
OFF THE DEEP END
Challenging observing projects for amateur astronomers

OFF THE DEEP END

Personal 24-inch f/3.7 Starstructure

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Jimi Lowrey's 48-inch f/4
Fort Davis, Texas

Abell Planetary Nebulae

- George Abell – worked on the famous Palomar Observatory Sky Survey as a Cal Tech grad student in the early 1950's
- Published an initial list of 73 planetaries in 1955 and final study in 1966 with 86 planetaries (Abell 1-86)
- Many are highly evolved with a large size but low surface brightness. Essential amateur observing tool – OIII filter (1980)

Spherical Symmetry
Abell 39 in Hercules

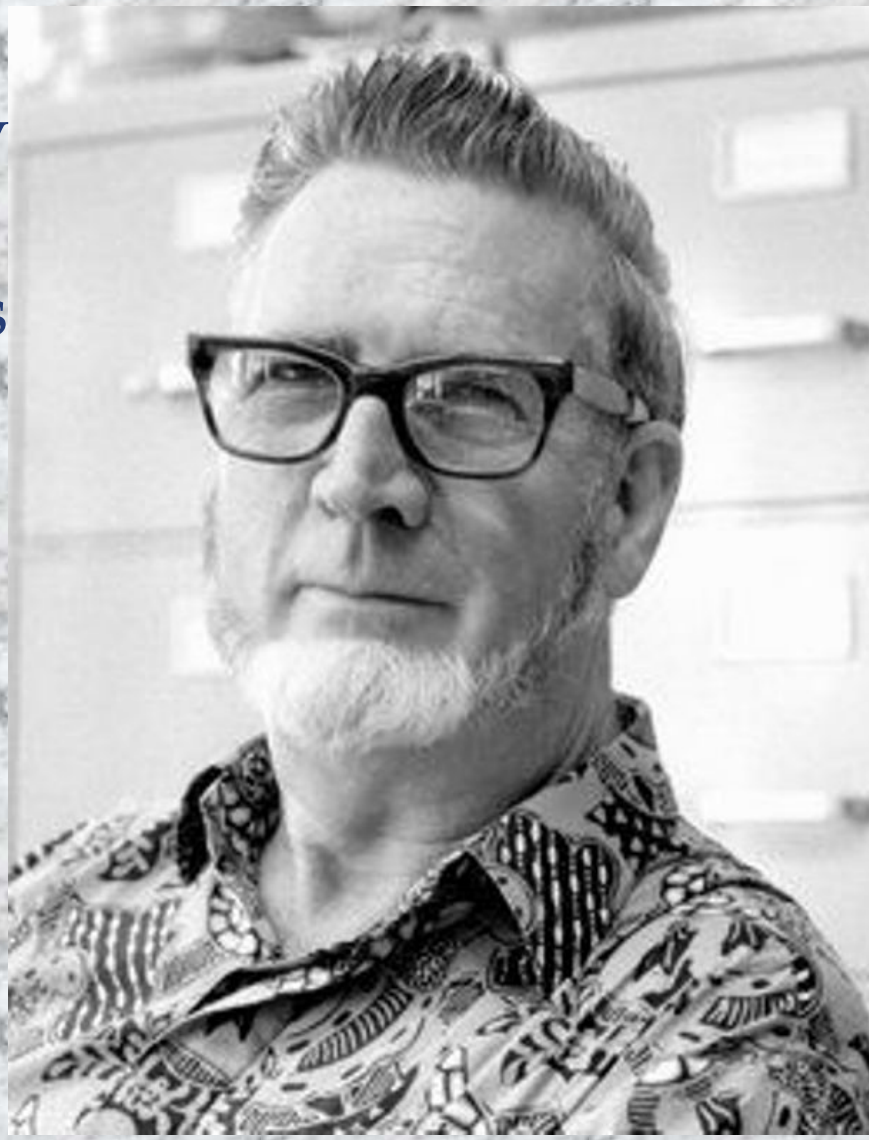
- 3′ diameter – perfect spherical bubble!
- Distance: 5,500 l.y
  Diameter: 5.5 l.y.
  Central star: 15.7
- Faintly visible unfiltered in 18″. With filter, visible in 8″ (or smaller).

Diamond Ring Planetary
Abell 70 in Aquila

- Background galaxy at 250 million l.y. shines through the rim! (10,000x distant)
- Rare barium-rich binary, with a white dwarf + "polluted" main-seq. star.
- Weak ring visually – galaxy visible as a brighter spot on rim – "Diamond Ring" effect.

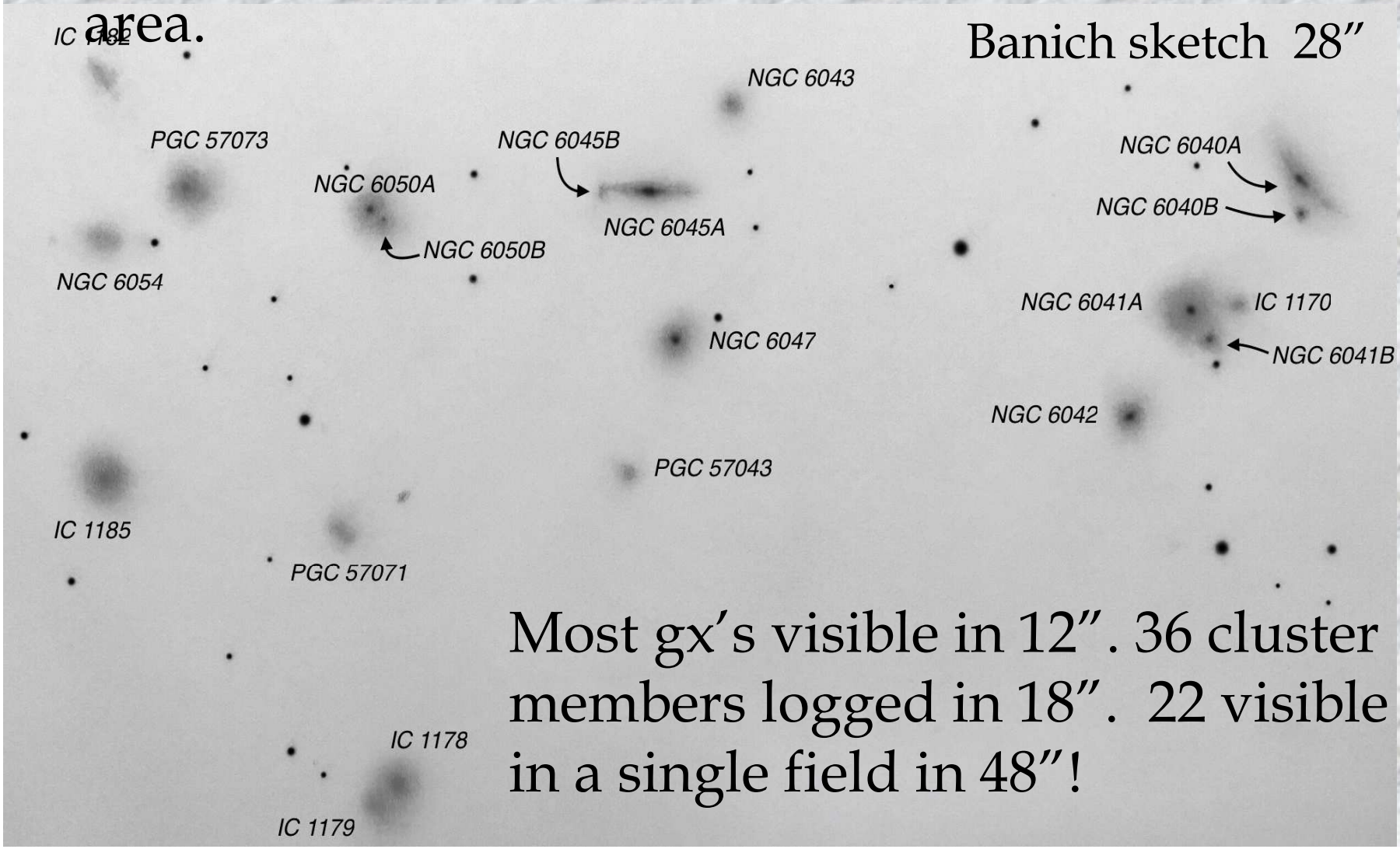
Abell Galaxy Clusters

- PhD dissertation on the distribution of rich galaxy clusters
- Only a few dozen clusters known prior to 1950.
- Seminal 1958 study on 2712 rich clusters found on the POSS.
- Galaxy clusters selected based on size, galaxy counts and richness. Distance estimated based on 10th brightest galaxy



Hercules Galaxy Cluster (Abell 2151)

500 million light years. Irregular structure with 50% spirals and irregulars. 300 members within a 1.5° area.

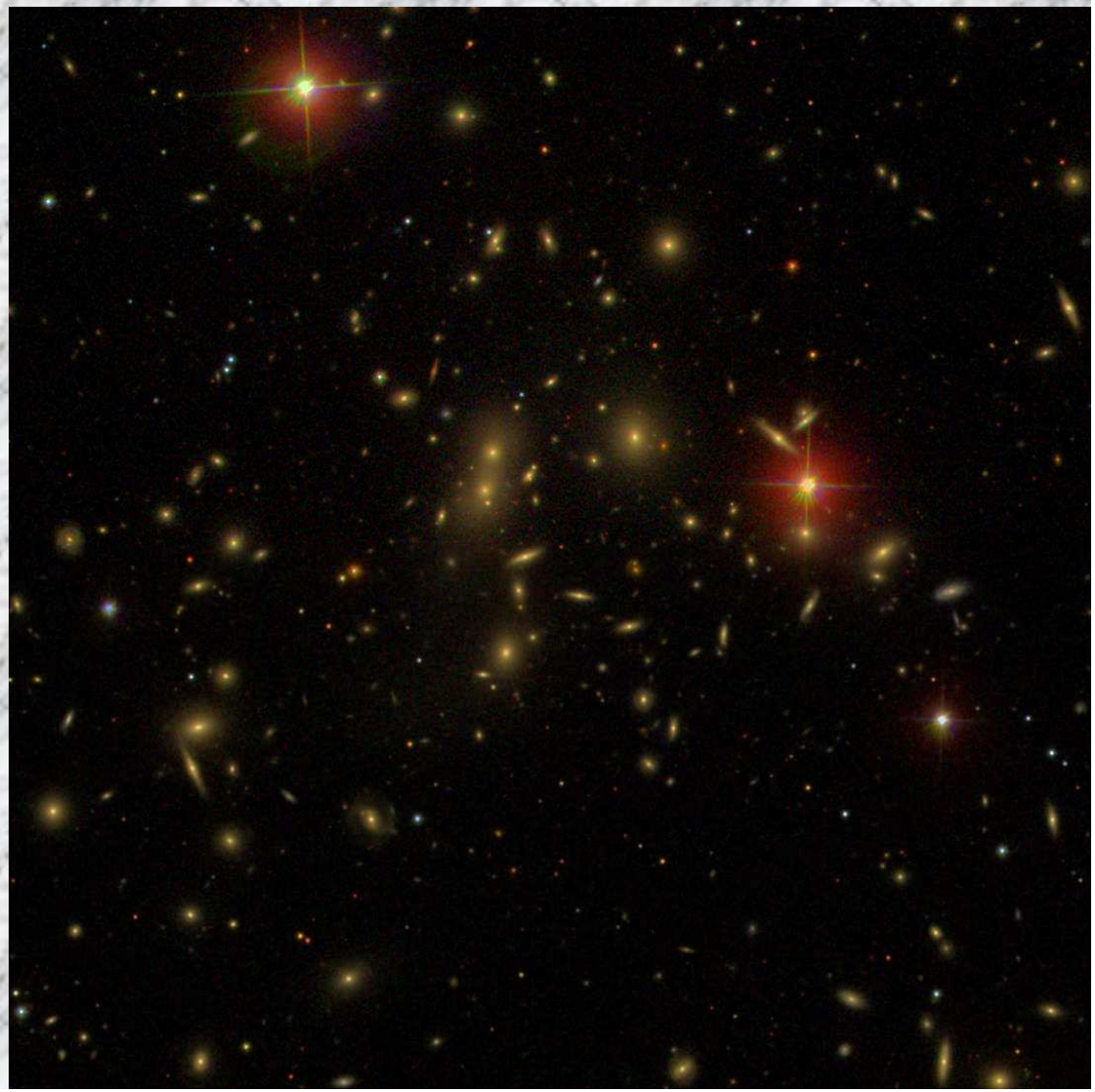


Banich sketch 28″

Most gx's visible in 12″. 36 cluster members logged in 18″. 22 visible in a single field in 48″!

A sea filled with galaxies
Corona Borealis GX Cluster

- Abell 2065: Over 400 members mag 16 and fainter.
- RASC: "Perhaps the most difficult object for amateur scopes"
- At 1 billion l.y., the most distant cluster visible in 18". Six members visible in 18". 35+ in a single field in 48"!



Palomar and Terzan Glob. Clusters

Agop Terzan

- In 1955, Abell published a list of 13 faint globulars found by Albert Wilson and himself on the Palomar Sky survey
- In the late 1960's Armenian astronomer Agop Terzan discovered 11 globular clusters in the near infrared while surveying the center of the Milky. Previously missed as highly obscured by dust.
- Terzan 7 and 8 may be captured from the Sagittarius Dwarf galaxy.

Palomar 8 in Sagittarius

- George Abell found Pal 8 on the POSS in the early 1950's
- But pouring over the Lick Archives I uncovered that E.E. Barnard discovered it visually in 1889 with a 12" refractor and even said it was likely a globular cluster.
- Reported to have been glimpsed in 70mm refractor. At least a dozen stars resolved in 18".

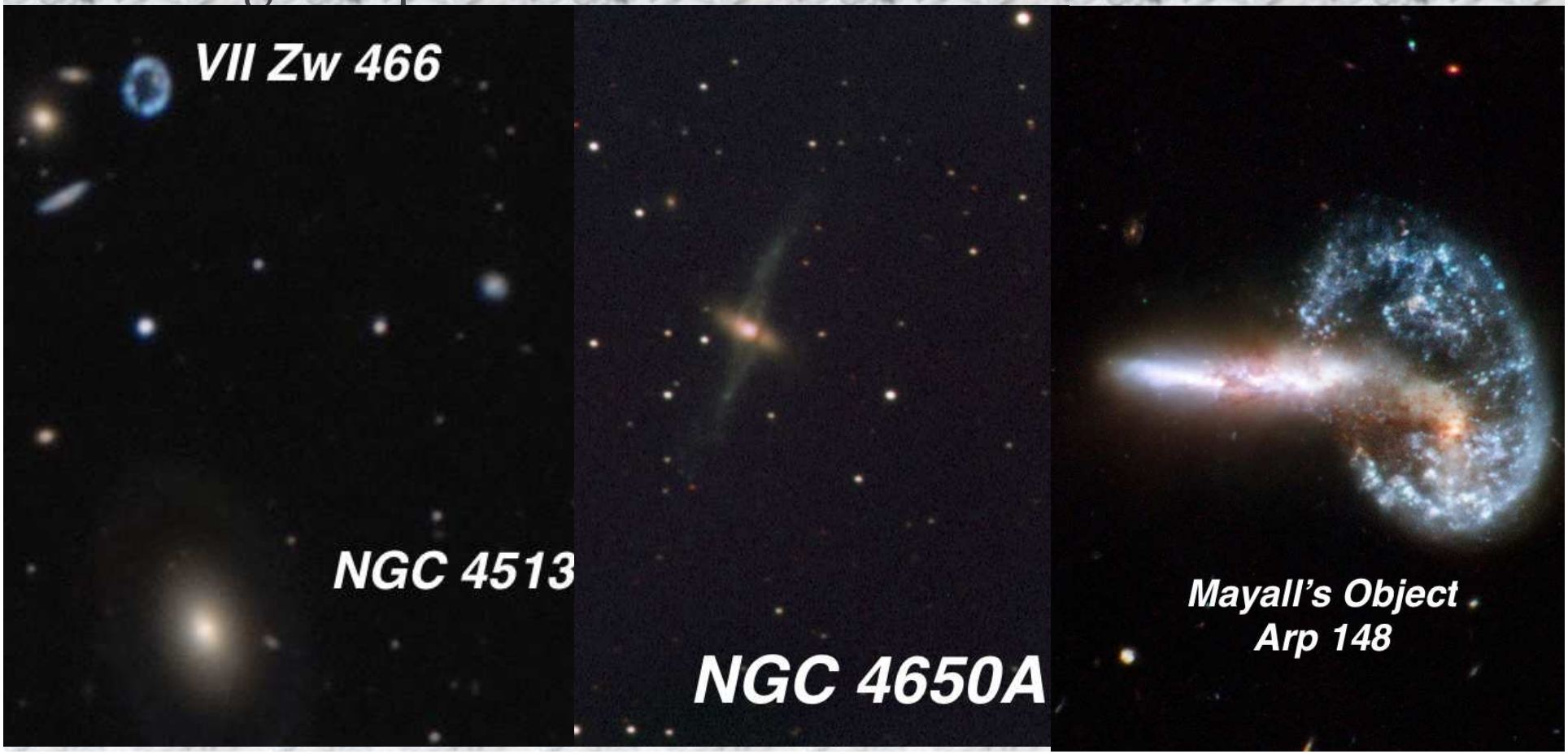
Terzan 1 in Scorpius

- Distance 20,000 light years. Consists of old red stars, highly obscured.
- X-ray burst discovered in 1980's from a binary with normal star and a dense neutron star snatching gas from companion.
- Very difficult visually, though seen in 24". In 48", half-dozen stars resolved at 697x.

HST image (WFPC2)

Ring Galaxies

- Various types including collisional ring, polar ring, Hoag ring, empty ring
- Challenging objects – in a few cases distinct donuts seen in large scopes and "Saturn-like" extensions.

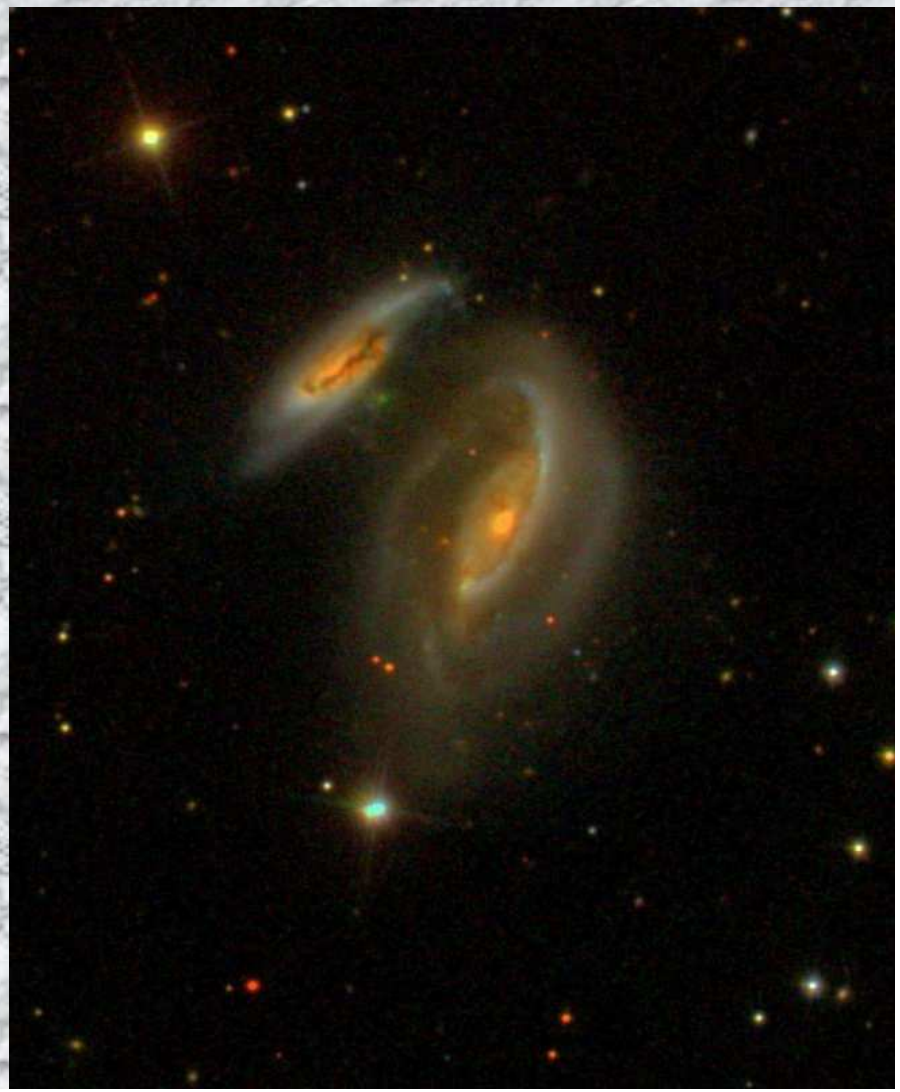


Boris Vorontsov-Velyaminov Interacting Galaxies (V-V)

- Second major study based on the POSS – 1959 ***Atlas and Catalogue of Interacting Galaxies***
- 355 interacting systems divided into 20 classes such as merging, nests and chains with bridges.
- Many deformed pairs of galaxies inspired Halton Arp's peculiar galaxies
- Minimum 8" scope. Vast majority visible in 18".

Heavenly Taffy – VV 254

- Two gas-rich spirals in Pegasus collided 20 million years ago.
- Connected by a gas bridge that resembles strands of pulled taffy
- Spiral arms visible in 48" and the arms nearly connect at the north end.



Hubble's Rose – VV 323

- Post-collision pair with smaller galaxy piercing main galaxy.
- Highly warped spiral arms, young blue star clusters.
- Spiral arms visible in 48″ and nearly connect to companion.

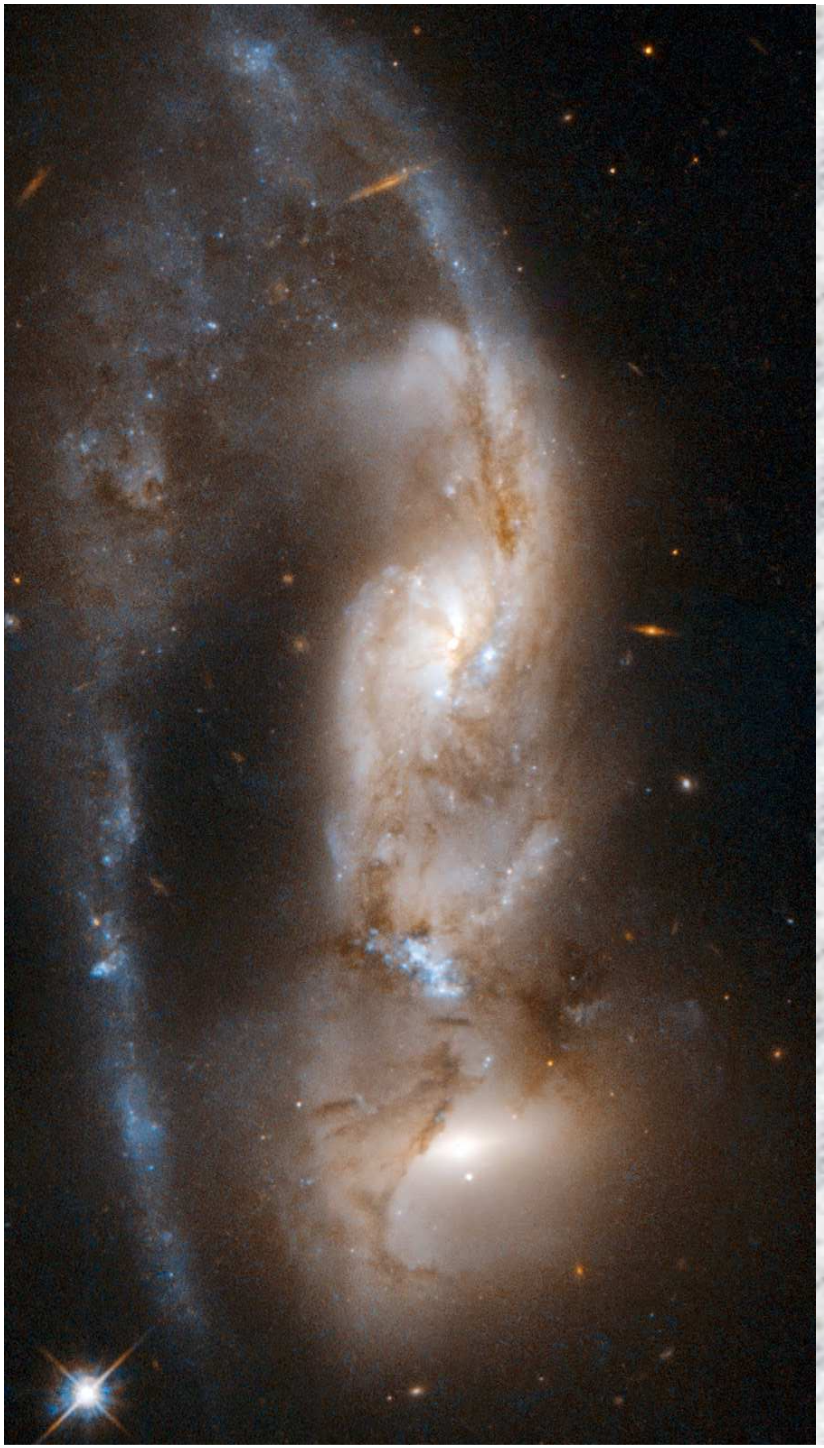
Coalescing Pair – VV 102

- Fused double system in Delphinus with two nuclei separated by only 16”!
- Distance of 420 million light years with nuclei 35,000 l.y. apart – on their way to merging
- Twin nuclei resolved in my 24” at 375x

Arp's Atlas of Peculiar Galaxies

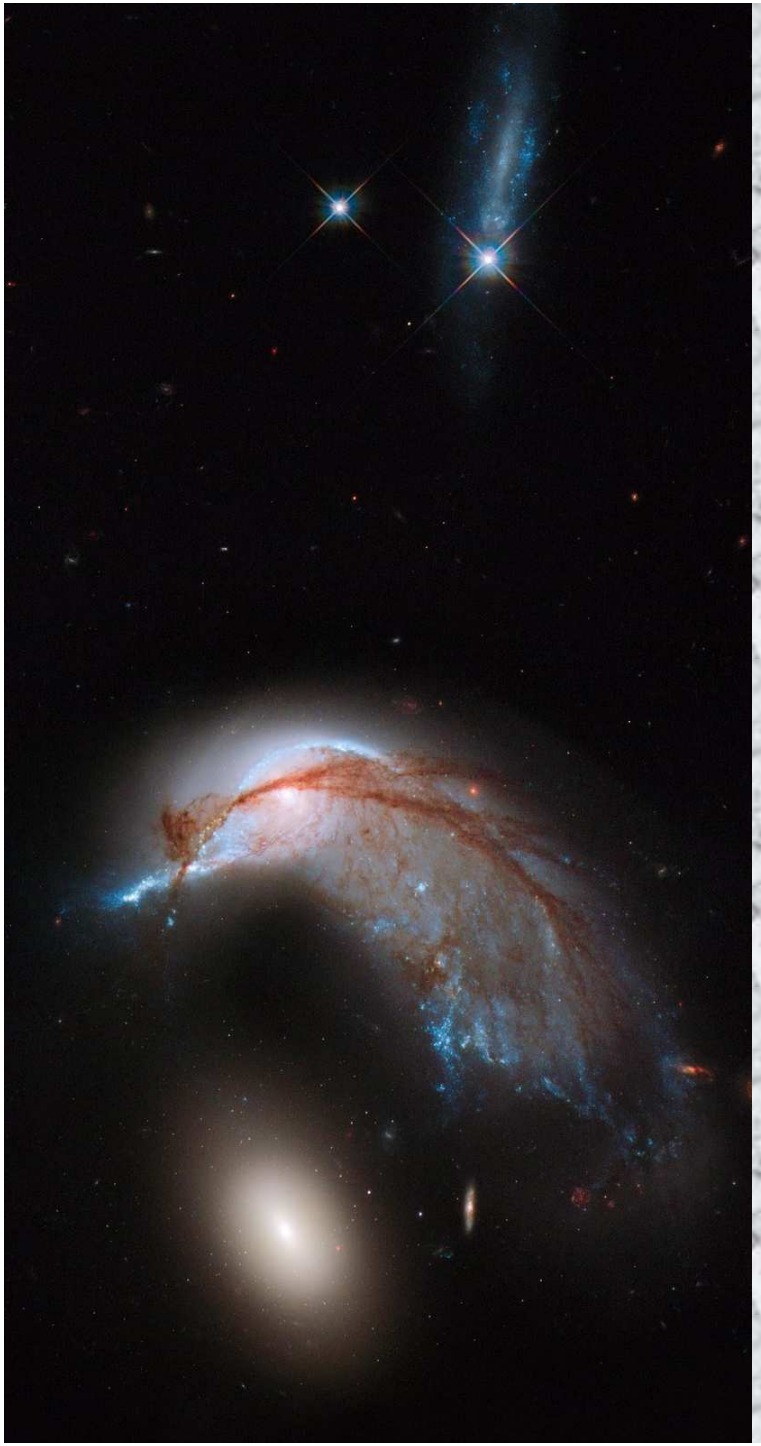
- Challenged foundations of modern astronomy by arguing the redshifts to quasars were not linked to distance -- essentially exiled from astro community.
- 1966 Atlas (images using Palomar 200") with 338 peculiar individual galaxies and groups, many interacting.

Split into numerous categories e.g. galaxies with rings, jets, interior absorption, ejected material, loops, double galaxies with connected arms, filaments, galaxy groups and chains. Challenging both to observe and detect structure with 16" and larger scopes



Edward's Galaxy
Arp 81 in Draco

- NGC 6621 and 6622 discovered in 1885 by 14 year-old Edward Swift
- Unusual one-sided tidal tail resulted from collision 100 million years ago
- Blue knot in overlap region – young super-star cluster
- Spiral arms, knots and entire tidal tail visible in 48″ at 697x



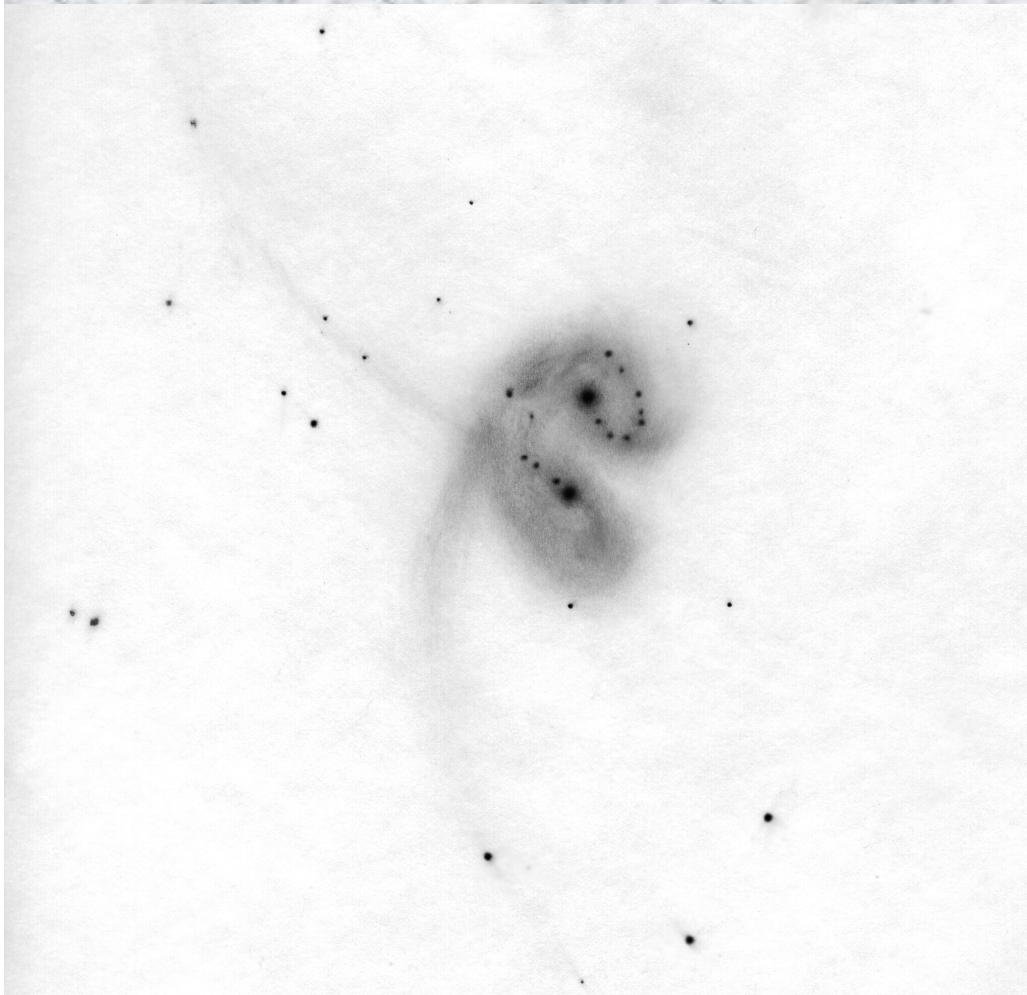
Penguin and Egg

Arp 142 in Hydra

- NGC 2937 (“Egg”) and NGC 2936 (“Penguin”), a highly distorted spiral with a warped disc crossed by dust lanes. A tidal tail with bursts of star formation forms the shredded “neck”
- Arp considered the blue galaxy at the top as a “shred” or “jet”, ejected from the collision but it lies in the foreground, at 70% distance.

The Antennae

Arp 244 in Corvus



Sketch: Howard Banich – 90″ Bok telescope

- NGC 4038/4039 is the closest extreme mash-up of two gas-rich spirals. Closest approach 250 million years ago.
- Giant molecular clouds were compressed during collision, triggering numerous super star clusters.
- Bizarre annular shape, distorted spiral arm (rim) with numerous HII knots and very challenging tidal tails

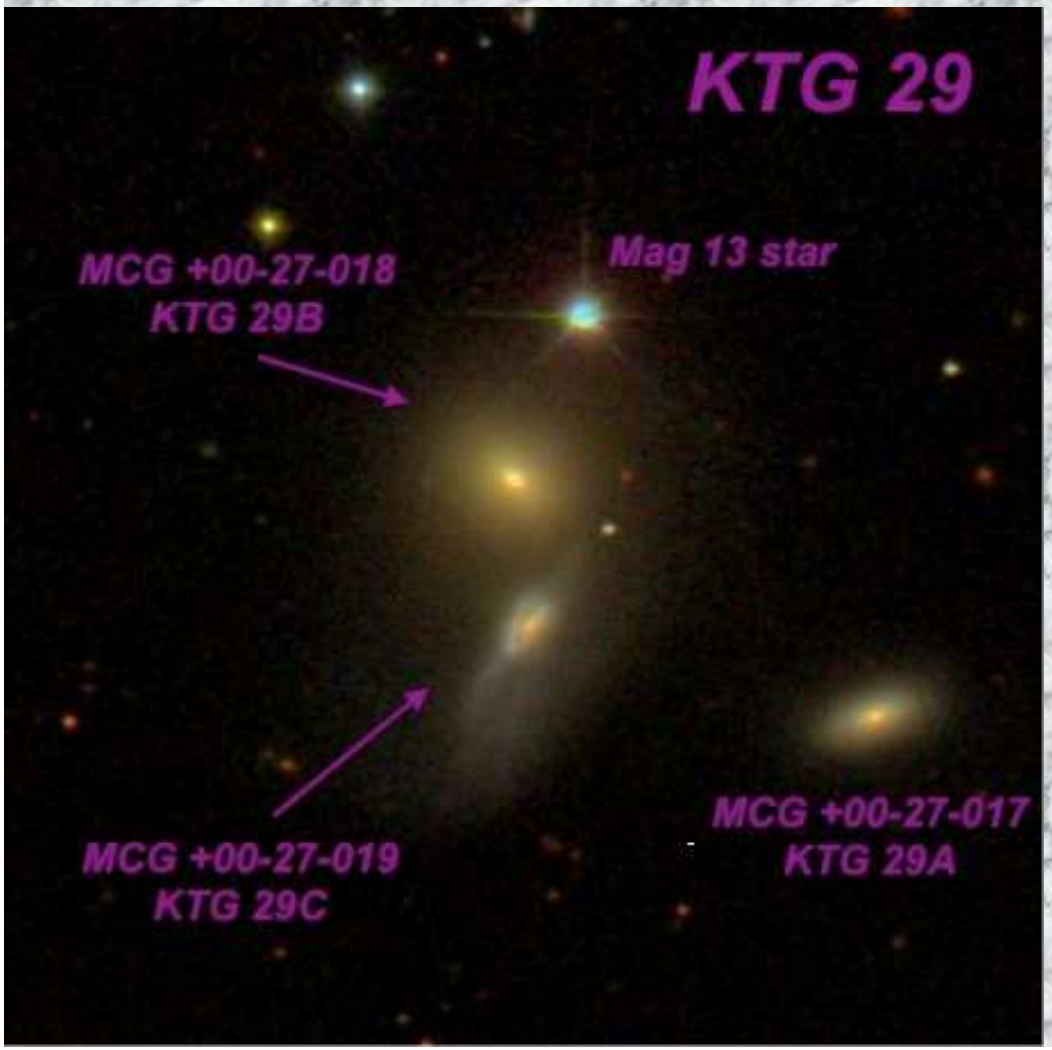
Karachentsev Triplets (KTG) and Rose Quartets

- 84 isolated northern triplets found in 1970's on POSS by husband/wife Igor and Valentina Karachentsev.
- Individual galaxies all 16th mag (pg.) or brighter.

Compact ***Rose Quartets*** found in the mid- 1970's by James Rose on POSS to mag 17.5.

Challenging observing projects for 14" to 24" scope

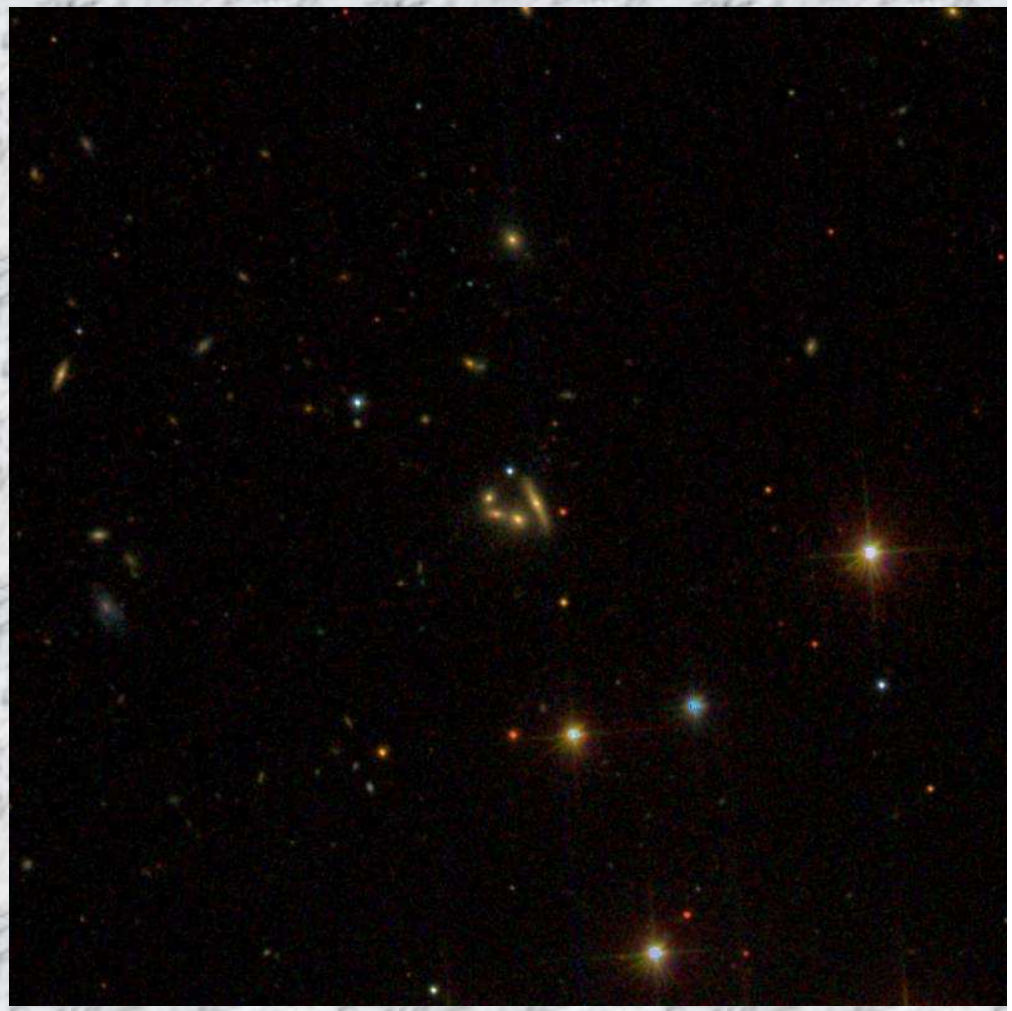
KTG 29 in Sextans



- Physical, interacting triplet at 300 million l.y.
- The three galaxies (also known as Holmberg 193) are crammed into 1.3′
- Close pair (30″ separation) resolved at 375x.

Rose 13 in Coma Berenices

- Very compact physical quartet between 925 and 950 million l.y.
- Also catalogued as Shakhbazian 13 and V-V 678
- Four mag 17 and 18 galaxies crammed into 20 arc seconds! Three resolved in 48".



Karachentsev Flat Galaxies (FGC)

Astronomical Observatory – Ukraine
Specialized in isolated galaxies

- FGC from 1993 consists of 4455 edge-on spirals found the POSS and ESO surveys with a diameter larger than 40″ and an axial ratio of 7:1
- Superthins are extreme cases – wafer-thin galaxies with axial ratios of 9:1 to 20:1. Studied by Goad and Roberts in 1981.
- Consist of gas-rich late-type spirals (Sc, Sd, Sm) with no discernable bulge or dust lane

Valentina Karachentseva

The View from Edge-on: FGC 1379

- UGC 7170 is a razor-thin edge-on in 18″. Located near globular cluster NGC 4147 in Coma Berenices.
- Superthin sliver in 48″ over 10:1 axial ratio. Almost no central bulge – just a weak central brightening. Slight warp at tips.

Flattest of the flats: FGC 1403

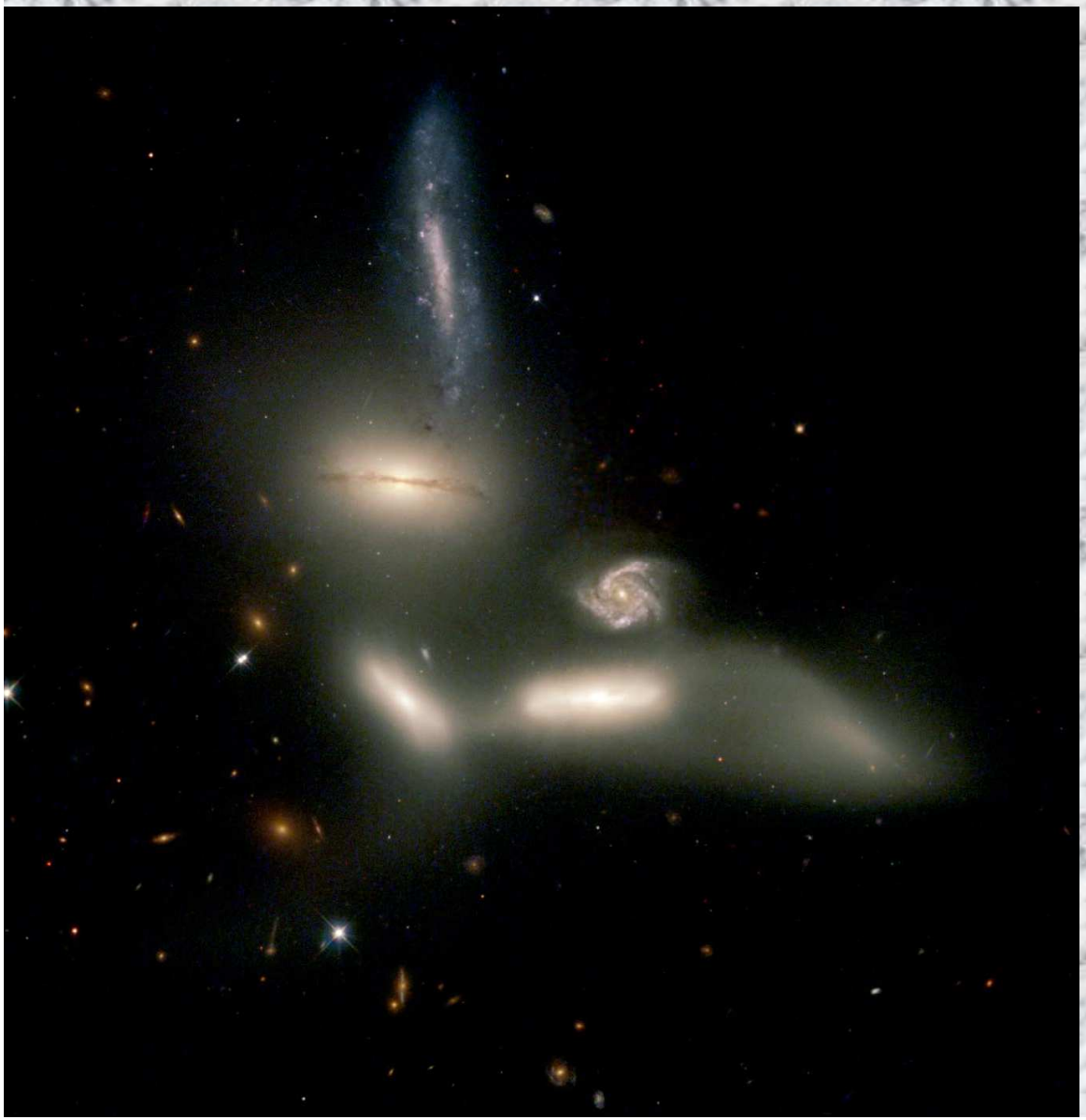
- UGC 7321 in Coma is remarkably narrow - one of the thinnest galaxies in the sky – axial ratio of 15.6 to 1!
- Visible in 18″ as a ghostly needle. Superthin sliver in 48″. Size ~5.2′ x 0.3′ (~17 to 1) . Absolutely no bulge – just a slight central brightening.

Quintets, Sextets and Septets

Hickson Compact Groups (HCG)

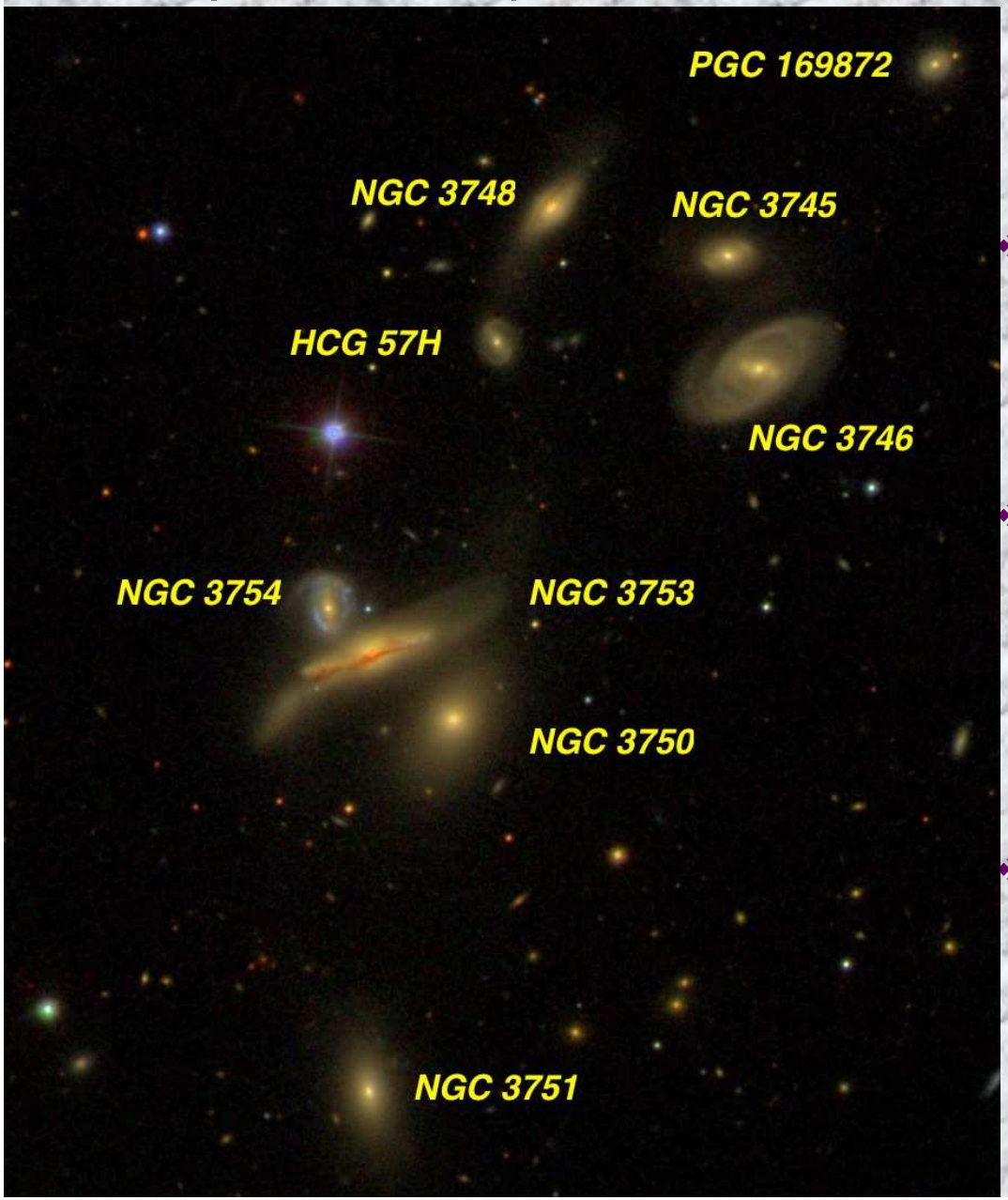
- Another major POSS-based study in 1982 *"Compact Galaxy Groups"* by Paul Hickson (100 HCG's)
- Includes several well known compact groups: Stephan's Quintet, Seyfert's Sextet and Copeland's Septet.
- All groups contain at least 4 galaxies, compact, isolated.
- Nearly all groups seen in 18" (at least 1 member)

Carl Seyfert's Sextet (HCG 79)



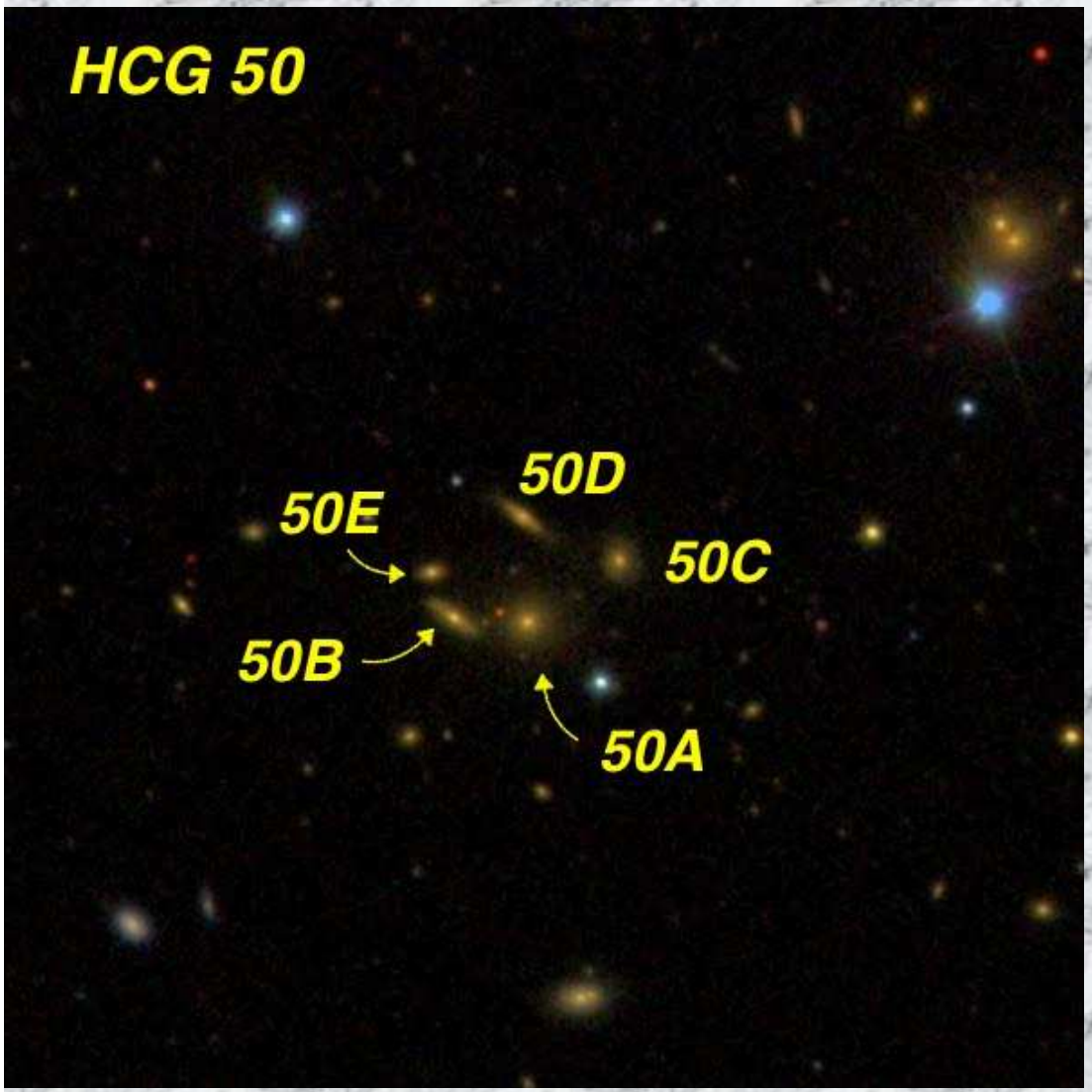
- Discovered visually by Stephan: "eF, vF star inv., 2 vF * near"
- Seyfert in 1948 on Schmidt plate: densest compact group (100,000 l.y.)
- One "member" is a tidal plume
- 3 visible in 12" and all 6 easy in 48"

Ralph Copeland's Septet (HCG 57)



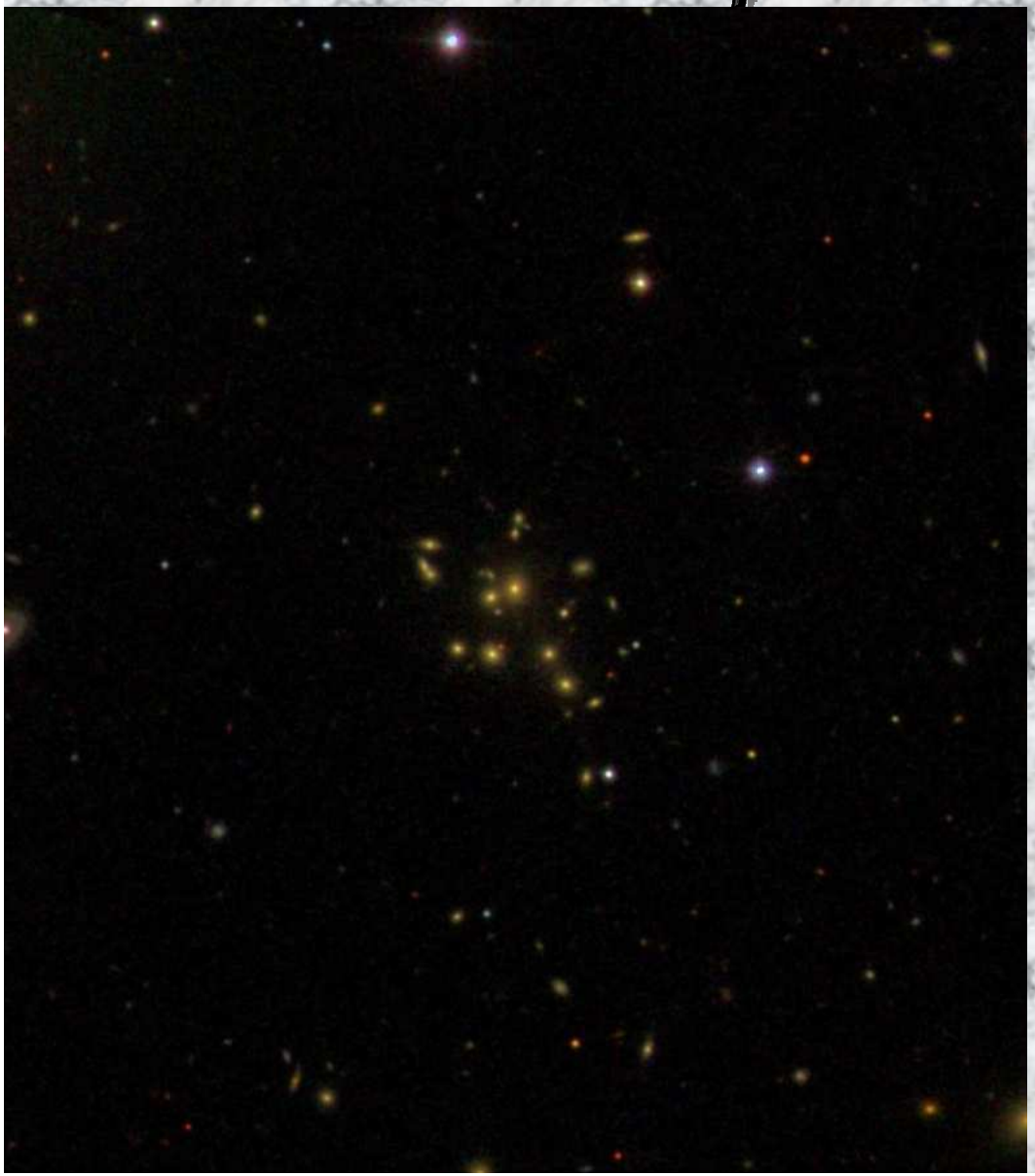
- Discovered by Ralph Copeland; observer on Lord Rosse's 72″
- Error in position – later claimed nonexistent in the *Revised New General Catalog*.
- All 7 visible in 16″

HCG 50



- Very compact quintet 20′ ESE of M97 (Owl Nebula).
- Five galaxies with V mags from 17.2-18.7 squeezed into 40″ at a distance of 1.8 billion l.y.
- 50A visible in 24″
- 50A/B/C/D in 48″

Shakhbazian's Compact Groups of Compact Galaxies



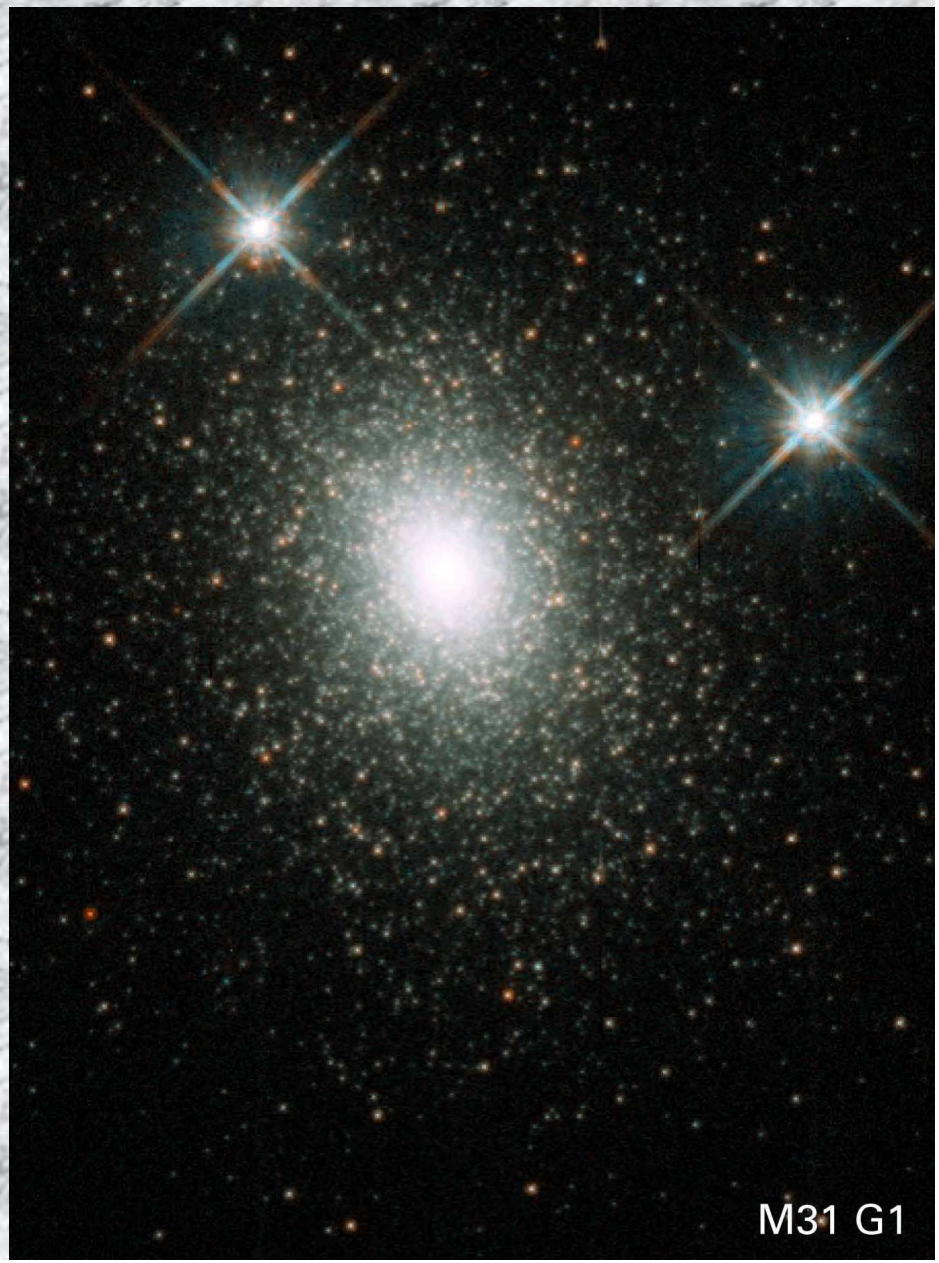
In 1957 Armenian astronomer Romela Shakhbazian found a compact group of red, stellar objects she assumed was a distant star cluster.

In 1973, Lick astronomers determined Shkh 1 was distant cluster of 18th mag galaxies at 1.5 billion l.y. Six viewed in 48" at 813x.

Shakhbazian catalogued 377 similar groups. Several visible in 18"

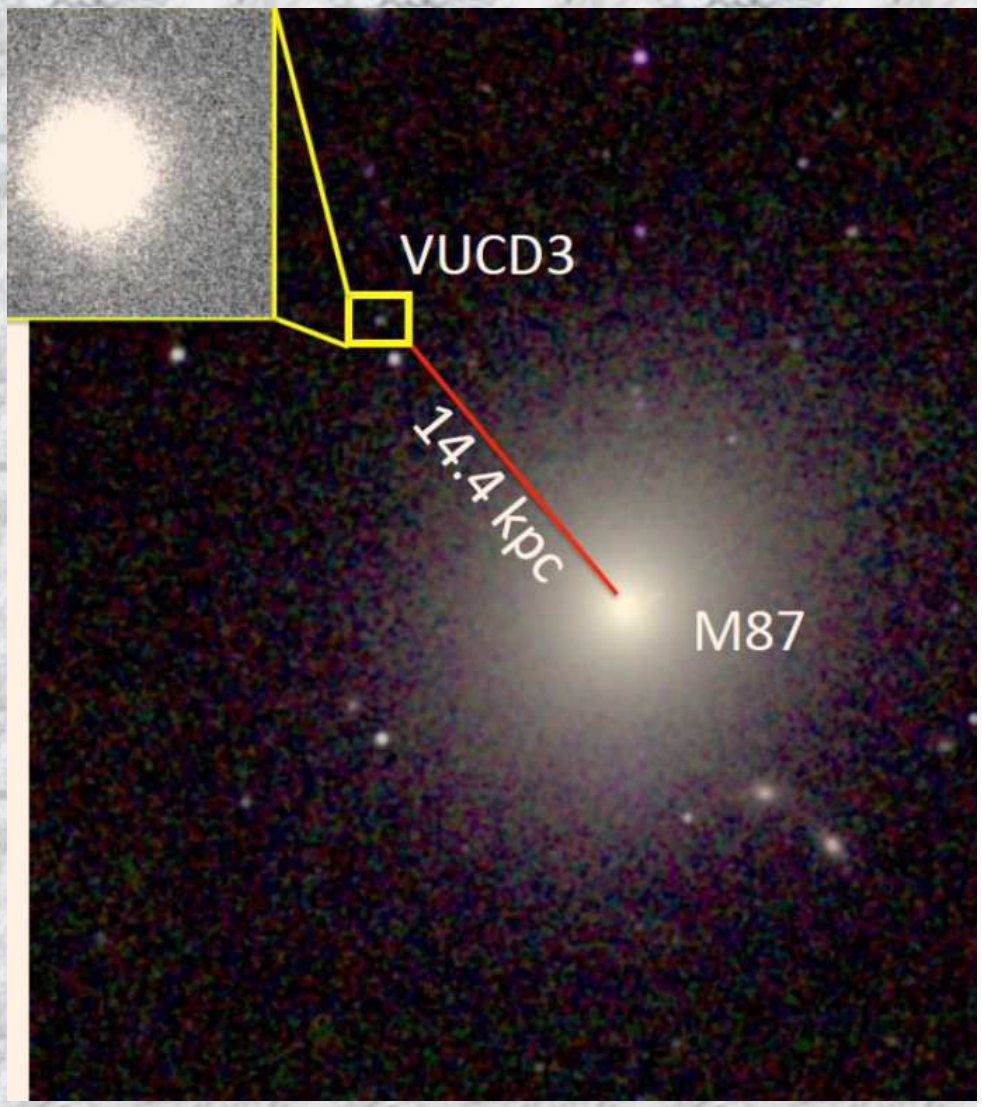
Extra-Galactic Globular Clusters

- 40 globulars observed in M31 – brightest is G1
- 5 globulars in Fornax Dwarf incl. NGC 1049
- 3 globulars in M33
- 1 or more globulars in Local Group members NGC 147, NGC 185 and WLM system in 18" scopes



Ultra-Compact Dwarfs (UCDs)

- Super-dense system of old stars, more compact than dwarf gx's, but larger, brighter, more massive than globulars.
- Several origin theories: Remnant nuclei of tidally stripped galaxies? Superbright globular clusters?
- Virgo UCD 3 in M87 contains a supermassive black hole – 4.4 million solar masses (13% of the mass of the UCD)
- With V = 18.3, it was visible in the 48" at 813x (stellar)



Proto-planetary Nebulae

Calabash or Rotten Egg Nebula in M46 (Puppis)

- Short-lived evolutionary phase (few thousand years) between asymptotic giant branch (AGB) and planetary nebula (PN)
- Central star too cool (5000° K) to ionize the ejected gas/dust shell (reflection or infrared nebula) and an OIII filter doesn't help.
- High velocity, collimated stellar winds often shapes the shell into small bipolar jets or wings
- Once the central star reaches 30,000° K, UV-radiation ionizes the gas and a PN is born.

Member of M46 - 6′ from NGC 2438

Exotic Boomerang Nebula

- Discovered in Centaurus in the late 1970's on Schmidt plate in Chile
- Study in 1979 revealed it is a protoplanetary with twin lobes shining by reflected polarized light.
- In 1995, studies revealed it was the coldest known place in universe (1° K). Dense ultracold CO gas apparently absorbed the 3° K background radiation
- Easy bipolar wings visible

Who lives in the neighborhood?
(Local Group Dwarfs)

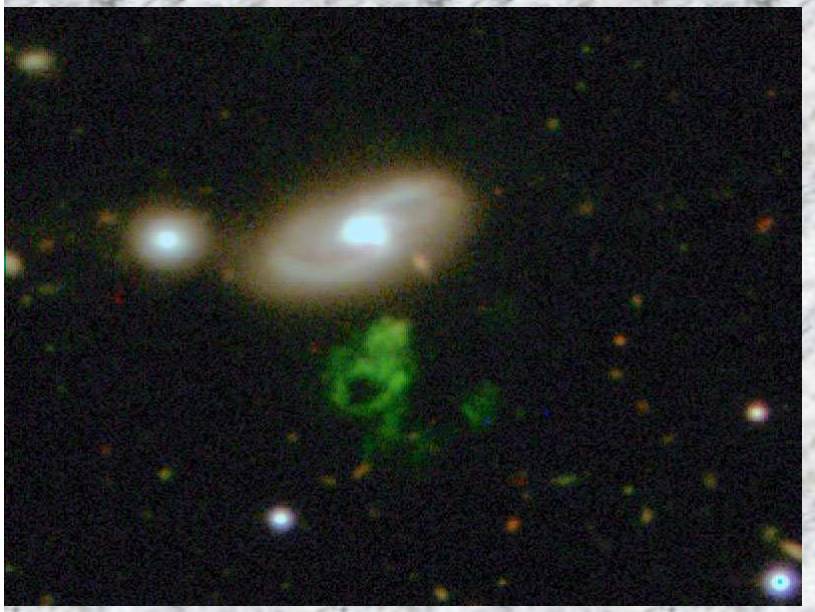
- Hubble in 1936: Local Group = MW, LMC, SMC, M31, M32, M110, M33, NGC 6822, IC 1613 and IC 10 (only 3 spirals)
- Currently at least 50 members – nearly all low luminosity dwarfs with very low surf. brightness
- Most discovered on sky surveys, including SDSS
- Due to low contrast - require dark skies, low power, careful sweeping for subtle "stains".

Sculptor Dwarf – Shapley, 1937

Ursa Minor Dwarf

- Discovered by Albert Wilson in 1954 on the POSS
- Dwarf elliptical at a distance of ~240,000 l.y.
- Old, low metallicity stars – little or no ongoing star formation
- Visually, very weak sky brightening at low power, 30′ x 20′

Exotic Objects

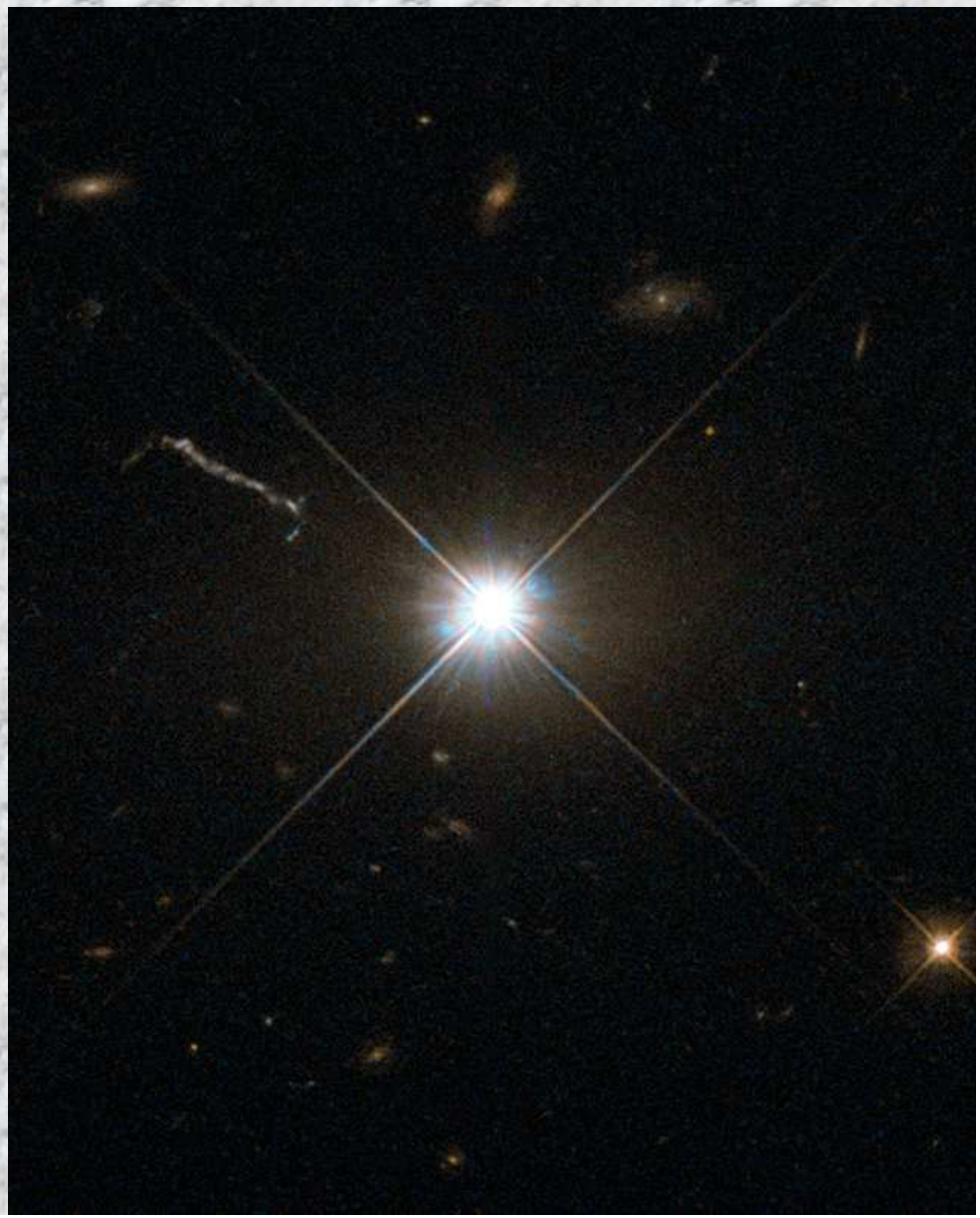


- Hanny's Voorwerp: discovered in 2007 as part of Galaxy Zoo data mining using SDSS.
- Hypothesis: ionized gas cloud or galaxy remnant lit up (type of light-echo) by a mini-quasar outburst in IC 2497.
- 18-19th magnitude – brighter knots visible in 48″

- Distant galaxy cluster WHL J123647.1+255131 at SE edge of NGC 4565.
- Distance 2.2 billion l.y.
- At least four 18th mag galaxies, only 4″ diameter, visible in 48″

So, how far can you see?

- 3C 273 in Virgo - brightest and most famous QSO – discovered as a powerful radio source in 1959.
- In 1963, Maartin Schmidt found a redshift z = .158, implying 2 billion l.y.
- Powered by supermassive black hole at center of a distant galaxy. Jet in 3C 273 glimpsed in 48-inch at 813x!
- 3 dozen QSO's viewed in 18".
- APM 08279+5255 in Lynx Mag 16; z = 3.91; Distance 11-12 billion l.y.!

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