Galaxy Clusters: Abell's, Hickson's, and Palomar's
(What are They, and How to Observe Them)

Introduction:

I love EAA observing galaxies!
Especially the large, bright showcase Messier and the NGC galaxies that show plenty of spiral arm details or interactions with other nearby galaxies.
But Galaxy Clusters,,,,, What are they? And how do the bright galaxies that we like to observe fit in with these clusters.

A few years back, I became interested in observing Hickson Compact Galaxy Clusters. That prompted me to also begin a detailed examination of the larger scale Abell clusters and the much smaller, more fainter & compact, Palomar clusters.
It's been an interesting observational journey into the 'universe' of galaxy clusters, macro to micro.
Most galaxy clusters are faint and / or sparse, and not very appealing visually, but each catalog has a number clusters that are worth looking for.

So today, we'll discuss what I've learned during that journey among the galaxy clusters, along with some of the people, behind these catalogs, and how to go about observing these objects. Along the way, we'll also review a number of my personal EAA observations of galaxy clusters.
Hopefully, when we are done, you will find them as interesting to hunt and observe as I do.

Outline:

> **Galaxies – What are they?:**
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> **Galaxy Groups & Clusters**:
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> **What is the "Local Group":**
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> **What is the Virgo Cluster:**
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> **What are Abell Galaxy Clusters:**
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> **What Are Hickson Compact Galaxy Clusters:**
>
> **What are Palomar Compact Galaxy Clusters:**
>
> **How to Observe Galaxy Clusters:**
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> **Amateur Observations of Galaxy Clusters:**
> > Abell Galaxy Clusters:
> > Hickson Compact Galaxy Clusters:
> > Palomar Compact Galaxy Clusters:
>
> **Conclusion :**

Galaxies – What are they?
Galaxies are large systems of stars and interstellar clouds of matter, typically containing from several hundred million to several trillion stars. They originate from large cosmic primordial clouds of hydrogen and helium gas through-out the universe that slowly collapsed. Most galaxies formed at about the same time, within the first few billion years after the universe started to expand. They run in size from a few 10's of thousands to several 100,000 light years in size, and are separated from other galaxies by millions of light years.

Classic Galaxy Morphology:

Galaxies come in several types, and though of a wide variety of shapes and appearances, have many basic common features. From their appearance, galaxies are classified as spiral, lenticular, and elliptical.

In the early 20th century, astronomer Edwin Hubble devised a galaxy classification diagram based on their visual appearance. This classification is commonly called the "Hubble Tuning Fork diagram". Hubble divided the galaxies into three broad classes: spiral, elliptical, and lenticular. All the main types have sub-category classifications, and we still use a modified version of this today.
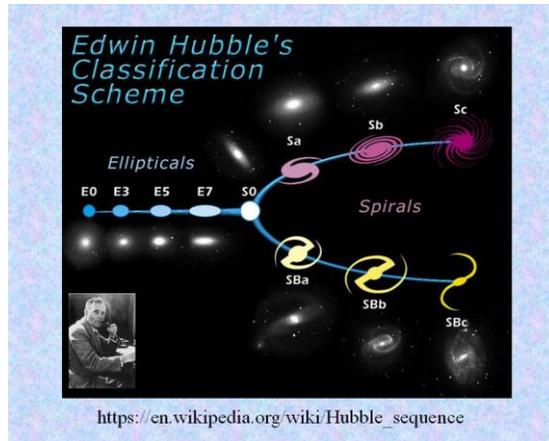
Elliptical - Elliptical galaxies are shaped like giant luminous cotton balls, and have no spiral or disk components. They have little or no rotation as a whole. Normally, elliptical galaxies contain very little or no interstellar matter, and consist of older population stars only:

Lenticular - Lenticular galaxies are shaped like spiral galaxies without a spiral structure. They are smooth disk galaxies, where stellar formation has stopped long ago, because the interstellar matter was used up. They consist of mostly older population stars only. From their appearance and stellar contents, they can often be observationally confused with ellipticals.

Spiral - Spiral galaxies usually consist of three major components: A flat, large disk which often contains interstellar matter visible as diffuse glowing emission nebulae or as dark dust clouds.

Young open star clusters, associations, and random stars arranged in conspicuous and striking spiral patterns and / or bar structures. Finally, a central bulge or core, consisting of older stellar populations with little interstellar matter, and often surrounded by a halo of older globular star clusters.

Irregular - Irregular galaxies have many different shapes and sizes due to distortion by the gravitational pull of their intergalactic neighbors. These galaxies do not fit into the scheme of spirals, disks and ellipsoids, and exhibit no particular shape.

Galaxy Groups & Clusters:

Galaxies are scattered throughout the visible universe. Some galaxies are isolated "island universes" which float lonely through an otherwise empty region of space. But the distribution of matter in the universe is not uniform.

The majority of galaxies are gravitationally clumped together in groups, running from a handful to a few dozens of galaxies, such as our "Local Group", to large clusters of hundreds of galaxies such as the Virgo galaxy cluster, to the larger Abell galaxy clusters of upwards to several thousands of galaxies, which in turn are bound into giant superclusters of 10's of thousands of galaxies. These huge structures are the fundamental building blocks of the universe!
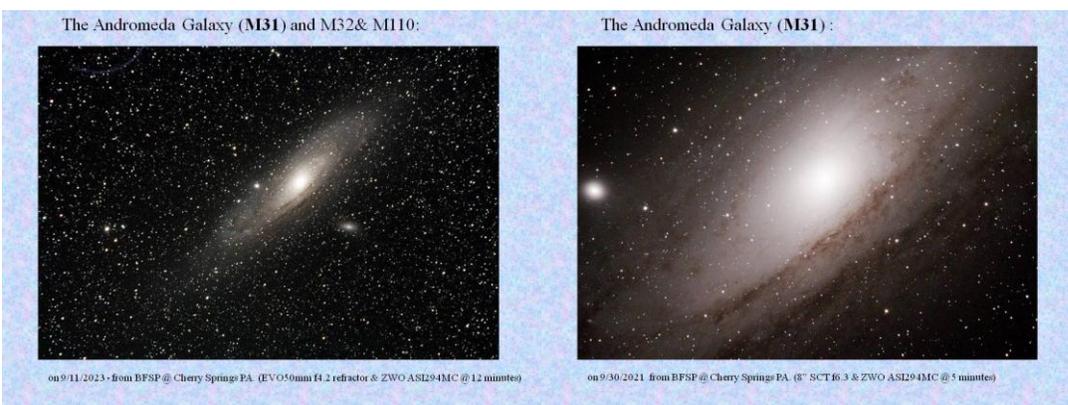
Coma Cluster

These groups are generally scattered across vast distances, but some are compact due to mutual gravitational interaction, which may have significant influence on their appearance. The individual galaxies of these groups vary in size and type classification, but most of the larger clusters contain one or more giant elliptical galaxies at their core.

What is the "Local Group":
The "Local Group" is the group of galaxies that includes our home galaxy, the Milky Way, and its neighbors. (Named as such by Edwin Hubble in 1936). It comprises more than 54 galaxies, the majority of which are low surface brightness dwarf. The most massive member of the group is M31, the Andromeda Galaxy, followed next by the Milky Way, with the third being M33, the Triangulum Galaxy. Both M31 and the Milky Way each have a system of satellite dwarf galaxies. http://stellar-journeys.org/LocalGroupTour.htm

The Milky Way: Summer
The Milky Way
The Milky Way – from Cherry Springs (fisheye lens & ZWO ASI294MC)
The Milky Way – from ORAS Observatory in NW PA. (fisheye lens & ZWO ASI224MC)

The gravitational center of the Local Group is located between the Milky Way and the Andromeda Galaxy. Overall, the Local Group has a rough diameter of around 10 million light-years, and contains three spirals, two elliptical, nine irregulars, and forty dwarf galaxies.

The Andromeda Galaxy (M31) and M32 & M110:
The Andromeda Galaxy (M31):
on 9/11/2023 - from BFSP @ Cherry Springs PA. (EVO50mm f4.2 refractor & ZWO ASI294MC @ 12 minutes)
on 9/30/2021 from BFSP @ Cherry Springs PA. (8" SCT f6.3 & ZWO ASI294MC @ 5 minutes)
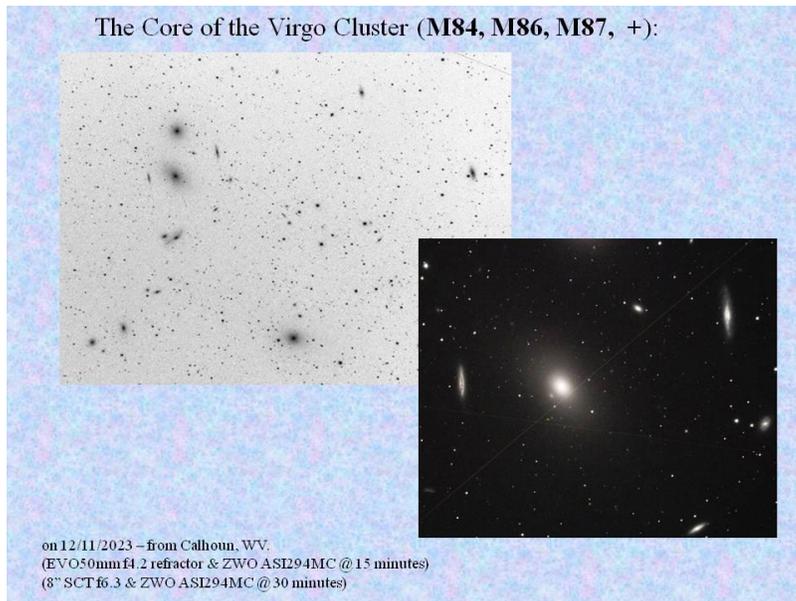
While there's currently 54 individual galaxies identified as members of the Local Group, with the Milky Way blocking a large band of the sky, new discoveries of small dwarf galaxy members with extremely low surface brightness, obscured by our galaxies dust are still being made, so the Local Group membership continues to rise.

The Triangulum Galaxy (M33):
on 11/10/2023 – from Calhoun, WV. (EVO50mm f4.2 refractor & ZWO ASI294MC @ 30 minutes)

The Triangulum Galaxy (M33):
on 9/18/20212 from BFSP @ Cherry Springs PA. (8" SCT f6.3 & ZWO ASI294MC @ 30 minutes)

What is the Virgo Cluster:

The Virgo Cluster is a grouping of over 1500 galaxies with a cluster diameter of around 54 million light-years centered on the giant ellipticals M84, M86, and M87. (The Local Group is near the outer edge and part of the larger Virgo Cluster). The Virgo cluster can be traced thru the sky starting in southern Virgo to Coma Berenices to Canes Venatici into Ursa Major. Edwin Hubble referred to this region of the sky as the "Realm of the Nebulae".

The Core of the Virgo Cluster (M84, M86, M87, +):
on 12/11/2023 – from Calhoun, WV.
(EVO50mm f4.2 refractor & ZWO ASI294MC @ 15 minutes)
(8" SCT f6.3 & ZWO ASI294MC @ 30 minutes)

Cluster Members: M86, M84, NGC438, NGC4388, NGC4402, NGC4413, NGC4425, and IC3303, IC3355, IC3363, and PGC40534, PGC40548, PGC40598, PGC40636, and many, many, more Messier, NGC, etc.

Other nearby galaxy groups within the Virgo Cluster in our neighborhood includes the Sculptor Galaxy Group (which includes NGC253), at about 8 million light years, the Ursa Major Galaxy Group (which includes M81 & M82) at about 10 million light years away, and the Centaurus Galaxy Group (NGC5128) at about 22 million light years.

Moving up in scale, the Virgo Cluster in combination with the Coma Galaxy Cluster (which contains over 1,000 member galaxies centered on the two giant ellipticals galaxies NGC4874 & NGC4889), is part of the Coma-Virgo Supercluster, (also called the Local Supercluster), a giant grouping of around 100 galaxy groups centered on the Virgo Cluster, with a total of over 20,000 galaxies, and a diameter of over 110 million light-years, that stretches across the sky from the constellations of Ursa Major thru Canes Venatici, Coma Berenices, Virgo, to Centaurus.

The Coma-Virgo Supercluster is itself part of an even larger structure, called the Laniakea Supercluster, (Hawaiian for "immense heaven'), and made up of at least four separate superclusters totaling over 100,000 galaxies stretched over 520 million light-years. And Laniakea in turn may be part of an even greater structure! The Universe is a big place!!

Laniakea Supercluster

Chart by ESO - Andrew Z. Colvin: Wikimedia
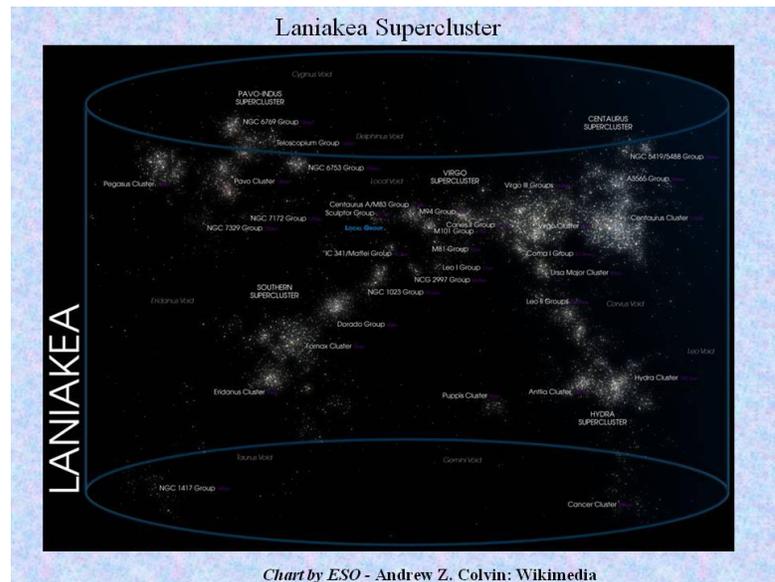
What are Abell Galaxy Clusters:

American astrophysicist George Abell was born on March 27th, 1927 in Los Angeles California. (Died from a heart attack at the age of 56, on October 7th, 1983). After graduating from High School in 1945, Abell joined the US Army Air Corps, hoping to become a pilot, but he was instead stationed over in Japan as an Air Corps weatherman. Upon discharge from the service, George enrolled at Caltech where he studied physics and astronomy.

During this time, Abell worked as a 'tour guide' and as a 'lecturer' at the Griffith observatory. Abell graduated in 1951 from the California Institute of Technology with a B.S. in astronomy, continued on for his masters in 1952, and then his doctorate in 1957. Abell's first professional job as a Caltech astronomer was working on the National Geographic Society Palomar Observatory Sky Survey, created using the Palomar 48-inch Schmidt telescope. George's primary research was reviewing the POSS survey photographic plates looking for the formation of galaxy clusters.

Using the Palomar 48-inch Schmidt telescope, Abell compiled a catalog of clusters of galaxies, (2,712), which was first published in 1958 titled "*The Distribution of Rich Clusters of Galaxies*". (Also later called the "*Northern Survey*").
An expanded version, published in 1989, of an additional 1,361 galaxy clusters, (in collaboration with astronomers Harold Corwin and Ronald Olowin), covering the southern hemisphere, brought the catalog up to 4,073 total galaxy clusters. (Often referred to as the "*Southern Survey*").

Abell's qualifications for a galaxy cluster to be included in the catalog were the following four criteria:
(1) A galaxy cluster must have a minimum population of 50 members within a two magnitude range of the 3rd-brightest galaxy cluster member.
These are then divided into six "richness groups" based on the number of galaxies their contained:
Group 0: 30 to 49 galaxies
Group 1: 50 to 79 galaxies
Group 2: 80 to 129 galaxies
Group 3: 130 to 199 galaxies
Group 4: 200 to 299 galaxies
Group 5: greater than 299 galaxies

 (The average Abell galaxy cluster contains 64 individual members, falling under the Group 1 classification)

(2) A cluster must be sufficiently compact that at least fifty or more of the cluster members must lie within a radius of about 2 mega parsecs from the clusters center.

(3) A catalog member cluster should have a redshift of between 0.02 and 0.2, corresponding to distances of between 85 and 850 Mega parsec (Mpc). As redshift distance calculation improved over time, Abell divided the galaxy clusters into seven "distance groups" according to the magnitudes of their tenth-brightest galaxy member:
Group 1: mag 13.3 to 14.0
Group 2: mag 14.1 to 14.8
Group 3: mag 14.9 to 15.6
Group 4: mag 15.7 to 16.4
Group 5: mag 16.5 to 17.2
Group 6: mag 17.3 to 18.0
Group 7: mag > 18.0

(4) In general, regions close to the galactic plane of the Milky Way were to be excluded from the study due to the interstellar obscuration by the Milky Way's spiral arms made it difficult to positively identify galaxy clusters.

Abell 2744 – Hubble Space Telescope Frontier Fields observing program.

Abell's catalog continues to be relevant to today's professional astronomers and cosmologist in studies of large-scale three-dimensional structures across the universe. His work is considered to be the first steps in leading to our understanding of the clustering of galaxies into filaments and voids.

What Are Hickson Compact Galaxy Clusters:
Canadian astrophysicist Paul Hickson graduated from the California Institute of Technology with a doctorate in astrophysics in 1976. A few years after, he became a professor at the University of British Columbia their Department of Physics and Astronomy. Using the Palomar Observatory Sky Survey (POSS), Hickson compiled a catalog of 100 faint, compact galaxy clusters which was he published in 1982.

His criteria for inclusion in the catalog was:
(1) Small, relatively isolated, system of typically 4 to 8 galaxies in close proximity to one another.
(2) Specifically, each galaxy cluster had to contain at least 4 members, not be part of a larger cluster of galaxies.
(3) The difference in magnitude between the brightest and faintest cluster member not be more than +3 magnitudes.
(4) Had to be a compact group, and cluster members must have a similar radius of spacing.

Hickson's research goal in creating his catalog was to develop a uniform statistically significant sample to aid in studying galaxy evolution and any discordant red shifts between the individual members of these compact groups.

What are Palomar Compact Galaxy Clusters:

Using the Palomar Observatory Sky Survey, in 2003, Italian astronomer Angela Iovino, of the Brera Astronomical Observatory in Milan Italy, published a research catalog of compact galaxy clusters using tighter selection criteria than what has been used in previous catalogs such as the Hickson Catalog.

Her criteria for inclusion in the catalog was:

(1) Galactic Latitude: Regions close to the galactic plane (+/- 40 deg) of the Milky Way were to be excluded from the study as the Milky Way's spiral arms made it difficult to positively identify faint galaxy clusters.

(2) Richness: A galaxy cluster must have a minimum population of 4 members with only a two magnitude range between the brightest and dimmest galaxy cluster member.

(3) Compactness: The apparent size of a cluster must be less than one arc minute in size. (Smaller than the visual size of the planet Jupiter's disk!)

(4) Isolation: A catalog member cluster must be at least three group size diameters away from any nearest galaxy (3 arc minutes or greater).
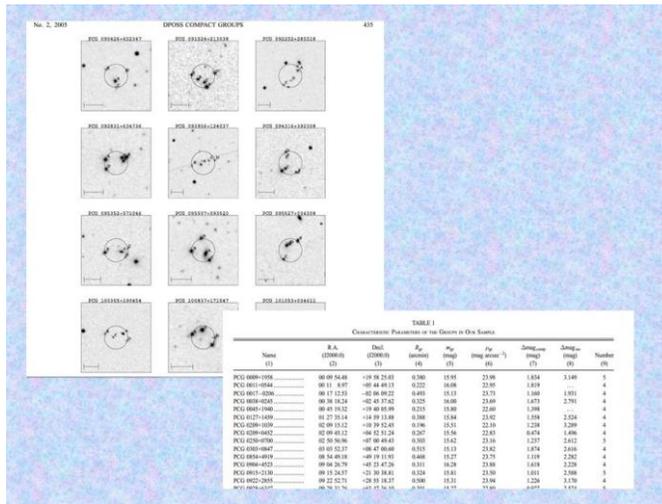
In her paper – "*A New Sample of Distant Compact Groups from the Digitized Second Palomar Observatory Sky Survey*", Dr Iovino identified 459 compact galaxy groups using her selection criteria covering both the northern and southern hemisphere:

How to Observe Galaxy Clusters:

So, where can you find Abell, Hickson, and Palomar galaxy clusters and how do you observe them?

Galaxies in general can be found opposite the glowing band of light that we call the "Milky-Way", our home galaxy. Usually, when we want to observe bright or dark nebula and star clusters, the Milky-Way is exactly where we want to look, but for galaxies, this is the "Zone of Avoidance', as all the gas and dust nebula and stars of the spiral arms of our galaxy tend to obscure all the faint extra-galactic 'nebula' that we want to observe. Generally, galaxies come in all shapes, sizes, and brightness, and many are very interesting and worth the effort to find, regardless of the equipment that you use. With a few exceptions most galaxy clusters are small faint, and will require large aperture telescopes or imaging setups, along with a dark-sky location such as Cherry Springs.

There are a number of good 'galaxy cluster' related observing guides available to the amateur astronomer.

One of my favorites is "*The Night Sky Observers Guide – Volumes 1 & 2.* These handbooks were written by George Kepple and Glen Sanner, each chapter covering a specific constellation, along with finder charts, sketches, images, and visual descriptions of various deep sky objects, including various galaxy clusters.

Amateur astronomer Alvin Huey has a great observing book on his website www.faintfuzzies.com devoted specifically to observing galaxy clusters. They contain finder charts, and DSS images for catalog members.
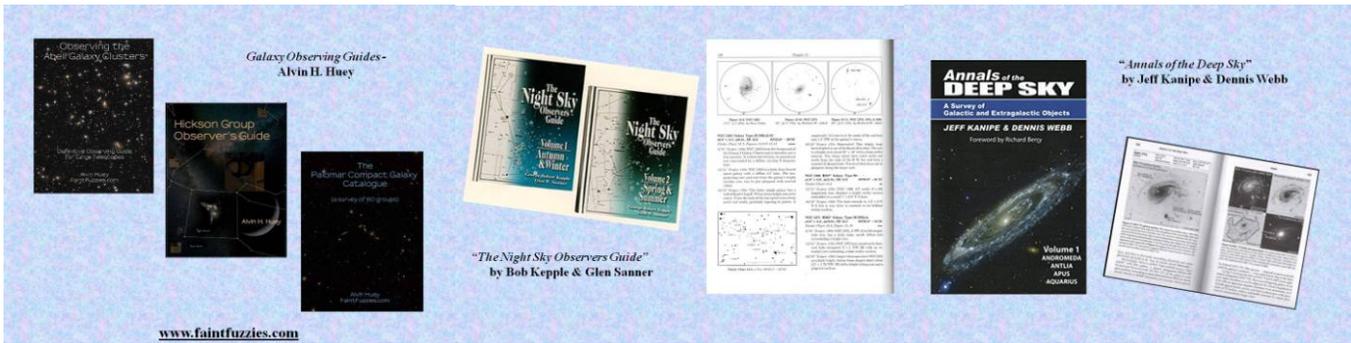
And "Annals of the Deep Sky!" – goes into deep details on all the current astrophysical characteristics of galaxy clusters.

Ingredients to successfully observe Galaxies:
While most galaxy clusters can be challenging, this is what makes them interesting to find and attempt to visually see or capture an image of. Observing them visually requires maintaining dark-adaptation, good starcharts, and slow sweeping with a wide-field low-power eyepiece and a fast low focal-length telescope. An 80mm F6 or shorter refractor piggybacked on a 10" or greater telescope would work very well. The 80mm acts as a low-power RFT giving you a wide-field in which to find the galaxy cluster and the larger telescope it is attached to allow use of higher magnification. You'll need all your visual observing skills to find and bring out these subtle clusters.
Many galaxy clusters are very faint, and depending on what size telescope you are using, most of their member galaxies may not be visible. The observer is much more likely to only see the higher contrast elliptical and lenticular galaxies, and edge-on spirals than any face-on low-surface brightness spirals. But like any deep-sky object, half the fun is just successfully finding the galaxy cluster and knowing what it is that you are observing.

For the Imagers, galaxy clusters can also be challenging due to their faintest or large scale, in that even with an accurate GOTO mount, it may not position the telescope squarely on the cluster to where it's framed the way you want it. Having a photographic atlas or picture of the galaxy cluster will help you in both locating and identifying the object and in framing your image. I've found that using short-exposure EAA camera techniques works great in positioning and identifying galaxies.

My Observations of Galaxy Clusters:
As I mentioned earlier, it's been an interesting observational journey among the 'universe' of galaxy clusters.
The Abell clusters – where the FOV overflows with numerous relatively nearby galaxies.
To the intermediate size, & distance Hickson clusters of compact groups of galaxies.
To the tiny, faint, and very distant Palomar compact clusters where the galaxies look like a few little grains of sand.

Abell Galaxy Clusters:
Abell's catalog is recognized as an excellent compilation of galaxy clusters for the observer with access to medium to large telescopes and dark skies. While several of the clusters contain one or more relatively bright NGC or IC galaxies, the majority of the catalog is galaxy clusters of faint PGC, UGC, or MCG galaxies. (+12th mag or fainter).
Many of the groups, (officially designated as 'ACO'), have at least one member plotted in several popular printed star atlases such as 'Uranometra 2000' or the 'Millennium Star Atlas". For the most part, they can be difficult to observe, but broadband filters, such as the L-Pro, can be a big help, allowing the galaxies to 'pop' from the star field.
http://stellar-journeys.org/AbellGalaxyTour.htm

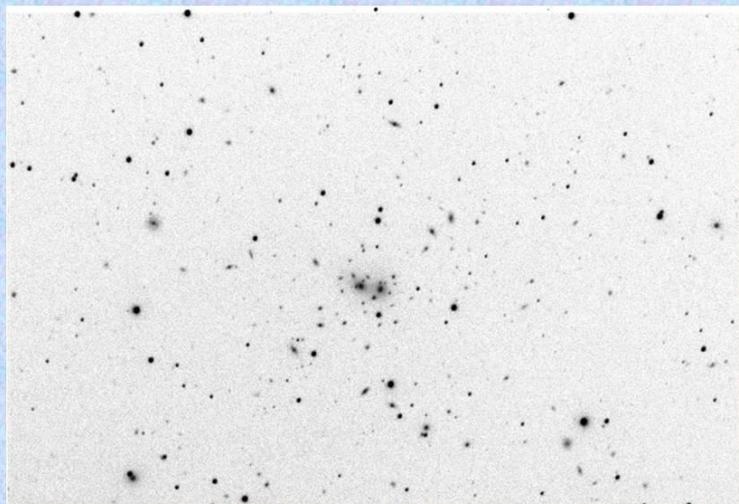Abell 154 - Pisces   (image scale = 24' x 16' arc minutes)
(cluster mag +15.7 – mag of the 10th brightest galaxy in the cluster), #members=35, Abell class richness / distance: '0/3'.
Located about 815 million light-years distant.
Core Cluster Members: IC1634 (brightest member +15.6 - elliptical), IC1635, PGC4253, PGC4193, PGC4209, PGC73760, PGC73748, PGC73743, PGC73761, PGC73764, PGC73766, PGC1535574, PGC1539023, MAC0110+1745A, MAC0110+1745B, MAC0110+1736, MAC0111+1738B, MAC0111+1741B
8" SCT optical tube @ f6.3, Atlas Gem mount, ASI294MC & L-Pro filter @ 180 seconds livestacked for 30 minutes.

Abell 154 – Pisces (Mag +15.7)   RA: 01 11 00   Dec: +17 39 00

(8" SCT f6.3 & ZWO ASI294MC and L-pro broadband filter, 180 second subs for 30 minutes)

Abell 262 - Andromeda   (image scale = 24' x 16' arc minutes)   (near open cluster NGC752)
(cluster mag +13.3 – 10th brightest galaxy in cluster), #members=40, Abell class richness / distance: '0/1'.
Located about 224 million light-years distant, most of its members are spirals, which is unusual for Abell galaxy clusters.
Core Cluster Members: NGC708 (brightest member +12.7 - elliptical), NGC700, NGC703, NGC704, NGC705, NGC709, NGC710, PGC6974, UGC1319, CGCG522-30, MCG+6-5-24
8" SCT optical tube @ f6.3, Atlas Gem mount, ASI294MC & L-Pro filter @ 180 seconds livestacked for 30 minutes.

Abell 262 – Andromeda (Mag +13.3)   RA: 01 52 48   Dec: +36 08 00
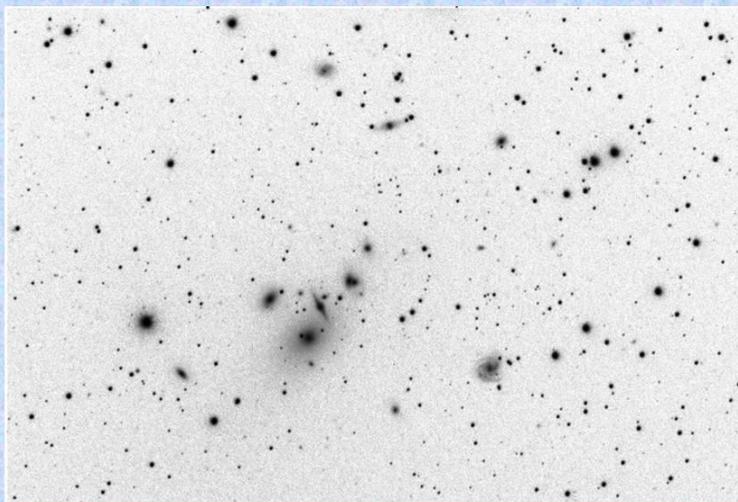
(8" SCT f6.3 & ZWO ASI294MC and L-pro broadband filter, 180 second subs for 30 minutes)

Abell 426 – Perseus   known as the "Perseus Galaxy Cluster" (image scale = 9' x 9' arc minutes) (near open cluster M34)
(cluster mag +12.5 – 10th brightest galaxy in cluster), #members=88, Abell class richness / distance: '2/0'.
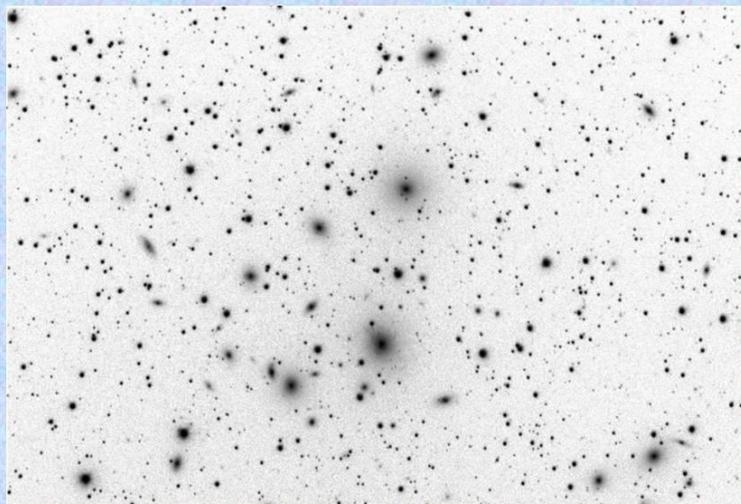Located about 230 million light-years distant, the closest of the nearby rich Abell galaxy clusters.
Core Cluster Members: NCG1275 (brightest member +11.9 – lenticular, X-ray & radio source 3C84 known as Perseus A,
which is a Seyfert galaxy with a quasar like core containing a supermassive blackhole),
NGC1270, NGC1271, NGC1272, NGC1273, NGC1277, NGC1278, NGC1281, NGC1282, NGC1283, IC1907
8" SCT optical tube @ f6.3, Atlas Gem mount, ASI294MC & L-Pro filter @ 180 seconds livestacked for 30 minutes.

Abell 671 - Cancer   (image scale = 24' x 16' arc minutes)
(cluster mag +14.9 – 10th brightest galaxy in cluster), #members=38, Abell class richness / distance: '0/3'.
Located about 600 million light-years distant.
Core Cluster Members: IC2380 (brightest member +11.1 - lenticular), IC2378, MAC0828+3024A, MAC0828+3024B,
MAC0828+3026, CGCG149-35, CGCG149-27, CGCG149-28
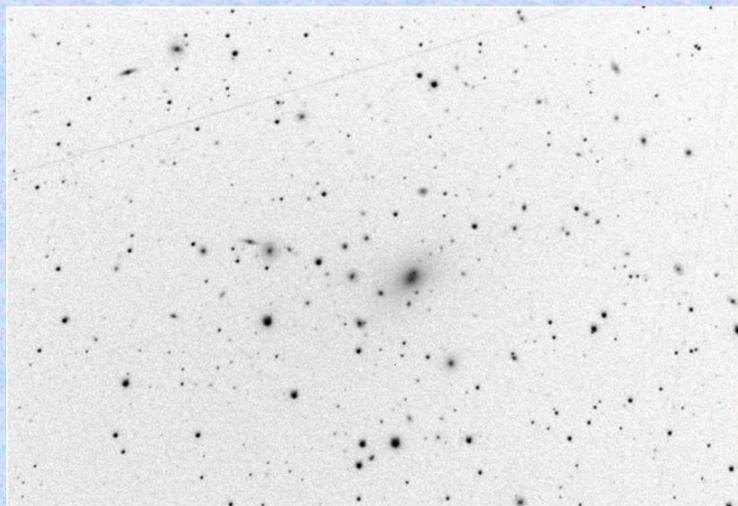8" SCT optical tube @ f6.3, Atlas Gem mount, ASI294MC & L-Pro filter @ 180 seconds livestacked for 30 minutes.
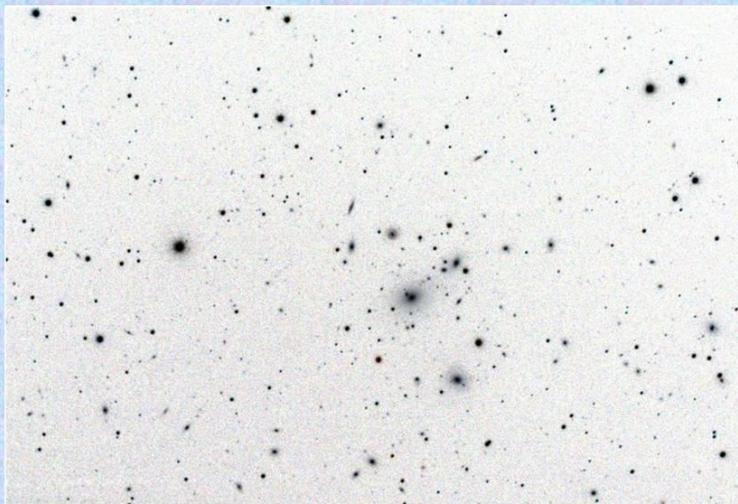
Abell 2199 - Hercules   (image scale = 24' x 16' arc minutes)   (near globular cluster M13)
(cluster mag +13.9 – 10th brightest galaxy in cluster), #members=88, Abell class richness / distance: '2/1'.
Located about 417 million light-years distant.
Core Cluster Members: NGC6166 (brightest member +12.8 - elliptical), NGC6166C, MCG+7-34-50, MCG+7-34-48,
PGC58277, PGC58278, PGC58279, PGC 58325, PGC58262, PGC2149914, PGC2153801, PGC2154233
8" SCT optical tube @ f6.3, Atlas Gem mount, ASI294MC & L-Pro filter @ 180 seconds livestacked for 30 minutes.

Abell 2199 – Hercules (Mag +13.9)   RA: 16 28 36   Dec: +39 31 00

(8" SCT f6.3 & ZWO ASI294MC and L-pro broadband filter, 180 second subs for 30 minutes)

Abell 4038 - Sculptor   (image scale = 24' x 16' arc minutes)
(cluster mag +14.7 – 10th brightest galaxy in cluster), #members=117, Abell class richness / distance: '2/2'.
Located about 430 million light-years distant.
Core Cluster Members: IC5358 (brightest member +13.4 - elliptical), IC5353, IC5354, PGC85756, PGC85759, PGC72451,
PGC72436, PGC72393, PGC85750, PGC85758, PGC72403, PGC747116
8" SCT optical tube @ f6.3, Atlas Gem mount, ASI294MC & L-Pro filter @ 180 seconds livestacked for 15 minutes.

Abell 4038 – Sculptor (Mag +14)   RA: 23 47 42   Dec: -28 08 00
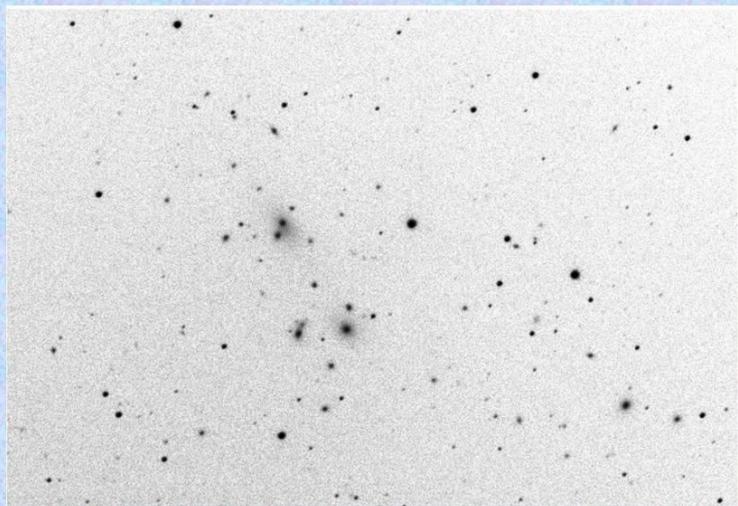
(8" SCT f6.3 & ZWO ASI294MC and L-pro broadband filter, 180 second subs for 30 minutes)

Hickson Compact Galaxy Clusters:

Hickson's catalog is recognized as an excellent compilation of challenging galaxy clusters for the observer with access to medium to large telescopes and dark skies. While several of the clusters contain one or more relatively bright NGC or IC galaxies, the majority of the catalog consists of faint galaxy clusters of PGC, UGC, or MCG galaxies.

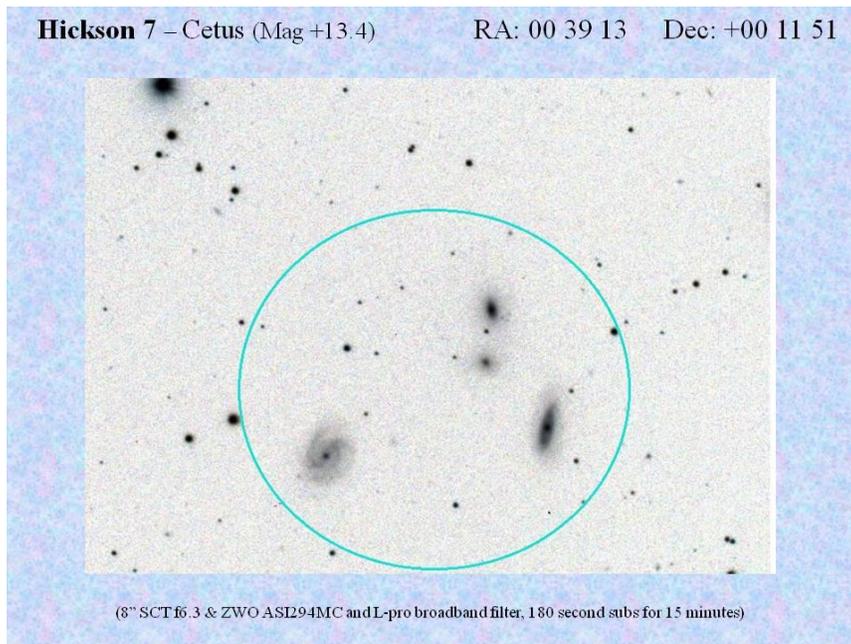(The average galaxy member magnitude is around +14. The faintest is HCG20 in Aries at +17.2).

Many of the groups have at least one member plotted in several popular printed star atlases such as 'Uranometra 2000' or the 'Millennium Star Atlas", and can also be found in various planetarium programs. You can also find 18 HCG's included within Halton Arp's 'Atlas of Peculiar Galaxies'. All 100 catalog members have high enough declinations to be viewable by northern hemisphere observers. http://stellar-journeys.org/HicksonGalaxy.htm

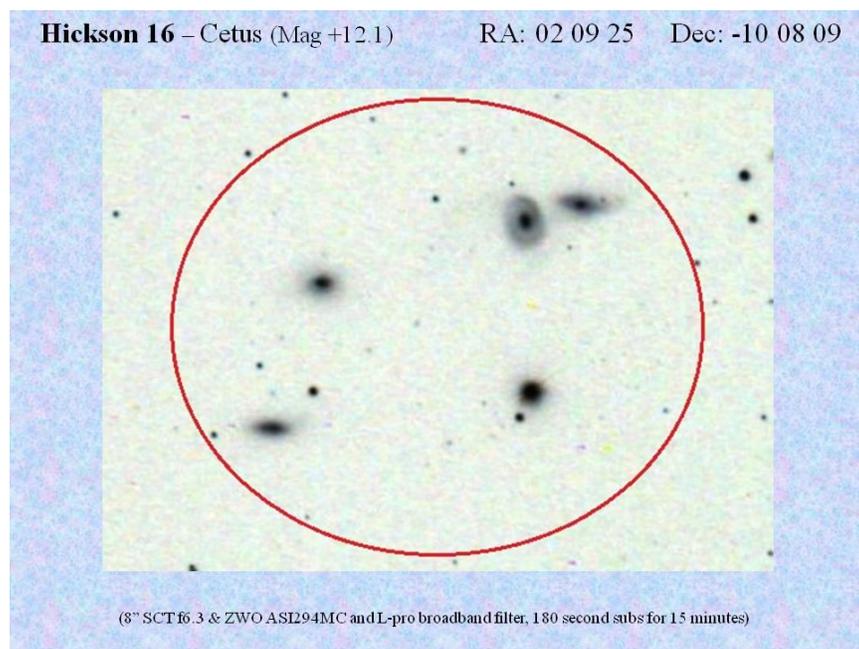HCG-7 - Cetus   (image scale = 16.5' x 12' arc minutes)
(Cluster mag +13.4 = brightest member), #members=4, Located about 189 million light-years distant.
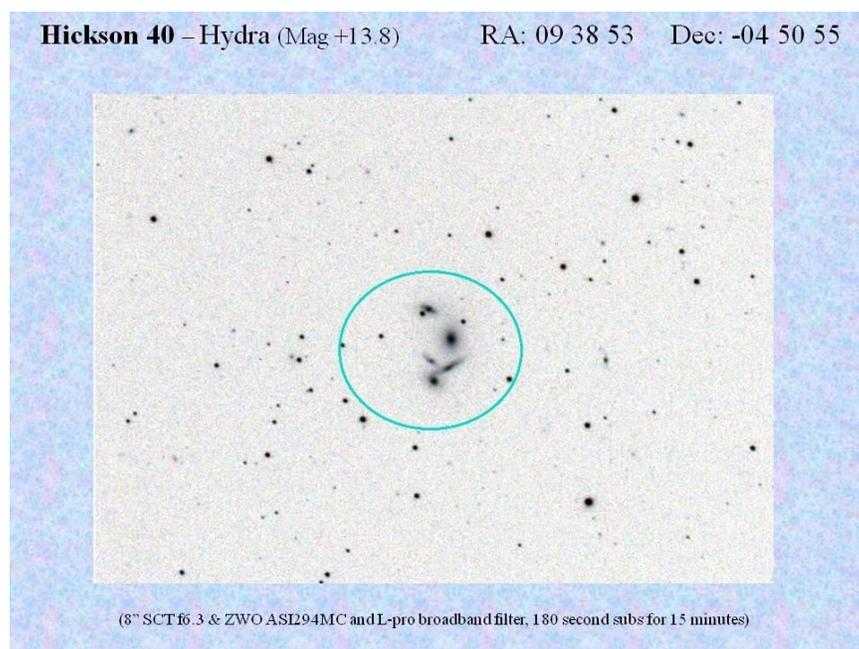Cluster Members: NGC192 (brightest - spiral), NGC196, NGC197, and NGC201
8" SCT optical tube @ f6.3, Atlas Gem mount, ASI294MC & L-Pro filter @ 180 seconds livestacked for 15 minutes.

Hickson 7 – Cetus (Mag +13.4)   RA: 00 39 13   Dec: +00 11 51

(8" SCT f6.3 & ZWO ASI294MC and L-pro broadband filter, 180 second subs for 15 minutes)

HCG-16 - Cetus   (image scale = 11' x 8' arc minutes)   Arp318
(Cluster mag +12.1 = brightest member), #members=4, Located about 110 million light-years distant.
Cluster Members: NGC835 (brightest - spiral),   NGC833, NGC838, and NGC839
8" SCT optical tube @ f6.3, Atlas Gem mount, ASI294MC & L-Pro filter @ 180 seconds livestacked for 15 minutes.

Hickson 16 – Cetus (Mag +12.1)   RA: 02 09 25   Dec: -10 08 09

(8" SCT f6.3 & ZWO ASI294MC and L-pro broadband filter, 180 second subs for 15 minutes)

HCG-40 - Hydra   (image scale = 16.5' x 12' arc minutes)   Arp321
(Cluster mag +13.8 = brightest member), #members=5, Located about 280 million light-years distant.
Cluster Members: MCG-1-25-9 (brightest - elliptical), MCG-1-25-8, MCG-1-25-10, MCG-1-25-11, MCG-1-25-12
8" SCT optical tube @ f6.3, Atlas Gem mount, ASI294MC & L-Pro filter @ 180 seconds livestacked for 15 minutes.

Hickson 40 – Hydra (Mag +13.8)   RA: 09 38 53   Dec: -04 50 55

(8" SCT f6.3 & ZWO ASI294MC and L-pro broadband filter, 180 second subs for 15 minutes)
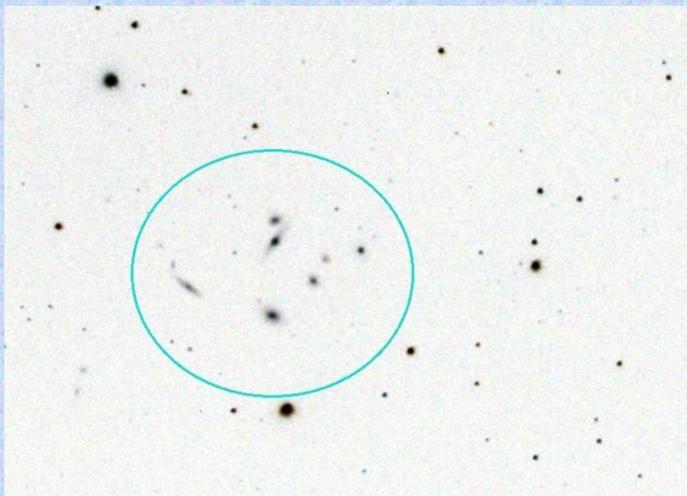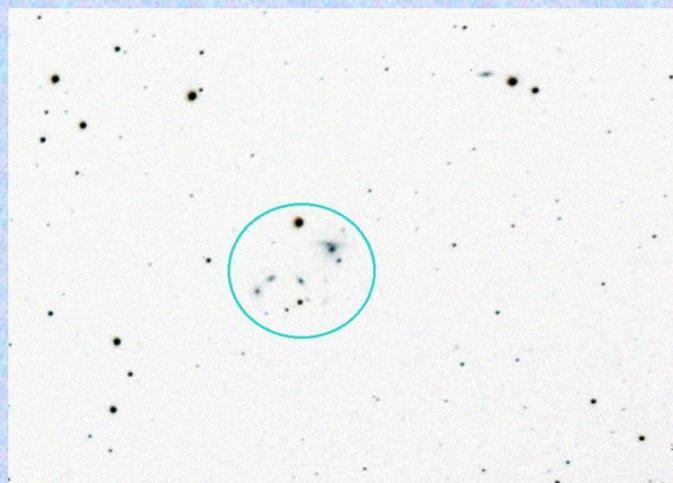
HCG-70 – Canes Venatici   (image scale = 16.5' x 12' arc minutes)
(Cluster mag +15.1 = brightest member), #members=7, Located about 375 million light-years distant.
Cluster Members: IC4370 (brightest - spiral),   IC4371, IC4369, PGC50123, MCG+6-31-65, MCG+6-31-60, MCG+6-31-57
8" SCT optical tube @ f6.3, Atlas Gem mount, ASI294MC & L-Pro filter @ 180 seconds livestacked for 15 minutes.

Hickson 70 – Canes Venatici (Mag +15.1) RA: 14 04 11 Dec: +38 18 29

(8" SCT f6.3 & ZWO ASI294MC and L-pro broadband filter, 180 second subs for 15 minutes)

HCG-75 – Serpens   (image scale = 16.5' x 12' arc minutes)
(Cluster mag +15.0 = brightest member), #members=6, Located about 596 million light-years distant.
Cluster Members: CGCG135-50 (brightest - elliptical), PGC54802, PGC54803, PGC54818, PGC54824, and PGC54827
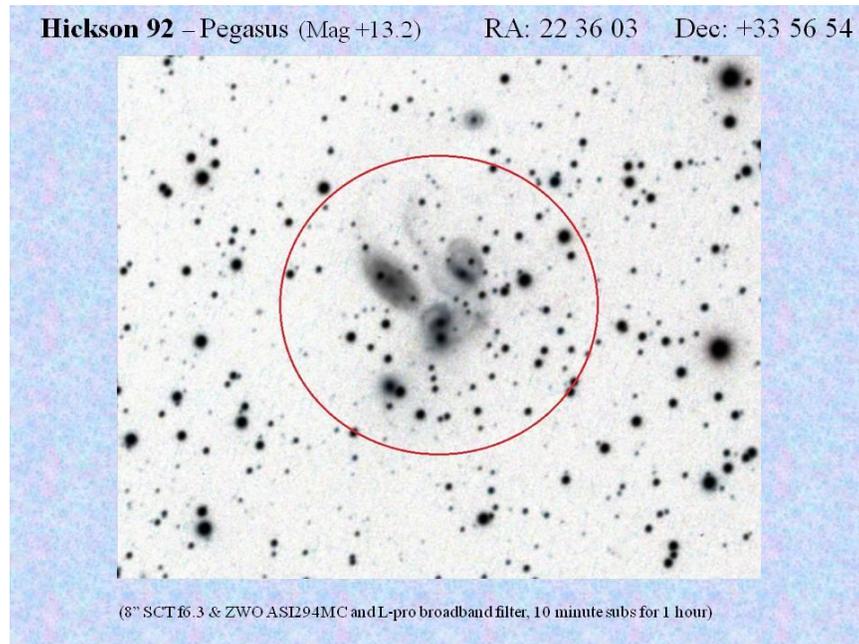Nearby Galaxies: PGC1646140
8" SCT optical tube @ f6.3, Atlas Gem mount, ASI294MC & L-Pro filter @ 180 seconds livestacked for 15 minutes.

Hickson 75 – Serpens (Mag +15.0)   RA: 15 21 30   Dec: +21 11 26

(8" SCT f6.3 & ZWO ASI294MC and L-pro broadband filter, 180 second subs for 15 minutes)

HCG-92 - Pegasus   (image scale = 14.5' x 12' arc minutes)   Arp 319 - "Stephans Quintet"
(Cluster mag +13.2 = brightest member), #members=5, Located about 280 million light-years distant.
Cluster Members: NGC7320 (brightest - spiral),   NGC7318B, NGC7319, NGC7318A, and NGC7317
8" SCT optical tube @ f6.3, Atlas Gem mount, ASI294MC & L-Pro filter @ 10 minute subs livestacked for 1 hour.

HCG-94 – Pegasus   (image scale = 16.5' x 12' arc minutes)
(Cluster mag +14.3 = brightest member), #members=7, Located about 564 million light-years distant.
Cluster Members: NGC7578A (brightest - elliptical),   NGC7578B, PGC70936, PGC70937 (+17.7), PGC70939 (+18.2),
PGC70941 (+18.4), PGC70943   Nearby Galaxies: MAC 2316+1845
8" SCT optical tube @ f6.3, Atlas Gem mount, ASI294MC & L-Pro filter @ 180 seconds livestacked for 15 minutes.
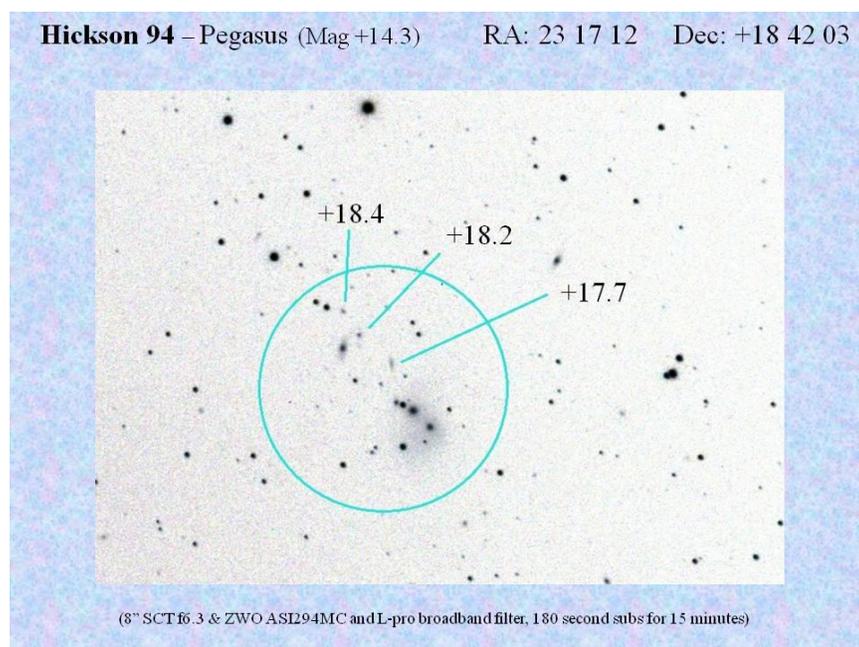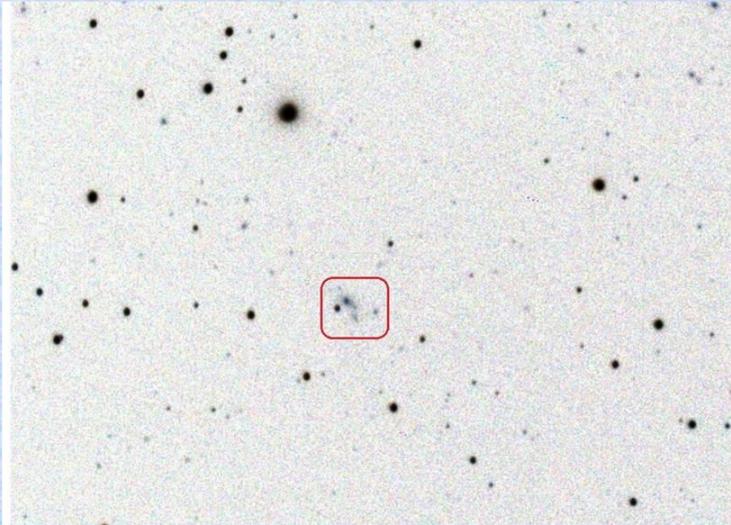
Palomar Compact Galaxy Clusters:
The Palomar catalog is recognized as an excellent compilation of very challenging galaxy clusters for the observer with access to large telescopes or imaging kits, and dark skies. Due to their great distance, the majority of the catalog members are very faint galaxy clusters, (+15th Mag and fainter), and generally not plotted on star atlases or listed in planetarium programs. You will need to utilize the cluster's RA & Dec to find the object. For the most part, Palomar clusters can be very difficult to observe visually, requiring large 24" and greater telescopes, along with dark skies. For imagers, 6" to 8" size optics will be required, and once again, broadband filters, such as the L-Pro, can be a big help.
http://stellar-journeys.org/PalomarGalaxyTour.htm

PCG2332+1144 – Pegasus   (image scale = 16.5' x 12' arc minutes)
(galaxy cluster mag +15.6), #members=4, Located about ??? billion light-years distant.
8" SCT optical tube @ f6.3, Atlas Gem mount, ASI294MC & L-Pro filter @ 180 seconds livestacked for 15 minutes.
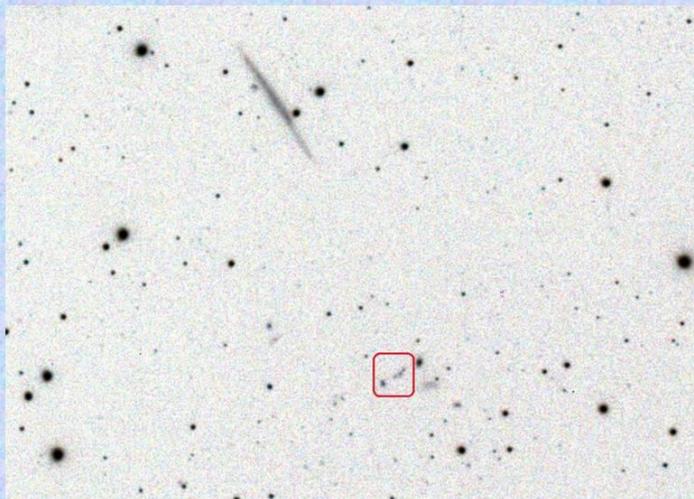

PCG2332+1144 – Pegasus (Mag +15.6) RA: 23 32 31   Dec: +11 44 32
(8" SCT f6.3 & ZWO ASI294MC and L-pro broadband filter, 180 second subs for 15 minutes)

PCG2259+1329 - Pegasus   (image scale = 16.5' x 12' arc minutes)
(galaxy cluster mag +15.7), #members=4, Located about 1.8 billion light-years distant. Nearby Galaxies: UGC12281

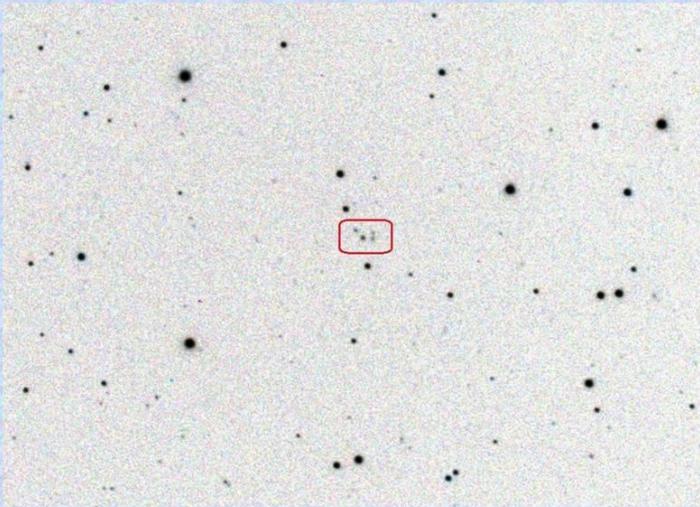PCG2259+1329 – Pegasus (Mag +15.7) RA: 22 59 03   Dec: +13 29 34
(8" SCT f6.3 & ZWO ASI294MC and L-pro broadband filter, 180 second subs for 15 minutes)

PCG0011+0544 - Pisces   (image scale = 16.5' x 12' arc minutes)
(galaxy cluster mag +16.1), #members=4, Located about 2.1 billion light-years distant.
 8" SCT optical tube @ f6.3, Atlas Gem mount, ASI294MC & L-Pro filter @ 180 seconds livestacked for 15 minutes.

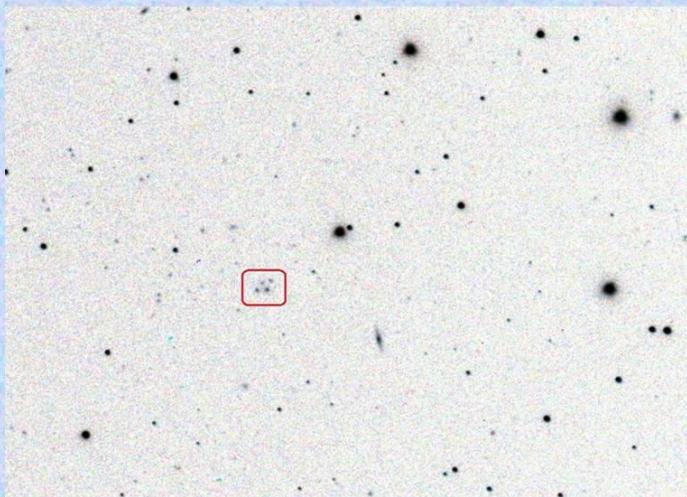PCG0011+0544 – Pisces (Mag +16.1)   RA: 00 11 09   Dec: +05 44 49

(8" SCT f6.3 & ZWO ASI294MC and L-pro broadband filter, 180 second subs for 15 minutes)

PCG0209+1039 - Aries   (image scale = 16.5' x 12' arc minutes)
(galaxy cluster mag +15.5), #members=4, Located about ??? billion light-years distant.
8" SCT optical tube @ f6.3, Atlas Gem mount, ASI294MC & L-Pro filter @ 180 seconds livestacked for 15 minutes.

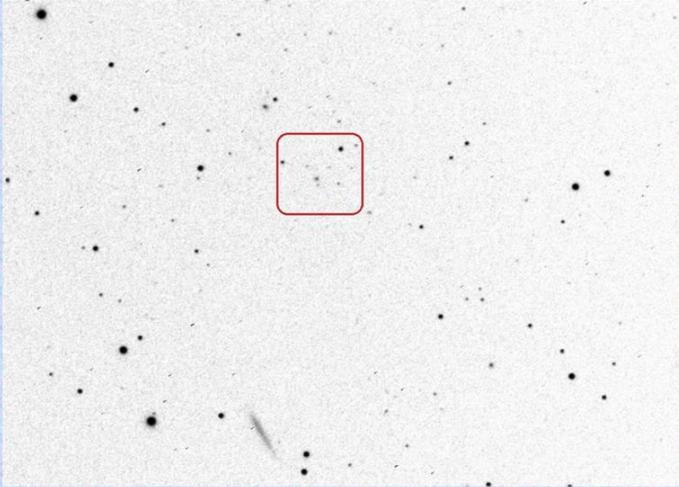PCG0209+1039 – Aries (Mag +15.5)   RA: 02 09 15   Dec: +10 39 53

(8" SCT f6.3 & ZWO ASI294MC and L-pro broadband filter, 180 second subs for 15 minutes)

PCG0904+4523 - Lynx   (image scale = 16.5' x 12' arc minutes)
(galaxy cluster mag +16.3), #members=4, Located about 2.9 billion light-years distant.
Nearby Bright Galaxies: PGC25472
8" SCT optical tube @ f6.3, Atlas Gem mount, ASI294MC & L-Pro filter @ 180 seconds livestacked for 15 minutes.

PCG0904+4523 –Lynx (Mag +16.3)   RA: 09 04 27   Dec: +45 23 47

(8" SCT f6.3 & ZWO ASI294MC and L-pro broadband filter, 180 second subs for 15 minutes)

PCG0854+4919 - Ursa Major   (image scale = 16.5' x 12' arc minutes)
(galaxy cluster mag +15.3), #members=4, Located about 2.7 billion light-years distant.
Nearby Bright Galaxies: PGC90877
8" SCT optical tube @ f6.3, Atlas Gem mount, ASI294MC & L-Pro filter @ 180 seconds livestacked for 15 minutes.

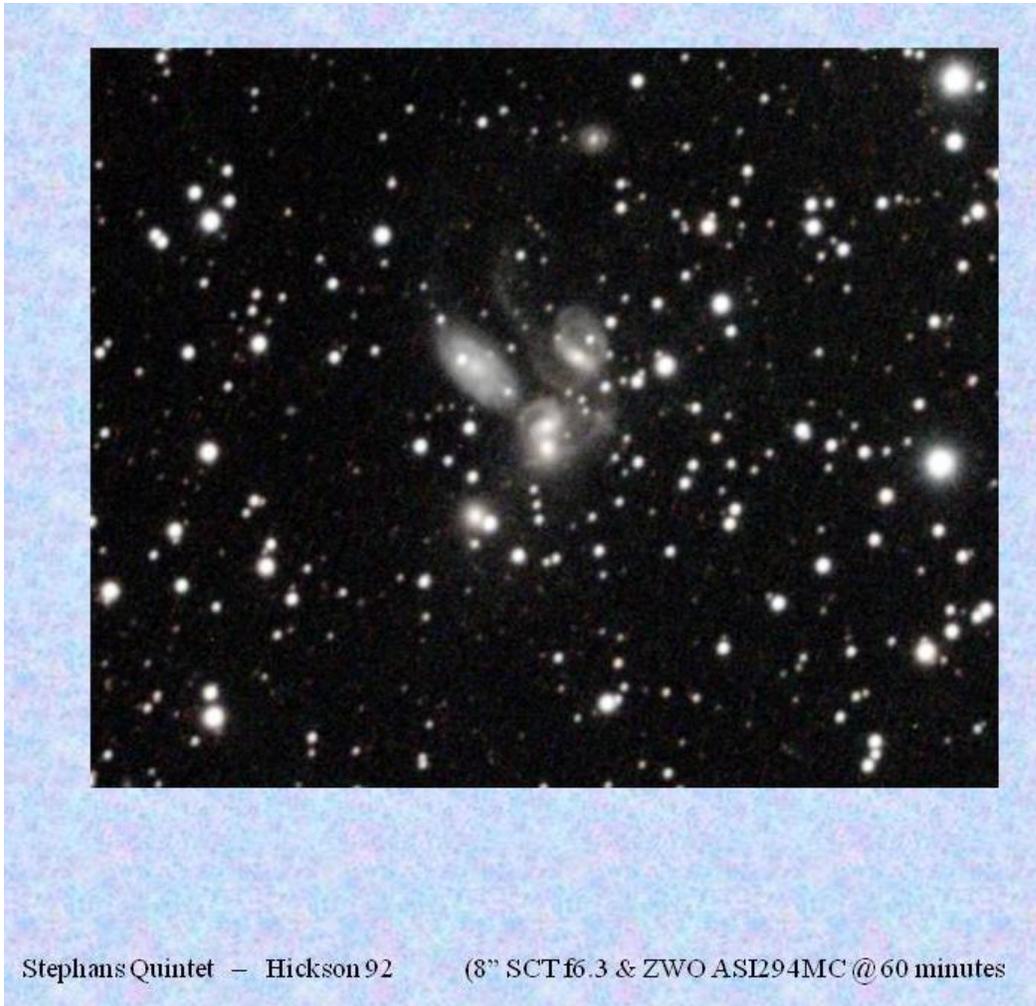PCG0854+4919 – Ursa Major (Mag +15.3) RA:08 54 49 Dec:+49 19 12
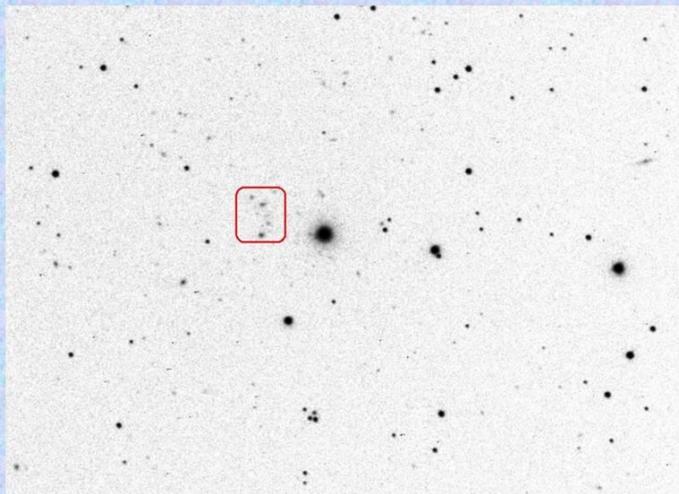
(8" SCT f6.3 & ZWO ASI294MC and L-pro broadband filter, 180 second subs for 15 minutes)

Conclusion :
So today I introduced you to a class of large scale deep sky objects – galaxy clusters, and some of their catalogs.
We learned a little about the individuals behind each catalog, and reviewed EAA capture image examples of various
members of each catalog. Hopefully this little presentation has inspired you to search-out and explore these very
rewarding celestial objects. These huge three-dimensional structures that are the fundamental building blocks of the
universe!

So I encourage everyone to get out tonight and try your hand at finding and observing these elusive deep-sky objects,
the galaxy clusters of George Abell, Paul Hickson, and Angela Iovino.

Stephans Quintet – Hickson 92   (8" SCT f6.3 & ZWO ASI294MC @ 60 minutes

Thank you.
Larry McHenry   http://stellar-journeys.org/

References

Books:
"*The Realm* of the *Nebulae*", by Edwin Hubble , 1936.
"*The Night Sky Observer's Guide Volume1 Autum & Winter*", by George Kepple & Glen Sanner, 1998.
"*The Local Group*", by Alvin Huey, 2008 www.faintfuzzies.com
"*Annals of the Deep Sky*", by Jeff Kanipe & Dennis Webb, Volume 1 & 7, 2015
"Webb Society Deep-Sky Observer's Handbook – Volume 5 Clusters of Galaxies", by Kenneth Glyn Jones, 1982.

Magazines:
"*All About M31*", Deep Sky , Fall 1984
"*Observing the Local Group*", Deep Sky , Autumn 1991
"*Welcome to the Neighborhood*", Astronomy, March 2019
"*A Visual Tour of M31*", Sky & Telescope, November 1993
"*Exploring Messier 31*", Sky & Telescope, November 2013
"*Exploring the Triangulum Galaxy*", Sky & Telescope, December 2013
"*A Universe of Galaxies*", Astronomy, March 2019
"*All About Our Local Supercluster*", Astronomy, March 2019

Professional Images:
M51 - Jon and Bryan Rolfe/Adam Block/NOAO/AURA/NSF
M82 - Joe Jordan/Adam Block/NOAO/AURA/NSF
M87 - Adam Block/NOAO/AURA/NSF
M101 - Adam Block/NOAO/AURA/NSF
NGC4565 - Bruce Hugo and Leslie Gaul/Adam Block/NOAO/AURA/NSF
NGC4535 - Doug Matthews and EJ Jones/Adam Block/NOAO/AURA/NSF
Stephans Quintet - Adam Block/NOAO/AURA/NSF
M66 - Jeff Hapeman/Adam Block/NOAO/AURA/NSF
NGC6822 - Julie and Jessica Garcia/Adam Block/NOAO/AURA/NSF
M104 - Morris Wade/Adam Block/NOAO/AURA/NSF
NGC7479 - Adam Block/NOAO/AURA/NSF
Coma Cluster - NOAO/AURA/NSF
Abell 671 - Michael Petrasko and Muir Eveden/Adam Block/NOAO/AURA/NSF

Internet resources:
Advanced Observing Program: National Optical Astronomy Observatory - Kitt Peak Az:
http://www.noao.edu/outreach/aop/observers/bestof.html
"Students for the Exploration and Development of Space": http://www.seds.org
"Earth Centered Universe" by David Lane: http://www.nova-astro.com/
Google & Wikipedia: *various entries*