$ | $\sigma$ | Comments |
|----------|---------|---------|-----------|-----------|-------|-------|--------|----------|
| $G_{12}$ | 16.069 | 16.728 | 0.085 | 0.075 | 0.659076 | 0.914629 | 0.494901 | $G_{12}$ make a pair. |
| $G_{13}$ | 16.069 | 17.218 | 0.085 | 0.342 | 1.177391 | $M$ |
| $G_{14}$ | 16.069 | 17.375 | 0.085 | 0.308 | 1.324902 | $M$ |
| $G_{15}$ | 16.069 | 17.984 | 0.085 | 0.297 | 1.926699 | $AD$ |
| $G_{23}$ | 16.728 | 17.218 | 0.075 | 0.342 | 0.558022 | $P$ |
| $G_{24}$ | 16.728 | 17.375 | 0.075 | 0.308 | 0.687676 | $P$ |
| $G_{25}$ | 16.728 | 17.984 | 0.075 | 0.297 | 1.275469 | $AD$ |
| $G_{34}$ | 17.218 | 17.375 | 0.342 | 0.308 | 0.160639 | $T$ |
| $G_{35}$ | 17.218 | 17.984 | 0.342 | 0.297 | 0.767321 | $P$ |
| $G_{45}$ | 17.375 | 17.984 | 0.308 | 0.297 | 0.609099 | $P$ |

| Galaxies | $(r_1)$ | $(r_2)$ | $(g-r)_1$ | $(g-r)_2$ | $e_1$ | $e_2$ | $\sigma$ | Comments |
|----------|---------|---------|-----------|-----------|-------|-------|--------|----------|
| $G_{12}$ | 16.85  | 16.865 | -0.003 | 0.227 | 0.230489 | 0.996795 | 0.572029 | $T$ |
| $G_{13}$ | 16.85  | 18.016 | -0.003 | 0.272 | 1.19799 | $M$ |
| $G_{14}$ | 16.85  | 18.087 | -0.003 | 0.279 | 1.268737 | $M$ |
| $G_{15}$ | 16.85  | 18.656 | -0.003 | 0.237 | 1.821877 | $AD$ |
| $G_{23}$ | 16.865 | 18.016 | 0.227 | 0.272 | 1.151879 | $M$ |
| $G_{24}$ | 16.865 | 18.087 | 0.227 | 0.279 | 1.223106 | $M$ |
| $G_{25}$ | 16.865 | 18.656 | 0.227 | 0.237 | 1.791028 | $AD$ |
| $G_{34}$ | 18.016 | 18.087 | 0.272 | 0.279 | 0.071344 | $T$ |
| $G_{35}$ | 18.016 | 18.656 | 0.272 | 0.237 | 0.640956 | $P$ |
| $G_{45}$ | 18.087 | 18.656 | 0.279 | 0.237 | 0.570548 | $P$ |

| Group 1151204+273803 | $T$ |
|------------------------|-----------------|
| $G_{12}$ | 16.214 | 16.585 | 0.015 | 0.211 | 0.419591 | 0.932219 | 0.490704 | $T$ |
| $G_{13}$ | 16.214 | 17.144 | 0.015 | 0.313 | 0.976578 | $M$ |
| $G_{14}$ | 16.214 | 17.372 | 0.015 | 0.397 | 1.21938 | $M$ |
| $G_{15}$ | 16.214 | 18.08 | 0.015 | 0.113 | 1.868572 | $AD$ |
| $G_{23}$ | 16.585 | 17.144 | 0.211 | 0.313 | 0.56823 | $P$ |
| $G_{24}$ | 16.585 | 17.372 | 0.211 | 0.397 | 0.808681 | $P$ |
| $G_{25}$ | 16.585 | 18.08 | 0.211 | 0.113 | 1.498209 | $AD$ |
| $G_{34}$ | 17.144 | 17.372 | 0.313 | 0.397 | 0.242981 | $T$ |
| $G_{35}$ | 17.144 | 18.08 | 0.313 | 0.113 | 0.957129 | $AD$ |
| $G_{45}$ | 17.372 | 18.08 | 0.397 | 0.113 | 0.762837 | $P$ |

| Group 1155174+232335 | $T$ |
|------------------------|-----------------|
| $G_{12}$ | 16.992 | 17.157 | 0.364 | 0.426 | 0.176264 | 0.493549 | 0.259143 | $T$ |
| $G_{13}$ | 16.992 | 17.363 | 0.364 | 0.477 | 0.387827 | $P$ |
| $G_{14}$ | 16.992 | 17.58 | 0.364 | 0.301 | 0.591365 | $M$ |
| $G_{15}$ | 16.992 | 17.979 | 0.364 | 0.334 | 0.987456 | $AD$ |
| $G_{23}$ | 17.157 | 17.363 | 0.426 | 0.477 | 0.212219 | $T$ |
| $G_{24}$ | 17.157 | 17.58 | 0.426 | 0.301 | 0.441083 | $P$ |
| $G_{25}$ | 17.157 | 17.979 | 0.426 | 0.334 | 0.827132 | $AD$ |
| $G_{34}$ | 17.363 | 17.58 | 0.477 | 0.301 | 0.279401 | $P$ |
| $G_{35}$ | 17.363 | 17.979 | 0.477 | 0.334 | 0.63238 | $AD$ |
| $G_{45}$ | 17.58 | 17.979 | 0.301 | 0.334 | 0.400362 | $P$ |
| Galaxies       | (r)  | (g-r)  | e         | e<sub>av</sub> | σ     | Comments               |
|---------------|------|--------|-----------|----------------|-------|------------------------|
| G<sub>12</sub>| 16.191| 16.341 | 0.417     | 0.143          | 0.312372| 0.716237| 0.364682| T | G<sub>12</sub> make a twin. |
| G<sub>13</sub>| 16.191| 17.162 | 0.417     | 0.254          | 0.984586| M         |            |   |                    |
| G<sub>14</sub>| 16.191| 17.326 | 0.417     | 0.311          | 1.139939| AD        |            |   |                    |
| G<sub>15</sub>| 16.191| 17.407 | 0.417     | 0.311          | 0.999224| M         |            |   |                    |
| G<sub>23</sub>| 16.341| 17.162 | 0.143     | 0.254          | 0.82847 | M         |            |   |                    |
| G<sub>24</sub>| 16.341| 17.326 | 0.143     | 0.311          | 0.999224| M         |            |   |                    |
| G<sub>25</sub>| 16.341| 17.407 | 0.143     | 0.404          | 1.097487| AD        |            |   |                    |
| G<sub>34</sub>| 17.162| 17.326 | 0.254     | 0.311          | 0.173623| T         |            |   |                    |
| G<sub>35</sub>| 17.162| 17.407 | 0.254     | 0.404          | 0.287272| P         |            |   |                    |
| G<sub>45</sub>| 17.326| 17.407 | 0.311     | 0.404          | 0.123329| P         |            |   |                    |

| Galaxies       | (r)  | (g-r)  | e         | e<sub>av</sub> | σ     | Comments               |
|---------------|------|--------|-----------|----------------|-------|------------------------|
| G<sub>12</sub>| 16.656| 17.437 | 0.392     | 0.674          | 0.830532| 0.833751| 0.450966| P | G<sub>12</sub> make a twin. |
| G<sub>13</sub>| 16.656| 17.744 | 0.392     | 0.786          | 1.157143| M         |            |   |                    |
| G<sub>14</sub>| 16.656| 18.147 | 0.392     | 0.824          | 1.552322| AD        |            |   |                    |
| G<sub>15</sub>| 16.656| 18.317 | 0.392     | 0.764          | 1.702147| AD        |            |   |                    |
| G<sub>23</sub>| 17.437| 17.744 | 0.674     | 0.786          | 0.326792| T         |            |   |                    |
| G<sub>24</sub>| 17.437| 18.147 | 0.674     | 0.824          | 0.725672| P         |            |   |                    |
| G<sub>25</sub>| 17.437| 18.317 | 0.674     | 0.764          | 0.88459 | AD        |            |   |                    |
| G<sub>34</sub>| 17.744| 18.147 | 0.786     | 0.824          | 0.404788| P         |            |   |                    |
| G<sub>35</sub>| 17.744| 18.317 | 0.786     | 0.764          | 0.573422| P         |            |   |                    |
| G<sub>45</sub>| 18.147| 18.317 | 0.824     | 0.764          | 0.180278| P         |            |   |                    |
| Group 123439+234951 | Galaxies | \(r_i\) | \(r_j\) | \(g-r_i\) | \(g-r_j\) | \(e_{ij}\) | \(e_{av}\) | \(\sigma\) | Comments |
|---------------------|----------|--------|--------|---------|---------|---------|---------|---------|----------|
| G_{12}              | 16.686   | 17.073 | 0.508  | 0.08    | 0.577021| 0.921547| 0.379633| P       | G_{12} make a pair. G_{23} make a pair. G_{34} make a twin. G_{35} make a pair. G_{45} make a pair. |
| G_{13}              | 16.686   | 17.835 | 0.508  | 0.297   | 1.168213|         |         | M       |          |
| G_{14}              | 16.686   | 18.038 | 0.508  | -0.025  | 1.45327 |         |         | AD      |          |
| G_{15}              | 16.686   | 18.249 | 0.508  | 0.52    | 1.560346|         |         | AD      |          |
| G_{23}              | 17.073   | 17.835 | 0.08   | 0.297   | 0.792296|         |         | P       |          |
| G_{24}              | 17.073   | 18.038 | 0.08   | -0.025  | 0.970696|         |         | M       |          |
| G_{25}              | 17.073   | 18.249 | 0.08   | 0.52    | 1.255618|         |         | AD      |          |
| G_{34}              | 17.835   | 18.038 | 0.297  | -0.025  | 0.380648|         |         | T       |          |
| G_{35}              | 17.835   | 18.249 | 0.297  | 0.52    | 0.470239|         |         | P       |          |
| G_{45}              | 18.038   | 18.249 | -0.025 | 0.52    | 0.584419|         |         | P       |          |

| Group 123813+501704 | Galaxies | \(r_i\) | \(r_j\) | \(g-r_i\) | \(g-r_j\) | \(e_{ij}\) | \(e_{av}\) | \(\sigma\) | Comments |
|---------------------|----------|--------|--------|---------|---------|---------|---------|---------|----------|
| G_{12}              | 16.901   | 16.956 | 0.531  | 0.477   | 0.077078| 0.581906| 0.2772  | T       | G_{12} make a twin. G_{23} make a pair. G_{34} make a twin. G_{35} make a pair. G_{45} make a pair. |
| G_{13}              | 16.901   | 17.51  | 0.531  | 0.382   | 0.626963|         |         | M       |          |
| G_{14}              | 16.901   | 17.658 | 0.531  | 0.222   | 0.817637|         |         | M       |          |
| G_{15}              | 16.901   | 17.819 | 0.531  | 0.699   | 0.933246|         |         | AD      |          |
| G_{23}              | 16.956   | 17.51  | 0.477  | 0.382   | 0.562086|         |         | P       |          |
| G_{24}              | 16.956   | 17.658 | 0.477  | 0.222   | 0.74688 |         |         | M       |          |
| G_{25}              | 16.956   | 17.819 | 0.477  | 0.699   | 0.891097|         |         | AD      |          |
| G_{34}              | 17.51    | 17.658 | 0.382  | 0.222   | 0.217954|         |         | T       |          |
| G_{35}              | 17.51    | 17.819 | 0.382  | 0.699   | 0.442685|         |         | P       |          |
| G_{45}              | 17.658   | 17.819 | 0.222  | 0.699   | 0.503438|         |         | P       |          |

| Group 125835+062246 | Galaxies | \(r_i\) | \(r_j\) | \(g-r_i\) | \(g-r_j\) | \(e_{ij}\) | \(e_{av}\) | \(\sigma\) | Comments |
|---------------------|----------|--------|--------|---------|---------|---------|---------|---------|----------|
| G_{12}              | 16.114   | 16.754 | 0.286  | 0.285   | 0.640001| 1.008713| 0.482853| P       | G_{12} make a pair. G_{13} make a pair. G_{23} make a pair. G_{34} make a twin. G_{35} make a pair. G_{45} make a pair. |
| G_{13}              | 16.114   | 17.067 | 0.286  | 0.29    | 0.953008|         |         | P       |          |
| G_{14}              | 16.114   | 17.933 | 0.286  | 0.435   | 1.825092|         |         | AD      |          |
| G_{15}              | 16.114   | 17.962 | 0.286  | 0.129   | 1.854657|         |         | AD      |          |
| G_{23}              | 16.754   | 17.067 | 0.285  | 0.29    | 0.31304 |         |         | T       |          |
| Group 134932+280017 | Galaxies | (r)$_i$ | (r)$_j$ | (g-r)$_i$ | (g-r)$_j$ | e$_ij$ | e$_av$ | σ | Comments |
|---------------------|----------|---------|---------|-----------|-----------|-------|-------|----|---------|
| G$_{12}$            | 16.102   | 17.365  | 0.312   | 0.296     | 1.263101  | 0.899066 | 0.536588 | M  | G$_{23}$ make a pair. |
| G$_{13}$            | 16.102   | 17.559  | 0.312   | -0.176    | 1.5363552 | 0.481362 | 0.510314 | AD | G$_{14}$ make a pair. |
| G$_{14}$            | 16.102   | 17.839  | 0.312   | 0.271     | 1.737484  | 0.510314 | 0.510314 | AD | G$_{15}$ make a pair. |
| G$_{15}$            | 16.102   | 17.84   | 0.312   | 0.374     | 1.739106  | 0.481362 | 0.510314 | AD | G$_{45}$ make a pair. |
| G$_{23}$            | 17.365   | 17.559  | 0.296   | -0.176    | 0.510314  | 0.481362 | 0.510314 | P  | G$_{1}$ may have a discordant attribute. |
| G$_{24}$            | 17.365   | 17.839  | 0.296   | 0.271     | 0.474659  | 0.481362 | 0.510314 | P  |               |
| G$_{25}$            | 17.365   | 17.84   | 0.296   | 0.374     | 0.481362  | 0.510314 | 0.510314 | P  |               |
| G$_{34}$            | 17.559   | 17.839  | -0.176  | 0.271     | 0.527455  | 0.510314 | 0.510314 | P  |               |
| G$_{35}$            | 17.559   | 17.84   | -0.176  | 0.374     | 0.617625  | 0.510314 | 0.510314 | P  |               |
| G$_{45}$            | 17.839   | 17.84   | 0.271   | 0.374     | 0.103005  | 0.510314 | 0.510314 | P  |               |

| Group 135426+265147 | Galaxies | (r)$_i$ | (r)$_j$ | (g-r)$_i$ | (g-r)$_j$ | e$_ij$ | e$_av$ | σ | Comments |
|---------------------|----------|---------|---------|-----------|-----------|-------|-------|----|---------|
| G$_{12}$            | 16.82    | 17.923  | 0.474   | 0.38      | 1.106998  | 0.929956 | 0.600096 | M  | G$_{23}$ make a pair. |
| G$_{13}$            | 16.82    | 18.473  | 0.474   | 0.288     | 1.663432  | 0.600096 | 0.600096 | AD | G$_{14}$ make a pair. |
| G$_{14}$            | 16.82    | 18.562  | 0.474   | 0.372     | 1.744984  | 0.600096 | 0.600096 | AD | G$_{15}$ make a twin. |
| G$_{15}$            | 16.82    | 18.806  | 0.474   | 0.307     | 1.993009  | 0.600096 | 0.600096 | AD | G$_{34}$ make a pair. |
| G$_{23}$            | 17.923   | 18.473  | 0.38    | 0.288     | 0.557641  | 0.600096 | 0.600096 | P  |               |
| G$_{24}$            | 17.923   | 18.562  | 0.38    | 0.372     | 0.63905   | 0.600096 | 0.600096 | P  |               |
| G$_{25}$            | 17.923   | 18.806  | 0.38    | 0.307     | 0.886012  | 0.600096 | 0.600096 | P  |               |
| G$_{34}$            | 18.473   | 18.562  | 0.288   | 0.372     | 0.122381  | 0.600096 | 0.600096 | T  |               |
| G$_{35}$            | 18.473   | 18.806  | 0.288   | 0.307     | 0.333542  | 0.600096 | 0.600096 | P  |               |
| G$_{45}$            | 18.562   | 18.806  | 0.372   | 0.307     | 0.252509  | 0.600096 | 0.600096 | P  |               |

| Group 142520+471513 | Galaxies | (r)$_i$ | (r)$_j$ | (g-r)$_i$ | (g-r)$_j$ | e$_ij$ | e$_av$ | σ | Comments |
|---------------------|----------|---------|---------|-----------|-----------|-------|-------|----|---------|
| G$_{12}$            | 16.363   | 16.573  | 0.385   | 0.182     | 0.292077  | 1.02258 | 0.503931 | T  | G$_{12}$ make a twin. |
| G$_{13}$            | 16.363   | 17.105  | 0.385   | 0.287     | 0.7484444 | 0.600096 | 0.600096 | P  | G$_{13}$ make a pair. |
| G$_{14}$            | 16.363   | 18.025  | 0.385   | 0.236     | 1.668666  | 0.600096 | 0.600096 | AD | G$_{23}$ make a pair. |
| G$_{15}$            | 16.363   | 18.097  | 0.385   | -0.006    | 1.777537  | 0.600096 | 0.600096 | AD | G$_{34}$ make a pair. |
| G$_{23}$            | 16.573   | 17.105  | 0.182   | 0.287     | 0.542263  | 0.600096 | 0.600096 | P  | G$_{4}$ and G$_{5}$ may have a discordant attribute. |
| G$_{24}$            | 16.573   | 18.025  | 0.182   | 0.236     | 1.453004  | 0.600096 | 0.600096 | M  |               |
| Group 143929+110605 | Galaxies | (r)$_i$ | (r)$_j$ | (g-r)$_i$ | (g-r)$_j$ | $e_j$ | $e_{av}$ | $\sigma$ | Comments |
|---------------------|----------|---------|---------|-----------|-----------|-------|---------|-------|----------|
| G$_{12}$            | 16.078   | 17.074  | 0.314   | 0.414     | 1.001007  | 0.942773 | 0.503739 | M      | G$_{23}$ make a twin. |
| G$_{13}$            | 16.078   | 17.234  | 0.314   | 0.24      | 1.158366  |         |         | M      | G$_{24}$ make a pair. |
| G$_{14}$            | 16.078   | 17.861  | 0.314   | 0.452     | 1.788332  |         |         | AD     | G$_{25}$ make a pair. |
| G$_{15}$            | 16.078   | 17.977  | 0.314   | 0.25      | 1.900078  |         |         | AD     | G$_{34}$ make a pair. |
| G$_{23}$            | 17.074   | 17.234  | 0.414   | 0.24      | 0.236381  |         |         | T      | G$_{35}$ make a pair. |
| G$_{24}$            | 17.074   | 17.861  | 0.414   | 0.452     | 0.787917  |         |         | P      | G$_{45}$ make a pair. |
| G$_{25}$            | 17.074   | 17.977  | 0.414   | 0.25      | 0.917772  |         |         | P      | G$_1$ and G$_2$ may have a discordant attribute. |
| G$_{34}$            | 17.234   | 17.861  | 0.24    | 0.452     | 0.661871  |         |         | P      | G$_3$ and G$_4$ may have a discordant attribute. |
| G$_{35}$            | 17.234   | 17.977  | 0.24    | 0.25      | 0.743067  |         |         | P      | G$_1$ and G$_2$ may have a discordant attribute. |
| G$_{45}$            | 17.861   | 17.977  | 0.452   | 0.25      | 0.232938  |         |         | P      | G$_3$ and G$_4$ may have a discordant attribute. |

| Group 145815+081912 | Galaxies | (r)$_i$ | (r)$_j$ | (g-r)$_i$ | (g-r)$_j$ | $e_j$ | $e_{av}$ | $\sigma$ | Comments |
|---------------------|----------|---------|---------|-----------|-----------|-------|---------|-------|----------|
| G$_{12}$            | 16.731   | 16.942  | 0.316   | 0.402     | 0.227853  | 0.711941 | 0.375964 | T      | G$_{12}$ make a twin. |
| G$_{13}$            | 16.731   | 17.668  | 0.316   | 0.381     | 0.939252  |         |         | M      | G$_{34}$ make a twin. |
| G$_{14}$            | 16.731   | 17.844  | 0.316   | 0.452     | 1.121278  |         |         | AD     | G$_{35}$ make a pair. |
| G$_{15}$            | 16.731   | 18.041  | 0.316   | 0.342     | 1.310258  |         |         | AD     | G$_{45}$ make a pair. |
| G$_{23}$            | 16.942   | 17.668  | 0.402   | 0.381     | 0.726304  |         |         | M      | G$_1$ and G$_2$ may have a discordant attribute. |
| G$_{24}$            | 16.942   | 17.844  | 0.402   | 0.452     | 0.903385  |         |         | M      | G$_3$ and G$_4$ may have a discordant attribute. |
| G$_{25}$            | 16.942   | 18.041  | 0.402   | 0.342     | 1.100637  |         |         | AD     | G$_1$ and G$_2$ may have a discordant attribute. |
| G$_{34}$            | 17.668   | 17.844  | 0.381   | 0.452     | 0.189781  |         |         | T      | G$_3$ and G$_4$ may have a discordant attribute. |
| G$_{35}$            | 17.668   | 18.041  | 0.381   | 0.342     | 0.375033  |         |         | P      | G$_1$ and G$_2$ may have a discordant attribute. |
| G$_{45}$            | 17.844   | 18.041  | 0.452   | 0.342     | 0.22563   |         |         | P      | G$_3$ and G$_4$ may have a discordant attribute. |

| Group 150457+070527 | Galaxies | (r)$_i$ | (r)$_j$ | (g-r)$_i$ | (g-r)$_j$ | $e_j$ | $e_{av}$ | $\sigma$ | Comments |
|---------------------|----------|---------|---------|-----------|-----------|-------|---------|-------|----------|
| G$_{12}$            | 16.645   | 16.919  | 0.344   | 0.131     | 0.347052  | 0.429552 | 0.166155 | P      | G$_{12}$ make a pair. |
| G$_{13}$            | 16.645   | 16.955  | 0.344   | 0.023     | 0.446252  |         |         | M      | G$_{23}$ make a twin. |
| G$_{14}$            | 16.645   | 17.281  | 0.344   | 0.364     | 0.636314  |         |         | AD     | G$_{24}$ make a pair. |
| G$_{15}$            | 16.645   | 17.379  | 0.344   | 0.303     | 0.735144  |         |         | AD     | G$_{45}$ make a pair. |
| G$_{23}$            | 16.919   | 16.955  | 0.131   | 0.023     | 0.113842  |         |         | T      | G$_1$ and G$_2$ may have a discordant attribute. |
| G$_{24}$            | 16.919   | 17.281  | 0.131   | 0.364     | 0.430503  |         |         | M      | G$_3$ and G$_4$ may have a discordant attribute. |
| G$_{25}$            | 16.919   | 17.379  | 0.131   | 0.303     | 0.491105  |         |         | AD     | G$_1$ and G$_2$ may have a discordant attribute. |
| Galaxies | \( (r_i) \) | \( (r_j) \) | \( (g-r_i) \) | \( (g-r_j) \) | \( e_{ij} \) | \( e_{av} \) | \( \sigma \) | Comments |
|----------|-------------|-------------|-------------|-------------|-------------|-------------|----------|----------|
| G_{12}   | 16.904      | 17.018      | 0.648       | 0.263       | 0.401523    | 0.743011    | 0.430969 | P \ G_{12} make a pair. |
| G_{13}   | 16.904      | 17.246      | 0.648       | 0.534       | 0.3605      |             |          | P \ G_{13} make a pair. |
| G_{14}   | 16.904      | 17.485      | 0.648       | 0.613       | 0.582053    |             |          | P \ G_{12} make a pair. |
| G_{15}   | 16.904      | 18.376      | 0.648       | 0.606       | 1.472599    |             |          | AD \ G_{15} make a pair. |
| G_{23}   | 17.018      | 17.246      | 0.263       | 0.534       | 0.354154    |             |          | P \ G_{23} make a pair. |
| G_{24}   | 17.018      | 17.485      | 0.263       | 0.613       | 0.5836      |             |          | P \ G_{24} make a pair. |
| G_{25}   | 17.018      | 18.376      | 0.263       | 0.606       | 1.400647    |             |          | AD \ G_{25} make a pair. |
| G_{34}   | 17.246      | 17.485      | 0.534       | 0.613       | 0.251718    |             |          | T \ G_{34} may have a discordant attribute. |
| G_{35}   | 17.246      | 18.376      | 0.534       | 0.606       | 1.132291    |             |          | AD \ G_{35} may have a discordant attribute. |
| G_{45}   | 17.485      | 18.376      | 0.613       | 0.606       | 0.891027    |             |          | AD \ G_{45} may have a discordant attribute. |

| Galaxies | \( (r_i) \) | \( (r_j) \) | \( (g-r_i) \) | \( (g-r_j) \) | \( e_{ij} \) | \( e_{av} \) | \( \sigma \) | Comments |
|----------|-------------|-------------|-------------|-------------|-------------|-------------|----------|----------|
| G_{12}   | 16.357      | 16.475      | 0.276       | 0.247       | 0.121511    | 1.103049    | 0.639375 | T \ G_{12} make a twin. |
| G_{13}   | 16.357      | 16.76       | 0.276       | 0.339       | 0.407895    |             |          | T \ G_{13} make a twin. |
| G_{14}   | 16.357      | 18.034      | 0.276       | 0.206       | 1.67846     |             |          | M \ G_{14} make a twin. |
| G_{15}   | 16.357      | 18.134      | 0.276       | -0.318      | 1.87365     |             |          | AD \ G_{15} make a twin. |
| G_{23}   | 16.475      | 16.76       | 0.247       | 0.339       | 0.299481    |             |          | T \ G_{23} make a twin. |
| G_{24}   | 16.475      | 18.034      | 0.247       | 0.206       | 1.559539    |             |          | M \ G_{24} make a twin. |
| G_{25}   | 16.475      | 18.134      | 0.247       | -0.318      | 1.752571    |             |          | AD \ G_{25} make a twin. |
| G_{34}   | 16.76       | 18.034      | 0.339       | 0.206       | 1.280923    |             |          | M \ G_{34} make a twin. |
| G_{35}   | 16.76       | 18.134      | 0.339       | -0.318      | 1.522999    |             |          | AD \ G_{35} make a twin. |
| G_{45}   | 18.034      | 18.134      | 0.206       | -0.318      | 0.533457    |             |          | P \ G_{45} make a twin. |

| Galaxies | \( (r_i) \) | \( (r_j) \) | \( (g-r_i) \) | \( (g-r_j) \) | \( e_{ij} \) | \( e_{av} \) | \( \sigma \) | Comments |
|----------|-------------|-------------|-------------|-------------|-------------|-------------|----------|----------|
| G_{12}   | 16.12       | 16.411      | 0.258       | 0.535       | 0.401759    | 0.46848     | 0.209074 | P \ G_{12} make a pair. |
| G_{13}   | 16.12       | 16.421      | 0.258       | 0.376       | 0.323303    |             |          | P \ G_{13} make a pair. |
| G_{14}   | 16.12       | 16.786      | 0.258       | 0.397       | 0.680351    |             |          | AD \ G_{14} make a pair. |
| G_{15}   | 16.12       | 16.973      | 0.258       | 0.599       | 0.918635    |             |          | AD \ G_{15} make a pair. |
| G_{23}   | 16.411      | 16.421      | 0.535       | 0.376       | 0.159314    |             |          | T \ G_{23} make a pair. |
| G_{24}   | 16.411      | 16.786      | 0.535       | 0.397       | 0.399586    |             |          | P \ G_{24} make a pair. |
| G_{25}   | 16.411      | 16.973      | 0.535       | 0.599       | 0.565632    |             |          | AD \ G_{25} make a pair. |
| G_{34}   | 16.421      | 16.786      | 0.376       | 0.397       | 0.365604    |             |          | P \ G_{34} make a pair. |
| Group 152853+423546 |   |   |   |   |   |   |   | Comments |
|---------------------|-----|-----|-----|-----|-----|-----|-----|----------|
| Galaxies            | (r<sub>i</sub>) | (r<sub>j</sub>) | (g-r<sub>i</sub>) | (g-r<sub>j</sub>) | e<sub>i</sub> | e<sub>av</sub> | σ   |          |
| G<sub>12</sub>      | 16.717 | 17.559 | 0.372 | 0.286 | 0.846381 | 0.66317 | 0.433068 | M   |
| G<sub>13</sub>      | 16.717 | 17.748 | 0.372 | 0.208 | 1.043962 |          |          |        |
| G<sub>14</sub>      | 16.717 | 17.872 | 0.372 | 0.304 | 1.157    |          |          |        |
| G<sub>15</sub>      | 16.717 | 18.199 | 0.372 | 0.273 | 1.485303 |          |          |        |
| G<sub>23</sub>      | 17.559 | 17.748 | 0.286 | 0.208 | 0.204463 |          |          |        |
| G<sub>24</sub>      | 17.559 | 17.872 | 0.286 | 0.304 | 0.331517 |          |          |        |
| G<sub>25</sub>      | 17.559 | 18.199 | 0.286 | 0.273 | 0.640132 |          |          |        |
| G<sub>34</sub>      | 17.748 | 17.872 | 0.208 | 0.304 | 0.156818 |          |          |        |
| G<sub>35</sub>      | 17.748 | 18.199 | 0.208 | 0.273 | 0.45566  |          |          |        |
| G<sub>45</sub>      | 17.872 | 18.199 | 0.304 | 0.273 | 0.328466 |          |          |        |

| Group 153322+493858 |   |   |   |   |   |   |   | Comments |
|---------------------|-----|-----|-----|-----|-----|-----|-----|----------|
| Galaxies            | (r<sub>i</sub>) | (r<sub>j</sub>) | (g-r<sub>i</sub>) | (g-r<sub>j</sub>) | e<sub>i</sub> | e<sub>av</sub> | σ   |          |
| G<sub>12</sub>      | 16.789 | 17.245 | 0.567 | -0.076 | 0.78828 | 0.944076 | 0.372005 | P |
| G<sub>13</sub>      | 16.789 | 17.8  | 0.567 | 0.363  | 1.031376 |          |          |        |
| G<sub>14</sub>      | 16.789 | 18.286 | 0.567 | 0.375  | 1.509262 |          |          |        |
| G<sub>15</sub>      | 16.789 | 18.407 | 0.567 | 0.127  | 1.67676  |          |          |        |
| G<sub>23</sub>      | 17.245 | 17.8  | -0.076 | 0.363  | 0.707634 |          |          |        |
| G<sub>24</sub>      | 17.245 | 18.286 | -0.076 | 0.375  | 1.134496 |          |          |        |
| G<sub>25</sub>      | 17.245 | 18.407 | -0.076 | 0.127  | 1.179599 |          |          |        |
| G<sub>34</sub>      | 17.8  | 18.286 | 0.363  | 0.375  | 0.486148 |          |          |        |
| G<sub>35</sub>      | 17.8  | 18.407 | 0.363  | 0.127  | 0.651264 |          |          |        |
| G<sub>45</sub>      | 18.286 | 18.407 | 0.375  | 0.127  | 0.275944 |          |          |        |

| Group 154629+005120 |   |   |   |   |   |   |   | Comments |
|---------------------|-----|-----|-----|-----|-----|-----|-----|----------|
| Galaxies            | (r<sub>i</sub>) | (r<sub>j</sub>) | (g-r<sub>i</sub>) | (g-r<sub>j</sub>) | e<sub>i</sub> | e<sub>av</sub> | σ   |          |
| G<sub>12</sub>      | 16.794 | 17.336 | 0.218 | 0.167  | 0.544394 | 0.738435 | 0.353629 | P   |
| G<sub>13</sub>      | 16.794 | 17.776 | 0.218 | -0.125 | 1.040179 |          |          |        |
| G<sub>14</sub>      | 16.794 | 18.032 | 0.218 | 0.047  | 1.249754 |          |          |        |
| G<sub>15</sub>      | 16.794 | 18.221 | 0.218 | 0.086  | 1.433092 |          |          |        |
| G<sub>23</sub>      | 17.336 | 17.776 | 0.167  | -0.125 | 0.528076 |          |          |        |
| G<sub>24</sub>      | 17.336 | 18.032 | 0.167  | 0.047  | 0.706269 |          |          |        |
| G<sub>25</sub>      | 17.336 | 18.221 | 0.167  | 0.086  | 0.888699 |          |          |        |
| G<sub>34</sub>      | 17.776 | 18.032 | -0.125 | 0.047  | 0.308415 |          |          |        |
| G<sub>35</sub>      | 17.776 | 18.221 | -0.125 | 0.086  | 0.49249  |          |          |        |
| Group 154748+364946 |   |   |   |   |   |   |   | Comments |
|-------------------|---|---|---|---|---|---|---|---------|
| Galaxies          | (r) | (r) | (g-r) | (g-r) | e | e | σ |         |
| G_{12}            | 16.132 | 17.16 | 0.321 | 0.262 | 1.029692 | 1.013845 | 0.453827 | M |
| G_{13}            | 16.132 | 17.408 | 0.321 | -0.057 | 1.330812 | M |
| G_{14}            | 16.132 | 17.713 | 0.321 | 0.641 | 1.613060 | AD |
| G_{15}            | 16.132 | 17.997 | 0.321 | 0.82 | 1.930602 | AD |
| G_{23}            | 17.16 | 17.408 | 0.262 | -0.057 | 0.490461 | T |
| G_{24}            | 17.16 | 17.713 | 0.262 | 0.641 | 0.670410 | P |
| G_{25}            | 17.16 | 17.997 | 0.262 | 0.82 | 1.005949 | P |
| G_{34}            | 17.408 | 17.713 | -0.057 | 0.641 | 0.761728 | P |
| G_{35}            | 17.408 | 17.997 | -0.057 | 0.82 | 1.056433 | AD |
| G_{45}            | 17.713 | 17.997 | 0.641 | 0.82 | 0.335704 | P |

| Group 155521+460427 |   |   |   |   |   |   |   | Comments |
|---------------------|---|---|---|---|---|---|---|---------|
| Galaxies            | (r) | (r) | (g-r) | (g-r) | e | e | σ |         |
| G_{12}              | 16.681 | 16.943 | 0.252 | 0.367 | 0.286128 | 0.792875 | 0.372727 | T |
| G_{13}              | 16.681 | 17.361 | 0.252 | 0.102 | 0.696348 | P |
| G_{14}              | 16.681 | 17.82 | 0.252 | 0.329 | 1.1416 | M |
| G_{15}              | 16.681 | 18.174 | 0.252 | 0.242 | 1.493033 | AD |
| G_{23}              | 16.943 | 17.361 | 0.367 | 0.102 | 0.494923 | P |
| G_{24}              | 16.943 | 17.82 | 0.367 | 0.329 | 0.877823 | M |
| G_{25}              | 16.943 | 18.174 | 0.367 | 0.242 | 1.23733 | AD |
| G_{34}              | 17.361 | 17.82 | 0.102 | 0.329 | 0.512064 | P |
| G_{35}              | 17.361 | 18.174 | 0.102 | 0.242 | 0.824966 | AD |
| G_{45}              | 17.82 | 18.174 | 0.329 | 0.242 | 0.364534 | P |

| Group 160905+311101 |   |   |   |   |   |   |   | Comments |
|---------------------|---|---|---|---|---|---|---|---------|
| Galaxies            | (r) | (r) | (g-r) | (g-r) | e | e | σ |         |
| G_{12}              | 16.681 | 16.874 | 0.378 | 0.43 | 0.199882 | 1.178104 | 0.706027 | T |
| G_{13}              | 16.681 | 18.435 | 0.378 | 0.236 | 1.759739 | M |
| G_{14}              | 16.681 | 18.553 | 0.378 | 0.23 | 1.877841 | M |
| G_{15}              | 16.681 | 18.652 | 0.378 | -0.071 | 2.021495 | AD |
| G_{23}              | 16.874 | 18.435 | 0.43 | 0.236 | 1.573009 | M |
| G_{24}              | 16.874 | 18.553 | 0.43 | 0.23 | 1.69087 | M |
| G_{25}              | 16.874 | 18.652 | 0.43 | -0.071 | 1.847237 | AD |
| G_{34}              | 18.435 | 18.553 | 0.236 | 0.23 | 0.118152 | T |
| G_{35}              | 18.435 | 18.652 | 0.236 | -0.071 | 0.375949 | P |
| G_{45}              | 18.553 | 18.652 | 0.23 | -0.071 | 0.316863 | P |
| Group 161348+232820 | (r)<sub>i</sub> | (r)<sub>j</sub> | (g-r)<sub>i</sub> | (g-r)<sub>j</sub> | e<sub>i</sub> | e<sub>av</sub> | σ | Comments |
|---------------------|----------------|----------------|----------------|----------------|--------|--------|-----|----------|
| G<sub>12</sub>      | 16.658         | 17.011         | 0.322          | 0.293          | 0.354189 | 0.839982 | 0.441222 | T        |
| G<sub>13</sub>      | 16.658         | 17.418         | 0.322          | 0.384          | 0.762525 | P       |     |          |
| G<sub>14</sub>      | 16.658         | 17.781         | 0.322          | 0.32           | 1.123002 | M       |     |          |
| G<sub>15</sub>      | 16.658         | 18.367         | 0.322          | 0.362          | 1.709468 | AD      |     |          |
| G<sub>23</sub>      | 17.011         | 17.418         | 0.293          | 0.384          | 0.417049 | P       |     |          |
| G<sub>24</sub>      | 17.011         | 17.781         | 0.293          | 0.32           | 0.770473 | P       |     |          |
| G<sub>25</sub>      | 17.011         | 18.367         | 0.293          | 0.362          | 1.357754 | AD      |     |          |
| G<sub>34</sub>      | 17.418         | 17.781         | 0.384          | 0.32           | 0.368599 | T       |     |          |
| G<sub>35</sub>      | 17.418         | 18.367         | 0.384          | 0.362          | 0.949255 | AD      |     |          |
| G<sub>45</sub>      | 17.781         | 18.367         | 0.32           | 0.362          | 0.587503 | P       |     |          |

| Group 161647+550218 | (r)<sub>i</sub> | (r)<sub>j</sub> | (g-r)<sub>i</sub> | (g-r)<sub>j</sub> | e<sub>i</sub> | e<sub>av</sub> | σ | Comments |
|---------------------|----------------|----------------|----------------|----------------|--------|--------|-----|----------|
| G<sub>12</sub>      | 16.295         | 16.507         | 0.224          | 0.185          | 0.215557 | 0.608445 | 0.237227 | T        |
| G<sub>13</sub>      | 16.295         | 16.712         | 0.224          | 0.605          | 0.564845 | P       |     |          |
| G<sub>14</sub>      | 16.295         | 17.14          | 0.224          | 0.28           | 0.846854 | AD      |     |          |
| G<sub>15</sub>      | 16.295         | 17.326         | 0.224          | 0.461          | 1.057889 | AD      |     |          |
| G<sub>23</sub>      | 16.507         | 16.712         | 0.185          | 0.605          | 0.46736  | P       |     |          |
| G<sub>24</sub>      | 16.507         | 17.14          | 0.185          | 0.28           | 0.640089 | M       |     |          |
| G<sub>25</sub>      | 16.507         | 17.326         | 0.185          | 0.461          | 0.864255 | AD      |     |          |
| G<sub>34</sub>      | 16.712         | 17.14          | 0.605          | 0.28           | 0.53741  | P       |     |          |
| G<sub>35</sub>      | 16.712         | 17.326         | 0.605          | 0.461          | 0.63066  | AD      |     |          |
| G<sub>45</sub>      | 17.14          | 17.326         | 0.28           | 0.461          | 0.259532 | P       |     |          |

| Group 163018+265636 | (r)<sub>i</sub> | (r)<sub>j</sub> | (g-r)<sub>i</sub> | (g-r)<sub>j</sub> | e<sub>i</sub> | e<sub>av</sub> | σ | Comments |
|---------------------|----------------|----------------|----------------|----------------|--------|--------|-----|----------|
| G<sub>12</sub>      | 16.36          | 16.562         | 0.177          | 0.612          | 0.479613 | 0.967046 | 0.395423 | T        |
| G<sub>13</sub>      | 16.36          | 17.434         | 0.177          | 0.626          | 1.164078 | M       |     |          |
| G<sub>14</sub>      | 16.36          | 17.692         | 0.177          | 0.195          | 1.332122 | M       |     |          |
| G<sub>15</sub>      | 16.36          | 17.998         | 0.177          | 0.493          | 1.668203 | AD      |     |          |
| G<sub>23</sub>      | 16.562         | 17.434         | 0.612          | 0.626          | 0.872112 | P       |     |          |
| G<sub>24</sub>      | 16.562         | 17.692         | 0.612          | 0.195          | 1.204487 | M       |     |          |
| G<sub>25</sub>      | 16.562         | 17.998         | 0.612          | 0.493          | 1.440922 | AD      |     |          |
| G<sub>34</sub>      | 17.434         | 17.692         | 0.626          | 0.195          | 0.50232  | T       |     |          |
| G<sub>35</sub>      | 17.434         | 17.998         | 0.626          | 0.493          | 0.57947  | P       |     |          |
| G<sub>45</sub>      | 17.692         | 17.998         | 0.195          | 0.493          | 0.42713  | P       |     |          |
| Group     | (r) | (g-r) | e_j | e_av | σ     | Comments                        |
|-----------|-----|-------|-----|------|-------|----------------------------------|
| Group 000954+195825 |     |       |     |      |       |                                  |
| G_{12}   | 16.861 | 0.341 | 174 | 0.584371 | 0.478391 | P  G_{12} make a pair.              |
| G_{13}   | 16.861 | 0.341 | 384 | 1.313704 | M       |                                  |
| G_{14}   | 16.861 | 0.341 | 382 | 1.595527 | AD      |                                  |
| G_{15}   | 16.861 | 0.341 | 316 | 1.834175 | AD      |                                  |
| G_{23}   | 17.421 | 0.174 | 384 | 0.781735 | P       |                                  |
| G_{24}   | 17.421 | 0.174 | 382 | 1.055694 | M       |                                  |
| G_{25}   | 17.421 | 0.174 | 316 | 1.281889 | AD      |                                  |
| G_{34}   | 18.174 | 0.384 | 382 | 0.282007 | T       |                                  |
| G_{35}   | 18.174 | 0.384 | 316 | 0.525419 | P       |                                  |
| G_{45}   | 18.456 | 0.382 | 316 | 0.247946 | P       |                                  |
| Group 003707+185546 |     |       |     |      |       |                                  |
| G_{12}   | 16.492 | 0.128 | 486 | 1.02458  | 0.909819 | 0.497851 | M  G_{12} make a twin.              |
| G_{13}   | 16.492 | 0.128 | 586 | 1.118107 | M       |                                  |
| G_{14}   | 16.492 | 0.128 | 323 | 1.665455 | AD      |                                  |
| G_{15}   | 16.492 | 0.128 | 643 | 1.847241 | AD      |                                  |
| G_{23}   | 17.452 | 0.486 | 586 | 0.116619 | T       |                                  |
| G_{24}   | 17.452 | 0.486 | 643 | 0.829002 | P       |                                  |
| G_{25}   | 17.452 | 0.486 | 643 | 0.829002 | P       |                                  |
| G_{34}   | 17.512 | 0.586 | 323 | 0.686385 | P       |                                  |
| G_{35}   | 17.512 | 0.586 | 643 | 0.756151 | P       |                                  |
| G_{45}   | 18.146 | 0.323 | 643 | 0.34176 | P       |                                  |
| Group 003943+211056 |     |       |     |      |       |                                  |
| G_{12}   | 16.828 | -0.217 | 322 | 0.540959 | 1.283999 | 0.700139 | T  G_{12} make a twin.              |
| G_{13}   | 16.828 | -0.217 | 108 | 0.368177 | T       |                                  |
| G_{14}   | 16.828 | -0.217 | 456 | 2.011901 | AD      |                                  |
| G_{15}   | 16.828 | -0.217 | 062 | 1.966888 | AD      |                                  |
| G_{23}   | 16.874 | 0.322 | 108 | 0.248847 | T       |                                  |
| G_{24}   | 16.874 | 0.322 | 456 | 1.854847 | M       |                                  |
| G_{25}   | 16.874 | 0.322 | 062 | 1.918698 | AD      |                                  |
| G_{34}   | 17.001 | 0.108 | 456 | 1.757792 | M       |                                  |
| G_{35}   | 17.001 | 0.108 | 062 | 1.774396 | AD      |                                  |
| G_{45}   | 18.724 | 0.456 | 062 | 0.397287 | P       |                                  |
| Group 005151+081326 |     |       |     |      |       |                                  |
| Galaxies | \( r_i \) | \( r_j \) | \( (g-r)_i \) | \( (g-r)_j \) | \( e_{ij} \) | \( e_{av} \) | \( \sigma \) | Comments |
|----------|----------|----------|----------|----------|----------|----------|-----------|----------|
| \( G_{12} \) | 16.352 | 17.154 | 0.389 | 0.691 | 0.856976 | 1.021251 | 0.541864 | \( G_{12} \) make a pair. \( G_{23} \) make a pair. \( G_{34} \) make a twin. \( G_{35} \) make a pair. \( G_{45} \) make a pair. |
| \( G_{13} \) | 16.352 | 17.961 | 0.389 | 0.377 | 1.609045 | AD |
| \( G_{14} \) | 16.352 | 18.177 | 0.389 | 0.375 | 1.825054 | AD |
| \( G_{15} \) | 16.352 | 18.329 | 0.389 | 0.515 | 1.981011 | AD |
| \( G_{23} \) | 17.154 | 17.961 | 0.691 | 0.377 | 0.865936 | P |
| \( G_{24} \) | 17.154 | 18.177 | 0.691 | 0.375 | 1.070694 | M |
| \( G_{25} \) | 17.154 | 18.329 | 0.691 | 0.515 | 1.188108 | AD |
| \( G_{34} \) | 17.961 | 18.177 | 0.377 | 0.375 | 0.216009 | T |
| \( G_{35} \) | 17.961 | 18.329 | 0.377 | 0.515 | 0.393024 | P |
| \( G_{45} \) | 18.177 | 18.329 | 0.375 | 0.515 | 0.206649 | P |

**Group 015402+013942**

| Galaxies | \( r_i \) | \( r_j \) | \( (g-r)_i \) | \( (g-r)_j \) | \( e_{ij} \) | \( e_{av} \) | \( \sigma \) | Comments |
|----------|----------|----------|----------|----------|----------|----------|-----------|----------|
| \( G_{12} \) | 16.192 | 16.209 | 0.406 | 0.44 | 0.038013 | 0.332002 | 0.180962 | \( G_{12} \) make a twin. \( G_{13} \) make a pair. \( G_{23} \) make a pair. \( G_{34} \) make a pair. \( G_{35} \) make a pair. \( G_{45} \) make a pair. \( G_4 \) and \( G_5 \) may have a discordant attribute. |
| \( G_{13} \) | 16.192 | 16.38 | 0.406 | 0.45 | 0.19308 | P |
| \( G_{14} \) | 16.192 | 16.696 | 0.406 | 0.484 | 0.51 | M |
| \( G_{15} \) | 16.192 | 16.763 | 0.406 | 0.422 | 0.571224 | AD |
| \( G_{23} \) | 16.209 | 16.38 | 0.44 | 0.45 | 0.171292 | P |
| \( G_{24} \) | 16.209 | 16.696 | 0.44 | 0.484 | 0.488984 | M |
| \( G_{25} \) | 16.209 | 16.763 | 0.44 | 0.422 | 0.554292 | AD |
| \( G_{34} \) | 16.38 | 16.696 | 0.45 | 0.484 | 0.317824 | P |
| \( G_{35} \) | 16.38 | 16.763 | 0.45 | 0.422 | 0.384022 | AD |
| \( G_{45} \) | 16.696 | 16.763 | 0.484 | 0.422 | 0.091285 | P |

**Group 025056+070049**

| Galaxies | \( r_i \) | \( r_j \) | \( (g-r)_i \) | \( (g-r)_j \) | \( e_{ij} \) | \( e_{av} \) | \( \sigma \) | Comments |
|----------|----------|----------|----------|----------|----------|----------|-----------|----------|
| \( G_{12} \) | 16.992 | 17.05 | 0.419 | 0.336 | 0.101257 | 0.664446 | 0.38599 | \( G_{12} \) make a twin. \( G_{13} \) make a twin. \( G_{23} \) make a twin. \( G_{34} \) make a pair. \( G_{35} \) make a pair. \( G_{45} \) make a pair. |
| \( G_{13} \) | 16.992 | 17.261 | 0.419 | 0.394 | 0.270159 | T |
| \( G_{14} \) | 16.992 | 17.785 | 0.419 | 0.49 | 0.796172 | M |
| \( G_{15} \) | 16.992 | 18.229 | 0.419 | 0.187 | 1.258568 | AD |
| \( G_{23} \) | 17.05 | 17.261 | 0.336 | 0.394 | 0.218826 | T |
| \( G_{24} \) | 17.05 | 17.785 | 0.336 | 0.49 | 0.75096 | M |
| \( G_{25} \) | 17.05 | 18.229 | 0.336 | 0.187 | 1.188378 | AD |
| \( G_{34} \) | 17.261 | 17.785 | 0.394 | 0.49 | 0.532721 | P |
| \( G_{35} \) | 17.261 | 18.229 | 0.394 | 0.187 | 0.989885 | AD |
| \( G_{45} \) | 17.785 | 18.229 | 0.49 | 0.187 | 0.537536 | P |

**Group 025903+100636**

| Galaxies | \( r_i \) | \( r_j \) | \( (g-r)_i \) | \( (g-r)_j \) | \( e_{ij} \) | \( e_{av} \) | \( \sigma \) | Comments |
|----------|----------|----------|----------|----------|----------|----------|-----------|----------|
| Galaxies | (r)_{i} | (r)_{j} | (g-r)_{i} | (g-r)_{j} | e_{ij} | e_{av} | σ | Comments |
|----------|--------|--------|-----------|-----------|--------|--------|----|----------|
| G_{12}   | 16.473 | 16.764 | 0.375     | 0.281     | 0.305805 | 0.989383 | 0.454412 | T | G_{12} make a twin. |
| G_{13}   | 16.473 | 17.452 | 0.375     | 0.384     | 0.979041 |        |     | P | G_{13} make a pair. |
| G_{14}   | 16.473 | 17.904 | 0.375     | -0.076    | 1.500387 |        |     | AD | G_{14} make a pair. |
| G_{15}   | 16.473 | 18.254 | 0.375     | 0.264     | 1.784456 |        |     | AD | G_{15} make a pair. |
| G_{23}   | 16.764 | 17.452 | 0.281     | 0.384     | 0.695667 |        |     | P | G_{23} make a pair. |
| G_{24}   | 16.764 | 17.904 | 0.281     | -0.076    | 1.194592 |        |     | M | G_{24} make a pair. |
| G_{25}   | 16.764 | 18.254 | 0.281     | 0.264     | 1.490097 |        |     | AD | G_{25} make a pair. |
| G_{34}   | 17.452 | 17.904 | 0.384     | -0.076    | 0.644906 |        |     | P | G_{34} make a twin. |
| G_{35}   | 17.452 | 18.254 | 0.384     | 0.264     | 0.810928 |        |     | P | G_{35} make a pair. |
| G_{45}   | 17.904 | 18.254 | -0.076    | 0.264     | 0.487955 |        |     | P | G_{45} make a pair. |

**Group 221414+002203**

| Galactic | (r)_{i} | (r)_{j} | (g-r)_{i} | (g-r)_{j} | e_{ij} | e_{av} | σ | Comments |
|----------|--------|--------|-----------|-----------|--------|--------|----|----------|
| G_{12}   | 16.9   | 17.486 | 0.61      | 0.307     | 0.659701 | 0.761779 | 0.378351 | P | G_{12} make a twin. |
| G_{13}   | 16.9   | 17.975 | 0.61      | 0.495     | 1.081134 |        |     | M | G_{13} make a pair. |
| G_{14}   | 16.9   | 18.222 | 0.61      | 0.409     | 1.337193 |        |     | AD | G_{14} make a pair. |
| G_{15}   | 16.9   | 18.376 | 0.61      | 0.548     | 1.477302 |        |     | AD | G_{15} make a twin. |
| G_{23}   | 17.486 | 17.975 | 0.307     | 0.495     | 0.523894 |        |     | P | G_{23} make a pair. |
| G_{24}   | 17.486 | 18.222 | 0.307     | 0.409     | 0.743034 |        |     | P | G_{24} make a twin. |
| G_{25}   | 17.486 | 18.376 | 0.307     | 0.409     | 0.922053 |        |     | P | G_{25} make a twin. |
| G_{34}   | 17.975 | 18.222 | 0.495     | 0.548     | 0.404487 |        |     | P | G_{34} make a pair. |
| G_{35}   | 17.975 | 18.376 | 0.495     | 0.409     | 0.261543 |        |     | T | G_{35} make a twin. |
| G_{45}   | 18.222 | 18.376 | 0.409     | 0.548     | 0.207454 |        |     | P | G_{45} make a pair. |

**Group 221442+012823**

| Galactic | (r)_{i} | (r)_{j} | (g-r)_{i} | (g-r)_{j} | e_{ij} | e_{av} | σ | Comments |
|----------|--------|--------|-----------|-----------|--------|--------|----|----------|
| G_{12}   | 16.399 | 17.47  | -0.112    | 0.615     | 1.294438 | 1.035617 | 0.58805 | M | G_{12} make a twin. |
| G_{13}   | 16.399 | 17.858 | -0.112    | 0.397     | 1.545238 |        |     | M | G_{13} make a pair. |
| G_{14}   | 16.399 | 18.131 | -0.112    | 0.261     | 1.771709 |        |     | AD | G_{14} make a pair. |
| G_{15}   | 16.399 | 18.397 | -0.112    | 0.714     | 2.162008 |        |     | AD | G_{15} make a pair. |
| G_{23}   | 17.47  | 17.858 | 0.615     | 0.397     | 0.445048 |        |     | T | G_{23} make a twin. |
| G_{24}   | 17.47  | 18.131 | 0.615     | 0.261     | 0.749825 |        |     | T | G_{24} make a pair. |
| G_{25}   | 17.47  | 18.397 | 0.615     | 0.714     | 0.932271 |        |     | P | G_{25} make a pair. |
| G_{34}   | 17.858 | 18.131 | 0.397     | 0.261     | 0.305   |        |     | T | G_{34} make a twin. |
| G_{35}   | 17.858 | 18.397 | 0.397     | 0.714     | 0.625308 |        |     | T | G_{35} make a pair. |
| G_{45}   | 18.131 | 18.397 | 0.261     | 0.714     | 0.525324 |        |     | P | G_{45} make a pair. |

**Group 222450+071501**

| Galactic | (r)_{i} | (r)_{j} | (g-r)_{i} | (g-r)_{j} | e_{ij} | e_{av} | σ | Comments |
|----------|--------|--------|-----------|-----------|--------|--------|----|----------|
| G_{12}   | 16.473 | 16.629 | 0.146     | 0.287     | 0.210278 | 1.111753 | 0.680205 | T | G_{12} make a twin. |
Some members appeared to have a discordant attribute and some group contained sub groups, to inspect the reality of the results we applied the combined coefficient

$$e_{m(jk)} = \frac{1}{2} (e_{mj} + e_{mk})$$

Where m, j and k are galaxy members of the same group
Applying the UPGMA method on the 5 member groups showed that most of the galaxies are real members while groups has a discordant attribute and should be discarded from their groups.

| Group ID      | Galaxy number |
|---------------|---------------|
| 091524+213038 | 1             |
| 094316+392308 | 1             |
| 101328-005522 | 1             |
| 111622+420044 | 1             |
| 115942+254940 | 1             |
| 122859+272547 | 4             |
| 125835+062246 | 4             |
| 134932+280017 | 1             |
| 135426+265147 | 1             |
| 142520+471513 | 4             |
| 143929+110605 | 1             |
| 151037+061618 | 5             |
| 151558+264612 | 4             |
| 152853+423546 | 1             |
| 154748+364946 | 1             |
| 003707+185546 | 1             |
| 003943+211056 | 4             |
| 005151+081326 | 1             |
| 015402+013942 | 4             |
| 025903+100636 | 1             |
| 221442+012823 | 1             |
| 222450+071501 | 4             |
| 231910-022709 | 1             |

References:
1. Sabry, M.A., Issa, I.A., Abdelrahman, H. and Shaker, A.A. 2012, NRIAG-JAG, 1, 81–86
2. Allam, S. S and Tucker, D. L. 2000, AN, 321, 2, 101
3. Barton, E., Geller, M. J., Ramella, M., Marzke, R., and da Costa L., 1996, AJ, 112,871
4. deCarvalho, R. R. et al. 2005, AJ, 130,425
5. Deng X.-F., He J.-Z., Ma X.-S., Jiang P., Tang X.-X., 2008, Central Eur. J. Phys., 6(2), 185
6. Diaz-Gimenez, E., Mamom, G. A., Pacheco, M., Mendes de Oliveira, C. and Alonso, M. V. 2012, MNRAS, 426, 1, 296
7. Focardi, P. and Kelm, B. 2002, A&A 301, 35
8. Garcia, A. M. 1995, A&A, 297, 1, 56
9. Hickson, P. 1982, ApJ, 255, 382
10. Hickson, P., Mendes de Oliveira, C., Huchra, J. P., and Palumbo, G. 1992, ApJ., 399, 353
11. Iovino, A. 2003, AJ, 125, 1660
12. Lee, B. C., Allam, S., Tucker, D. L., Annis, J., Johnston, D., Scranton, R., Acebo, Yamina, Bahcall, Neta A., and 14 coauthors.2004, AJ, 127,1811L
13. McConnachie, Alan W. 2009, MNRAS. 395, 255
14. Prandoni, I., Iovino, A. and MacGillivray, H. T. 1994, AJ, 107, 4, 1235
15. Romesburg, H.Charles, 1984, Cluster Analysis for Researchers, Lifetime learning publications, U.S.A
16. Sabry A. Mohamed, IssaA.Issa., A.I.Osman., A.Bakry, and M. Beahary, 2009, Investigation in Groups of Galaxies, PhD. Azharuniv.
17. Seyfert, C. K., 1948, AJ, 53, 203
18. Shakhbazian, R. K. 1957, Astron. Tsirk., 177, 11
19. Shakhbazian, R. K. 1973, Ap, 9, 4, 296-304
20. Stephan, M. E., 1877, MNRAS, 37, 334