NRIAG Journal of Astronomy and Geophysics 6 (2017) 267–274

Contents lists available at ScienceDirect

NRIAG Journal of Astronomy and Geophysics

journal homepage: www.elsevier.com/locate/nrjag

Full length article

Statistical study of some Lee galaxy groups

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ARTICLE INFO

Article history:
Received 2 May 2017
Revised 1 June 2017
Accepted 3 June 2017
Available online 14 July 2017

Keywords:
Galaxies
Cluster analysis
Galaxy groups
Lee galaxy groups

ABSTRACT

Compact groups of galaxies are systems of small number of galaxies close to each other. They are *a* good laboratory to study galaxy properties, such as structure, morphology and evolution which are affected by the environment and galaxy interactions. We applied the tree clustering technique (the Euclidean separation distance coefficients) to test the physical reality of groups and used certain criteria (Sabry et al., 2009) depending on the physical attributes of the galaxies. The sample of the data is the quintets groups of Lee compact groups of galaxies (Lee et al., 2004). It is based on a modified version of Hickson's criteria (Hickson, 1982). The results reveal the membership of each galaxy and how it is related to its group. The tables of groups and their members are included.

Our results indicates that 12 Groups are real groups with real members while 18 Groups have one galaxy that has attribute discordant and should be discarded from its group.

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1. Introduction

A Group of galaxies is an accumulation of galaxies that must satisfy a certain criteria. Most of the group - finder methods are made to be applied on a galaxy survey in order to pick out groups of 2–50 galaxies in one group according to this criteria.

There are many different catalogs of galaxy groups made using different methods and criteria depending on position, magnitude, mean separation distances between the center of groups and members, Radii of members and mean surface brightness (Shakhbazian, 1957; Shakhbazyan, 1973; de Vaucouleurs, 1975; Turner and Gott, 1976a, 1976b; Rose, 1977; Karachentsev et al., 1979; Huchra and Geller, 1982; Hickson, 1982; Huchra et al., 1983; Tully, 1987a, 1987b; Rubin et al., 1991; Hickson et al., 1992; Prandoni et al., 1994; Garcia, 1995; Barton et al., 1996; Allam and Tucker, 2000; Focardi and Kelm, 2002; deCarvalho et al., 2005; Deng et al., 2008; Diaz-Gimenez et al., 2012; McConnachie et al., 2009; Wang et al., 2008; Sohn et al., 2015).

Because most of selection criteria in the group of galaxies catalogues depends on the determine the member's distance from the center of the group and the radii of the members too. So we can see that the uncertainties in determining the radii of galaxies (R) are big especially due to uncertainties in distance determinations (D). The latter depends on the measured velocities (V) and the value of Hubble constant (H_0). This can be added to the fact that one is not sure if these groups are true physical groups or just projection (Sulentic, 1983). Later studies on some of these catalogs showed that some of the galaxies in the groups don't belong to their groups and were thus discarded. This in turn could lead to removing the group from the catalog since it doesn't follow the original criteria (Hickson, 1982; Hickson et al., 1992).

The aim of this paper is to investigate the membership of the galaxies in their groups by applying a clustering analysis technique which makes use of the physical attributes of the galaxies and find the similarity or dissimilarity between members of the same group.

This paper is organized as follows: Section 2 describes the method and data used, Section 3: describe the results obtained while Section 4: describe the conclusion.

2. Data, method and technique

2.1. Data

Lee et al. (2004) presented an objectively defined catalog of Compact groups (CGs) in 153 deg^2 of the Sloan Digital Sky Survey

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Peer review under responsibility of National Research Institute of Astronomy and Geophysics.

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http://dx.doi.org/10.1016/j.nrjag.2017.06.002
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(SDSS). They applied a modified version of Hickson's criteria (Hickson, 1982) aimed to finding the highest-density compact groups and thus reducing the number of chance alignments. This catalog contains 175 CGs down to a limiting galaxy magnitude of $r^* = 21$ where r^* is the SDSS r-band. The resulting catalog has a median depth of zmed ~ 0.13.

We used the unweighted pair Group Method using arithmetic average (UPGMA) (Sokal and Michener, 1958; William and Edelsbrununer, 1984; Murtagh 1984; Romesburg, 1984) to measure the similarity or dissimilarity between any two member's astrophysical parameters in each group.

Galaxies in the same groups are supposed to have similar properties that connect them together. Thus our technique depends on studying the similarity between some attributes of objects which seems to form a group or catalogued as a group and testing the similarity between the properties of the members in each group. If these attributes are similar or nearly equal, according to the philosophy of the technique then it may form a group.

This is most effectively defined by the Euclidean distance (separation) coefficient given by the following equation.

$$e_{jk} = \sqrt{\sum_{i=1}^{3} (X_{ij} - X_{ik})^2} \tag{1}$$

This means that to compute e_{jk} for two objects J and K, we use the data in the jth and kth columns of the original data matrix. Adding a third attribute, the Euclidian distance coefficient is given by just adding a third term, i.e.

A generalization of n attribute can take the form

$$e_{jk} = \sqrt{\sum_{i=1}^{n} (X_{ij} - X_{ik})^2} \tag{2}$$

Eq. (2) gives the square root of the sum of the squares of the differences of the values of the n attributes.

The average Euclidean distance coefficient d_{jk} is defined as the average of the squares of the differences, expressed as,

$$d_{jk} = \sqrt{\sum_{i=1}^{n} \left[\frac{(X_{ij} - X_{ik})^2}{n} \right]} \tag{3}$$

In all these equations X_{ij} stands for the value of the ith attribute measured on the jth object and X_{ik} is the value of the ith attribute measured for the kth object, (Romesburg, 1984).

The UPGMA method is used to reanalyze quintet members groups in Lee catalog (Lee et al., 2004). The Euclidean distance coefficient, which one of the clustering techniques, is used. Depending on the Euclidean distance coefficient, we can decide whether we are dealing with a cluster, sub cluster, twin or a triplet, etc.

We used the same criteria in Sabry et al. (2009), (2012), (2016) and Sabry (2016a,b) to test the physical reality of each members in all quintet Lee groups. Which suppose that:

1. Galaxies of coefficients smaller by any value than $e_{av} - \sigma$ are given the name Twin (T). The twin property is here of a relative sense, because it depends on the attributes of the groups. No standardization has been done yet.
2. Galaxies of coefficients of the order $e_{ij} < e_{av}$ given the name pair (P).
3. Coefficients ranging between $e_{av} \leqslant e_{ij} \leqslant e_{av} + \sigma$ are given the name member (M)
4. If the coefficients are $e_{ij} > e_{av} + \sigma$, it is called attribute discordant galaxy (AD). It is the galaxy that, whenever its attributes enters with attributes of the other galaxies in an assembly falsifies the Euclidean coefficients.
5. To decide the triplet character, the Combined Euclidean Distance Coefficient (CEC) should be determined. Although triplets can be seen directly from the coefficients, we found it necessary to determine the CEC to confirm the results and isolate them quantitatively.

Table 1
The attributes of 5 galaxies in LeeCG 6.

Attributes	Object				
	1	2	3	4	5
$(r^* - i^*)$	0.533	0.53	0.506	0.523	0.627
$(i^* - z^*)$	0.446	0.434	0.422	0.468	0.563

Table 2
Resemblance matrix coefficients.

	1	2	3	4
1				
2	0.012369			
3	0.036125	0.026833		
4	0.024166	0.034713	0.049041	
5	0.150083	0.1614	0.185801	0.140858

The following Table 1 is an example to indicate how to deal with. For LeeCG 6 from catalogue of Lee et al. (2004), a segment of the Lee list is shown in Table 1 where, row 1 gives the attributes (the (non-dreddened) SDSS r $\sim$ band and i $\sim$ band model magnitude of the 5 members and row 2 gives the (non-dreddened) SDSS i $\sim$ band and z $\sim$ band model magnitude of the same members.

Applying Eq. (2) gives the Euclidian distance coefficient which shows the degree of similarity or dissimilarity between the two objects.

We get resemblance matrix of LeeCG 6 in Table 2.

Following the criteria we can say that galaxies 1 and 2 make a twin, galaxies 1 and 3 make a pair, galaxies 1 and 4 make a pair too, galaxies 3 and 4 make a pair binary and galaxy 5 may be attribute discordant

3. Results

By Appling the UPGAMA method in the lee Compact Groups which have five members only from the catalog of Lee et al. (2004) and calculating the astrophysical euclidean separation coefficients 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 we get the results shown in Table 3 as follows:

Column (1): the number of the euclidean confidents array, column (2): the (non-dreddened) SDSS r $\sim$ band and i $\sim$ band model magnitude of the first object, column (3): the (non-dreddened) SDSS r $\sim$ band and i $\sim$ band model magnitude of the second, column (4): the (non-dreddened) SDSS i $\sim$ band and z $\sim$ band model magnitude of the first object, column (5): the (non-dreddened) SDSS i $\sim$ band and z $\sim$ band model magnitude of the second object, column(6): the calculated Astrophysical euclidean coefficient, column (7) is the average astrophysical euclidean coefficient, column (8): the standard deviation, column (9): the classification of every two galaxies regarding each other and column (10) is the comments.

Table 3
The Average Astrophysical Euclidean Coefficients in the quintet Lee Groups of Galaxies.

	$(r^*-i^*)_i$	$(r^*-i^*)_j$	$(i^*-z^*)_i$	$(i^*-z^*)_j$	e_{ij}	e_{av}	σ		Comments
LeeCG No.6									
e_{12}	0.533	0.53	0.446	0.434	0.012369	0.082139	0.068184	T	
e_{13}	0.533	0.506	0.446	0.422	0.036125			P	G_{12} makes a twin
e_{14}	0.533	0.523	0.446	0.468	0.024166			P	G_{13} makes a pair
e_{15}	0.533	0.627	0.446	0.563	0.150083			M	G_{14} makes a pair
e_{23}	0.53	0.506	0.434	0.422	0.026833			P	G_{34} makes a pair
e_{24}	0.53	0.523	0.434	0.468	0.034713			P	Galaxy 5 may be attribute discordant
e_{25}	0.53	0.627	0.434	0.563	0.1614			AD	
e_{34}	0.506	0.523	0.422	0.468	0.049041			P	
e_{35}	0.506	0.627	0.422	0.563	0.185801			AD	
e_{45}	0.523	0.627	0.468	0.563	0.140858			P	
LeeCG No.8									
e_{12}	0.564	0.569	0.396	0.326	0.070178	0.081988	0.037814	P	
e_{13}	0.564	0.581	0.396	0.28	0.117239			M	G_{12} makes a pair
e_{14}	0.564	0.576	0.396	0.294	0.102703			M	G_{23} makes a pair
e_{15}	0.564	0.665	0.396	0.359	0.107564			M	G_{24} makes a twin
e_{23}	0.569	0.581	0.326	0.28	0.047539			P	G_{34} makes a twin
e_{24}	0.569	0.576	0.326	0.294	0.032757			T	
e_{25}	0.569	0.665	0.326	0.359	0.101514			M	
e_{34}	0.581	0.576	0.28	0.294	0.014866			T	
e_{35}	0.581	0.665	0.28	0.359	0.115313			M	
e_{45}	0.576	0.665	0.294	0.359	0.110209			P	
LeeCG No.16									
e_{12}	0.497	0.394	0.365	0.265	0.143558	0.185915	0.093258	P	G_{12} makes a pair
e_{13}	0.497	0.403	0.365	0.469	0.140186			P	G_{13} makes a pair
e_{14}	0.497	0.447	0.365	0.417	0.072139			T	G_{14} makes a twin
e_{15}	0.497	0.468	0.365	0.118	0.248697			M	G_{34} makes a twin
e_{23}	0.394	0.403	0.265	0.469	0.204198			M	
e_{24}	0.394	0.447	0.265	0.417	0.160975			P	Galaxy 5 may be attribute discordant
e_{25}	0.394	0.468	0.265	0.118	0.164575			P	
e_{34}	0.403	0.447	0.469	0.417	0.068118			T	
e_{35}	0.403	0.468	0.469	0.118	0.356968			AD	
e_{45}	0.447	0.468	0.417	0.118	0.299737			AD	
LeeCG No.18									
e_{12}	0.534	0.527	0.433	0.375	0.058421	0.260222	0.168838	T	G_{12} makes a twin.
e_{13}	0.534	0.532	0.433	0.348	0.085024			T	G_{13} makes a twin
e_{14}	0.534	0.875	0.433	0.581	0.371732			M	G_{14} makes a twin
e_{15}	0.534	0.35	0.433	0.537	0.211358			P	G_{23} makes a twin
e_{23}	0.527	0.532	0.375	0.348	0.027459			T	G_{25} makes a pair
e_{24}	0.527	0.875	0.375	0.581	0.404401			M	
e_{25}	0.527	0.35	0.375	0.537	0.239944			P	
e_{34}	0.532	0.875	0.348	0.581	0.414654			M	
e_{35}	0.532	0.35	0.348	0.537	0.262383			M	
e_{45}	0.875	0.35	0.581	0.537	0.526841			AD	
LeeCG No.20									
e_{12}	0.52	0.52	0.459	0.466	0.007	0.20478	0.194589	T	G_{12} makes a twin
e_{13}	0.52	0.522	0.459	0.441	0.018111			P	G_{13} makes a pair.
e_{14}	0.52	0.481	0.459	0.543	0.092612			P	G_{14} makes a pair
e_{15}	0.52	0.935	0.459	0.508	0.417883			AD	G_{34} makes a twin
e_{23}	0.52	0.522	0.466	0.441	0.02508			P	Galaxy 5 may be attribute discordant
e_{24}	0.52	0.481	0.466	0.543	0.086313			P	
e_{25}	0.52	0.935	0.466	0.508	0.41712			AD	
e_{34}	0.522	0.481	0.441	0.543	0.109932			P	
e_{35}	0.522	0.935	0.441	0.508	0.418399			AD	
e_{45}	0.481	0.935	0.543	0.508	0.455347			AD	
LeeCG No.27									
e_{12}	0.452	0.414	0.349	0.332	0.041629	0.100521	0.070676	P	G_{12} makes a pair
e_{13}	0.452	0.421	0.349	0.344	0.031401			P	G_{13} makes a pair
e_{14}	0.452	0.396	0.349	0.278	0.090427			P	G_{14} makes a pair
e_{15}	0.452	0.291	0.349	0.209	0.213357			AD	G_{23} makes a twin
e_{23}	0.414	0.421	0.332	0.344	0.013892			T	G_{24} makes a pair
e_{24}	0.414	0.396	0.332	0.278	0.056921			P	G_{34} makes a twin Galaxy 5 may be attribute discordant
e_{25}	0.414	0.291	0.332	0.209	0.173948			AD	
e_{34}	0.421	0.396	0.344	0.278	0.070576			P	
e_{35}	0.421	0.291	0.344	0.209	0.187417			AD	
e_{45}	0.396	0.291	0.278	0.209	0.125642			P	
LeeCG No.36									
e_{12}	0.485	0.677	0.415	0.384	0.194487	0.251859	0.156003	P	G_{12} makes a pair
e_{13}	0.485	0.264	0.415	0.071	0.408873			AD	G_{14} makes a twin

(*continued on next page*)

Table 3 (*continued*)

	$(r^*-i^*)_i$	$(r^*-i^*)_j$	$(i^*-z^*)_i$	$(i^*-z^*)_j$	e_{ij}	e_{av}	σ		Comments
e_{14}	0.485	0.568	0.415	0.379	0.090471			T	G_{24} makes a pair
e_{15}	0.485	0.479	0.415	0.299	0.116155			P	G_{34} makes a twin
e_{23}	0.677	0.264	0.384	0.071	0.518207			AD	Galaxy 5 may be attribute discordant
e_{24}	0.677	0.568	0.384	0.379	0.109115			P	
e_{25}	0.677	0.479	0.384	0.299	0.215474			P	
e_{34}	0.264	0.568	0.071	0.379	0.432759			AD	
e_{35}	0.264	0.479	0.071	0.299	0.313383			M	
e_{45}	0.568	0.479	0.379	0.299	0.11967			P	
LeeCG No.43									
e_{12}	0.431	0.435	0.351	0.404	0.053151	0.070563	0.037519	P	G_{12} makes a pair
e_{13}	0.431	0.459	0.351	0.352	0.028018			T	G_{13} makes a twin
e_{14}	0.431	0.466	0.351	0.389	0.051662			P	G_{14} makes a pair
e_{15}	0.431	0.548	0.351	0.416	0.133843			AD	G_{23} makes a pair
e_{23}	0.435	0.459	0.404	0.352	0.057271			P	G_{24} makes a pair
e_{24}	0.435	0.466	0.404	0.389	0.034438			P	G_{34} makes a twin
e_{25}	0.435	0.548	0.404	0.416	0.113635			AD	Galaxy 5 may be attribute discordant
e_{34}	0.459	0.466	0.352	0.389	0.037656			P	
e_{35}	0.459	0.548	0.352	0.416	0.109622			AD	
e_{45}	0.466	0.548	0.389	0.416	0.086331			P	
LeeCG No.46									
e_{12}	0.456	0.441	0.401	0.378	0.027459	0.052783	0.023332	T	
e_{13}	0.456	0.402	0.401	0.344	0.078518			AD	G_{12} makes a twin
e_{14}	0.456	0.473	0.401	0.351	0.052811			M	G_{14} makes a pair
e_{15}	0.456	0.406	0.401	0.34	0.078873			AD	G_{23} makes a pair
e_{23}	0.441	0.402	0.378	0.344	0.05174			P	G_{24} makes a pair
e_{24}	0.441	0.473	0.378	0.351	0.041869			P	G_{35} makes a twin
e_{25}	0.441	0.406	0.378	0.34	0.051662			P	
e_{34}	0.402	0.473	0.344	0.351	0.071344			M	The group have 2 subgroups
e_{35}	0.402	0.406	0.344	0.34	0.005657			T	
e_{45}	0.473	0.406	0.351	0.34	0.067897			P	
LeeCG No.48									
e_{12}	0.419	0.406	0.354	0.335	0.023022	0.101133	0.070278	T	G_{12} makes a twin
e_{13}	0.419	0.282	0.354	0.217	0.193747			AD	G_{14} makes a pair
e_{14}	0.419	0.401	0.354	0.343	0.021095			T	G_{24} makes a twin
e_{15}	0.419	0.439	0.354	0.265	0.09122			P	G_{24} makes a pair
e_{23}	0.406	0.282	0.335	0.217	0.171172			M	G_{45} makes a twin
e_{24}	0.406	0.401	0.335	0.343	0.009434			T	
e_{25}	0.406	0.439	0.335	0.265	0.077389			P	Galaxy 3 may be attribute discordant
e_{34}	0.282	0.401	0.217	0.343	0.173312			AD	
e_{35}	0.282	0.439	0.217	0.265	0.164174			M	
e_{45}	0.401	0.439	0.343	0.265	0.086764			P	
LeeCG No.57									
e_{12}	0.422	0.334	0.375	0.161	0.231387	0.169933	0.093076	M	
e_{13}	0.422	0.557	0.375	0.365	0.13537			P	G_{13} makes a pair.
e_{14}	0.422	0.436	0.375	0.339	0.038626			T	G_{14} makes a twin
e_{15}	0.422	0.48	0.375	0.453	0.097201			P	G_{23} makes a twin
e_{23}	0.334	0.557	0.161	0.365	0.302233			AD	G_{35} makes a pairG_{34} makes a pair
e_{24}	0.334	0.436	0.161	0.339	0.205154			M	
e_{25}	0.334	0.48	0.161	0.453	0.326466			AD	The groups have 2 subgroups
e_{34}	0.557	0.436	0.365	0.339	0.123762			P	
e_{35}	0.557	0.48	0.365	0.453	0.116932			P	
e_{45}	0.436	0.48	0.339	0.453	0.122197			M	
LeeCG No.59									
e_{12}	0.557	0.465	0.326	0.554	0.245862	0.330385	0.205104	P	G_{12} makes a pair
e_{13}	0.557	0.417	0.326	0.435	0.177429			P	G_{13} makes a pair.
e_{14}	0.557	0.551	0.326	0.579	0.253071			P	G_{14} makes a pair
e_{15}	0.557	0.068	0.326	0.812	0.689432			AD	G_{23} makes a pair
e_{23}	0.465	0.417	0.554	0.435	0.128316			P	G_{24} makes a twin
e_{24}	0.465	0.551	0.554	0.579	0.08956			T	G_{34} makes a pair
e_{25}	0.465	0.068	0.554	0.812	0.473469			M	
e_{34}	0.417	0.551	0.435	0.579	0.196703			P	Galaxy 5 may be attribute discordant
e_{35}	0.417	0.068	0.435	0.812	0.513741			M	
e_{45}	0.551	0.068	0.579	0.812	0.536263			AD	
LeeCG No.61									
e_{12}	0.516	0.504	0.391	0.36	0.033242	0.267024	0.266684	P	G_{12} makes a pair
e_{13}	0.516	0.447	0.391	0.34	0.085802			P	G_{13} makes a pair
e_{14}	0.516	0.429	0.391	0.355	0.094154			P	G_{14} makes a pair
e_{15}	0.516	0.043	0.391	−0.018	0.625308			AD	G_{23} makes a twin
e_{23}	0.504	0.447	0.36	0.34	0.060407			P	G_{24} makes a pair
e_{24}	0.504	0.429	0.36	0.355	0.075166			P	G_{34} makes a twin
e_{25}	0.504	0.043	0.36	−0.018	0.596159			AD	

Table 3 (*continued*)

	$(r^*-i^*)_i$	$(r^*-i^*)_j$	$(i^*-z^*)_i$	$(i^*-z^*)_j$	e_{ij}	e_{av}	σ		Comments
e_{34}	0.447	0.429	0.34	0.355	0.023431			P	Galaxy 5 is attribute
e_{35}	0.447	0.043	0.34	−0.018	0.539796			AD	Discordant
e_{45}	0.429	0.043	0.355	−0.018	0.536773			AD	
LeeCG No.68									
e_{12}	0.484	0.436	0.438	0.468	0.056604	0.097034	0.045157	P	G_{12} makes a pair
e_{13}	0.484	0.438	0.438	0.428	0.047074			T	G_{13} makes a twin
e_{14}	0.484	0.392	0.438	0.371	0.113811			M	G_{14} makes a pair
e_{15}	0.484	0.419	0.438	0.554	0.13297			M	G_{23} makes a twin
e_{23}	0.436	0.438	0.468	0.428	0.04005			T	G_{34} makes a twin
e_{24}	0.436	0.392	0.468	0.371	0.106513			M	The group have 2 subgroups
e_{25}	0.436	0.419	0.468	0.554	0.087664			P	
e_{34}	0.438	0.392	0.428	0.371	0.073246			P	
e_{35}	0.438	0.419	0.428	0.554	0.127424			M	
e_{45}	0.392	0.419	0.371	0.554	0.184981			AD	
LeeCG No.76									
e_{12}	0.565	0.491	0.343	0.516	0.188162	0.125526	0.062014	AD	G_{15} makes a pair.
e_{13}	0.565	0.522	0.343	0.518	0.180205			M	G_{14} makes a twin
e_{14}	0.565	0.531	0.343	0.39	0.058009			T	G_{23} makes a twin
e_{15}	0.565	0.492	0.343	0.325	0.075186			P	G_{24} makes a pair
e_{23}	0.491	0.522	0.516	0.518	0.031064			T	G_{23} makes a twin
e_{24}	0.491	0.531	0.516	0.39	0.132197			M	
e_{25}	0.491	0.492	0.516	0.325	0.191003			AD	The group have 2 subgroups
e_{34}	0.522	0.531	0.518	0.39	0.128316			M	
e_{35}	0.522	0.492	0.518	0.325	0.195318			AD	
e_{45}	0.531	0.492	0.39	0.325	0.075802			M	
LeeCG No.77									
e_{12}	0.372	−0.099	0.345	0.083	0.538967	1.063901	0.570769	P	G_{12} makes a pair
e_{13}	0.372	0.678	0.345	0.411	0.313037			T	G_{13} makes a twin.
e_{14}	0.372	−0.425	0.345	−0.253	0.9964			P	G_{14} makes a pair
e_{15}	0.372	−0.584	0.345	−1.199	1.816004			AD	G_{23} makes a twin
e_{23}	−0.099	0.678	0.083	0.411	0.843394			P	G_{24} makes a twin
e_{24}	−0.099	−0.425	0.083	−0.253	0.468158			T	G_{34} makes a twin
e_{25}	−0.099	−0.584	0.083	−1.199	1.370675			M	
e_{34}	0.678	−0.425	0.411	−0.253	1.287441			M	Galaxy 5 is attribute
e_{35}	0.678	−0.584	0.411	−1.199	2.045665			AD	Discordant
e_{45}	−0.425	−0.584	−0.253	−1.199	0.959269			P	
LeeCG No.79									
e_{12}	0.193	0.311	0.462	0.415	0.127016	0.290079	0.138596	T	G_{12} makes a twin
e_{13}	0.193	0.571	0.462	0.045	0.562826			AD	G_{14} makes a pair
e_{14}	0.193	0.407	0.462	0.349	0.242002			P	G_{24} makes a twin
e_{15}	0.193	0.293	0.462	0.177	0.302035			M	
e_{23}	0.311	0.571	0.415	0.045	0.452217			AD	The group have 2 subgroups
e_{24}	0.311	0.407	0.415	0.349	0.116499			T	(Triplet 1,2,4)
e_{25}	0.311	0.293	0.415	0.177	0.23868			P	
e_{34}	0.571	0.407	0.045	0.349	0.345416			M	
e_{35}	0.571	0.293	0.045	0.177	0.307747			M	
e_{45}	0.407	0.293	0.349	0.177	0.206349			P	
LeeCG No.81									
e_{12}	0.462	0.546	0.362	0.379	0.085703	0.197575	0.099497	T	G_{12} makes a twin
e_{13}	0.462	0.592	0.362	0.328	0.134373			P	G_{13} makes a pair.
e_{14}	0.462	0.341	0.362	0.123	0.267884			M	G_{15} makes a twin
e_{15}	0.462	0.374	0.362	0.394	0.093638			T	G_{23} makes a twin
e_{23}	0.546	0.592	0.379	0.328	0.06868			T	G_{24} makes a pair
e_{24}	0.546	0.341	0.379	0.123	0.327965			AD	G_{34} makes a twin
e_{25}	0.546	0.374	0.379	0.394	0.172653			P	
e_{34}	0.592	0.341	0.328	0.123	0.324077			AD	
e_{35}	0.592	0.374	0.328	0.394	0.227772			M	
e_{45}	0.341	0.374	0.123	0.394	0.273002			P	
LeeCG No.84									
e_{12}	0.414	0.391	0.381	0.235	0.147801	0.095612	0.054239	M	
e_{13}	0.414	0.455	0.381	0.383	0.041049			T	G_{13} makes a twin.
e_{14}	0.414	0.443	0.381	0.383	0.029069			T	G_{14} makes a twin
e_{15}	0.414	0.358	0.381	0.308	0.092005			P	G_{15} makes a pair
e_{23}	0.391	0.455	0.235	0.383	0.161245			AD	G_{34} makes a twin
e_{24}	0.391	0.443	0.235	0.383	0.156869			AD	
e_{25}	0.391	0.358	0.235	0.308	0.080112			P	Galaxy 2 may be attribute discordant
e_{34}	0.455	0.443	0.383	0.383	0.012			T	
e_{35}	0.455	0.358	0.383	0.308	0.122613			M	
e_{45}	0.443	0.358	0.383	0.308	0.113358			M	
LeeCG No.109									
e_{12}	0.54	0.288	0.312	0.403	0.267927	0.205419	0.109647	M	
e_{13}	0.54	0.523	0.312	0.279	0.037121			T	

(*continued on next page*)

Table 3 (*continued*)

	$(r^* - i^*)_i$	$(r^* - i^*)_j$	$(i^* - z^*)_i$	$(i^* - z^*)_j$	e_{ij}	e_{av}	σ		Comments
e_{14}	0.54	0.581	0.312	0.338	0.048549			T	G_{13} makes a twin
e_{15}	0.54	0.435	0.312	0.1	0.236578			M	G_{14} makes a twin
e_{23}	0.288	0.523	0.403	0.279	0.265708			M	G_{34} makes a twin
e_{24}	0.288	0.581	0.403	0.338	0.300123			M	G_{35} makes a pair
e_{25}	0.288	0.435	0.403	0.1	0.336776			AD	Galaxy 2 may be attribute discordant
e_{34}	0.523	0.581	0.279	0.338	0.082735			T	
e_{35}	0.523	0.435	0.279	0.1	0.199462			P	
e_{45}	0.581	0.435	0.338	0.1	0.279213			M	
LeeCG No.119									
e_{12}	0.388	0.459	0.138	0.337	0.211287	0.135359	0.067929	AD	
e_{13}	0.388	0.389	0.138	0.223	0.085006			P	G_{13} makes a pair.
e_{14}	0.388	0.372	0.138	0.105	0.036674			T	G_{14} makes a twin
e_{15}	0.388	0.385	0.138	0.301	0.163028			M	G_{23} makes a pair
e_{23}	0.459	0.389	0.337	0.223	0.133776			P	G_{34} makes a pair
e_{24}	0.459	0.372	0.337	0.105	0.247776			AD	G_{25} makes a pair
e_{25}	0.459	0.385	0.337	0.301	0.082292			P	G_{35} makes a twin
e_{34}	0.389	0.372	0.223	0.105	0.119218			P	
e_{35}	0.389	0.385	0.223	0.301	0.078102			P	
e_{45}	0.372	0.385	0.105	0.301	0.196431			M	
LeeCG No.134									
e_{12}	0.44	0.44	0.376	0.34	0.036	0.102824	0.064404	T	
e_{13}	0.44	0.349	0.376	0.196	0.201695			AD	G_{12} makes a twin.
e_{14}	0.44	0.432	0.376	0.324	0.052612			P	G_{14} makes a pair
e_{15}	0.44	0.366	0.376	0.363	0.075133			P	G_{24} makes a twin
e_{23}	0.44	0.349	0.34	0.196	0.170344			AD	G_{45} makes a pair
e_{24}	0.44	0.432	0.34	0.324	0.017889			T	Galaxy 3 is attribute
e_{25}	0.44	0.366	0.34	0.363	0.077492			P	discordant
e_{34}	0.349	0.432	0.196	0.324	0.152555			M	
e_{35}	0.349	0.366	0.196	0.363	0.167863			AD	
e_{45}	0.432	0.366	0.324	0.363	0.076662			P	
LeeCG No.136									
e_{12}	0.444	0.436	0.358	0.346	0.014422	0.21172	0.117359	T	G_{12} makes a twin
e_{13}	0.444	0.388	0.358	0.3	0.080623			T	G_{13} makes a twin
e_{14}	0.444	0.475	0.358	0.022	0.337427			AD	
e_{15}	0.444	0.284	0.358	0.111	0.294294			M	G_{23} makes a twin
e_{23}	0.436	0.388	0.346	0.3	0.066483			T	The group have 2 subgroups(
e_{24}	0.436	0.475	0.346	0.022	0.326339			M	Triplet 1,2,3) and (double 4,5)
e_{25}	0.436	0.284	0.346	0.111	0.279873			M	
e_{34}	0.388	0.475	0.3	0.022	0.291295			M	
e_{35}	0.388	0.284	0.3	0.111	0.215724			M	
e_{45}	0.475	0.284	0.022	0.111	0.210718			P	
LeeCG No.146									
e_{12}	0.46	0.239	0.353	0.209	0.263775	0.168751	0.113867	M	
e_{13}	0.46	0.434	0.353	0.379	0.03677			T	G_{13} makes a twin
e_{14}	0.46	0.442	0.353	0.437	0.085907			P	G_{14} makes a pair
e_{15}	0.46	0.548	0.353	0.376	0.090956			P	G_{15} makes a pair
e_{23}	0.239	0.434	0.209	0.379	0.258699			M	G_{34} makes a pair.
e_{24}	0.239	0.442	0.209	0.437	0.305275			AD	G_{35} makes a pair
e_{25}	0.239	0.548	0.209	0.376	0.351241			AD	
e_{34}	0.434	0.442	0.379	0.437	0.058549			P	The group have 2 subgroups
e_{35}	0.434	0.548	0.379	0.376	0.114039			P	
e_{45}	0.442	0.548	0.437	0.376	0.122299			M	
LeeCG No.153									
e_{12}	0.465	0.466	0.362	0.325	0.037014	0.276173	0.169258	T	
e_{13}	0.465	0.383	0.362	0.346	0.083546			T	G_{12} makes a twin
e_{14}	0.465	0.243	0.362	0.021	0.406897			M	G_{13} makes a twin.
e_{15}	0.465	0.323	0.362	0.596	0.273715			P	G_{15} makes a pair
e_{23}	0.466	0.383	0.325	0.346	0.085615			T	G_{23} makes a twin
e_{24}	0.466	0.243	0.325	0.021	0.377021			M	G_{35} makes a pair
e_{25}	0.466	0.323	0.325	0.596	0.306415			M	Galaxy 4 may be attribute discordant
e_{34}	0.383	0.243	0.346	0.021	0.353871			M	
e_{35}	0.383	0.323	0.346	0.596	0.257099			P	
e_{45}	0.243	0.323	0.021	0.596	0.580539			AD	
LeeCG No.162									
e_{12}	0.453	0.484	0.389	0.312	0.083006	0.197763	0.10372	T	
e_{13}	0.453	0.444	0.389	0.134	0.255159			M	G_{12} makes a twin
e_{14}	0.453	0.407	0.389	0.087	0.305483			AD	G_{15} makes a pair.
e_{15}	0.453	0.552	0.389	0.404	0.10013			P	G_{14} makes a pair
e_{23}	0.484	0.444	0.312	0.134	0.182439			P	G_{23} makes a pair
e_{24}	0.484	0.407	0.312	0.087	0.237811			M	G_{34} makes a twin
e_{25}	0.484	0.552	0.312	0.404	0.114403			P	
e_{34}	0.444	0.407	0.134	0.087	0.059816			T	

Table 3 (*continued*)

	$(r^*-i^*)_i$	$(r^*-i^*)_j$	$(i^*-z^*)_i$	$(i^*-z^*)_j$	e_{ij}	e_{av}	σ		Comments
e_{35}	0.444	0.552	0.134	0.404	0.290799			M	
e_{45}	0.407	0.552	0.087	0.404	0.348589			AD	
LeeCG No.163									
e_{12}	0.353	0.596	0.187	0.422	0.338044	0.271832	0.11377	M	
e_{13}	0.353	0.467	0.187	0.463	0.298617			M	G_{14} makes a twin
e_{14}	0.353	0.395	0.187	0.191	0.04219			T	G_{23} makes a twin
e_{15}	0.353	0.153	0.187	0.326	0.243559			P	G_{24} makes a pair
e_{23}	0.596	0.467	0.422	0.463	0.135359			T	G_{34} makes a twin
e_{24}	0.596	0.395	0.422	0.191	0.306206			M	
e_{25}	0.596	0.153	0.422	0.326	0.453282			AD	
e_{34}	0.467	0.395	0.463	0.191	0.281368			M	
e_{35}	0.467	0.153	0.463	0.326	0.342586			M	
e_{45}	0.395	0.153	0.191	0.326	0.277108			M	
LeeCG No.166									
e_{12}	0.45	0.519	0.38	0.433	0.087006	0.099357	0.058149	P	G_{12} makes a pair
e_{13}	0.45	0.464	0.38	0.372	0.016125			T	G_{13} makes a twin
e_{14}	0.45	0.444	0.38	0.234	0.146123			M	G_{15} makes a pair
e_{15}	0.45	0.451	0.38	0.332	0.04801			P	G_{23} makes a pair
e_{23}	0.519	0.464	0.433	0.372	0.082134			P	G_{35} makes a pair
e_{24}	0.519	0.444	0.433	0.234	0.212664			AD	Galaxy 4 may be attribute discordant
e_{25}	0.519	0.451	0.433	0.332	0.121758			M	
e_{34}	0.464	0.444	0.372	0.234	0.139442			M	
e_{35}	0.464	0.451	0.372	0.332	0.042059			P	
e_{45}	0.444	0.451	0.234	0.332	0.09825			P	
LeeCG No.170									
e_{12}	0.44	0.508	0.364	0.254	0.129321	0.38615	0.19257	T	G_{12} makes a twin
e_{13}	0.44	0.323	0.364	0.264	0.153912			T	G_{13} makes a twin
e_{14}	0.44	0.193	0.364	−0.04	0.473524			M	G_{23} makes a twin
e_{15}	0.44	0.214	0.364	0.708	0.411597			M	G_{34} makes a pair
e_{23}	0.508	0.323	0.254	0.264	0.18527			T	Galaxy 5 is attribute
e_{24}	0.508	0.193	0.254	−0.04	0.430884			M	Discordant
e_{25}	0.508	0.214	0.254	0.708	0.540881			M	
e_{34}	0.323	0.193	0.264	−0.04	0.33063			P	
e_{35}	0.323	0.214	0.264	0.708	0.457184			M	
e_{45}	0.193	0.214	−0.04	0.708	0.748295			AD	
LeeCG No.172									
e_{12}	0.511	0.526	0.382	0.313	0.070612	0.062451	0.034972	M	G_{14} makes a twin
e_{13}	0.511	0.441	0.382	0.398	0.071805			M	G_{15} makes a twin
e_{14}	0.511	0.506	0.382	0.384	0.005385			T	Galaxy 2 and 3 may
e_{15}	0.511	0.525	0.382	0.399	0.022023			T	Be attribute discordant
e_{23}	0.526	0.441	0.313	0.398	0.120208			AD	
e_{24}	0.526	0.506	0.313	0.384	0.073763			M	
e_{25}	0.526	0.525	0.313	0.399	0.086006			M	
e_{34}	0.441	0.506	0.398	0.384	0.066491			M	
e_{35}	0.441	0.525	0.398	0.399	0.084006			M	
e_{45}	0.506	0.525	0.384	0.399	0.024207			M	
LeeCG No.175									
e_{12}	0.567	0.492	0.372	0.44	0.101237	0.518455	0.413914	T	G_{12} makes a twin
e_{13}	0.567	0.469	0.372	0.335	0.104752			P	G_{13} makes a pair.
e_{14}	0.567	0.612	0.372	0.083	0.292482			P	G_{14} makes a pair
e_{15}	0.567	0.353	0.372	−0.65	1.044165			AD	G_{23} makes a pair
e_{23}	0.492	0.469	0.44	0.335	0.10749			P	G_{24} makes a pair
e_{24}	0.492	0.612	0.44	0.083	0.376628			P	G_{34} makes a pair
e_{25}	0.492	0.353	0.44	−0.65	1.098827			AD	Galaxy 5 may be attribute discordant
e_{34}	0.469	0.612	0.335	0.083	0.289746			P	
e_{35}	0.469	0.353	0.335	−0.65	0.991807			AD	
e_{45}	0.612	0.353	0.083	−0.65	0.777412			P	

4. Conclusion

By applying Unweighted pair group method (UPGMA method) on the quintet groups of Lee compact groups of galaxies catalog (Lee et al., 2004) and using the Euclidian separation coefficient as a dissimilarity measure and calculating the difference between the astrophysical parameters (the (non-dreddened) SDSS r ∼ band and i ∼ band model magnitude, the (non-dreddened) SDSS i ∼ band and z ∼ band model magnitude) of the members in each groups to inspect the reality of the members of galaxies in each group, we classify each two galaxies (T, P, M, AD) according to the value of the similarity.

Sabry et al. (2009) criteria were used along with the method on the quintet groups of galaxies in the Lee catalog (Lee et al., 2004).

The results from quintet Lee groups show that most of the members in the groups are real members while some groups have one or more attribute discordant galaxies and some groups contain two sub groups.

To inspect the reality of the results the combined Euclidean coefficient was applied

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

where m, j and k are galaxy members of the same group

Table 4
List of eighteen groups that have one or more galaxy that has attribute discordant and should be discarded from the group.

Group No.	Attribute discordant galaxy Number
LeeCG No.6	5
LeeCG No.16	5
LeeCG No.20	5
LeeCG No.27	5
LeeCG No.36	5
LeeCG No.43	5
LeeCG No.48	3
LeeCG No.59	5
LeeCG No.61	5
LeeCG No.77	5
LeeCG No.84	2
LeeCG No.109	2
LeeCG No.134	3
LeeCG No.153	4
LeeCG No.166	4
LeeCG No.170	5
LeeCG No.172	2,3
LeeCG No.175	5

Applying the combined Euclidean coefficient showed that:

1. 12 Groups are real groups with real members
2. 18 Groups have one or more galaxy that has attribute discordant and should be discarded from its group (Table 4).

References

Allam, S.S., Tucker, D.L., 2000. AN 321 (2), 101.
Barton, E., Geller, M.J., Ramella, M., Marzke, R., da Costa, L., 1996. AJ 112, 871.
de Vaucouleurs, G., 1975. ApJ 202, 319.
deCarvalho, R.R. et al., 2005. AJ 130, 425.
Deng, X.-F., He, J.-Z., Ma, X.-S., Jiang, P., Tang, X.-X., 2008. Central Eur. J. Phys 6 (2), 185.
Diaz-Gimenez, E., Mamon, G.A., Pacheco, M., Mendes de Oliveira, C., Alonso, M.V., 2012. MNRAS 426 (1), 296.
Focardi, P., Kelm, B., 2002. A&A 301, 35.
Garcia, A.M., 1995. A&A 297 (1), 56.
Hickson, P., 1982. ApJ 255, 382.
Hickson, P., Mendes de Oliveira, C., Huchra, J.P., Palumbo, G., 1992. ApJ 399, 353.
Huchra, J.P., Geller, M.J., 1982. ApJ 257, 423.
Huchra, J.P., Davis, M., Latham, D.W., Tonry, J., 1983. ApJS 52, 89.
Karachentsev, V.E., Karachentsev, I.D., Scherbanovsky, A.L., 1979. IZv. Space. Astrophys. Obs. 11, 3.
Lee, B.C., Allam, S., Tucker, D.L, Annis, J., Johnston, D., Scranton, R., Acebo, Yamina, Bahcall, Neta, A., et al., 2004, AJ, vol. 127, pp. 1811L.
McConnachie, Alan W., Brasseur, Crystal M., Ellison, Sara L., Patton, David R., 2009, MNRAS, vol. 395, pp. 255.
Mohamed, Sabry A., 2016a. Int. J. Adv. Res. 4 (5), 364–384.
Mohamed, Sabry A., 2016b. Int. J. Adv. Res. 4 (7), 708–734.
Mohamed, Sabry A., Issa, Issa A., Osman, A.I., Bakry, A., Beahary, M., 2009. Investigation in Groups of Galaxies (PhD). Azhar Univ.
Mohamed, Sabry A., Youssef, Shahinaz M., Aboushelib, Mohamed F., 2016. Int. J. Adv. Res. 4 (4), 1439–1456.
Murtagh, F., 1984. Complexities of Hierarchic Clustering Algorithms: the state of the art. Comput. Stat. Quart. 1, 101–113.
Prandoni, I., Iovino, A., MacGillivray, H.T., 1994, AJ, vol. 107, 4, pp. 1235.
Romesburg, H. Charles, 984. Cluster Analysis for Researchers. Lifetime Learning Publications, USA.
Rose, J.A., 1977. ApJ 211, 311.
Rubin, Vera C., Hunter, Deidre A., Ford, W. Kent Jr., 1991, ApJS, vol. 76, pp. 153R.
Sabry, M.A., Issa, I.A., Abdelrahman, H., Shaker, A.A., 2012. NRIAG-JAG 1, 81.
Shakhbazian, R.K., 1957. Astron. Tsirk. 177, 11.
Shakhbazyan, R.K., 1973, Ap, vol. 9, 4, pp. 296–304.
Sohn, Jubee, Hwang, Ho Seong, Geller, Margaret J., Diaferio, Antonaldo, Rines, Kenneth J., Lee, Myung Gyoon, Lee, Gwang-Ho, 2015, 2015 JKASEllipsis, 48.381S.
Sokal, R., Michener, C., 1958. A statistical method for evaluating systematic relationships. Univ. Kansas Sci. Bull. 38, 1409–1438.
Sulentic, J.W., 1983, BAAS, 15, 945S.
Tully, R.B., 1987a. ApJ 321, 280.
Tully, R.B., 1987b. Nearby Galaxies Catalog. Cambridge Univ Press, Cambridge.
Turner, E.L., Gott, J., R., 1976a, ApJS, vol. 32, pp. 409.
Turner, E. L., and Gott, J., R., 1976b, ApJ, 209, 6.
Wang, Yu, Yang, Xiaohu, Mo, H.J., van den Bosch, Frank C., Weinmann, Simone M., Chu, Yaoquan, 2008, ApJ, vol. 687, pp. 919.
William, H.E., Edelsbrunner, Herbert, 1984–12-01. Efficient algorithms for agglomerative hierarchical clustering methods. J. Classif., vol. 1, 1, pp. 7–24.