A Hierarchical Framework for Organizing the Laniakea Basin

Bianchini, S.R. (2026) *A Field Guide to Laniakea*

Abstract

This paper presents a hierarchical organizational framework for cataloging the contents of Laniakea, the basin of attraction containing the Milky Way and Local Group as defined by Tully et al. (2014). While the Laniakea Basin boundaries are well constrained through velocity field analysis, no comprehensive public catalog organizing its principal galaxy groups and structural regions by cosmic web topology has yet been published.

The framework organizes Laniakea's four major supercluster lobes (Virgo, Hydra, Centaurus, and Pavo-Indus) into structural regions defined by cosmic web topology: sheets, filaments, walls, clusters, streams, clouds, and void boundaries. This approach prioritizes physical relationships and gravitational flow dynamics over traditional distance-based or brightness-limited organization, creating an intuitive framework for understanding the large-scale structure of the universe.

Additionally, this work proposes standardized terminology for basin-scale structures and introduces hierarchical categories for organizing galaxy groups within each supercluster. The complete catalog contains ~128 galaxy groups and ~718 individual galaxies organized into 27 major structural regions across the four superclusters.

The framework serves multiple purposes: (1) as an educational tool for teaching cosmic web structure, (2) as an observational reference for amateur astronomers, (3) an organizational standard for future Laniakea studies, and (4) a template methodology for organizing other basins of attraction. The complete catalog is made freely available to enable community use and extension.

1 – Introduction

1.1 – The Laniakea Supercluster

In 2014, Tully et al. revolutionized our understanding of the local universe by defining Laniakea, a basin of attraction spanning approximately 500 million light-years and containing the Milky Way along with tens of thousands of other galaxies. The name, meaning "immeasurable heaven" in Hawaiian, reflects both the structure's vast scale and honors the contribution of Hawaiian observatories to its discovery. Unlike traditional superclusters, Laniakea was delineated through velocity-watershed analysis of the Cosmicflows-2 catalog, identifying the region of space where galaxy peculiar velocities converge toward a common gravitational basin.

This velocity-field approach represented a fundamental shift in how astronomers conceptualize large-scale cosmic structure. Rather than treating superclusters as loosely associated overdensities, the watershed method identifies dynamically coherent regions—true basins of attraction where matter flows toward common gravitational attractors. The technique revealed that the Virgo Supercluster constitutes only one lobe (or sub-basin) of a much larger structure. The Laniakea Basin comprises four major supercluster lobes: Virgo (containing the Local Group), Hydra, Centaurus, and Pavo-Indus, each anchored by prominent galaxy clusters but unified by their convergent velocity flows.

The discovery of Laniakea clarified long-standing questions about local large-scale dynamics. Previous observations had revealed unexpected bulk flows in the local universe, attributed to a "Great Attractor" pulling our region of space. The basin analysis demonstrated that these flows result from gravitational convergence toward the core of Laniakea, located in the Norma-Centaurus region where the four supercluster sub-basins meet. This region, heavily obscured by the Milky Way's Zone of Avoidance, contains massive galaxy clusters including the Norma Cluster (Abell 3627) that anchor the basin's gravitational potential.

While the Laniakea Basin boundaries are now well-established through velocity field analysis, and subsequent Cosmicflows releases have refined distance measurements to member galaxies, the internal organization of the basin's galaxy populations has not yet been systematically cataloged for public use. The original Tully et al. (2014) work focused on defining basin boundaries and demonstrating the watershed methodology, not on comprehensive cataloging of member groups and their structural relationships. This gap motivates the organizational framework presented in this paper.

1.2 – The Need for an Organizational Framework

The Laniakea Basin's discovery generated significant public interest in large-scale cosmic structure, yet comprehensive resources for understanding its contents remain fragmented across professional databases and incomplete public references. While several valuable resources exist for accessing galaxy data, none provides systematic organization of Laniakea's member groups according to cosmic web topology, nor do they clarify the hierarchical relationship between the basin's structural regions.

Professional astronomical databases such as the NASA/IPAC Extragalactic Database (NED) and HyperLeda provide essential raw data—positions, redshifts, morphologies, and photometric measurements for individual galaxies. These resources serve researchers admirably for targeted queries and detailed analysis of specific objects. However, their utility for understanding large-scale structure is limited by their design: they present galaxies as isolated catalog entries rather than as components of coherent structures. A user seeking to understand which galaxy groups belong to the Virgo Supercluster versus the Hydra Supercluster, or how these superclusters relate to the broader Laniakea Basin, must piece together this information from scattered sources and technical literature. This barrier limits the effectiveness of these professional tools for educational and public outreach purposes.

Public resources have made astronomical information increasingly accessible to non-specialists, often providing detailed descriptions of galaxy groups and their associations. These community-driven efforts have been instrumental in democratizing astronomical knowledge. However, even the most comprehensive public resources (at the time of writing) lack systematic organization at the basin scale. Information about Laniakea's contents is distributed across hundreds of individual articles (galaxy groups, clusters, and superclusters) without a unified framework connecting them. Moreover, the hierarchical relationship between structures—distinguishing clusters from superclusters and superclusters from basins—remains unclear in public literature, partly due to the inconsistent terminology across sources.

This terminological inconsistency presents a second, related challenge. The use of "supercluster" to describe both individual structures like the Virgo Supercluster and larger basins of attraction like Laniakea creates confusion about hierarchical relationships and relative scales. Are these the same type of structure at different distances, or fundamentally different scales of organization? The answer—that Virgo, Hydra, Centaurus, and Pavo-Indus are supercluster lobes within the larger Laniakea Basin—is obscured by applying the same "supercluster" label to both organizational levels. This ambiguity hinders public understanding of how our Local Group fits within progressively larger structures: the Local Sheet, the Virgo Supercluster, and the Laniakea Basin.

What is needed, therefore, is twofold: first, a comprehensive catalog organizing Laniakea's principal galaxy groups according to their positions within cosmic web structures (sheets, filaments, clusters, walls, streams, etc.), and second, standardized terminology that clearly delineates hierarchical levels from groups and clusters through superclusters to basins of attraction. Such a framework would serve multiple communities—educators teaching the large-scale structure of the cosmic web, amateur astronomers seeking observational context, and researchers requiring organized references to Laniakea's contents. By organizing galaxy groups according to flow and physical structure rather than purely by distance or brightness, this framework enables users to develop intuitive three-dimensional mental maps of our cosmic neighborhood, understanding not just where objects are, but how they relate dynamically within the flowing cosmic web.

1.3 – Goals of This Work

This work pursues four primary goals in organizing and clarifying the structure of the Laniakea Basin:

1. **Structure-Based Categorization:** The framework categorizes galaxy groups according to their positions within cosmic web structures—sheets, filaments, walls, clusters, streams, clouds, and void boundaries—rather than organizing purely by distance or observational brightness. This approach reflects the physical relationships and gravitational flows that shape large-scale cosmic architecture.
2. **Standardized Terminology:** A hierarchy is proposed to clarify relationships in large-scale structure, establishing "basin of attraction" (or simply "basin") as the appropriate designation for velocity-watershed-defined regions like Laniakea, while reserving "supercluster" for the overdensity lobes (Virgo, Hydra, Centaurus, Pavo-Indus) that center on major galaxy clusters. This provides clear levels: clusters (virialized, gravitationally bound) → superclusters (cluster-centered overdensities) → basins (velocity-watershed regions).

(3) **Field Guide Catalog:** The catalog includes principal galaxy groups and notable individual galaxies across Laniakea's four superclusters, organized into structural regions according to the framework defined above. This catalog demonstrates the framework's practical application and provides a comprehensive reference for the basin's contents.

(4) **Open Access:** The complete framework and catalog are made freely available to enable community use, extension, and adaptation. This open approach invites others to develop educational materials, create interactive visualizations and three-dimensional atlases, incorporate the framework into planetarium software, and apply the organizational methodology to other basins of attraction (e.g. Perseus-Pisces).

1.4 – Scope and Limitations

This framework organizes galaxy groups and individual galaxies that serve as structural anchors within the Laniakea Basin's cosmic web. Galaxy groups are included when they contain multiple large galaxies sufficient to define overdensity nodes in large-scale cosmic structure. Individual galaxies are cataloged based on their structural significance, observational prominence, or role as notable satellites to major systems. The catalog draws from standard astronomical designations (Messier, NGC, IC catalogs), with limited inclusion of ESO catalog objects for the heavily obscured Norma Cluster region. This approach emphasizes the organizational framework rather than exhaustive enumeration of all the Laniakea Basin's members, focusing on structures that define the basin's topology.

The structural categories employed here—sheets, filaments, walls, clusters, streams, clouds, and void boundaries—synthesize velocity field data with observed galaxy distributions. The framework requires both coherent flow patterns (from Cosmicflows analysis) with observable galactic overdensities to define structural regions, prioritizing regions that exhibit sufficient galaxy populations to serve as observational anchors. Some boundaries between structural regions necessarily involve interpretive decisions grounded in available data, and alternative organizational schemes could reasonably delineate these boundaries differently. The framework presented here represents one systematic approach to organizing the Laniakea Basin's contents according to cosmic web topology.

This work does not catalog detailed physical properties of individual galaxies, focusing instead on structural relationships and group memberships. Structures beyond Laniakea's velocity-watershed boundaries are excluded by design. The Milky Way's Zone of Avoidance significantly limits observations in the Norma-Centaurus region that contains Laniakea's gravitational core, creating unavoidable uncertainties in group memberships and structural delineations for this area. These observational limitations affect roughly 20% of the sky and are particularly problematic for the southern superclusters (Kraan-Korteweg & Lahav 2000), though future radio and infrared observations may improve coverage of these obscured regions.

2 – Methodology

2.1 – Data Sources

Galaxy positions, redshifts, and physical properties were obtained from the NASA/IPAC Extragalactic Database (NED; Helou et al. 1991), which provides comprehensive multi-wavelength data for extragalactic objects. Distance measurements and velocity field data derive primarily from the Cosmicflows program, specifically Cosmicflows-2 (Tully et al. 2013), Cosmicflows-3 (Tully et al. 2016), and Cosmicflows-4 (Tully et al. 2023), which provide peculiar velocities and flow-corrected distances essential for understanding basin-scale structure, with later releases superseding earlier distance estimates where discrepancies occur. The Laniakea Basin itself was defined through velocity-watershed analysis by Tully et al. (2014), establishing the boundaries and internal flow patterns that inform the organizational framework presented here.

Galaxy group memberships were compiled through cross-referencing Cosmicflows velocity data with established galaxy catalogs, particularly Tully's (1988) Nearby Galaxies Catalog and Garcia's (1993) Lyons Groups of Galaxies, which provide fundamental group association data for the local universe. For specific cluster regions, published cluster surveys provided detailed membership information and substructure analysis, including studies of the Virgo Cluster (Binggeli et al. 1985, 1993; Mei et al. 2007), Fornax Cluster (Ferguson 1989; Jordán et al. 2007), Hydra Cluster (Richter 1989; Hess et al. 2022), Centaurus Cluster (Lucey et al. 1986), and others listed in References. The Local Sheet structure specifically draws on McCall's (2014) "Council of Giants" framework, which identifies the major galaxies anchoring this region of the Virgo Supercluster.

Galaxy designations employ standard astronomical nomenclature from historical catalogs: the Messier catalog for the brightest galaxies, the New General Catalogue and the Index Catalogue (NGC; IC) for the majority of galaxies, the Caldwell catalog (Moore 1995) for additional prominent deep-sky objects, and the ESO catalog (Lauberts 1982) specifically for Southern Hemisphere objects in heavily obscured regions such as the Norma Cluster. This multi-catalog approach ensures comprehensive coverage across both hemispheres and accounts for the Zone of Avoidance limitations that affect southern supercluster observations.

Published cluster memberships and group associations were cross-referenced with public astronomical resources including Wikipedia's extensive galaxy group articles and Richard Powell's Atlas of the Universe (Powell 2006) to ensure consistency between professional catalogs and publicly accessible references. This process confirmed that the organizational framework aligns with both established research and community understanding of large-scale structure, bridging professional and public knowledge bases.

2.2 – Organizational Philosophy

This framework organizes Laniakea's contents according to cosmic web topology and gravitational flow patterns rather than traditional distance-based or brightness-limited schemes. Unlike organizational approaches that prioritize proximity to the Milky Way or observational convenience, this structure-based philosophy groups galaxies according to their physical relationships within the basin's flowing architecture. The framework synthesizes two complementary data sources: velocity field analysis from Cosmicflows, which reveals coherent flow patterns and basin dynamics, and observed galaxy distributions from catalogs and surveys, which show where matter concentrates. A fundamental principle underlying this approach is requiring convergent evidence—structural regions must exhibit both coherent gravitational flow patterns and observable galactic overdensities. This dual requirement ensures that organizational categories reflect both the large-scale cosmic web structure inferred from velocity fields and observable galaxy distributions accessible to researchers and observers, avoiding inclusion of flow regions that lack sufficient galaxy populations to serve as observational anchors. The framework categorizes structures as sheets, filaments, walls, clusters, streams, clouds, or void boundaries based on their morphology, density, characteristics, and flow behavior within the cosmic web (detailed definitions in Section 3). While grounded in observational data and velocity field analysis, the framework acknowledges that component boundaries involve interpretive decisions, as cosmic web structures often blend continuously rather than exhibiting sharp discontinuities.

This organizational philosophy aims to enable intuitive three-dimensional mental maps of cosmic structure, allowing users to understand not just where objects are located in space, but how they relate dynamically within the flowing cosmic web. By organizing galaxies according to their structural relationships rather than simple distance metrics, the framework reveals connections that might otherwise remain obscure—for example, understanding that M51 resides within the Local Filament that connects the Local Sheet to the gravitational center of the Virgo Supercluster provides richer context than simply stating its distance of 23 million light-years. This approach serves multiple audiences: educators teaching large-scale structure can use the framework to illustrate cosmic web topology, amateur astronomers gain observational context for familiar galaxies, and researchers benefit from systematic organization of basin contents. While developed specifically for organizing Laniakea's structure as a velocity-watershed-defined basin containing four major supercluster lobes, this philosophical approach to structure-based organization is extensible to other basins of attraction, providing a methodological template that can be adapted to regions such as Perseus-Pisces or the Shapley Concentration as observational data becomes available.

2.3 – Hierarchical Structure

The framework employs hierarchical organization to manage the complexity of basin-scale structure, progressing from the largest velocity-watershed-defined regions down through progressively finer levels of structural detail. This nested approach reflects the physical reality that cosmic structure exists at multiple scales, with smaller structures embedded within larger gravitational flows. Hierarchical organization also facilitates both comprehensive overview (understanding the basin as a whole) and detailed examination (exploring specific regions or objects), allowing users to navigate between scales depending on their needs.

The framework organizes the Laniakea Basin's contents across five nested hierarchical levels:

(1) **Basin of Attraction** – Laniakea
 └ (2) **Superclusters** – Virgo, Hydra, Centaurus, Pavo-Indus
  └ (3) **Structural Regions** – sheets, filaments, clusters, etc.
   └ (4) **Galaxy Groups** – Local Group, M51 Group, M87 Subgroup, etc.
    └ (5) **Individual Galaxies** – Milky Way, Andromeda, etc.

(1) At the highest level, the **basin of attraction** (Laniakea itself) represents the outermost organizational tier, encompassing all structures whose peculiar velocities converge toward the basin's gravitational core in the

Norma-Centaurus region. This basin-supercluster relationship is fundamental to the proposed terminological framework: basins are velocity-watershed-defined regions (Tully et al. 2014), while superclusters are the major overdensity lobes within basins, anchored by massive clusters.

(2) Within the Laniakea Basin, four major **superclusters**—Virgo, Hydra, Centaurus, and Pavo-Indus—represent the primary sub-basins (or lobes), each anchored by prominent galaxy clusters (Virgo Cluster, Hydra Cluster, Centaurus Cluster, and the Pavo and Indus clusters respectively) but unified by convergent velocity flows toward the common basin attractor.

(3) The third level comprises **structural regions**, representing distinct topological features of the cosmic web within each supercluster, categorized as sheets, filaments, clusters, walls, streams, clouds, or void boundaries according to morphology and density (see Section 3 for detailed definitions).

(4) At the fourth level, **galaxy groups** represent gravitationally bound or associated collections of galaxies—such as the M81 Group, M101 Group, or NGC 5846 Group—assigned to structural regions based on their positions within the cosmic web and participation in shared flow patterns. Notably, galaxy groups and clusters are the only gravitationally bound structures in the hierarchy; basins, superclusters, and most structural regions represent organizational categories based on flow patterns and overdensity distributions rather than virialized systems.

(5) The fifth and finest level catalogs **individual galaxies** of particular structural significance or observational prominence, including large galaxies comparable to the Milky Way, notable satellite galaxies, and observationally prominent objects from Messier, NGC, and IC catalogs, emphasizing structural anchors and observationally accessible objects rather than exhaustive enumeration.

This hierarchical framework organizes Laniakea into four superclusters, 27 structural regions, approximately 128 galaxy groups, and 718 cataloged individual galaxies, as defined in this framework. These levels form a strict hierarchical nesting: each individual galaxy belongs to a group, each group to a structural component, each component to a supercluster, and all detailed superclusters to the Laniakea Basin. This nested organization ensures that every cataloged object has a clear position within the basin's overall structure, enabling systematic navigation from cosmic web topology down to individual observable galaxies.

2.4 – AI-Assisted Compilation

Google's Gemini Pro AI was used to assist in cross-referencing large astronomical datasets, enabling systematic synthesis at a scale impractical for fully manual compilation given the size of the Laniakea Basin. This computational assistance was integrated into a rigorous verification workflow that maintained human oversight at all critical decision points. For each structural component, Gemini Pro was provided with relevant distance ranges and velocity field parameters from Cosmicflows data. The AI then cross-referenced NED catalog entries with Cosmicflows measurements to identify galaxies and groups meeting these criteria, proposing candidate memberships for verification. Google's NotebookLM feature additionally assisted in analyzing the published cluster surveys cited in Section 2.1, helping to verify that proposed structural groupings aligned with findings from peer-reviewed literature. Gemini Pro served as a computational tool for efficient data processing, while the author designed the organizational framework, defined structural regions, established verification criteria, and made all interpretive decisions about boundary cases and component assignments.

The verification process required convergent evidence from multiple sources, with group memberships accepted only when supported by published literature, consistent with Cosmicflows velocity data, and verified against independent references. Discrepancies between sources triggered manual examination of original catalog data to resolve conflicts. The verification process resulted in corrections to AI-suggested group memberships, particularly in cases where the AI failed to properly account for distance depth, instead relying primarily on two-dimensional sky positions that could incorrectly associate foreground or background galaxies with structures at different distances. The methodology described here is replicable by other researchers with access to large language models and the astronomical databases cited, with the key requirement being rigorous verification protocols rather than the specific AI platform choice. The framework and complete catalog are made available to enable community verification, extension, and refinement.

3 – Terminology and Definitions

3.1 – Large-Scale Structure Terminology

This framework proposes clarified terminology for the highest levels of large-scale cosmic structure to resolve ambiguity in current usage. Two key terms are established and refined: **basin of attraction** and **supercluster**. The proposed definitions provide clear hierarchical distinctions necessary for systematic organization of the cosmic web.

> **Basin of Attraction:** A vast region of space where the peculiar velocities of galaxies converge toward a common gravitational attractor, encompassing multiple superclusters and spanning hundreds of millions of light-years.

Basins represent the highest level of large-scale structure organization, delineated through velocity-watershed analysis of peculiar velocity fields from programs such as Cosmicflows (Tully et al. 2013, 2016, 2023). The velocity-watershed method identifies boundaries where flow directions diverge—analogous to topographic watersheds that separate drainage basins on Earth—delineating volumes where matter flows toward common gravitational attractors. While Tully et al. (2014) labeled Laniakea a "supercluster," their velocity-watershed methodology actually defines a basin of attraction. This framework proposes adopting "basin of attraction" (or simply "basin") as the appropriate designation for velocity-watershed-defined regions, reserving "supercluster" for the overdensity lobes within basins. This terminological distinction resolves ambiguity about hierarchical relationships and clarifies that structures like Virgo, Hydra, Centaurus, and Pavo-Indus are superclusters (sub-basin lobes), while Laniakea is the basin containing them. Basins typically span 300-500 million light-years in diameter and contain masses on the order of 10^{17} solar masses. Examples include the Laniakea Basin (containing the Virgo, Hydra, Centaurus, and Pavo-Indus superclusters) and Perseus-Pisces Basin (Tully et al. 2023).

> **Supercluster:** A large-scale overdensity of galaxy groups and clusters, spanning tens to hundreds of millions of light-years, often serving as sub-basins within larger basins of attraction.

Historically, "supercluster" has been applied to structures at various scales, from local overdensities like the Virgo Supercluster (de Vaucouleurs 1956) to larger velocity-watershed-defined regions like the "Laniakea Supercluster" (Tully et al. 2014). This framework proposes reserving "supercluster" for the former—major overdensity lobes concentrated around massive galaxy clusters—while using "basin of attraction" for velocity-watershed-defined regions. Superclusters represent gravitationally influenced but not virialized structures, characterized by coherent flow patterns which converge toward massive clusters that serve as gravitational anchors. Within the Laniakea Basin, four major superclusters are identified: Virgo (centered on the Virgo Cluster), Hydra (centered on the Hydra Cluster/A1060), Centaurus (centered on the Centaurus Cluster/A3526), and Pavo-

Indus (centered on the Pavo and Indus clusters/A3742/A3656). Superclusters typically span 100-200 million light-years and contain masses of 10^{15}-10^{16} solar masses. This hierarchical distinction—where superclusters function as sub-basin lobes within larger basins—provides a clearer organizational framework than using “supercluster” at multiple scales.

3.2 – Structural Component Categories

Structural regions within superclusters are categorized according to their morphology, density characteristics, and dynamic behavior within the flowing cosmic web. This framework employs seven categories representing distinct topological features, spanning a density hierarchy from virialized clusters to sparse void boundaries. These categories enable systematic organization of galaxy groups according to their positions within the cosmic web architecture, with each category defined by convergent evidence from morphology, overdensity measurements, and velocity field coherence.

Sheet: A flattened, low-to-moderate-density planar structure of relative quiescence where peculiar velocities are minimal, typically defining the interfacial boundaries of the cosmic web and often bordering voids.

Filament: A massive, thread-like, moderate-to-high-density feature of the cosmic web spanning tens of millions of light-years that connects major structural regions, acting as the primary pathway along which matter flows between supercluster nodes.

Cluster: A high-density, virialized region containing hundreds to thousands of galaxies, often sitting at the intersection of filaments and serving as the deepest gravitational wells within a supercluster or basin.

Wall: A massive, high-density, planar structure with significant lateral extent perpendicular to the supergalactic plane, often serving as a boundary between superclusters or between superclusters and voids.

Stream: A linear, often narrow, low-to-moderate-density procession of galaxy groups flowing coherently toward a larger structure.

Cloud: A diffuse, amorphous region of moderate density in which galaxy groups lack the tight core and virialization of a cluster, the flattened morphology of a sheet or wall, or the linear flow of a stream or filament.

Void Boundary: A sparse region of very low density characterized not by its own internal structure, but by its proximity to cosmic voids—vast underdense regions largely devoid of galaxies.

These seven categories reflect the fundamental morphological and dynamical diversity of the cosmic web. The morphological distinctions—nodal (clusters), linear (filaments and streams), planar (sheets and walls), amorphous (clouds), and interfacial (void boundaries)—correspond to different roles within basin-scale gravitational flows. Clusters represent convergence points where multiple filaments intersect, creating the deepest potential gravitational wells. Filaments serve as moderate-to-high density conduits connecting these nodes, while streams represent lower-density flows feeding into larger structures. Sheets and walls define planar structures, with walls representing higher-density, more substantial boundaries (often perpendicular to sheets relative to the Supergalactic plane), while sheets mark lower-density planes that often border voids. Clouds occupy an intermediate category—concentrations too structured to qualify as void boundaries but lacking the geometric regularity of filaments, sheets, walls, or streams. Void boundaries mark the transition between supercluster structures and the underdense regions they surround.

The distinction between morphologically similar categories rests primarily on density and dynamical role. Filaments and streams are both linear but differ in density (moderate-to-high vs. moderate-to-low) and function (filaments connect major nodes, while streams flow toward them). Similarly, walls and sheets are both planar but differ in density (high vs. moderate-to-low) and orientation (walls often perpendicular to sheets). These distinctions enable precise categorization while acknowledging that cosmic web structure exists along continua rather than in discrete bins. The 27 structural regions identified within the Laniakea Basin's four superclusters (presented in Section 4) demonstrate the practical application of these categories to basin-scale organization.

3.3 – Specific Regional Terminology

To enable clear communication about specific regions within Laniakea, this framework employs descriptive regional nomenclature combining structural type and location. Terms such as "Local Sheet" or "Hydra-Centaurus Stream" immediately convey both morphology and position within the basin's architecture. This naming convention facilitates intuitive recognition of each region's character and role within the larger cosmic web structure.

In addition to the seven standard structural categories defined in Section 3.2, this framework employs several catalog-specific descriptive terms for organizational purposes:

> **Complex:** An aggregate designation grouping multiple distinct clusters or structural features into a single catalog section.
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> **Association:** An isolated, loosely organized concentration of galaxy groups that, unlike clouds, are not physically connected to a major cluster or filament.
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> **Field Galaxy:** A designation for dispersed isolated galaxies residing outside defined structural boundaries.
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> **Extension:** A term applied when a structural region comprises multiple smaller streams that merit grouped treatment rather than individual designation.

The complex designation is employed in two contexts: when neighboring structures are individually too small to warrant separate top-level categories (the Fornax Complex combines the Fornax and Eridanus clusters), or when the Zone of Avoidance limits resolution of internal substructure (Norma Complex, Pavo-Indus Complex). Associations represent "free-floating" structures not physically embedded in the main flow structures of their host supercluster (Leo Association, Ara Association). Field galaxies are functionally equivalent to void boundaries but reflect observational density differences in an organizational context. The Virgo Supercluster contains sufficient cataloged field galaxies (~40) to warrant subdivision into four specific void boundary regions, while the more distant superclusters contain fewer cataloged field galaxies due to observational selection effects, making subdivision impractical and resulting in collective field galaxy designations.

The framework identifies 27 structural regions organized across the Laniakea Basin's four superclusters:

> **Virgo Supercluster (10 regions):** Local Sheet, Local Filament, Virgo Cluster, Northern Cloud, Southern Extension, Local Infall[1], Virgo Stream, Fornax Complex, Leo Association, Virgo Void Boundaries
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> **Hydra Supercluster (6 regions):** Antlia Stream, Antlia Cluster, Northern Filament, Hydra Cluster, Hydra Cloud, Hydra Field Galaxies

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[1] From a broader cosmic reference frame, the Local Sheet and Local Infall represent components of the Local Filament. Separate designations reflect the Local Group's observational perspective.

Centaurus Supercluster (5 regions): Centaurus Wall, Centaurus Cluster, Hydra-Centaurus Stream, Norma Complex, Centaurus Field Galaxies

Pavo-Indus Supercluster (6 regions): Telescopium Cloud, Southern Filament, Pavo-Indus Complex, Microscopium Extension, Ara Association, Pavo-Indus Field Galaxies

The organization and detailed descriptions of these regions are presented in Section 4.

4 – The Laniakea Framework

4.1 – Overview of the Four Superclusters

The Laniakea Basin comprises four major superclusters—Virgo, Hydra, Centaurus, and Pavo-Indus—functioning as sub-basin lobes within the larger velocity-watershed-defined structure. These superclusters represent distinct overdensity concentrations, each anchored by massive galaxy clusters, yet unified through convergent velocity flows toward the basin's gravitational core. The Local Group resides within the Virgo Supercluster, the nearest and best-observed of these four lobes. This framework organizes Laniakea's contents according to cosmic web topology, identifying 27 structural regions across the four superclusters based on morphology, density, and flow dynamics rather than simple distance or brightness-limited schemes.

The four superclusters exhibit convergent velocity flows toward the "Great Attractor" (the basin's core) in the Norma-Centaurus region, the defining characteristic of Laniakea as a basin of attraction. The Virgo Supercluster flows southeastward toward this convergence point, while the Hydra and Centaurus superclusters, positioned south of Virgo, also contribute major flow streams toward Norma. The Pavo-Indus Supercluster, the most distant lobe, flows northward toward the same gravitational attractor. This convergent flow pattern, revealed through Cosmicflows velocity field analysis, demonstrates that these four superclusters are not independent structures but interconnected components of a unified dynamical system. The Norma-Centaurus region, heavily obscured by the Milky Way's Zone of Avoidance, represents the deepest gravitational potential well within Laniakea, where flows from all four superclusters converge.

Each supercluster exhibits distinct structural characteristics reflecting its position within the basin and observational constraints. The Virgo Supercluster (spanning approximately 0-110 Mly from the Local Group, ~10^{15} solar masses) contains the most detailed catalog due to proximity, with well-resolved regions including the Local Sheet, multiple regions connecting to the Virgo Cluster, the Fornax Complex (incl. Fornax and Eridanus clusters), and clearly delineated void boundaries (Local, Sculptor, Northern, Eridanus). The Hydra Supercluster (centered ~160 Mly distant, ~10^{15} solar masses) is characterized by prominent streams—particularly the Antlia Stream—feeding into the Antlia and Hydra clusters and continuing as the Hydra-Centaurus Stream flowing toward the basin's core. The Centaurus Supercluster (centered ~170 Mly distant, ~10^{15}-10^{16} solar masses) features the massive Centaurus Wall and the Norma Complex (incl. Norma Wall, Norma Cluster)—part of the basin's gravitational core. The Pavo-Indus Supercluster (centered ~220 Mly distant, ~10^{15} solar masses) represents the most distant lobe, with regions including the Telescopium Cloud and the Pavo-Indus Complex where multiple clusters (incl. Pavo, Indus) are grouped together due to limited resolution.

The organization presented in the following sections reflects this hierarchical structure: each supercluster's section describes its constituent structural regions in a cosmographic and topological context, proceeding from sheets and filaments through clusters and walls to streams, clouds, and void boundaries. This approach enables an understanding of how galaxy groups relate not just spatially but dynamically within the flowing architecture of the cosmic web and the Laniakea Basin.

4.2 – Virgo Supercluster Organization

Having established Laniakea's four-supercluster structure, we now examine the Virgo Supercluster in detail. As the nearest supercluster lobe and home to the Local Group, Virgo offers the most complete observational data within the Laniakea Basin, enabling detailed resolution of its internal substructure. The Virgo Supercluster spans approximately 0-110 million light-years from the Local Group and contains an estimated mass of 10^{15} solar masses distributed across ten distinct structural regions. These regions range from the quiescent Local Sheet—a low-density plane containing our own Milky Way galaxy—through the massive Virgo Cluster at the supercluster's gravitational center, to sparse void boundaries marking transitions to underdense regions. The organizational framework presented here demonstrates how cosmic web topology—sheets, filaments, clusters, walls, streams, clouds, and void boundaries—provides intuitive structure for understanding the Local Group's position within progressively larger gravitational flows, from our immediate neighborhood through the broader Virgo Supercluster to the Laniakea Basin.

4.2.1 – Local Sheet

The Local Sheet represents the nearest and most intimately studied structural region within the Virgo Supercluster, distinguished by its remarkably flattened geometry and role as home to the Local Group. McCall (2014) definitively established the Local Sheet as a kinematically distinct structure rather than a simple extension of the broader Virgo Supercluster, revealing it as an extremely thin disc extending approximately 16 million light-years in radius yet maintaining a vertical thickness of only 750,000 light-years. This severe flattening—a thickness-to-radius ratio of less than 5%—characterizes the Local Sheet as a classic low-density sheet structure within cosmic web topology. The Sheet exhibits minimal internal velocity dispersion, indicating a dynamically "cold" structure that has not yet fully adjusted to its gravitational environment, yet participates in coherent large-scale flow toward the Virgo Cluster and the broader Laniakea Basin's gravitational core (Tully et al. 2023).

Within this flattened plane, the Local Group occupies a central position surrounded by what McCall termed the "Council of Giants"—a ring of major galaxies arranged at a radius of approximately 12 million light-years. This Council comprises five principal galaxy groups: the Maffei Group (containing Maffei 1, Maffei 2, and IC 342), the Sculptor Group (anchored by NGC 253), the M81 Group (dominated by M81 and M82), the M83 Group (including M83, Centaurus A, NGC 4945, and Circinus), and the M94 Group (Canes I; containing M94 and M64). Together with the Local Group itself—containing the Milky Way, Andromeda (M31), and Triangulum (M33) as principal members—these six groups define the populated region of the Local Sheet. The Council exhibits a striking feature: it contains only two giant elliptical galaxies, Maffei 1 and Centaurus A (NGC 5128), positioned on opposite sides of the ring separated by 175 degrees. This "elliptical dipole" may have influenced the formation and evolution of disc galaxies within the Local Group, with the gravitational influence of these massive ellipticals potentially shepherding gas dynamics during the early universe (McCall 2014).

The Local Group itself contains three primary spiral galaxies—the Milky Way, Andromeda, and Triangulum—along with their associated satellite systems including the Large and Small Magellanic Clouds orbiting the Milky Way and M110 and M32 accompanying Andromeda. McCall's analysis revealed that the Local Group's realm of gravitational influence extends approximately 8.5 million light-years, where its gravity balances that of the surrounding Council. The Local Group moves along a trajectory nearly parallel to the axis connecting Maffei 1 and

Centaurus A, exhibiting motion relative to the Council's center while simultaneously participating in the larger-scale flow toward the Virgo Cluster. The alignment of the Milky Way-Andromeda system deviates only 11 degrees from the Local Sheet plane, suggesting their binary configuration arose within and was shaped by this flattened cosmographic framework.

The Local Sheet's dynamic behavior illustrates the hierarchical nature of cosmic structure: while internally quiescent with minimal vertical motions perpendicular to the Sheet plane, the entire region participates in bulk flow toward the Virgo Cluster at approximately ~200 km/s and ultimately toward the Norma-Centaurus core of the Laniakea Basin (Tully et al. 2023). This contrast between internal calm and external motion reflects the nested organization of gravitational flows operating at progressively larger scales.

Cataloged groups in this region (6): Local Group, Maffei Group, Sculptor Group, M81 Group, M83/Centaurus A Group, M94 Group

4.2.2 – Local Filament

Beyond the velocity discontinuity at approximately 23 million light-years that marks the outer boundary of the Local Sheet, the Local Filament emerges as a bridge structure connecting the quiescent plane of the Local Sheet to the Virgo Cluster's deep gravitational well. This filamentary region synthesizes regions identified in literature as the Coma-Sculptor Cloud and the Leo Spur (Tully et al. 2008), unifying them within the Laniakea framework as a moderate-to-high density conduit along which matter flows toward the Virgo Cluster and ultimately toward the basin's core (Tully et al. 2023). The Local Filament exhibits the characteristic morphology of filamentary structures—extended linearly along the flow direction while maintaining coherent velocity patterns distinct from the cold kinematics of the Local Sheet. Where the Sheet demonstrates minimal internal velocity dispersion, the Local Filament displays organized infall patterns as galaxy groups participate in accelerating motion toward Virgo, illustrating the transition from sheet-like quiescence to active filamentary flow.

The Leo Spur component of the Local Filament contains several prominent galaxy groups including the M96 Group (Leo I) anchored by the giant elliptical M105, the M66 Group forming the famous Leo Triplet, and associated groups. Tully (2008) identified the Leo Spur as kinematically distinct from the Local Sheet, with galaxies exhibiting large negative peculiar velocities indicating infall toward and past the

Local Sheet plane. The catalog incorporates the Leo Spur within the Local Filament due to its physical attachment to the filamentary structure and its position in the foreground relative to more distant Leo concentrations (Leo II; detailed separately as the Leo Association). The Coma-Sculptor Cloud component extends through groups including the M101 Group (containing the Pinwheel Galaxy), the M51 Group (featuring the iconic Whirlpool Galaxy), the M106 Group (Canes II), and the Coma I Group. These galaxy concentrations define overdensity nodes along the filament's extent, marking the pathway through which matter streams from the Local Sheet environment toward the Virgo Cluster.

The Local Filament's transitional character—positioned between the Local Sheet's relative stability and the Virgo Cluster's overwhelming gravitational dominance—creates interpretive challenges for boundary delineation. The Filament gradually merges into the Virgo Cluster infall region where distinguishing filamentary structure from cluster-dominated dynamics becomes increasingly ambiguous. This boundary ambiguity reflects the continuous nature of cosmic web structures, where categories blend rather than exhibiting sharp discontinuities. Despite this gradual transition, the Local Filament remains identifiable through its moderate density, linear morphology parallel to the Virgocentric flow direction, and the coherent streaming motions of its constituent galaxy groups. The region serves as the primary conduit connecting our immediate cosmic neighborhood to the broader Virgo Supercluster sub-basin, channeling matter from the Local Sheet's flattened distribution toward the cluster region that anchors the supercluster's gravitational center.

Cataloged groups in this region (9): M101 Group, M51 Group, M106 Group, NGC 4631 Group, M96 Group, M66 Group, NGC 4565 Group, NGC 5033 Group, Coma I Group

4.2.3 – Virgo Cluster

The Virgo Cluster represents the gravitational anchor of the Virgo Supercluster and one of the nearest major galaxy clusters to the Local Group, located at approximately 52 million light-years distant. Unlike relaxed, virialized clusters that have settled into dynamical equilibrium, the Virgo Cluster exhibits the characteristics of an active assembly site where multiple substructures are currently merging into a unified system. This non-equilibrium state manifests in the cluster's complex velocity structure and its organization into six distinct subgroups:

Virgo A (M87 Subgroup), Markarian's Chain (M86 Subgroup), Virgo B (M49 Subgroup), Virgo C (M60 Subgroup), the Southern Cloud (M61 Subgroup), and the Northern Cloud [2] (M100 Subgroup). The cluster's membership has been carefully established through detailed morphological analysis and radial velocity measurements (Binggeli et al. 1985, 1993; Mei et al. 2007), excluding background structures such as the W Cloud that contaminated earlier catalogs. This rigorous membership determination confirms approximately 2,000 galaxies as genuine cluster members distributed across these subgroups, creating a mass concentration that dominates the Virgo Supercluster's gravitational potential and serves as the primary attractor for surrounding regions including the Local Sheet and Local Filament.

Virgo A, centered on the supergiant elliptical galaxy M87, constitutes the primary anchor of the cluster and represents the deepest gravitational well within the Virgo Supercluster. M87 itself hosts the supermassive black hole M87*, famously the first black hole ever directly imaged by the Event Horizon Telescope Collaboration (2019), underscoring the galaxy's status as one of the most intensively studied objects in extragalactic astronomy. The Virgo A subgroup is the most dynamically evolved region of the cluster and is approximately virialized within its inner core, representing a mature, gravitationally bound structure around which the other subgroups are assembling. Major members include the prominent spirals M90, M58, M88, and M91, along with numerous elliptical and lenticular companions that define the cluster's virialized center. While M87 serves as the accepted "bottom of the well"—the deepest point in the cluster's gravitational potential—the Virgo Cluster's overall structure reflects comparable-mass contributions from multiple subgroups. Virgo B, centered on the giant elliptical M49 approximately 3 million light-years south of M87, represents a distinct substructure of roughly equal mass to Virgo A (Binggeli et al. 1993). These two massive concentrations sit side by side in a configuration that may represent ongoing merger dynamics, though Virgo B maintains sufficient separation to constitute a dynamically distinct component. The careful separation of Virgo B membership from background W Cloud contamination (Binggeli et al. 1985) confirms genuine cluster members including NGC 4535 (the Lost Galaxy), NGC 4526, and numerous dwarf companions to M49.

The most dramatic evidence for the Virgo Cluster's active assembly emerges from analysis of Markarian's Chain, a visually striking alignment of galaxies centered on M86 that proves to be not merely a projection effect but a genuine physical

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[2] Refers strictly to the infalling M100 Subgroup. Distinct from the broader "Northern Cloud" region (Ursa Major groups) of the greater Virgo Supercluster.

subclump currently colliding with the Virgo A core (Binggeli et al. 1993). This M86 Subgroup occupies a position physically behind the M87 core and is falling forward toward the cluster center at high velocity, creating the distinctive blue-shifted (negative) velocities that characterize M86 and its surrounding dwarf elliptical companions. M86 exhibits a heliocentric velocity of -227 km/s, appearing to rush toward Earth as it plunges into the cluster from the far side. This infall has produced a concentrated swarm of dwarf galaxies sharing M86's peculiar kinematics, including the famous interacting pair "The Eyes" (NGC 4438 and NGC 4435) and prominent elliptical M84. The sharp velocity contrast between M86 and nearby M84 (which exhibits +1,000 km/s recession velocity) demonstrates the complex, non-equilibrium dynamics characterizing this merger event. The kinematic evidence indicates that the Virgo Cluster core has not yet achieved full virial equilibrium but represents the imminent merging of the virialized Virgo A subgroup with the substantial M86 subclump, a process that will ultimately incorporate Markarian's Chain into the unified cluster core.

Surrounding these merging core structures, the Northern and Southern Clouds represent spiral-rich populations falling into the cluster from opposite directions. The Southern Cloud (M61 Subgroup), dominated by the grand design spiral M61 along with NGC 4527 and NGC 4536, occupies the near side of the cluster and exhibits systematically higher recession velocities as these galaxies fall away from Earth toward the cluster center. The Northern Cloud (M100 Subgroup), featuring the prominent spirals M100, M98, M99 (St. Catherine's Wheel), and NGC 4651, falls from the far side and consequently displays lower recession velocities as these galaxies approach Earth while falling toward the cluster core. Gavazzi et al. (1999) confirmed through three-dimensional distance measurements that both clouds reside at the same distance as the main cluster (~52 Mly), establishing them as genuine infalling populations rather than foreground or background structures. These clouds exhibit the broad velocity dispersion characteristics of unrelaxed, first-infall galaxies that have not yet undergone virial equilibrium within the cluster potential. Virgo C (M60 Subgroup) is anchored by the elliptical M60 and includes M59 and the distinctive edge-on lenticular NGC 4762, representing an additional concentration within the cluster's eastern region. The ongoing infall of these spiral-rich clouds, combined with the merger of the M86 Subgroup into the Virgo A core, demonstrates that the Virgo Cluster remains an active construction site where multiple streams of matter converge toward the supercluster sub-basin's deepest gravitational potential, ultimately feeding the growth of the massive region that anchors the entire Virgo Supercluster within the broader Laniakea Basin.

Cataloged groups in this region (6): M87 Subgroup (Virgo A), M86 Subgroup (Markarian's Chain), M49 Subgroup (Virgo B), M61 Subgroup (Southern Cloud), M60 Subgroup (Virgo C), M100 Subgroup (Northern Cloud)

The Local Sheet, Local Filament, and Virgo Cluster together define the primary architecture of the Virgo Supercluster's inner structural regions, establishing the fundamental flow pattern from the quiescent plane of the Local Sheet through the filamentary bridge toward the cluster's deep gravitational well. This progression—from low-density sheet through moderate-density filament to high-density virialized cluster—illustrates the hierarchical organization of matter within the cosmic web, where structures at each scale participate in flows toward progressively larger gravitational attractors. The forthcoming structural regions complete this flow picture by describing outer concentrations surrounding the Virgo Cluster region and the extended pathways through which matter reaches the cluster core. The Northern Cloud and Southern Extension represent outer concentrations of galaxy groups participating in the bulk flow toward the Virgo Cluster from greater distances, while the Local Infall and Virgo Stream define flows extending in opposite directions from the Local Sheet-Filament-Cluster axis—one reaching back toward the Local Void, the other streaming forward toward the gravitational core of the Laniakea Basin in the Norma-Centaurus region.

4.2.4 – Northern Cloud and Southern Extension

Beyond the Virgo Cluster's immediate domain, two substantial outer concentrations define regions where galaxy groups stream toward the cluster from greater distances, completing the picture of matter converging on the Virgo Supercluster's gravitational center. The Northern Cloud and Southern Extension represent distinct environments—one a low-density aggregation approaching from the north, the other a flattened concentration feeding the cluster from the south—yet both participate in the large-scale flow channels through the supercluster. These outer regions bridge the gap between the inner regions already described and the truly peripheral regions that mark the supercluster's boundaries, demonstrating how cosmic web architecture organizes galaxy populations across scales from individual groups through intermediate concentrations to cluster-dominated cores.

The Northern Cloud, synthesizing structures identified in literature as the Ursa Major Cluster, Draco Spur, and Ursa Major Cloud, extends northward from the Virgo Cluster region as a low-density aggregation of nine major groups including the

NGC 4111 Group, NGC 4157 Group, M109 Group, NGC 3631 Group (together representing the Ursa Major Cluster), NGC 5866 Group (the Draco Spur, anchored by the Spindle Galaxy), and the remaining groups which comprise the Ursa Major Cloud component. Unlike the virialized Virgo Cluster core with its internal velocity dispersion of ~700 km/s, the Northern Cloud exhibits the characteristics of a loose aggregation with dispersions around ~100 km/s and galaxy populations dominated by late-type spirals and irregulars. Pak et al. (2014) demonstrated that the Ursa Major Cluster groups maintain a fundamentally different environment from the dense Virgo Cluster, with early-type dwarf galaxies in this region predominantly exhibiting ongoing star formation in contrast to the quenched populations typical of high-density cluster cores. This low-density environment allows the Northern Cloud's member groups to retain gas and continue forming stars while participating in the general flow toward the Virgo Cluster, illustrating how different positions within the cosmic web structure support different evolutionary stages even within a single supercluster.

The Southern Extension, corresponding to structures traditionally identified as the Virgo II groups and the Crater Cloud, unified here as multiple streams converging through the NGC 4753 Group before entering the Virgo Cluster's gravitational domain. Karachentsev & Nasonova (2013) revealed this region as a flattened concentration approximately 49 million light-years long, 23 million light-years wide, and only 6.5 million light-years thick, oriented nearly perpendicular to the Supergalactic plane and attached to the Virgo Cluster at a right angle relative to our line of sight. Most significantly, the Southern Extension resides at essentially the same distance and exhibits the same mean radial velocity as the Virgo Cluster itself (approximately ~55 Mly, ~1,000 km/s), revealing it as a sheet-like structure currently merging with the cluster rather than a distant feeding stream. The region comprises seven cataloged groups including the NGC 4753 Group (serving as the common gravitational drain for both inflowing streams), the M104 Group (anchored by the famous Sombrero Galaxy), along with the Crater Cloud component containing the NGC 4038 Group—home to the Antennae Galaxies, an archetypal galactic collision featuring two merging spirals (NGC 4038 and NGC 4039) with dramatic tidal tails and intense starburst activity—among others. Tully (1982) identified groups within the Southern Extension exhibiting clear infall motion with relative velocities approaching ~500 km/s directed toward the Virgo Cluster, leading to the assessment that this region is "destined to be digested into the Virgo Cluster." The flat geometry and substantial mass (approximately 6×10^{13} solar masses) establish the Southern Extension as a significant region demonstrating the ongoing assembly of the Virgo Cluster through accretion of surrounding structures.

Cataloged groups in these regions: *Northern Cloud (9):* NGC 4111 Group, NGC 4157 Group, M109 Group, NGC 3631 Group, NGC 5866 Group, NGC 2985 Group, NGC 3079 Group, NGC 2841 Group, NGC 2768 Group; *Southern Extension (7):* NGC 4753 Group, NGC 4699 Group, NGC 4038 Group, NGC 3672 Group, NGC 4697 Group, M104 Group, NGC 5084 Group

4.2.5 – Local Infall and Virgo Stream

The Local Infall represents an original synthesis within this framework, unifying galaxy groups in the southern sky (Pavo, Ara, Grus constellations) previously treated as peripheral or ambiguously classified by defining them through velocity-watershed analysis rather than sky position or distance alone. These groups lie spatially between the Local Sheet and the Local Void—the vast underdense region whose expansion contributes approximately ~260 km/s to the Local Group's peculiar motion (Tully et al. 2023)—yet remain kinematically distinct from the more distant Pavo-Indus Supercluster despite their visual proximity on the sky. The defining characteristic of the Local Infall is its participation in the Local Sheet's bulk flow motion toward the Virgo Cluster rather than the Pavocentric flow toward the Pavo-Indus sub-basin, with the gravitational watershed separating these flows occurring near heliocentric velocities of ~2,000 km/s in this sector, as inferred from flow-field reconstructions (Tully et al. 2013). Major concentrations include the NGC 6744 Group—featuring NGC 6744 (Caldwell 101), widely regarded as a prime example of a Milky Way analog, offering a spectacular near-perfect mirror image of what our own galaxy would appear like to a distant observer—the IC 1459 Group representing the deepest concentration in this region, and the NGC 7582 Group containing the Grus Quartet (NGC 7582, NGC 7552, NGC 7590, NGC 7599), a rare visual spectacle where four bright interacting spiral galaxies are packed close enough to observe simultaneously in a single telescopic field of view. The Local Infall extends the Local Filament structure in the direction opposite from the Virgo Cluster, gathering matter from the boundary regions of the Local Void and channeling it through the Local Sheet toward the supercluster's gravitational center, demonstrating that filamentary structures extend bidirectionally in space even while matter flows unidirectionally down gravitational gradients.

The Virgo Stream, traditionally known as the Virgo III groups, extends southward from the Virgo Cluster as a string of galaxy concentrations aligned along a filamentary stream approximately 38 million light-years in length. Castignani et al. (2022) mapped this structure as one of thirteen feeding the Virgo Cluster, revealing it as an alignment of several groups rather than a smooth flow—a "string of pearls" configuration where matter concentrates in group-scale knots connected by lower-density bridges. One major concentration includes the NGC 5846 Group, which serves as a dense filamentary knot that anchors the stream's eastern terminus. The Virgo Stream demonstrates active environmental pre-processing of its member galaxies, with groups within the stream showing intermediate properties between those of isolated field galaxies and dense cluster members—galaxies here exhibit significant atomic hydrogen deficiency and reduced star formation rates compared to field populations, indicating that filamentary environments strip gas and suppress star formation well before galaxies enter the Virgo Cluster core. This pre-processing reflects the moderate-density characteristic of filamentary structures in the cosmic web, where tidal interactions and group-scale processes begin transforming galaxy properties during their journey from low-density sheets toward high-density clusters.

Cataloged groups in these regions: *Local Infall (5):* NGC 6744 Group, NGC 6221 Group, NGC 7232 Group, IC 1459 Group, NGC 7582 Group; *Virgo Stream (5):* NGC 5364 Group, NGC 5566 Group, NGC 5806 Group, NGC 5746 Group, NGC 5846 Group

The core architecture and extended flow structures discussed thus far account for approximately ~97 million light-years of the radial extent from the Local Group—spanning from the Local Sheet through the Virgo Cluster to the terminal concentrations of the Virgo Stream. This leaves the outermost ~13 million light-years to the gravitational ridge marking the transition between the Virgo Supercluster sub-basin and the neighboring Hydra-Centaurus Supercluster lobes, completing the 0-110 million light-year span established in Section 4.1. This peripheral zone occupies the region where the Virgo Supercluster's gravitational influence diminishes and the watershed boundaries separating it from adjacent supercluster lobes become apparent. The remaining structural regions represent three distinct types of organization: the Fornax Complex, functioning as a secondary hub anchored by multiple galaxy clusters in the supercluster's southern reaches; the Leo Association, a dispersed aggregation of groups occupying an isolated position removed from the main flow structures; and the Virgo Void Boundaries, encompassing fringe groups and field galaxies organized according to their proximity to the underdense voids that bound the supercluster.

4.2.6 – Fornax Complex

The Fornax Complex, sometimes referred to in literature as the Southern Supercluster or the Fornax Wall, functions as a secondary hub in the Virgo Supercluster's southern reaches, anchored by multiple galaxy clusters and associated groups that demonstrate gravitational association despite spatial separation (Willmer et al. 1989). This aggregation brings together three major components. These include the Dorado Stream feeding the region through observable concentrations including the Dorado Group, the Fornax Cluster proper—the second most massive cluster in the Virgo Supercluster lobe after the Virgo Cluster itself—and the Eridanus Cluster (also called the Eridanus Cloud), a system of subgroups actively merging to form a unified cluster. The Complex occupies a distinct position from the flow structures converging on the Virgo Cluster, instead defining a separate concentration approximately 60 million light-years from the Local Group where matter accumulates in the southern portion of the Virgo Supercluster. This secondary hub demonstrates how supercluster-scale organization supports multiple gravitational centers rather than funneling all matter through a single dominant cluster.

The Dorado Stream channels matter toward the Fornax region through observable galactic overdensities including the Dorado Group—dominated by NGC 1566 (the Spanish Dancer), a magnificent barred spiral, along with several elliptical galaxies and the interacting system NGC 1672—flanked by the NGC 2442 Group (containing the Meathook Galaxy, notable for its highly asymmetric spiral arms). The stream's morphological diversity is further exemplified by the NGC 1532 Group, featuring "Haley's Coronet" (NGC 1532) in a dramatic display of galactic cannibalism as a massive spiral warps and devours its neighbor, and the NGC 1232 Group, anchored by the "Eye of God" (NGC 1232)—widely considered one of the most perfect face-on spirals in the sky. These groups establish the stream as a moderate-density feature feeding the Complex from surrounding regions, providing a steady influx of galaxies that will eventually be incorporated into the cluster-dominated core structures.

The Fornax Cluster represents a substantial concentration in its own right, though considerably smaller than its Virgo counterpart. Ferguson (1989) cataloged

340 likely cluster members compared to the thousands populating the Virgo Cluster, establishing Fornax as a significant but more compact system, while Jordán et al. (2007) conducted detailed Hubble Space Telescope imaging of 43 early-type galaxies to study the cluster's structure. The cluster exhibits clear internal organization with a dynamical core dominated by NGC 1399, a luminous elliptical galaxy, accompanied by NGC 1404 and other early-type giants that define the main subgroup. The NGC 1316 Subgroup forms a distinct concentration featuring Fornax A (NGC 1316)—a peculiar shell galaxy associated with prominent radio emission—along with NGC 1317 and NGC 1310, demonstrating that the Fornax Cluster maintains a recognizable substructure despite its evolved core. The cluster retains notable morphological diversity, including not only the early-type galaxies typical of cluster cores but also prominent spirals such as NGC 1365 (the Great Barred Spiral) and the irregular galaxy NGC 1427A, suggesting Fornax remains an actively assembling system rather than a fully relaxed cluster. This combination of a clear gravitational center anchored by NGC 1399, distinct subgroup structure around NGC 1316, and mixed galaxy populations establishes the Fornax Cluster as a virialized but still-evolving region serving as a major node in the southern Virgo Supercluster.

The Eridanus Cluster constitutes the most dynamically active component of the Fornax Complex, comprising three subgroups—centered on Eridanus A (NGC 1407), NGC 1332, and NGC 1395—that are gravitationally bound and actively merging to form a unified cluster. Brough et al. (2006) designated this structure as a "supergroup," defining it as a collection of groups in the process of collapsing to form a cluster with a projected final mass of approximately 7×10^{13} solar masses. The NGC 1407 Subgroup represents the most evolved and massive component, dominated by early-type galaxies with Eridanus A itself exhibiting the symmetric X-ray emission characteristics of a mature fossil group. The compact NGC 1332 Subgroup provides a second concentration, while the NGC 1395 Subgroup maintains a looser, more irregular structure with a notably higher fraction of spiral galaxies, illustrating how the merging subgroups retain distinct evolutionary states. Omar & Dwarakanath (2005) characterized the Eridanus Cluster environment as intermediate between loose groups like those in the Northern Cloud region and rich clusters like Virgo and Fornax, finding that gas removal proceeds primarily through tidal interactions rather than the ram-pressure stripping dominant in denser environments—many galaxies show warped or lopsided neutral hydrogen discs indicative of gravitational encounters while the intragroup medium remains too diffuse for efficient stripping. The internal merger of these three subgroups operates on relatively short timescales, yet Willmer et al. (1989) demonstrated that while the Eridanus and Fornax clusters constitute a gravitationally bound binary system, they are currently on an expanding orbit moving apart at ~340 km/s, a relationship that highlights hierarchical assembly: structures merge at small scales while participating in larger-scale motions that may not converge for cosmological timescales.

The Fornax Complex's role as a secondary hub within the Virgo Supercluster illustrates an essential organizational principle: large-scale cosmic web architecture can support multiple significant nodes of mass concentration. While the Virgo Cluster serves as the primary gravitational anchor toward which most of the supercluster's flow structures converge, the Fornax Complex defines a separate accumulation region in the southern portion of the sub-basin where substantial mass has collected into cluster-scale regions. The entire Complex participates in the Virgo Supercluster's collective motion toward the "Great Attractor" at the Laniakea Basin's core, demonstrating how structures at different hierarchical scales—from merging subgroups through individual clusters to multi-cluster complexes and supercluster lobes—operate simultaneously within the framework organizing matter across hundreds of millions of light-years.

Cataloged groups in this region (8): NGC 1512 Group, NGC 1433 Group, Dorado Group, NGC 2442 Group, Fornax Cluster, NGC 1532 Group, NGC 1232 Group, Eridanus Cluster

4.2.7 – Leo Association

The Leo Association, referred to in literature as the Leo II groups to distinguish them from the nearer Leo I groups (the Leo Spur component of the Local Filament covered in Section 4.2.2), occupies an isolated position within the Virgo Supercluster removed from the main flow structures that define the supercluster's architecture. Unlike the filaments and streams that channel matter toward the Virgo Cluster, or the outer concentrations that mark extended infall regions, the Leo Association represents a dispersed aggregation of galaxy groups that lacks a physical connection to the larger-scale flows despite residing within the supercluster's sub-basin. This isolation, combined with a significantly underdense environment relative to the cosmic average, distinguishes the Leo Association as a loosely organized region occupying a position between the more coherent cosmic web features and the truly peripheral void boundaries.

Karachentsev et al. (2015) characterized the Leo Association as a “scattered cloud association” comprising distinct groups that span distances from approximately 65-88 million light-years, positioning these concentrations at comparable distances to the Virgo Cluster region but spatially separated from the connected regions feeding that cluster. This configuration suggests a structure analogous to a topographic plateau: a flattened, dispersed region offset from the supercluster’s dominant flow plane and isolated from the active filamentary channels feeding the cluster core. The NGC 3607 Group serves as the most substantial concentration within the Association, anchoring the region with the highest luminosity and galactic mass among the member groups, while the NGC 3640 Group and several smaller groups complete the scattered population.

The region exhibits complex kinematics driven by large-scale flows: the Association participates in a convergence pattern with the Local Volume, exhibiting a peculiar velocity of approximately ~500 km/s toward the Local Sheet, while the entire system demonstrates motion driven partly by recession from the Local Void—the same underdense region pushing the Local Sheet and associated structures toward the Virgo Cluster (Karachentsev et al. 2015). Despite these dynamical connections to the broader environment, the Leo Association maintains its character as a loose aggregation rather than a coherent structure embedded in filamentary flows, occupying space within the Virgo Supercluster while remaining structurally distinct from the organized flow architecture that characterizes most of the supercluster’s mass distribution. The underdense environment surrounding these groups reflects their isolated nature, creating conditions fundamentally different from the filaments and streams that dominate the supercluster’s connected regions.

Cataloged groups in this region (8): NGC 3640 Group, NGC 3607/3686 Group, NGC 3504 Group, NGC 3338 Group, NGC 3254/3245 Group, NGC 3227 Group, NGC 3169 Group, NGC 3370 Group

4.2.8 – Virgo Void Boundaries

The outermost regions of the Virgo Supercluster are defined not by sheets, filaments, or clusters but by their proximity to the vast underdense regions—cosmic voids—that bound the supercluster and separate it from neighboring lobes within the Laniakea Basin’s gravitational watershed. These void boundaries complete the topological description of the Virgo Supercluster by identifying the fringe groups and field galaxies that occupy the transitional zones where the supercluster's matter distribution fades into the near emptiness of voids. Four major voids establish these boundaries: to the north, the Local Void and the Northern Void (also termed the Ursa Major Void and typically considered an appendage of the Local Void), and to the south, the Sculptor Void and Eridanus Void[3] (sometimes collectively termed the Southern Void). Together, these underdense regions define the boundaries between the Virgo Supercluster and adjacent supercluster lobes within Laniakea, shaping the basin's structure through the absence of matter as much as through gravitational attraction.

The Local Void boundary harbors several prominent groups and isolated galaxies positioned along the interface between the Virgo Supercluster's matter distribution and the nearest major underdense region. The NGC 1023 Group and M74 Group (containing the Phantom Galaxy) represent fringe concentrations, while isolated field galaxies including NGC 6946 (the Fireworks Galaxy, notable for its prolific supernova rate) and NGC 7331 occupy positions near the void's edge. Most remarkably, NGC 6503—the Lost-in-Space Galaxy—exemplifies a true void galaxy, drifting in isolation within the Local Void far from any neighboring systems. This isolation produces distinctive characteristics: lacking neighbors to drive spiral density waves, NGC 6503 forms patchy flocculent arms rather than the grand spiral structure typical of disc galaxies, and despite rich gas reserves, its central black hole remains unusually quiet, missing the gravitational interactions that typically funnel fuel inward in more populated environments.

The Sculptor Void boundary to the south contains the M77 Group and the NGC 134 Group as fringe concentrations, along with scattered field galaxies including NGC 3621 and the Bubble Galaxy (NGC 3521). The Northern Void boundary features the NGC 2775 Group and several field galaxies, while the Eridanus Void boundary includes the IC 1954 Group alongside isolated systems such as NGC 1097 and NGC 613. The Sculptor Void hosts the Topsy Turvy Galaxy (NGC 1313), a second true void galaxy that presents a scientific paradox: despite existing in extreme isolation without an obvious companion to drive tidal disruption, it exhibits the deformed morphology and intense starburst activity typical of violent galactic collisions, with its misaligned rotational axis and unexplained internal chaos housing a rare intermediate-mass black hole candidate. The two void galaxies—Lost-in-Space and Topsy Turvy—represent the extremes of galactic

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[3] The Eridanus Void referenced here should not be confused with the much larger and more distant Eridanus Supervoid, which lies far beyond the Laniakea Basin.

isolation, demonstrating how the absence of large-scale structure profoundly affects galaxy evolution and morphology.

The void boundary designation reflects an organizational principle central to this framework: cosmic web structure is defined as much by underdense voids as by overdense clusters, with voids acting as the boundaries that separate superclusters and shape the basin's architecture. Fringe groups positioned near void edges, field galaxies scattered in low-density environments, and the rare true void galaxy occupying the voids themselves all participate in the Virgo Supercluster's overall gravitational flows while residing in environments fundamentally different from the filaments, clusters, and sheets that dominate the supercluster's connected structures. Organizing these objects by their proximity to specific voids provides coherent structure to what might otherwise appear as a miscellaneous collection of peripheral objects, demonstrating that even the emptiest regions play essential roles in defining the large-scale architecture of the cosmic web.

Cataloged groups in these regions: *Local Void (3):* NGC 1023 Group, M74 Group, Local Field Galaxies; *Sculptor Void (3):* M77 Group, NGC 134 Group, Sculptor Field Galaxies; *Northern Void (3):* NGC 2775 Group, NGC 3665 Group, Northern Field Galaxies; *Eridanus Void (2):* IC 1954 Group, Eridanus Field Galaxies

The ten structural regions of the Virgo Supercluster—from the Local Sheet through the Virgo Cluster via the Local Filament, the Northern Cloud & Southern Extension, Local Infall & Virgo Stream, the Fornax Complex, Leo Association, and the Virgo Void Boundaries—demonstrate how cosmic web topology organizes matter across a hundred million light-years of space surrounding the Local Group. This detailed organizational framework, enabled by the Virgo Supercluster's proximity and the resulting wealth of observational data, illustrates the hierarchical flows that channel matter from quiescent sheets, through filamentary bridges, toward cluster-dominated cores, supplemented by secondary hubs, isolated associations, and void-bounded peripheries. The progression from the Local Sheet's immediate neighborhood through intermediate flow structures of the Virgo Cluster's gravitational center, and onward through extended streams toward the deeper wells of the Laniakea Basin's core, reveals the nested architecture of gravitational attraction operating simultaneously at group, cluster, supercluster, and basin scales. The three remaining superclusters—Hydra, Centaurus, and Pavo-Indus—occupy greater distances where observational resolution decreases and the Zone of Avoidance increasingly limits coverage, particularly for the southern lobes. These more distant sub-basins receive correspondingly condensed treatment reflecting available data, though the same organizational principles apply: cosmic web topology defines structural regions, and matter flows toward gravitational attractors within the unified Laniakea Basin.

4.3 – Hydra Supercluster Organization

The Hydra Supercluster appears as the morphological twin of the Virgo Supercluster within Laniakea's structure. Both exhibit flattened, spur-like geometries dominated by single rich clusters that anchor their gravitational centers. Where the Virgo sub-basin organizes around the Virgo Cluster, the Hydra lobe centers on Abell 1060 (the Hydra Cluster), with the supercluster extending as a flattened appendage approximately 160 million light-years from the Local Group (Richter 1989). This twin morphology reflects a common architectural pattern in basin-scale structure: extended concentrations of galaxy groups arranged in sheet-like or filamentary configurations, punctuated by a massive cluster node that serves as the primary gravitational anchor. Despite this structural similarity, Hydra's greater distance reduces observational resolution compared to Virgo's detailed ten-region organization, resulting in five distinct structural regions (plus a field galaxies category) identified through the convergence of flow patterns and observable galactic overdensities. The Hydra Supercluster participates in the broader convergent flow toward the Laniakea Basin's core in the Norma-Centaurus region (Tully et al. 2014), with its internal structure revealing how matter streams through moderate-density filaments and clouds toward the central cluster anchor before joining the basin-scale gravitational currents.

The **Antlia Stream**—referred to in some literature as the Antlia Strand—represents the first of three structural components that together constitute what Tully et al. (2014) identified as the "Antlia Wall," an extended feature serving as a bridge between Laniakea and the neighboring Perseus-Pisces Basin. Within the framework presented here, the Antlia Stream specifically designates the moderate-density filamentary flow channeling matter from the peripheral regions of the Virgo Supercluster, including the Leo Association, toward the Antlia Cluster that marks the gateway into the Hydra Supercluster lobe. This stream demonstrates the characteristic morphology of filamentary streams: a linear arrangement of galaxy groups connected by lower-density bridges, creating a "string of pearls" configuration where matter concentrates in group-scale knots along the flow pathway toward deeper gravitational wells.

The Stream contains four principal galaxy groups flowing along this filamentary corridor. The NGC 3256 Group anchors the stream's most prominent concentration, dominated by NGC 3256 itself—a luminous interacting system resulting from a major merger, exhibiting the tidal disruption and intense starburst activity characteristic of colliding spirals. The NGC 3557 Group provides a second substantial node centered on the elliptical NGC 3557, while the NGC 3347 Group and NGC 3100 Group mark additional overdensity concentrations along the stream's extent. Group memberships were established through the Kourkchi & Tully (2017) catalog of galaxy groups within the local universe, cross-referenced with Cosmicflows velocity data to confirm participation in the coherent flow pattern connecting the Virgo Supercluster's outer regions to the Hydra Supercluster's Antlia Cluster anchor. Together, these groups define the pathway through which matter flows from the Virgo sub-basin toward the gravitational wells that characterize the Hydra lobe.

The **Antlia Cluster** represents the second component of the Antlia Wall structure described by Tully et al. (2014), serving as the gravitational anchor where matter flowing through the Antlia Stream first concentrates before continuing onward toward the Hydra Cluster and ultimately the "Great Attractor" at Laniakea's core. Located approximately 130 million light-years from the Local Group, the Antlia Cluster distinguishes itself as a dynamically young system actively assembling through the merger of two distinct subgroups (and an infall region) rather than existing as a relaxed, virialized cluster. Hess et al. (2015) confirmed through radio observations that the Antlia Cluster formed from the collision of an older, evolved core centered on NGC 3268 (Antlia A) with a more recently arrived concentration anchored by NGC 3258 (Antlia B), creating a cluster that exhibits clear internal substructure and ongoing dynamical evolution. This active merger state contrasts with more evolved clusters like the Virgo Cluster's virialized core or the Fornax Cluster's established central concentration, while positioning Antlia more similarly to Eridanus—as a cluster caught in the process of assembly rather than representing a mature endpoint of hierarchical cluster formation.

The cluster's three-component structure reveals different evolutionary states within the merging system. Antlia A, centered on the giant elliptical NGC 3268 alongside NGC 3267 and NGC 3269, constitutes the older, dynamically evolved core characterized by early-type galaxies and significant neutral hydrogen deficiency typical of dense cluster environments where ram-pressure stripping and tidal interactions have removed gas reservoirs. Antlia B, dominated by NGC 3258 with the prominent spiral NGC 3251 among its members, represents the main infalling subgroup currently merging with the established core. Beyond these two main concentrations, Antlia C (the NGC 3281 Subgroup) defines another infall region located roughly 650,000 to 2 million light-years from the cluster center, forming a ring of gas-rich, star-forming galaxies actively accreting onto the cluster from surrounding filamentary structures (Hess et al. 2015). NGC 3281 itself—a Seyfert II galaxy exhibiting neutral hydrogen absorption—exemplifies galaxies in this transitional zone, falling into the cluster while retaining sufficient gas to fuel both star formation and active galactic nucleus activity. Ferguson & Sandage (1990) identified the two primary concentrations through optical surveys before kinematic analysis confirmed their merger dynamics, establishing Antlia as a moderately compact cluster with elongated morphology reflecting its multi-component structure and demonstrating the ongoing hierarchical assembly processes that characterize dynamically young clusters within the cosmic web.

The **Northern Filament** completes the three-component Antlia Wall structure, distinguished from the Antlia Stream and the Antlia Cluster by its directional role within the Hydra Supercluster's architecture. Where the Antlia Stream channels matter from near the ridge between Virgo and Hydra toward the Antlia Cluster anchor, the Northern Filament extends in the opposite direction—northward from the cluster region toward the velocity-watershed boundary separating the Laniakea Basin from its neighbor, the Perseus-Pisces Basin. This configuration establishes the Antlia Wall as a bidirectional bridge structure: one filamentary arm (the Stream) feeds the central cluster node from interior regions of Laniakea, while the opposite arm (the Northern Filament) reaches toward the basin's outer boundary, demonstrating how supercluster-scale structures can serve simultaneously as internal connectors and external bridges within basin architecture. The Northern Filament contains several galaxy groups defining overdensity nodes along its extent, anchored most prominently by the NGC 3054 Group. This group provides the most substantial concentration, exhibiting a mix of spiral galaxies (NGC 3054) and ellipticals (NGC 3078, NGC 3051) that illustrates the morphological diversity typical of moderate-density filamentary environments where tidal interactions begin transforming galaxy properties without the intense processing characteristic of cluster regions.

The **Hydra Cluster** (Abell 1060) serves as the gravitational anchor of the Hydra Supercluster, paralleling the Virgo Cluster's role within the Virgo lobe and completing the morphological twin relationship between these two sub-basins of Laniakea. Located approximately 160 million light-years from the Local Group, the Hydra Cluster presents a paradox that distinguishes it from other major clusters within Laniakea: while the cluster appears spatially smooth and relaxed in optical surveys—suggesting a mature, virialized system—detailed analysis of galaxy velocities reveals significant departures from dynamical equilibrium. Richter (1989) cataloged 581 galaxies within the cluster field, establishing comprehensive membership lists that revealed Hydra's remarkable isolation in redshift space compared to complex systems like the Virgo Cluster, where distinguishing cluster members from foreground and background contamination presents substantial challenges. This clean separation simplified membership determination yet paradoxically highlighted an anomaly in how the cluster's galaxies move: rather than exhibiting the smooth, bell-curve distribution of velocities expected for a settled, gravitationally relaxed cluster, Hydra displays an unusually flat velocity spread that suggests hidden complexity beneath its smooth morphological appearance. This contrast between spatial regularity and kinematic peculiarity—differing markedly from the Virgo Cluster's obviously complex merger state and the Antlia Cluster's visibly young, actively assembling structure—motivated detailed investigation into the cluster's true dynamical state.

Fitchett & Merritt (1988) resolved the velocity paradox through statistical decomposition, demonstrating that Hydra's central region comprises not a single virialized entity but rather a superposition of three distinct subgroups projected along the line of sight, each contributing galaxies with different characteristic velocities to create the observed flat distribution. Hydra A, centered on the supergiant elliptical galaxy NGC 3311 alongside NGC 3308 and NGC 3307, constitutes the main potential well with velocities around ~3,400 km/s, representing the cluster's evolved gravitational core and deepest concentration within the Hydra Supercluster sub-basin. Hydra B forms a background component anchored by NGC 3309 and including the prominent spiral NGC 3336, exhibiting systematically higher velocities around ~4,000 km/s that reveal its position behind the main cluster core. Hydra C represents a foreground subgroup centered on NGC 3312 with velocities below ~3,100 km/s, positioned in front of the main concentration and currently moving outward after passing through or near to the cluster center. This three-component structure explains the flat velocity histogram without requiring extreme orbital configurations, revealing Hydra as a dynamically active system currently accreting surrounding groups despite its deceptively smooth optical appearance—a cluster caught not in relaxed equilibrium but in ongoing hierarchical assembly as smaller groups merge into the growing potential well.

The physical reality of this substructure—originally inferred from statistical analysis of velocity distributions—received direct observational confirmation through high-sensitivity neutral hydrogen observations. Hess et al. (2022) utilized MeerKAT radio data to reveal clear ram-pressure stripping signatures in Hydra C galaxies, particularly NGC 3312 and NGC 3314A, which exhibit characteristic "jellyfish" morphologies with compressed gas distributions and extended neutral hydrogen tails stripped by their motion through the intracluster medium. Critically, the orientation of these gas tails indicates the galaxies are moving toward Earth rather than falling into the cluster, confirming they belong to the foreground substructure that has already passed the cluster center and is now moving outward—galaxies caught in the aftermath of their first passage through the dense cluster core rather than approaching on initial infall. The ram-pressure stripping has removed substantial gas fractions from these galaxies while triggering star formation within the stripped tails themselves, demonstrating the environmental processing that transforms infalling spirals into the gas-poor systems characteristic of cluster populations. Together, the kinematic decomposition and physical stripping evidence establish the Hydra Cluster as a system actively assembling through the accretion of distinct subgroups, its smooth appearance concealing the complex dynamics of ongoing hierarchical structure formation within one of Laniakea's major cluster anchors.

The **Hydra Cloud** surrounds the Hydra Cluster as an amorphous association of galaxy groups, analogous to the Virgo Northern Cloud. Just as Tully et al. (2014) identified the broader "Antlia Wall" structure—subdivided here into distinct regions—Fairall (1998) described a large-scale "Hydra Wall" that splits into two filamentary branches—one extending toward the Antlia Cluster (becoming Tully's Antlia Wall) and another toward the Hydra Cluster itself, also encompassing the Cloud region defined here. The Cloud contains several galaxy groups arrayed around the anchor cluster, including Hickson 42 (the NGC 3091 Group) which stands as the most evolved concentration of the region—a dense, compact association of ancient, gas-poor elliptical galaxies representing the final evolutionary stage of a galaxy group collapsing into a single fossilized structure. This compact group demonstrates advanced dynamical evolution compared to the spiral-rich groups that characterize most of the Hydra Cloud's population.

Beyond the Cloud's group-scale concentration, the periphery of the Hydra Supercluster includes five cataloged field galaxies occupying the most diffuse regions of the supercluster's gravitational influence—a sparse population compared to the Virgo Supercluster's field galaxy catalog, reflecting Hydra's greater distance (which limits detection of faint isolated systems). Among these field galaxies, NGC 3081 stands as a morphological masterpiece: a lenticular galaxy featuring a rare resonance ring completely detached from the central bar, creating a near-perfect circle of star formation that gives the system the appearance of a cosmic bullseye. While resonance features are common, NGC 3081's highly symmetric, detached ring mimics the rare 'Hoag-type' morphology (found in fewer than 1% of galaxies) despite being driven by secular evolution rather than collision (Buta & Combes 1996). Together, the Hydra Cloud groups and sparse field population define the supercluster's outer envelope, the transitional zone where matter streams from lower-density filamentary structures toward the Hydra Cluster's gravitational center before joining the basin-scale flow toward the "Great Attractor" at the core of the neighboring Centaurus Supercluster sub-basin.

The Hydra Supercluster's organization—from the Antlia Stream's filamentary bridge through the dynamically young Antlia Cluster, extending via the Northern Filament toward the Perseus-Pisces boundary, and anchored by the deceptively smooth Hydra Cluster surrounded by its diffuse Cloud—demonstrates how sub-basin structures channel matter through hierarchical gravitational wells toward progressively deeper cosmic attractors. The similar structure between the Virgo and Hydra lobes reveals that, like the galaxies they are ultimately composed of, superclusters can exhibit common morphologies. The matter streaming through Hydra's internal architecture does not terminate at the Hydra Cluster but continues flowing southward, joining material from the Centaurus Supercluster in the Hydra-Centaurus Stream—a major filamentary conduit funneling matter from both sub-basins toward the "Great Attractor" in the obscured Norma Cluster region, where Laniakea's deepest potential wells concentrate mass and anchor the basin's convergent flow patterns.

Cataloged groups in these regions: *Antlia Stream (4):* NGC 3100/3095 Group, NGC 3256/3261 Group, NGC 3347 Group, NGC 3557 Group; *Antlia Cluster (3):* NGC 3268 Subgroup (Antlia A), NGC 3258 Subgroup (Antlia B), NGC 3281 Subgroup (Antlia C); *Northern Filament (3):* NGC 3038 Group, NGC 3393 Group, NGC 3054 Group; *Hydra Cluster (3):* NGC 3311 Subgroup (Hydra A), NGC 3309 Subgroup (Hydra B), NGC 3312 Subgroup (Hydra C); *Hydra Cloud (4):* NGC 3313 Group, NGC 2935 Group, NGC 3450 Group, NGC 3091 Group; Hydra Field Galaxies

4.4 – Centaurus Supercluster Organization

The Centaurus Supercluster presents a fundamental challenge in the study of Laniakea's structure: its gravitational influence dominates the entire basin of attraction, yet the dense stellar fields and dust lanes of the Milky Way's disc obscure much of its internal substructure. The "Great Attractor"—the deepest well of gravitational potential within Laniakea—resides within this supercluster, drawing matter not only from Centaurus, but from Virgo, Hydra, and Pavo-Indus as well (Tully et al. 2014). Although some astronomical literature treats the Hydra and Centaurus lobes as a unified "Hydra-Centaurus Supercluster," this framework separates them into distinct sub-basins based on their independent topological structure and divergent flow patterns within the basin hierarchy. The Centaurus Supercluster's internal organization reveals itself through four principal regions (with an additional field galaxy population): the Centaurus Wall forms a broad sheet structure along the supercluster's periphery—dividing it from Virgo—while the Centaurus Cluster (Abell 3526) anchors the visible core with its rich galaxy population. The Hydra-Centaurus Stream channels matter from the boundary between adjacent lobes, and the Norma Complex, though severely compromised by Zone of Avoidance obscuration, harbors the massive structures associated with the Great Attractor itself. Together, these regions trace a cosmic architecture whose full extent remains an ongoing challenge for observational astronomy.

The **Centaurus Wall** forms the boundary region separating the Virgo Supercluster lobe from the Centaurus Supercluster sub-basin, a broad sheet of galaxies perpendicular to the Supergalactic plane that marks the transition into the most gravitationally dominant region of Laniakea. This structure occupies intermediate redshift space beyond approximately 2,000 km/s, where the flow patterns shift from Virgocentric influence toward the deeper potential well of the Great Attractor in the Norma region. The Wall's orientation tilts roughly 15 degrees relative to the Supergalactic plane as it crosses the galactic equator (Woudt et al. 2000), entering the Zone of Avoidance where dust and stellar crowding severely limit optical surveys. The observable portion of this boundary reveals itself through concentrations like the NGC 5061 Group—anchored by the elliptical NGC 5061 alongside the edge-on spirals NGC 5078 and IC 879—and the NGC 5044 Group, dominated by its giant elliptical in a rich X-ray halo. Further along the accessible edge lies the NGC 4645 Group, notable for containing NGC 4603, a spiral galaxy whose Cepheid variable stars contributed to early Hubble constant measurements (Newman et al. 1999). These three groups represent only the outermost visible trace of a structure whose full extent plunges behind the Milky Way's obscuring disc, leaving the Wall's complete architecture—and its connection to the deeper Centaurus Supercluster regions—largely inferred from redshift surveys and peculiar velocity studies rather than direct observation.

The **Centaurus Cluster** (Abell 3526) anchors the Wall structure, providing the gravitational core that organizes galaxy flows across this region of the sub-basin. Unlike the apparently relaxed structures observed in Virgo or Hydra, the Centaurus Cluster reveals itself as two distinct components caught in the act of merging—a dynamic system whose bimodal velocity distribution was first recognized by Lucey et al. (1986). The primary subgroup, Centaurus A[4] (Cen 30), centers on the giant elliptical NGC 4696 at roughly 3,000 km/s, while the secondary subgroup, Centaurus B (Cen 45), centers on NGC 4709 at approximately 4,500 km/s. This nearly ~1,500 km/s velocity separation initially suggested two unrelated systems along the same line of sight, but detailed analysis of luminosity functions and galaxy populations confirmed that both components lie at the same distance (~170 Mly), representing instead a major merger event that shapes the cluster's current architecture. The collision between these two massive subgroups contributes to the Centaurus lobe's role as the deepest gravitational well within Laniakea, though the merger's full physical extent remains partially hidden behind the Milky Way's galactic plane.

Centaurus A (Cen 30) dominates the cluster, containing roughly 2.5 times the population of its companion and representing the main concentration of the system's total

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[4] Not to be confused with the radio galaxy Centaurus A (NGC 5128) in the Local Sheet (section 4.2.1).

mass. NGC 4696, itself a supergiant elliptical and the cluster's brightest member, sits at the peak of X-ray emission that traces the cluster's hot intracluster medium. The subgroup's rich galaxy population includes numerous bright ellipticals such as NGC 4744, NGC 4743, and NGC 4373, alongside spiral members like NGC 4499 and the peculiar polar-ring galaxy NGC 4650, whose ring of stars and gas orbits perpendicular to its main disc. The concentration of massive early-type galaxies in Centaurus A (Cen 30) reflects the environmental processing typical of cluster cores, where galaxy interactions and the hot intracluster medium strip gas from infalling spirals and drive morphological transformation. This population anchors the gravitational potential that defines the cluster's central region, creating the dominant mass concentration toward which galaxies in this region of the Centaurus Supercluster flow.

Centaurus B (Cen 45), though less populous than its companion, plays a crucial role in the ongoing merger that characterizes the Centaurus Cluster's present state. The subgroup centers on NGC 4709, positioned to the east-southeast of NGC 4696, with a smaller retinue that includes the spiral NGC 4679 and the remarkable NGC 4622—the "Backward Galaxy," whose leading spiral arms open outward in the direction of rotation rather than trailing behind, a configuration likely produced by past merger activity that created two nested arm systems winding in opposite directions. X-ray observations by Churazov et al. (1999) revealed that the gas surrounding NGC 4709 is significantly hotter than expected for a group of its mass, providing direct evidence that shock heating from the merger interaction is energizing the intracluster medium. The elongation of the cluster's X-ray isophotes toward NGC 4709 traces the gravitational influence between the two components, while possible gas stripping from infalling galaxies suggests ongoing dynamical processing as Centaurus B (Cen 45) plunges through the main cluster's dense environment. This merger represents one of the most energetic gravitational events currently observable within the Laniakea Basin, though the full three-dimensional geometry remains uncertain due to our viewing angle through the Zone of Avoidance.

The **Hydra-Centaurus Stream** represents a major filamentary stream channeling matter from the boundary between the Hydra lobe and the Centaurus sub-basin toward the Great Attractor region, tracing one of the principal flow patterns that dictate galaxy motions across the core of the Laniakea Basin. While the Centaurus Wall forms a sheet-like boundary dividing the Virgo and Centaurus lobes, the Stream forms a filamentary geometry that bridges concentrations in the southern Hydra Supercluster to the massive structures embedded deeper within Centaurus. Da Costa et al. (1987) recognized this connection in their analysis of the Hydra-Centaurus Supercluster Complex, identifying what they described as a "localized low-density bridge" linking the two regions—a structure that reveals itself through galaxy groups occupying intermediate velocity space between the outer boundary and the gravitational depths of the Norma region. The Stream's extent spans from the NGC 4936 Group near the Hydra-Centaurus ridge, through intermediate concentrations like the NGC 5266 and NGC 5011 groups, to its anchor in the IC 4296 Group (Abell 3565) positioned closer to the Great Attractor's influence. IC 4296, itself a supergiant elliptical, marks the most substantial concentration along this filamentary stream, representing a significant mass node that helps define the Stream's role in the larger flow-field. This filamentary conduit illustrates how matter moves through Laniakea's structure not simply through diffuse infall but along organized pathways that connect discrete overdensities across the basin's hierarchical architecture and converge on its deepest gravitational wells.

The **Norma Complex**—an aggregate designation including the Norma Wall and Norma Cluster—presents the greatest observational challenge in mapping Laniakea's internal structure. Otherwise known as the "Great Attractor," it lies not in the distant reaches of the basin but at the very bottom of its potential gravitational well, where the Zone of Avoidance creates a region of nearly complete obscuration. For decades, astronomers recognized the signature of an enormous gravitational anomaly—the Great Attractor—through its influence on galaxy velocities across the local universe, yet the massive structures responsible remained hidden behind the galactic plane. The breakthrough came through deep optical surveys and X-ray observations that penetrated the Zone of Avoidance to reveal the Norma Cluster (Abell 3627) as the long-sought core of the Great Attractor region (Woudt et al. 2000). This discovery allowed our understanding of Laniakea's architecture to begin to come into focus: the deepest gravitational potential well in the basin, toward which Virgo, Hydra, Centaurus, and Pavo-Indus all converge, resides near a collection of massive clusters whose very existence was uncertain until systematic surveys pierced the obscuring veil. The Norma Complex encompasses both these remarkable clusters and the broader wall structure in which the Norma Cluster is embedded, representing the gravitational anchor point that organizes flows across the entire basin of attraction.

The first component of the Complex—the **Norma Wall**—forms a broad sheet structure that intersects the galactic plane at a steep angle, anchored by the IC 4329 Group (Abell 3574) and extending to connect with concentrations in the Pavo-Indus Supercluster to the south. This wall-like overdensity provides the larger structural region within which the Norma Cluster itself resides, much as the Centaurus Wall hosts the Centaurus Cluster—a pattern of massive clusters embedded within sheet structures that appears repeatedly across the Laniakea Basin. The Wall's geometry and the cluster's position within it create a confluence of matter streams converging from multiple directions, concentrating mass at the intersection of large-scale filaments and sheets. However, the Wall's full extent and detailed structure remain among the most poorly constrained elements of the basin's organization within this framework, as systematic galaxy surveys face their greatest limitations precisely where this structure crosses the Milky Way's Zone of Avoidance.

The second component—the **Norma Cluster** (Abell 3627) itself—stands as the most massive concentration in the Great Attractor region, with a dynamical mass approaching 10^{15} solar masses—comparable to the distant Coma Cluster (a defining component of the CfA2 "Great Wall") and representing one of the most substantial structures in the nearby universe (Woudt et al. 2008). Detailed spectroscopic analysis of nearly 300 member galaxies reveals a complex, dynamically active system with a velocity dispersion of ~925 km/s and clear evidence of ongoing merger activity. The cluster exhibits significant substructure, particularly in its spiral and irregular galaxy populations, which are organized into distinct subgroups designated Norma A and Norma B aligned along the wall structure. The central giant elliptical ESO 137-006 displays a large peculiar velocity relative to the cluster mean, while X-ray observations show disturbed gas morphology—both signatures of an active merger with a central subgroup. Within this violent environment, ram-pressure stripping reaches its most extreme expression in galaxies like ESO 137-001, the "Jellyfish Galaxy," whose headlong plunge through the Norma Cluster's superheated intracluster medium tears away its gas in spectacular trailing tentacles of star formation. This single system encapsulates the environmental processing that transforms galaxy populations in massive clusters: as ESO 137-001 falls toward the cluster core at high velocity, the ram-pressure of its passage through the hot X-ray-emitting gas exceeds the galaxy's ability to retain its own fuel, creating blue streamers of shocked gas and newborn stars extending behind it like a cosmic wake.

Despite the Norma Cluster's enormous mass and central position, precise measurements of its motion relative to the Cosmic Microwave Background (CMB) reveal a peculiar velocity near-zero (Mutabazi et al. 2014). While other massive clusters in the region display substantial bulk flow—hundreds of kilometers per second of motion toward the Great Attractor, the Norma Cluster itself remains essentially stationary in the CMB rest frame. This lack of motion provides the definitive confirmation that Norma occupies the true bottom of Laniakea's gravitational potential well, the point toward which all other flows within the basin accelerate. Yet even this identification does not complete our understanding of the region's full architecture. Systematic X-ray surveys designed to penetrate the Zone of Avoidance have revealed additional massive clusters like CIZA J1324.7-5736 (Ebeling et al. 2002), suggesting that the Great Attractor region may be more extended and structurally complex than optical surveys alone could reveal. The discovery of such "hidden clusters" demonstrates that despite decades of dedicated observation and the identification of the Norma Cluster as the gravitational core, significant mass concentrations remain undetected behind the Milky Way's obscuring disc—a reminder that our map of Laniakea's deepest regions remains fundamentally incomplete.

The Norma Cluster's stationary position in the CMB rest frame validates both the concept of Laniakea as a coherent basin of attraction and the identification of Norma itself as the prime candidate for the "Great Attractor." The three superclusters examined thus far mirror, at basin-scale, the sheet-filament-cluster hierarchy observed within individual lobes: Virgo and Hydra form the outer structural framework, while the Centaurus sub-basin provides the deep gravitational core that influences flows across the entire system via Norma and the Great Attractor. This progression from boundary structures through intermediate concentrations to the central potential wells reveals Laniakea's cosmographic profile as genuinely hierarchical, with organizational principles that operate consistently across multiple scales. With the Centaurus Supercluster established as the gravitational anchor, the framework turns to the final component of this basin-scale structure: the Pavo-Indus Supercluster, which occupies the peripheral flows south of the Norma Complex and completes the field guide catalog of Laniakea's major structural divisions.

Cataloged groups in these regions: *Centaurus Wall (3):* NGC 5061 Group, NGC 5044 Group, NGC 4645 Group; *Centaurus Cluster (2):* NGC 4696 Subgroup (Centaurus A), NGC 4709 Subgroup (Centaurus B); *Hydra-Centaurus Stream (4):* NGC 4936 Group, NGC 5266 Group, NGC 5011 Group, IC 4296 Group; *Norma Complex (4):* NGC 5152 Group, NGC 5488 Group, IC 4239 Group, Norma Cluster; Centaurus Field Galaxies

4.5 – Pavo-Indus Supercluster Organization

The Pavo-Indus Supercluster occupies the southern extremity of the Laniakea Basin, lying approximately 220 million light-years from the Local Group—the most distant of the basin's major lobes. This remoteness, combined with severe obscuration by the Zone of Avoidance, makes Pavo-Indus among the least well-characterized of the sub-basins within Laniakea. Despite these observational challenges, the supercluster exhibits a distinctive chain-like morphology with major concentrations linked along a curving filamentary path that extends from the dense Pavo-Indus Complex through the Telescopium Cloud. This structural arrangement culminates in the Pavo-Indus Arch, a filamentary extension that bounds the Local Void and connects the supercluster to the neighboring Perseus-Pisces Basin (Tully et al. 2019). Unlike the twin morphology of Virgo and Hydra or the gravitationally consolidated structure of Centaurus, the Pavo-Indus lobe displays an elongated, arc-like configuration that follows the basin's southern boundary.

This framework identifies four distinct structural regions within the supercluster: the diffuse Telescopium Cloud marking the supercluster's northern reaches, the linear Southern Filament, the gravitationally dominant Pavo-Indus Complex, and the extended structures of Microscopium and Ara that define the sub-basin's periphery.

The **Telescopium Cloud** region forms the northern extent of the Pavo-Indus Supercluster. Despite its general observational challenges—Zone of Avoidance obscuration and its position as the most distant lobe of Laniakea—this region benefits from relative proximity and a bridging position between the better-characterized Virgo lobe and the most distant concentrations of Pavo-Indus. The Cloud exhibits the diffuse, unrelaxed nature typical of peripheral supercluster regions, with galaxy groups distributed across a broad volume rather than consolidated into dense cores. Foqué et al. (1993) conducted comprehensive redshift surveys identifying multiple bound concentrations throughout this region, including the NGC 7049 Group, NGC 7144 Group, and NGC 7079 Group. Dynamical analysis suggests most groups have not yet reached equilibrium states, with their ongoing assembly reflecting the supercluster's youth. This framework distinguishes the Pavocentric portion from the kinematically distinct Grus concentration, which participates in Virgocentric flow, despite spatial proximity to the Telescopium Cloud, and is therefore cataloged within the Local Infall region of the Virgo Supercluster.

The **Telescopium Cluster** (AS0851) represents the gravitational anchor of the Telescopium Cloud, dominated by two massive elliptical galaxies: NGC 6868, the anchor and brightest member, and NGC 6861, its interacting companion. X-ray observations reveal that this apparent single cluster is actually a merger in progress between two distinct subgroups, each originally centered on one of these elliptical galaxies (Machacek et al. 2010). The interaction has created dramatic features in the surrounding hot gas—NGC 6868 exhibits a sharp cold front edge and a trailing spiral tail as it moves at transonic speeds through the intragroup medium, while NGC 6861 is wrapped in a hot gas sheath with extended tails marking its trajectory through the merger. The encounter appears to unfold primarily in the plane of the sky, which accounts for the similar radial velocities of the two galaxies despite their ongoing gravitational interaction. Perhaps most remarkably, NGC 6861 harbors a central black hole of approximately 2.5×10^9 solar masses—an order of magnitude more massive than expected for its bulge size based on standard scaling relations. This anomaly may reflect unusual growth triggered by the merger environment, distinguishing NGC 6861 from the more typical NGC 6868, whose central black hole follows predicted relationships. The Telescopium Cluster's merger state exemplifies the ongoing assembly processes characteristic of the Pavo-Indus Supercluster, where gravitational consolidation continues at both group and cluster scales, building the chain-like filamentary structure that extends southward (ultimately toward Norma-Centaurus) through the remaining structural regions.

The **Southern Filament** extends the structure of Pavo-Indus from the Telescopium Cloud region toward the gravitational core of the sub-basin (treated as part of a continuous Pavo-Indus Filament in literature). This linear connector bridges the diffuse northern extent and the dense southern concentrations, tracing overdensity nodes along the supercluster's elongated morphology. Among the galaxy groups distributed along the Filament's extent, two concentrations stand out as structural anchors. The IC 5156 Group represents a substantial node featuring the compact group Hickson 90 (including NGC 7173, NGC 7174, and NGC 7176)—a dense configuration of interacting galaxies embedded within the broader group environment. Further south along the Filament lies the NGC 6769 Group, known as the "Devil's Mask," a gravitationally bound triplet system undergoing active merger. The three galaxies—two spirals (NGC 6769 and NGC 6770) with wrapping spiral arms engaged in close interaction, accompanied by a lenticular companion (NGC 6771)—provide a snapshot of galactic evolution in progress, illustrating the dynamical complexity that emerges when multiple massive galaxies encounter one another within filamentary environments. These groups, together with additional intermediate concentrations, delineate the Southern Filament's path toward the Pavo-Indus Complex, where the supercluster's gravitational core resides in a multi-cluster configuration that anchors the entire sub-basin's structure.

The **Pavo-Indus Complex** forms the gravitational core of the sub-basin, where three galaxy clusters concentrate along the supercluster's elongated structure: the Pavo Cluster (AS0805), the Indus Cluster (Abell 3742), and the cluster anchored by IC 4931 (Abell 3656), with the Pavo Group (Pavo I) representing an additional concentration within the complex. The alignment of these three principal clusters along a common filamentary axis proved historically significant, helping astronomers recognize the Great Attractor during early large-scale structure surveys. Despite this discovery role, the Pavo-Indus Complex remains among the least-studied cluster concentrations in Laniakea, with only the two Pavo systems receiving dedicated observational campaigns while the Indus Cluster and IC 4931 Group remain characterized solely through large-scale redshift surveys. This dramatic contrast in observational coverage reflects the broader challenge of characterizing structures in the Zone of Avoidance, where galactic obscuration prevents the systematic study that has illuminated comparable cluster systems in clearer regions of the sky.

The **Pavo Cluster** (AS0805) represents the larger of the two Pavo concentrations, anchored by the massive elliptical galaxy IC 4765 and comprising at least fifteen member galaxies distributed across the cluster's extent. This system is commonly known as Pavo II in astronomical literature, distinguishing it from the nearby Pavo Group (Pavo I), though the two represent separate gravitational systems rather than merging components of a single structure. X-ray observations reveal the cluster possesses a cool core, yet spectroscopic analysis demonstrates it lacks the vigorous star formation activity characteristic of classical cooling flow systems. The first detailed optical spectroscopy of cluster members, conducted by de Rocha-Poppe et al. (2019), identified distinct nuclear activity signatures across the galaxy population. IC 4765 exhibits LINER-type emission indicative of low-ionization nuclear activity common in cool core environments. The peculiarly shaped IC 4767, which the study dubbed the "Crystal Frog," displays similar LINER characteristics despite its distinctive morphology—its distorted structure suggesting past gravitational interactions within the cluster environment. In contrast, the spiral galaxy IC 4770 shows typical star-forming regions, representing the continued stellar birth seen in galaxies that have avoided the quenching processes common in denser cluster cores. This diversity of nuclear activity and star formation states illustrates the range of evolutionary pathways galaxies follow within intermediate-density cluster environments.

The Pavo Group (commonly designated Pavo I in literature and centered on NGC 6876) is an example of a smaller, non-cluster-scale concentration within the complex. The dominant central elliptical galaxy NGC 6876 provides the gravitational anchor, but the group's most remarkable feature is the enormous spiral galaxy NGC 6872—the Condor Galaxy. Spanning approximately 522,000 light-years from tip to tip, NGC 6872 ranks among the largest known spiral galaxies in the observable universe. Its extraordinary size results from a gravitational interaction with its smaller companion IC 4970, which has stretched the spiral's arms into an immense bird-like shape that inspired the "Condor" nickname. This interaction has also produced one of the most striking examples of stripped gas dynamics yet observed in a poor galaxy group. XMM-Newton observations revealed an unprecedented X-ray trail extending roughly 300,000 light-years between NGC 6872 and the central elliptical NGC 6876—one of the longest such features detected in any environment (Machacek et al. 2005). The trail formed during a supersonic fly-by encounter, when NGC 6872 passed through the group center at high velocity. The interaction triggered two combined stripping processes: gravitational focusing of intragroup gas into a wake behind the moving spiral (Bondi-Hoyle accretion), and turbulent removal of gas directly from NGC 6872 itself. Spectral analysis indicates the trail consists of thermally mixed material—roughly two-thirds ambient intragroup medium and one-third gas stripped from the galaxy—creating a luminous tracer of NGC 6872's recent path through the Pavo Group's gravitational potential.

The **Indus Cluster** (Abell 3742) represents the third major concentration within the Complex, though it has not been the subject of dedicated dynamical studies comparable to the Pavo systems. Instead, its principal galaxies are valued primarily as calibrators and survey hosts rather than as direct targets of dynamical study, meaning the cluster's structure is known mostly through indirect characterization. NGC 7038 serves as a Tully-Fisher distance calibrator—a symmetric spiral galaxy whose well-defined rotation properties make it a standard reference for measuring cosmic distances across the southern sky. NGC 7014, the massive elliptical anchor of the cluster, hosts a population of rare Ultra-Compact Dwarf objects in its halo, systems that occupy the size regime between globular clusters and dwarf galaxies. The cluster centered on IC 4931 (Abell 3656) marks the final major concentration within the complex, though it also remains largely uncharacterized beyond basic catalog entries. Together, these clusters form the gravitational core anchoring the Pavo-Indus Supercluster lobe, with the sub-basin's filamentary morphology continuing onward through the obscured Ara region to merge with the Great Attractor flow in the Norma-Centaurus region.

The **Microscopium Extension** diverges from the Pavo-Indus lobe’s primary filamentary structure that continues toward the Norma-Centaurus region. Instead, this structural region represents streams of galaxies fed by infall from the Microscopium Void, similar in character to the Virgo Southern Extension examined earlier in the framework. Several concentrations trace these streams, including the NGC 6902 Group and NGC 6925 Group, though the most comprehensively studied system within this region is the NGC 6907 Group. This concentration features an interacting galaxy pair whose recent collision history illuminates the dynamical processes operating in void-boundary environments. High-resolution radio and optical observations by Scarano et al. (2008) resolved long-standing ambiguity about whether NGC 6908 represented a distinct object or merely a structural component of its larger companion. The study confirmed NGC 6908 as a separate lenticular galaxy that crossed through the disk of the spiral galaxy NGC 6907 approximately 34 million years ago—a remarkably recent encounter on cosmic timescales. The collision left distinctive signatures in the neutral hydrogen distribution, which extends 2.4 times farther than the optical emission and exhibits asymmetries characteristic of disc disruption. The interaction exemplifies how galaxies entering denser supercluster environments from surrounding voids undergo transformative encounters that alter their structure and evolution, feeding material into the broader Pavo-Indus Supercluster.

The **Ara Association** resumes the main filamentary flow of the Pavo-Indus sub-basin, extending toward the Great Attractor in the Norma-Centaurus region. This zone experiences the most severe galactic plane obscuration within the entire supercluster, limiting characterization to a sparse population of individual galaxies rather than the groups cataloged in less-obscured sectors. Among the few systems detectable in this region, two galaxies provide insight into the diverse evolutionary processes operating along the Norma boundary. NGC 6328 hosts a young, radio-loud active galactic nucleus (AGN) whose recent activation presents an intriguing case for understanding black hole feeding mechanisms. Rather than being triggered by a major merger—the traditional explanation for radio AGN—observations suggest the activity results from the accretion of small cold gas clouds falling into the central black hole from the galaxy's surrounding hot halo (Maccagni et al. 2014). This chaotic feeding process represents an alternative pathway for activating supermassive black holes in relatively isolated environments. NGC 6156 exhibits a different evolutionary signature: a gas-rich spiral galaxy with an anomalous polar-ring structure—originally detected through velocity-field analysis rather than standard surface brightness mapping (Deg et al. 2023). The polar gas component, likely acquired through recent accretion, contributes to vigorous ongoing star formation throughout the system. Despite incomplete observational coverage, these systems complete the path connecting Pavo-Indus to the broader Great Attractor region beyond the sub-basin's boundary.

The Pavo-Indus Supercluster's organization across five structural regions—the Telescopium Cloud, Southern Filament, the Pavo-Indus Complex, Microscopium Extension, and the Ara Association (plus a sparse field galaxy population)—reveals the sub-basin's distinctive morphology within Laniakea's architecture. Unlike the sheet-based configurations of Virgo and Hydra or the gravitationally consolidated structure of Centaurus, Pavo-Indus exhibits an elongated chain-like arrangement of major concentrations extending from the diffuse Telescopium Cloud through the multi-cluster Pavo-Indus Complex and to the heavily obscured Ara Association. This internal structure anchors the broader Pavo-Indus Arch, a filamentary extension that serves dual basin-scale functions: bounding the Local Void to the Supergalactic north while reaching toward the velocity-watershed boundary separating Laniakea from the Perseus-Pisces Basin (Tully et al. 2019). The arch configuration establishes Pavo-Indus as both an internal structural component and an external boundary feature, connecting the sub-basin's flow toward the Great Attractor in the Norma-Centaurus region—and ultimately completing this framework’s structural map of the Laniakea Basin.

Cataloged groups in these regions: *Telescopium Cloud (6):* NGC 7049/7162 Group, NGC 7144 Group, NGC 7079 Group, IC 4797 Group, Telescopium Cluster, NGC 6753 Group; *Southern Filament (5):* IC 5156 Group, NGC 7196 Group, NGC 7329 Group, NGC 6769 Group, IC 4845 Group; *Pavo-Indus Complex (4):* Pavo Cluster, Pavo Group, Indus Cluster, IC 4931 Group; *Microscopium Extension (3):* NGC 6902 Group, NGC 6925 Group, NGC 6907 Group; Ara Association; Pavo-Indus Field Galaxies

5 – Discussion

5.1 – Advantages of Structure Based Organization

This framework's primary contribution lies in establishing terminological clarity between basins of attraction and superclusters—a distinction that addresses genuine confusion in current literature and pedagogy. The Tully et al. (2014) velocity-watershed analysis identified Laniakea as a dynamically coherent region, yet both professional and public discourse frequently apply "supercluster" to both the basin itself and to its constituent lobes like Virgo or Hydra. This terminological ambiguity obscures hierarchical relationships: when Laniakea and Virgo both carry the "supercluster" label, understanding that Virgo represents one lobe within the larger Laniakea Basin becomes unnecessarily difficult. The framework addresses this by reserving "basin of attraction" for velocity-watershed-defined regions (Laniakea, Perseus-Pisces, Shapley) and "supercluster" for the major overdensity lobes often within basins (Virgo, Hydra, Centaurus, Pavo-Indus). This distinction serves both pedagogical and research purposes: educators gain clearer language for teaching cosmic hierarchies, while researchers working on basin-scale studies benefit from standardized terminology that reflects the physical distinction between watershed-defined basins and their constituent supercluster sub-basins.

The organizational philosophy itself represents a methodological synthesis built upon the foundation established by the Cosmicflows program. Rather than generating new cosmographic insights, the framework's contribution lies in systematic organization and interpretation of existing velocity-field and catalog data. The dual-requirement approach—insisting that structural regions exhibit both coherent flow patterns and observable galactic overdensities—distinguishes this framework from inferred cosmic web classifications by anchoring every organizational category in accessible observations. This makes the framework practically usable by observers and educators rather than limiting it to theoretical applications, while simultaneously preventing the cataloging of flow-only regions that lack sufficient galaxy populations to serve as observational reference points. The requirement for convergent evidence constrains but does not eliminate interpretive flexibility, ensuring that structural designations reflect both large-scale dynamics and distributions of matter that observers can actually detect and study.

A notable empirical pattern emerges from the systematic cataloging: basin-level structural organization mirrors supercluster-level patterns through self-similar hierarchical relationships. This repetition, while theoretically expected from hierarchical structure formation, becomes clearly visible through the framework's organizational lens. Laniakea itself exhibits web-like morphology at the basin scale—multiple filamentary lobes converging toward a central gravitational core—mirroring the internal structure observed within the Virgo and Hydra superclusters. The Shapley Concentration demonstrates a core-dominated morphology at the basin scale analogous to the gravitationally consolidated structure of the Centaurus Supercluster at the sub-basin scale, while the Perseus-Pisces Basin exhibits an elongated filamentary morphology similar to the chain-like configuration of the Pavo-Indus Supercluster. These morphological analogies across organizational scales suggest that the structural categories defined for supercluster organization (sheets, filaments, clusters, etc.) represent recurring patterns that manifest across multiple orders of cosmic magnitude. The framework's systematic approach to structural classification reveals these self-similar patterns empirically within Laniakea's architecture, demonstrating how organizational methodology can illuminate broader cosmographic principles.

This hierarchical anchoring principle extends further still, down to galactic nuclear scales. The framework positions brightest cluster galaxies (BCGs) as gravitational anchors at the deepest potential wells of their respective structural regions—a designation consistent with the **M – σ relation** (Ferrarese & Merritt 2000; see also Gebhardt et al. 2000), which links black hole mass to the velocity dispersion of the host galaxy's central bulge. The catalog's cluster-anchoring BCGs bear this out: their central black holes overwhelmingly exceed 10^9 solar masses, with even the smallest among them surpassing 10^8 solar masses—an order of magnitude above Sagittarius A*, the Milky Way's own supermassive black hole. That the same organizational logic governing basin-scale structure finds expression in the masses of galactic nuclei reflects the physical coherence of the hierarchical framework. Gravitational anchoring thus operates as a consistent principle from the scale of the Laniakea Basin down through its constituent superclusters and clusters, ultimately to the black holes at their centers.

5.2 – Application

The framework's utility extends across multiple domains, from educational contexts to observational planning to serving as a methodological template for future basin-scale studies. The organizational approach transforms how familiar objects are contextualized: locating M51 (the Whirlpool Galaxy) within the Local Filament reveals its participation in the flow connecting the Local Sheet to the Virgo Cluster core, contextualizing the galaxy's position within basin-scale dynamics rather than treating distance measurements as endpoints in themselves. This principle—that structural relationships enhance comprehension beyond positional data alone—underlies the framework's practical applications.

For educational purposes, the hierarchical organization provides natural scaffolding for teaching cosmic web topology. Students can trace the Local Group's position within progressively larger structures (Local Sheet → Local Filament → Virgo Supercluster → Laniakea Basin), making the nested architecture of cosmic structure concrete rather than abstract. The seven structural categories (sheets, filaments, clusters, walls, streams, clouds, and void boundaries) similarly transform cosmic web morphology from theoretical concept to observable classification, enabling students to recognize these patterns in astronomical data. The framework's success in linking M87 to the Virgo Cluster's role as gravitational anchor for the entire Virgo Supercluster lobe illustrates this contextual value: M87* appears among the only supermassive black holes large enough to be currently resolvable from Earth not simply due to proximity, but because it sits at the bottom of the potential well for Laniakea's Virgo sub-basin—a position that both maximizes its mass and minimizes its apparent motion relative to our observational vantage point.

The framework's 27 structural regions and five hierarchical levels provide a ready-made organizational schema for visualization applications, mapping naturally onto zoom-based interfaces in platforms ranging from planetarium dome presentations to interactive web-based cosmic atlases. This hierarchical structure enables intuitive navigation from basin overview down to individual galaxies, with each organizational level corresponding to a natural zoom threshold in three-dimensional space. The structural categorization similarly enables color-coding or filtering by cosmic web topology, allowing users to visualize how sheets connect to filaments, how filaments feed clusters, and how void boundaries mark transitions between overdense and underdense regions.

The framework also contextualizes environmental processing across structural scales. The extreme ram-pressure stripping exhibited by ESO 137-001—the Jellyfish Galaxy in the Norma Cluster (Abell 3627)—becomes fully interpretable only within basin-scale context: this galaxy experiences environmental processing not merely within a rich cluster, but at the deepest potential well of the entire Laniakea Basin, where the convergent flows from four supercluster lobes create the most extreme intracluster medium conditions observable within the local universe. Similarly, structural position predicts observable galaxy properties: galaxies in stream regions like the Virgo Stream exhibit intermediate characteristics between isolated field populations and dense cluster members, showing significant HI deficiency and suppressed star formation that reflect environmental pre-processing during their journey along moderate-density filamentary pathways (Castignani et al. 2022). The framework's structural categories thus correlate directly with measurable evolutionary states.

The organizational approach handles complex multi-scale dynamics that would remain obscure under simpler classification schemes. The Grus concentration exemplifies how the framework prioritizes dynamical membership over spatial proximity: groups in the Grus region (NGC 7582 Group, IC 1459 Group, NGC 6744 Group) lie spatially close to the Telescopium Cloud in the Pavo-Indus Supercluster but participate in Virgocentric rather than Pavocentric flow, with the velocity watershed separating these flows occurring near ~2,000 km/s. The framework assigns these groups to the Local Infall region of the Virgo Supercluster based on their flow pattern, illustrating how velocity-based organization reveals dynamical associations that spatial proximity alone does not capture. The Fornax Complex similarly captures relationships that span multiple dynamical scales simultaneously: the Fornax and Eridanus clusters remain gravitationally bound despite currently separating on an expanding orbit (Willmer et al. 1989), while subgroups merge within individual clusters, and the entire Complex participates in the Virgo Supercluster's bulk flow toward the Great Attractor. The "Complex" designation accommodates these three levels of dynamical behavior operating concurrently within a single structural region.

Beyond organizing Laniakea specifically, the methodology serves as a template extensible to other basins of attraction as Cosmicflows coverage expands. The Perseus-Pisces Basin is currently described in literature through its constituent clusters—the Perseus Cluster (Abell 426), the Pisces clusters, and the Pegasus Cluster. This region could be systematically organized using this framework's approach—applying Cosmicflows velocity data to identify it as a basin of attraction composed of three supercluster lobes anchored by these recognized clusters, then cataloging the structural regions within each sub-basin according to cosmic web topology and flow patterns. The same methodology could be applied to the Shapley Concentration, to the more distant Pisces-Cetus superclusters, or even to structures functioning as inter-basin connective tissue like the Ophiuchus Supercluster linking Laniakea's outflow to Shapley. The standardized terminology and dual-requirement organizational philosophy established here provide consistent language and methodology for comparative basin-scale studies, enabling systematic cosmographic mapping as observational coverage improves.

5.3 – Limitations and Uncertainties

The framework lacks formal quantitative criteria for boundary placement between structural regions, relying instead on qualitative convergence of velocity field patterns and observable galactic overdensity distributions. While the dual-requirement principle (requiring both coherent flow and galactic concentrations) constrains the space of reasonable organizational choices, it does not produce a unique solution. Two researchers applying the same convergent-evidence approach might reasonably delineate different boundaries, particularly for transitional structures where one morphological type grades into another—the Local Filament's merger with the Virgo Cluster infall region (discussed in Section 4.2.2) exemplifies this kind of boundary ambiguity. In practice, most structural boundaries proved reasonably clear during catalog compilation, but this clarity emerged from interpretive judgement informed by multiple data sources rather than from application of strict quantitative thresholds. This subjectivity is inherent to any organizational framework applied to continuous cosmic structure and does not invalidate the resulting organization, but it does mean the framework should be understood as one well-motivated systematic approach rather than as the uniquely correct decomposition of the Laniakea Basin's contents.

The seven structural categories (sheets, filaments, clusters, walls, streams, clouds, and void boundaries) are defined by morphology, density characteristics, and dynamical role in Section 3.2, but the framework does not provide quantitative thresholds that would enable strict operational testing. The distinction between filaments and streams depends on density and function; the distinction between sheets and walls relies on density and orientation—yet the paper does not specify, for example, that filaments must exhibit density contrast **δ** above some numerical threshold while streams must fall below it. This represents a genuine limitation for reproducibility, as independent researchers might classify borderline structures differently. However, this limitation exists within the broader context of cosmic web classification generally: structures exist along continua rather than in discrete bins, and the categories function as physically motivated descriptive tools for organizational and pedagogical purposes rather than as quantitatively defined observational classifications. The framework's utility lies in providing intuitive structural context grounded in observable properties, not in achieving perfect categorical precision.

The framework's decomposition of Laniakea into four distinct supercluster lobes—Virgo, Hydra, Centaurus, and Pavo-Indus—reflects an organizational choice informed by the topological structures and flow patterns (discussed in section 4.4), but much of the literature treats Hydra and Centaurus as a unified "Hydra-Centaurus Supercluster." The separation adopted here is supported by their independent internal organization (Hydra's extended filamentary morphology versus Centaurus' gravitationally consolidated structure) and their distinct participation in basin-scale flow patterns, but future Cosmicflows releases with improved velocity-field resolution, particularly behind the Zone of Avoidance, may further clarify whether this four-lobe decomposition or an alternative three-lobe treatment better represents Laniakea's sub-basin architecture.

The catalog compilation employed AI-assisted systematic cross-referencing at a scale impractical for manual compilation alone, as described in Section 2.4. The specific documented failure mode—AI conflating two-dimensional sky positions with three-dimensional structural membership—illustrates why the verification protocol matters more than the tool choice itself. The framework's reliance on this methodology introduces dependency on verification procedures to catch systematic errors of this type. The open-access publication of the complete catalog enables community verification and correction, mitigating this limitation by inviting independent review of group assignments and structural classifications.

The framework's observational resolution degrades with distance from the Local Group and with increasing Zone of Avoidance obscuration. This asymmetry affects particularly the southern superclusters, where the Milky Way's galactic disc limits detailed characterization of groups and structural relationships. The resulting variation in catalog completeness across different regions reflects data availability rather than inherent differences in structural complexity, meaning that less-detailed treatment of distant or obscured regions should not be interpreted as evidence for simpler organization in those areas.

Finally, the framework reflects current observational data and represents a snapshot based on available Cosmicflows releases rather than a definitive mapping. Future improvements in distance measurements, particularly behind the Zone of Avoidance, and refinements to peculiar velocity determinations may alter group assignments, adjust structural boundaries, or reveal previously undetected concentrations. The framework is designed to be updatable as observations improve, with the open-access catalog enabling community revision and extension as new data becomes available. Similarly, the catalog has not yet been tested against independent organizational attempts applying the same methodology—the framework is presented as one systematic approach whose utility will be evaluated through community use and potential alternative implementations.

5.4 – Future Directions

While grounded in current Cosmicflows data and cluster surveys, the framework is designed to evolve. The next decade of observational programs will provide the high-resolution data capable of testing the framework's organizational choices, hardening its structural boundaries, and filling its most significant gaps.

WALLABY (Widefield ASKAP L-band Legacy All-sky Blind Survey) and MeerKAT detect neutral hydrogen through its 21-cm radio emission, which passes through the Milky Way's dust lanes unobstructed. This directly addresses the Zone of Avoidance obstruction that limits characterization of the Norma Complex and Ara Association—two of the framework's least well-observed regions. WALLABY's southern-sky coverage is positioned to reveal gas-rich galaxies hidden behind the galactic plane, potentially mapping the full structure of heavily obscured regions and identifying additional concentrations in the Great Attractor region, including the true extent of the Pavo-Indus Arch. MeerKAT, already cited in this paper for Hydra Cluster substructure observations (Hess et al. 2022), provides complementary high-sensitivity HI observations for targeted follow-up of specific structures. Together these radio programs represent the most direct path to completing the catalog's coverage of its most obscured regions.

The Dark Energy Spectroscopic Instrument's Bright Galaxy Survey is densely mapping the local universe with precise spectroscopic distances and velocities for millions of galaxies. This directly addresses the limitations that the framework's structural categories lack quantitative density thresholds—the boundaries between filaments and streams, or sheets and walls, are currently defined by qualitative morphological and dynamical criteria. DESI's statistical density is positioned to provide the overdensity metrics (δ) needed to transform these qualitative boundaries into mathematically reproducible definitions, particularly for well-observed regions including the Virgo Supercluster and its boundary with the Perseus-Pisces Basin.

ESA's Euclid space telescope measures weak gravitational lensing to map dark matter distributions directly, rather than inferring mass from luminous galaxies and X-ray gas alone. This capability can test whether the structural anchors identified by the framework—the BCGs positioned at the centers of each cluster region—truly sit at the deepest points of the underlying dark matter scaffolding, providing independent validation of the hierarchical anchoring principle central to the framework's organizational logic. Euclid's near-infrared capability also offers improved penetration of dusty regions compared to optical surveys.

Future Cosmicflows releases will refine peculiar velocity measurements and flow-field reconstructions, potentially redrawing sub-basin boundaries, reclassifying group memberships, and testing the framework's highest-level organizational choices. Improved velocity data, particularly in the Great Attractor region behind the Zone of Avoidance, will be especially consequential for evaluating sub-basin structure and group assignments in the Norma Complex and throughout the Pavo-Indus Supercluster. The framework is designed to accommodate such refinements—updating group memberships and boundary placements as observational precision improves without requiring revision to the underlying hierarchical philosophy or structural categorization approach.

6 – Conclusion

The framework presents a comprehensive organizational structure for the Laniakea Basin, cataloging four major superclusters (Virgo, Hydra, Centaurus, and Pavo-Indus) subdivided into 27 structural regions defined by cosmic web topology, containing approximately 128 galaxy groups and ~718 individual galaxies. The organizational philosophy requires convergent evidence from both velocity field analysis and observable galactic overdensities, ensuring that every structural designation reflects both large-scale gravitational dynamics and accessible observational anchors. This systematic approach reveals an architectural pattern: Laniakea exhibits self-similar hierarchical organization across multiple scales, with basin-level morphology mirroring supercluster-level structure. The four supercluster lobes converge toward a common gravitational basin in the Norma-Centaurus region, their internal organizations reflecting recurring sheet-to-filament-to-cluster progressions that operate across different orders of cosmic magnitude. The framework demonstrates that structural position within gravitational flows, not spatial proximity alone, defines cosmic organization at basin scales.

The framework’s most durable contribution lies in establishing terminological clarity between velocity-watershed-defined basins of attraction and overdensity-defined superclusters. The catalog will be updated as observations improve; the structural categories may gain quantitative precision from future surveys; but the conceptual distinction between Laniakea as a basin containing four supercluster lobes resolves genuine ambiguity in current usage and provides standardized language for educators, researchers, and public communication alike. This terminological framework extends beyond Laniakea itself, offering consistent vocabulary for discussing Perseus-Pisces, Shapley, and other basin-scale structures as cosmographic mapping expands.

The framework and complete catalog are published openly to enable verification, extension, and adaptation by the astronomical community. The hierarchical structure and organizational methodology are designed to absorb new data—updated group memberships, refined boundaries, newly detected structures behind the Zone of Avoidance—without requiring revision to the underlying dual requirement philosophy or structural categorization approach. The seven structural categories, the five-level hierarchy, and the requirement for convergent evidence from velocity fields and observable overdensities constitute a methodological template applicable to other basins as Cosmicflows coverage expands and radio surveys pierce remaining obscured regions. The framework is offered as a tool built for community use and iterative improvement.

7 – Data Availability

The primary data product of this work is the *Field Guide to Laniakea Catalog*, presented in the Appendix. This catalog contains the complete organizational framework including all group memberships, structural region assignments, and individual galaxy listings across the four superclusters and 27 structural regions described in this paper. The framework does not generate new observational data; all underlying astronomical measurements (galaxy positions, redshifts, distances, and velocities) are drawn from publicly available sources (cited in Section 2.1), principally the NASA/IPAC Extragalactic Database (NED), the Cosmicflows program (Tully et al. 2013, 2016, 2023), and the published galaxy catalogs and cluster surveys listed in References. The catalog's contribution is the organizational compilation and structural classification of the existing data. Machine-readable versions of the catalog and supplementary digital resources are planned for future releases through a public repository.

References

Binggeli, B., Sandage, A., & Tammann, G. A. (1985). Studies of the Virgo cluster. II. A catalog of 2096 galaxies in the Virgo cluster area. *The Astronomical Journal*, **90**, 1681-1758.

Binggeli, B., Popescu, C. C., & Tammann, G. A. (1993). The kinematics of the Virgo cluster revisited. *Astronomy and Astrophysics Supplement Series*, **98**, 275.

Brough, S., Forbes, D. A., Kilborn, V. A., Couch, W., & Colless, M. (2006). Eridanus – a supergroup in the local Universe? *Monthly Notices of the Royal Astronomical Society*, **369**(3), 1351-1374.

Buta, R. & Combes, F. (1996). Galactic Rings. *Fundamentals of Cosmic Physics*, **17**, 95-281.

Castignani, G., Combes, F., Jablonka, P., Finn, R. A., Rudnick, G., Vulcani, B., Desai, V., Zaritsky, D., & Salomé, P. (2022). Virgo filaments. I. Processing of gas in cosmological filaments around the Virgo cluster. *Astronomy & Astrophysics*, **657**, 76.

Castignani, G., Vulcani, B., Finn, R. A., Combes, F., Jablonka, P., Rudnick, G., Zaritsky, D., Whalen, K., Conger, K., De Lucia, G., Desai, V., Koopmann, R. A., Moustakas, J., Norman, D. J., & Townsend, M. (2022). Virgo Filaments. II. Catalog and First Results on the Effect of Filaments on Galaxy Properties. *The Astrophysical Journal Supplement Series*, **259**(2), 24.

Churazov, E., Gilfanov, M., Forman, W., & Jones, C. (1999). Evidence for Merging in the Centaurus Cluster. *The Astrophysical Journal*, **520**(1), 105-110.

Crook, A. C., Huchra, J. P., Martimbeau, N., Masters, K. L., Jarrett, T., & Macri, L. M. (2007). Groups of Galaxies in the Two Micron All Sky Redshift Survey. *The Astrophysical Journal*, **665**(2), 790-813.

da Costa, L. N., Willmer, C., Pellegrini, P. S., & Chincarini, G. (1987). The Centaurus-Hydra Supercluster Region. II. *The Astronomical Journal*, **93**, 1338.

da Rocha-Poppe, P. C., Fernandes-Martin, V. A., Faúndez-Abans, M., de Oliveira-Abans, M., Silva, G. A., Freitas-Lemes, P., & Lima-Dias, C. (2019). Optical long-slit spectroscopy in the cluster Abell S0805. *Monthly Notices of the Royal Astronomical Society*, **488**(3), 3685-3715.

de Vaucouleurs, G. (1956). The distribution of bright galaxies and the local supergalaxy. *Vistas in Astronomy*, **2**(1), 1584-1606.

Deg, N., Palleske, R., Spekkens, K., Wang, J., Jarrett, T., English, J., Lin, X., Yeung, J., Mould, J. R., Catinella, B., Dénes, H., Elagali, A., For, B. Q., Kamphuis, P., Koribalski, B. S., Lee-Waddell, K., Murugeshan, C., Oh, S., Rhee, J., Serra, P., et al. (2023). WALLABY pilot survey: the potential polar ring galaxies NGC 4632 and NGC 6156. *Monthly Notices of the Royal Astronomical Society*, **525**(3), 4663-4684.

Ebeling, H., Mullis, C. R., & Tully, R. B. (2002). A Systematic X-Ray Search for Clusters of Galaxies behind the Milky Way. *The Astrophysical Journal*, **580**(2), 774-788.

Event Horizon Telescope Collaboration, Akiyama, K., Alberdi, A., Alef, W., Asada, K., Azulay, R., Baczko, A. K., Ball, D., Baloković, M., Barrett, J., Bintley, D., Blackburn, L., Boland, W., Bouman, K. L., Bower, G. C., Bremer, M., Brinkerink, C. D., Brissenden, R., Britzen, S., Broderick, A. E., et al. (2019). First M87 Event Horizon Telescope Results. I. The Shadow of the Supermassive Black Hole. *The Astrophysical Journal Letters*, **875**(1), L1.

Fairall, A. P. (1998). *Large-scale structures in the universe*. John Wiley & Sons.

Ferguson, H. C. (1989). Population Studies in Groups and Clusters of Galaxies. II. A Catalog of Galaxies in the Central 3.5 Degrees of the Fornax Cluster. *The Astronomical Journal*, **98**, 367.

Ferguson, H. C. & Sandage, A. (1990). Population Studies in Groups and Clusters of Galaxies. III. A Catalog of Galaxies in Five Nearby Galaxies. *The Astronomical Journal*, **100**, 1.

Ferrarese, L. & Merritt, D. (2000). A Fundamental Relation between Supermassive Black Holes and Their Host Galaxies. *The Astrophysical Journal*, **539**(1), L9-L12.

Fitchett, M. & Merritt, D. (1988). Dynamics of the Hydra I Galaxy Cluster. The *Astrophysical Journal*, **335**, 18.

Foqué, P., Proust, D., Quintana, H., & Ramirez, A. (1993). Dynamics of the Pavo-Indus and Grus clouds of galaxies. *Astronomy and Astrophysics Supplement Series*, **100**, 493-500.

Garcia, A. M. (1993). General study of group membership. II. Determination of nearby groups. *Astronomy and Astrophysics Supplement Series*, **100**, 47-90.

Gavazzi, G., Boselli, A., Scodeggio, M., Pierini, D., & Belsole, E. (1999). The 3D structure of the Virgo cluster from H-band Fundamental Plane and Tully-Fisher distance determinations. *Monthly Notices of the Royal Astronomical Society*, **304**(3), 595-610.

Gebhardt, K., Bender, R., Bower, G., Dressler, A., Faber, S. M., Filippenko, A. V., Green, R., Grillmair, C., Ho, L. C., Kormendy, J., Lauer, T. R., Magorrian, J., Pinkney, J., Richstone, D., & Tremaine, S. (2000). A Relationship between Nuclear Black Hole Mass and Galaxy Velocity Dispersion. *The Astrophysical Journal,* **539**(1), L13-L16.

Helou, G., Madore, B. F., Schmitz, M., Bicay, M. D., Wu, X., & Bennett, J. (1991). The NASA/IPAC Extragalactic Database. In M. A. Albrecht & D. Egret (Eds.), *Databases and On-line Data in Astronomy*, 89-106, Kluwer Academic Publishers.

Hess, K. M., Jarrett, T. H., Carignan, C., Passmoor, S. S., & Goedhart, S. (2015). KAT-7 science verification: cold gas, star formation, and substructure in the nearby Antlia Cluster. *Monthly Notices of the Royal Astronomical Society*, **452**(2), 1617-1636.

Hess, K. M., Kotulla, R., Chen, H., Carignan, C., Gallagher, J. S., Jarrett, T. H., & Kraan-Korteweg, R. C. (2022). NGC 3314a/b and NGC 3312: Ram pressure stripping in Hydra I cluster substructure. *Astronomy & Astrophysics*, **668**, 20.

Jordán, A., Blakeslee, J. P., Côté, P., Ferrarese, L., Infante, L., Mei, S., Merritt, D., Peng, E. W., Tonry, J. L., & West, M. J. (2007). The ACS Fornax Cluster Survey. I. Introduction to the Survey and Data Reduction Procedures. *The Astrophysical Journal Supplement Series*, **169**(2), 213-224.

Karachentsev, I. D. & Nasonova, O. G. (2013). Intense look at Virgo Southern Extension. *Monthly Notices of the Royal Astronomical Society*, **429**(3), 2677-2686.

Karachentsev, I. D., Nasonova, O. G., & Karachentseva, V. E. (2015). Large-scale structure and galaxy motions in the Leo/Cancer constellations. *Astrophysical Bulletin*, **70**(1), 1-15.

Kourkchi, E. & Tully, R. B. (2017). Galaxy Groups Within 3500 km s^{-1}. *The Astrophysical Journal*, **843**(1), 21.

Kraan-Korteweg, R. C. & Lahav, O. (2000). The Universe behind the Milky Way. *The Astronomy and Astrophysics Review*, **10**(3), 211-261.

Lauberts, A. (1982). *ESO/Uppsala Survey of the ESO(B) Atlas*. European Southern Observatory.

Lucey, J. R., Currie, M. J., & Dickens, R. J. (1986). The Centaurus cluster of galaxies – II. The bimodal velocity structure. *Monthly Notices of the Royal Astronomical Society*, **221**, 453-472.

Maccagni, F. M., Morganti, R., Oosterloo, T. A., & Mahony, E. K. (2014). What triggers a radio AGN? The intriguing case of PKS B1718-649. *Astronomy & Astrophysics*, **571**, 8.

Machacek, M. E., Nulsen, P., Stirbat, L., Jones, C., & Forman, W. R. (2005). XMM-Newton Observation of an X-Ray Trail between the Spiral Galaxy NGC 6872 and the Central Elliptical Galaxy NGC 6876 in the Pavo Group. *The Astrophysical Journal*, **630**(1), 280-297.

Machacek, M. E., O'Sullivan, E., Randall, S. W., Jones, C., & Forman, W. R. (2010). The Mysterious Merger of NGC 6868 and NGC 6861 in the Telescopium Group. *The Astrophysical Journal*, **711**(2), 1316-1332.

McCall, M. L. (2014). A Council of Giants. *Monthly Notices of the Royal Astronomical Society*, **440**(1), 405-426.

Mei, S., Blakeslee, J. P., Côté, P., Tonry, J. L., West, M. J., Ferrarese, L., Jordán, A., Peng, E. W., Anthony, A., & Merritt, D. (2007). The ACS Virgo Cluster Survey. XIII. SBF Distance Catalog and the Three-dimensional Structure of the Virgo Cluster. *The Astrophysical Journal*, **665**(1), 144-162.

Moore, P. (1995). Beyond Messier: The Caldwell Catalog. *Sky & Telescope*, **90**(6), 38-43.

Mutabazi, T., Blyth, S. L., Woudt, P. A., Lucey, J. R., Jarrett, T. H., Bilicki, M., Schröder, A. C., & Moore, S. A. W. (2014). The Norma cluster (ACO 3627) – III. The distance and peculiar velocity via the near-infrared K_s-band Fundamental Plane. *Monthly Notices of the Royal Astronomical Society*, **439**(4), 3666-3682.

Newman, J. A., Zepf, S. E., Davis, M., Freedman, W. L., Madore, B. F., Stetson, P. B., Silbermann, N., & Phelps, R. (1999). A Cepheid Distance to NGC 4603 in Centaurus. *The Astrophysical Journal*, **523**(2), 506-520.

Omar, A. & Dwarakanath, K. S. (2005). GMRT HI Observations of the Eridanus Group of Galaxies I. *Journal of Astrophysics and Astronomy*, **26**(1), 1-33.

Pak, M., Rey, S. C., Lisker, T., Lee, Y., Kim, S., Sung, E. C., Jerjen, H., & Chung, J. (2014). The properties of early-type galaxies in the Ursa Major cluster. *Monthly Notices of the Royal Astronomical Society*, **445**(1), 630-647.

Powell, R. (2006). *An Atlas of the Universe*. Retrieved February 18, 2026, from http://www.atlasoftheuniverse.com

Richter, O. G. (1989). The Hydra I cluster of galaxies. V. A catalogue of galaxies in the cluster area. *Astronomy and Astrophysics Supplement Series*, **77**, 237-256.

Ryder, S.D., Walsh, W., & Malin, D. (1999). HI Study of the NGC 6744 system. *Publications of the Astronomical Society of Australia*, **16**(1), 84-88.

Scarano, S., Madsen, F. R. H., Roy, N., & Lépine, J. R. D. (2008). H I aperture synthesis and optical observations of the pair of galaxies NGC 6907 and 6908. *Monthly Notices of the Royal Astronomical Society*, **386**(2), 963-972.

Tully, R. B. (1982). The Local Supercluster. *The Astrophysical Journal*, **257**(1), 389-422.

Tully, R. B. (1988). *Nearby galaxies catalog*. Cambridge: University Press.

Tully, R. B. (2008). Our Peculiar Motion Away from the Local Void. *Bulletin of the American Astronomical Society*, **39**, 240.

Tully, R. B., Courtois, H. M., Dolphin, A. E., Fisher, J. R., Héraudeau, P., Jacobs, B. A., Karachentsev, I. D., Makarov, D., Makarova, L., Mitronova, S., Rizzi, L., Shaya, E. J., Sorce, J. G., & Wu, P. F. (2013). Cosmicflows-2: The Data. *The Astronomical Journal*, **146**(4), 25.

Tully, R. B., Courtois, H. M., Hoffman, Y., & Pomarède, D. (2014). The Laniakea supercluster of galaxies. *Nature*, **513**(7516), 71-73.

Tully, R. B., Courtois, H. M., & Sorce, J. G. (2016). Cosmicflows-3. *The Astronomical Journal*, **152**(2), 21.

Tully, R. B., Pomarède, D., Graziani, R., Courtois, H. M., Hoffman, Y., & Shaya, E. J. (2019). Cosmicflows-3: Cosmography of the Local Void. *The Astrophysical Journal*, **880**(1), 24.

Tully, R. B., Kourkchi, E., Courtois, H. M., Anand, G. S., Blakeslee, J. P., Brout, D., Jaeger, T., Dupuy, A., Guinet, D., Howlett, C., Jensen, J. B., Pomarède, D., Rizzi, L., Rubin, D., Said, K., Scolnic, D., & Stahl, B. E. (2023). Cosmicflows-4. *The Astrophysical Journal*, **944**(1), 31.

Willmer, C. N. A., Focardi, P., da Costa, L. N., & Pellegrini, P. S. (1989). Studies of Nearby Poor Clusters: The Eridanus Group. *The Astronomical Journal*, **98**, 1531.

Woudt, P. A., Kraan-Korteweg, R. C., & Fairall, A. P. (2000). The Core of the Great Attractor. *Cosmic Flows Workshop*, **201**, 88.

Woudt, P. A., Kraan-Korteweg, R. C., Lucey, J. R., Fairall, A. P., & Moore, S. A. W. (2008). The Norma cluster (ACO 3627) – I. A dynamical analysis of the most massive cluster in the Great Attractor. *Monthly Notices of the Royal Astronomical Society*, **383**(2), 445-457.

Appendix A – Glossary of Terms

Association: An isolated, loosely organized concentration of galaxy groups that, unlike a cloud, is not physically connected to a major cluster or filament.

Basin of Attraction: A vast region of space where the peculiar velocities of galaxies converge toward a common gravitational attractor, encompassing multiple superclusters and spanning hundreds of millions of light-years.

Brightest Cluster Galaxy (BCG): The most massive and luminous galaxy within a cluster, typically a giant elliptical located at or near the cluster's kinematic center. BCGs serve as the primary observational and gravitational anchors of cluster regions.

Bulk flow: The coherent, directional motion of a large-scale volume of space relative to the CMB rest frame, encompassing multiple galaxy groups and clusters.

Cloud: A diffuse, amorphous region of moderate density in which galaxy groups lack the tight core and virialization of a cluster, the flattened morphology of a sheet or wall, or the linear flow of a stream or filament.

Cluster: A high-density, virialized region containing hundreds to thousands of galaxies, often sitting at the intersection of filaments and often serving as the deepest gravitational potential well within a supercluster or basin.

CMB rest frame: The standard cosmological frame of reference in which the Cosmic Microwave Background (CMB) radiation appears uniform in all directions, serving as a universal standard of rest against which the peculiar velocities and bulk flows of all galaxies are measured.

Complex: An aggregate designation used to group multiple distinct, spatially proximate clusters or structural features into a single catalog section.

Extension: An aggregate designation used to group multiple smaller, spatially proximate streams that merit collective treatment rather than individual categorization.

Field Galaxy: An isolated galaxy residing outside of defined structural boundaries.

Filament: A massive, thread-like, moderate-to-high-density feature of the cosmic web spanning tens of millions of light-years that connects major structural regions and acts as the primary pathway along which matter flows between supercluster nodes.

Great Attractor: The gravitational convergence point of the Laniakea Basin, located in the Norma-Centaurus region. Originally inferred from anomalous bulk flows in the local universe, it is associated with the Norma Cluster (A3627) and surrounding massive clusters, many of which remain obscured by the Zone of Avoidance.

Hubble flow: The observed recession of galaxies due to the expansion of the universe, in which more distant galaxies recede at proportionally greater velocities. In large-scale kinematics, it serves as the cosmological baseline from which peculiar velocities are derived.

Intracluster medium (ICM): The hot, diffuse gas that pervades the space between galaxies within a cluster, typically heated to tens of millions of degrees and observable through X-ray emission. This is the medium responsible for ram-pressure stripping of gas from galaxies moving through cluster environments.

Peculiar velocity: The motion of a galaxy or group of galaxies relative to the CMB rest frame, representing its deviation from the Hubble flow caused by local and large-scale gravitational influences rather than cosmological expansion.

Ram-pressure stripping: A process in which a galaxy moving through the dense intracluster medium has its interstellar gas stripped away by the pressure of the encounter. It transforms gas-rich spiral galaxies into gas-poor systems, quenching star formation and producing characteristic "jellyfish" morphologies.

Sheet: A flattened, low-to-moderate-density, planar structure of relative quiescence where peculiar velocities are minimal, typically defining the interfacial boundaries of the cosmic web and often bordering voids.

Stream: A linear, often narrow, low-to-moderate-density procession of galaxy groups flowing coherently toward a larger structure.

Supercluster: A large-scale overdensity of galaxy groups and clusters, spanning tens to hundreds of millions of light-years, often serving as a sub-basin (or lobe) within a larger basin of attraction.

Supergalactic plane: A reference plane defined by the concentration of nearby clusters and superclusters that forms the equator of the supergalactic coordinate system.

Velocity dispersion: The range of velocities exhibited by galaxies within a gravitationally bound system, such as a group or cluster, reflecting the depth of the system's gravitational potential well. Higher velocity dispersions indicate more massive systems.

Velocity-watershed: An analytical method that identifies the kinematic boundaries separating adjacent basins of attraction by mapping where galaxy peculiar velocity flows diverge.

Virialization: The process by which a gravitationally bound system reaches a state of dynamical equilibrium, where the kinetic energy of its components balances the gravitational potential energy of the system. A virialized cluster has settled into a stable configuration; a partially virialized system is still actively assembling through mergers and accretion.

Void Boundary: A sparse region of very low density characterized not by its own internal structure, but by its proximity to a cosmic void.

Wall: A massive, high-density, planar structure with significant lateral extent perpendicular to the supergalactic plane, often serving as a boundary between superclusters or between superclusters and voids.

Zone of Avoidance (ZoA): The region of the sky where the Milky Way's galactic disc obscures observations of extragalactic objects behind it, affecting roughly 20% of the sky.

Appendix B – Field Guide Catalog

The Field Guide Catalog presents the complete contents of the Laniakea Basin as organized within this framework. Table B.1 provides a structural overview; Tables B.2—B.5 present the full galaxy-level catalog for each supercluster. Coordinates (J2000), heliocentric velocities, and morphological types are sourced from NED—with group distances based on the anchor galaxy's distance from NED-D; additional sources are indicated in the footnotes. An asterisk (*) denotes a satellite galaxy.

B.1 – Field Guide Catalog Overview

Region	Groups	Galaxies
VIRGO SUPERCLUSTER (~0-110 MLY)		
Local Sheet	6	37
Local Filament	9	47
Virgo Cluster	6	59
Southern Extension	7	42
Northern Cloud	9	51
Local Infall	5	25
Virgo Stream	5	33
Fornax Complex	8	66
Leo Association	8	43
Virgo Void Boundaries	11	40
HYDRA SUPERCLUSTER (~160 MLY)		
Antlia Stream	4	19
Antlia Cluster	3	17
Northern Filament	3	16
Hydra Cluster	3	13
Hydra Cloud	4	15
Hydra Field Galaxies	1	4
CENTAURUS SUPERCLUSTER (~170 MLY)		
Centaurus Wall	3	17
Centaurus Cluster	2	21
Hydra-Centaurus Stream	4	16
Norma Complex	4	29
Centaurus Field Galaxies	3	7
PAVO-INDUS SUPERCLUSTER (~220 MLY)		
Telescopium Cloud	6	28
Southern Filament	5	26
Pavo-Indus Complex	4	30
Microscopium Extension	3	10
Ara Association	1	3
Pavo-Indus Field Galaxies	1	4
TOTAL	128	718

B.2 – Virgo Supercluster

Galaxy	Alias	Type (RC3)	RA (J2000)	Dec (J2000)	v_Helio (km/s)
I. LOCAL SHEET					
Local Group (~2.5 Mly)					
Milky Way	—	SB(rs)bc	17 45 40.0	-29 00 28.1	-8
Large Magellanic Cloud*	LMC	SB(s)m	05 23 34.6	-69 45 22.0	278
Small Magellanic Cloud*	SMC	SB(s)m pec	00 52 44.8	-72 49 43.0	146
Andromeda	M31	SA(s)b	00 42 44.4	+41 16 08.6	-297
M110*	—	E5 pec	00 40 22.1	+41 41 07.4	-241
M32*	—	E2	00 42 41.9	+40 51 55.4	-213
Triangulum	M33	SA(s)cd	01 33 50.9	+30 39 36.8	-179
Maffei Group (~11 Mly)					
Maffei 1	—	S0	02 36 35.5	+59 39 17.7	66
Dwingeloo 1*	—	SB(s)cd	02 56 51.6	+58 54 42.0	110
Maffei 2	—	SAB(rs)bc	02 41 55.0	+59 36 14.6	-17
Hidden Galaxy	IC 342	SAB(rs)cd	03 46 48.5	+68 05 46.9	31
NGC 1560	—	SA(s)d	04 32 49.1	+71 52 59.2	-36
Sculptor Group (~11.4 Mly)					
Sculptor Galaxy	NGC 253	SAB(s)c	00 47 33.1	-25 17 17.1	242
NGC 247*	—	SAB(s)d	00 47 08.5	-20 45 36.7	174
NGC 7793*	—	SA(s)d	23 57 49.7	-32 35 27.6	224
String of Pearls Galaxy	NGC 55	SB(s)m	00 14 53.6	-39 11 47.7	131
Sculptor Pinwheel Galaxy	NGC 300	SA(s)d	00 54 53.5	-37 41 03.2	147
NGC 45	—	SA(s)dm	00 14 04.0	-23 10 55.4	467
M81 Group (~12 Mly)					
Bode's Galaxy	M81	SA(s)ab	09 55 33.2	+69 03 55.1	-39
NGC 2976*	—	SAc pec	09 47 15.3	+67 55 00.0	3
NGC 3077*	—	I0 pec	10 03 19.1	+68 44 02.1	14
Cigar Galaxy	M82	I0	09 55 52.9	+69 40 46.1	269
NGC 2403	—	SAB(s)cd	07 36 51.3	+65 36 09.7	133
NGC 4236	—	SB(s)dm	12 16 42.1	+69 27 45.3	82
Coddington's Nebula	IC 2574	SAB(s)m	10 28 23.4	+68 24 43.8	57
M83/Centaurus A Group (~14.7 Mly)					
Southern Pinwheel Galaxy	M83	SAB(s)c	13 37 01.0	-29 51 55.5	513
Centaurus A	NGC 5128	S0 pec	13 25 27.6	-43 01 08.8	547
Iota's Ghost*	NGC 5102	SA0	13 21 57.6	-36 37 48.9	466
NGC 4945	—	SB(s)cd	13 05 27.5	-49 28 04.9	563
Circinus	—	SA(s)b	14 13 10.0	-65 20 20.7	434
M94/Canes I Group (~16.7 Mly)					
Cat's Eye Galaxy	M94	(R)SA(r)ab	12 50 53.1	+41 07 13.7	308
Silver Needle Galaxy	NGC 4244	SA(s)cd	12 17 29.5	+37 48 26.5	244
NGC 4395	—	SA(s)m	12 25 48.9	+33 32 48.7	319
Black Eye Galaxy	M64	(R)SA(rs)ab	12 56 43.7	+21 40 58.8	409
NGC 4449	—	IBm	12 28 11.1	+44 05 37.2	207
NGC 4214	—	IAB(s)m	12 15 39.2	+36 19 36.8	291
IC 4182	—	SA(s)m	13 05 48.7	+37 36 13.0	321
II. LOCAL FILAMENT					
M101 Group (~21.7 Mly)					
Pinwheel Galaxy	M101	SAB(rs)cd	14 03 12.5	+54 20 56.2	241
NGC 5474*	—	SA(s)cd pec	14 05 01.6	+53 39 44.2	262
NGC 5477*	—	SA(s)m	14 05 33.3	+54 27 40.2	315
NGC 5204*	—	SA(s)m	13 29 36.5	+58 25 07.4	201

Galaxy	**Alias**	**Type (RC3)**	**RA (J2000)**	**Dec (J2000)**	**v_Helio (km/s)**
NGC 5585	—	SAB(s)d	14 19 48.2	+56 43 46.1	303
M106/Canes II Group (~23.7 Mly)					
M106	NGC 4258	SAB(s)bc	12 18 57.5	+47 18 14.3	461
NGC 4248*	—	I0	12 17 49.9	+47 24 33.0	482
Cocoon Galaxy	NGC 4490	SB(s)d pec	12 30 36.2	+41 38 38.0	565
NGC 4485*	—	IB(s)m pec	12 30 31.0	+41 42 01.4	418
NGC 4618	IC 3667	SB(rs)m	12 41 32.8	+41 09 03.6	544
NGC 4625*	IC 3675	SAB(rs)m pec	12 41 52.7	+41 16 26.4	621
NGC 4096	—	SAB(rs)c	12 06 01.1	+47 28 42.8	572
NGC 4217	—	Sb	12 15 50.9	+47 05 30.4	1028
M51 Group (~23.8 Mly)					
Whirlpool Galaxy	M51	SA(s)bc pec	13 29 56.2	+47 13 50.0	600
M51B*	NGC 5195	I0 pec	13 29 59.5	+47 15 58.2	455
Sunflower Galaxy	M63	SA(rs)bc	13 15 49.3	+42 01 45.6	500
NGC 5023	—	Scd	13 12 12.6	+44 02 28.4	407
NGC 4631 Group (~24 Mly)					
Whale Galaxy	NGC 4631	SB(s)d	12 42 07.7	+32 32 30.1	610
Hockey Stick Galaxy*	NGC 4656/57	SB(s)m pec	12 43 57.7	+32 10 05.3	646
NGC 4627*	—	E4 pec	12 41 59.7	+32 34 25.8	542
M66 Group/Leo Triplet (~31.4 Mly)					
M66	NGC 3627	SAB(s)b	11 20 15.0	+12 59 29.8	722
M65	NGC 3623	SAB(rs)a	11 18 55.9	+13 05 32.3	803
Hamburger Galaxy	NGC 3628	Sb pec	11 20 17.0	+13 35 21.9	846
M96/Leo I Group (~35.4 Mly)					
M96	NGC 3368	SAB(rs)ab	10 46 45.7	+11 49 12.0	888
M105	NGC 3379	E1	10 47 49.6	+12 34 53.8	907
NGC 3384*	NGC 3371	SB0	10 48 16.9	+12 37 45.5	704
M95	NGC 3351	SB(r)b	10 43 57.8	+11 42 13.5	779
NGC 3377	—	E5	10 47 42.3	+13 59 09.3	664
NGC 4565 Group (~38.2 Mly)					
Needle Galaxy	NGC 4565	SA(s)b	12 36 20.8	+25 59 15.7	1282
NGC 4725	—	SAB(r)ab pec	12 50 26.6	+25 30 02.8	1209
NGC 4747*	—	SBcd pec	12 51 45.9	+25 46 36.7	1190
Koi Fish Galaxy	NGC 4559	SAB(rs)cd	12 35 57.6	+27 57 35.9	814
NGC 4393	—	SABd	12 25 51.4	+27 33 44.0	751
NGC 4494	—	E1-2	12 31 24.1	+25 46 30.9	1342
NGC 4455	—	SB(s)d	12 28 44.1	+22 49 13.6	644
NGC 5033 Group (~53.7 Mly)					
NGC 5033	—	SA(s)c	13 13 27.5	+36 35 38.1	873
NGC 5014*	—	Sa	13 11 31.2	+36 16 55.2	1135
NGC 5005	Caldwell 29	SAB(rs)bc	13 10 56.3	+37 03 32.6	946
NGC 5112	—	SB(rs)cd	13 21 56.4	+38 44 04.5	974
Coma I Group (~55.3 Mly)					
NGC 4278	—	E1-2	12 20 06.8	+29 16 50.7	649
NGC 4283*	—	E0	12 20 20.9	+29 18 39.4	1056
NGC 4274	—	(R)SB(r)ab	12 19 50.6	+29 36 52.9	930
NGC 4448	—	SB(r)ab	12 28 15.4	+28 37 13.2	658
NGC 4314	—	SB(rs)a	12 22 31.8	+29 53 45.2	963
NGC 4245	—	SB0	12 17 36.8	+29 36 28.8	869
NGC 4251	—	SB0	12 18 08.3	+28 10 31.3	1066
NGC 4286	IC 3181	SA0	12 20 42.1	+29 20 45.2	637
III. VIRGO CLUSTER					
Virgo A/M87 Subgroup (~54.7 Mly)					
Virgo A	M87	cD0	12 30 49.4	+12 23 28.0	1284
NGC 4478*	—	E2	12 30 17.4	+12 19 43.2	1349

Galaxy	**Alias**	**Type (RC3)**	**RA (J2000)**	**Dec (J2000)**	**v_Helio (km/s)**
NGC 4476*	—	SA0	12 29 59.1	+12 20 55.5	1960
M90	NGC 4569	SAB(rs)ab	12 36 49.8	+13 09 46.6	-235
IC 3583*	—	IBm	12 36 43.5	+13 15 33.6	1121
M58	NGC 4579	SAB(rs)b	12 37 43.5	+11 49 05.5	1517
M91	NGC 4548	SB(rs)b	12 35 26.5	+14 29 46.9	486
M89	NGC 4552	E0-1	12 35 39.8	+12 33 22.8	340
M88	NGC 4501	SA(rs)b	12 31 59.2	+14 25 13.0	2284
Silver Streak Galaxy	NGC 4216	SAB(s)b	12 15 54.4	+13 08 58.1	131
NGC 4206*	IC 3064	SA(s)bc	12 15 16.8	+13 01 26.4	703
NGC 4222*	—	Sd	12 16 22.5	+13 18 24.7	230
Siamese Twins	NGC 4567	SA(rs)bc	12 36 32.7	+11 15 29.0	2247
Siamese Twins	NGC 4568	SA(rs)bc	12 36 34.3	+11 14 20.5	2232
NGC 4429	—	SA0	12 27 26.5	+11 06 27.5	1104
NGC 4596	—	SB0	12 39 56.0	+10 10 34.3	1892
NGC 4371	—	SB0	12 24 55.4	+11 42 15.0	933
NGC 4571	IC 3588	SA(r)d	12 36 56.4	+14 13 02.6	332
NGC 4550	—	SB0	12 35 30.6	+12 13 15.0	459
Markarian's Chain/M86 Subgroup (~53.4 Mly)					
M86	NGC 4406	E3	12 26 11.8	+12 56 46.3	-224
M84	NGC 4374	E1	12 25 03.7	+12 53 13.1	1017
The Eyes	NGC 4438	SA0	12 27 45.7	+13 00 32.0	71
The Eyes	NGC 4435	SB0	12 27 40.5	+13 04 44.5	791
NGC 4388	—	SA(s)b	12 25 46.8	+12 39 43.8	2524
NGC 4461	NGC 4443	SB0	12 29 03.0	+13 11 01.8	1924
NGC 4473	—	E5	12 29 48.9	+13 25 45.9	2244
NGC 4477	—	SB0	12 30 02.2	+13 38 11.5	1338
NGC 4459	—	SA0	12 29 00.0	+13 58 42.9	1192
NGC 4402	—	Sb	12 26 07.7	+13 06 48.0	237
Virgo B/M49 Subgroup (~52.4 Mly)					
M49	NGC 4472	E2	12 29 46.8	+08 00 01.7	981
NGC 4467*	—	E2	12 29 30.3	+07 59 34.3	1390
NGC 4464*	—	E3	12 29 21.3	+08 09 24.0	1243
Lost Galaxy	NGC 4535	SAB(s)c	12 34 20.3	+08 11 52.5	1964
NGC 4526	NGC 4560	SAB0	12 34 03.0	+07 41 56.9	617
NGC 4442	—	SB0	12 28 03.9	+09 48 13.3	547
NGC 4570	—	S0	12 36 53.4	+07 14 47.6	1787
Southern Cloud/M61 Subgroup (~52.5 Mly)					
Swelling Spiral Galaxy	M61	SAB(rs)bc	12 21 54.9	+04 28 25.6	1566
NGC 4527	—	SAB(s)bc	12 34 08.5	+02 39 14.4	1736
NGC 4536	—	SAB(rs)bc	12 34 27.1	+02 11 17.7	1808
Virgo C/M60 Subgroup (~52.8 Mly)					
M60	NGC 4649	E2	12 43 40.0	+11 33 09.4	1110
NGC 4647*	—	SAB(rs)c	12 43 32.3	+11 34 58.0	1409
NGC 4638*	NGC 4667	S0	12 42 47.4	+11 26 33.1	1152
M59	NGC 4621	E5	12 42 02.3	+11 38 49.0	467
Paper Kite Galaxy	NGC 4762	SB0	12 52 56.0	+11 13 51.5	986
NGC 4754	—	SB0	12 52 17.5	+11 18 49.9	1351
NGC 4654	—	SAB(rs)cd	12 43 56.6	+13 07 35.7	1036
NGC 4698	—	SA(s)ab	12 48 22.9	+08 29 14.5	1009
NGC 4606	—	SB(s)a	12 40 57.6	+11 54 43.2	1649
NGC 4607*	—	SBb	12 41 12.4	+11 53 12.5	2259
Northern Cloud/M100 Subgroup (~52.6 Mly)					
Mirror Galaxy	M100	SAB(s)bc	12 22 54.9	+15 49 17.9	1571
NGC 4328*	—	SA0	12 23 20.0	+15 49 13.4	484
NGC 4323*	—	SB0	12 23 01.7	+15 54 19.8	1820

Galaxy	**Alias**	**Type (RC3)**	**RA (J2000)**	**Dec (J2000)**	**v_Helio (km/s)**
M98	NGC 4192	SAB(s)ab	12 13 48.3	+14 54 01.9	-142
St. Catherine’s Wheel	M99	SA(s)c	12 18 49.6	+14 24 59.4	2406
M85	NGC 4382	SA0	12 25 24.1	+18 11 27.9	729
NGC 4394*	—	(R)SB(r)b	12 25 55.6	+18 12 50.2	922
NGC 4293	—	(R)SB0	12 21 12.8	+18 22 57.3	900
NGC 4450	—	SA(s)ab	12 28 29.6	+17 05 06.1	1956
Umbrella Galaxy	NGC 4651	SA(rs)c	12 43 42.7	+16 23 36.2	800
IV. SOUTHERN EXTENSION					
NGC 4753 Group (~60 Mly)					
NGC 4753	—	I0	12 52 22.1	-01 11 58.6	1163
NGC 4636	—	E0-1	12 42 49.8	+02 41 16.1	938
NGC 4665*	NGC 4624	SB0	12 45 06.0	+03 03 20.9	912
NGC 4600*	—	S0	12 40 23.0	+03 07 04.0	836
NGC 4643	—	SB0	12 43 20.2	+01 58 41.7	1333
NGC 4856	—	SB0	12 59 21.3	-15 02 31.2	1353
NGC 4179	—	S0	12 12 52.1	+01 17 58.9	1300
NGC 4845	NGC 4910	SA(s)ab	12 58 01.2	+01 34 32.4	1098
NGC 4984*	—	(R)SAB0	13 08 57.3	-15 30 58.7	1279
NGC 4772	—	SA(s)a	12 53 29.2	+02 10 06.2	1040
NGC 4900	—	SB(rs)c	13 00 39.3	+02 30 02.7	963
NGC 4691	—	(R)SB0	12 48 13.6	-03 19 57.7	1120
NGC 4699 Group (~64.1 Mly)					
NGC 4699	—	SAB(rs)b	12 49 02.2	-08 39 51.9	1394
NGC 4781	—	SB(rs)d	12 54 23.8	-10 32 13.7	1260
NGC 4700	—	SB(s)c	12 49 08.2	-11 24 34.8	1409
NGC 4818	—	SAB(rs)ab	12 56 48.9	-08 31 30.9	1065
NGC 4790	—	SB(rs)c	12 54 52.0	-10 14 52.2	1344
NGC 4722	IC 3833	SB0	12 51 32.4	-13 19 48.0	1312
NGC 4038 Group (~68.7 Mly)					
Antennae Galaxies	NGC 4038	SB(s)m pec	12 01 53.0	-18 52 03.5	1624
Antennae Galaxies	NGC 4039	SA(s)m pec	12 01 53.5	-18 53 10.3	1641
NGC 4030	—	SA(s)bc	12 00 23.6	-01 06 00.2	1458
NGC 3981	—	SA(rs)bc	11 56 07.5	-19 53 45.2	1723
NGC 4027	—	SB(s)dm	11 59 30.1	-19 15 55.1	1671
NGC 4027A*	—	IB(s)m	11 59 29.3	-19 19 59.5	1700
NGC 4033	—	E6	12 00 34.8	-17 50 33.4	1617
NGC 3672 Group (~80.4 Mly)					
NGC 3672	—	SA(s)c	11 25 02.5	-09 47 42.9	1871
NGC 3636	—	E0	11 20 25.1	-10 16 54.0	1791
NGC 3637	—	(R)SB0	11 20 39.6	-10 15 26.1	1846
M104 Group (~36.6 Mly)					
Sombrero Galaxy	M104	SA(s)a	12 39 59.4	-11 37 23.1	1089
NGC 4487	—	SAB(rs)cd	12 31 04.4	-08 03 14.1	1036
NGC 4504	—	SA(s)cd	12 32 17.4	-07 33 48.9	998
NGC 4802	NGC 4804	SA0	12 55 49.7	-12 03 18.7	941
NGC 4697 Group (~38.5 Mly)					
NGC 4697	Caldwell 52	E6	12 48 35.9	-05 48 02.3	1241
NGC 4731	—	SB(s)cd	12 51 01.1	-06 23 35.0	1491
NGC 4731A*	—	Im pec	12 51 13.4	-06 33 33.4	1514
NGC 4958	—	SB0	13 05 48.9	-08 01 12.8	1455
NGC 4775	—	SA(s)d	12 53 45.7	-06 37 20.7	1566
NGC 4941	—	(R)SAB(r)ab	13 04 13.1	-05 33 05.7	1132
NGC 4951	—	SAB(rs)cd	13 05 07.7	-06 29 37.8	1177
NGC 5084 Group (~62.1 Mly)					
NGC 5084	—	S0	13 20 16.8	-21 49 38.4	1721

Galaxy	Alias	Type (RC3)	RA (J2000)	Dec (J2000)	v_Helio (km/s)
NGC 5087	—	SA0	13 20 25.0	-20 36 39.3	1858
NGC 5134	—	SA(s)b	13 25 18.5	-21 08 03.1	1758
V. NORTHERN CLOUD					
NGC 3631 Group (~30.7 Mly)					
NGC 3631	—	SA(s)c	11 21 02.9	+53 10 11.0	1151
NGC 3913*	IC 740	(R)SA(rs)d	11 50 38.9	+55 21 13.9	955
NGC 3657*	—	SAB(rs) c pec	11 23 55.6	+52 55 15.4	1217
NGC 3972	—	SA(s)bc	11 55 45.1	+55 19 14.1	842
NGC 4111 Group (~39.4 Mly)					
NGC 4111	—	SA0	12 07 03.1	+43 03 56.5	788
IC 750*	—	Sab	11 58 52.3	+42 43 20.6	701
NGC 4117*	—	S0	12 07 46.1	+43 07 34.9	934
NGC 4051	—	SAB(rs)bc	12 03 09.6	+44 31 52.7	700
NGC 3938	—	SA(s)c	11 52 49.4	+44 07 14.8	808
NGC 4013	—	Sb	11 58 31.3	+43 56 50.7	831
NGC 4143	—	SAB0	12 09 36.1	+42 32 03.2	946
NGC 4157 Group (~55.8 Mly)					
NGC 4157	—	SAB(s)b	12 11 04.4	+50 29 06.0	771
NGC 4088	—	SAB(rs)bc	12 05 34.3	+50 32 21.8	746
NGC 4085*	—	SAB(s)c	12 05 22.7	+50 21 10.3	760
M109 Group (~67.2 Mly)					
Vacuum Cleaner Galaxy	M109	SB(rs)bc	11 57 36.0	+53 22 29.0	1047
NGC 3928*	—	SA(s)b	11 51 47.6	+48 40 59.7	978
NGC 3953	—	SB(r)bc	11 53 49.0	+52 19 36.5	1050
NGC 3998	—	SA0	11 57 56.1	+55 27 12.9	1020
NGC 3990*	—	S0	11 57 35.6	+55 27 31.5	690
NGC 3917	—	SAcd	11 50 45.5	+51 49 28.6	965
NGC 3982	—	SAB(r)b	11 56 28.1	+55 07 30.8	1122
NGC 3893	—	SAB(rs)c	11 48 38.2	+48 42 39.2	967
NGC 3896*	—	SB0 pec	11 48 56.5	+48 40 28.3	922
NGC 3877	—	SA(s)c	11 46 07.7	+47 29 40.4	895
NGC 3726	—	SAB(r)c	11 33 21.1	+47 01 45.2	864
NGC 3718	—	SB(s)a pec	11 32 34.9	+53 04 04.5	993
NGC 3729*	—	SB(r)a pec	11 33 49.4	+53 07 32.0	1000
NGC 4026	—	S0	11 59 25.1	+50 57 42.0	986
NGC 4100	—	(R)SA(rs)bc	12 06 08.5	+49 34 57.0	1074
NGC 3949	—	SA(s)bc	11 53 41.8	+47 51 31.4	794
NGC 4102	—	SAB(s)b	12 06 23.1	+52 42 39.7	785
NGC 5866 Group (~49.9 Mly)					
Spindle Galaxy	NGC 5866	SA0	15 06 29.5	+55 45 47.6	755
Splinter Galaxy	NGC 5907	SA(s)c	15 15 53.2	+56 19 47.6	665
NGC 5879	—	SA(rs)bc	15 09 46.7	+57 00 00.9	770
NGC 5963	—	S pec	15 33 27.9	+56 33 35.1	656
NGC 2841 Group (~53.3 Mly)					
NGC 2841	—	SA(r)b	09 22 02.7	+50 58 35.8	635
NGC 2541	—	SA(s)cd	08 14 40.2	+49 03 43.0	548
Bear Paw Galaxy	NGC 2537	SB(s)m pec	08 13 14.7	+45 59 24.0	431
Little Pinwheel Galaxy	NGC 3184	SAB(rs)cd	10 18 16.9	+41 25 27.4	582
NGC 3198	—	SB(rs)c	10 19 55.0	+45 32 59.3	660
NGC 3079 Group (~53.6 Mly)					
NGC 3079	—	SB(s)c	10 01 57.9	+55 40 46.9	1106
NGC 3073*	—	SAB0	10 00 52.1	+55 37 07.7	1128
NGC 3359	—	SB(rs)c	10 46 36.8	+63 13 27.2	1014
NGC 2768 Group (~66.7 Mly)					
NGC 2768	—	E6	09 11 37.5	+60 02 14.0	1353

Galaxy	**Alias**	**Type (RC3)**	**RA (J2000)**	**Dec (J2000)**	**v_Helio (km/s)**
NGC 2742	NGC 2816	SA(s)c	09 07 33.6	+60 28 45.6	1292
NGC 2726	—	Sa	09 04 56.8	+59 55 58.7	1555
NGC 2654	—	SBab	08 49 11.8	+60 13 16.4	1339
NGC 2985 Group (~70.1 Mly)					
NGC 2985	—	(R)SA(rs)ab	09 50 22.2	+72 16 43.1	1324
NGC 3027	—	SB(rs)d	09 55 40.3	+72 12 13.4	1060
NGC 3252	—	SBd	10 34 23.2	+73 45 53.0	1156
NGC 3403	—	SAbc	10 53 54.9	+73 41 25.4	1261
VI. LOCAL INFALL					
NGC 6744 Group (~23.6 Mly)					
NGC 6744	Caldwell 101	SAB(r)bc	19 09 46.2	-63 51 27.0	841
NGC 6744A*[5]	—	IB(s)m	19 08 43.8	-63 43 49.8	765
NGC 6684	—	(R)SB0	18 48 57.9	-65 10 24.4	883
IC 4710	—	SB(s)m	18 28 38.0	-66 58 56.2	739
NGC 6221 Group (~36.7 Mly)					
NGC 6221	—	SB(s)c	16 52 46.1	-59 13 04.0	1499
NGC 6215	—	SA(s)c	16 51 06.8	-58 59 35.4	1564
NGC 6300	—	SB(rs)b	17 16 59.6	-62 49 14.0	1109
NGC 7582 Group/Grus Quartet (~69.2 Mly)					
NGC 7582	—	(R)SB(s)ab	23 18 23.6	-42 22 13.5	1622
NGC 7552	IC 5294	(R)SB(s)ab	23 16 10.7	-42 35 04.9	1608
NGC 7590	—	SA(rs)bc	23 18 54.8	-42 14 20.6	1575
NGC 7599	—	SA(s)c	23 19 21.1	-42 15 25.2	1651
NGC 7496	—	SB(s)b	23 09 47.3	-43 25 40.3	1639
NGC 7632	IC 5313	(R)SB0	23 22 00.9	-42 28 49.9	1535
NGC 7531	—	SAB®bc	23 14 48.5	-43 35 59.3	1596
NGC 7232 Group (~72.7 Mly)					
NGC 7232	—	SB(rs)a	22 15 38.0	-45 51 00.2	1915
NGC 7233	—	SAB0	22 15 49.0	-45 50 47.8	1841
NGC 7213	—	SA(s)a	22 09 16.3	-47 10 00.3	1750
IC 5181	—	SA0	22 13 21.7	-46 01 03.2	1987
IC 1459 Group (~85.4 Mly)					
IC 1459	IC 5265	E3-4	22 57 10.6	-36 27 44.0	1802
IC 5267	—	SA0	22 57 13.5	-43 23 45.2	1712
NGC 7410	—	SB(s)a	22 55 00.9	-39 39 41.0	1790
IC 5269	—	SAB0	22 57 43.7	-36 01 34.4	1967
IC 5269B*	—	SB(rs)cd	22 56 36.7	-36 14 59.7	1667
NGC 7418	—	SAB(rs)cd	22 56 36.1	-37 01 47.8	1450
NGC 7421	—	SB(rs)bc	22 56 54.4	-37 20 50.3	1792
VII. VIRGO STREAM					
NGC 5364 Group (~52.9 Mly)					
NGC 5364	NGC 5317	SA(rs)bc pec	13 56 12.0	+05 00 53.4	1267
NGC 5363	—	I0	13 56 07.2	+05 15 17.2	1139
NGC 5338*	—	SB0	13 53 26.6	+05 12 27.7	810
NGC 5300	—	SAB(r)c	13 48 16.0	+03 57 03.1	1171
NGC 5356	—	SABbc	13 54 58.4	+05 20 01.1	1371
NGC 5248	Caldwell 45	SAB(rs)bc	13 37 32.0	+08 53 06.9	1151
NGC 5566 Group (~65.5 Mly)					
NGC 5566	—	SB(r)ab	14 20 19.9	+03 56 01.7	1507
NGC 5560*	—	SB(s)b pec	14 20 04.5	+03 59 33.8	1729
NGC 5569*	—	SAB(rs)cd	14 20 32.1	+03 58 59.6	1772
NGC 5576	—	E3	14 21 03.7	+03 16 15.4	1506
NGC 5574*	—	SB0	14 20 56.0	+03 14 17.0	1583

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[5] Heliocentric velocity for NGC 6744A from Ryder et al. (1999); not available in NED.

Galaxy	**Alias**	**Type (RC3)**	**RA (J2000)**	**Dec (J2000)**	**v_Helio (km/s)**
NGC 5577	—	SA(rs)bc	14 21 13.1	+03 26 09.3	1489
NGC 5806 Group (~80.3 Mly)					
NGC 5806	—	SAB(s)b	15 00 00.4	+01 53 28.8	1347
NGC 5838	—	SA0	15 05 26.2	+02 05 57.3	1252
NGC 5839*	—	SAB0	15 05 27.5	+01 38 05.3	1220
NGC 5746 Group (~86 Mly)					
Mini Sombrero Galaxy	NGC 5746	SAB(rs)b	14 44 55.9	+01 57 18.0	1728
NGC 5701	—	(R)SB0	14 39 11.1	+05 21 48.7	1505
NGC 5705*	—	SB(rs)d	14 39 49.8	-00 43 06.5	1773
NGC 5740	—	SAB(rs)b	14 44 24.4	+01 40 47.3	1566
NGC 5713	—	SAB(rs)bc pec	14 40 11.5	-00 17 20.1	1883
NGC 5719	—	SAB(s)ab pec	14 40 56.4	-00 19 05.8	1733
NGC 5750	—	SB0	14 46 11.1	-00 13 22.7	1659
NGC 5638	—	E1	14 29 40.4	+03 13 59.8	1676
NGC 5636*	—	SAB0	14 29 39.0	+03 15 58.9	1644
NGC 5668	—	SA(s)d	14 33 24.3	+04 27 01.8	1583
NGC 5691	—	SAB(s)a pec	14 37 53.4	-00 23 56.6	1870
NGC 5846 Group (~93.8 Mly)					
NGC 5846	—	E0-1	15 06 29.2	+01 36 22.6	1712
NGC 5846A*	—	E2	15 06 29.2	+01 35 41.9	2197
NGC 5813	—	E1-2	15 01 11.2	+01 42 07.1	1956
NGC 5831	—	E3	15 04 07.0	+01 13 11.8	1630
NGC 5854	—	SB0	15 07 47.7	+02 34 07.1	1663
NGC 5864	—	SB0	15 09 33.6	+03 03 10.1	1885
NGC 5869	—	S0	15 09 49.4	+00 28 12.5	2085
VIII. FORNAX COMPLEX					
NGC 1433 Group (~29.5 Mly)					
NGC 1433	—	(R)SB(r)ab	03 42 01.5	-47 13 17.8	1076
NGC 1448	NGC 1457	SAcd	03 44 31.9	-44 38 41.2	1168
NGC 1527	—	SAB0	04 08 24.1	-47 53 48.8	1212
NGC 1495	—	Sc	03 58 21.9	-44 27 58.9	1284
NGC 1494	—	SAB(s)d	03 57 43.0	-48 54 28.0	1131
NGC 1493	—	SB(r)cd	03 57 27.5	-46 12 38.6	1053
NGC 1411	IC 1943	SA0	03 38 44.9	-44 06 02.1	983
NGC 1512 Group (~40.7 Mly)					
NGC 1512	—	SB(r)a	04 03 54.2	-43 20 55.7	898
NGC 1510*	—	SA0	04 03 32.7	-43 23 59.9	913
NGC 1487	—	Pec	03 55 47.8	-42 21 49.1	848
NGC 1232 Group (~50.3 Mly)					
The Eye of God	NGC 1232	SAB(rs)c	03 09 45.4	-20 34 44.4	1603
NGC 1300	—	SB(rs)bc	03 19 41.0	-19 24 40.2	1578
NGC 1297*	—	SAB0	03 19 14.2	-19 06 00.4	1586
NGC 1187	—	SB(r)c	03 02 37.6	-22 52 01.6	1390
Dorado Group (~54 Mly)					
Spanish Dancer	NGC 1566	SAB(s)bc	04 20 00.4	-54 56 16.6	1504
NGC 1553	—	SA0	04 16 10.4	-55 46 48.0	1080
NGC 1549	—	E0-1	04 15 45.1	-55 35 31.9	1256
NGC 1543	—	(R)SB0	04 12 43.2	-57 44 16.4	1176
NGC 1546	—	SA0	04 14 36.4	-56 03 39.7	1284
NGC 1533	—	SB0	04 09 51.8	-56 07 06.4	790
NGC 1536*	—	SB(s)c	04 10 60.0	-56 28 50.7	1217
NGC 1515	—	SAB(s)bc	04 04 02.7	-54 06 00.6	1175
NGC 1574	—	SA0	04 21 58.8	-56 58 28.2	1041
IC 2056	—	(R)SAB(r)bc	04 16 24.5	-60 12 23.5	1133
NGC 1672	—	SB(s)b	04 45 42.5	-59 14 50.2	1331

Galaxy	**Alias**	**Type (RC3)**	**RA (J2000)**	**Dec (J2000)**	**v_Helio (km/s)**
NGC 1617	—	SB(s)a	04 31 39.4	-54 36 07.5	1069
NGC 1596	—	SA0	04 27 38.1	-55 01 39.7	1510
NGC 1602*	—	IB(s)m	04 27 54.9	-55 03 27.8	1568
Fornax Cluster (~57.8 Mly)					
NGC 1399	—	E1 pec	03 38 29.0	-35 27 00.7	1425
NGC 1404*	—	E1	03 38 51.9	-35 35 38.8	1933
Great Barred Spiral	NGC 1365	SB(s)b	03 33 36.4	-36 08 24.7	1636
NGC 1380	—	SA0	03 36 27.6	-34 58 33.7	1878
NGC 1344	NGC 1340	E5	03 28 19.6	-31 04 05.3	1241
NGC 1350	—	(R)SB(r)ab	03 31 08.1	-33 37 42.0	1905
NGC 1386	—	SB0	03 36 46.3	-35 59 58.0	915
NGC 1381	—	SA0	03 36 31.7	-35 17 42.5	1743
NGC 1387	—	SAB0	03 36 57.0	-35 30 23.5	1303
NGC 1425	—	SA(s)b	03 42 11.5	-29 53 36.3	1512
NGC 1427	—	cD	03 42 19.4	-35 23 33.0	1434
NGC 1427A*	—	IB(s)m	03 40 09.0	-35 37 34.0	2028
Fornax A	NGC 1316	SAB0	03 22 41.7	-37 12 28.6	1802
NGC 1317	NGC 1318	SAB(r)a	03 22 44.3	-37 06 12.9	1941
NGC 1326	—	(R)SB0	03 23 56.4	-36 27 52.2	1360
NGC 1341	—	SAB(s)ab	03 27 58.4	-37 09 00.9	1876
NGC 1310	—	SA(s)c	03 21 03.4	-37 06 06.3	1805
NGC 1532 Group (~58.3 Mly)					
Haley's Coronet	NGC 1532	SB(s)b pec	04 12 04.3	-32 52 26.8	1040
NGC 1531*	—	S0	04 11 59.3	-32 51 03.4	1190
NGC 1537	—	SAB0	04 13 40.7	-31 38 42.7	1429
NGC 2442 Group (~68.5 Mly)					
Meathook Galaxy	NGC 2442/43	SAB(s)bc pec	07 36 23.8	-69 31 50.9	1466
NGC 2434	—	E0-1	07 34 51.2	-69 17 02.8	1390
NGC 2397	—	SB(s)b	07 21 19.9	-69 00 04.9	1355
Eridanus Cluster (~74.3 Mly)					
NGC 1395	—	E2	03 38 29.9	-23 01 38.9	1717
NGC 1332	—	S0	03 26 17.2	-21 20 06.6	1619
NGC 1325	—	SA(s)bc	03 24 25.6	-21 32 38.4	1591
NGC 1415	IC 1983	(R)SAB0	03 40 56.9	-22 33 52.5	1552
NGC 1353	—	SB(rs)b	03 32 03.0	-20 49 08.1	1525
NGC 1426	—	E4	03 42 49.1	-22 06 30.0	1443
NGC 1439	—	E1	03 44 49.9	-21 55 14.3	1667
NGC 1371	NGC 1367	SAB(rs)a	03 35 01.4	-24 55 59.6	1463
NGC 1385	—	SB(s)cd	03 37 29.0	-24 29 60.0	1497
Eridanus A	NGC 1407	E0	03 40 11.8	-18 34 48.2	1779
NGC 1398	—	(R)SB(r)ab	03 38 52.1	-26 20 15.6	1396
NGC 1400	—	SA0	03 39 30.8	-18 41 17.5	590
NGC 1482	—	SA0	03 54 39.0	-20 30 08.0	1916
NGC 1452	NGC 1455	(R)SB0	03 45 22.3	-18 37 59.8	1737
NGC 1359	—	SB(s)m	03 33 47.8	-19 29 32.0	1973
IX. LEO ASSOCIATION					
NGC 3227 Group (~61.2 Mly)					
NGC 3227	—	SAB(s)a pec	10 23 30.6	+19 51 54.3	1126
NGC 3226*	—	E2 pec	10 23 27.0	+19 53 54.8	1315
NGC 3190	NGC 3189	SA(s)a pec	10 18 05.6	+21 49 56.0	1310
NGC 3187*	—	SB(s)c pec	10 17 47.9	+21 52 24.0	1586
NGC 3193	—	E2	10 18 24.9	+21 53 38.6	1381
NGC 3185	—	(R)SB(r)a	10 17 38.6	+21 41 17.6	1230
NGC 3162	NGC 3575	SAB(rs)bc	10 13 31.6	+22 44 15.2	1302
NGC 3301	—	(R)SB0	10 36 56.1	+21 52 55.7	1339

Galaxy	Alias	Type (RC3)	RA (J2000)	Dec (J2000)	v_Helio (km/s)
NGC 3607/3686 Group (~69.8 Mly)					
NGC 3607	—	SA0	11 16 54.7	+18 03 06.4	930
NGC 3605*	—	E4-5	11 16 46.6	+18 01 02.0	642
NGC 3608	—	E2	11 16 59.0	+18 08 55.4	1253
NGC 3686	—	SB(s)bc	11 27 44.0	+17 13 27.1	1157
NGC 3626	NGC 3632	(R)SA0	11 20 03.8	+18 21 24.6	1494
NGC 3684	—	SA(rs)bc	11 27 11.2	+17 01 48.5	1163
NGC 3681	—	SAB(r)bc	11 26 29.8	+16 51 48.4	1232
NGC 3338 Group (~73.3 Mly)					
NGC 3338	—	SA(s)c	10 42 07.5	+13 44 49.4	1300
NGC 3346	—	SB(rs)cd	10 43 38.9	+14 52 18.9	1274
NGC 3389	NGC 3373	SA(s)c	10 48 27.9	+12 31 59.9	1303
NGC 3169 Group (~73.4 Mly)					
NGC 3169	—	SA(s)a pec	10 14 15.1	+03 27 57.9	1232
NGC 3165*	—	SA(s)dm	10 13 31.3	+03 22 30.0	1310
NGC 3166	—	SAB0	10 13 45.7	+03 25 29.3	1183
NGC 3156	—	S0	10 12 41.3	+03 07 45.8	1338
NGC 3640 Group (~74.7 Mly)					
NGC 3640	—	E3	11 21 06.8	+03 14 05.7	1298
NGC 3641*	—	E pec	11 21 08.8	+03 11 40.5	1780
NGC 3630	NGC 3645	S0	11 20 17.0	+02 57 52.0	1499
NGC 3604	NGC 3611	SA(s)a pec	11 17 30.2	+04 33 20.1	1565
NGC 3664	—	SB(s)m pec	11 24 24.2	+03 19 30.6	1382
NGC 3664A*	—	(R)SB(s)m	11 24 25.2	+03 13 18.9	1326
NGC 3370 Group (~86.1 Mly)					
NGC 3370	—	SA(s)c	10 47 04.1	+17 16 25.6	1281
NGC 3455	—	(R)SAB(rs)b	10 54 31.1	+17 17 04.6	1105
NGC 3454	—	SB(s)c	10 54 29.5	+17 20 37.5	1101
NGC 3443	—	Sad	10 53 00.2	+17 34 26.5	1132
NGC 3504 Group (~86.4 Mly)					
NGC 3504	—	(R)SAB(s)ab	11 03 11.2	+27 58 21.3	1521
NGC 3414	—	S0 pec	10 51 16.2	+27 58 30.3	1470
NGC 3512	—	SAB(rs)c	11 04 03.0	+28 02 12.9	1373
NGC 3451	—	Sd	10 54 20.9	+27 14 23.2	1332
NGC 3254/3245 Group (~94.8 Mly)					
NGC 3254	—	SA(s)bc	10 29 20.0	+29 29 30.6	1355
NGC 3245	—	SA0	10 27 18.4	+28 30 26.6	1326
NGC 3277	—	SA(r)ab	10 32 55.5	+28 30 42.4	1415
NGC 3395	IC 2613	SAB(rs)cd	10 49 50.1	+32 58 57.8	1617
NGC 3396*	—	IBm pec	10 49 55.1	+32 59 27.0	1660
NGC 3430	—	SAB(rs)c	10 52 11.4	+32 57 01.4	1586
NGC 3424	—	SB(s)b	10 51 46.3	+32 54 02.7	1494
X. VIRGO VOID BOUNDARIES					
Local Void Boundary					
M74 Group (~31 Mly)					
Phantom Galaxy	M74	SA(s)c	01 36 41.8	+15 47 01.3	657
NGC 660	—	SB(s)a pec	01 43 02.4	+13 38 42.1	848
NGC 1023 Group (~31.6 Mly)					
NGC 1023	—	SB0	02 40 24.0	+39 03 47.9	636
Outer Limits Galaxy	NGC 891	SA(s)b	02 22 32.9	+42 20 54.0	528
NGC 925	—	SAB(s)d	02 27 16.8	+33 34 44.9	553
NGC 1003	—	SA(s)cd	02 39 17.0	+40 52 21.3	624
IC 239	—	SAB(rs)cd	02 36 27.8	+38 58 09.1	893
Local Field Galaxies					
Fireworks Galaxy	NGC 6946	SAB(rs)cd	20 34 52.3	+60 09 14.1	40

Galaxy	**Alias**	**Type (RC3)**	**RA (J2000)**	**Dec (J2000)**	**v_Helio (km/s)**
NGC 7331	Caldwell 30	SA(s)b	22 37 04.1	+34 24 56.7	816
Dusty Hand Galaxy	NGC 2146	SA(s)ab pec	06 18 37.7	+78 21 25.3	899
NGC 7217	—	(R)SA(r)ab	22 07 52.4	+31 21 33.7	945
NGC 4605	—	SB(s)c pec	12 39 59.3	+61 36 33.4	157
Lost-in-Space Galaxy (~19.4 Mly)					
Lost-in-Space Galaxy	NGC 6503	SA(s)cd	17 49 26.4	+70 08 39.6	25
Sculptor Void Boundary					
M77 Group (~34.5 Mly)					
Squid Galaxy	M77	(R)SA(rs)b	02 42 40.7	-00 00 47.8	1137
NGC 1055	—	SBb	02 41 45.2	+00 26 36.0	996
NGC 1073	—	SB(rs)c	02 43 40.5	+01 22 34.1	1203
NGC 134 Group (~54.9 Mly)					
NGC 134	—	SAB(s)bc	00 30 22.0	-33 14 38.3	1582
NGC 131*	—	SB(s)b	00 29 38.5	-33 15 35.5	1410
NGC 115	—	SB(s)bc	00 26 46.3	-33 40 37.1	1831
NGC 148	—	S0	00 34 15.5	-31 47 09.5	1867
Sculptor Field Galaxies					
NGC 3621	—	SA(s)d	11 18 16.5	-32 48 49.7	720
Bubble Galaxy	NGC 3521	SAB(rs)bc	11 05 48.6	-00 02 09.1	799
NGC 2997	—	SAB(rs)c	09 45 38.8	-31 11 27.3	1089
NGC 5068	—	SAB(rs)cd	13 18 54.8	-21 02 19.7	670
NGC 3115	Caldwell 53	S0	10 05 14.0	-07 43 06.9	686
NGC 5643	—	SAB(rs)c	14 32 40.7	-44 10 28.0	1199
Topsy Turvy Galaxy (~15.1 Mly)					
Topsy Turvy Galaxy	NGC 1313	SB(s)d	03 18 16.1	-66 29 53.7	470
Northern Void Boundary					
NGC 2775 Group (~50.6 Mly)					
NGC 2775	Caldwell 48	SA(r)ab	09 10 20.1	+07 02 17.1	1349
NGC 2777*	—	Sab	09 10 41.9	+07 12 24.2	1471
NGC 3665 Group (~81.1 Mly)					
NGC 3665	—	SA0	11 24 43.6	+38 45 46.2	2069
NGC 3652	—	Scd	11 22 39.0	+37 45 54.4	1989
Northern Field Galaxies					
UFO Galaxy	NGC 2683	SA(rs)b	08 52 41.3	+33 25 18.7	411
NGC 2903	NGC 2905	SAB(rs)bc	09 32 10.1	+21 30 03.0	550
NGC 3344	—	(R)SAB(r)bc	10 43 31.1	+24 55 21.0	580
Eridanus Void Boundary					
IC 1954 Group (~48.1 Mly)					
IC 1954	—	SB(s)b	03 31 31.3	-51 54 17.1	1062
NGC 1249	—	SB(s)cd	03 10 01.2	-53 20 08.8	1073
IC 1933	—	SAB(s)d	03 25 40.0	-52 47 07.5	1060
Eridanus Field Galaxies					
NGC 1097	Caldwell 67	SB(s)b	02 46 19.1	-30 16 29.7	1271
NGC 613	—	SB(rs)bc	01 34 18.2	-29 25 06.9	1481
NGC 1291	—	(R)SB0	03 17 18.6	-41 06 28.7	839

B.3 – Hydra Supercluster

Galaxy	Alias	Type (RC3)	RA (J2000)	Dec (J2000)	v_Helio (km/s)
I. ANTLIA STREAM					
NGC 3347 Group (~98.5 Mly)					
NGC 3347	—	SB(rs)b	10 42 46.6	-36 21 11.2	3010
NGC 3358*	—	(R)SAB0	10 43 33.0	-36 24 38.4	2988
NGC 3354	—	S pec	10 43 03.0	-36 21 44.2	2999
NGC 3366	IC 2592	(R)SB(r)b	10 35 08.3	-43 41 30.0	2891
NGC 3557 Group (~107 Mly)					
NGC 3557	—	E3	11 09 57.6	-37 32 21.0	3079
NGC 3564*	—	S0	11 10 36.4	-37 32 51.1	2852
NGC 3568	—	SB(s)c	11 10 48.5	-37 26 51.6	2444
NGC 3533	—	(R)SAB(r)ab	11 07 07.6	-37 10 21.7	3100
NGC 3573	—	SA0 pec	11 11 18.6	-36 52 32.1	2491
NGC 3256/3261 Group (~122 Mly)					
NGC 3256	—	Pec	10 27 51.0	-43 54 18.2	2804
NGC 3261	—	SB(rs)b	10 29 01.5	-44 39 24.7	2563
NGC 3263	—	SB(rs)cd	10 29 13.3	-44 07 22.3	3002
NGC 3262*	—	SAB0	10 29 06.2	-44 09 35.0	2834
NGC 3318	—	SAB(rs)b	10 37 15.5	-41 37 38.9	2775
NGC 3250	—	E4	10 26 32.3	-39 56 38.6	2824
NGC 3100/3095 Group (~143 Mly)					
NGC 3100	NGC 3103	SAB0	10 00 40.8	-31 39 52.4	2642
NGC 3095	—	SAB(rs)c	10 00 05.8	-31 33 10.3	2723
NGC 3108	—	SA0	10 02 29.0	-31 40 38.6	2673
IC 2539	—	SA(s)bc	10 04 16.2	-31 21 46.6	2834
II. ANTLIA CLUSTER					
Antlia A/NGC 3268 Subgroup (~132 Mly)					
NGC 3268	—	E2	10 30 00.7	-35 19 31.6	2800
NGC 3267	—	SAB0	10 29 48.6	-35 19.20.5	3709
NGC 3269	—	SA0	10 29 57.0	-35 13 27.8	3754
NGC 3271	IC 2585	SB0	10 30 26.5	-35 21 34.2	3804
NGC 3289	—	SB0	10 34 07.4	-35 19 23.9	2754
Antlia B/NGC 3258 Subgroup (~134 Mly)					
NGC 3258	—	E1	10 28 53.6	-35 36 19.9	2878
NGC 3257	—	SAB0	10 28 47.1	-35 39 29.3	3237
NGC 3273	—	SA0	10 30 29.2	-35 36 38.1	2660
NGC 3260	—	E	10 29 06.4	-35 35 42.3	2416
Antlia C/NGC 3281 Subgroup (~145 Mly[6])					
NGC 3281	—	SA(s)ab	10 31 52.1	-34 51 13.3	3464
NGC 3275	—	SB(r)ab	10 30 51.8	-36 44 13.2	3211
NGC 3249	—	SAB(rs)cd	10 26 22.2	-34 57 48.8	3406
NGC 3223	IC 2571	SA(s)b	10 21 35.1	-34 16 00.6	2893
NGC 3224	—	cD	10 21 41.2	-34 41 48.3	3088
IC 2560	—	(R)SB(r)b	10 16 18.7	-33 33 49.7	2925
IC 2552	—	SAB0	10 10 46.2	-34 50 41.2	3009
IC 2559	—	SB(s)b	10 14 45.4	-34 03 31.7	2987
III. NORTHERN FILAMENT					
NGC 3038 Group (~117 Mly)					

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[6] Distance estimate sourced from Crook et al. (2007).

Galaxy	Alias	Type (RC3)	RA (J2000)	Dec (J2000)	v_Helio (km/s)
NGC 3038	—	SA(rs)b	09 51 15.5	-32 45 09.3	2790
NGC 3087	—	cD	09 59 08.7	-34 13 30.8	2672
IC 2532*	—	(R)SB(rs)a	10 00 05.4	-34 13 41.7	2822
NGC 3120	—	SAB(s)bc	10 05 23.0	-34 13 11.8	2788
NGC 3001	—	SAB(rs)bc	09 46 18.7	-30 26 15.3	2464
NGC 3054 Group (~131 Mly)					
NGC 3054	—	SAB(r)b	09 54 28.6	-25 42 12.3	2426
NGC 3078	—	E2-3	09 58 24.6	-26 55 36.0	2580
NGC 3051	NGC 3046	(R)SB0	09 53 58.6	-27 17 11.1	2552
NGC 3084	IC 2528	(R)SB(s)ab	09 59 06.4	-27 07 43.3	2542
NGC 3089	—	SAB(rs)b	09 59 36.7	-28 19 52.7	2708
IC 2531	—	Sc	09 59 55.5	-29 37 03.2	2472
IC 2537	—	SAB(rs)c	10 03 51.9	-27 34 15.4	2793
NGC 3393 Group (~183 Mly)					
NGC 3393	—	(R)SB(rs)a	10 48 23.5	-25 09 43.4	3833
NGC 3463	—	Sb	10 55 13.4	-26 08 26.9	3950
NGC 3383	—	SB(rs)bc	10 47 19.2	-24 26 17.4	3649
NGC 3369	—	SA0	10 46 44.7	-25 14 40.1	3587
IV. HYDRA CLUSTER					
Hydra A/NGC 3311 Subgroup (~187 Mly)					
NGC 3311	—	cD2	10 36 42.8	-27 31 41.2	3825
NGC 3308	—	SAB0	10 36 22.3	-27 26 17.3	3554
NGC 3315	—	S0	10 37 19.2	-27 11 31.3	3791
NGC 3307	—	SB0	10 36 17.2	-27 31 47.0	3781
IC 2586	—	E4	10 31 02.4	-28 43 00.0	3645
Hydra B/NGC 3309 Subgroup (~177 Mly)					
NGC 3309	—	E3	10 36 35.7	-27 31 05.8	4075
NGC 3336	—	SAB(rs)c pec	10 40 17.0	-27 46 37.4	4000
NGC 3316	—	SB0	10 37 37.3	-27 35 38.8	3940
NGC 3305	—	E0	10 36 11.8	-27 09 44.1	3927
Hydra C/NGC 3312 Subgroup (~161 Mly)					
NGC 3312	IC 629	SA(s)b	10 37 02.5	-27 33 53.9	2886
NGC 3285B	—	SAB(r)b	10 34 36.9	-27 39 10.5	2952
NGC 3314A	—	Sab	10 37 12.9	-27 41 02.2	2859
IC 2597	—	cD4	10 37 47.3	-27 04 52.4	2267
V. HYDRA CLOUD					
NGC 2935 Group (~119 Mly)					
NGC 2935	—	(R)SAB(s)b	09 36 44.9	-21 07 41.5	2271
NGC 2986	—	E2	09 44 16.0	-21 16 40.9	2302
NGC 2983	—	SB0	09 43 41.1	-20 28 38.0	2032
NGC 3091 Group (~179 Mly)					
NGC 3091	—	E3	10 00 14.1	-19 38 11.3	3964
NGC 3052	—	SAB(r)c	09 54 28.0	-18 38 19.5	3778
NGC 3124	—	SAB(rs)bc	10 06 39.9	-19 13 17.4	3562
NGC 3096	—	SB0	10 00 33.1	-19 39 42.9	4228
NGC 3313 Group (~181 Mly)					
NGC 3313	—	(R)SB(rs)ab	10 37 25.4	-25 19 08.9	3706
NGC 3331	—	SB(s)c	10 40 09.0	-23 49 13.6	3632
NGC 3335	—	SAB0	10 39 34.1	-23 55 21.6	3882
IC 2594	—	SA0	10 36 04.2	-24 19 23.2	3547
IC 2589	—	S	10 32 20.8	-24 02 14.9	3681
NGC 3450 Group (~211 Mly)					
NGC 3450	—	SB(r)b	10 48 03.6	-20 50 56.9	4027
NGC 3464	—	SB(rs)c	10 54 40.1	-21 03 59.6	3737
NGC 3453	—	SB(s)b	10 53 40.5	-21 47 34.0	3996

Galaxy	**Alias**	**Type (RC3)**	**RA (J2000)**	**Dec (J2000)**	**v_Helio (km/s)**
VI. HYDRA FIELD GALAXIES					
NGC 3285	—	SB(s)a pec	10 33 35.9	-27 27 16.0	3378
NGC 3081	IC 2529	(R)SAB0	09 59 29.5	-22 49 34.7	2443
NGC 3241	—	SA(r)ab	10 24 17.0	-32 28 57.8	3019
NGC 3244	—	SA(rs)cd	10 25 28.9	-39 49 39.2	2762

B.4 – Centaurus Supercluster

Galaxy	Alias	Type (RC3)	RA (J2000)	Dec (J2000)	v_Helio (km/s)
I. CENTAURUS WALL					
NGC 5061 Group (~78.5 Mly)					
NGC 5061	—	E0	13 18 05.1	-26 50 14.2	2082
NGC 5101	—	(R)SB0	13 21 46.2	-27 25 49.5	1868
NGC 5078	—	SA(s)a	13 19 50.0	-27 24 37.0	2168
NGC 5085	—	SA(s)c	13 20 17.8	-24 26 22.9	1956
IC 4231	—	Sbc	13 23 13.5	-26 18 01.0	2260
IC 879	IC 4222	SB(s)ab pec	13 19 40.6	-27 25 44.8	2388
IC 874	—	SB0	13 19 00.5	-27 37 42.9	2323
NGC 4645 Group (~123 Mly)					
NGC 4645	—	cD	12 44 10.0	-41 44 59.8	2630
NGC 4603	—	SA(s)c	12 40 55.3	-40 58 35.0	2592
NGC 4650B	NGC 4661	cD	12 45 14.9	-40 49 27.2	2507
NGC 5044 Group (~124 Mly)					
NGC 5044	—	E0	13 15 24.0	-16 23 07.8	2782
NGC 5049	—	S0	13 15 59.3	-16 23 49.5	3023
NGC 5017	—	cD	13 12 54.5	-16 45 56.8	2546
NGC 5030	—	SB0	13 13 54.2	-16 29 27.2	2397
NGC 5031	—	S0	13 14 03.2	-16 07 23.0	2839
NGC 5035	—	SAB0	13 14 49.2	-16 29 33.3	2181
IC 863	—	SB0	13 17 12.4	-17 15 15.9	2514
II. CENTAURUS CLUSTER					
Centaurus A/NGC 4696 Subgroup (~123 Mly)					
NGC 4696	—	cD1 pec	12 48 49.3	-41 18 39.1	2969
NGC 4744	—	SB0	12 52 19.6	-41 03 36.3	3358
NGC 4743	—	SA0	12 52 16.0	-41 23 25.7	2984
NGC 4767	—	E	12 53 52.9	-39 42 51.3	2995
NGC 4683	—	SB0	12 47 42.3	-41 31 41.6	3570
NGC 4729	—	cD	12 51 46.3	-41 07 56.0	3344
NGC 4373	—	SAB0	12 25 17.8	-39 45 35.2	3396
NGC 4499	—	SB(rs)bc	12 32 04.9	-39 58 56.6	3729
NGC 4507	—	(R)SAB(rs)b	12 35 36.6	-39 54 33.7	3538
NGC 4553	—	SA0	12 36 07.6	-39 26 19.2	3145
NGC 4573	—	(R)SB0	12 37 43.8	-43 37 15.8	2980
NGC 4601	—	SAB0	12 40 46.8	-40 53 34.4	3251
NGC 4650	—	SB0	12 44 19.6	-40 43 54.4	2953
NGC 4672	—	SA(s)a pec	12 46 15.7	-41 42 21.1	3202
NGC 4681	—	Sab	12 47 28.8	-43 20 05.5	3313
IC 3370	—	E2-3	12 27 37.3	-39 20 16.0	2930
IC 3290	—	(R)SB0	12 25 09.0	-39 46 31.8	3342
Centaurus B/NGC 4709 Subgroup (~132 Mly)					
NGC 4709	—	E1	12 50 03.9	-41 22 55.1	4678
NGC 4679	—	SB(s)c	12 47 30.3	-39 34 15.0	4643
Backward Galaxy	NGC 4622	(R)SA(r)a pec	12 42 37.6	-40 44 39.0	4367
NGC 4616	—	cD	12 42 16.5	-40 38 31.4	4586
III. HYDRA-CENTAURUS STREAM					
NGC 5266 Group (~103 Mly)					
NGC 5266	—	SA0	13 43 02.1	-48 10 09.9	3002
NGC 5266A*	—	SAcd	13 40 37.1	-48 20 30.9	2869
NGC 5333	—	SB0	13 54 24.2	-48 30 44.8	2752

Galaxy	Alias	Type (RC3)	RA (J2000)	Dec (J2000)	v_Helio (km/s)
NGC 4936 Group (~114 Mly)					
NGC 4936	—	E0	13 04 16.9	-30 31 34.5	3117
NGC 4955	—	E2	13 06 04.8	-29 45 15.2	3462
NGC 5011 Group (~137 Mly)					
NGC 5011	—	E1-2	13 12 51.9	-43 05 46.6	3159
NGC 4946	—	cD	13 05 29.4	-43 35 28.3	3079
NGC 5090	—	E2	13 21 12.9	-43 42 16.8	3386
NGC 5091	—	Sb pec	13 21 17.7	-43 43 10.7	3602
NGC 5026	—	(R)SB0	13 14 13.6	-42 57 40.7	3549
IC 4296 Group (~153 Mly)					
IC 4296	—	E	13 36 39.0	-33 57 57.1	3737
NGC 5140	—	SAB0	13 26 21.7	-33 52 05.9	3879
NGC 5114	—	SAB0	13 24 01.7	-32 20 38.1	3581
IC 4299	—	SAB(s)a	13 36 47.6	-34 03 57.0	4035
NGC 5193	—	E	13 31 53.5	-33 14 03.4	3711
NGC 5215	—	S0 pec	13 35 08.3	-33 29 01.8	4013
IV. NORMA COMPLEX					
NGC 5488 Group (~177 Mly)					
NGC 5488	IC 4375	SABbc	14 08 03.1	-33 18 53.8	4360
NGC 5419	—	E	14 03 38.7	-33 58 41.8	4126
NGC 5397	—	SAB0	14 01 10.5	-33 56 44.8	4161
IC 4366	—	SAB(rs) pec	14 05 11.5	-33 45 36.3	4621
IC 4329 Group (~191 Mly)					
IC 4329	—	SAB0	13 49 05.3	-30 17 44.8	4539
IC 4329A*	—	SA0	13 49 19.3	-30 18 34.2	4813
NGC 5328	—	E1	13 52 53.3	-28 29 21.7	4740
NGC 5292	—	(R)SA(rs)ab	13 47 40.1	-30 56 21.8	4466
NGC 5357	—	E	13 55 59.5	-30 20 29.4	4868
NGC 5298	—	SB(r)b	13 48 36.5	-30 25 42.4	4350
IC 4319	—	SA(s)bc	13 43 26.6	-29 48 12.0	4653
IC 4326	—	S	13 48 21.5	-29 37 35.3	4530
NGC 5291	—	E	13 47 24.5	-30 24 25.6	4378
IC 4328	—	S	13 49 02.9	-29 56 13.4	4170
NGC 5152 Group (~201 Mly)					
NGC 5152	—	SB(s)b	13 27 51.2	-29 37 06.9	3889
NGC 5124	IC 4233	E6	13 24 50.3	-30 18 27.9	3976
NGC 5135	—	SB(s)ab	13 25 44.0	-29 50 00.4	4105
NGC 5182	—	(R)SB(r)bc	13 30 41.1	-28 09 01.4	4370
NGC 5153	—	E1 pec	13 27 54.4	-29 37 04.7	4321
NGC 5150	—	SBbc	13 27 36.6	-29 33 44.4	3884
IC 4251	—	S0	13 27 24.3	-29 26 39.7	4481
IC 4248	—	S	13 26 47.2	-29 52 52.8	4103
IC 4275	—	SB	13 31 51.3	-29 43 56.5	4321
Norma Cluster (~228 Mly)					
ESO 137-006	—	E1	16 15 03.8	-60 54 25.8	5444
ESO 137-008	—	S0	16 15 46.1	-60 55 07.4	3839
Jellyfish Galaxy	ESO 137-001	SBc	16 13 27.2	-60 45 50.4	4647
ESO 137-007	—	S0	16 15 32.9	-60 39 55.3	4945
ESO 137-002	—	S0	16 13 35.7	-60 51 54.6	5691
ESO 137-003	—	S0	16 13 47.8	-61 00 12.7	3975
V. CENTAURUS FIELD GALAXIES					
NGC 5018 Group (~115 Mly)					
NGC 5018	—	E3	13 13 01.1	-19 31 05.5	2816
NGC 5006*	—	(R)SB0	13 11 45.8	-19 15 42.3	2751
NGC 3923 Group (~146 Mly)					

Galaxy	Alias	Type (RC3)	RA (J2000)	Dec (J2000)	v_Helio (km/s)
NGC 3923	—	E4-5	11 51 01.7	-28 48 21.4	1739
NGC 3904*	—	E2-3	11 49 13.2	-29 16 36.5	1576
Centaurus Field Galaxies					
NGC 3783	—	(R)SB(r)ab	11 39 01.7	-37 44 19.0	2917
NGC 3749	—	SA(s)a pec	11 35 53.2	-37 59 50.9	2702
NGC 3742*	—	(R)SAB(rs)ab	11 35 32.5	-37 57 23.2	2718

B.5 – Pavo-Indus Supercluster

Galaxy	Alias	Type (RC3)	RA (J2000)	Dec (J2000)	v_Helio (km/s)
I. TELESCOPIUM CLOUD					
NGC 7144 Group (~90.8 Mly)					
NGC 7144	—	E0	21 52 42.5	-48 15 13.9	1932
NGC 7145	—	E0	21 53 20.3	-47 52 56.5	1967
NGC 7151	—	SAB(rs)cd	21 55 04.1	-50 39 26.9	1867
NGC 7155	IC 5143	SB0	21 56 09.7	-49 31 19.0	1981
IC 4797 Group (~95.9 Mly)					
IC 4797	—	cD	18 56 29.7	-54 18 20.6	2678
NGC 6707	—	SB(s)c	18 55 22.1	-53 49 05.9	2728
IC 4796	—	SB0	18 56 27.9	-54 12 50.6	3108
NGC 6708	—	Sb	18 55 35.6	-53 43 24.5	2579
NGC 7049/7162 Group (~99 Mly)					
NGC 7049	—	SA0	21 19 00.3	-48 33.43.5	2285
NGC 7041	—	SA0	21 16 32.4	-48 21 48.7	1946
NGC 7162	—	SA(s)c	21 59 39.1	-43 18 21.8	2314
NGC 7166	—	SA0	22 00 32.9	-43 23 22.8	2466
Telescopium Cluster (~110 Mly)					
NGC 6868	—	E2	20 09 54.1	-48 22 46.8	2854
NGC 6861	IC 4949	SA0	20 07 19.5	-48 22 12.5	2829
NGC 6870	—	SAB(r)ab	20 10 10.9	-48 17 13.3	2951
NGC 6875	—	SAB0	20 13 12.3	-46 09 43.2	3121
NGC 6893	—	SAB0	20 20 49.6	-48 14 20.6	3056
NGC 6851	—	E	20 03 34.4	-48 17 04.4	3036
IC 4943	—	E	20 06 28.3	-48 22 32.0	2969
NGC 7079 Group (~111 Mly)					
NGC 7079	—	SB0	21 32 35.3	-44 04 03.4	2684
NGC 7070	—	SA(s)cd	21 30 25.4	-43 05 13.5	2376
NGC 7097	—	E5	21 40 12.9	-42 32 21.9	2616
NGC 7107	—	SB(s)m	21 42 26.5	-44 47 25.0	2205
NGC 6753 Group (~150 Mly)					
NGC 6753	—	(R)SA(r)b	19 11 23.6	-57 02 57.4	3169
NGC 6758	—	cD	19 13 52.4	-56 18 36.1	3404
NGC 6780	—	SAB(rs)c	19 22 50.9	-55 46 33.2	3496
IC 4832	—	SA(s)a	19 14 03.9	-56 36 38.6	3420
IC 4856	—	IB(s)m	19 27 30.9	-54 54 26.1	3314
II. SOUTHERN FILAMENT					
IC 5156 Group (~120 Mly)					
IC 5156	—	SB(s)ab	22 03 14.9	-33 50 18.6	2755
NGC 7172	—	Sa pec	22 02 01.9	-31 52 10.5	2616
NGC 7173	—	cD	22 02 03.2	-31 58 25.3	2497
NGC 7174	—	Sab pec	22 02 06.5	-31 59 33.7	2659
NGC 7176	—	E	22 02 08.4	-31 59 23.6	2511
NGC 7163	—	(R)SB(rs)ab	21 59 20.5	-31 52 59.4	2754
NGC 7187	—	(R)SA0	22 02 44.6	-32 48 07.8	2670
NGC 7154	—	SB(s)m	21 55 21.2	-34 48 51.7	2616
NGC 7329 Group (~146 Mly)					
NGC 7329	—	SB(r)b	22 40 24.2	-66 28 44.1	3252
NGC 7417	—	(R)SB(r)ab	22 57 49.5	-65 02 18.8	3196
NGC 7358	—	SA0	22 45 36.4	-65 07 18.4	3337
IC 5250	—	S0	22 47 20.5	-65 03 32.0	3616

Galaxy	Alias	Type (RC3)	RA (J2000)	Dec (J2000)	v_Helio (km/s)
IC 5266	—	Sb	22 58 20.9	-65 07 46.0	3191
NGC 7408	—	SB(s)cd	22 55 56.0	-63 41 40.7	3494
IC 5272	—	Irr	22 59 31.3	-65 11 36.5	3383
NGC 7196 Group (~147 Mly)					
NGC 7196	—	E	22 05 54.8	-50 07 09.6	2923
NGC 7200	—	cD	22 07 09.5	-49 59 43.6	2897
NGC 7168	—	E3	22 02 07.4	-51 44 34.9	2760
The Devil's Mask/NGC 6769 Group (~183 Mly)					
NGC 6769	—	SAB(r)b pec	19 18 22.6	-60 30 03.2	3863
NGC 6770	—	SAB(rs)b pec	19 18 37.3	-60 29 47.5	3841
NGC 6771	—	SB0	19 18 39.5	-60 32 46.6	4216
IC 4845 Group (~187 Mly)					
IC 4845	—	SA(rs)b	19 20 22.5	-60 23 20.7	3944
NGC 6782	—	(R)SAB(r)a	19 23 57.9	-59 55 20.9	3920
NGC 6739	—	SA0	19 07 48.7	-61 22 05.1	4253
IC 4827	—	SA(s)ab	19 13 21.3	-60 51 36.7	4399
NGC 6746	—	SA0	19 10 22.3	-61 58 09.8	4161
III. PAVO-INDUS COMPLEX					
Pavo Group (~147 Mly)					
NGC 6876	—	E3	20 18 19.2	-70 51 31.3	4010
NGC 6877	—	E6	20 18 36.1	-70 51 12.2	4440
NGC 6880	—	SAB0	20 19 29.6	-70 51 35.3	3928
IC 4992	—	SB(s)c	20 23 27.7	-71 33 54.0	4167
IC 4981	—	Irr pec	20 19 39.4	-70 50 54.6	3812
IC 4899	—	S	19 54 26.8	-70 35 23.1	4106
IC 4967	—	E	20 16 23.2	-70 33 52.6	4112
Condor Galaxy	NGC 6872	SB(s)b pec	20 16 56.4	-70 46 05.2	4818
IC 4970*	—	SA0	20 16 57.4	-70 45 00.0	4727
Pavo Cluster (~193 Mly)					
IC 4765	—	cD4	18 47 18.1	-63 19 52.1	4507
NGC 6722	—	Sb	19 03 40.4	-64 53 40.1	4625
IC 4745	—	Sab	18 42 35.9	-64 56 34.5	4715
NGC 6733	—	SAB0	19 06 10.7	-62 11 48.7	4897
IC 4728	—	SB(rs)ab	18 37 57.0	-62 31 52.0	4578
IC 4800	—	(R)SB(s)a	18 58 43.6	-63 08 21.2	4498
IC 4696	—	SAB(rs)bc	18 20 17.9	-64 44 03.2	4676
NGC 6614	—	SB0	18 25 07.2	-63 14 54.1	4319
IC 4741	—	SA(r)ab	18 41 43.5	-63 56 53.4	4633
IC 4727	—	S0	18 37 56.0	-62 42 02.5	4566
IC 4769	—	(R)SB(s)b pec	18 47 44.1	-63 09 25.1	4534
IC 4754	—	(R)SB(r)b	18 44 00.3	-61 59 24.2	4406
IC 4799	—	SB(rs)ab	18 58 56.6	-63 55 51.6	4533
Crystal Frog Galaxy	IC 4767	S0 pec	18 47 41.7	-63 24 20.4	3516
IC 4770	—	(R)SAB(rs)a	18 48 10.3	-63 23 00.6	4338
Indus Cluster (~200 Mly)					
NGC 7038	—	SAB(s)c	21 15 07.5	-47 13 13.7	4938
NGC 7014	—	cD	21 07 52.2	-47 10 44.1	4857
NGC 6987	—	E0	20 58 10.4	-48 37 49.1	5239
NGC 6970	—	SB(rs)ab	20 52 09.5	-48 46 40.0	5254
IC 4931 Group (~242 Mly)					
IC 4931	—	cD	20 00 50.4	-38 34 30.2	6008
IC 4926*	—	E	20 00 12.2	-38 34 42.5	5618
IV. MICROSCOPIUM EXTENSION					
NGC 6925 Group (~93 Mly)					
NGC 6925	IC 5015	SA(s)bc	20 34 20.6	-31 58 51.0	2789

Galaxy	**Alias**	**Type (RC3)**	**RA (J2000)**	**Dec (J2000)**	**v_Helio (km/s)**
NGC 6923	IC 5004	SB(rs)b	20 31 39.1	-30 49 54.7	2826
IC 5020	—	SA(s)bc	20 30 38.5	-33 29 08.3	3085
NGC 6907 Group (~104 Mly)					
NGC 6907	—	SB(s)bc	20 25 06.6	-24 48 33.5	3169
NGC 6908*	—	S0	20 25 09.0	-24 48 03.1	3060
IC 5005	—	SB(s)cd	20 25 20.2	-25 49 45.2	3112
IC 4999	—	SB(rs)c	20 23 56.4	-26 00 53.5	3156
NGC 6902 Group (~120 Mly)					
NGC 6902	IC 4948	SA(r)b	20 24 28.1	-43 39 12.5	2796
NGC 6902B*	—	SAB(s)cd	20 23 07.1	-43 52 07.2	2960
IC 4946	—	SAB0	20 23 58.1	-43 59 42.8	2902
V. ARA ASSOCIATION					
NGC 6328	—	SAB(s)ab	17 23 41.0	-65 00 36.6	4325
NGC 6183	—	SAa	16 41 41.9	-69 22 19.9	4880
NGC 6156	—	SAB(rs)c	16 34 52.5	-60 37 08.1	3263
VI. PAVO-INDUS FIELD GALAXIES					
NGC 6958	—	cD	20 48 42.6	-37 59 50.8	2713
NGC 6438	—	S0	18 22 17.5	-85 24 07.1	2437
NGC 6438A*	—	Irr	18 22 36.7	-85 24 23.8	2515
NGC 6810	—	SA(s)ab	19 43 34.4	-58 39 20.1	2031