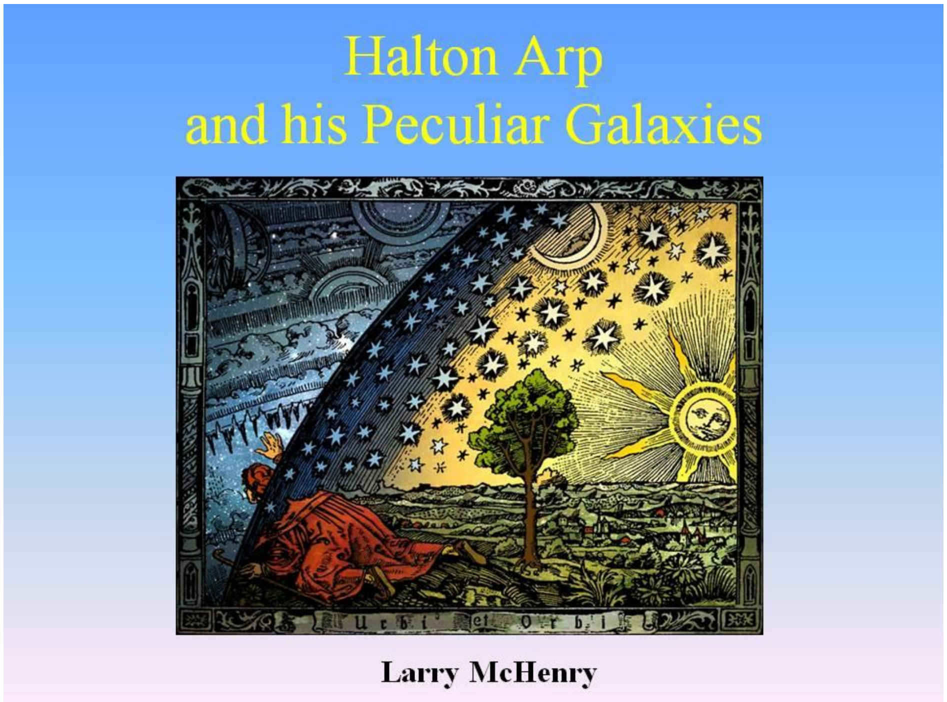


Introduction:

In 1966 American astrophysicist Halton Arp published a paper titled "Atlas of Peculiar Galaxies", which list 338 ‘interesting’ photographs of galaxies that didn’t fit into the normal Hubble classification scheme. Arp was a professor of astronomy at the California Institute of Technology and staff observer at Palomar Observatory. His paper cataloged a series of peculiar galaxies, giving them numerical designations, using the Palomar 48” and 200” telescopes. Through his work of studying these types of unusual galaxies, Arp broke new ground in our understanding the universe, and along the way sparked a debate that challenged the basics of the Big Band Theory. Today, we’re going to look-back on his life and accomplishments, talk a little bit about the redshift controversy, and his Atlas.
We’ll also review a number of my observations of his peculiar galaxies.

Discussion outline:

Galaxies – What are they?
- **Classic Morphology**
- **Peculiar Galaxies**

Halton C Arp:
- **Childhood & Education**
- **Life as an Astronomer:**

Redshift Controversy:

My Observations of Arp’s Peculiar Galaxies:

Arp’s Legacy & Conclusion

Galaxies – What are they?

Galaxies are large systems of stars and interstellar matter, typically containing from several million to several trillion stars. 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.

How do Galaxies form?

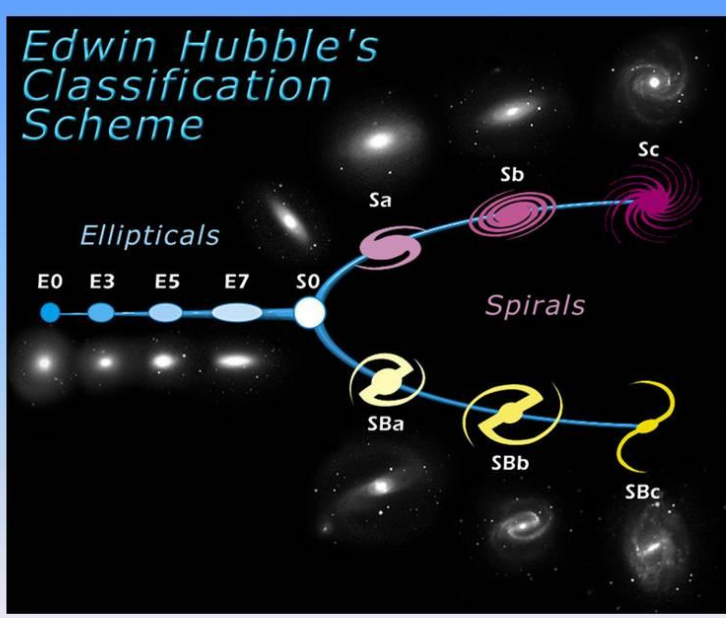
They originate from large cosmic primordial clouds of gaseous matter (hydrogen and helium) in our Universe that slowly collapsed. Most galaxies have formed at about the same time, within the first billion years after the universe started to expand, from an initial hot state.
Thus, they are all almost as old as the universe itself, currently thought to be about 14 billion years.

Where are Galaxies Located?

Galaxies are scattered throughout the visible universe. We live inside a giant spiral galaxy, called the Milky-Way Galaxy. The Milky-Way is about 100,000 light years in diameter and contains a mass equal to about a trillion stars. Our galaxy has several small dwarf galaxies orbiting around it that are only a few 100,000 light years distant. The nearest giant galactic neighbor, the Andromeda Galaxy, also a spiral, is about 2-3 million light years distant. Some galaxies are isolated "island universes" which float lonely through an otherwise empty region of the universe. But the distribution of matter in the Universe is not uniform. That causes groups of galaxies, running to few dozens of galaxies, or even large clusters of up to several thousands of galaxies, to form. The galaxies of these groups are in mutual gravitational interaction, which may have significant influence on their appearance.

Classic Morphology

Galaxies come in several types, and though of a wide variety of shapes and appearances, have many basic common features. They are huge conglomerations of stars like our Sun. From their appearance, galaxies are classified as spiral, lenticular, elliptical, and irregular. 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: spirals, elliptical, and lenticulars, along with a fourth class of irregulars.
All the main types have sub-category classifications, and we still use a modified version of this today.



https://en.wikipedia.org/wiki/Hubble_sequence

Elliptical
Elliptical galaxies are shaped like giant luminous cosmic 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.

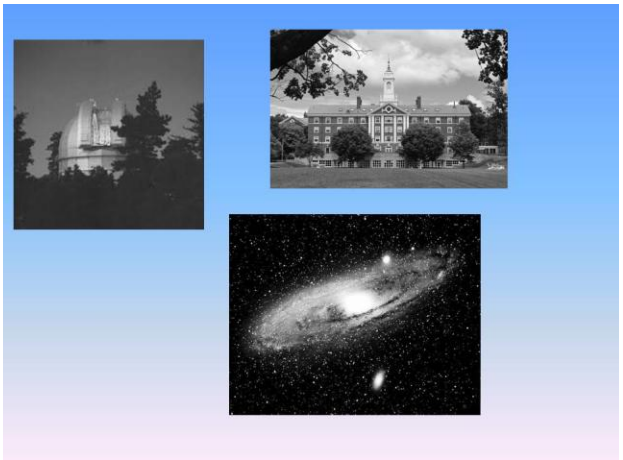
Spiral
Spiral galaxies usually consist of three major components:
A flat, large disk which often contains interstellar matter visible as diffuse glowing emission nebulae or as dark dust clouds. Young open star clusters, associations, and random stars arranged in conspicuous and striking spiral patterns 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.

Peculiar Galaxies
Peculiar galaxies come in various types, those with jets, split arms, diffuse tails, filaments and ejected material, and for the most part, peculiar galaxies can be found anywhere along the Hubble classifications system. But a large number can be found along the 'spiral' sections of Hubble's Tuning Fork, such as interacting galaxies (colliding galaxies being the most interesting), whose gravitational fields result in a disturbance of one another. An example of a minor interaction is a small satellite galaxy's disturbing the primary galaxy's spiral arms. Or it could be a major interaction, such as a galactic collision of two large galaxies, with one diving into the core of the other, shredding both in the process. Because of the tenuous distribution of matter in most galaxies, these collisions are not like a head-on car wreck, but more of a gravitational interaction that eventually combines two or more individuals into one large galaxy. The significance of peculiar galaxies is that from studying the Hubble Space Telescope deep-field images, close to 30% of all galaxies exhibit some type of disturbance or distortion, and the deeper the images go, the higher the number of galaxies that don't cleanly fit within the Hubble classifications. More research needs to be done on these galaxies and what it means for cosmology.

Halton C Arp:
Childhood & Education
Halton Christian Arp was born on March 21st, 1927 in New York City to August and Anita Arp.
Arp's parents were both artists and he was a distant cousin to the French abstract sculptor and painter Jean 'Hans' Arp. Halton grew up in the Greenwich Village area of Manhattan and also spent time with his parents travelling to Woodstock, New York for seasonal art fairs. They gave him the nickname "Chippy", which Halton later shortened to "Chip" and was called that by his friends.
Arp did not attend formal public school until he was almost 10 years old, being self-taught at home by his parents and others from the local artist community, where he was exposed to the roots of the bohemian counterculture movement that arose there in the late 1950's. When he was older, Arp was sent to a US Naval Academy prep school in Buzzards Bay, Massachusetts, where after he graduated with his high school diploma, he spent two years in the Navy before enrolling at Harvard.

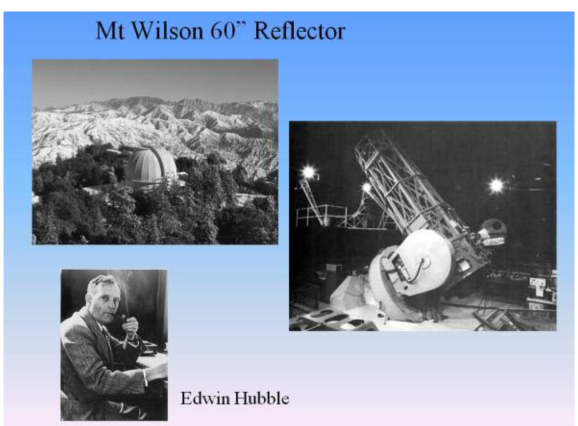
Arp graduated from Harvard College in 1949 with a major in astronomy and received his doctorate from Caltech in 1953. While a student at Caltech, he worked under Edwin Hubble at Mt Wilson assisting Hubble with his search for nova's in the Andromeda Galaxy, and specialized in study of distant galaxies.

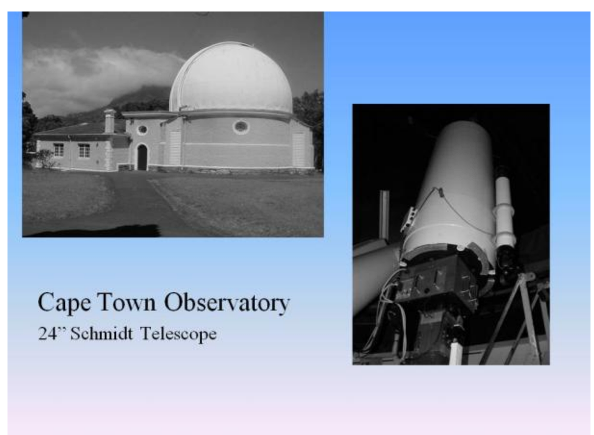


As a student at Harvard, Arp was a champion fencer and participated in national matches. During one practice session his career almost came to a short end, as during a match, his opponent's blade snapped and Arp was impaled by the broken tip. He was hospitalized for a week in serious condition, but eventually recovered. He kept up with his sport while at Caltech and afterwards while working as an astronomer. In 1965, he joined the US men's fencing team and competed in the Paris world fencing championship. Arp's love of the sport of Fencing and its techniques became useful later in professional life as he used the concept of thrust and parry verbally when participating in debates, making for lively discussions. Over the years, Arp married three times and has four daughters and five grandchildren.

<u>Life as an Astronomer</u>

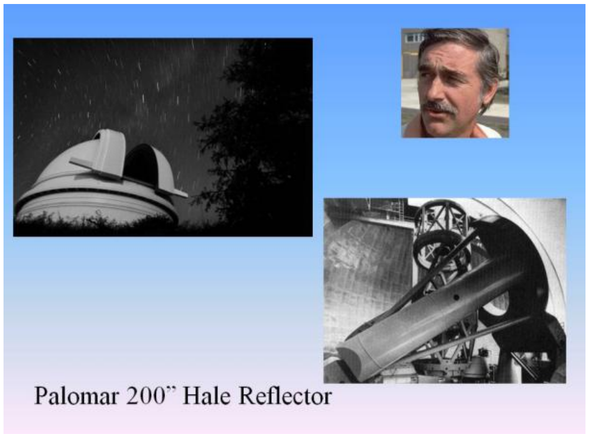
Arp's first professional job as an astronomer was after graduating from Harvard in 1949, when he was employed as a 'computer' at Mt Wilson observatory as a summer intern. Upon graduating from Caltech in 1953, Hubble offered Arp a job once again at Mt Wilson, and Arp worked directly with Hubble, using the 60" reflector to gather the nova data that Hubble required for his distance scale research. After Hubble passed away from a sudden stroke in the fall of 1953, the observatory director kept Arp on staff for the next two years to finish Hubble's last project. Afterwards, Arp's next job was in 1955 for the University of Indiana as a Research Assistant on assignment to South Africa to use the 24" Schmidt telescope at the observatory in Cape Town to study Cepheid variables in the Small Magellanic Cloud.





Upon completing that work in 1957, Arp then became a Fellow of the Carnegie Institution and a full staff astronomer at Palomar Observatory, and worked there for the next 29 years. While there, he had frequent access to the 200" Hale reflector where he pursued observations of galaxies.
Arp was considered a master of astronomical photographic techniques with the 200" telescope.

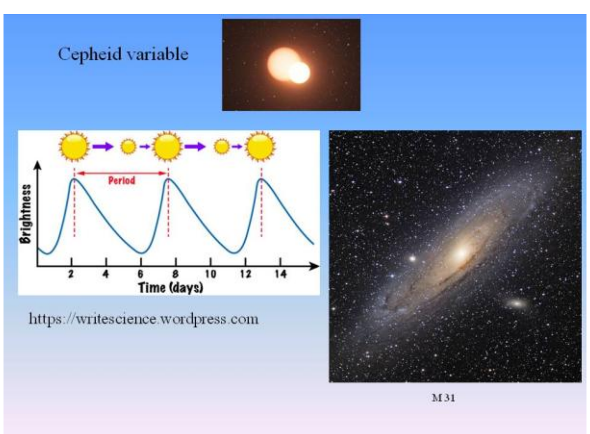
As a staff astronomer at Palomar Observatory with observational use of the 200" Hale Reflector, along with degrees from Harvard and Caltech, Halton Arp wasn't your average astrophysicist. Over the years, he earned a number of professional awards, including the American Astronomical Society's Helen B. Warner prize for research and the American Association for the Advancement of Science's Newcomb Cleveland award for published research, both in 1960. From 1981 to 1983, Arp served as President of the Astronomical Society of the Pacific. And in 1984, he received the Alexander von Humboldt Senior Scientist award for research.

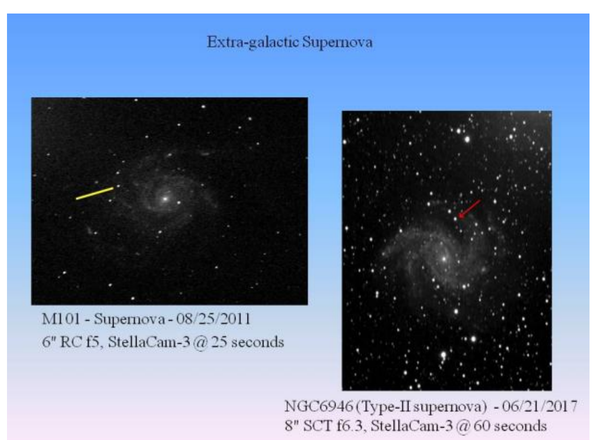


In 1983 Arp retired from Caltech and joined the staff of the Max Planck Institute for Astrophysics near Munich, Germany. While he no longer had personal observing access to large observatory telescope, Arp did have access to data in multiple wavelengths from European observatories around the world and was able to continue his research.

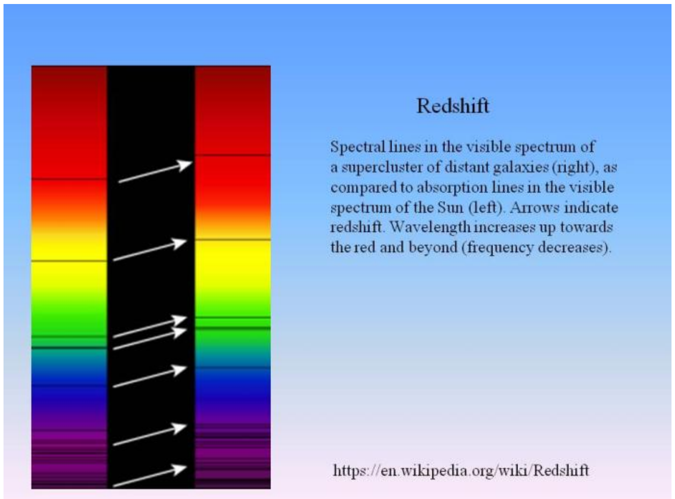
<u>Redshift Controversy:</u>

At the turn of the 20th century, one of the major questions that professional astronomers were trying to answer was "how far away are the galaxies?" The first accurate distances to galaxies were determined by Edwin Hubble in the 1920's by using Cepheid variables. Cepheid variables are stars that vary their brightness by a specific range and timeframe. This relationship between the star's luminosity and period of change allows astronomers to determine what its true brightness is and allows them to determine the star's distance. Using this relationship, astronomers were able to accurately calculate distances to Cepheid's in our Milky-Way galaxy. Then the discovery of Cepheid's in the nearby galaxies, such as M31 the Andromeda Galaxy, allowed astronomers to extend accurate distances throughout the Local Group of galaxies. But in galaxies much further away, Cepheid's were not identifiable, so astronomers turned to another celestial yardstick, supernovas. Extra-galactic nova's and supernova's are similar to Cepheid's in that their intrinsic brightness could be compared against these stellar explosions that have occurred within our own galaxy. This allowed us to measure distances out into our nearby supercluster of galaxies, (Virgo and Coma Clusters). To go even further out into the universe, astronomers discovered that every galaxy has a measurable redshift that could be utilized.



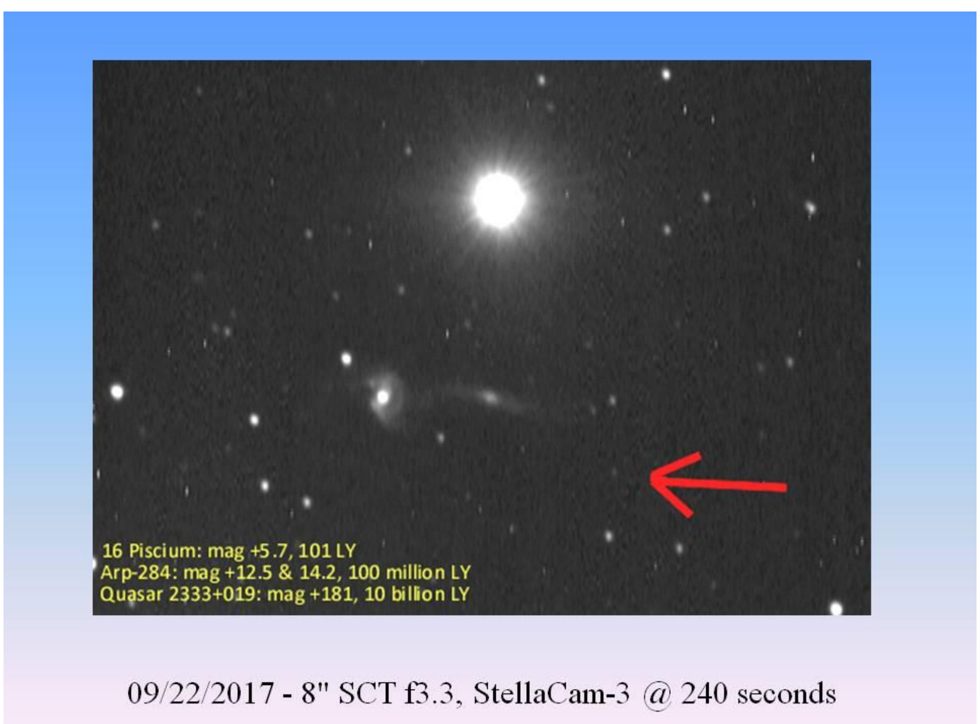


Every star gives off a spectrum of bright and dark emission and absorption lines, when viewed thru a spectrograph prism, made up of the various atomic elements within the star. Hydrogen and helium being the primary elements, along with oxygen, carbon, neon and nitrogen. Depending on the direction that the star is moving, either toward us or away from us, the star's spectrum exhibits a lightwave Doppler shift, similar to the soundwave Doppler effect, such as from a passing train. If the object is approaching us, it is blueshifted, if it is receding from us, the spectrum is redshifted.

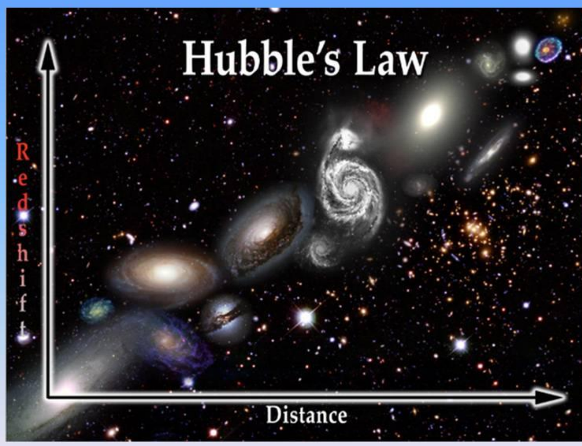


The greater the spectral lines of an object are shifted towards the red end of the spectrum, the greater its distance is from us.
The symbol for redshift, expressed as a fractional displacement of wavelength is 'z'.
An object with z=0.00 or smaller has a low redshift and is nearby. A redshift greater than z=0.0 is a high redshift and represents an object very far away.
(The bigger the number, the father away it is).

An example of using redshift to measure cosmological distances is Arp284: interacting galaxies NGC7714 & 7715 and the Quasar 2333+019, mentioned in the October 2017 issue of 'Sky & Telescope' magazine, located near the 5th magnitude star 16 Piscium.
The authors of the article had used a 48" reflector visually to make the observation.
The bright +5.7 star is about 101 light-years away, the pair of +12.5 & +14.2 galaxies at z=0.0093 or about 100 million light-years, and the +18th magnitude Quasar at z=1.871 or about 10 billion light-years, nearly 2/3 the age of the universe!
(Here's a 3 minute video-capture taken with a Celestron 8" SCT @ f6.3 and StellaCam-3 video-cam)



A central part of today's 'Big Bang' cosmology this key tenet is named Hubble's Law. Basically stated, Hubble's Law is that the larger an objects redshift, the farther away it is and the faster it is receding from us. All astronomers had to do was measure the redshift of a galaxy and then it was just a matter of computing the distance of that galaxy. It is a critical piece of the expanding universe theory.

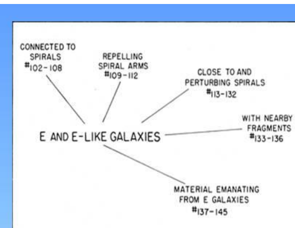


https://www.quora.com/

While at Palomar, Arp began 'collecting' unusual galaxies that other researchers would drop from their studies as being too unusual or peculiar. Using his artist 'eye', Arp realized that these odd galaxies represented different stages in galaxy evolution, and devoted his career to studying them utilizing the 200-inch Hale telescope. His research goal was to produce a catalog that other cosmologist could use to model and test the Hubble theory of galaxy formation.

From his catalog, Arp noticed that some of his elliptical galaxies associated with disturbed spirals (Arp#100 thru #150) seemed to have relationships with nearby quasi-stellar objects (QSOs), or quasar radio sources - which in the mid-1960's had recently been discovered having high redshifts, indicating great distances. Quasars were considered to be 'left-over's' from the creation of the early universe, and their great distance indicated their extreme age. But from Arp's Palomar observational evidence from the 200" Hale telescope, it appeared that some high velocity quasars were physically connected to bright, nearby galaxies with a much lower redshift. A theoretical impossibility!
Arp coined a new phrase to describe what he was seeing – 'discordant redshift'.
He came to believe that an objects redshift may not be solely explained by its distance and velocity, and there may be some other cosmological mechanism at work. Thus, not all redshifts can be attributed to the expansion of the universe.

This eventually led to his challenging the current interpretation of these highly red-shifted sources, even calling into question the Big Bang theory, and that the universe may not actually be expanding.
This became a long running controversy between the majority of the traditional astronomical world that supports Big Bang cosmology and a small band of challengers led by Arp and a few other prominent astronomers that still hasn't quite died down even today.

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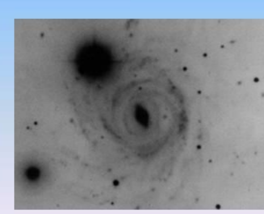
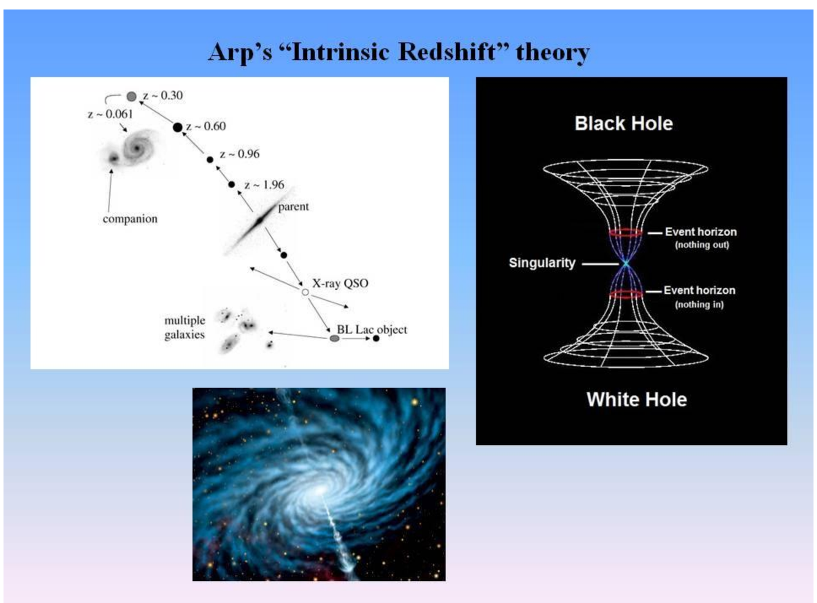
Hubble Image


Arp117 - IC950

The debate over whether redshifts were cosmological or something else came to a head in December 1972, as at a symposium on December 30th, Arp and Princeton astronomer John Bachall held a debate to a packed audience of astronomers and cosmologist. Arp's main argument was that something unexplained was happening with the examples that he had brought with him. Bachall's rebuttal was that Arp didn't have any explanation to his observations; therefore they must be observational errors.
The back and forth was intense with both sides eventually claiming victory, but the general consensus of the astronomy community was that Arp lost the debate due to his not yet having developed a theory to support his observations.

Arp's willingness as a scientist to stand behind his data in challenging the Big Bang model eventually cost him his observing privileges at Palomar in 1983, and many astrophysics journals began rejecting the research papers that he would submit. This led Arp to retire from Caltech and move to Germany where he could continue his research work at the Max Planck Institute for Astrophysics.

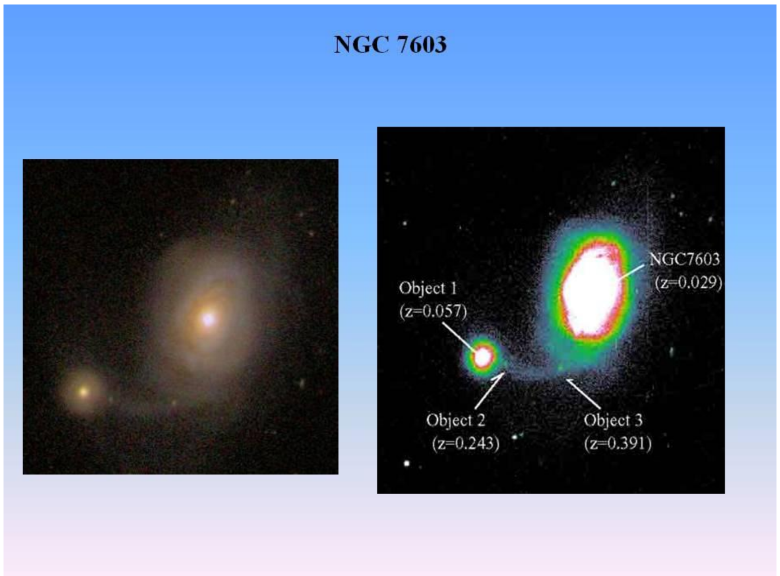
From his research, Arp eventually developed a theory which he called "intrinsic redshift", that in the core of active galaxies, new matter is created from a whitehole singularity, with the new matter having zero to low mass and is ejected as a quasar from the parent galaxy with a high velocity redshift. During the ejection process, the new material interacts with the older galactic material of the host galaxy, causing the new material to increase in mass, which in turn causes its high redshift to slow down as it moves away from the host galaxy and evolves into the more traditional redshifted companion objects.



As it was difficult to get published in scientific journals, Arp wrote and published two books documenting his discordant redshift observations and cosmological theories:
"*Quasars, Redshifts and Controversies*" and "*Seeing Red*". Supporters of Arp's alternate theories are still gathering observational research and studying whether everything seen in peculiar galaxies can be explained by conventional astrophysics, or if some new physical mechanism exists that we are still unaware of. A few examples of these ongoing studies are NGC7603 (Arp92) in Pisces and NGC4319 & Markarian205 in Draco.

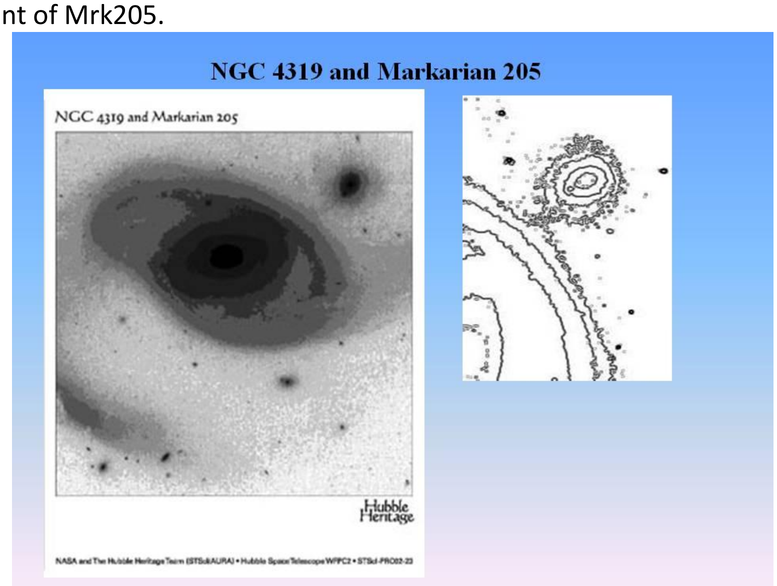
NGC7603 (Arp92) in Pisces:

NGC7603 is a Seyfert type spiral galaxy with an active galactic nucleus and a redshift of z=0.029. It has a small elliptical companion at the end of one arm with double the redshift of the parent galaxy, z=0.057. Additionally, along the arm connecting the elliptical are several small knots of material with very high redshifts, z=0.243 & z=0.391. Arp believed that all three high redshift objects were ejected from the core of NGC7601, with the elliptical being the oldest and furthest object with its redshift having slowed. Most other astronomers believe this is just a chance alignment between NGC7603's spiral arms, and a further out in the distance elliptical galaxy, and several cosmologically distant quasars.

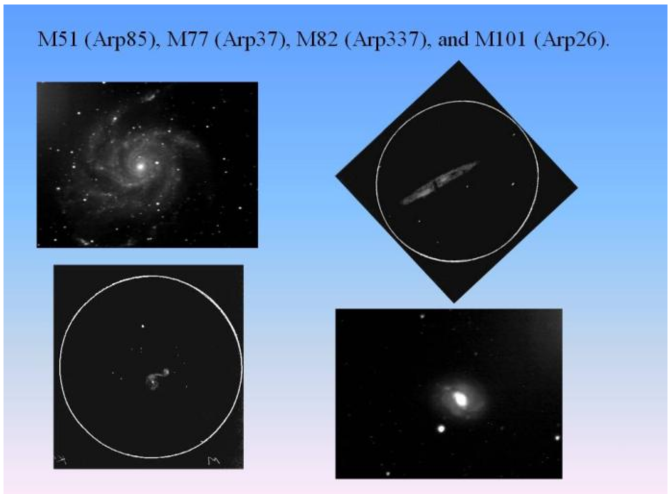


NGC4319 & Markarian205 in Draco:

NGC4319 is a typical 'Barred Spiral' galaxy with an internal bar structure with spiral arms coming off of. It has a redshift of z=0.0046 making it relatively nearby in cosmological distances.
Markarian205 is a low-luminosity active quasar at a redshift of z=0.071 making it about 15 times more distant than NGC4319. What makes these two 'peculiar' is what appears to be a very faint filament bridge that connects the two. This would not be possible given the difference in redshifts.
Arp believed that this is a true connection, as Mrk205 must have been ejected by NGC4319 and is trailing material. But the conclusion of the majority of astronomers is that this bridge is just some irregularity in the spiral arm structure of NGC4319 and a chance alignment or optical illusion of material projected in front of Mrk205.



My Observations of Arp’s Peculiar Galaxies:
So, where can you find Arp’s Peculiar Galaxies?   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. Among galaxies, peculiar 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. Some large bright galaxies are best suited for medium-size telescopes, while others are very faint and require large apertures.

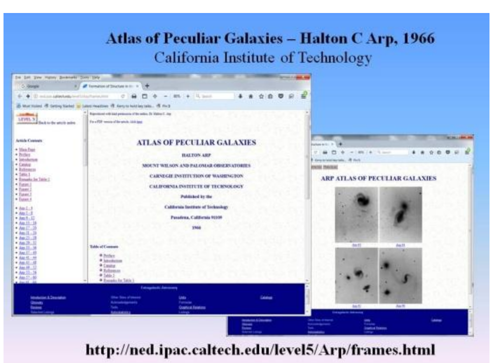


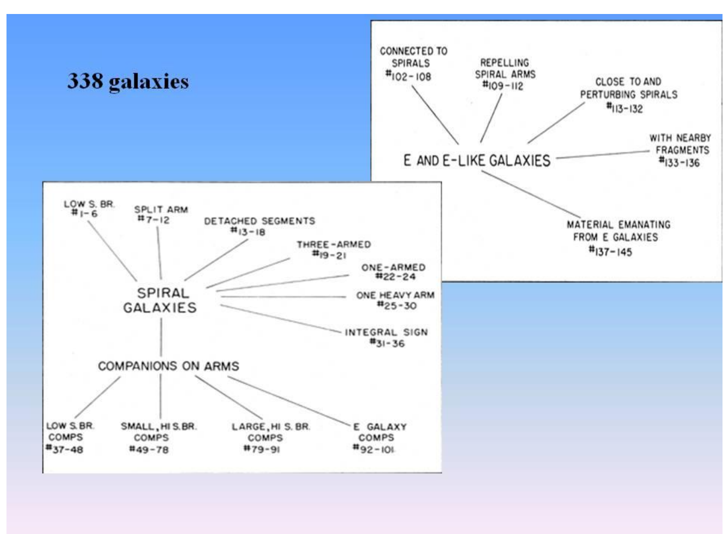
There are even some galaxies that display nicely using binoculars or small telescopes. A number of Messier Objects are Also Arp galaxies, and observing these are a good way to get started, even using smaller 8 – 10” telescopes. These include M51 (Arp85), M77 (Arp37), M82 (Arp337), and M101 (Arp26).

It helps to have a list of the Arp catalog. There’s a number of ways to find these peculiar galaxies. You can get a computer software program to help: “Deep Sky Planner” – Steve Tuma & Dean Williams Do a search for Arp’s catalog, and generate a star chart. Or, if you’re using a planetarium program, you can utilize its settings to show the galaxies that you are interested in finding. This example is from my favorite program – “Earth Centered Universe”

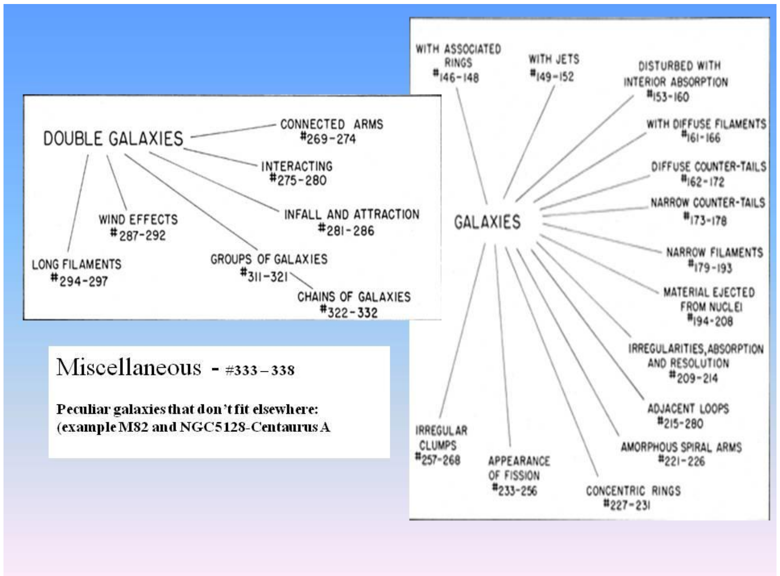
You can also download a PDF copy of Arp’s original atlas to your computer, tablet, or smart phone. The catalog is organized into 5 main areas or classes with each having many sub-classifications. There are 338 galaxies with some type of irregularity or odd features.

Spiral Galaxies: Arp1 – 101 are spiral galaxies that have various types & shaped arms, along with detached segments, and faint companion galaxies.
Elliptical and Elliptical-Like: Arp102 – 145 are elliptical galaxies with associated fragments or ejected material, and connected to or disturbing close spirals.

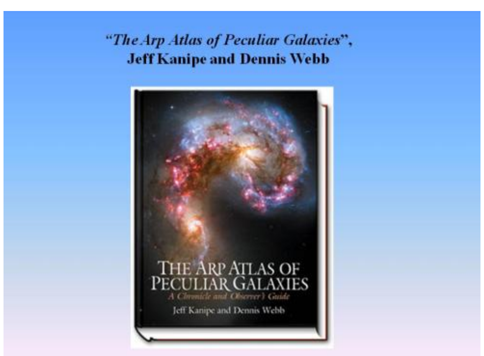


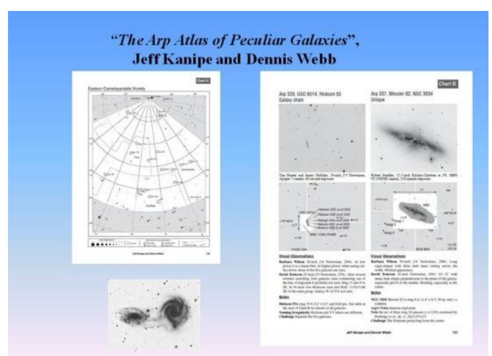


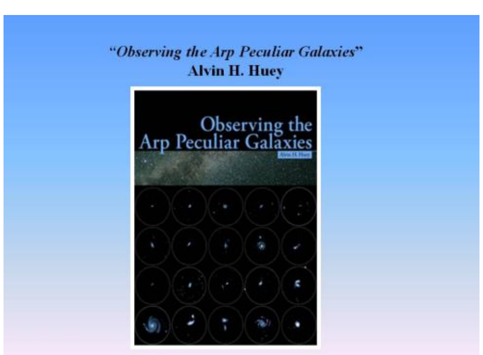
Galaxies: Arp146 – 268 are spirals and elliptical not included with the first two classes that have filaments, rings, tails, jets, loops, and other nearby features.
Double Galaxies: Arp269 – 332 are multiple galaxies or groups that are connected by long filaments, bridges, or aligned in a chain.
And **Miscellaneous:** Arp 333 – 338 are really unusual galaxies that don't fit anywhere else, such as M82 or NGC5128-Centaurus A.

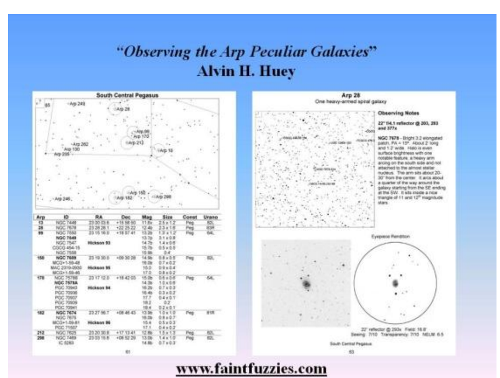


In 2006 Amateur Astronomers Jeff Kanipe and Dennis Webb expanded Arp's atlas into an observers guide, complete with Arp's original images, along with finder charts and CCD images and visual observations from other participating amateurs. It's a great book to use in the field!!
Also, amateur astronomer Alvin Huey has a great observing book on his website www.faintfuzzies.com It too contains finder charts, DSS images, and eyepiece sketches.

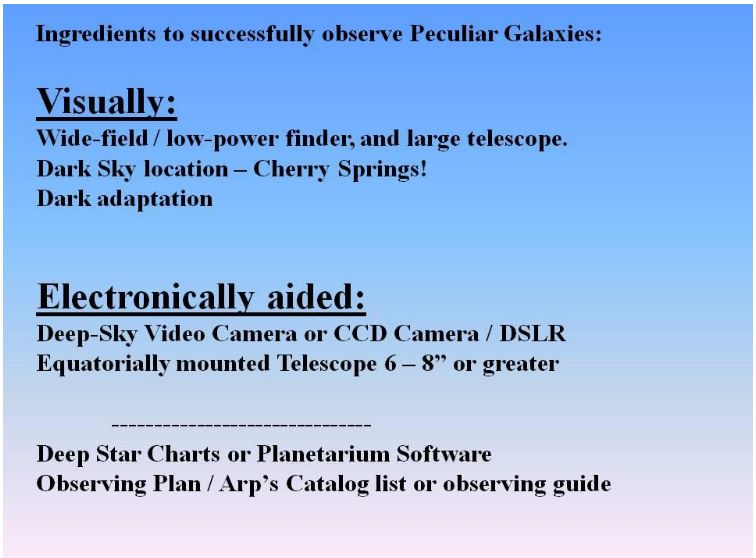








Ingredients to successfully observe Peculiar Galaxies:
All of Arp's galaxies exhibit some form of abnormality, whether they're multiple interacting or just have oddball shapes or features. This is what makes them interesting to find and attempt to visually see or capture an image of.

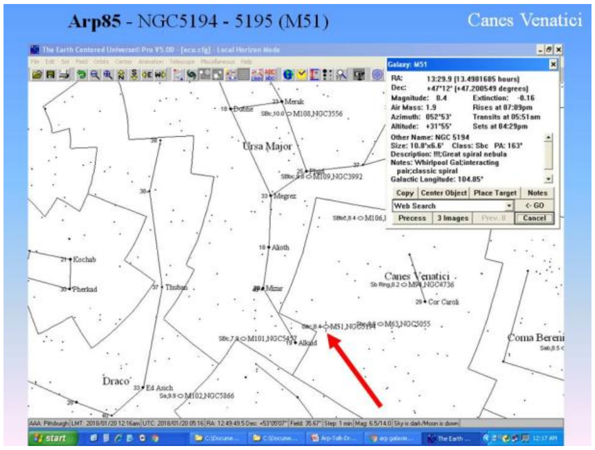


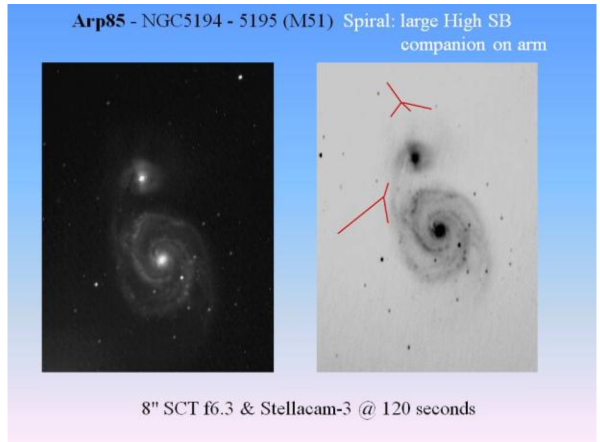
Observing them visually requires maintaining dark-adaptation, good starcharts, and slow sweeping with a wide-field low-power eyepiece and a fast low focal-length telescope. A nice 80mm F6 or shorter refractor piggybacked on a 10" or greater telescope would work very well. The 80mm acts as a low-power RFT giving you a wide-field in which to find the galaxy and the larger telescope it is attached to allows use of higher magnifications, depending on the object. You'll need all your visual observing skills to find and bring out the subtle differences in these objects. Many of Arp's features are very faint, and depending on what size telescope you are using, may not be visible. But like any deep-sky object, half the fun is just successfully finding it and knowing what it is that you are observing.

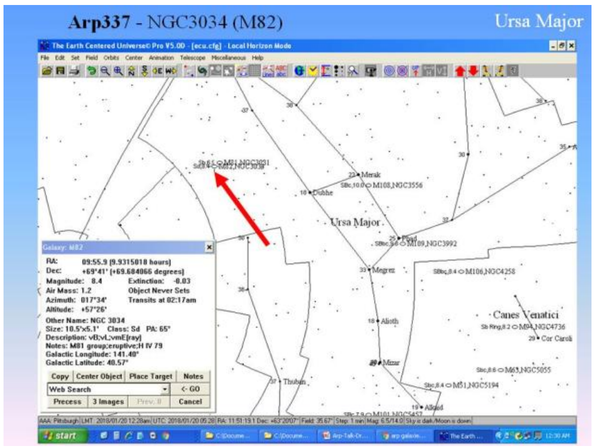
For the Imagers, Peculiar Galaxies can also be challenging, in that even with an accurate GOTO mount, it may not position the telescope squarely on the object to where it's framed the way you want it. Having a photographic atlas or picture of the galaxy will help you in both locating and identifying the most interesting sections of the object and in framing your image. I've found that using short-exposure video-astronomy cameras works great in positioning and identifying Peculiar Galaxies.

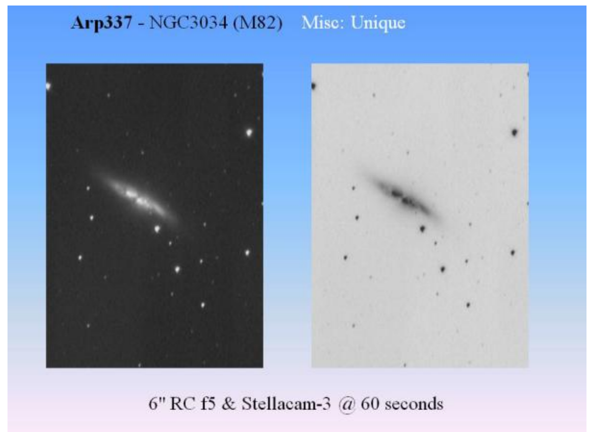
My Observations of Arp's Peculiar Galaxies:

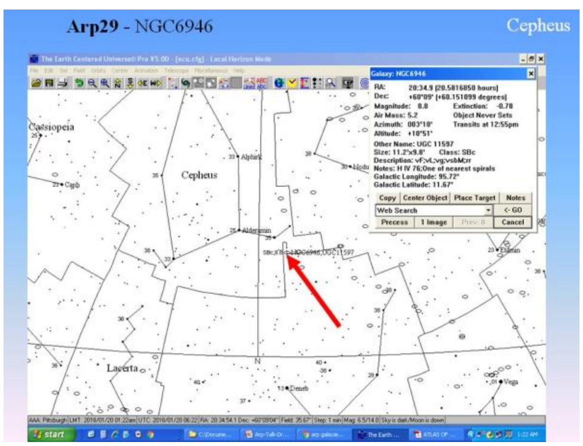
Arp85 - NGC5194-5195 (M51)	*Spiral: large High Surface Brightness companion on arm*
Arp337 - NGC3034 (M82)	*Misc: Unique*
Arp29 - NGC6946	*Spiral: one heavy arm*
Arp310 - NGC7317, 18A, 18B, 19, 20 (Stephan's Quintet) Galaxy *Group*	
Arp284 - NGC7714 & 7715	*Double Galaxies*
Arp13 - NGC 7448	*Spiral: detached segments*
Arp30 - NGC6365A & B	*Spiral: one heavy arm*
Arp38 - NGC6412	*Spiral: Low SB companion on arm*
Arp78 - NGC770 & 772	*Spiral: Small High SB on arm*
Arp84 - NGC5394 & 5395	*Spiral: large High SB on arm*
Arp273 - UGC1810-1813	*Galaxies: With Connected Arms*
Arp185 - NGC6217	*Spiral: Narrow filaments*
Arp92 - NGC7603	*Spiral: elliptical companion on arm*
NGC 4319 and Markarian 205	

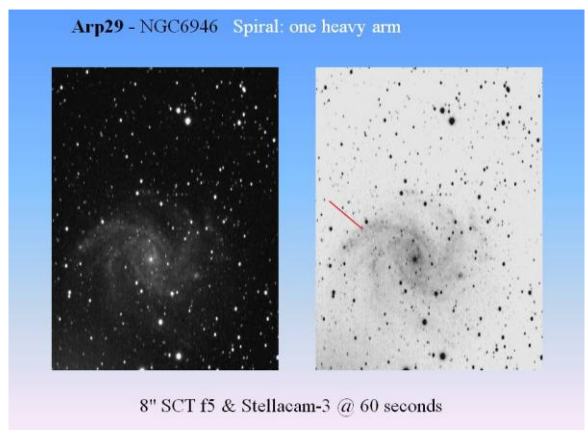

Arp85 - NGC5194 - 5195 (M51)
Canes Venatici
Ursa Major
Canes Venatici
Draco

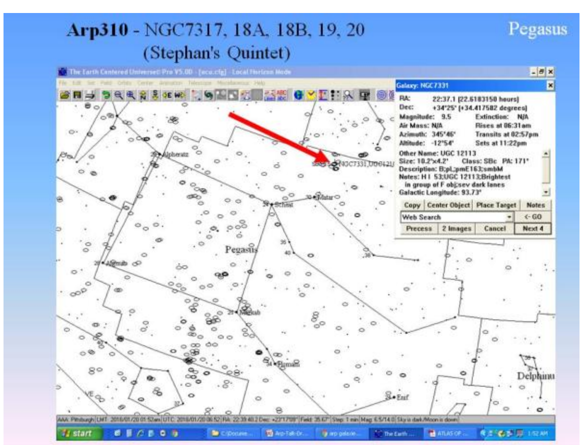

Arp85 - NGC5194 - 5195 (M51) Spiral: large High SB companion on arm
8" SCT f6.3 & Stellacam-3 @ 120 seconds

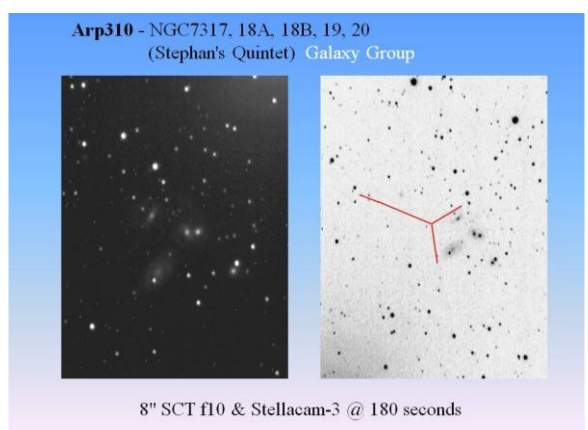

Arp337 - NGC3034 (M82)
Ursa Major
Ursa Major
Canes Venatici

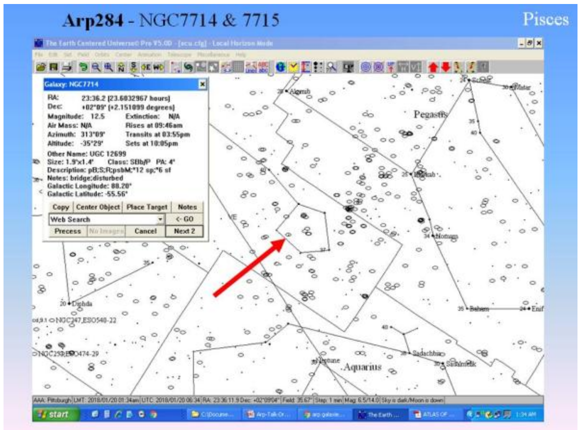

Arp337 - NGC3034 (M82) Misc: Unique
6" RC f5 & Stellacam-3 @ 60 seconds

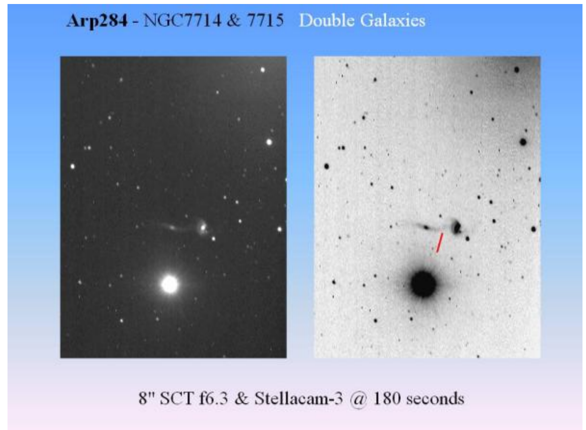

Arp29 - NGC6946
Cepheus
Cassiopeia
Cepheus
Lacerta

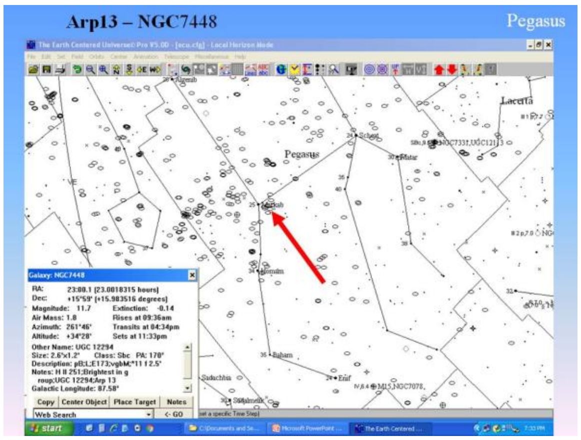

Arp29 - NGC6946 Spiral: one heavy arm
8" SCT f5 & Stellacam-3 @ 60 seconds

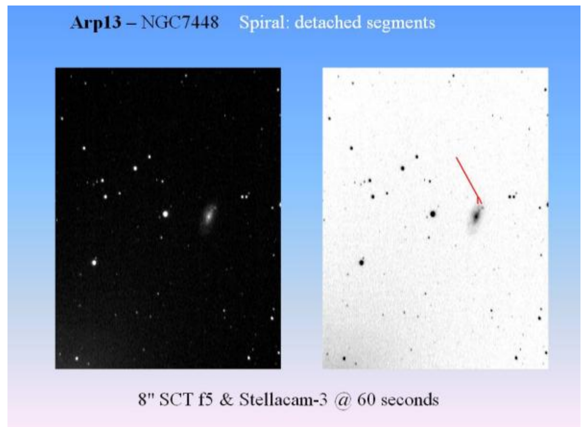

Arp310 - NGC7317, 18A, 18B, 19, 20
(Stephan's Quintet)
Pegasus
Pegasus

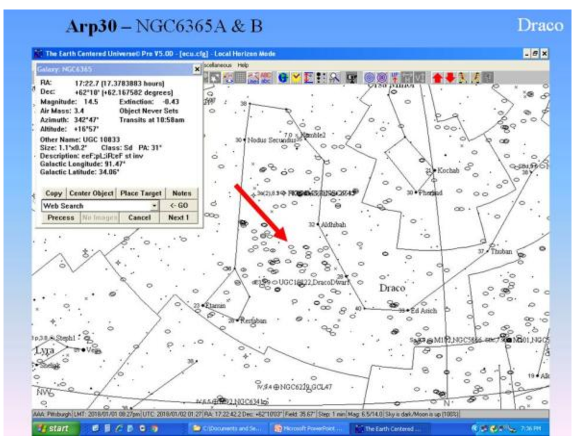

Arp310 - NGC7317, 18A, 18B, 19, 20
(Stephan's Quintet) Galaxy Group
8" SCT f10 & Stellacam-3 @ 180 seconds

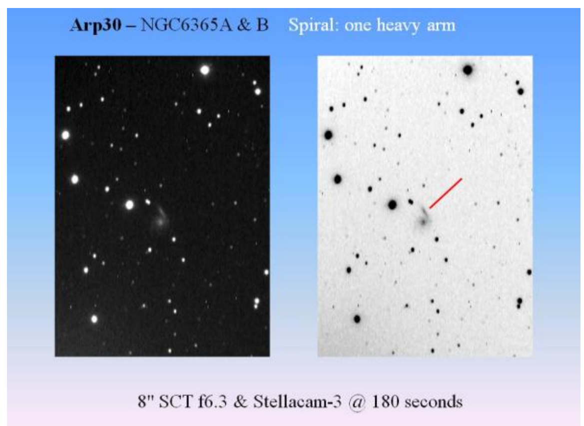

Arp284 - NGC7714 & 7715
Pisces
Galaxy: NGC7714

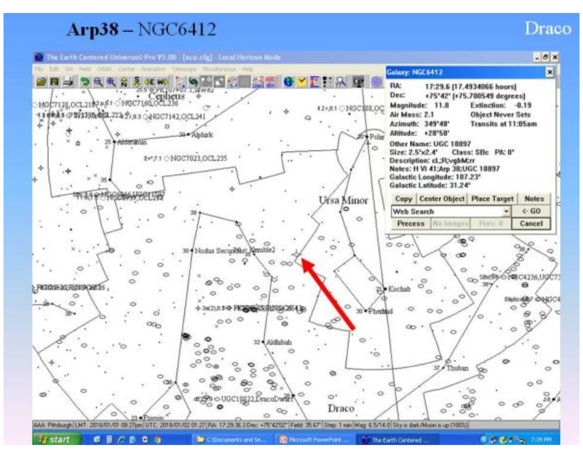

Arp284 - NGC7714 & 7715 Double Galaxies
8" SCT f6.3 & Stellacam-3 @ 180 seconds

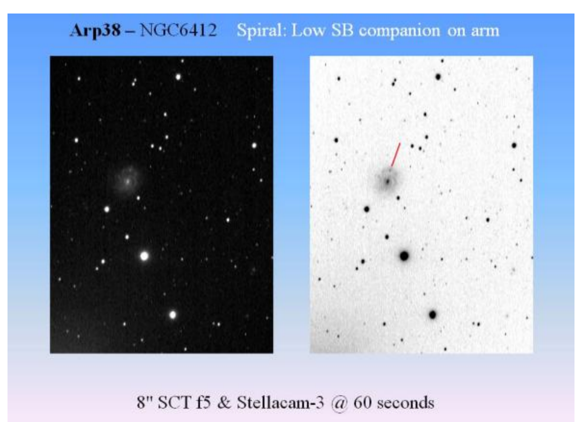

Arp13 – NGC7448
Pegasus
Galaxy: NGC7448

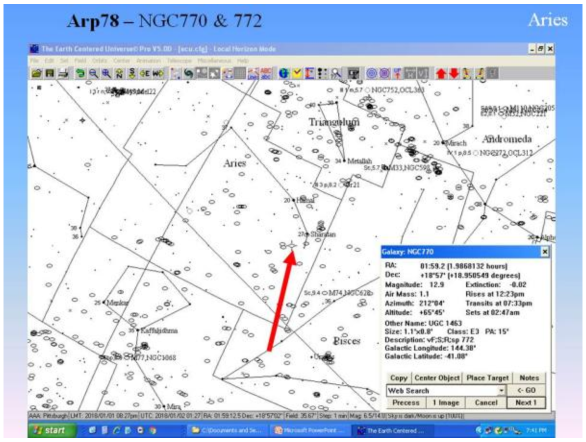

Arp13 – NGC7448 Spiral: detached segments
8" SCT f5 & Stellacam-3 @ 60 seconds

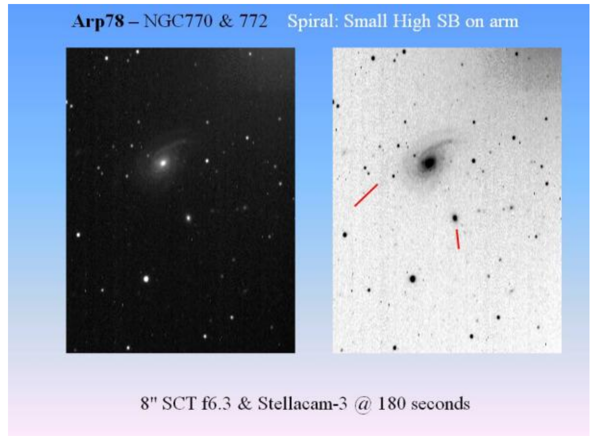

Arp30 – NGC6365A & B
Draco
Galaxy: NGC6365

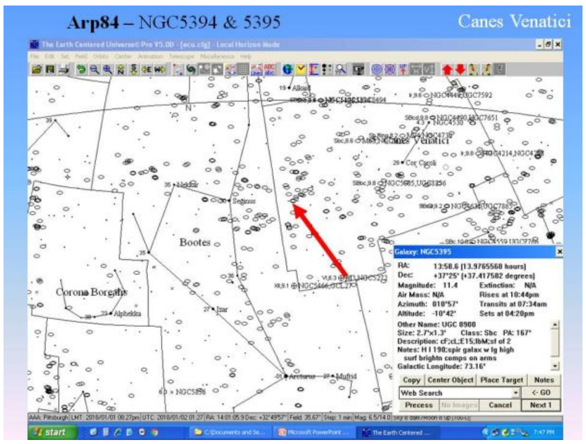

Arp30 – NGC6365A & B Spiral: one heavy arm
8" SCT f6.3 & Stellacam-3 @ 180 seconds

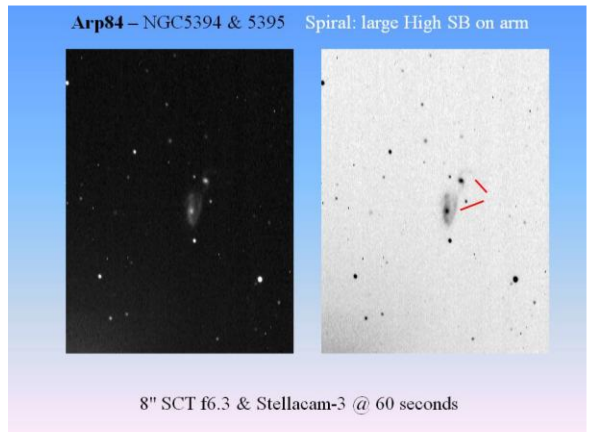

Arp38 – NGC6412
Draco
Galaxy: NGC6412

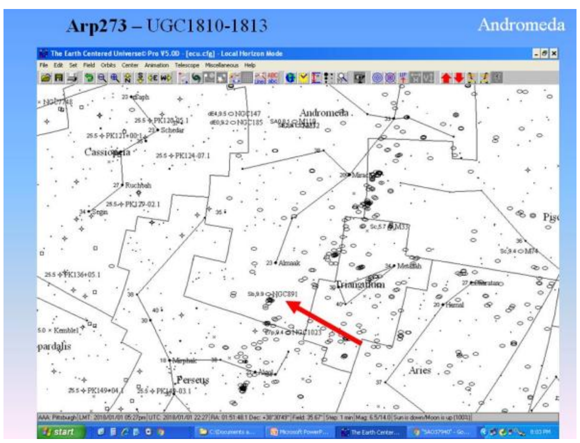

Arp38 – NGC6412 Spiral: Low SB companion on arm
8" SCT f5 & Stellacam-3 @ 60 seconds

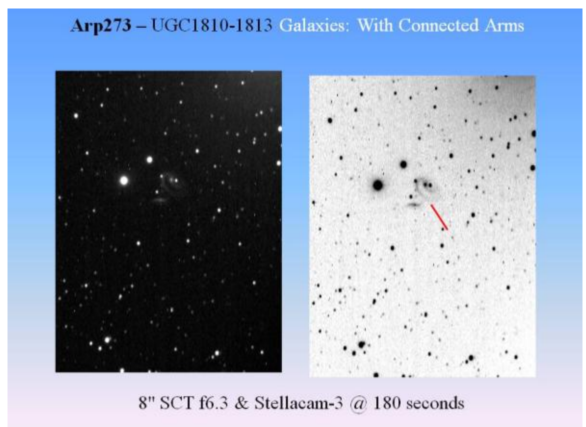

Arp78 – NGC770 & 772
Aries
Triangulum
Andromeda
Pisces

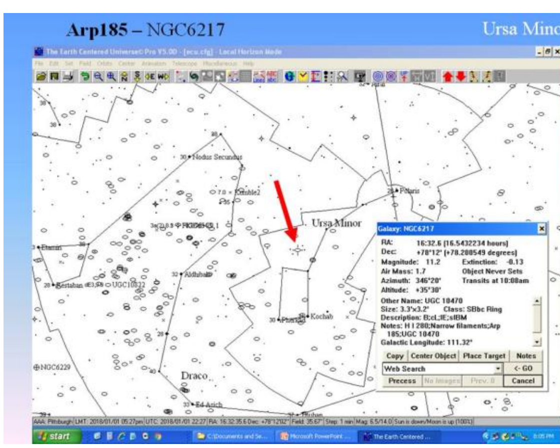

Arp78 – NGC770 & 772 Spiral: Small High SB on arm
8" SCT f6.3 & Stellacam-3 @ 180 seconds

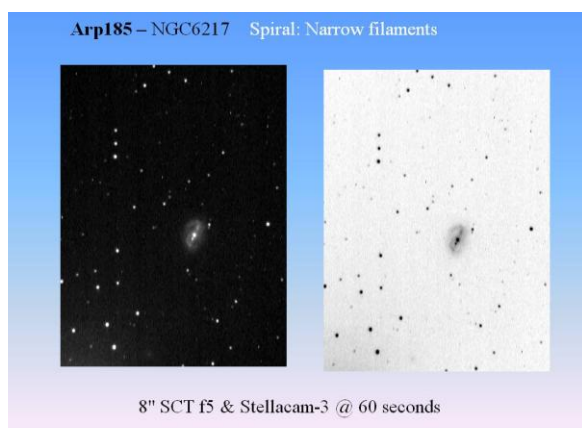

Arp84 – NGC5394 & 5395
Canes Venatici
Bootes
Corona Borealis

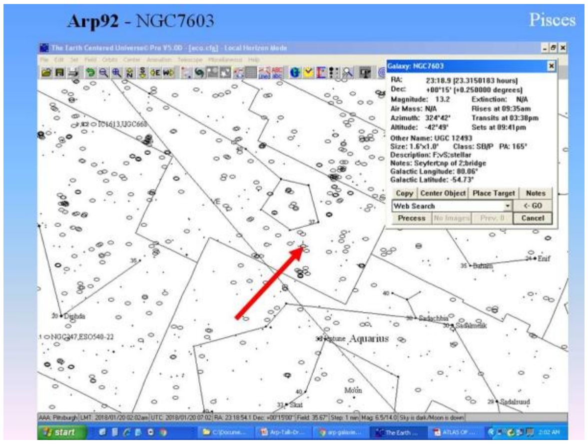

Arp84 – NGC5394 & 5395 Spiral: large High SB on arm
8" SCT f6.3 & Stellacam-3 @ 60 seconds

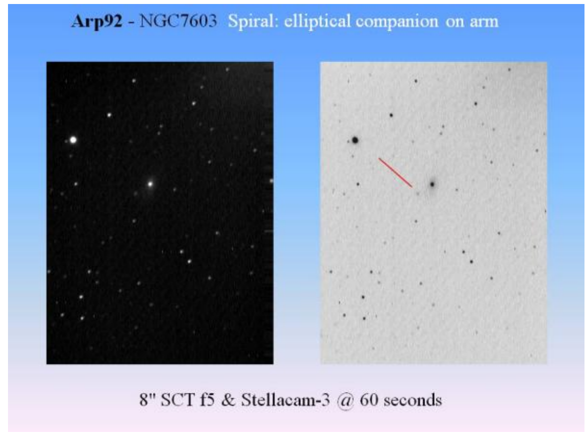

Arp273 – UGC1810-1813
Andromeda
Cassiopeia
Triangulum
Perseus
Aries

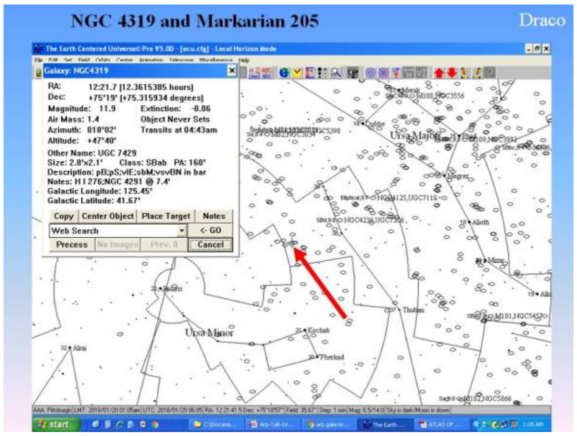

Arp273 – UGC1810-1813 Galaxies: With Connected Arms
8" SCT f6.3 & Stellacam-3 @ 180 seconds

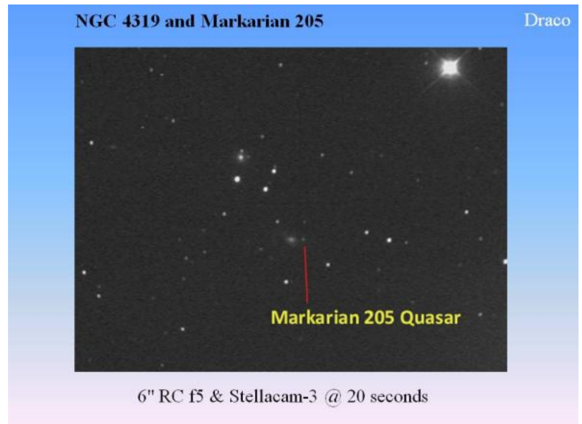

Arp185 – NGC6217
Ursa Minor
Draco


Arp185 – NGC6217 Spiral: Narrow filaments
8" SCT f5 & Stellacam-3 @ 60 seconds









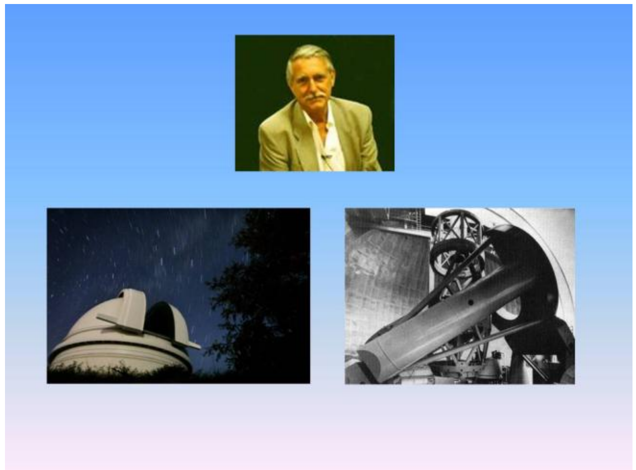
Arp's Legacy & Conclusion

Until his death at the age of 86 on December 28th, 2013, in Munich Germany, Arp continued to hold his contrary view of the Big Bang and published his research in both popular and scientific literature. Today, with modern observatories such as the Keck's and VLT, along with new CCD cameras and space telescopes available, new data such as the Sloan Digital Sky Survey and the Hubble Deep Field across multiple bandwidths of the observable spectrum with higher resolution and dynamic range, along with conclusive research has proven Arp's "counter-theories" of intrinsic redshift to be incorrect.
But, even though he was eventually proven to be wrong, Halton Arp made significant contributions to astrophysics by his strong challenges to accepted theory, based on observations, forcing other astronomers to re-validate their assumptions about galaxy formation and cosmology.

Halton C Arp's Atlas of Peculiar Galaxies is not just a neat list of interesting looking galaxies, but also has become a useful tool for the advanced amateur astronomer looking for deep-sky observing/imaging projects. Professionally, Arp's atlas is recognized as an excellent compilation of interacting and merging galaxies that provides a useful benchmark of local peculiar galaxies to compare against more distant objects being discovered in deep HST images.

Halton Arp is considered by some to be one of the great American observational astronomers of the latter half of the 20th century, living at the dawn of the age of the "Quasar" – which discovery of led to a deeper understanding of our expanding universe. His willingness to follow the observational data, even if it didn't fit into accepted theory, to wherever it led, is a hallmark of the scientific method.
Arp's work lives on today, both for the professional astrophysicist and amateur astronomer alike.

So I encourage everyone to get out tonight and try your hand at finding and observing these strange and elusive deep-sky objects, the *Peculiar Galaxies* of Halton C Arp.



Credits

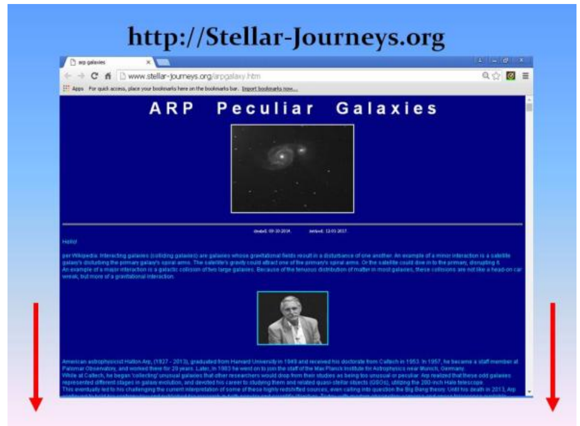
"*Arp Atlas of Peculiar Galaxies*", Halton C Arp, 1966, http://ned.ipac.caltech.edu/level5/Arp/frames.html
"*The Arp Atlas of Peculiar Galaxies – A Chronicle and Observers Guide*", Jeff Kanipe & Dennis Webb, 2006
"*Observing the Arp Peculiar Galaxies*", Alvin Huey, www.faintfuzzies.com
"*Webb Society Deep-Sky Observers Handbook – Vol4 Galaxies*", Kenneth Glyn Jones, 1981
"*Seeing Red: Redshifts, Cosmology, and Academic Science*", Halton C Arp, 1998
"*The Galileo of Palomar: Essays in Memory of Halton Arp*", Christopher Fulton & Martin Kokus, 2017
"*The Red Limit*", Timothy Ferris, 1977
"*Sky & Telescope Magazine – Galaxies in Collision*", Steve Gottlieb, May 2017

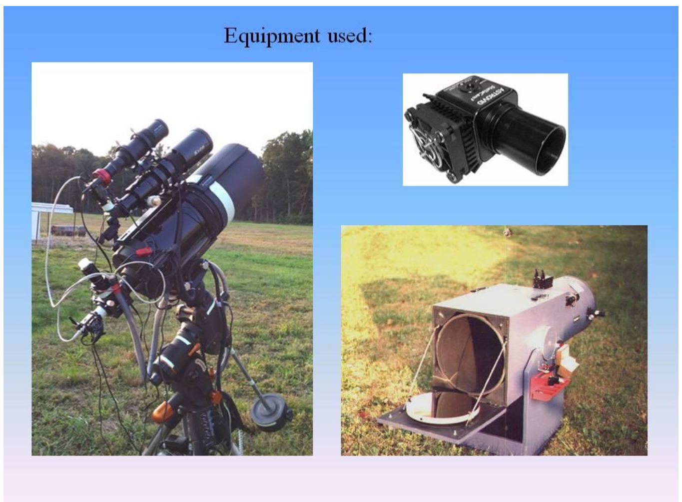
Advanced Observing Program: National Optical Astronomy Observatory - Kitt Peak Az
http://www.noao.edu/outreach/aop/observers/bestof.html
20in RC Optical Systems telescope Operating at f/8.4   Paramount ME Robotic Telescope Mount
SBIG ST10XME CCD camera with color filter wheel

M31 - Adam Block/NOAO/AURA/NSF
M51 - Jon and Bryan Rolfe/Adam Block/NOAO/AURA/NSF
M82 - Joe Jordan/Adam Block/NOAO/AURA/NSF
M84 - 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
M81 - Jeff Cremer/Adam Block/NOAO/AURA/NSF
NGC4535 - Doug Matthews and EJ Jones/Adam Block/NOAO/AURA/NSF
M64 - Anne Beiter and Jon Shallop/Adam Block/NOAO/AURA/NSF
M86 - NOAO/AURA/NSF
M89 - NOAO/AURA/NSF
NGC4449 - John and Christie Connors/Adam Block/NOAO/AURA/NSF
NGC4631 - John Vickery and Jim Matthes/Adam Block/NOAO/AURA/NSF
Stephan's Quintet - Adam Block/NOAO/AURA/NSF
NGC4568 - Bill and Marian Wallace/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

"Students for the Exploration and Development of Space"   http://www.seds.org
"Earth Centered Universe" by David Lane   http://www.nova-astro.com/


http://Stellar-Journeys.org
www.stellar-journeys.org
Stellar-Journeys
Larry's Astronomical Observations
OB Association Tour
Open Cluster Tours
Local Group Galaxy Tour
Arp Peculiar Galaxies Tour
Abell Planetary Nebula Tour
Three Views of the Sun
Current Solar Observations
Venus Transit - 2004
Venus Transit - 2012


http://Stellar-Journeys.org
www.stellar-journeys.org/arpgalaxy.htm
ARP Peculiar Galaxies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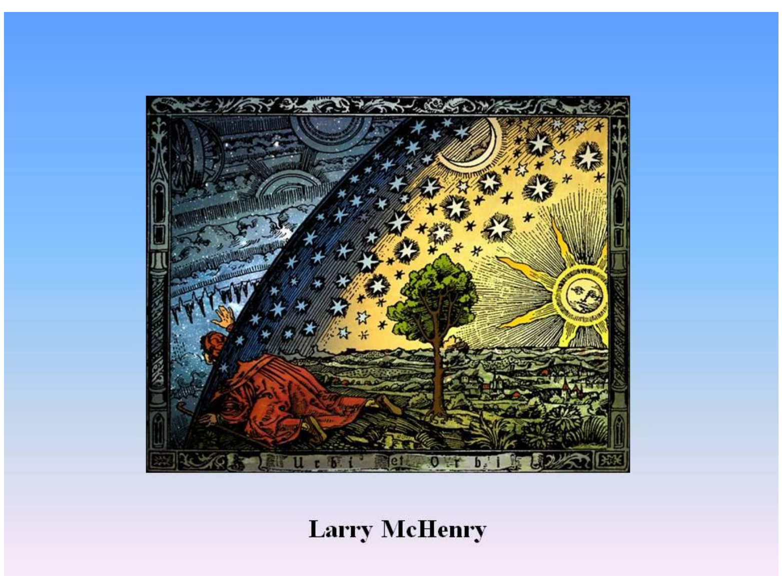
Larry McHenry