Compact Group Selection From Redshift Surveys

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ABSTRACT

For the first time, we construct a catalog of compact groups selected from a complete, magnitude-limited redshift survey. We select groups with \( N \geq 3 \) members based on projected separation and association in redshift space alone. We evaluate the characteristics of the Redshift Survey Compact Groups (RSCG’s). Their physical properties (membership frequency, velocity dispersion, density) are similar to those of the Hickson [ApJ, 255, 382 (1982)] Compact Groups. Hickson’s isolation criterion is a strong function of the physical and angular group radii and is a poor predictor of the group environment. In fact, most RSCG’s are embedded in dense environments. The luminosity function for RSCG’s is mildly inconsistent with the survey luminosity function — the characteristic luminosity is brighter and the faint end shallower for the RSCG galaxies. We construct a model of the selection function of compact groups. Using this selection function, we estimate the abundance of RSCG’s; for groups with \( N \geq 4 \) members the abundance is \( 3.8 \times 10^{-5} \, h^3 \, \text{Mpc}^{-3} \). For all RSCG’s \( (N \geq 3) \) the abundance is \( 1.4 \times 10^{-4} \, h^3 \, \text{Mpc}^{-3} \).

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1. Introduction

Compact groups are the densest known systems of galaxies in the universe. Rose (1977) and Hickson (1982) made the first large-scale, systematic searches for dense systems on the sky. Subsequent studies of the properties and environments of Hickson’s 100 Compact Groups indicate that they are probably not dynamically simple, isolated systems.

Here, for the first time, we select compact systems from a complete, magnitude-limited redshift survey. We select groups based on physical extent, rather than angular size. This approach eliminates some of the systematic biases intrinsic to identification of systems on the sky. Because we begin with a complete, magnitude-limited survey we can model the residual selection effects from first principles. We use the redshifts of galaxies surrounding our compact groups to explore the embedding of the Redshift Survey Compact Groups (RSCG’s, hereafter) in their environments.

Hickson’s work sparked debates about the physics of compact groups. The existence of compact groups is a challenge for dynamical models because their measured crossing times are generally much smaller than the Hubble time. Numerical simulations indicate that compact group galaxies merge to form bright elliptical galaxies on timescales comparable to the group crossing times (Barnes 1989; Carnevali, Cavaliere & Santangelo 1981; Cavaliere et al. 1983; Governato, Bhatia & Chincarini 1991). To resolve this problem, Mamon (1986) suggested that a large fraction of compact groups are merely unbound chance superpositions of galaxies within loose groups (Mamon 1986, 1987). Hernquist, Katz & Weinberg (1995) suggested that compact groups are unbound superpositions of galaxies viewed along filaments. In contrast, simulations by Hickson & Rood (1988) and Diaferio, Geller & Ramella (1995) and observational work by Zepf (1993) and Pildis, Bregman & Schombert (1995) suggest that many of Hickson’s compact groups (HCG’s, hereafter) are, in fact, bound systems.

The short crossing times of HCG’s are not a problem if the groups form continually in dense environments like loose groups (Barnes 1989, Diaferio, Geller & Ramella 1994). Studies of the environments around some of the HCG’s reveal that many of them are indeed embedded in larger, looser systems (Ramella et al. 1994; de Carvalho, Ribeiro & Zepf 1994).

Compact groups have implications for cosmology, the development of large-scale structure and the evolution of the galaxy population. Compact groups are more likely to form during the present epoch in a dense universe (Diaferio 1994, Governato, Tozzi & Cavaliere 1995). Diaferio, Geller & Ramella (1994) and Ramella et al. (1994) realized that compact groups may be a clue to the evolutionary state of loose groups. If compact
groups are dense environments, galaxy interactions and mergers within them are likely (Barnes 1989).

Here, we apply an objective group-finding algorithm for identifying HCG-like systems in the CfA2+SSRS2 Redshift Survey. In §2 we describe previous sky-selected compact group surveys. In §3 we describe the redshift surveys. §4 contains a description of our group-finding algorithm and the biases it introduces. In §5 we present the catalog and evaluate the physical properties of RSCG’s. In §6 we apply Hickson’s (1982) selection criteria to RSCG’s. §7 contains an analysis of the environments of RSCG’s. In §8 we evaluate the luminosity function of galaxies in RSCG’s. We then calculate the selection function and compute the resulting abundance of RSCG’s.

2. Compact Group Selection on the Sky

Examination of photographic plates led to the identification of compact groups as unusually dense, apparently isolated knots of galaxies on the sky (Shakhbazyan 1973; Vorontsov-Velyaminov 1959, 1977; Burbidge & Burbidge 1961; Arp 1966). Rose (1977) made the first large statistical study of these systems. Hickson (1982) later defined quantitative criteria for population, isolation on the sky, and compactness. He identified 100 HCG’s on the POSS R plates which satisfy 3 criteria:

- \( N \geq 4 \) where \( N \) is the number of members within 3 magnitudes of the brightest galaxy, \( m_1 \).
- \( \theta_N \geq 3 \theta_G \) where \( \theta_G \) is the angular radius of the smallest circle which contains the geometric centers of all the suggested group members. The radius \( \theta_N \) is the angular radius of the largest concentric circle which contains no further galaxies with \( m < m_1 + 3 \).
- \( \mu_G < 26 \) where \( \mu_G \) is the total magnitude of the galaxies in the R band averaged over the circle of radius \( \theta_G \), in magnitudes arcsecond\(^{-2} \).

Hickson examined the entire POSS including regions at low Galactic latitude. Later, Hickson et al. (1992) measured radial velocities of galaxies in HCG’s, and defined a set of 92 HCG’s with \( N \geq 3 \) where \( N \) now refers to the number of members within 1000 km s\(^{-1} \) of the median group velocity. The median redshift of these HCG’s is 0.030. Prandoni, Iovino & MacGillivray (1994) applied Hickson’s original criteria to automated plate scans and identified 59 candidate compact systems.
These catalogs of systems on the sky have a number of unavoidable systematic problems. First, in spite of their large projected surface density, the group candidates may include interlopers with redshifts substantially different from the systemic mean. Among the 100 systems originally identified by Hickson, 92% have $N \geq 3$; only 69% actually have $N \geq 4$ (Hickson et al. 1992). Selection on the sky unavoidably introduces correlations of group properties with distance. For example, nearby systems with a large angular scale are underrepresented in these catalogs.

3. The CfA2 + SSRS2 Redshift Survey

We select compact groups from redshift surveys which include 14,383 galaxies. CfAnorth covers the declination range $8.5^\circ \leq \delta \leq 44.5^\circ$ and right ascension range $8^h \leq \alpha \leq 17^h$ (B1950) and includes 6500 galaxies (Geller & Huchra 1989; Huchra et al. 1990; Huchra et al. 1995). CfAsouth covers the region $-2.5^\circ \leq \delta \leq 48^\circ$ and $20^h \leq \alpha \leq 4^h$ and includes 4283 galaxies (Giovanelli & Haynes 1985; Giovanelli et al. 1986; Haynes et al. 1988; Giovanelli & Haynes 1989; Wegner, Haynes & Giovanelli 1993; Giovanelli & Haynes 1993; Vogeley 1993). SSRS2 includes 3600 galaxies and is complete over 1.13 steradians of the southern galactic cap in the declination range $-40^\circ \leq \delta \leq -40^\circ$ (da Costa et al. 1994). Both SSRS2 and CfA2 are magnitude-limited to $m_B \leq 15.5$. SSRS2 is derived from plate scans. CfA2 is based on the Zwicky catalog. We use only the $cz$ range 300 km s$^{-1}$ to 15,000 km s$^{-1}$; the full sample we examine includes 14,011 galaxies.

The coordinate uncertainties in the redshift catalog are about one arcminute. We test the possible effects of the uncertainties on the very dense RSCG’s. They do not affect our compact group catalog.

4. Compact Group Selection in Redshift Space

We develop an algorithm for identifying compact systems from a complete redshift survey. Our criteria mimic the ones established by Hickson. Application of our procedure to a distance limited redshift catalog would yield a set of systems with properties independent of distance. To obtain the largest possible sample of systems, we analyze a magnitude limited redshift survey. This limitation introduces some biases as a function of distance, but they are less severe than those introduced by selection on the sky. Because we start with a complete survey we can account for these biases.

The objective algorithm we use to select compact group candidates from the redshift
surveys is a modification of the friends-of-friends algorithm developed by Huchra & Geller (1982). We use a new group-finding code from Ramella, Pisani & Geller (1996). We identify groups of galaxies as linked sets of “neighboring” galaxies. To determine whether two galaxies belong to a group, we consider both their projected separation, $\Delta D$, and their line-of-sight velocity difference, $\Delta V$. The projected separation of the pair is $\Delta D = 2 \left( \frac{v_{H_0}}{c} \right) \sin \left( \frac{\Delta \theta}{2} \right)$, where $\Delta \theta$ is the angular separation on the sky and $v = cz$ is the average redshift. Throughout the paper we use $H_0 = 100 \text{ km s}^{-1}\text{Mpc}^{-1}$.

We restrict the size of our groups by specifying limiting parameters, $D_0$ and $V_0$. If $\Delta D \leq D_0$ and $\Delta V \leq V_0$, the galaxies are neighbors. We search each galaxy in a pair of neighbors for additional neighbors. Linked sets of neighbors are groups. Groups with three or more members constitute our objective sample of compact groups. We select values of $V_0$ and $D_0$ which produce a catalog of systems with properties similar to those of Hickson Compact Groups. We keep $D_0$ fixed to ensure that we identify only systems where inter-galaxy separations are comparable with their physical size.

The line-of-sight velocity difference between galaxies in a gravitationally bound system is a measure of their relative peculiar velocity. The median radial velocity dispersion in HCG’s is only $\sim 200 \text{ km s}^{-1}$ (Hickson et al. 1992). We choose the value $V_0 = 1000 \text{ km s}^{-1}$, which is large enough to include most physically associated galaxies in compact groups. This value of $V_0$ is, however, not so large that the resulting “groups” accidentally span voids in the galaxy distribution (Geller & Huchra 1989). This value is consonant with Hickson’s procedure of rejecting galaxies with velocities different from the median group velocity by $\geq 1000 \text{ km s}^{-1}$ (Hickson et al. 1992).

The parameter $D_0$ directly limits the physical extent of our compact groups. We use $D_0$ to match our sample to the HCG’s. As a measure of the spatial extent of HCG’s, we use the distribution of all projected separations, $\Delta D$, among Hickson group members. We compare the distribution to the distribution of all projected separations in compact group catalogs extracted from the CfAnorth catalog. We apply the friends-of-friends algorithm to construct catalogs of compact group candidates at several values of $D_0$. Figure 1 shows that the value $D_0 = 50 \text{ kpc}$ yields the best match between CfAnorth (solid line) and the HCG’s (dashed line). A K-S test indicates that the null hypothesis that the density values are drawn from the same distribution is acceptable at the 19% confidence level. On the basis of this match, the catalog with $V_0 = 1000 \text{ km s}^{-1}$ and $D_0 = 50 \text{ kpc}$ is our objectively selected catalog of compact groups, the RSCG’s. Table 1 lists the median, first and third quartiles of the separation distributions for the HCG catalog and the CfAnorth catalog of compact groups. Table 1 also includes physical parameters for the RSCG’s we extract from CfAsouth, SSRS2 and CfA2+SSRS2 using $D_0 = 50 \text{ kpc}$ and $V_0 = 1000 \text{ km s}^{-1}$. Note that
the third quartile value for the SSRS2 sample (and for the CfA + SSRS2 sample) is inflated by the presence of a single group of 13 galaxies.

The physical properties of RSCG’s are similar to the HCG’s, even though we do not implement all of Hickson’s selection criteria directly. First, we do not take galaxy magnitudes into account in the group selection; some of our systems have fewer than three galaxies in the interval \([m_1, m_1 + 3]\). Furthermore, many of our groups have \(m_1 + 3 > m_{\text{lim}}\), where \(m_{\text{lim}, Zw} = 15.5\) is the limiting magnitude of the survey. Thus we do not necessarily include all of the galaxies which might be in the interval \([m_1, m_1 + 3]\). We later examine POSS images of the groups and find few fainter galaxies inside the group radii.

Second, we do not implement Hickson’s isolation criteria in our initial group selection. Third, we do not reject groups on the basis of surface brightness. However, all but four very nearby groups in our catalog automatically satisfy the surface brightness criterion because we require galaxy projected separations comparable with the size of a galaxy. Finally, we note that unlike the HCG’s, our sample is a complete listing of compact groups of three or more galaxies. Hickson includes a triplet only when one member of his initial group has a discordant redshift.

In general, our limits on the physical extent of compact groups are more restrictive than Hickson’s. 23 HCG’s are within the redshift survey boundaries and contain at least three galaxies brighter than the magnitude limit. We detect parts or all of 15 of these HCG’s. We fail to detect the other HCG’s because the physical or velocity separation of member galaxies exceeds our limits, or because of magnitude errors.

Both our selection procedure and Hickson’s introduce biases as a function of redshift or distance. The most important bias is the dependence of density on distance. At large distances, any magnitude-limited survey samples only the bright end of the luminosity function. Both our sample of galaxies and Hickson’s are magnitude-limited; Hickson’s limit is fainter. Because our selection criteria do not vary with redshift to compensate for the magnitude limit, the systems we detect at large distances are generally denser than the average nearby system. Hickson’s sample suffers from a similar bias. His distant groups are more likely to have larger total populations because of the magnitude limit, but there is no fixed upper limit to the physical inter-galaxy separations. We model these effects in Section 8.2.

Nearby groups with large angular radii are absent from the HCG catalog because of the large probability of interlopers within the annulus \(\theta_G \leq \theta \leq 3\theta_G\). These nearby groups are also more difficult to spot by eye. Figure 2 shows the redshift distribution of HCG’s (dotted line) and RSCG’s (solid line). We identify groups where Hickson’s approach is least
effective; the two compact group surveys complement one another.

5. The Compact Group Catalog

The search algorithm, applied to the CfA2+SSRS2 survey, yields a catalog of 89 groups of three or more galaxies with properties similar to the HCG’s. There are 50 groups in CfAnorth, 23 groups in CfAsouth and 16 groups in the SSRS. 15 of these groups are HCG’s or subsets of HCG’s. Table 2 lists the locations and basic properties of these groups. The median redshift of our sample of compact groups is $z = 0.014$, only half of the median HCG redshift, $z = 0.030$.

Figures 3 and 4 show Digitized Sky Survey images of RSCG 7 and RSCG 47, respectively. Neither RSCG is an HCG. In each image, the inner circle is the smallest circle containing the centers of all member galaxies. It has angular radius $\theta_G = 2.94$ arcmin for RSCG 7 and $\theta_G = 2.14$ arcmin for RSCG 47. The outer circle has radius $3\theta_G$. RSCG 7, a group with $N = 3$, has galaxies in its isolation annulus. The two brightest galaxies in this annulus are in the survey, but their velocities are about 1600 km s$^{-1}$ from the group median. The other galaxies are too faint to be in the survey. RSCG 47, a group with $N = 4$ galaxies, is isolated according to Hickson’s criterion.

Because of the large scale structure in the redshift surveys, the distribution of groups with redshift is nonuniform and varies among the three portions of the survey. The median group redshifts for individual portions of the survey are: $z = 0.007$ for CfAnorth, $z = 0.017$ for CfAsouth and $z = 0.012$ for SSRS2.

Next, we explore the properties of the RSCG’s and compare them with the HCG’s. Although the selection algorithms for HCG’s and RSCG’s are not identical, the systems in the two catalogs have similar physical properties.

5.1. Membership Frequency

Figure 5a shows the frequency of occurrence of groups of all populations $N$ in our catalog (solid line) and in the HCG catalog (dashed line). The overall distributions do not match. Hickson only finds triplets when his groups selected on the sky contain interlopers; in other words, triplets are underrepresented relative to our sample. However, the match is excellent for groups with $N \geq 4$ (Figure 5b), when the distribution is renormalized. Both distributions also agree with models of compact groups formed as subsystems within loose groups (Diaferio, Geller & Ramella 1994). In this section, we consider the distributions of
various compact group properties separately for groups of $N = 3$ and groups of $N \geq 4$. One physical motivation is the much greater likelihood that tight groups of $N \geq 4$ are bound. Diaferio, Geller & Ramella (1994) find that within loose groups only 50% of triplets are bound systems, whereas 80% of systems with four or more galaxies are bound systems.

5.2. Velocity Dispersion

In Figures 6a and b, we plot the distribution of the velocity dispersions of the HCG’s (dashed line) and of the 89 RSCG’s (solid line). Figure 6a is the distribution for groups of 3 and Figure 6b includes only groups of $N \geq 4$. Table 3 lists the median, first and third quartiles of these distributions. The distributions are similar. K-S tests indicate that the probability these samples are drawn from the same parent distribution is 86.5% for groups with $N = 3$ and 26.5% for groups with $N \geq 4$.

5.3. Density

We also compare the group densities. We choose the density statistic $n = \frac{2N}{4\pi R^3}$, with $N$ the number of detected galaxies and $R$ the radius of the smallest circle which encloses all the galaxy centers in the RSCG. Figures 7a and 7b show the distribution of log($n$) for both the HCG’s (solid line) and all RSCG’s (dotted line). Figure 7a includes only groups with $N = 3$ and Figure 7b includes only groups with $N \geq 4$. Table 4 lists the median, first and third quartiles of these distributions. As expected, the RSCG density distributions agree well with the HCG density distributions at high densities.

The density distributions of our compact groups fall off sharply below log($n$) $\approx 4$, where $n$ is in Mpc$^{-3}$, especially for groups with $N = 3$. This cutoff is an artifact of our search algorithm. Any galaxy in a compact group has a projected separation of at most 50 kpc = 0.05 Mpc from at least one other galaxy in its group. For a group of 3, the minimum density allowed is then 3 galaxies in a line, separated by 0.05 Mpc; the group radius is $R = 0.05$ Mpc. The minimum group density is then $n = 5.7 \times 10^3$ Mpc$^{-3}$; log($n_{\text{min}}$) = 3.76. A similar calculation for a group of 4 galaxies yields log($n_{\text{min}}$) = 3.35. In general, the search algorithm introduces a complex selection as a function of density, but this selection is only relevant over a small range of densities. The HCG’s do not display this sharp cutoff because selection is based on angular rather than physical extent. These criteria lead to a range of HCG densities corresponding to a range of distances.
6. Hickson’s Criteria

Unlike Hickson, we do not include isolation and luminosity criteria in our selection algorithm. Here we investigate the physical implications of the application of Hickson’s more restrictive criteria.

6.1. Population and Surface Brightness Criteria

Hickson limited group membership to galaxies with $m \leq m_1 + 3$ because galaxies with similar magnitudes are more likely to be at the same redshift than galaxies with a broader magnitude distribution. This problem is irrelevant for groups selected in redshift space. Furthermore, faint galaxies are probably less massive and hence less important dynamically. This effect is relevant to very nearby groups in our sample. Seven of our groups (all with median velocities $\leq 1600$ km s$^{-1}$) contain fewer than three members in the interval $[m_1,m_1 + 3]$. Most of these groups are located in the outskirts of the Virgo cluster [see, for example, Mamon (1989), who finds RSCG 65 in Virgo]. In general, these nearby systems contain one or two large galaxies along with small satellites; they are therefore different in character from the other RSCG’s and from the HCG’s. To exclude these systems, in later Sections we ignore nearby groups ($cz \leq 2300$ km s$^{-1}$) when exploring the environments of RSCG’s and when calculating the compact group selection function.

Hickson required $\mu_G < 26.0$, where $\mu_G$ is the surface brightness in E, for the POSS plates, of the group in magnitudes arcsec$^{-2}$. We translate this criterion as $\mu_{G,Zw} < 27.7$ using arguments from Prandoni, Iovino & MacGillivray (1994) that a surface brightness of 26.0 magnitudes arcsec$^{-1}$ in E is equivalent to a surface brightness of 27.7 magnitudes arcsec$^{-1}$ in $b_j$ which is similar to the Zwicky magnitude scale. Four of our compact groups do not meet this requirement. All of these groups are in the CfAnorth survey. They are nearby ($cz \leq 1200$ km s$^{-1}$), and have large angular radii ($\theta_G > 14'$). All of these groups fail the isolation criterion as well.

6.2. Isolation Criterion

Hickson’s isolation criterion has complex physical implications. In a survey of compact groups selected on the sky, interloping galaxies can appear in the isolation annulus ($\theta_G < \theta < 3\theta_G$) and thus can cause bonafide systems to fail the isolation criterion.

Because we have a complete catalog in redshift space, we can apply a cleaner isolation
criterion in three dimensions. We compute the isolation ratio, \( \Upsilon \equiv \theta_N / \theta_G \), for all groups in the sample. \( \theta_G \) is again the radius of the smallest circle which contains the centers of all the group members and \( \theta_N \) is the angular radius of the largest concentric circle which contains no further galaxies within 1200 km s\(^{-1}\) of the median group velocities. Our velocity separation cutoff is somewhat arbitrary; it is more relaxed than the group selection cutoff to allow for a larger velocity dispersion in the group environment. Our isolation criterion is not completely equivalent to Hickson’s criterion because we only search for surrounding galaxies brighter than the magnitude limit, \( m_{Zw} = 15.5 \). Thus, for groups with \( m_1 > 12.5 \), we do not search for surrounding galaxies throughout \([m_1, m_1 + 3]\). Twenty-five RSCG’s fail the “isolation criterion” which requires \( \Upsilon > 3 \). Six of these groups have \( N = 3 \), 19 have \( N \geq 4 \).

We explore the differences between “isolated” groups and groups with \( \Upsilon < 3 \). The isolation parameter \( \Upsilon \) is a strong function of group radius. Figure 3 shows \( \log(\Upsilon) \) as a function of projected group radius in kpc. The horizontal line is \( \Upsilon = 3 \). Groups with large angular radii are not isolated simply because their isolation annuli are larger. Because of this dependence, \( \Upsilon \) alone does not specify the physical environment of a particular RSCG. In fact, there is evidence that most HCG’s are also embedded in larger systems (de Carvalho et al. 1994; Ramella et al. 1994).

The correlation of \( \Upsilon \) with radius results in a correlation of \( \Upsilon \) with group density. Figures 9a and 9b show the density distributions of the two subsamples (isolated and not isolated) for groups with \( N = 3 \) and with \( N \geq 4 \), respectively. We apply a K-S test to the density distributions of the two subsamples in each case. The null hypothesis that the density values are drawn from the same distribution is acceptable only at the 3.6% significance level for groups with \( N = 3 \) and the 0.46% level for groups with \( N \geq 4 \). Thus isolation does imply higher density, as expected. The correlation is not physical; it is a result of the correlation of \( \Upsilon \) with group radius.

The velocity distributions are consistent for the two samples. The velocity dispersion distributions of the subsamples agree at the 99% confidence level for \( N = 3 \) and at the 49% confidence level for \( N \geq 4 \). Figures 10a and 10b show the velocity distributions for groups with \( N = 3 \) and groups with \( N \geq 4 \), respectively. We note, however, that the subsamples of RSCG’s in these comparisons are small. There are 11 groups with \( N \geq 4 \) and \( \Upsilon > 3 \), 19 groups with \( N \geq 4 \) and \( \Upsilon < 3 \), 53 groups with \( N = 3 \) and \( \Upsilon > 3 \), and only 6 groups with \( N = 3 \) and \( \Upsilon < 3 \).

We visually examine regions around the 48 RSCG’s with \( \Upsilon > 3 \) and \( cz > 2300 \) km s\(^{-1}\) using Digitized Sky Survey images. About 1/3 of these groups have faint galaxies (with \( m \ll m_1 + 3 \)) in their isolation annuli without measured redshifts. In other words, at least
30 of the RSCG’s are isolated according to Hickson’s criteria. However, this apparent isolation is not a good predictor of the environment of compact systems and contains no information about the physics of the systems.

7. Environments of Compact Groups

Previous studies of the environments of compact groups of galaxies yield mixed messages; some investigators find that compact groups are in dense regions and others conclude that they are not (Rood & Williams 1989; Rubin, Hunter & Ford 1991; de Carvalho, Ribeiro & Zepf 1994; Ramella et al. 1994). These discrepant conclusions are at least in part a result of incomplete data sets. We investigate the environments of the RSCG’s in redshift space. We find that most of them are embedded in loose groups or clusters.

Using the method of Ramella et al. (1994), we count the number of galaxies (including the galaxies in the RSCG), \( N_n \), in the redshift survey within 1.5 \( h^{-1} \) Mpc (projected) of the group center and within 1500 km s\(^{-1}\) of the median group velocity, \( v_{\text{med}} \). These scales are well-matched to the size of loose groups (Ramella, Geller & Huchra 1989).

For the remaining analyses, we exclude the 31 RSCG’s with redshifts less than 2300 km s\(^{-1}\). Many of these systems differ significantly from more distant RSCG’s, making them difficult to model. They are often composed of a bright galaxy and its very faint satellites (see §6.1), a combination that we cannot detect at higher redshift. In addition, these groups are hard to model because they are within the local supercluster.

Table 5 lists \( \frac{N_n}{N_{\text{int,env}}} \) for RSCG’s with average redshifts greater than 2300 km s\(^{-1}\). \( N_{\text{int,env}} \) is the expected number of interlopers within 1.5 \( h^{-1} \) Mpc of the group center in the velocity interval \([v_{\text{med}} - 1500, v_{\text{med}} + 1500]\);

\[
N_{\text{int,env}} \approx \int_{V_{\text{env}}} \bar{\rho}dV,
\]

where \( \bar{\rho} \) is the average density of the relevant portion of the survey and \( V_{\text{env}} \) is the volume of the environment of the group. Similarly,

\[
N_n \approx \int_{V_{\text{env}}} \rho_{\text{env}}dV,
\]

where \( \rho_{\text{env}} \) is the density of the environment of the group. Therefore,

\[
\frac{N_n}{N_{\text{int,env}}} \approx \frac{\langle \rho_{\text{env}} \rangle}{\langle \bar{\rho} \rangle},
\]
where the brackets denote averaging over the volume of the environment of the RSCG. To calculate this expected number of interlopers we integrate over the true luminosity function (Table 6). We use the true luminosity function instead of the observed one for ease of calculation; the error introduced is small. Therefore,

$$N_{\text{int,env}} = \int_{v_{\text{med}} - 1500}^{v_{\text{med}} + 1500} \int_{-\infty}^{M_{\text{lim}}(v)} \pi \left( \frac{1.5 \text{ Mpc} \times v}{v_{\text{med}}} \right)^2 \Phi_{\text{true}}(M) dM \frac{dv}{H_0},$$

where $M_{\text{lim}}(v)$ is the limiting absolute magnitude at redshift $v$, $\Phi_{\text{true}}$ is the true luminosity function of the relevant survey and $v_{\text{med}}$ is the median RSCG velocity. When calculating $N_{\text{int,env}}$ we integrate over 1.5 $h^{-1}$ projected Mpc, although some groups are centered on the edge of the survey where we do not observe all galaxies in the neighborhood. We indicate these groups in the table.

We also list $N_{\text{int,cg}}$ in Table 5. We calculate this number by replacing 1.5 Mpc with $R_{\text{cg}}$, the group radius in Mpc, in Equation 1. We then compute the overdensity of the RSCG, $\frac{N_{\text{cg}}}{N_{\text{int,cg}}} \approx \langle \rho_{\text{cg}} \rangle / \langle \rho \rangle$. $N_{\text{cg}}$ is the number of galaxies in the RSCG and $\rho_{\text{cg}}$ is the density of the compact group. The RSCG’s have $460 < \langle \rho_{\text{cg}} \rangle / \langle \rho \rangle < 150,000$.

For $cz \geq 2300$ km s$^{-1}$, 43 RSCG’s (74%) have $\langle \rho_{\text{env}} \rangle \gg \langle \rho \rangle$. This result gives the same impression as the conclusion of Ramella et al. that most but not all HCG’s are embedded in looser systems.

All 10 RSCG’s with $cz \geq 2300$ km s$^{-1}$ which fail the “isolation” criterion (§6) satisfy $N_n > N_{\text{int}} + 3\sqrt{N_{\text{int}}}$, as expected. However, 30 isolated RSCG’s with $cz \geq 2300$ km s$^{-1}$ also satisfy $N_n > N_{\text{int}} + 3\sqrt{N_{\text{int}}}$ (for $m_{Zw} \leq 15.5$) — another indication that “isolation” is not physically meaningful.

Figures 11 – 14 show examples of the embedding of RSCG’s within the large-scale structure of the nearby universe. They show galaxies with redshifts in the interval (300 km s$^{-1}$, 15,000 km s$^{-1}$) in the redshift surveys (·) and RSCG centers (×) (including RSCG’s with $cz < 2300$ km s$^{-1}$). Compact groups generally follow the large-scale distribution of galaxies, often appearing in the densest regions of the survey. However, Figure 14 shows the seemingly rare example of a compact group in an apparent void.

Most RSCG’s are embedded in larger systems regardless of how “isolated” they appear. The isolation criterion is unphysical: groups with smaller radii are more likely to appear “isolated” mainly because their isolation annuli are smaller. This variation with radius leads to a dependence of density, $n$, on isolation only because density is computed using the group radius; thus the correlation of $\Upsilon$ with $n$ is unphysical. From here on we include all RSCG’s whether they satisfy the isolation criterion or not.
8. Abundance of Compact Groups

The abundance of compact groups has important physical implications for cosmology. The compact group abundance can indicate whether compact groups are bound systems or chance alignments of galaxies within loose groups or along filaments. If CG’s are truly compact systems, the abundance of these systems is dependent on the density parameter, $\Omega_0$. If $\Omega_0 \sim 1$ these systems should be forming in the present epoch. Furthermore, the abundance of compact systems should be related to the merger rate at the current epoch.

We calculate the volume number density of RSCG’s. We compute abundances using all RSCG’s and using only RSCG’s with $N \geq 4$. We consider only systems with median redshifts $> 2300 \text{ km s}^{-1}$.

8.1. The Luminosity Distribution of Galaxies in Compact Groups

To model the selection function of compact groups, we have to evaluate the luminosity function (LF) for compact group members. We compute the Schechter (1976) function parameters (Marzke, Huchra & Geller 1994, Efstathiou, Ellis & Peterson 1988, Loveday et al. 1992), $\alpha_{cg}$ and $M_{*,cg}$, for the CfAnorth, CfAsouth and SSRS2 RSCG samples. Table 7 lists $\alpha_{cg}$ and $M_{*,cg}$ for the CfAnorth, CfAsouth and SSRS2 catalogs of compact group galaxies. The samples include 84 galaxies, 77 galaxies and 34 galaxies, respectively. In all cases, $M_{*,cg} < M_{*,survey}$ and $\alpha_{survey} < \alpha_{cg}$, where $M_{*,survey}$ and $\alpha_{survey}$ are the Schechter function parameters for each region of the complete redshift survey (Table 6). In other words, the characteristic luminosity is brighter and the faint end shallower for the compact groups. Figure 15 illustrates the significance of these differences; it shows 1$\sigma$ contours for the compact group galaxies (dotted lines) and 2$\sigma$ contours for all CfAnorth, CfAsouth, and SSRS2 survey galaxies (solid lines). These differences are similar for all portions of the redshift survey. The 1$\sigma$ error ellipse for the compact group galaxies does not overlap the 2$\sigma$ survey error ellipse for any of the surveys.

Mendes de Oliveira & Hickson (1991), Prandoni, Iovino & MacGillivray (1994), and Ribeiro, de Carvalho & Zepf (1994) have also compared compact group LF’s with the “field”. Mendes De Oliveira & Hickson (1991) used simulations of compact groups to derive an HCG galaxy LF. They fit a Schechter function with parameters $\alpha = -0.2^{+0.8}_{-0.5}$ and $L_* = 1.1 \pm 0.2 \times 10^{10}h^{-2}L_\odot$ ($M_{*,B} = -19.6 \pm 0.2$). We show the value of Mendes de Oliveira & Hickson, with error bars, in Figure 15. The error bars of Mendes de Oliveira & Hickson overlap the 1$\sigma$ LF parameter error ellipses of all three RSCG subsamples. Mendes De Oliveira & Hickson claim a significant deficiency of low-luminosity galaxies, as compared
to field, loose group and cluster galaxies. Prandoni, Iovino & MacGillivray (1994) and Ribeiro, de Carvalho & Zepf do not confirm this deficiency, although their samples may be contaminated by superimposed background galaxies. Ribeiro, de Carvalho & Zepf compare faint galaxy counts inside and outside 22 HCG’s. They find that the LF inside HCG’s is consistent with the field LF.

### 8.2. The Selection Function of Compact Groups

For the following analysis, we use the survey LF’s when estimating the compact group selection function because the survey LF’s are much better determined and better understood. We thus underestimate the selection function of compact groups somewhat and we overestimate the compact group density slightly, assuming that the differences in luminosity functions are real.

We require that each compact group contain \( j \) or more galaxies coincident in redshift space, where \( j = 3 \) is our criterion for selection; we also restrict our sample for comparison to Hickson’s (1982) by adopting \( j = 4 \). We thus estimate the selection function for RSCG’s analytically, by modeling the probability of detecting the \( j \)th brightest galaxy. We assume that the galaxies in RSCG’s are drawn at random from a magnitude distribution of fixed form: \( \Phi(M) \). We calculate \( P_j(M)dM \), the probability that the \( j \)th brightest member of a group of galaxies lies in the interval \([M, M + dM]\); this probability is proportional to \( P_{(j-1)<M}(M)\Phi(M)dM \), where \( P_{(j-1)<M}(M) \) is the probability that exactly \( j - 1 \) members of the group are brighter than \( M \). If \( \lambda_M \) is the average number of galaxies in a group brighter than \( M \), then,

\[
\lambda_M = \kappa \int_{-\infty}^{M} \Phi(M')dM',
\]

where, in general, \( \kappa = \kappa(M) \) is a normalization parameter. Then from the Poisson distribution we derive

\[
P_{(j-1)<M} = \frac{e^{-\lambda_M} \lambda_M^{(j-1)}}{(j-1)!}.
\]

For a survey with a limiting apparent magnitude of 15.5, the limiting absolute magnitude at any redshift \( v = cz \) is \( M_{\text{lim}}(v) = -9.5 - 5 \log_{10}(\frac{v}{H_0}) \), where the dimensions of \( \frac{v}{H_0} \) are Mpc. Therefore, the probability of detecting \( j \) or more members of a group of galaxies is

\[
P_{\text{detection}}(v) = \frac{1}{\mathcal{N}} \int_{-\infty}^{M_{\text{lim}}(v)} P_j(M)dM = \frac{1}{\mathcal{N}} \int_{-\infty}^{M_{\text{lim}}(v)} \frac{e^{-\lambda_M} \lambda_M^{(j-1)}}{(j-1)!} \Phi(M)dM.
\]

The factor \( \mathcal{N} \) is the normalization of \( P_{\text{detection}}(v) \) which ensures that \( P_{\text{detection}}(0) = 1 \).
8.2.1. Estimating the $\kappa$ parameter

In order to evaluate the probability of detecting a compact group [Equation 4] we assume that $\kappa(M)$ in Equation 2 is a constant. In other words, we assume that the number of galaxies brighter than $M$ in a compact group, $\lambda_M$, is proportional to the integral of the luminosity distribution of galaxies and that the normalization ($\kappa$) is the same for every compact group. These assumptions are not strictly correct. The inaccuracy introduced by approximating $\lambda_M$ by a smooth function, rather than a step function, is large because the numbers of galaxies involved is small.

Below, we compute the density of RSGC’s twice, using systems of $N \geq 3$ [$j = 3$ in Equation 4] and then using systems with $N \geq 4$ [$j = 4$ in Equation 4]. If Equation 2 were strictly true for a constant $\kappa$, we would obtain the same density for the two samples. However, our RSGC’s with $N = 3$ include both groups with a small true $\kappa$ value (these groups contain three and only three bright members) and more distant groups with a larger true $\kappa$ value (these groups contain more than three bright members, but only three above the magnitude limit). Thus the two density estimates are estimates of two fundamentally different quantities. Our compact groups are not uniformly dense, and they do not occupy the same volumes; thus their $\kappa$ values actually vary.

The properties of distant RSGC’s differ from those of the nearby systems. If the population of galaxies in an RSGC brighter than $M_{\text{lim}}(v)$ is in fact proportional to $\int_{-\infty}^{M_{\text{lim}}(v)} \Phi(M) dM$ as we have assumed, then some distant systems are far more populated, and probably much denser, than the nearby RSGC’s. Thus assuming a single value of $\kappa$ for all RSGC-type systems is only an approximation. We do so to construct a manageable model of the selection function for these systems.

Some assumption about the number of bright galaxies in compact groups is necessary in order to construct a selection function. Monte Carlo simulations of compact groups aimed at computing a selection function make implicit assumptions (e.g., Mendes de Oliveira & Hickson 1991). Our approach enables us to make the assumptions explicit and their effects can be easily explored.

In a magnitude-limited redshift survey, we detect only galaxies brighter than the limiting magnitude $M_{\text{lim}}(v)$. Because we have no information about fainter galaxies we must estimate $\kappa$ for each compact group;

$$\kappa_{\text{estim}} = \left[ \frac{V_{cg} \rho_{cg, < M}}{\int_{-\infty}^{M_{\text{lim}}(v)} \Phi(M') dM'} \right] = \left[ \frac{N}{\int_{-\infty}^{M_{\text{lim}}(v)} \Phi(M') dM'} \right].$$  \hspace{1cm} (5)

Here, $\rho_{cg, < M}$ is the compact group density of galaxies brighter than $M = M_{\text{lim}}(v)$, $v$ is the
median galaxy velocity in the RSCG, $V_{cg}$ is the volume of the RSCG and $N$, as usual, is the number of detected galaxies in the RSCG. There is a lower bound and an effective upper bound to the actual number of observed galaxies in a compact group. We select only systems with $N \geq 3$. We expect from theoretical arguments (Diaferio, Geller & Ramella 1994) and observation (Hickson 1982) only systems with $N \lesssim 6$. For $N \gtrsim 6$ the probability is so small that we expect none even in a volume much larger than the region we survey. Therefore, $N_{\text{min}} = 3$ and $N_{\text{max}} \approx 6$. As $N$ falls only in the range $N_{\text{min}} \leq N \lesssim N_{\text{max}}$, $\kappa_{\text{estim}}$ is limited to the range $\kappa_{\text{min}}(v) \leq \kappa_{\text{estim}} \lesssim \kappa_{\text{max}}(v)$ where

$$\kappa_{\text{min}}(v) = \left[ \frac{3}{\int_{-\infty}^{M_{\text{lim}}(v)} \Phi(M')dM'} \right]$$

and

$$\kappa_{\text{max}}(v) = \left[ \frac{6}{\int_{-\infty}^{M_{\text{lim}}(v)} \Phi(M')dM'} \right].$$

Figure 17 shows $\kappa_{\text{min}}(v)$ and $\kappa_{\text{max}}(v)$ computed assuming the CfAnorth survey LF.

Figure 16 shows $\kappa_{\text{estim}}$ as a function of redshift for RSCG’s with $cz < 10,000$ km s$^{-1}$ in all of the surveys; we compute $\kappa_{\text{estim}}$ using Equation 5. Figure 16a shows only the 15 groups with $N \geq 4$; Figure 16b shows all of the RSCG’s. The median, first and third quartiles of the distribution of $\kappa$ in Figure 16a are 7.7, 4.2, and 19, respectively; for Figure 16b they are 5.5, 3.6, and 11, respectively. The points are confined to a region similar to the region between the curves in Figure 17.

Figure 17 illustrates an important difficulty in choosing an appropriate $\kappa$. Assume that hypothetical “true” compact groups have a distribution of $\kappa$ values that is, for simplicity, a gaussian with a non-negligible width. The width must be large enough to allow all the measured values of $\kappa_{\text{estim}}$. Then the “true” distribution of $\kappa$ for RSCG-type systems might approximate the distribution of points in Figure 17. This figure depicts a random sampling of a Gaussian distribution of “$\kappa$” values with a peak at the median measured value of $\kappa$ for all RSCG’s and a width equal to the interquartile range. The sampling is weighted according to the volume sampled, with a minimum velocity of 2300 km s$^{-1}$ and a maximum velocity of 10,000 km s$^{-1}$. Because we use a magnitude-limited sample we measure $\kappa$ only between $\kappa_{\text{min}}(v)$ and $\kappa_{\text{max}}(v)$. Therefore, it is difficult to reconstruct the “true” $\kappa$ distribution. We are guided only by the available estimators, the median, first and third quartiles of the observed $\kappa_{\text{estim}}$ distribution.
8.2.2. Calculation of the selection function

Assuming a constant value of $\kappa$ simplifies the selection function. In this case, we substitute the differential form of Equation 2 into Equation 4 with $j = 3$ and integrate over $\lambda_M$ to find the probability of detecting three or more galaxies as a function of redshift,

$$P_{\text{detection}}(v) = 1 - \frac{1}{2}e^{-\lambda_{\text{lim}}(v)} \left[ \lambda_{\text{lim}}^2(v) + 2\lambda_{\text{lim}}(v) + 2 \right].$$  \hspace{1cm} (8)

Similarly, we calculate the probability of detecting four or more galaxies by using $j = 4$ in Equation 4,

$$P_{\text{detection}}(v) = 1 - \frac{1}{6}e^{-\lambda_{\text{lim}}(v)} \left[ \lambda_{\text{lim}}^3(v) + 3\lambda_{\text{lim}}^2(v) + 6\lambda_{\text{lim}}(v) + 6 \right].$$  \hspace{1cm} (9)

When computing $\lambda_{\text{lim}}(v)$ we use the observed LF, which is the true LF convolved with a gaussian of width of about the size of the magnitude errors (Efstathiou, Ellis & Peterson 1988).

8.3. Abundance of Compact Groups

The selection function is the first step toward calculating the volume number density of compact groups. In the case of a uniform spatial distribution of compact groups, the product of $P_{\text{detection}}$, the survey volume at a particular redshift, and the average volume number density of compact groups ($\varrho_{\text{cga}}$) is the differential expected number of compact groups,

$$\frac{dN_{\text{cg}}}{dv} = \varrho_{\text{cga}} \frac{\Omega}{H_0} \left( \frac{v}{H_0} \right)^2 P_{\text{detection}}(v).$$  \hspace{1cm} (10)

We average the estimated density over the solid angle of each survey, $\Omega$. For a survey bounded by redshifts $v_i$ and $v_f$, the density is approximated by

$$\varrho_{\text{cga},s} = \frac{N_s}{\Omega \int_{v_i}^{v_f} \left( \frac{v}{H_0} \right)^2 P_{\text{detection}}(v) d \left( \frac{v}{H_0} \right)}.$$

$N_s$ is the number of compact groups with an average redshift in the interval $[v_i, v_f]$.

Using Equation 11 altered to select groups of $N \geq 4$ ($j = 4$), we calculate the space density of RSCG’s with $N \geq 4$. There are 15 of these groups in our catalog. Figure 18a shows $\varrho_{\text{cga}}$ for these groups as a function of $\kappa$. The figure includes data from all three surveys. Vertical lines indicate the median, first and third quartiles of the relevant $\kappa$ distribution. Table 8 lists the density of compact groups at each of these values of $\kappa$. The combined-survey density estimate at the median value of $\kappa$ is $3.8 \times 10^{-5}$ Mpc$^{-3}$. 

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In selection from a redshift survey we have greater confidence in the triplets than Hickson had for selection on the sky. We repeat the calculation of the space density of compact groups using all RSCG’s with average velocities greater than 2300 km s\(^{-1}\). We use a selection function computed with \(j = 3\) in Equation 4 to include the abundant observed triplets. The density of these compact systems exceeds both the original HCG abundance estimate of Mendes de Oliveira & Hickson (1991) and our value for the density of RSCG’s derived from groups with \(N \geq 4\). Figure 18b shows \(\varrho_{\text{cga}}\) for these groups (including all surveys) as a function of \(\kappa\). Once again, we use vertical lines to indicate the median, first and third quartiles of the relevant \(\kappa\) distribution. Table 9 lists the density of compact groups at these \(\kappa\) values for each survey and for all surveys combined. The combined-survey density estimate at the median value of \(\kappa\) is \(1.41 \times 10^{-4}\) Mpc\(^{-3}\), almost four times the estimate for \(N \geq 4\).

Figure 19 shows our model for the number density of all RSCG’s as a function of redshift, \(\frac{dN_{\text{cga}}}{dv}\), from Equation 10, for all the surveys combined. The figure shows the models for the median (solid line), first quartile (dotted line), and third quartile (dashed line) \(\kappa\) values. The models assume a uniform space density of compact groups; we adopt the \(\varrho_{\text{cga}}\) values in Table 9. We plot a histogram of the RSCG’s for comparison. The distribution corresponds roughly to a \(\kappa\) value in the proper range. However, the Figure shows variation in the volume number density of compact groups with redshift which results from the large-scale structure in the nearby universe.

We estimate the volume number density of RSCG’s with \(N \geq 4\) and all RSCG’s again, at each redshift bin. For this purpose, we choose a bin size of 1000 km s\(^{-1}\) for groups with \(N \geq 4\) and 500 km s\(^{-1}\) for the set of all RSCG’s. Figure 20 shows \(\varrho_{\text{cga}}(v)\) calculated for each bin using Equation 11. We display the results for the median value of \(\kappa\). There is a large variation in RSCG density with redshift partly because of the small number of groups. However, Figure 20b shows that the density of RSCG’s exceeds the value of Mendes de Oliveira & Hickson (1991), the horizontal line, in most (nearby) redshift bins.

Hickson, Kindl & Auman (1989) arrive at a compact group selection function as a function of apparent magnitude empirically. The results are not directly comparable to our \(P_{\text{detection}}\) because we calculate a selection function as a function of redshift; they calculate a distribution as a function of redshift. Our density estimate derived from RSCG’s with \(N \geq 4\) roughly agrees with the estimated density of HCG’s. Our estimate of \(\varrho_{\text{cga}}\) for all compact systems, \(1.4 \times 10^{-4} h^3\) Mpc\(^{-3}\), greatly exceeds previous estimates of the abundance of compact systems in the universe. In particular, it places stronger demands on theories in which compact groups are chance alignments in loose groups or “filaments” in the universe.
9. Conclusion

We apply the friends-of-friends group-finding algorithm to the CfA2+SSRS2 Redshift Survey to identify systems similar to Hickson’s compact groups. The result is the first objectively defined and well-controlled sample of compact groups selected in redshift space. We evaluate the physical characteristics of the RSCG’s and find the following:

- The physical properties of the RSCG’s (membership frequency, velocity dispersion, density) are similar to those of the HCG’s.
- The isolation of a compact group is a strong function of group radius and is a poor predictor of the group environment; it probably has little relevance to the dynamical history of these systems.
- Most RSCG’s are embedded in dense environments. Their distribution generally follows the large-scale structure evident in the redshift survey.
- The luminosity distribution of galaxies in RSCG’s is mildly inconsistent with the survey LF. The characteristic luminosity is brighter and the faint end shallower for the RSCG galaxies.
- We model the selection function of compact groups to estimate the abundance of RSCG’s. When we include only groups with \( N \geq 4 \) the abundance is \( 3.8 \times 10^{-5} \ h^3 \text{Mpc}^{-3} \); when we include all RSCG’s the abundance is \( 1.4 \times 10^{-4} \ h^3 \text{Mpc}^{-3} \).

We plan to measure redshifts of fainter galaxies in and around some RSCG’s to explore their embedding in the surrounding environment. In addition, we will compare the RSCG catalog to a similar objectively-defined catalog of loose groups in the same region (Ramella et al. 1996). We are also searching the ROSAT all-sky survey for x-ray emission from RSCG’s. Eventually, we intend to apply the compact group search algorithm to a deeper redshift survey.

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Fig. 1.— Projected separation distributions of the CfAnorth (solid line) and Hickson Compact Group Catalogs (dotted line).

Fig. 2.— Redshift distribution of HCG’s (dotted line) and RSCG’s (solid line).
Fig. 3.— RSCG 7: The inner circle is the smallest circle (radius $\theta_G = 2.99$ arcmin) enclosing all the centers of the galaxies in the RSCG. The outer circle is $3\theta_G$. We calculate the circle with coordinates derived from the Digitized Sky Survey for this figure. The figure is available via anonymous ftp at ftp://cfa0.harvard.edu/outgoing/barton.

Fig. 4.— RSCG 47: The inner circle is the smallest circle (radius $\theta_G = 2.01$ arcmin) enclosing all the centers of the galaxies in the RSCG. The outer circle is $3\theta_G$. We calculate the circle with coordinates derived from the Digitized Sky Survey for this figure. The figure is available via anonymous ftp at ftp://cfa0.harvard.edu/outgoing/barton.

Fig. 5.— Population frequency distributions of RSCG’s and HCG’s: (a) RSCG’s with $N \geq 3$ (solid line) and HCG’s with $N \geq 3$ (dotted line), and (b) RSCG’s with $N \geq 4$ (solid line) and HCG’s with $N \geq 4$ (dotted line).
Fig. 6.— Velocity dispersion distributions of compact groups: (a) RSCG’s with $N = 3$ (solid line) and all HCG’s with $N = 3$ (dotted line), and (b) all RSCG’s with $N \geq 4$ (solid line) and all HCG’s with $N \geq 4$ (dotted line).

Fig. 7.— Density distributions of compact groups: (a) all RSCG’s with $N = 3$ (solid line) and all HCG’s with $N = 3$ (dotted line), and (b) all RSCG’s with $N \geq 4$ (solid line) and all HCG’s with $N \geq 4$ (dotted line).
Fig. 8.— Dependence of isolation on group radius: \( \log(\Upsilon) \) vs. radius in kpc. The horizontal line is the boundary between groups that satisfy the "isolation criterion" and groups that do not.

Fig. 9.— Density distributions of RSCG’s: (a) all isolated compact groups with \( N = 3 \) (solid line) and non-isolated compact groups with \( N = 3 \) (dotted line), and (b) all isolated compact groups with \( N \geq 4 \) (solid line) and non-isolated compact groups with \( N \geq 4 \) (dotted line).
Fig. 10.— Velocity dispersion distributions of compact groups: (a) all isolated RSCG’s with \( N = 3 \) (solid line) and non-isolated RSCG’s with \( N = 3 \) (dotted line), and (b) all isolated RSCG’s with \( N \geq 4 \) (solid line) and non-isolated RSCG’s with \( N \geq 4 \) (dotted line).
Fig. 11.— Distributions of redshift survey galaxies (·) and RSCG’s (×). CfAnorth survey: $8.5^\circ < \delta < 17.5^\circ$. 
Fig. 12.— Distributions of redshift survey galaxies (·) and RSCG’s (×). CfAnorth survey: $26.5^\circ < \delta < 35.5^\circ$. 
Fig. 13.— Distributions of redshift survey galaxies (·) and RSCG’s (×). CfAsouth survey: $10^\circ < \delta < 22^\circ$. 


Fig. 14.— Distributions of redshift survey galaxies (·) and RSCG’s (×). SSRS2 survey: $-30^\circ < \delta < -20^\circ$. 
Fig. 15.— Confidence levels (ellipses) for Schechter function parameters describing separately the SSRS2, CfAnorth and CfAsouth RSCG’s (dotted line, 1σ) and the confidence levels (solid line, 2σ) for the entire CfAnorth and CfAsouth surveys and the SSRS2 survey (Marzke, Huchra & Geller 1994; da Costa et al. 1994). Mendes de Oliveira & Hickson (1991) HCG LF parameters are shown as a single point with errors.
Fig. 16.— $\kappa$ estimates vs. redshift for CfAnorth (×), CfAsouth (·) and SSRS2 (○): (a) groups with $N \geq 4$, and (b) all RSCG’s. The figure includes only groups with median $cz < 10^4$ km s$^{-1}$.

Fig. 17.— A random sampling of a gaussian $\kappa$ distribution. The lines show the “artificial” limits imposed by detecting only groups of $N \geq 3$ and $N \leq 6$ for CfAnorth (solid line).
Fig. 18.— Abundance of RSCG’s as a function of \( \kappa \). The median (solid line), first (dotted line) and third (dashed line) quartiles of the \( \kappa \) distribution are shown as vertical lines: (a) RSCG’s with \( c_z \geq 2300 \text{ km s}^{-1} \) and \( N \geq 4 \), and (b) all RSCG’s with \( c_z \geq 2300 \text{ km s}^{-1} \).

Fig. 19.— RSCG median velocity distribution and models. The three models use the median (solid line), first quartile (dotted line), and third quartile (dashed line) values of \( \kappa \).
Fig. 20. — Compact Group space density as a function of redshift computed with the median values of $\kappa$: (a) RSCG’s with $N \geq 4$, and (b) all RSCG’s. The dotted lines represent $\sqrt{N}$ compact group population errors. The horizontal line is the estimate of Mendes de Oliveira & Hickson (1991) of the volume number density of HCG’s.
Table 1. Projected separation distributions.

| Sample of Groups | Median (kpc) | First Quartile (kpc) | Third Quartile (kpc) |
|------------------|--------------|---------------------|---------------------|
| HCG's            | 39           | 24                  | 64                  |
| CfAnorth         | 40           | 26                  | 56                  |
| CfAsouth         | 42           | 28                  | 56                  |
| SSRS2            | 57           | 35                  | 102                 |
| CfA2 + SSRS2     | 44           | 28                  | 63                  |
### Table 2. Catalog of RSCG's.

| Group | N  | Coordinates (B1950) | $z$ | $\theta_G$ (arcmin) | Radius (kpc) | Comments |
|-------|----|---------------------|-----|---------------------|--------------|----------|
| 1     | 5  | 00h15m50s +29°46'33" | 0.023 | 1.99 | 40.20 |          |
| 2     | 3  | 00 31 18 +06 58 30 | 0.018 | 1.57 | 24.90 |          |
| 3     | 3  | 00 36 42 +00 36 49 | 0.014 | 1.57 | 19.20 | HCG7 ^a |
| 4     | 3  | 00 40 21 -23 49 37 | 0.022 | 1.02 | 19.90 |          |
| 5     | 5  | 01 04 38 +32 05 23 | 0.017 | 3.40 | 50.20 |          |
| 6     | 3  | 01 13 15 +46 28 30 | 0.017 | 1.63 | 24.60 |          |
| 7     | 3  | 01 20 20 +33 11 32 | 0.015 | 2.94 | 37.40 |          |
| 8     | 5  | 01 20 41 +33 00 39 | 0.017 | 3.66 | 55.60 |          |
| 9     | 3  | 01 22 36 +14 36 30 | 0.021 | 1.54 | 28.40 |          |
| 10    | 3  | 01 22 53 -01 46 42 | 0.017 | 1.90 | 28.20 |          |
| 11    | 5  | 01 23 21 -01 35 11 | 0.018 | 2.14 | 34.30 |          |
| 12    | 3  | 01 23 34 +34 27 18 | 0.016 | 2.67 | 36.20 |          |
| 13    | 3  | 01 40 55 -34 27 43 | 0.013 | 1.90 | 21.20 |          |
| 14    | 3  | 01 46 56 +21 45 29 | 0.010 | 3.83 | 32.70 |          |
| 15    | 4  | 01 49 45 +35 54 00 | 0.016 | 2.09 | 28.70 |          |
| 16    | 3  | 01 52 03 +36 39 30 | 0.018 | 1.63 | 25.50 |          |
| 17    | 3  | 01 53 45 +05 23 58 | 0.019 | 1.23 | 19.80 |          |
| 18    | 3  | 01 53 53 +32 47 17 | 0.015 | 1.72 | 21.90 |          |
| 19    | 4  | 02 07 04 -10 23 40 | 0.013 | 3.11 | 35.30 | HCG 16   |
| 20    | 3  | 03 01 12 -15 49 55 | 0.009 | 2.06 | 16.20 | HCG 22   |
| 21    | 3  | 03 16 18 +41 22 48 | 0.017 | 2.47 | 35.70 |          |
| 22    | 3  | 03 24 16 -21 27 35 | 0.005 | 4.18 | 18.80 |          |
| 23    | 3  | 03 33 16 -32 43 04 | 0.005 | 6.45 | 26.90 |          |
| 24    | 13 | 03 34 38 -35 41 22 | 0.005 | 28.56 | 113.40 |          |
| 25    | 4  | 03 37 49 -18 45 45 | 0.005 | 9.53 | 44.30 |          |
| 26    | 4  | 04 10 30 -33 03 12 | 0.004 | 7.07 | 24.50 |          |
| 27    | 3  | 04 13 10 -28 36 29 | 0.018 | 0.30 | 4.80  |          |
| 28    | 3  | 09 01 09 +22 10 30 | 0.010 | 4.55 | 41.00 |          |
| 29    | 4  | 09 07 13 +23 03 02 | 0.038 | 1.00 | 32.80 |          |
| 30    | 3  | 09 09 30 +35 11 28 | 0.007 | 4.04 | 23.70 |          |
| 31    | 3  | 09 14 09 +42 10 00 | 0.006 | 3.05 | 15.30 |          |
| 32    | 3  | 09 16 42 +33 57 18 | 0.020 | 0.72 | 12.80 |          |
| 33    | 3  | 09 31 12 +10 18 30 | 0.011 | 3.80 | 35.00 |          |
| 34    | 3  | 09 40 15 +32 08 32 | 0.005 | 5.54 | 24.90 |          |
| 35    | 4  | 10 15 16 +22 02 28 | 0.004 | 8.16 | 31.70 | HCG 44   |
| 36    | 3  | 10 45 30 +12 49 32 | 0.003 | 4.72 | 12.60 |          |
| 37    | 3  | 10 45 31 +14 22 00 | 0.002 | 11.60 | 21.50 |          |
| 38    | 3  | 10 49 00 +33 07 27 | 0.005 | 7.46 | 30.80 |          |
| 39    | 4  | 10 52 27 +17 26 30 | 0.004 | 14.03 | 45.20 |          |
| 40    | 5  | 11 13 38 +18 15 34 | 0.003 | 14.09 | 39.00 |          |
| 41    | 4  | 11 24 38 +17 17 37 | 0.004 | 14.20 | 47.90 |          |
| 42    | 3  | 11 34 15 +20 15 55 | 0.021 | 1.27 | 23.40 |          |
| 43    | 3  | 11 35 17 +22 15 24 | 0.030 | 0.46 | 12.00 | HCG 57   |
| 44    | 6  | 11 41 25 +20 13 23 | 0.021 | 3.20 | 58.20 |          |
| 45    | 3  | 11 41 44 +20 06 46 | 0.018 | 0.62 | 9.80  |          |
| 46    | 4  | 11 45 52 +12 59 21 | 0.013 | 1.53 | 17.90 | HCG 59   |
| 47    | 4  | 11 55 03 +32 34 60 | 0.011 | 2.14 | 20.00 |          |
| 48    | 3  | 12 04 18 +43 24 30 | 0.003 | 9.82 | 23.00 |          |
| Group |  | Coordinates (B1950) | z  | $\theta_G$ (arcmin) | Radius (kpc) | Comments |
|-------|----|---------------------|----|---------------------|--------------|----------|
|       | N | $\alpha$            | $\delta$ |  |  |  |  |  |  |
| 49    | 3 | 12 09 51            | +29 26 43 | 0.013 | 1.87 | 21.60 | HCG 61 |
| 50    | 3 | 12 12 27            | +13 25 00 | 0.002 | 20.64 | 37.70 |
| 51    | 7 | 12 18 30            | +29 56 45 | 0.002 | 26.01 | 49.70 |
| 52    | 3 | 12 18 30            | +40 09 30 | 0.022 | 1.50 | 29.10 |
| 53    | 3 | 12 19 24            | +14 57 30 | 0.004 | 7.34 | 24.20 |
| 54    | 3 | 12 22 51            | +18 28 30 | 0.003 | 7.84 | 17.30 |
| 55    | 4 | 12 24 04            | +09 18 39 | 0.025 | 2.15 | 47.10 |
| 56    | 5 | 12 24 56            | +12 41 59 | 0.003 | 10.05 | 26.70 |
| 57    | 6 | 12 25 54            | +09 55 58 | 0.002 | 24.08 | 44.80 |
| 58    | 3 | 12 25 56            | +13 21 59 | 0.002 | 11.68 | 23.20 |
| 59    | 3 | 12 26 56            | +14 17 51 | 0.004 | 6.94 | 24.50 |
| 60    | 4 | 12 26 58            | +09 08 25 | 0.002 | 19.53 | 40.90 |
| 61    | 5 | 12 28 00            | +12 38 11 | 0.005 | 7.81 | 31.10 |
| 62    | 5 | 12 28 57            | +11 57 57 | 0.003 | 14.46 | 43.70 |
| 63    | 4 | 12 32 58            | +12 45 45 | 0.002 | 15.76 | 25.50 |
| 64    | 3 | 12 38 60            | +26 19 30 | 0.016 | 1.50 | 21.00 |
| 65    | 7 | 12 39 48            | +11 38 32 | 0.004 | 22.67 | 72.20 |
| 66    | 3 | 12 40 47            | +13 28 12 | 0.003 | 9.91 | 30.10 |
| 67    | 3 | 12 57 08            | +28 13 37 | 0.024 | 0.64 | 13.40 |
| 68    | 3 | 12 57 46            | +28 14 26 | 0.022 | 1.76 | 33.30 |
| 69    | 3 | 13 14 57            | +20 53 13 | 0.022 | 1.37 | 26.80 |
| 70    | 3 | 13 22 42            | +36 40 00 | 0.018 | 2.33 | 36.00 | HCG 68 |
| 71    | 5 | 13 51 34            | +40 33 50 | 0.008 | 4.52 | 31.60 |
| 72    | 3 | 13 54 45            | +12 15 00 | 0.021 | 1.24 | 22.20 |
| 73    | 3 | 14 00 18            | +09 36 00 | 0.019 | 1.48 | 24.90 |
| 74    | 3 | 14 09 54            | +16 05 30 | 0.017 | 1.50 | 22.80 |
| 75    | 3 | 14 44 42            | +11 48 00 | 0.029 | 1.47 | 37.40 |
| 76    | 3 | 15 04 30            | +13 03 00 | 0.022 | 1.46 | 28.40 |
| 77    | 3 | 15 57 00            | +20 53 59 | 0.014 | 0.30 | 3.80 | HCG 79 |
| 78    | 4 | 20 44 39            | +00 10 60 | 0.013 | 4.59 | 50.40 |
| 79    | 3 | 21 08 48            | -23 22 05 | 0.036 | 0.64 | 20.30 |
| 80    | 3 | 21 59 10            | -32 10 19 | 0.009 | 3.67 | 27.70 | HCG 90 |
| 81    | 3 | 22 06 20            | -28 02 30 | 0.023 | 1.09 | 22.00 | HCG 91 |
| 82    | 4 | 22 33 40            | +33 42 02 | 0.022 | 1.52 | 29.10 | HCG 92 |
| 83    | 3 | 22 59 28            | +15 42 24 | 0.007 | 1.13 | 6.40 |
| 84    | 3 | 23 11 51            | -02 57 31 | 0.012 | 2.64 | 26.60 |
| 85    | 3 | 23 19 09            | +26 49 30 | 0.020 | 1.64 | 28.30 |
| 86    | 4 | 23 36 04            | +26 44 47 | 0.029 | 1.26 | 32.10 |
| 87    | 3 | 23 44 49            | -02 36 14 | 0.021 | 1.52 | 27.60 | HCG 97 |
| 88    | 3 | 23 44 53            | -28 24 02 | 0.028 | 0.79 | 19.10 |
| 89    | 3 | 23 58 09            | +28 06 55 | 0.029 | 1.11 | 28.00 | HCG 99 |

*We label RSCG’s as HCG’s if the RSCG contains all or part of the HCG.

Notes to Table 2.
Catalog of RSCG’s: (1) Group number, (2) Number of galaxies in group, (3) Right ascension, (4) Declination, (5) Redshift, (6) Angular radius, (7) Linear radius, and (8) Comments.
### Table 3. Compact group velocity dispersion distributions.

| Sample of Groups | Number of Groups | Median (km s\(^{-1}\)) | First Quartile (km s\(^{-1}\)) | Third Quartile (km s\(^{-1}\)) |
|------------------|------------------|-------------------------|-------------------------------|-------------------------------|
| HCG’s \((N = 3)\) | 23               | 123                     | 70                            | 291                           |
| RSCG’s \((N = 3)\) | 59               | 129                     | 68                            | 249                           |
| HCG’s \((N \geq 4)\) | 69               | 214                     | 148                           | 301                           |
| RSCG’s \((N \geq 4)\) | 30               | 262                     | 154                           | 376                           |

### Table 4. Compact group density distributions.

| Sample of Groups | Number of Groups | Median \((10^4 \, h^3 \, \text{Mpc}^{-3})\) | First Quartile \((10^4 \, h^3 \, \text{Mpc}^{-3})\) | Third Quartile \((10^4 \, h^3 \, \text{Mpc}^{-3})\) |
|------------------|------------------|---------------------------------------------|------------------------------------------------|---------------------------------------------|
| HCG’s \((N = 3)\) | 23               | 3.6                                        | 1.0                                           | 7.9                                        |
| RSCG’s \((N = 3)\) | 59               | 5.1                                        | 3.1                                           | 9.2                                        |
| HCG’s \((N \geq 4)\) | 69               | 2.4                                        | 0.76                                          | 5.1                                        |
| RSCG’s \((N \geq 4)\) | 30               | 1.9                                        | 0.94                                          | 3.9                                        |
| Group | N | \(v_{\text{med}}\) (km s\(^{-1}\)) | \(N_n\) | \(N_{\text{int,env}}\) | \(\rho_{\text{env}}\) | \(N_{\text{int,cg}}\) | \(\rho_{\text{cg}}\) | Comments |
|-------|---|----------------|-----|----------------|-------------|----------------|-------------|----------|
| 1     | 5 | 6942.         | 18  | 1.3            | 13.8        | 1.1           | 45.        |
| 2     | 3 | 5449.         | 6   | 2.3            | 2.6         | 0.4           | 69.        |
| 3     | 3 | 4210.         | 14  | 3.5            | 4.0         | 0.4           | 71.        |
| 4     | 3 | 6692.         | 4   | 2.0            | 2.0         | 0.3           | 119.       |
| 5     | 5 | 5071.         | 48  | 2.6            | 18.4        | 3.1           | 15.        |
| 6     | 3 | 5188.         | 3   | 2.5            | 1.2         | 0.5           | 57.        |
| 7     | 3 | 4375.         | 59  | 3.3            | 17.6        | 1.9           | 15.        |
| 8     | 4 | 5217.         | 58  | 2.5            | 23.4        | 4.1           | 9.         |
| 9     | 3 | 6356.         | 7   | 1.6            | 4.3         | 0.4           | 71.        |
| 10    | 3 | 5107.         | 40  | 2.6            | 15.5        | 0.8           | 36.        |
| 11    | 5 | 5509.         | 41  | 2.2            | 18.4        | 0.9           | 57.        |
| 12    | 3 | 4660.         | 45  | 3.0            | 14.9        | 1.6           | 19.        |
| 13    | 3 | 3846.         | 8   | 5.4            | 1.5         | 0.9           | 32.        |
| 14    | 3 | 2935.         | 11  | 5.5            | 2.0         | 1.9           | 15.        |
| 15    | 4 | 4722.         | 65  | 3.0            | 22.0        | 1.0           | 41.        |
| 16    | 3 | 5400.         | 54  | 2.3            | 23.3        | 0.6           | 51.        |
| 17    | 3 | 5553.         | 15  | 2.2            | 6.8         | 0.4           | 81.        |
| 18    | 3 | 4379.         | 18  | 3.3            | 5.4         | 0.6           | 53.        |
| 19    | 4 | 3914.         | 9   | 5.3            | 1.7         | 2.3           | 17.        |
| 20    | 3 | 2705.         | 15  | 8.5            | 1.8         | 0.7           | 42.        |
| 21    | 3 | 4974.         | 39  | 2.7            | 14.4        | 1.5           | 20.        |
| 27    | 3 | 5536.         | 3   | 3.0            | 1.0         | 0.0           | 1500.      |
| 28    | 3 | 3093.         | 8   | 12.2           | 0.7         | 6.6           | 4.         |
| 29    | 4 | 11252.        | 6   | 0.2            | 29.7        | 0.1           | 444.       |
| 32    | 3 | 6106.         | 10  | 3.2            | 3.1         | 0.3           | 103.       |
| 33    | 3 | 3171.         | 14  | 11.8           | 1.2         | 4.7           | 6.         |
| 42    | 3 | 6328.         | 16  | 2.9            | 5.6         | 0.5           | 54.        |
| 43    | 3 | 8977.         | 8   | 0.8            | 10.6        | 0.0           | 750.       |
| 44    | 6 | 6258.         | 61  | 3.0            | 20.5        | 4.6           | 13.        |
| 45    | 3 | 5440.         | 49  | 4.3            | 11.3        | 0.2           | 176.       |
| 46    | 4 | 4008.         | 12  | 8.2            | 1.5         | 1.1           | 37.        |
| 47    | 4 | 3200.         | 20  | 11.7           | 1.7         | 1.6           | 25.        |
| 49    | 3 | 3956.         | 18  | 8.4            | 2.1         | 1.3           | 23.        |
| 52    | 3 | 6665.         | 5   | 2.5            | 2.0         | 0.7           | 42.        |
| 55    | 4 | 7538.         | 14  | 1.6            | 8.8         | 1.5           | 26.        |
| 64    | 3 | 4801.         | 7   | 5.8            | 1.2         | 0.9           | 34.        |
| 67    | 3 | 7145.         | 97  | 1.9            | 50.0        | 0.1           | 250.       |
| 68    | 3 | 6497.         | 96  | 2.7            | 36.1        | 1.2           | 26.        |
| 69    | 3 | 6743.         | 3   | 2.4            | 1.3         | 0.5           | 55.        |
| 70    | 3 | 5303.         | 9   | 4.6            | 1.9         | 2.2           | 13.        |
| 71    | 5 | 2401.         | 45  | 16.7           | 2.7         | 6.2           | 8.         |
| 72    | 3 | 6160.         | 9   | 3.1            | 2.9         | 0.5           | 62.        |
| 73    | 3 | 5792.         | 32  | 3.7            | 8.7         | 0.8           | 36.        |
| 74    | 3 | 5219.         | 15  | 4.8            | 3.1         | 0.8           | 39.        |
| 75    | 3 | 8753.         | 14  | 0.8            | 16.5        | 0.4           | 73.        |
| 76    | 3 | 6688.         | 10  | 2.4            | 4.1         | 0.7           | 45.        |
| 77    | 3 | 4292.         | 21  | 7.2            | 2.9         | 0.0           | 750.       |
| 78    | 4 | 3776.         | 11  | 4.1            | 2.7         | 4.1           | 9.         |
### Table 5. (continued)

| Group | N  | \(v_{\text{med}}\) (\text{km s}^{-1}) | \(N_n\) | \(N_{\text{int.env}}\) | \(\langle \rho_{\text{env}} \rangle\) \((\times 10^{-3})\) | \(N_{\text{int.cg}}\) | \(\langle \rho_{\text{cg}} \rangle\) \((\times 10^2)\) | Comments |
|-------|----|----------------------------------|--------|----------------|----------------|----------------|----------------|-----------|
| 79    | 3  | 10877                            | 8      | 0.5            | 17.2           | 0.1            | 428.          |           |
| 80    | 3  | 2596.                            | 27     | 8.9            | 3.0            | 2.2            | 13.           |           |
| 81    | 3  | 6949.                            | 12     | 1.9            | 6.5            | 0.3            | 93.           |           |
| 82    | 4  | 6614.                            | 16     | 1.5            | 10.8           | 0.6            | 70.           |           |
| 84    | 3  | 3475.                            | 5      | 6.2            | 0.8            | 1.4            | 21.           | near survey edge |
| 85    | 3  | 5932.                            | 9      | 1.9            | 4.7            | 0.5            | 54.           |           |
| 86    | 4  | 8760.                            | 20     | 0.6            | 32.4           | 0.3            | 129.          |           |
| 87    | 3  | 6239.                            | 6      | 2.4            | 2.5            | 0.8            | 38.           | near survey edge |
| 88    | 3  | 8299.                            | 18     | 1.2            | 15.4           | 0.1            | 230.          |           |
| 89    | 3  | 8705.                            | 5      | 0.6            | 7.9            | 0.2            | 150.          |           |

Notes to Table 5.

Environments of RSCG’s: (1) Group number, (2) number of galaxies in group, (3) median group velocity, (4) number of galaxies in neighborhood, (5) expected number of interlopers in neighborhood, (6) resulting ratio of environment density to average survey density, (7) expected number of interlopers in compact group volume, and (8) resulting ratio of compact group density to average density.

### Table 6. Survey schechter parameters.

| Survey      | \(\alpha_{\text{survey}}\) | \(M_{*,\text{survey}}\) |
|-------------|----------------|----------------|
| CfAnorth a  | -1.03          | -18.67        |
| CfAsouth a  | -0.89          | -18.93        |
| CIA-Combined a | -1.00       | -18.75        |
| SSRS2 b     | -1.20          | -19.50        |

\(\text{aMarzke, Huchra \& Geller (1994).}\)

\(\text{bda Costa et al. (1994).}\)

### Table 7. Best-Fit RSCG Schechter parameters.

| Survey      | \(\alpha_{\text{cg}}\) | \(M_{*,\text{cg}}\) |
|-------------|----------------|----------------|
| CfAnorth    | -1.01          | -19.33        |
| CfAsouth    | -0.56          | -19.29        |
| SSRS2       | -0.79          | -19.92        |
### Table 8. Abundances of RSCG’s with $N \geq 4$. 

| Survey     | Compact Group Abundance $(10^{-5} \text{ Mpc}^{-3})$ at Median $\kappa$ at 1st Quartile $\kappa$ at 3rd Quartile $\kappa$ |
|------------|-------------------------------------------------|
| Cfanorth   | 8.4 20 3.4                                       |
| Cfasouth   | 6.6 16 2.6                                       |
| SSRS2      | 0.50 1.0 0.22                                    |
| All Combined| 3.8 8.6 1.6                                     |

### Table 9. Abundances of RSCG’s with $N = 3$. 

| Survey     | Compact Group Abundance $(10^{-5} \text{ Mpc}^{-3})$ at Median $\kappa$ at 1st Quartile $\kappa$ at 3rd Quartile $\kappa$ |
|------------|-------------------------------------------------|
| Cfanorth   | 34 57 17                                        |
| Cfasouth   | 17 30 8.4                                       |
| SSRS2      | 5.3 8.3 2.8                                     |
| All Combined| 14 23 7.2                                     |