The Herschel's and their Catalog

Larry McHenry

1. Introduction

Good afternoon. Today we are going to take a retrospective look back at the lives of William and Caroline Herschel. Two of the greatest astronomers from the 'Age of Enlightenment', which marked the birth of modern science. We'll also cover their greatest contribution – their catalogue of deep-sky objects, and we'll discuss my personal observations of these objects.

2. Outline

- William Herschel:
- Caroline Herschel:
- Together in England:
  - The Survey begins.
  - Dangerous work
- The Herschel Catalog – 2400+ objects:
  - Herschel's classification system: a scientific revolution.
  - My examples from all 8 Herschel classes.
- William and Caroline's lifetime achievements:

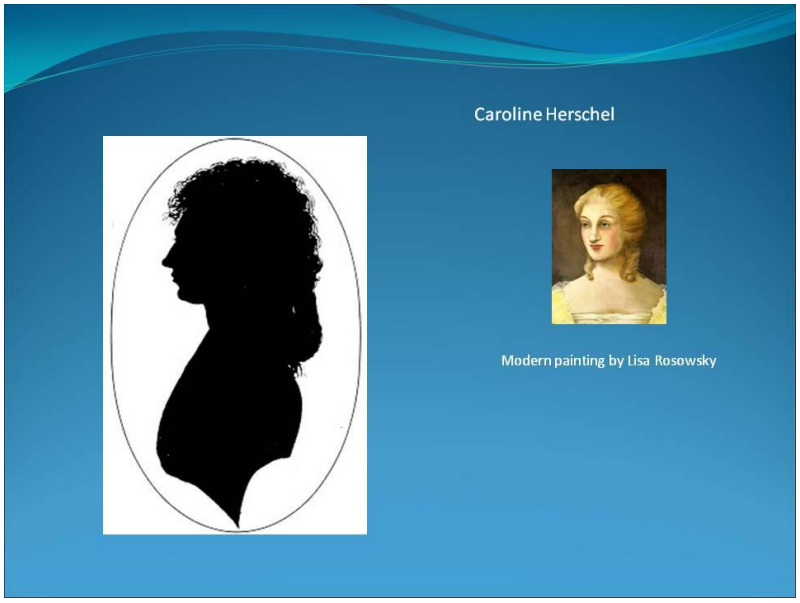
3. William Herschel

Friedrich Wilhelm (William) Herschel was born on November 15th 1738 in Hanover Germany.
He was the third child (out of an eventual 10), of his parents, Isaac and Anna Herschel.
Isaac was a member of the Royal Hanoverian Foot Guard regimental band, where he played the oboe.
Early on, Isaac taught William and his other brothers music, using various instruments as the oboe and violin. He also paid to have his sons receive extra instructions from the garrison teacher in math and French.
Additionally, Isaac was a keen reader and loved to discuss philosophy at home with William and his older brothers. But, most importantly for both William and Caroline, Isaac had a personal interest in astronomy, and taught all his children the constellations and names of the stars at night.
As a teenager, William joined his father as a member of the Hanoverian Guard band.
At age 19, William ended up fighting with the Hanoverian regiment during the 'Seven Years War' in a disastrous battle with the French at Hastenbeck. With his regiment defeated and musket balls flying around him, William took refuge behind a hedge and made it back to Hanover.

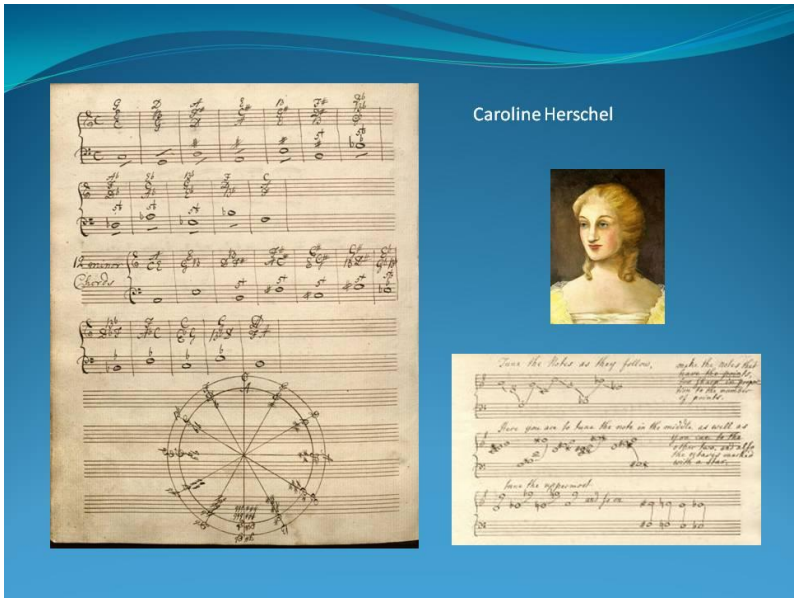
With the fear of French invasion, and as William was just a musician and not really enlisted or trained as a full-time soldier, his father Isaac decided it would be best for William to leave Prussia and helped him to escape to England in 1757.
There, William found employment as a music teacher and organist in Bath England.
In addition to the oboe, he played the violin and harpsichord and later the organ at a local chapel.
Herschel quickly became a very successful musician. He composed numerous musical works, including 24 symphonies, as well as some church music, and gave many concerts. He was eventually able to fund his younger brother Alexander and sister Caroline to come join him in England in 1772.
Herschel was eventually appointed director of the Bath orchestra, and his sister Caroline, who he trained, would often appear as soprano soloist.

4. Caroline Herschel:

Caroline Herschel was born in Hanover on March 16th, 1750, 6th out of 10 siblings.
Her mother Anna Herschel was illiterate and generally disapproved of education for girls.
But she did allow Caroline to learn basic reading and writing, along with home skills such as knitting, washing, and cooking that would make her more eligible for marriage. Her father, Isaac, did teach Caroline how to play the violin, and William and his older brothers would sneak music lesions to Caroline as often as they could. At the age of ten, Caroline was struck with typhus, which stunted her growth and she never grew taller than four foot three inches.

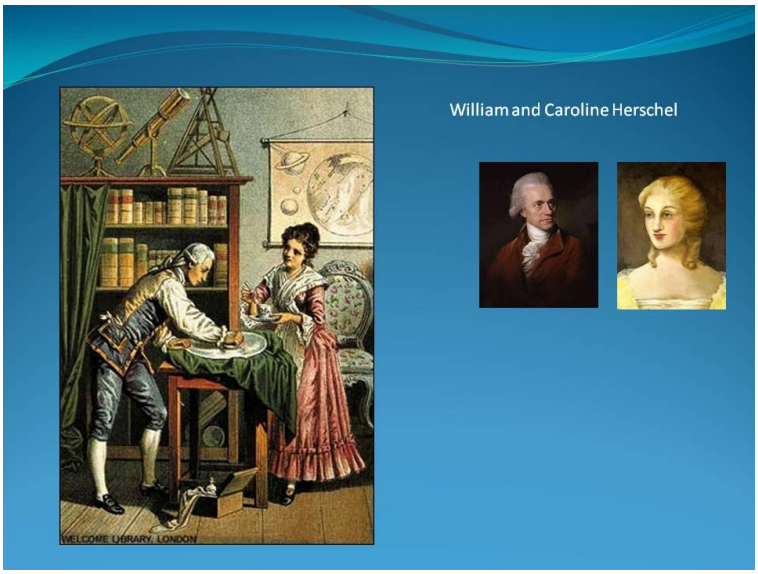


As a young girl, Caroline always looked up to her older brother William, and greatly missed him when he moved to England. So she was quite excited when William came home to Hanover on a trip in 1772 and brought her back to England to live with him. On the long trip back to England William began teaching her to speak English, and at night, when their coach was traveling thru the countryside, he would point out the constellations to Caroline. Once settled in at her new home in Bath, Caroline began taking several singing lessons a day from William. This was in addition to also learning bookkeeping, and being put in charge of running the household for her two brothers.
Soon Caroline became the principal singer at his concerts, and acquired such a reputation of her own as a vocalist that she was offered various engagements such as the annual Birmingham festival.



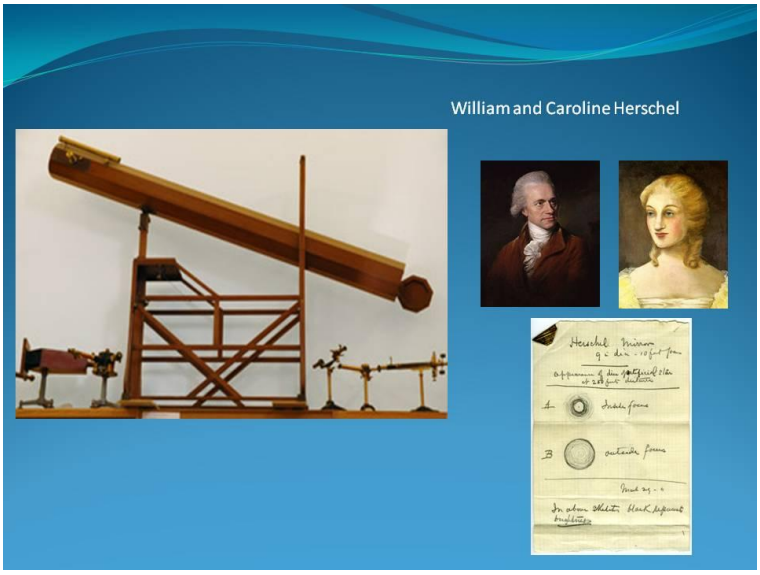
5. Together in England:

During this time, after Caroline had joined him in England, Herschel's music career led him to an interest in mathematics and lenses. This in turn, led to an interest in astronomy, and like his father, William became an avid amateur astronomer in the spring of 1773, first reading any astronomical book or list of tables he could borrow or purchase, then buying a quadrant to measure the location of stars, to renting a small reflector, and then finally proceeding to build his own 7" reflecting telescope with help from Caroline. *(aperture fever)* He would spend up to 16 hours a day grinding and polishing the speculum metal primary mirrors, which was the standard of the day. William wouldn't even take time out to sit down for dinner, so Caroline was forced to cut up his food and feed it to him while he worked.



Caroline and her brother Alexander were also themselves greatly involved with the construction, working on the telescope tube and eyepieces. All this took up every free moment of time they had, as there was still music lessons, concerts, and Church performances they gave to keep the house over their heads and to pay for the workshop equipment and supplies need to construct the telescope.
Finally, in late 1773 the telescope was finished, and Herschel began observing the stars and planets.

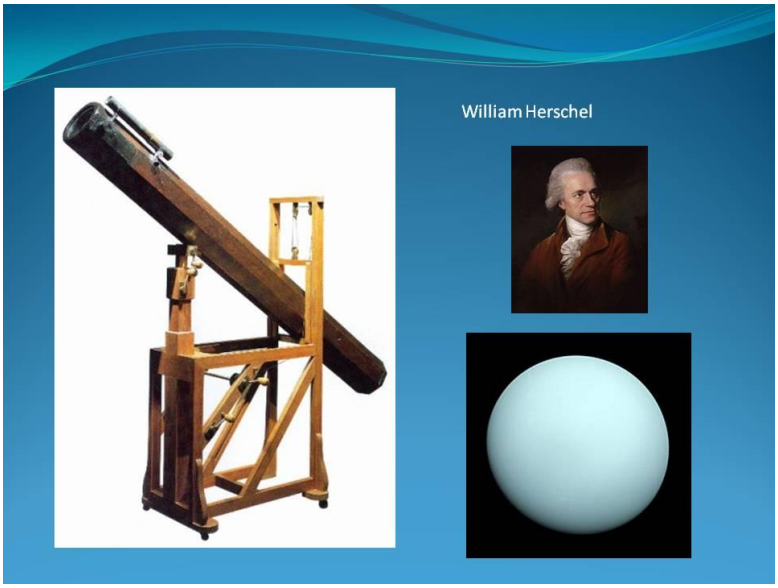
Soon Herschel developed a reputation as a somewhat obsessed observer, going as far as when in the middle of a music lesion, William spied clearing skies out the window, he dropped his violin, and ran out to observe with his telescope, dragging the music student along. Word of his observing skills with his telescope began to spread far and wide, leading to other local astronomers stopping in to introduce themselves and to have a look thru his telescope. Thru this, William's interest in astronomy grew even stronger, especially after he made the acquaintance of the English Astronomer Royal Nevil Maskelyne, thru a mutual friend who had become impressed with Herschel's knowledge of the sky and his skill as a telescope maker and had reported such to Maskelyne. With the Astronomer Royal's encouragement, William began sending regular letters and observing reports to him, and he in turn passed them on to others at the Royal Society, praising Herschel's observing and telescope construction skills. Herschel's early observational work focused on the search for pairs of stars that were very close together visually. In October 1779, with encouragement from the Astronomer Royal, Herschel began a systematic search for such stars among "every star in the Heavens". He soon discovered many more binary and multiple stars than expected, and compiled them with careful measurements of their relative positions in two catalogues presented to the Royal Society in London in 1782 (269 double-star systems) and 1784 (434 systems). Herschel eventually discovered over 800 confirmed double star systems, and his theoretical and observational work provided the foundation for modern binary/double-star astronomy.



But beforehand, on March 13th, 1781, at the age of 42, Herschel observed an object with an unusual disk-like shape. At first he thought it was a new comet, but after following it for several nights and calculating its orbit, he realized that it was instead a new planet with an orbit beyond Saturn. William quickly sent a report to the Astronomer Royal, who encourage Herschel to write an account of his discover and technical details of telescope used and his observing methods, and that was presented to the Royal Society on April 26th., which led to an invitation to travel to London for a formal reception. Once the new discovery had been confirmed over the summer by various observations from professional astronomers across Europe, Herschel was invited back in November to London, where he received a gold medal from the Royal Society, and inducted as a member.

Herschel wanted to name his new planet after King George III of England, but the general consensus of the worldwide astronomical community was to follow the classical Greek/Roman Gods naming of planets and Uranus was the name chosen.

For his discovery, King George in 1782, knighted Herschel as the “Kings Personal Astronomer” was given an annual pension. This allowed Herschel to retire from music and devote himself fulltime to astronomy.



Like William, Caroline had always been interested in the night sky from her father teaching them the constellations, so she was a willing participant in William's new endeavor. After William began his astronomy surveys, She learned to record, reduce, and organize her brother's astronomical observations.

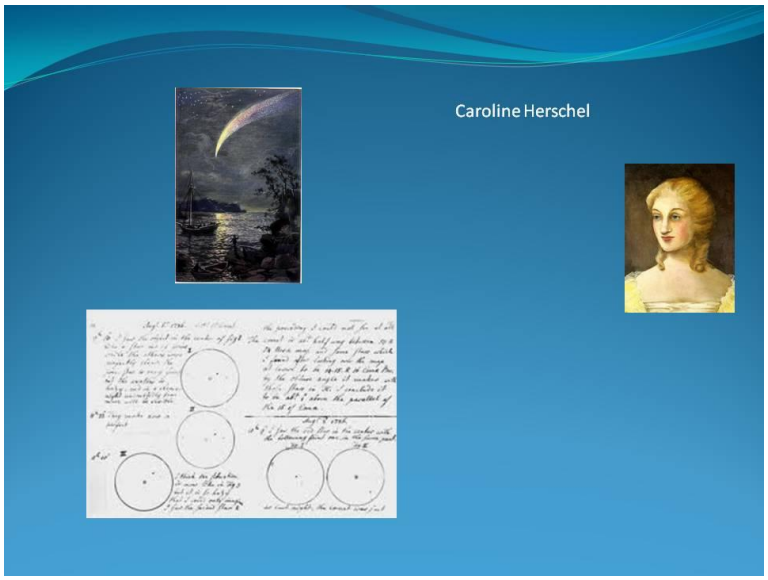
At William's insistence in 1782, Caroline even began making her own solo observations, first using a small spyglass telescope. Seeing Caroline's determination to make her own observations, in 1783 William gave Caroline a 4.2" f6 reflector telescope that he built for her, and she began to make astronomical discoveries in her own right, particularly comets.

She eventually discovered eight comets, and 10 new deep-sky objects (1 galaxy and 9 starclusters). Caroline kept track of her deep-sky discoveries with the intention of creating her own catalog, eventually recording entries for 21 different objects. But five of the objects observed by Caroline had been previously discovered a few years prior by Charles Messier (M29, M46, M48, M93, & M110) and two by Philippe de Cheseaux (NGC6633 & IC4665), all of which Caroline had been unaware of due to their either being unpublished, reported with positional errors, or miss-identified by Caroline. Additionally, two objects were never able to be reconfirmed and are considered lost, and one object was a duplicate.

It's been suggested that William was so impressed by Caroline's deep-sky discoveries that had been missed by other astronomers, that she was what inspired him to undertake his great survey to find and observe all the possible deep-sky objects from England. William incorporated all of Caroline's discoveries into his catalog, and gave her credit for discovering them, but over the years due to clerical errors, a few of these were mistakenly attributed to William.

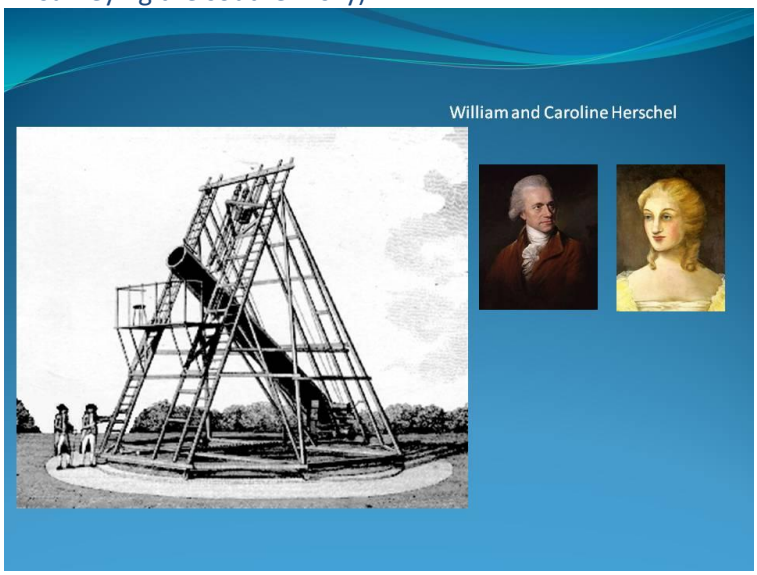
Caroline also updated and corrected John Flamsteed's catalog of star positions. This was published as the British Catalogue of Stars, and she was honored for this work by the recently formed Royal Astronomical Society. Caroline also continued to serve as William's assistant at the telescope. In 1787, she became the first woman to receive a salary for services to science when she was granted an annual pension by King George III for her work as William's assistant.

With the increasing demands on Caroline's time from assisting her brother in his own survey, to being responsible for running the Herschel household, Caroline abandoned her own catalog and focused her free time on comet sweeping.



The Survey begins.

That summer of 1782, the Herschel's quickly relocated to a small village within a mile of Windsor Castle and commenced building a new giant telescope, a permanently installed "20-foot Reflector".
For the next 20 years, from late 1782 to 1802, William and Caroline Herschel conducted systematic surveys in search of "deep sky" or non-stellar objects with his telescopes.
Herschel used two telescopes for his survey, a "20-foot Reflector", which had an 18.5" speculum-metal mirror, and later after they had relocated to a better location nearby at Slough, the great "40-foot Reflector" with a 48" mirror. Both mirrors were made by the Herschel's and had to be regularly polished, as the metal mirrors were quick to tarnish in the wet climate that England is noted for. When he constructed the "40-foot", Herschel actually made two sets of mirrors, one of which he kept polished and stored indoors, ready to be swapped out with the working mirror every year when it began to go bad. Then during the day, he would work on getting the swapped mirror re-polished while continuing his and Caroline's nightly observations with the new mirror.
Most of Herschel's recorded observations were made using the '20-foot' telescope, as the larger '40-foot- was cumbersome to use and suffered from tube current distortions. (it was no modern day truss tube).
(the '20-foot' was the instrument that William's son John Herschel took with him years later to Capetown South Africa to use in surveying the southern sky).



Herschel's telescopes didn't have clock drives to track the stars, so instead, he would point the telescope to the meridian and let the Earth's rotation carry objects across his field of view while he was up on a latter observing. William would then call down to Caroline, at the bottom of the telescope, whenever he saw anything interesting, and she would write down his descriptions and time and where the telescope was pointing. Caroline would then quickly read this back to William and he would confirm the observation while the object was still in the eyepiece. This method allowed them to observe and record a nightly east-west strip of sky. The next day, the two of them would use their recorded observation to calculate the objects position on a star atlas. They would then move the telescope's elevation up or down, in preparation of the next nights survey run. Using this method, they were eventually able to observe all of the sky visible from England. They ultimately discovered over 2400 objects defined by his unique classification system.
During this 20 year survey period, William Herschel also wrote numerous papers on varying astronomical subjects when he regularly presented to the Royal Society. He also supplemented his annual income by producing over 300 telescope mirrors sold around the world.

Dangerous work.

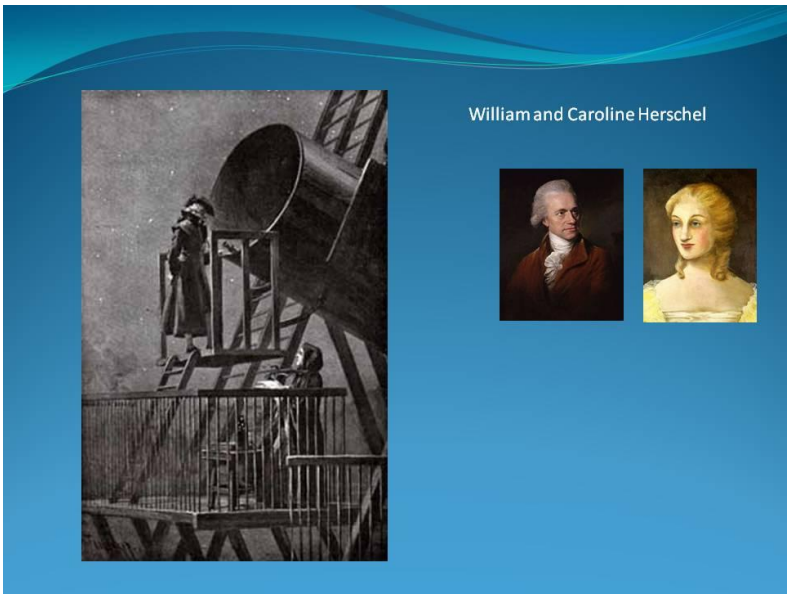
Even with a pension as the 'Kings Personal Astronomer' didn't necessarily mean that the Herschel's led a leisure free life. They still needed to build, maintain, and physically use the telescopes at night.
This sometimes led to dangerous accidents.

In the summer of 1781, William, who was always trying to make bigger mirrors, attempted to cast a 36" speculum mirror using a new metal alloy formula that he hoped would be strong enough not to sag from its own weight. William and his brother Alexander had completed the mirror mold, fired-up their furnace oven, and melted over 500 pounds of metal for casting the mirror. As they poured the molten metal into the mold, it began leaking from a crack. Before they could do anything, the metal poured out, and hit the stone floor causing it to crack and literally explode flinging chucks over their heads as they ran for the door.

Another time, late at night, William went to sharpen one of his tools, and nearly took off his fingers on the grindstone.

Caroline was William's constant companion in his nightly observations, recording at night everything William observed at the telescope, and fetching anything he might need. During one winter observation run on the "20-Foot"telescope in 1783, Caroline, coming back from an errand adjusting the telescope alignment tripped on the telescope's framework and became impaled on an iron hook used for securing the ropes that controlled where the telescope pointed. She was pinned to the sharp hook, which had gone deep into her leg, and had to call for help. After several minutes wondering where she had gone, William finally heard Caroline calling and had to run back to the house to fetch several servants to help pull her of the sharp hook. Caroline didn't come off the hook easily, and later wrote that when she was helped off "...they could not lift me without leaving nearly 2 ounces of my flesh behind". She was laid up for several weeks, recovering.

Finally, William and Alexander narrowly avoided being crushed by the 1-ton "40-Foot" mirror when swapping it out to be re-polished, the tackle-beam snapped, dropping the mirror several feet.



6. **The Herschel Catalog – 2400+ objects:**

A: Herschel's classification system, a scientific revolution.

William Herschel published his deep-sky discoveries as three separate catalogues:
Catalogue of One Thousand New Nebulae and Clusters of Stars (1786),
Catalogue of a Second Thousand New Nebulae and Clusters of Stars (1789),
Catalogue of 500 New Nebulae ... (1802).

Herschel classified his list into eight sub-categories:

Class I - Bright Nebulae;
Class II - Faint Nebulae;
Class III - Very Faint Nebulae;
Class IV - Planetary Nebulae;
Class V - Very Large Nebulae;
Class VI - Very Compressed and Rich Clusters of Stars;
Class VII - Compressed Clusters of Small and Large Stars;
Class VIII - Coarsely Scattered Clusters of Stars.

One of Herschel's main goals was to observe the sky systematically and map the distribution of stars, to gain a picture of where the sun stood in relation to the Milky Way. In all, Herschel catalogued close to 9,000 stars, far more than any of his predecessors, and he increased the number of known nebulae and clusters from Messiers 103 to almost 2500 objects. Herschel was the first to invent and use a method of classifying deep-sky objects. This was a powerful tool in understanding the relationships between the different objects in the heavens, and changed the focus of astronomy. Herschel was especially interested in the classes of nebula that he discovered. Herschel theorized that the difference in various nebulas appearance was due to their distance, age, and effects of gravity. He felt these objects were evolving over time, and that the universe was in constant state of change. Herschel's theory resulted in a scientific revolution that the later Victorian and Modern day astronomers used to create our present-day understanding of our galaxy and the universe.

Each of Herschel's sub-category objects are numbered in the sequential order by when they were discovered. So unlike the Messier Objects, Herschel Object# VII-255 may have been discovered years before object# III-81. In Herschel's time, the galaxies were considered to be all just nebula, so there is no separate class for them, and they are mixed among the first five classes.
Nearly three-fourths of Herschel's objects are classified as type II & III, faint and very faint. (mostly galaxies).
Herschel's classes are actually useful in giving the observer an idea of what the object will look like visually at the telescope. For example, Class-I objects are bright nebulous objects, though some are actually galaxies. Class-VI objects are generally nice bright, rich open star clusters.

B: My examples from all 8 Herschel classes.

Ingredients to successfully observing the Herschel Objects:

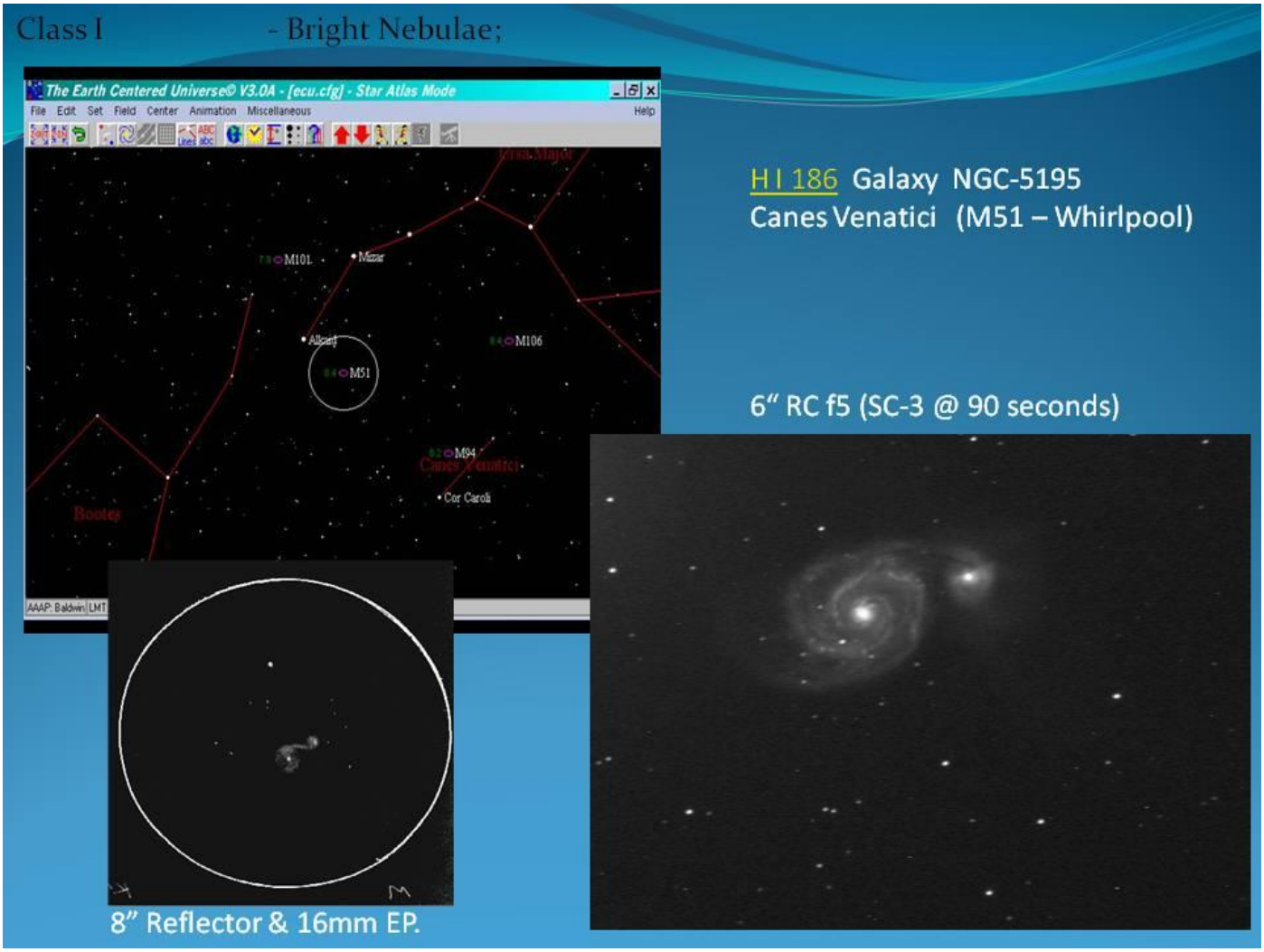
Visually:
Moderate sized telescope – 10"+ or greater mirror
Dark Sky location – Cherry Springs
Electronically aided:
Deep-Sky Video Camera
CCD Camera or DSLR
Equatorially mounted Telescope 4"+ or greater
Deep Star Chart or Planetarium Software
Observing Plan

Class I - Bright Nebulae:

This Herschel class tends to be objects of various sizes and shapes, such as galaxies, clusters, and nebula. But the one thing they all have in common is that they are very bright.

These are the easiest Herschel Objects to observe.

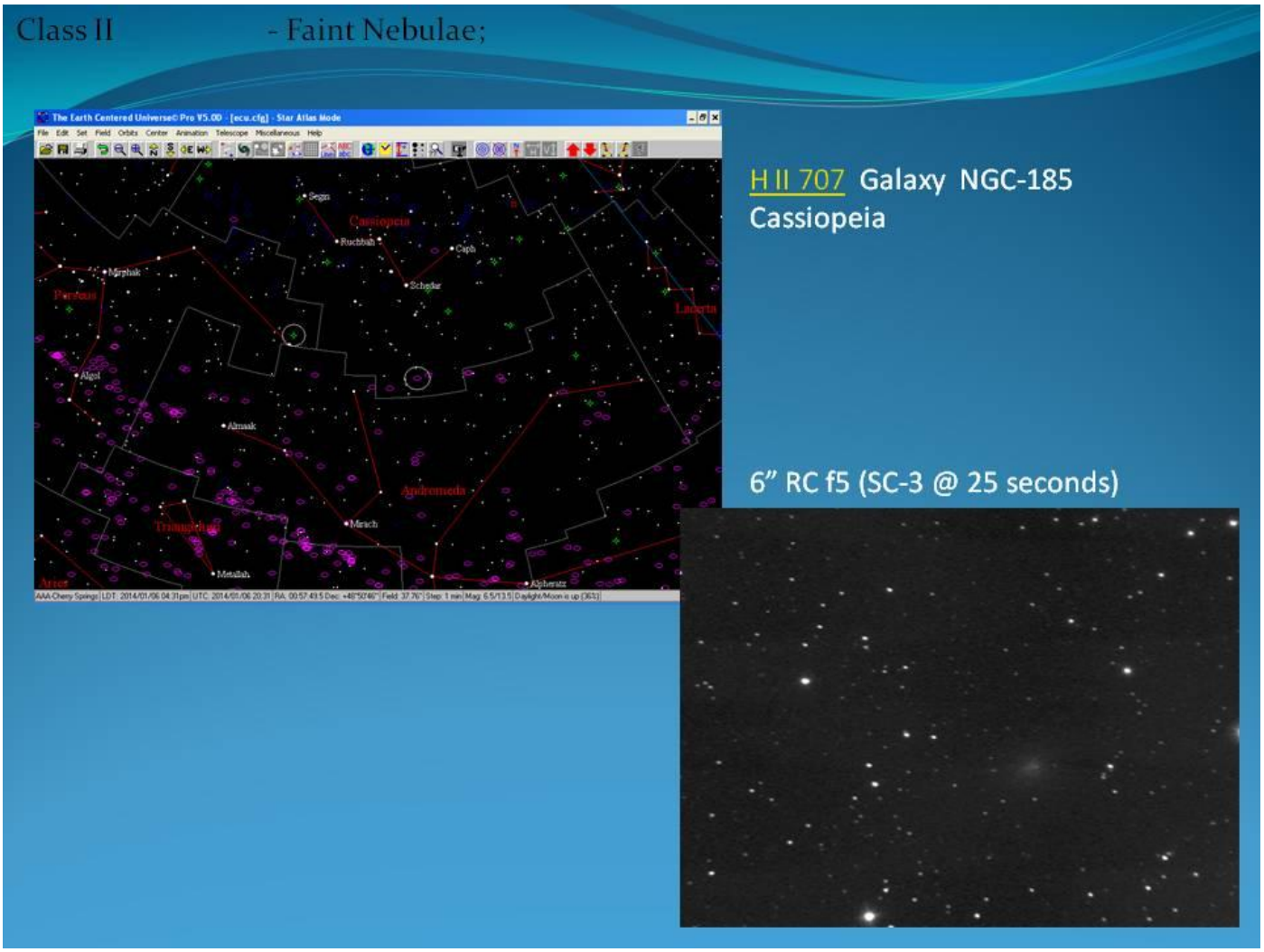
NGC-651 (H1-193, planetary neb: Perseus)
NGC-5195 M51 (H1-156, galaxy, Canes Ven)
NGC-6934 (H1-103, glob Cluster: Delphinus)
NGC-7331 (H1-53, galaxy: Pegasus)



Class II - Faint Nebulae:

This Herschel class tends to be objects that are generally faint, such as unresolved clusters and dim galaxies. You'll need fairly dark skies and a medium to large telescope.

NGC-185 (HII-707, galaxy: Cass)
NGC-5694 (HII-196, glob Cluster: Hydra)
NGC-6287 (HII-195, Glob, Oph)

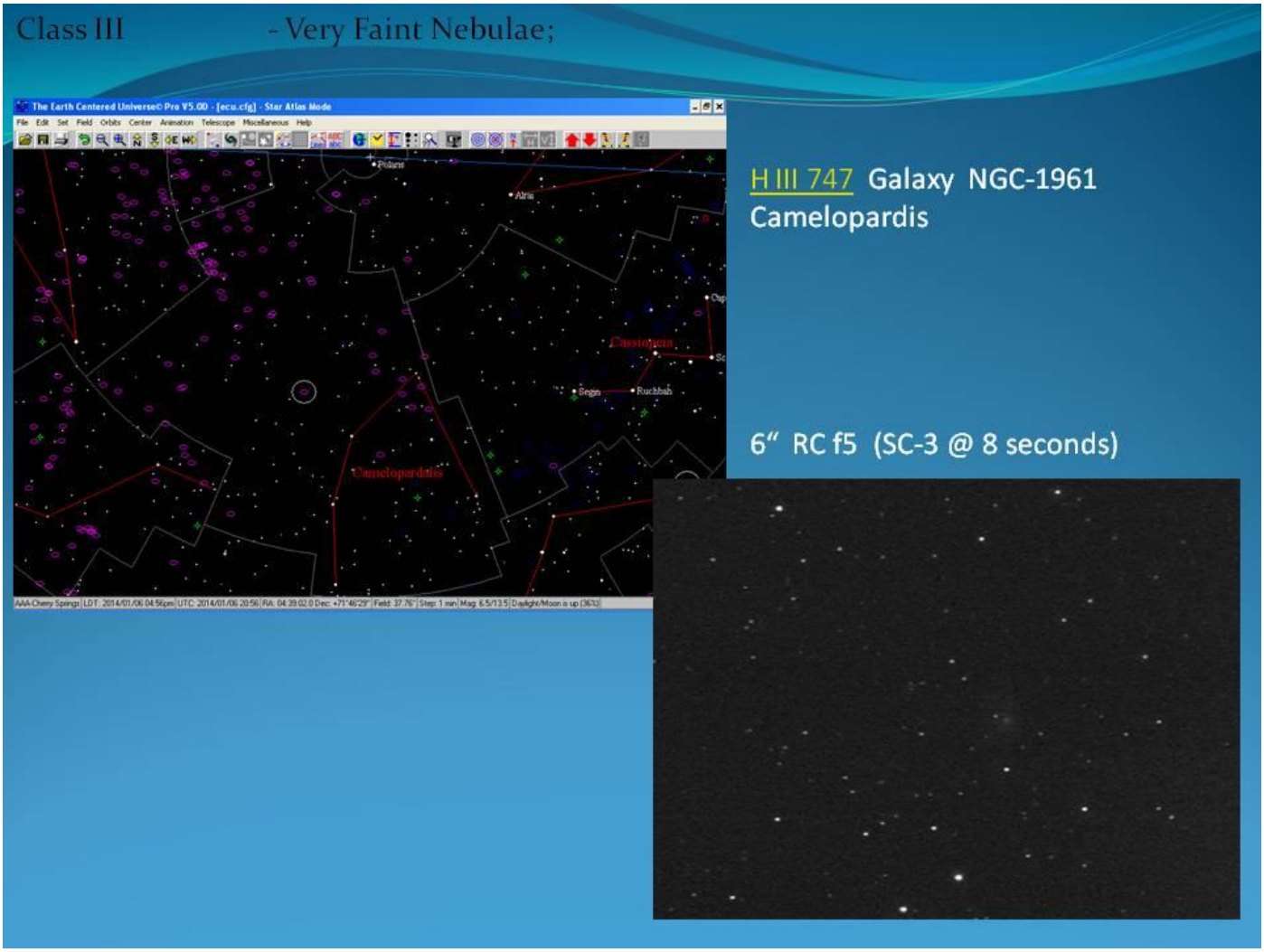


Class III - Very Faint Nebulae:

This Herschel class tends to be made up of very, very faint objects, mostly galaxies. This class of objects will require a dark sky location, a large telescope, or video / CCD camera, and a bit of luck.

NGC-488 (HIII-252, galaxy: Pisces)

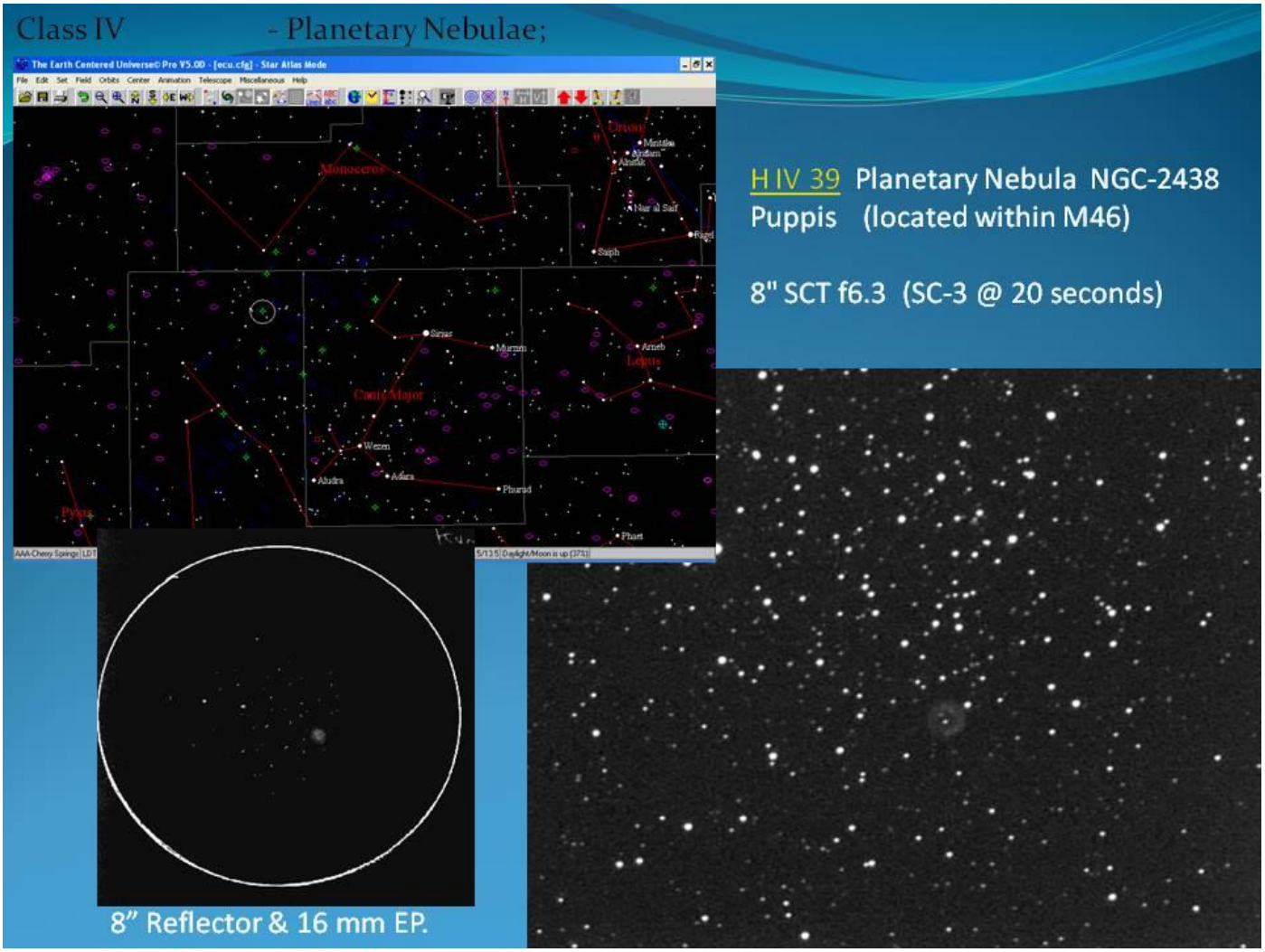
NGC-1961 (HIII-747, galaxy: Camelopardis)



Class IV - Planetary Nebulae:

This Herschel class tends to be made up of objects that are actually planetary nebula, but you can find some emission nebula and galaxies mixed in.

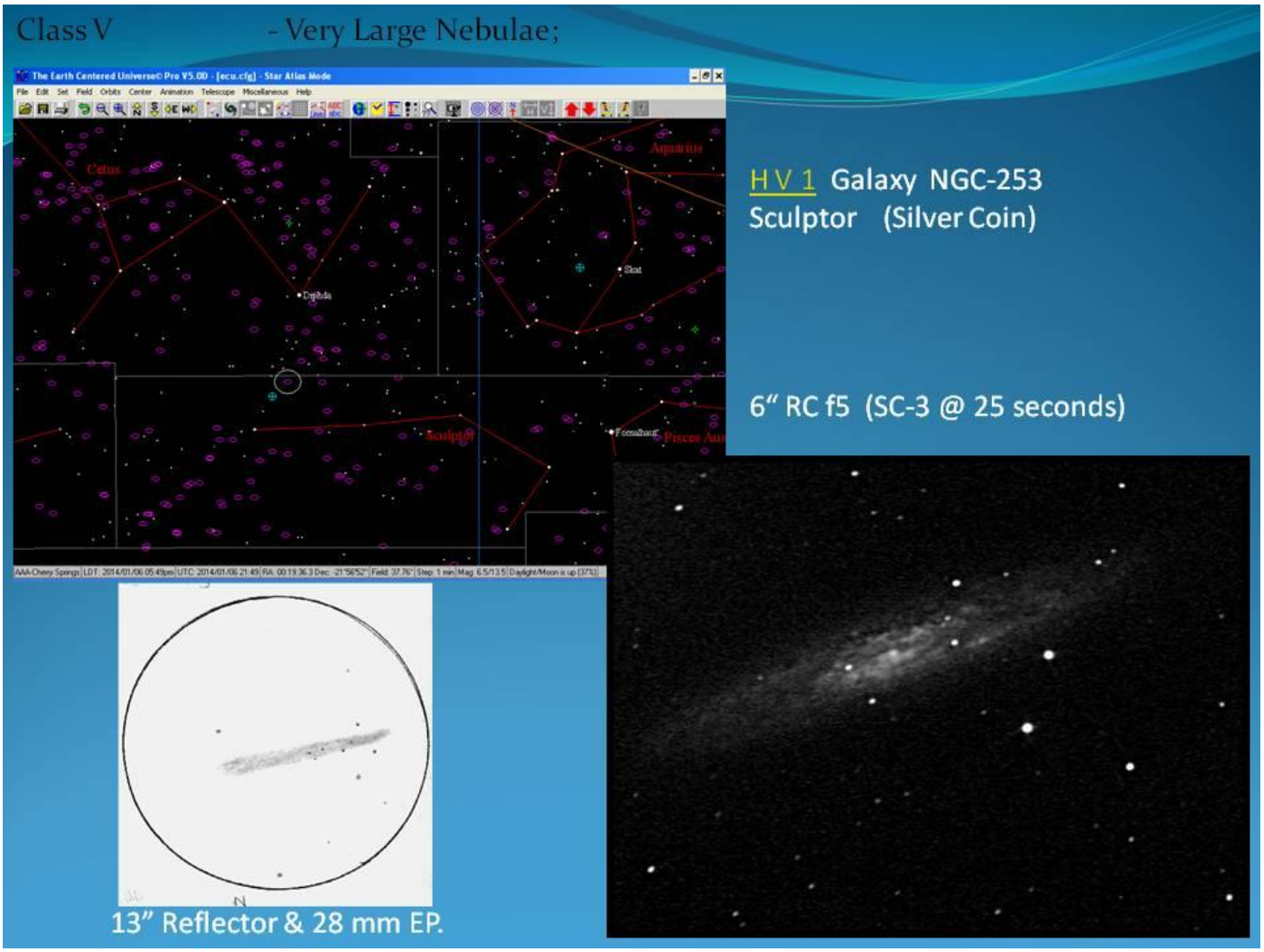
NGC-40 (HIV-58, Pl neb: Cepheus)
NGC-2392 (HIV-45, Pl Neb 'Eskimo' : Gemini)
NGC-2438 (HIV-39, Pl Neb 'in M46': Puppis)
NGC-7009 (HIV-1, Pl Neb ' Saturn': Aquarius),



Class V - Very Large Nebulae:

This Herschel class tends to consist of very large deep-sky objects. They may not necessarily be very bright. Depending on the object, you may need a dark-sky location, and a wide-field eyepiece.

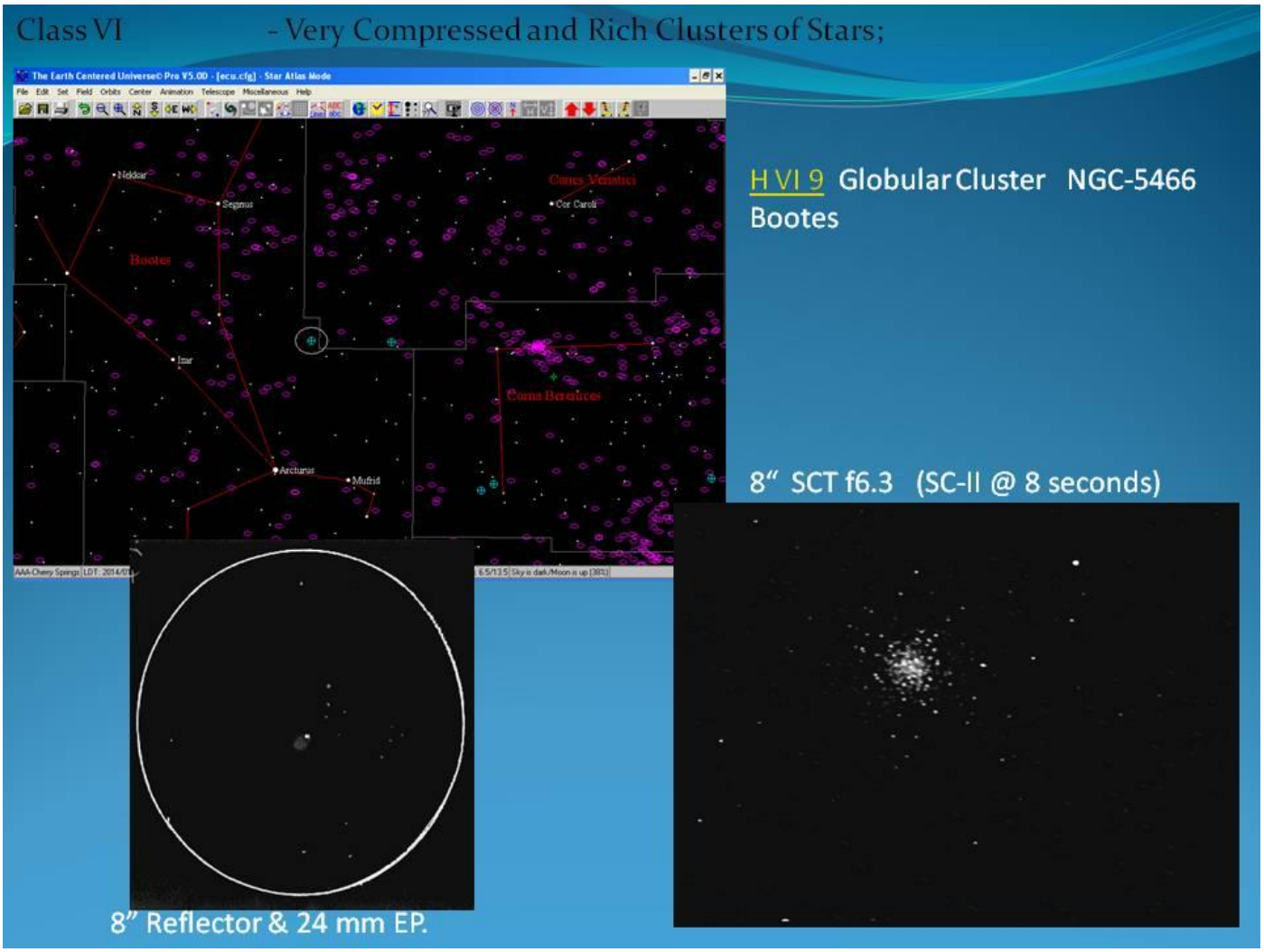
NGC-253 (HV- 1, galaxy: Sculptor)
NGC-598 (HV-17, galaxy 'M33': Triangulum)
NGC-891 (HV-19, galaxy: Andromeda)
NGC-2024 (HV-28, Neb 'Flame': Orion)
NGC-6514 (HV-10,11,12, Neb 'M20': Sagittarius)



Class VI - Very Compressed and Rich Clusters of Stars:

This Herschel class tends to be mostly bright resolvable globular clusters, and large open clusters with numerous members.

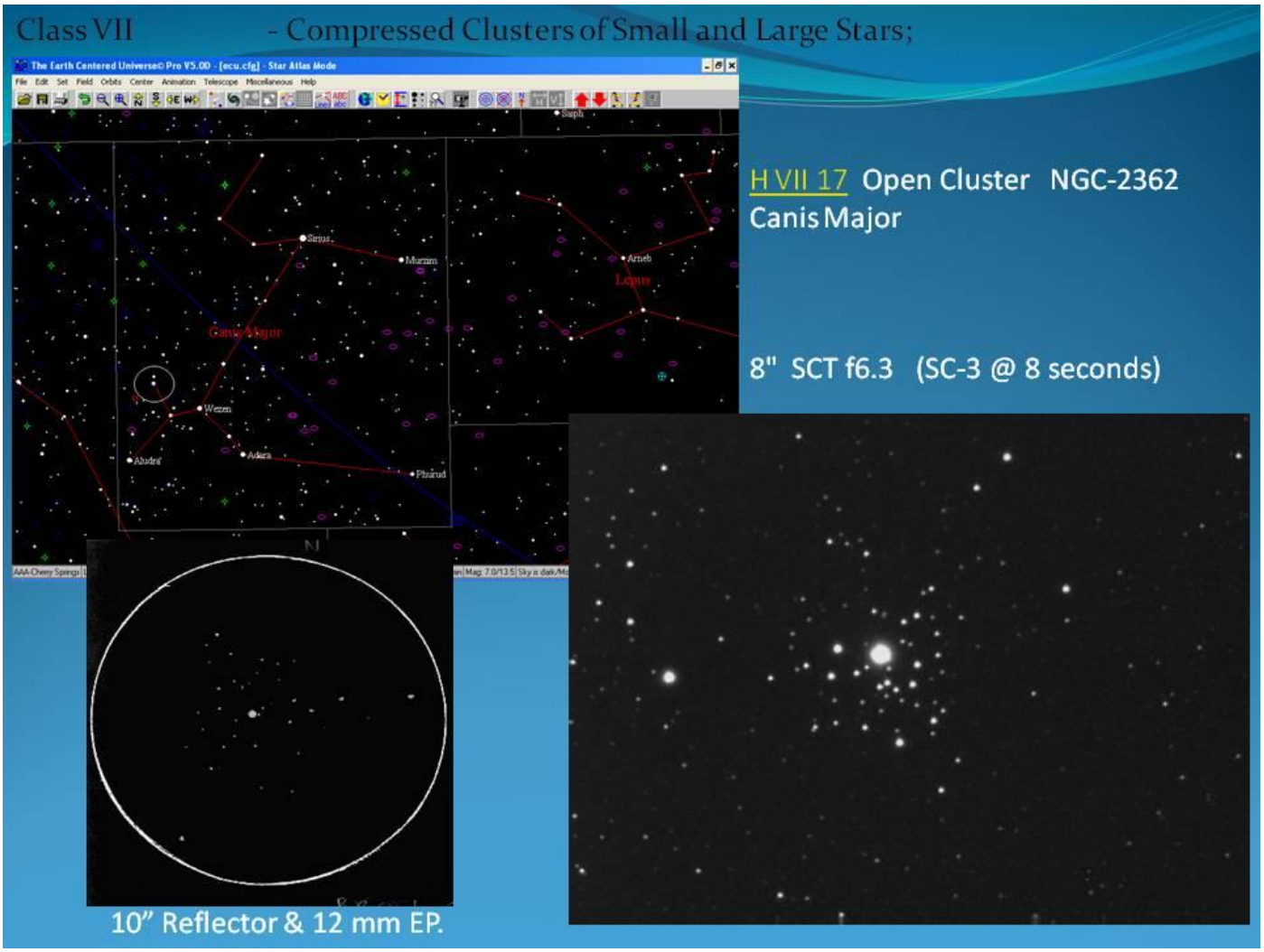
NGC-869 (HVI-33, OC 'Double': Perseus) & NGC-884 (HVI-34, OC 'Double': Perseus)
NGC-1245 (HVI-25, OC: Perseus)
NGC-5466 (HVI-9, Glob Cluster: Bootes)
NGC-5897 (HVI-19, Glob Cluster: Lybra)



Class VII - Compressed Clusters of Small and Large Stars:

This Herschel class tends to be open clusters containing bright fore-ground stars, or cluster members with widely varying luminosities.

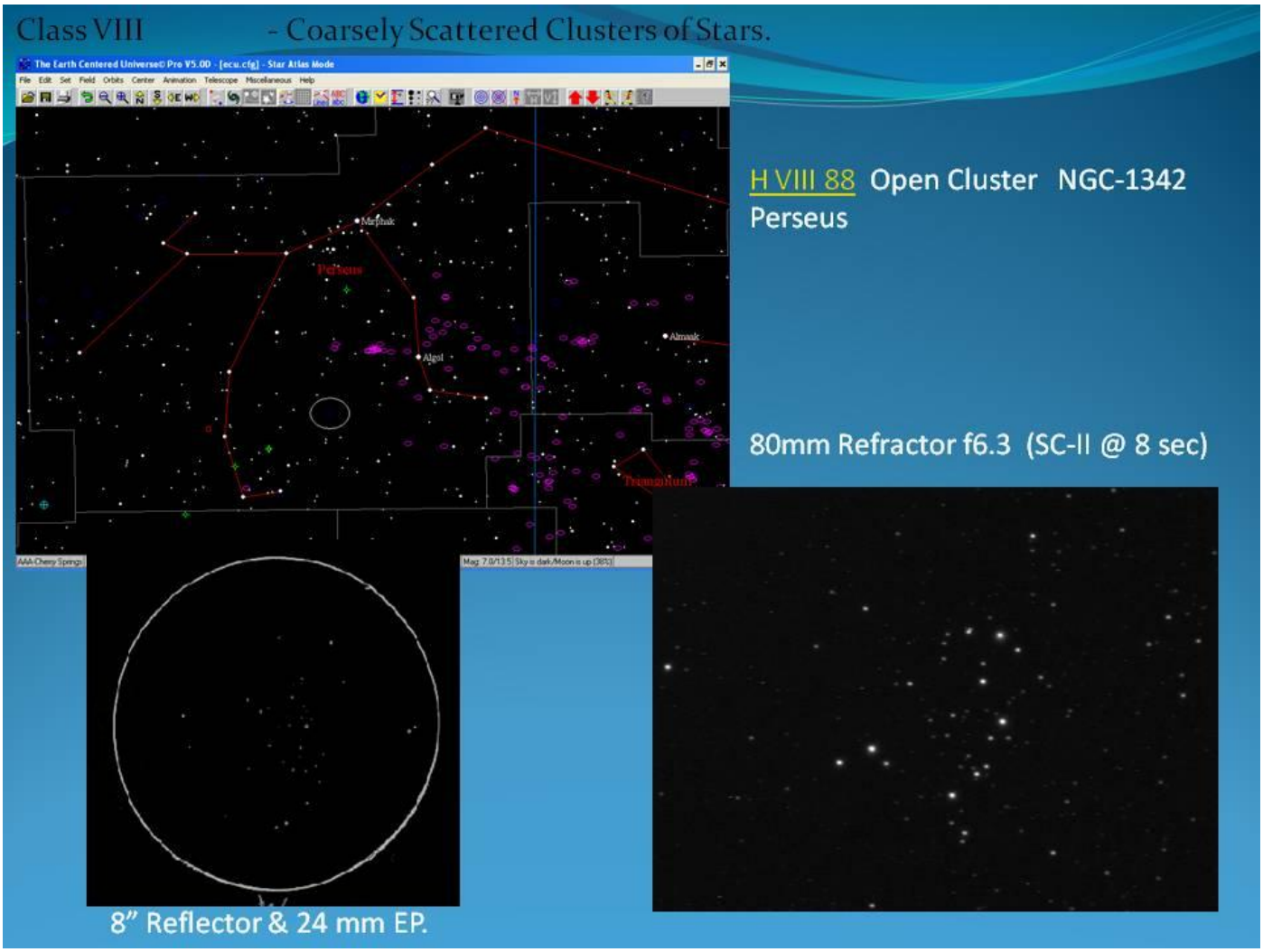
NGC-457 (HVII-42, OC, 'ET': Cass)
NGC-1502 (HVII-47, OC: Camelopardis)
NGC-2362 (HVII-17, OC:Canis Major)
NGC-6940 (HVII-8, OC: Vulpecula)



Class VIII - Coarsely Scattered Clusters of Stars:

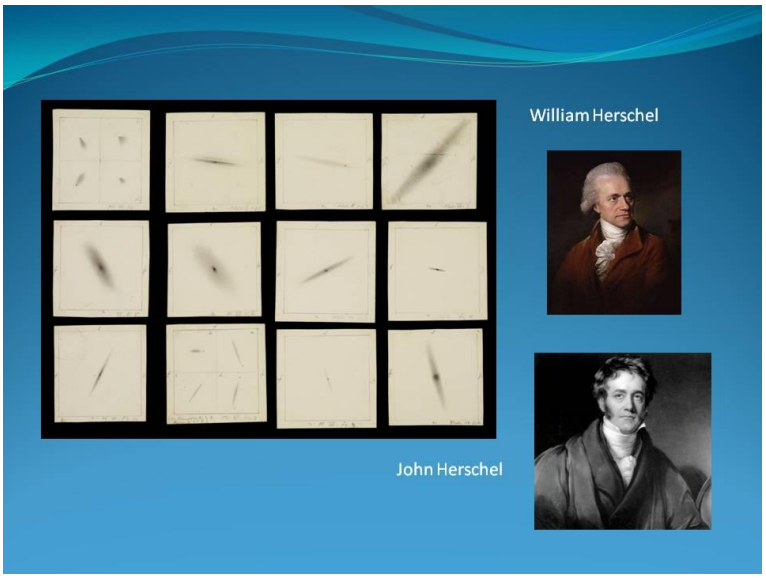
This Herschel class tends to be loose, somewhat dim open clusters . Best suited for wide-field eyepieces.

NGC-225 (HVIII-78, OC: Cass),
NGC-1342 (HVIII-88, OC: Perseus)
NGC-1664 (HVIII-59, OC: Auriga)
NGC-6910 (HVIII-56, OC: Cygnus)

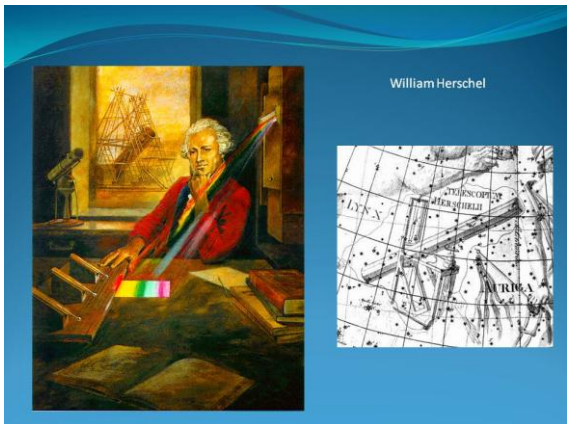


7. William and Caroline's lifetime achievements:

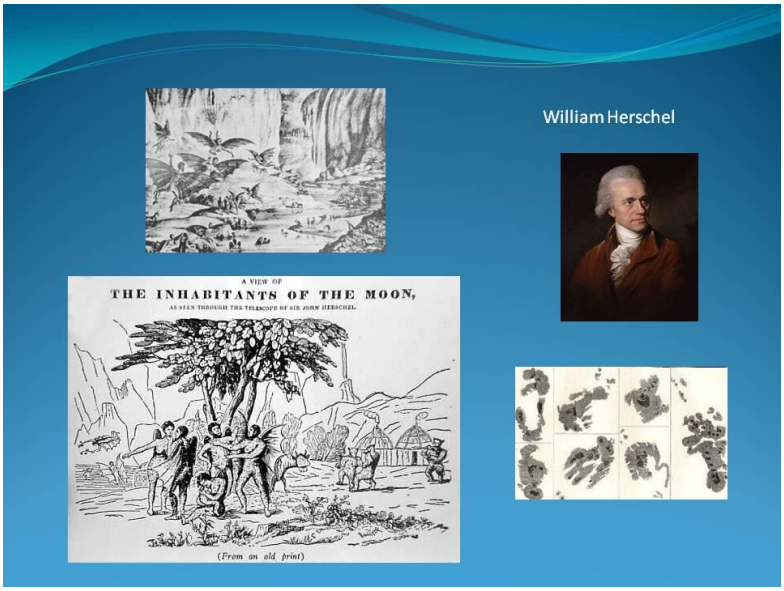
On November 30th, 1788, at the age of 50, William Herschel finally settled down to a family life by marrying a local, Mary Pitt, who he had courted for a few years. William and Mary had one child, John Herschel, born at Observatory House on March 7th, 1792. John didn't take up astronomy until after 1816, having first pursued careers as a lawyer and then a mathematics professor at Cambridge. But like his father, John soon became obsessed with all things astronomy, eventually learning how to polish the "20-Foot" speculum mirror from his father and building a new telescope framework for the mirror. In 1821, with William at the age of 82, in declining health, he and sister Caroline made one last survey sweep of the skies, in order to train John on the proper procedures of using the '20-Foot' telescope and recording the observations in the same format they used since 1782. John then went on to expand his father's deep-sky catalog using the '20-Foot' telescope at Capetown South Africa, and became a great astronomer in his own right.



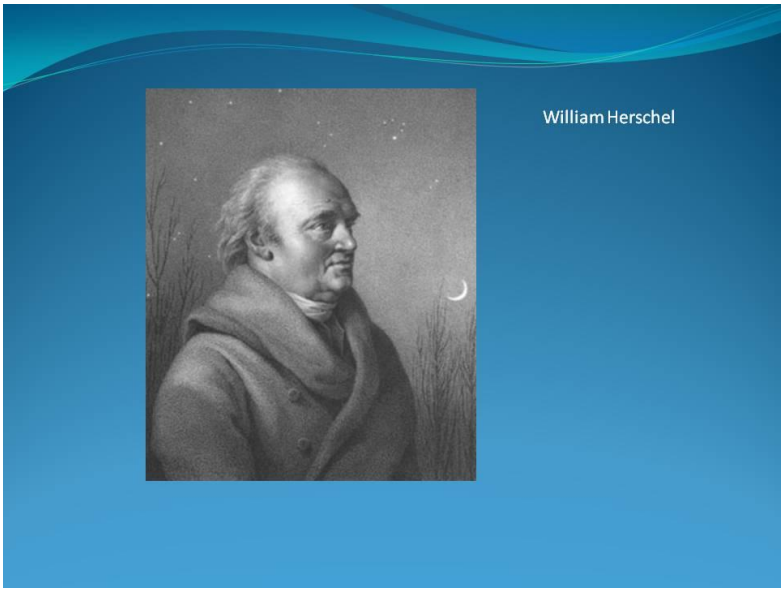
In addition to his discovery of the Planet Uranus, William Herschel also discovered two of Uranus's moons, Titania and Oberon, along with two additional moons of Jupiter, Mimas and Encleladus.
Herschel was the first to measure the axial tilt of Mars, and discovered that the Martian season impacted the size of the ice-caps. He invented the word 'asteroid' (meaning 'star-like') for the class of minor planets that were being discovered during his time. Herschel also observed the Sun and tracked sunspots, and while trying to build a better solar-filter in 1800, discovered infrared radiation heating by sunlight. He did this by experimenting with passing light thru a prism and using a thermometer to measure each color spectrum's temperature. After taking the temperature of 'red', he moved the thermometer outside the 'red' range and got a higher reading than any in the visible range. He discovered nearly 1000 double-stars and that they move around a common gravitational center, along with our solar systems direction of travel thru space.
He was the first to devise the theory that our galaxy was disk-shaped, and believed that the nebulae we know today as galaxies were clusters of unresolved stars which he called "Island Nebulae".



Despite his numerous important scientific discoveries, Herschel also had a few wild ideas.
In particular, he believed every planet and moon in the solar system was inhabited.
He even thought that sunspots where actually 'holes' in the Sun's luminous upper cloud atmosphere that allowed views to the Sun's surface below, which he also thought would be inhabited.

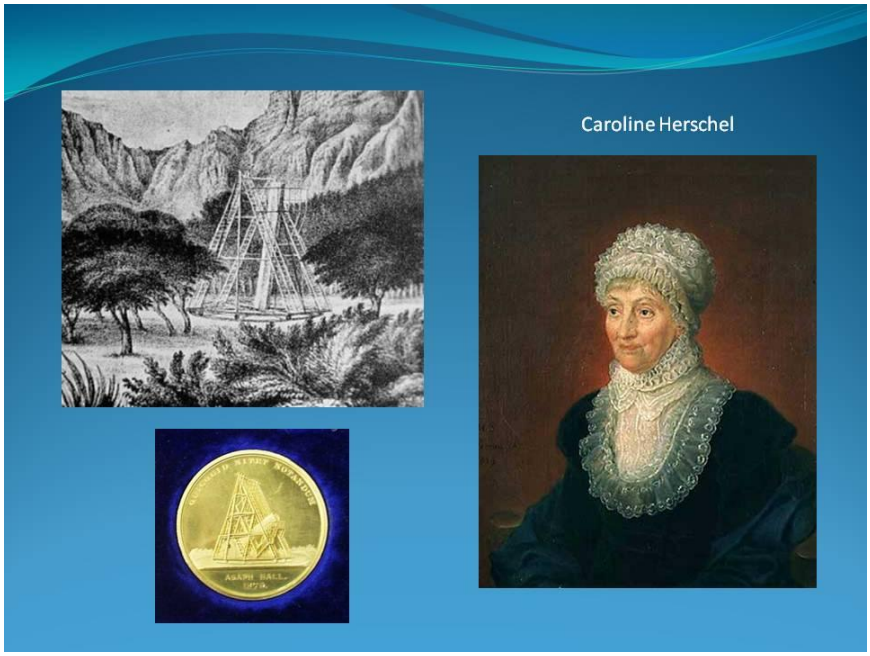


On August 25th, 1822, at age age of 83, William Herschel died at Observatory House, Windsor Road, Slough, and is buried at nearby St Laurence's Church, Upton. After William's death, his son John had the no longer used great "40-Foot" telescope dismantled and held a farewell party inside of the telescope tube.



In 1822 following her brother's death, Caroline Herschel returned to Hanover Prussia.
She had never married while living with her brother, and did not get along very well with William's wife Mary, and as the survey work had stopped, there was nothing holding her in England.
Caroline did stay in-touch with her favorite (and only) nephew John, and constantly exchanged letters.
Upon John's request in 1825, she revised William's original catalog to make it easier for John to navigate.
The Royal Astronomical Society in 1828 presented her with their Gold Medal for this work.
In 1834, When John took the '20-foot' telescope to South Africa, he would send back his observing records to Caroline, who would perform the charting calculations, just as she once did for her brother and John's father, William. In 1835, she was elected to honorary membership of the Royal Astronomical Society; as the first honorary female member.

In 1846, at the age of 96, she was awarded the Gold Medal for Science by the King of Prussia.
Caroline Herschel died at Hanover on January 9 1848, at the age of 97, and is buried there.

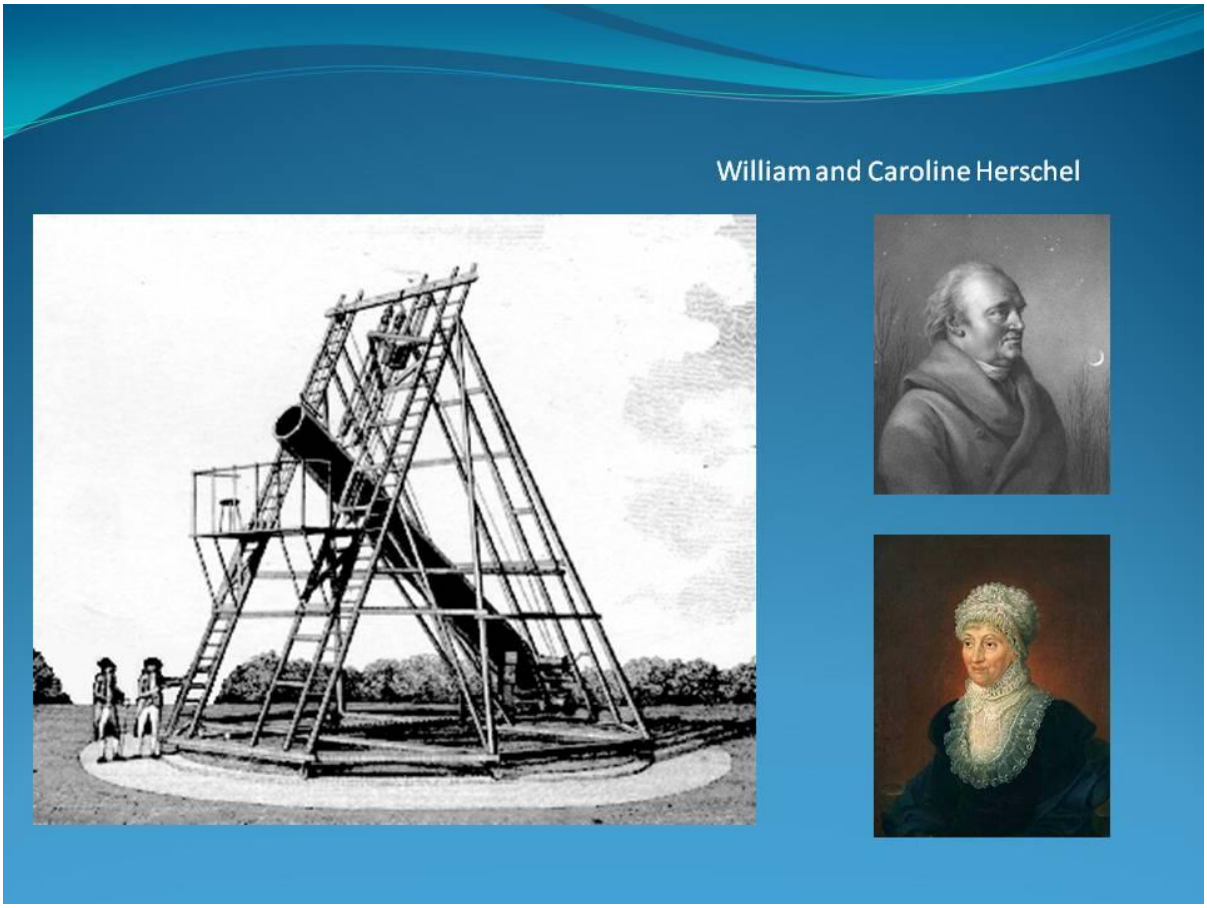


8. Conclusion :

William Herschel's discoveries of 2500 deep-sky objects were supplemented by those of Caroline Herschel (10 objects) and his son John Herschel's South African observations (1754 objects) and published by John as the *General Catalogue of Nebulae and Clusters* in 1864.
This catalogue was later edited by John Dreyer, supplemented with discoveries by many other 19th century astronomers, and published in 1888 as the *New General Catalogue* (abbreviated NGC) of 7840 deep sky objects. Today, the NGC, along with the supplement Index Catalog (IC) is at over 13,225 objects!!

The Herschel's observing technique of surveying, cataloguing, and classifying what they found, and then using that data to try and understand the structure of the universe, has become one of the most important tools of modern astronomy.

William Herschel was one of the most notable observers in the history of astronomy, and is often referred to as the 'father of observational astronomy'.
In a way, both William and Caroline are the 'mother and father of amateur astronomy', as all of their discoveries were made with telescopes and mirrors of their own making.
And as most stargazers do today, all of their observations were made outside in the open, exposed to the elements, and not from inside an observatory building.



Credits:

"The Georgian Star" by Michael Lemonick

"The Comet Sweeper" by Clare Brock

"The Age of Wonder" by Richard Holmes

"Observe the Herschel Objects" by Astronomical League & Ancient City astronomy club

"Exploring the Herschel Catalog" – Dennis di Cicco , Sky & Telescope, Sept 1992

"In Caroline Herschel's Footsteps" – Michael Hoskin , Sky & Telescope, Aug 2007

"The Herschel Project" – Rod Mollise, Sky & Telescope, August 2012

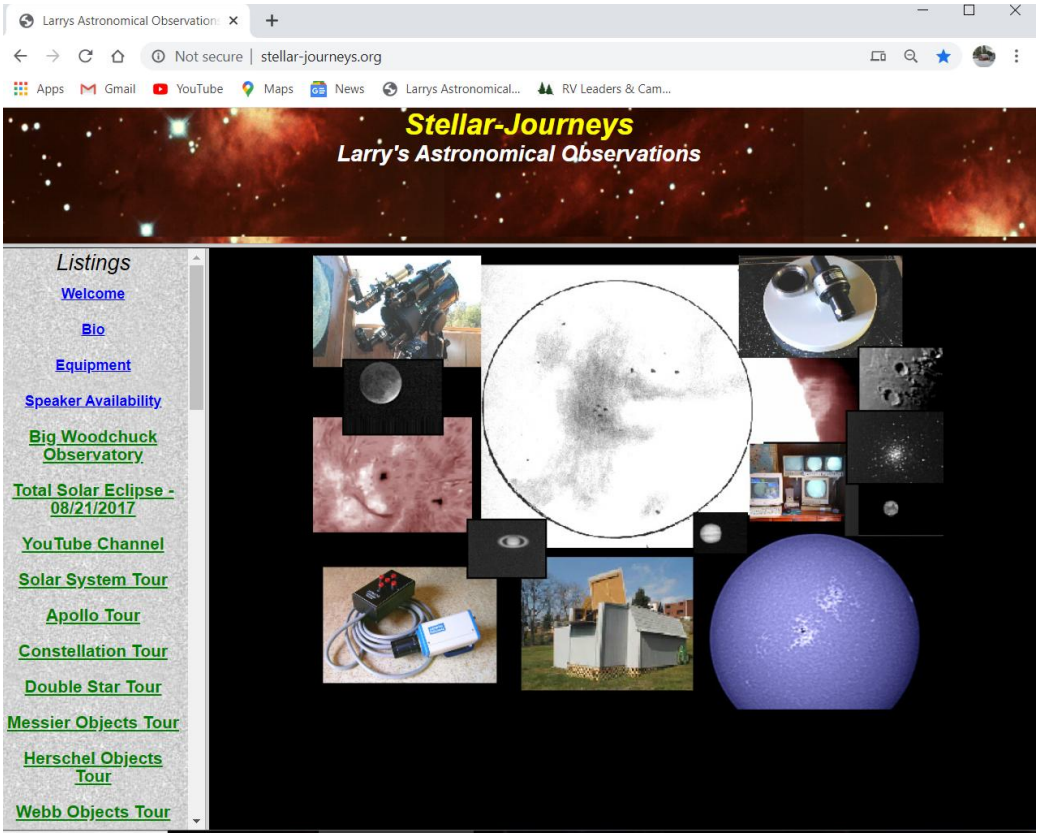
"Explore Caroline Herschel's Celestial Showpieces" – Bob King , Sky & Tel website, Sep 23 2021

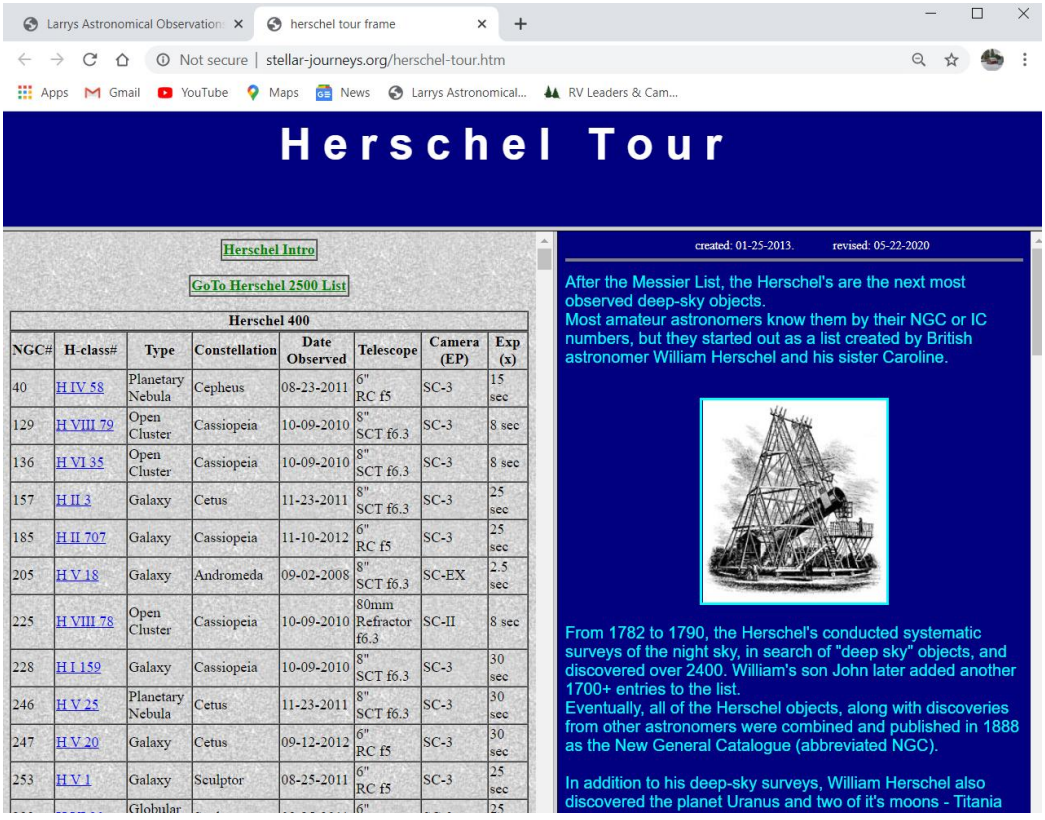
http://www.messier.seds.org/xtra/similar/cher.html Michael Hoskin's recent work

"Earth Centered Universe" planetarium software by David Lane http://www.nova-astro.com/

Internet: Google & Wikipedia

http://stellar-journeys.org/





Herschel 400

NGC#	H-class#	Type	Constellation	Date Observed	Telescope	Camera (EP)	Exp (x)
40	H IV 58	Planetary Nebula	Cepheus	08-23-2011	6" RC f5	SC-3	15 sec
129	H VIII 79	Open Cluster	Cassiopeia	10-09-2010	8" SCT f6.3	SC-3	8 sec
136	H VI 35	Open Cluster	Cassiopeia	10-09-2010	8" SCT f6.3	SC-3	8 sec
157	H II 3	Galaxy	Cetus	11-23-2011	8" SCT f6.3	SC-3	25 sec
185	H II 707	Galaxy	Cassiopeia	11-10-2012	6" RC f5	SC-3	25 sec
205	H V 18	Galaxy	Andromeda	09-02-2008	8" SCT f6.3	SC-EX	2.5 sec
225	H VIII 78	Open Cluster	Cassiopeia	10-09-2010	80mm Refractor f6.3	SC-II	8 sec
228	H I 159	Galaxy	Cassiopeia	10-09-2010	8" SCT f6.3	SC-3	30 sec
246	H V 25	Planetary Nebula	Cetus	11-23-2011	8" SCT f6.3	SC-3	30 sec
247	H V 20	Galaxy	Cetus	09-12-2012	6" RC f5	SC-3	30 sec
253	H V 1	Galaxy	Sculptor	08-25-2011	6" RC f5	SC-3	25 sec
		Globular			6"		25