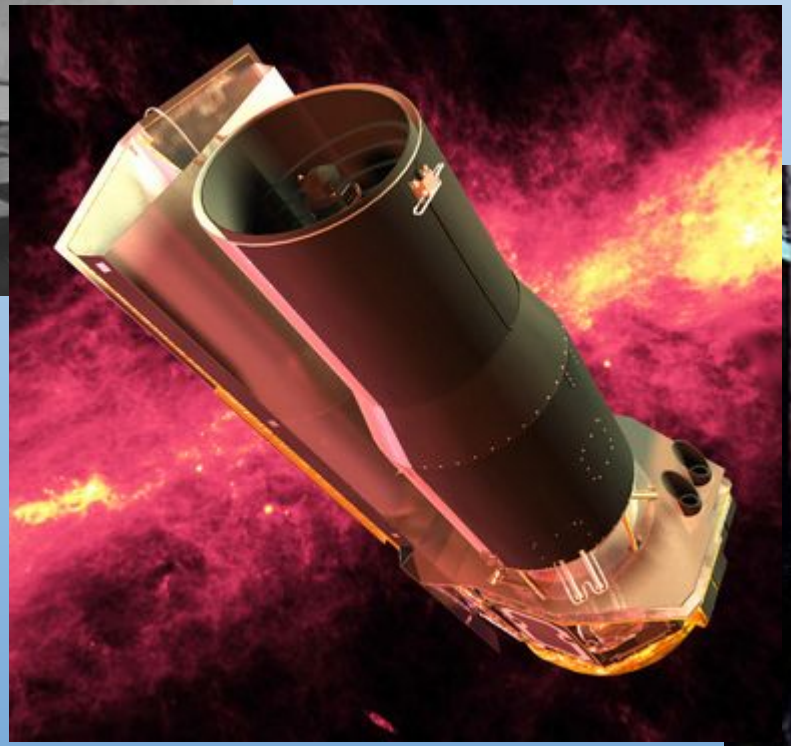
Astronomy



From Galileo to Spitzer and Beyond!

Syllabus

Week 1: Introduction. Beginning Astronomy. Naked eye viewing, finding your way in the (Northern hemisphere) sky, some interesting objects.

Week 2: Telescopes, history, types and use. Visual fields, understanding magnification, what sort of telescope to use for what sort of observation. Some minimal math.

Week 3: Telescope setup – how to get the most from your instruments.

Week 4: Basic physics. What are Stars, planets, asteroids, moons, comets, etc. What do we see in the night sky? What do we NOT see? What is our Galaxy?

Week 5: Local viewing – Moon and planets

Week 6: Stars, gas, dust and Pretty Pictures

Week 7: Looking at Deep-Sky Objects – Nebulae and Galaxies

Week 8: Astrophotography

But First…

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How do we determine the age of a star (or other astronomical object)?

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(I didn't really think that it was EASY!)

But First…

Video explanation: How we guess the age of stars

But First…

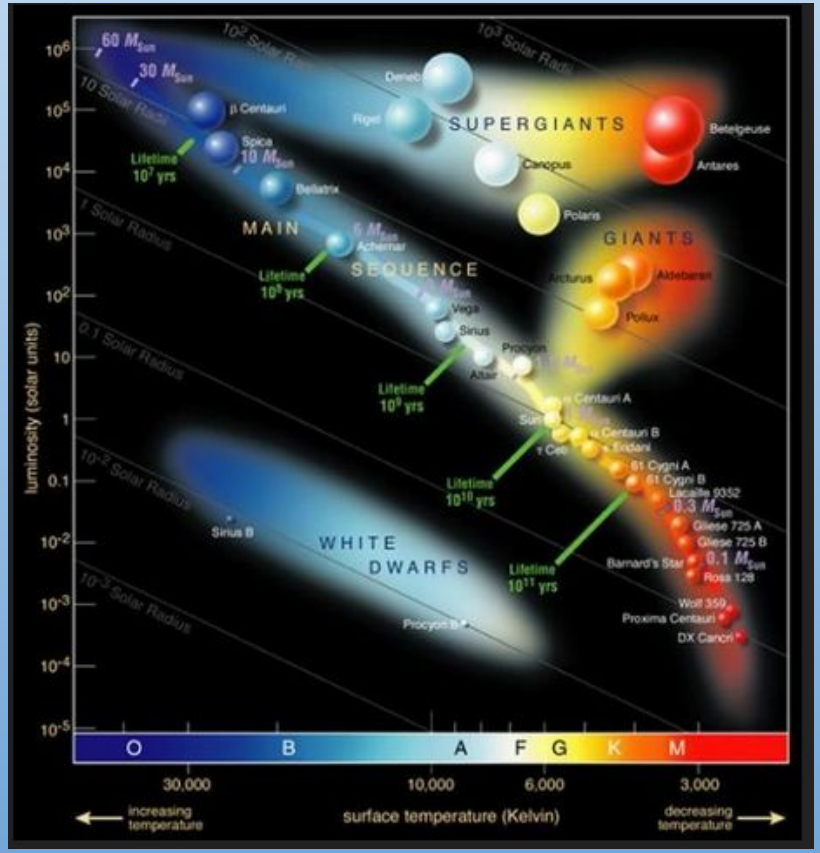
So - From the video, we know that aging stars is not very easy - and maybe not even all that accurate.

It involves gathering as much data as possible - distance, mass, spin and composition at the very lease.

Additional data from CHEOPS and TESS and other new satellites and space telescopes will add information.

It is a relatively new science - dating primarily from studies of star spin in the 1970s. Turns out this isn't very accurate as stars pass "middle-age"

It is one of the toughest questions in astrophysics to answer!



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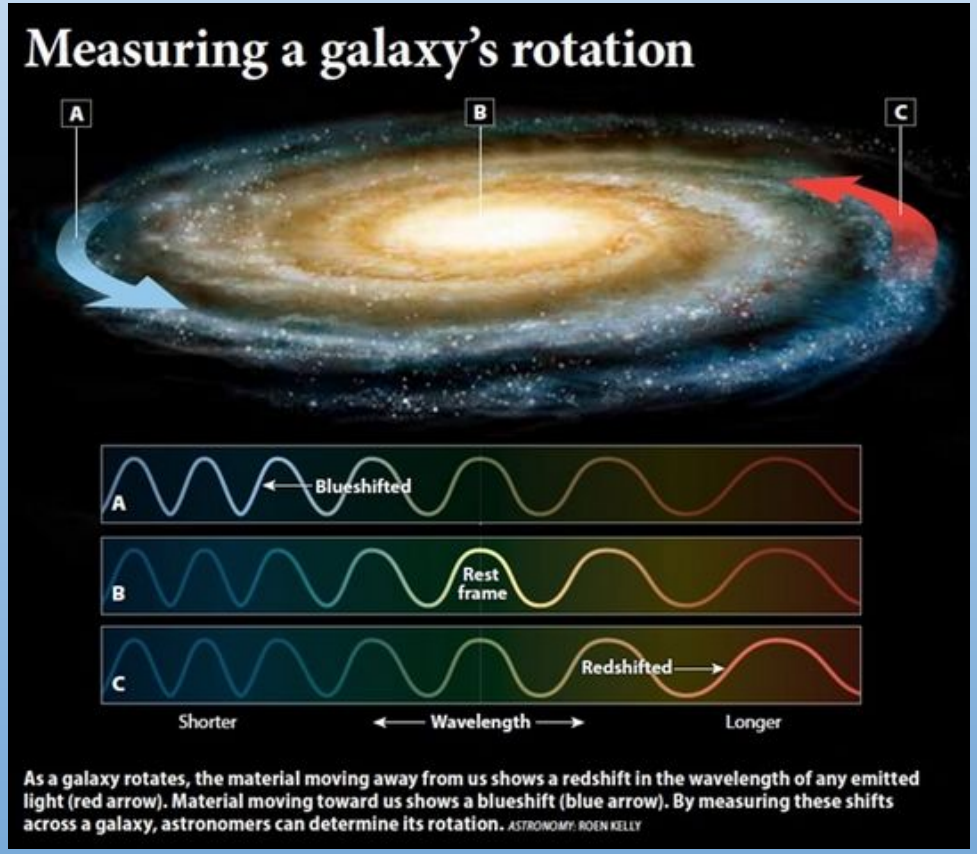
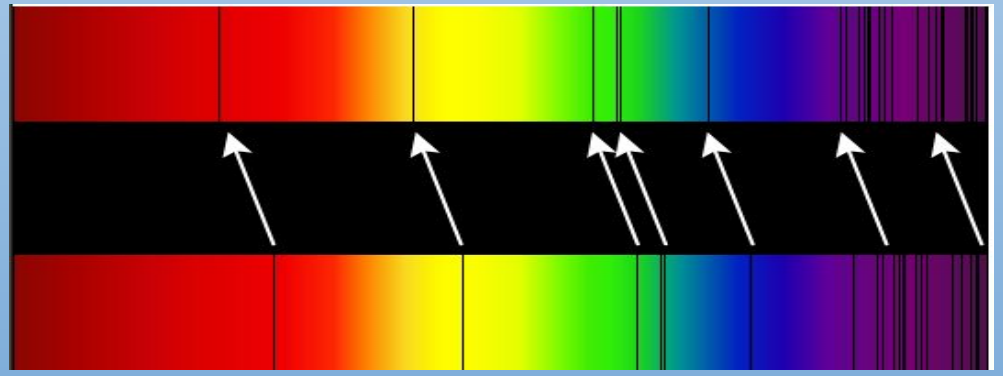


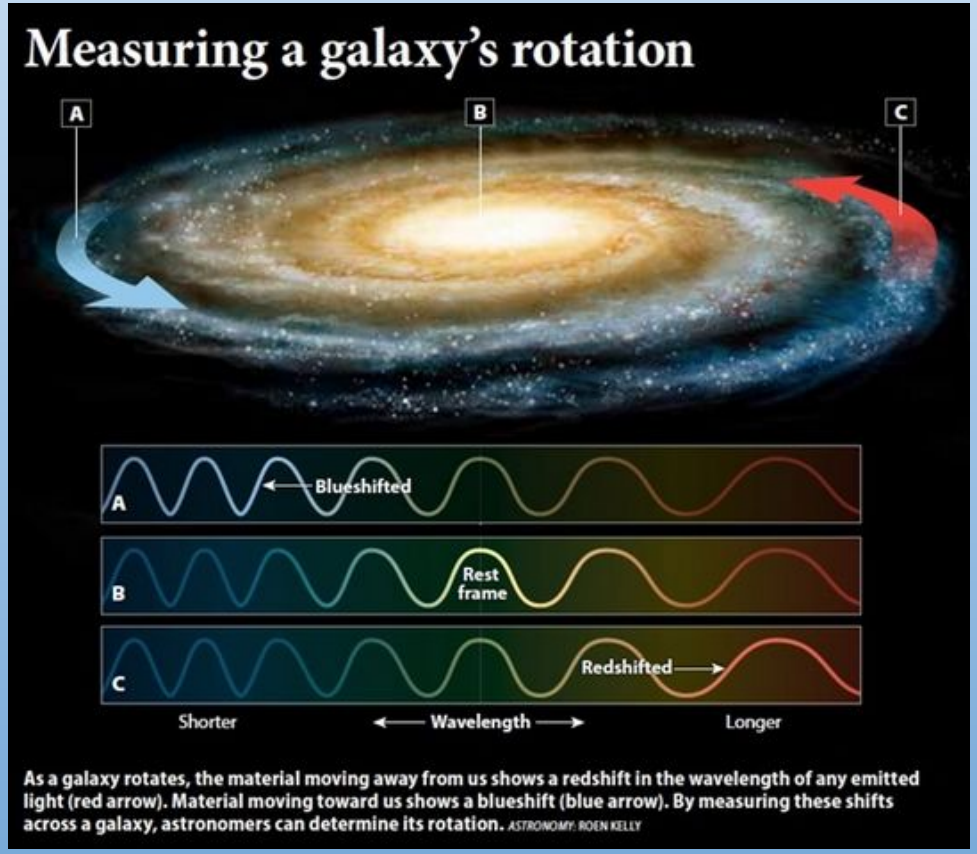
Hydrogen Balmer spectrum lines

656.28 nm (air)
656.46 nm (Vacuum)



https://astronomy.com/magazine/ask-astro/2018/05/rotational-speed-of-a-galaxy

But First…



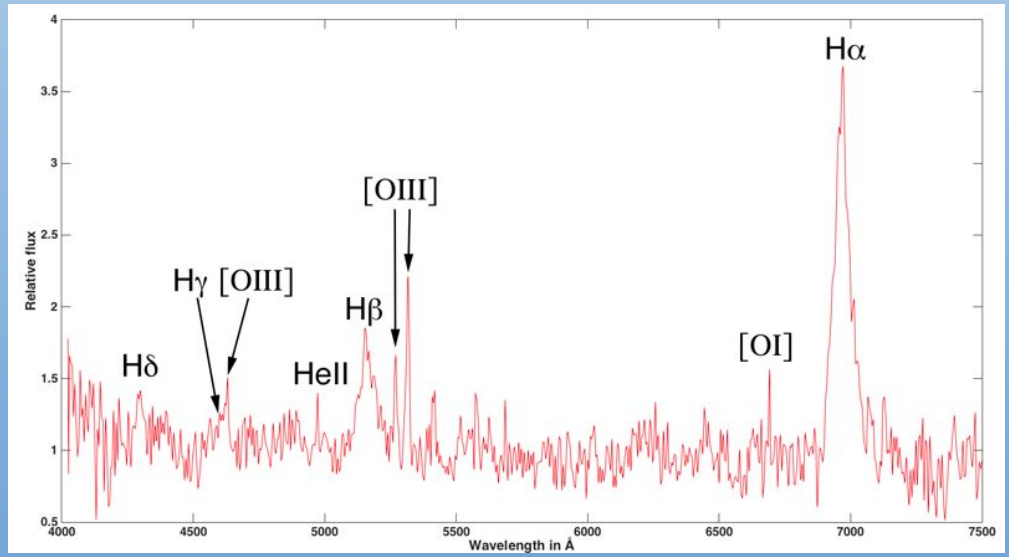
https://astronomy.com/magazine/ask-astro/2018/05/rotational-speed-of-a-galaxy

H-α

Hydrogen Balmer spectrum lines

656.28 nm (air)
656.46 nm (Vacuum)

nm x 10 = Å



What are Deep Sky Objects?

Anything outside our Solar System is technically a “Deep Sky Object” or DSO

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For our purposes though, we are going to talk about Galaxies and Nebulae as “DSO” items.

And there are a LOT of them! Partial list from Astronomy.com of the BRIGHTEST nebulae →

https://astronomy.com/observing/tour-the-deep-sky/2010/03/the-deep-sky

A list of the brightest nebulae

Catalog name	R.A.	Dec.	Size
NGC 281	00h53m	56°36'	35' by 30'
IC 63	00h59m	60°56'	10' by 3'
IC 1795	02h26m	61°59'	12' by 12'
NGC 1432	03h46m	24°09'	60' by 40'
NGC 1499	04h01m	36°38'	160' by 40'
NGC 1491	04h03m	51°19'	6' by 9'
NGC 1624	04h41m	50°26'	5' by 5'
NGC 1788	05h06m	-03°21'	2' by 2'
NGC 1931	05h31m	34°12'	4' by 4'
NGC 1952	05h35m	22°02'	8' by 4'
IC 431	05h41m	-01°31'	8' by 5'
IC 432	05h42m	-01°34'	10' by 10'
IC 434	05h42m	-02°19'	90' by 30'
NGC 2023	05h42m	-02°19'	10' by 8'
NGC 1976	05h35m	-05°28'	90' by 60'
NGC 1999	05h36m	-06°44'	2' by 2'
NGC 2064	05h47m	00°01'	10' by 10'
NGC 2170	06h07m	-06°23'	2' by 2'
NGC 2182	06h09m	-06°21'	3' by 2'
NGC 2175	06h10m	20°29'	40' by 30'
NGC 2238	06h33m	04°58'	80' by 60'
NGC 2245	06h33m	10°10'	2' by 2'
NGC 2247	06h33m	10°21'	2' by 2'
NGC 2261	06h39m	08°43'	2' by 1'
NGC 2264	06h41m	09°54'	10' by 7'
IC 2177	07h04m	-10°25'	20' by 20'
NGC 2467	07h52m	-26°28'	8' by 7'
IC 4606	16h29m	-26°37'	60' by 40'
NGC 6514	18h02m	-23°00'	20' by 20'
NGC 6523	18h04m	-24°20'	45' by 30'
NGC 6559	18h10m	-23°59'	15' by 10'
IC 1274	18h11m	-23°44'	20' by 5'
NGC 6590	18h17m	-19°44'	4' by 3'
NGC 6611	18h19m	-13°49'	120' by 25'
NGC 6618	18h21m	-15°59'	40' by 30'
NGC 6888	20h13m	38°19'	20' by 10'
IC 1318A	20h17m	41°49'	45' by 25'
NGC 6914	20h25m	42°19'	3' by 3'
IC 1318B	20h28m	40°00'	45' by 20'
IC 5067	20h51m	44°21'	25' by 10'
IC 5076	20h56m	47°24'	10' by 10'
NGC 7023	21h02m	68°12'	10' by 8'
NGC 7129	21h42m	66°04'	2' by 2'
NGC 7380	22h47m	58°01'	25' by 20'
NGC 7538	23h14m	61°29'	8' by 7'
NGC 7635	23h20m	61°11'	15' by 8'

Some lists

Great objects from Barnard's catalog

Catalog name	Common name	R.A.	Dec.	Size
B33	Horsehead	05h41m	-02.5	6' by 4'
B42	Rho Ophiuchi	16h29m	-24.3	12' by 12'
B65/6/7	Pipe (stem)	17h21m	-26.8	300' by 60'
B72	Snake	17h24m	-23.6	30' by 30'
B78	Pipe (bowl)	17h33m	-25.7	200' by 140'
B86	Ink Spot	18h03m	-27.8	5' by 3'
B87	Parrot's Head	18h04m	-32.7	12' by 12'
B142/3	Barnard's E	19h41m	11.0	110' by 80'
B348/9	Cygnus Rift	20h37m	42.2	240' by 240'

Some of the finest planetary nebulae

Common name	Catalog name	R.A.	Dec.
Blinking Planetary	NGC 6826	19h45m	50°32'
Blue Snowball	NGC 7662	23h26m	42°32'
Box Nebula	NGC 6309	17h14m	-12°55'
Bug Nebula	NGC 6302	17h14m	-37d06'
Cat's Eye Nebula	NGC 6543	17h59m	66°38'
Clown Face Nebula	NGC 2392	07h29m	20°55'
Crescent Nebula	NGC 6445	17h49m	-20°01'
Dumbbell Nebula	NGC 6853 (M27)	19h59m	22°43'
Eight Burst Nebula	NGC 3132	10h07m	-40°26'
Eskimo Nebula	NGC 2392	07h29m	20°55'
Fetus Nebula	NGC 7008	21h01m	54°33'
Ghost of Jupiter	NGC 3242	10h25m	-18°39'
Helix Nebula	NGC 7293	22h30m	-20°50'
Little Dumbbell Nebula	NGC 650/651 (M76)	01h42m	51°35'
Little Gem Nebula	NGC 6818	19h44m	-14°09'
Owl Nebula	NGC 3587 (M97)	11h15m	55°01'
Red Spider Nebula	NGC 6537	18h06m	-19°51'
Ring Nebula	NGC 6720 (M57)	18h54m	33°02'
Saturn Nebula	NGC 7009	21h04m	-11°22'
Southern Ring Nebula	NGC 3132	10h07m	-40°26'

The 25 brightest globular clusters

Catalog name	Common name	Constellation	Magnitude
NGC 5139	Omega Centauri	Centaurus	3.9
NGC 104	47 Tuc	Tucana	4.0
NGC 6656	M22	Sagittarius	5.2
NGC 6397		Ara	5.3
NGC 6752		Pavo	5.3
NGC 6121	M4	Scorpius	5.4
NGC 5904	M5	Serpens	5.4
NGC 6205	M13	Hercules	5.8
NGC 6218	M12	Ophiuchus	6.1
NGC 2808		Carina	6.2
NGC 6809	M55	Sagittarius	6.3
NGC 6541		Corona Australis	6.3
NGC 5272	M3	Canes Venatici	6.3
NGC 7078	M15	Pegasus	6.3
NGC 6266	M62	Ophiuchus	6.4
NGC 6341	M92	Hercules	6.5
NGC 6254	M10	Ophiuchus	6.6
NGC 7089	M2	Aquarius	6.6
NGC 362		Tucana	6.8
NGC 6723		Sagittarius	6.8
NGC 6388		Scorpius	6.8
NGC 6723	M19	Ophiuchus	6.8
NGC 7099	M30	Capricornus	6.9
NGC 3201		Vela	6.9
NGC 6626	M28	Sagittarius	6.9

Galaxies brighter than 10th magnitude

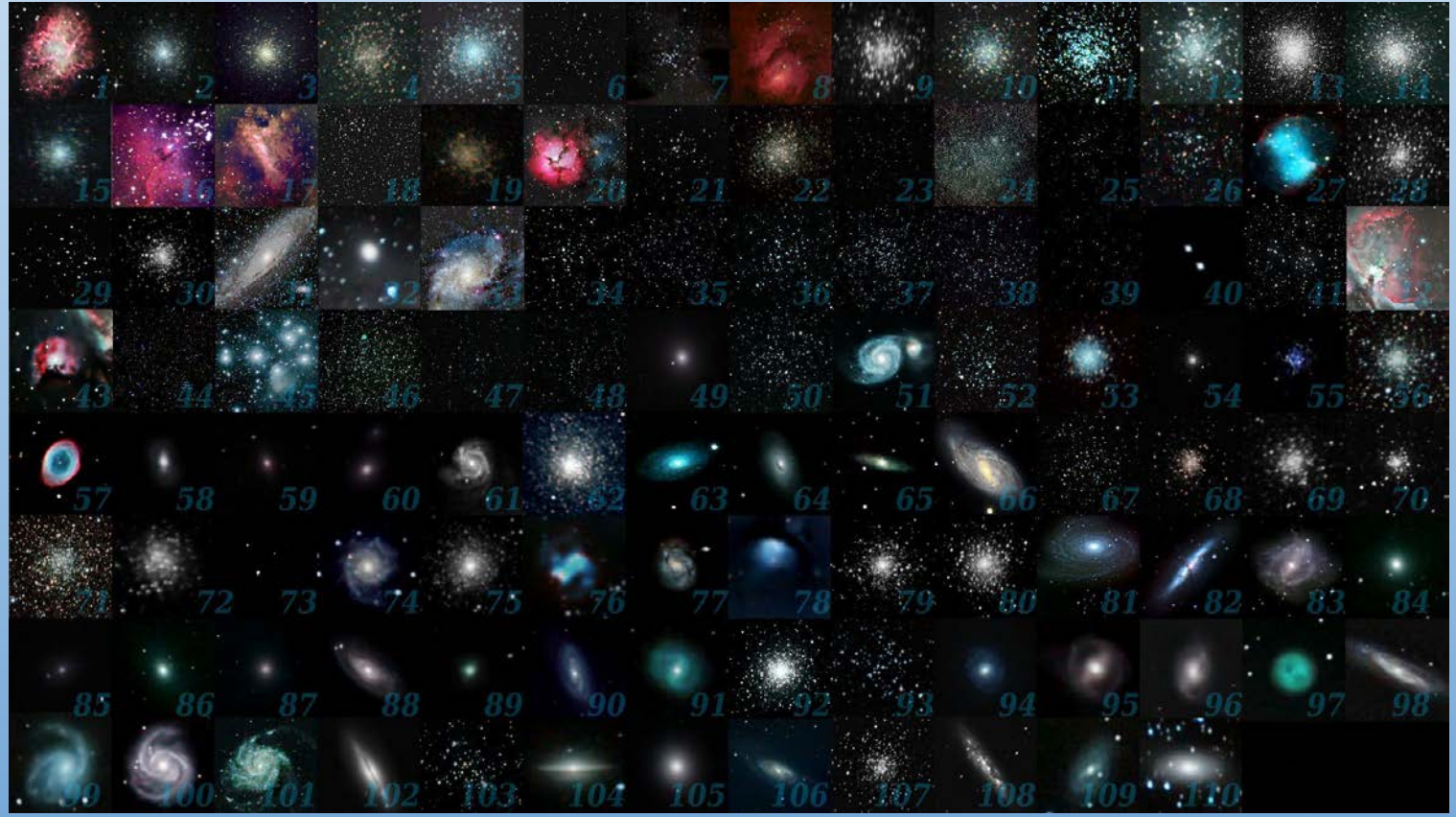
Catalog name	R.A.	Dec.	Magnitude
LMC	05h24m	-69°45'	0.91
SMC	00h53m	-72°48'	2.70
NGC 224	00h43m	41°16'	4.36
NGC 598	01h34m	30°40'	6.27
NGC 5128	13h25m	-43°01'	7.84
NGC 3031	09h56m	69°04'	7.89
NGC 253	00h48m	-25°17'	8.04
NGC 5236	13h37m	-29°52'	8.20
NGC 5457	14h03m	54°21'	8.31
Fornax	02h40m	-34°27'	8.40
NGC 55	00h15m	-39°13'	8.42
NGC 300	00h55m	-37°41'	8.72
NGC 205	00h40m	41°41'	8.92
NGC 2403	07h37m	65°36'	8.93
NGC 5194	13h30m	47°12'	8.96
NGC 4594	12h40m	-11°37'	8.98
NGC 4736	12h51m	41°07'	8.99
NGC 221	00h43m	40°52'	9.03
IC 342	03h47m	68°06'	9.10
NGC 4258	12h19m	47°18'	9.10
NGC 6744	19h10m	-63°51'	9.14
NGC 1313	03h18m	-66°30'	9.20
NGC 3034	09h56m	69°41'	9.30
NGC 4945	13h05m	-49°28'	9.30
NGC 5055	13h16m	42°02'	9.31
NGC 6822	19h45m	-14°48'	9.31
NGC 4826	12h57m	21°41'	9.36
NGC 4472	12h30m	07°59'	9.37
NGC 1291	03h17m	-41°06'	9.39
NGC 1316	03h23m	-37°12'	9.42
Sculptor	01h00m	-33°43'	9.50
NGC 4486	12h31m	12°23'	9.59
NGC 1068	02h43m	-00°01'	9.61
NGC 6946	20h35m	60°09'	9.61
NGC 7793	23h58m	-32°35'	9.63
NGC 3627	11h20m	12°59'	9.65
NGC 247	00h47m	-20°46'	9.67
NGC 2903	09h32m	21°30'	9.68
NGC 4631	12h42m	32°32'	9.75
NGC 4649	12h44m	11°33'	9.81
NGC 3521	11h06m	-00°02'	9.83
NGC 4406	12h26m	12°57'	9.83
NGC 3115	10h05m	-07°43'	9.87
IC 1613	01h05m	02°07'	9.88
NGC 628	01h37m	15°47'	9.95
NGC 4449	12h28m	44°06'	9.99

Fifty bright open clusters

Catalog name	Constellation	Magnitude
M45	Taurus	1.6
M7	Scorpius	3.3
M44	Cancer	3.9
NGC 869/884	Perseus	4.4
NGC 2244	Monoceros	4.8
NGC 2362	Canis Major	4.8
M41	Canis Major	5.0
M47	Puppis	5.0
M39	Cygnus	5.3
NGC 2244	Monoceros	5.3
NGC 6633	Ophiuchus	5.3
M6	Scorpius	5.5
M35	Gemini	5.6
NGC 7686	Cassiopeia	5.6
M34	Perseus	5.8
M23	Sagittarius	5.9
M48	Hydra	6.0
NGC 1647	Taurus	6.0
NGC 1746	Taurus	6.0
NGC 1981	Orion	6.0
NGC 2264	Monoceros	6.0
NGC 2301	Monoceros	6.0
M67	Cancer	6.1
NGC 7160	Cepheus	6.1
M25	Sagittarius	6.2
M37	Auriga	6.2
NGC 1545	Perseus	6.2
M50	Monoceros	6.3
NGC 6940	Vulpecula	6.3
NGC 457	Cassiopeia	6.4
NGC 7243	Lacerta	6.4
M21	Sagittarius	6.5
M36	Auriga	6.5
M93	Puppis	6.5
NGC 129	Cassiopeia	6.5
NGC 654	Cassiopeia	6.5
NGC 752	Andromeda	6.5
NGC 663	Cassiopeia	6.5
NGC 1528	Perseus	6.5
M16	Serpens	6.6
M46	Puppis	6.6
NGC 1027	Cassiopeia	6.7
NGC 2343	Monoceros	6.7
NGC 2423	Puppis	6.7
NGC 7209	Lacerta	6.7
NGC 7789	Cassiopeia	6.7
M11	Scutum	6.8
NGC 7036	Cygnus	6.8
M103	Cassiopeia	6.9
M38	Auriga	7.0

https://astronomy.com/observing/tour-the-deep-sky/2010/03/the-deep-sky

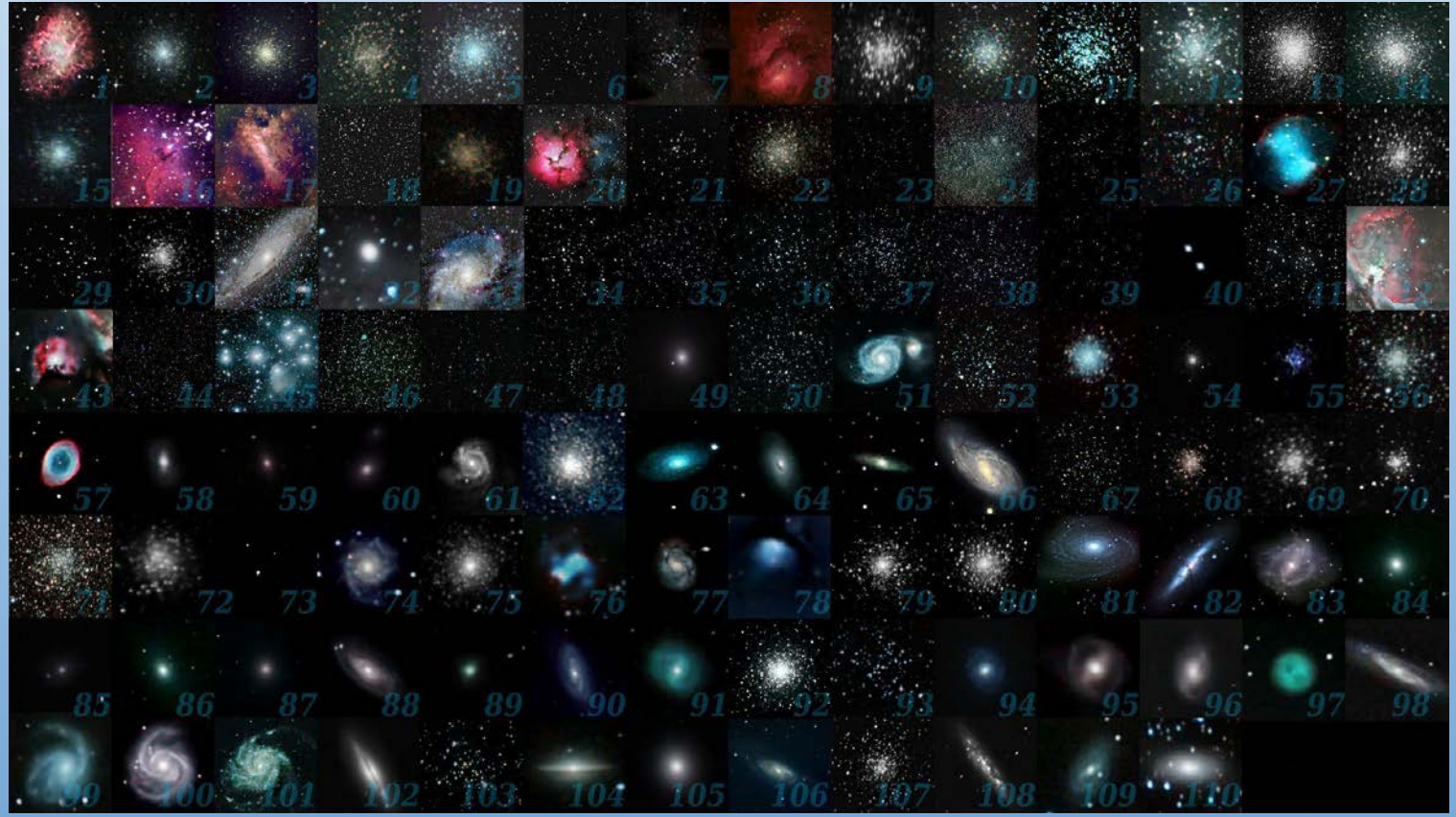
A well-known list



By Michael A. Phillips
http://astromaphilli14.blogspot.com.br/p/m.html official blog

Messier

First edition: 1774



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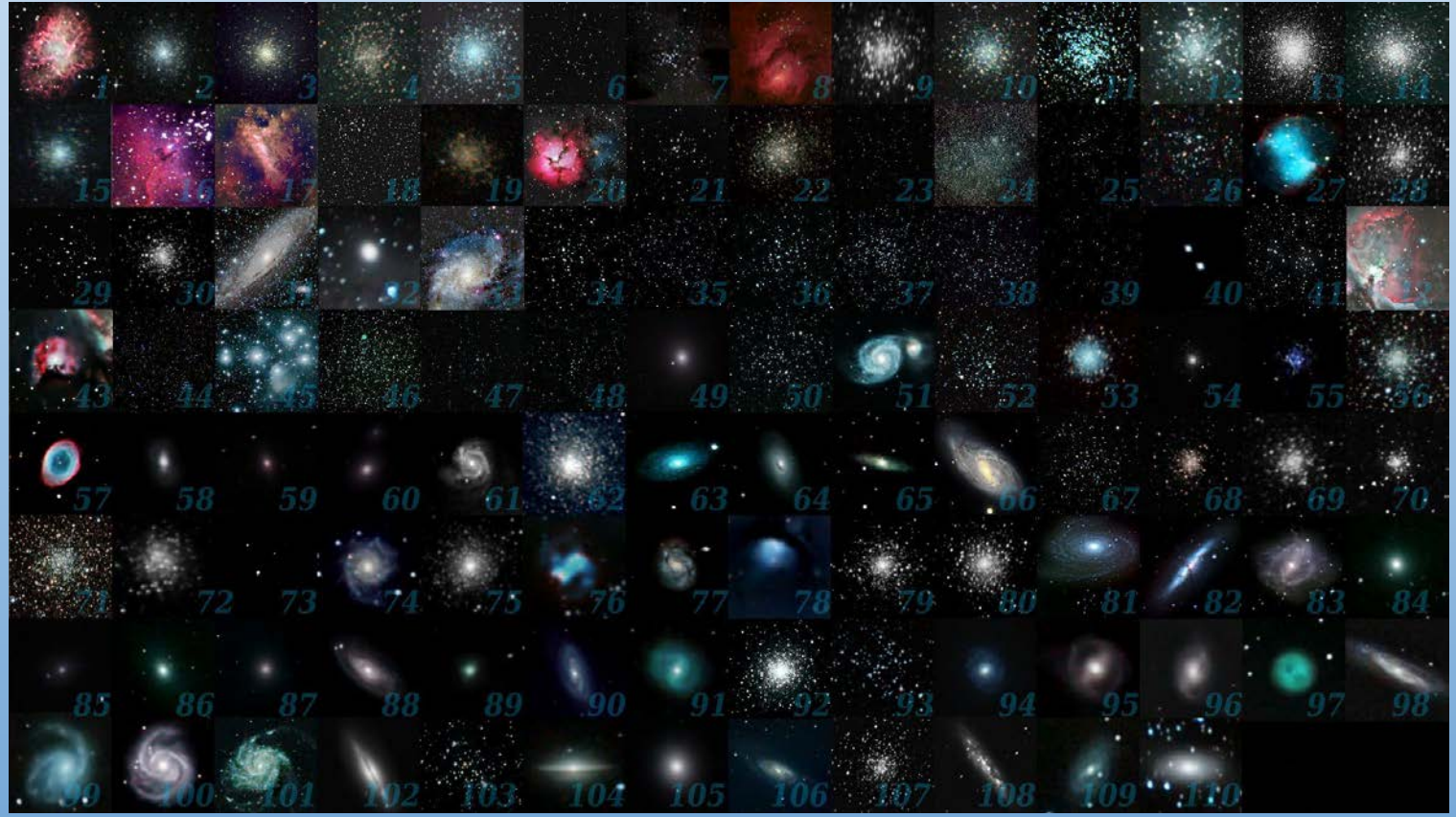
Messier

First edition: 1774
45 objects,
not numbered yet.



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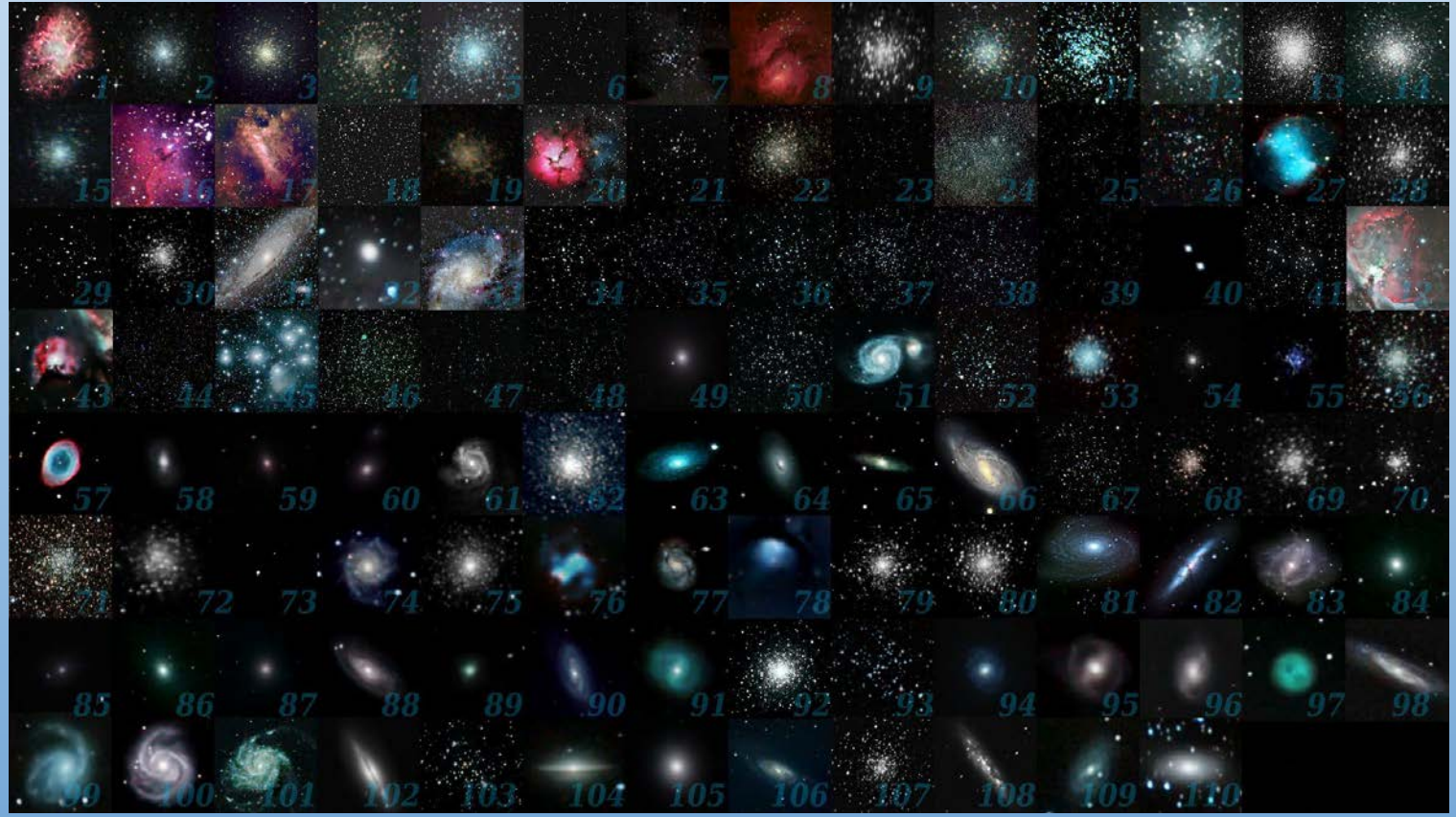
Messier

First edition: 1774
45 objects,
not numbered yet.
Final edition from
Messier: 1781



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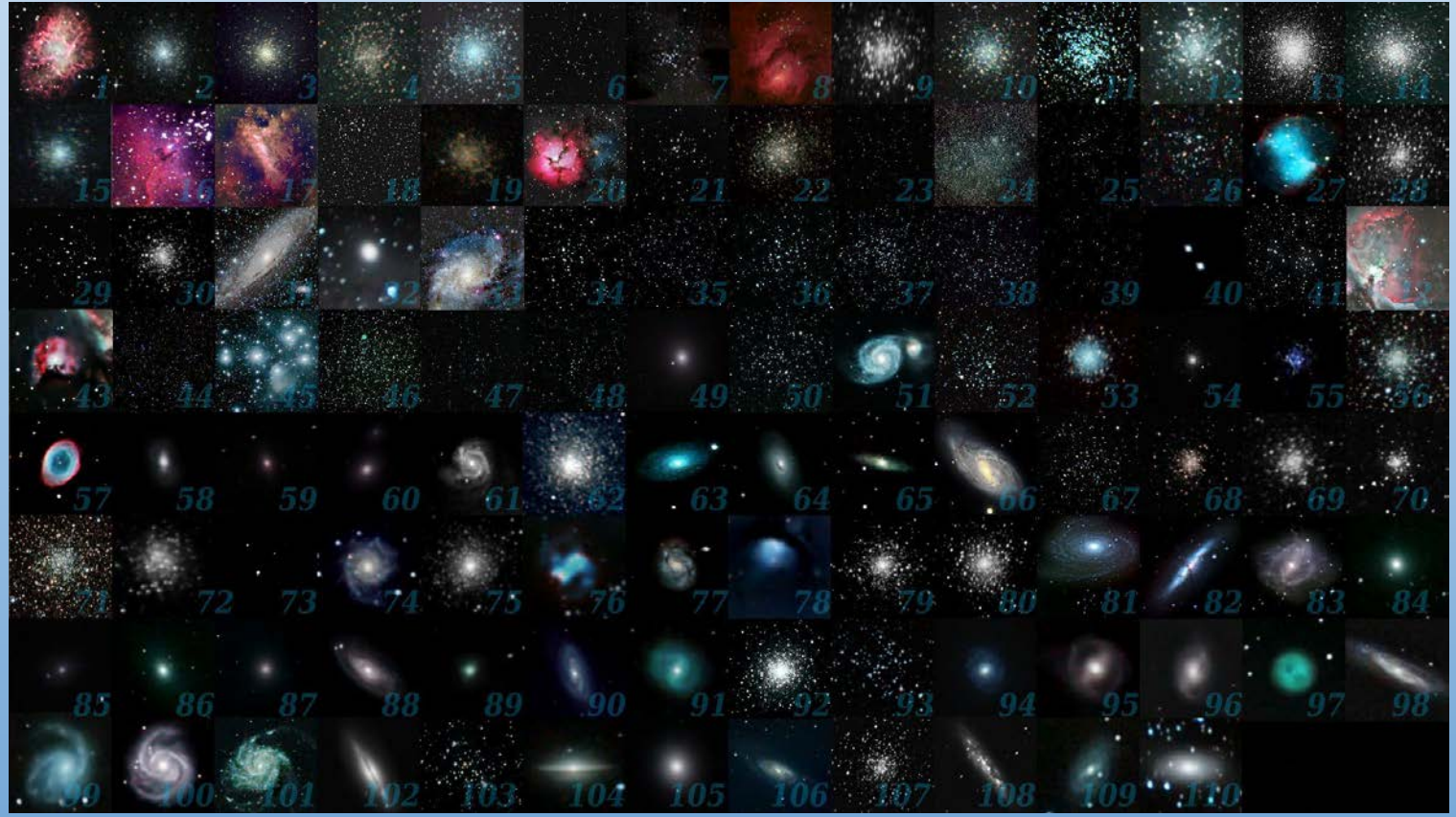
Messier

First edition: 1774
45 objects,
not numbered yet.
Final edition from
Messier: 1781
103 objects



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Messier

First edition: 1774
45 objects,
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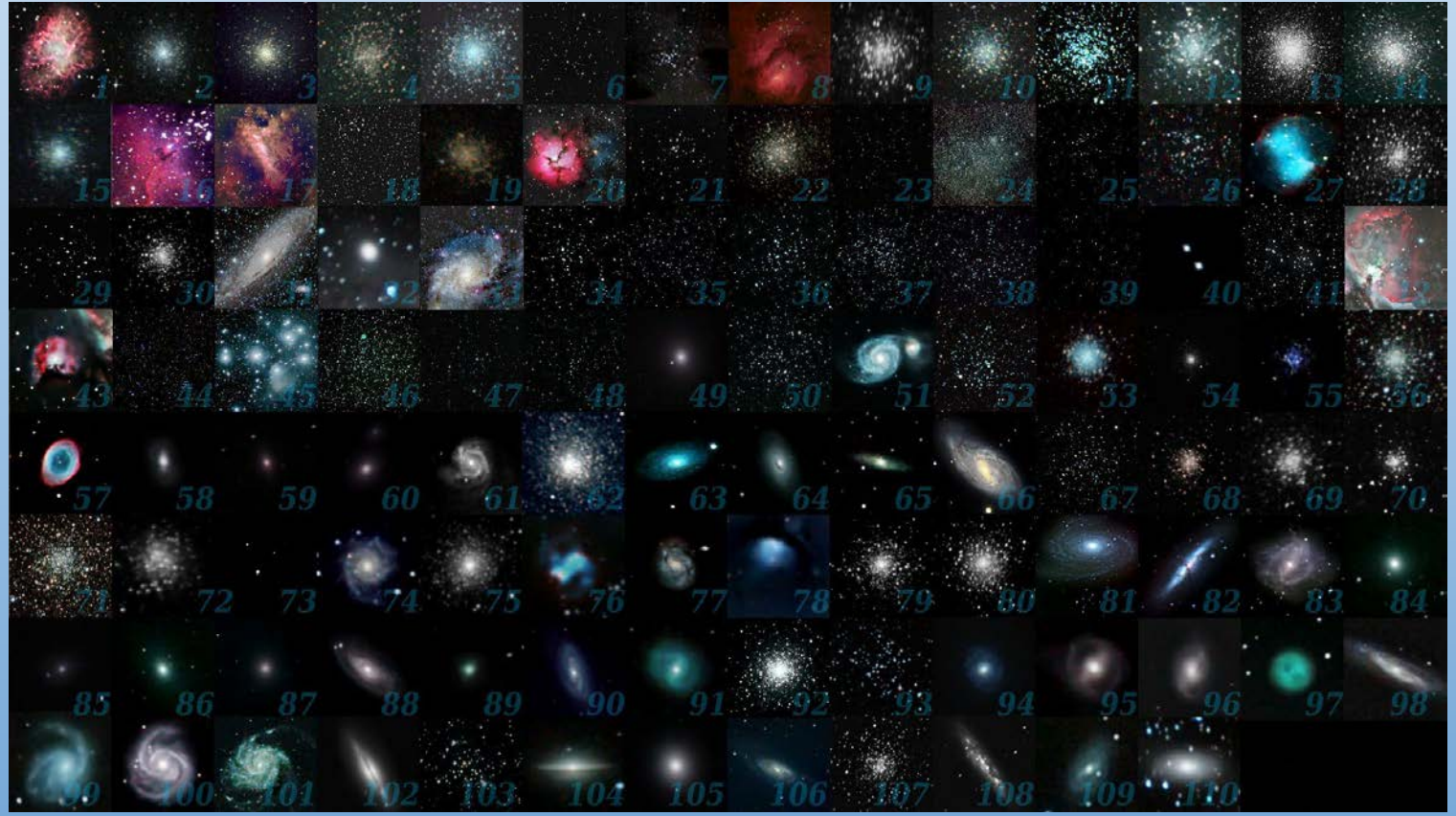
Final edition from
Messier: 1781
103 objects
14 discovered by
Messier.



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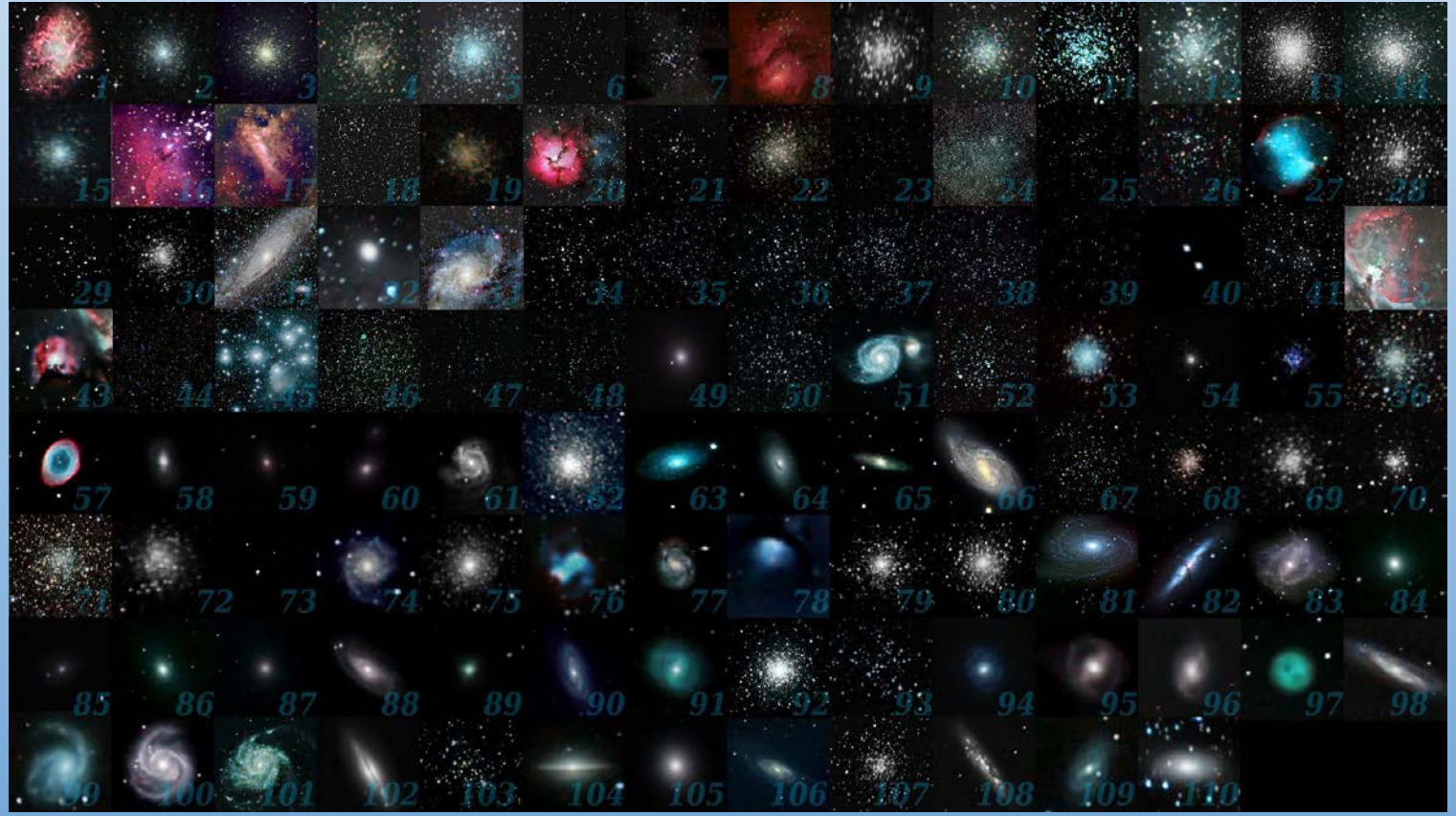
Messier: 1781
103 objects
14 discovered by
Messier.

A further 7 objects added at later dates by other observers, based on Messier's notes.



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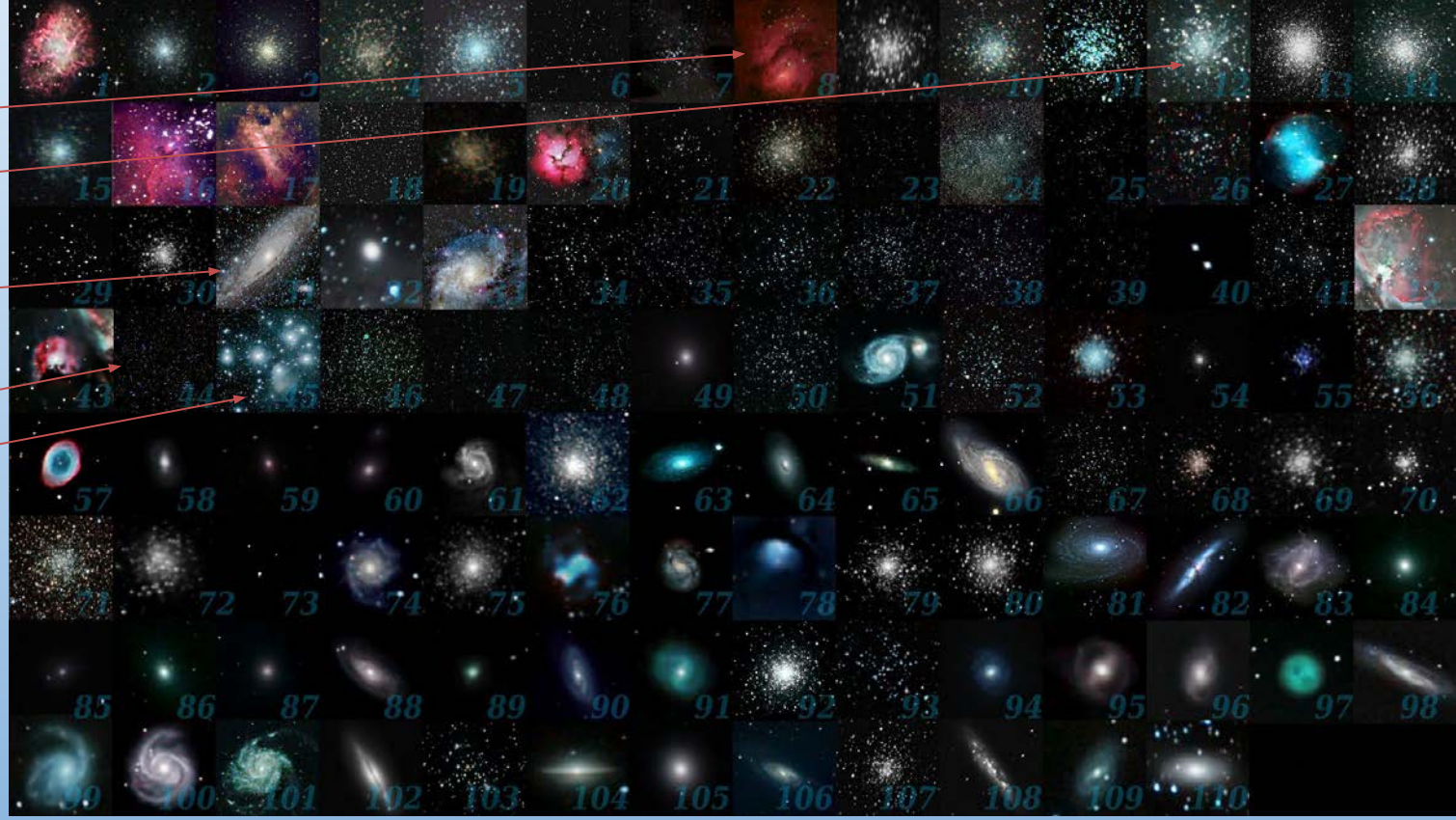
M8 - Lagoon Nebula

M13 - Great Hercules cluster

M31 - Andromeda galaxy

M44 - Beehive cluster

M45 - Pleiades



Other catalogs

NGC (New General Catalog) compiled by John Louis Emil Dreyer in 1888. The NGC contains 7,840 objects, including galaxies, star clusters and emission nebulae.

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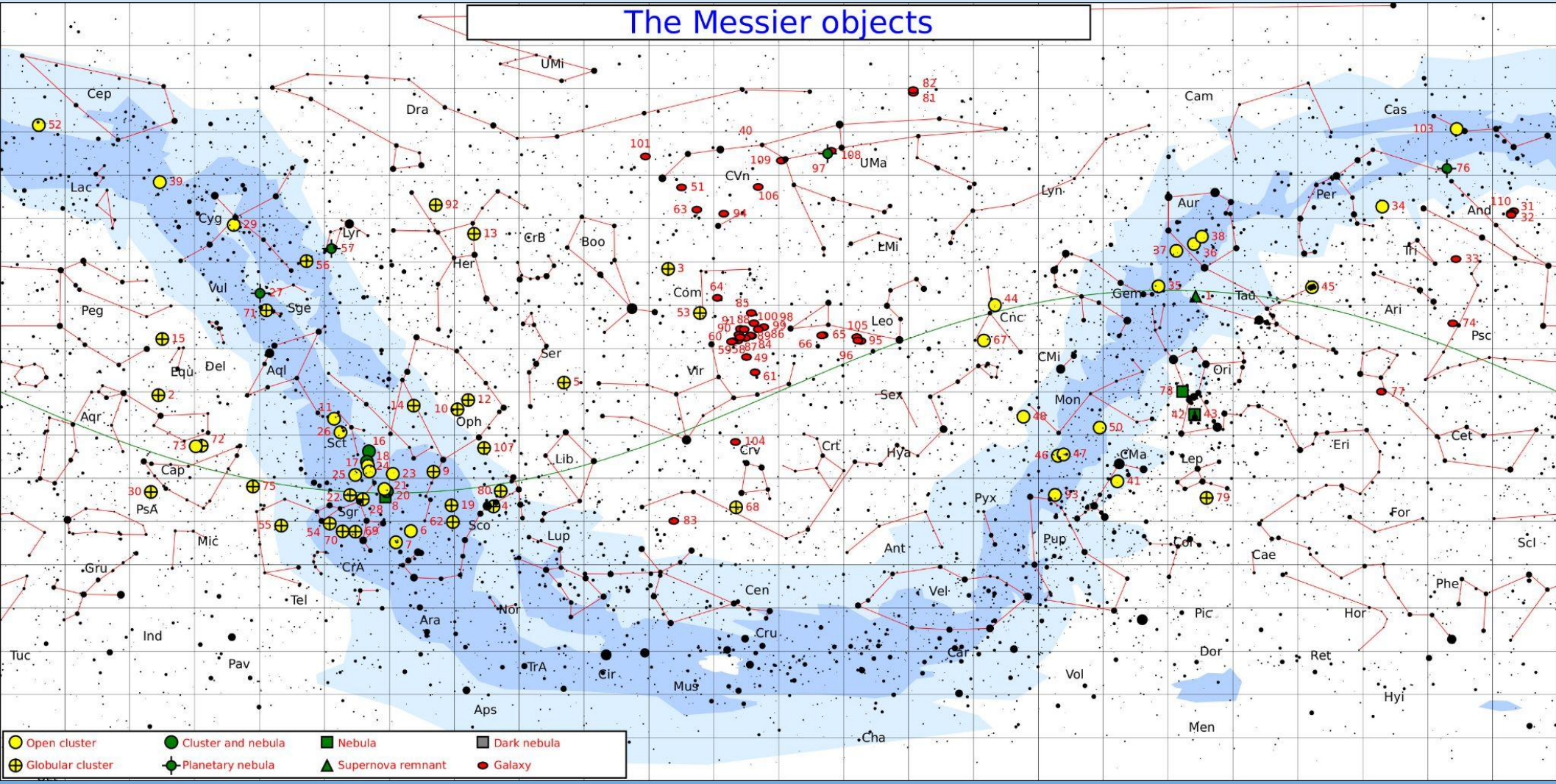
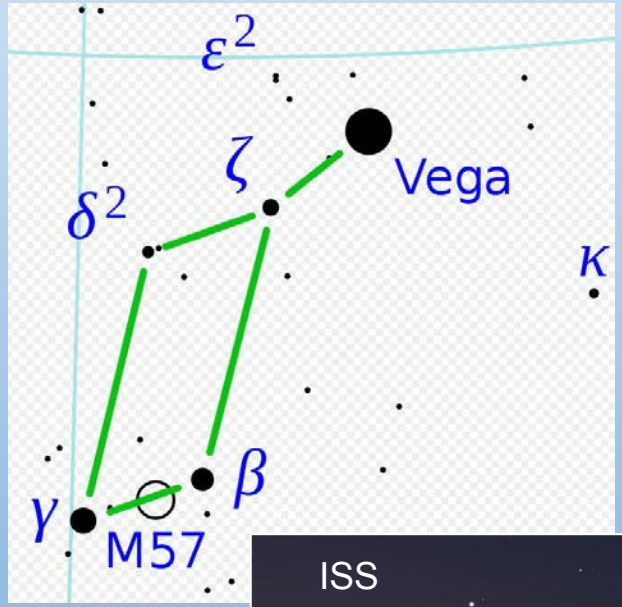
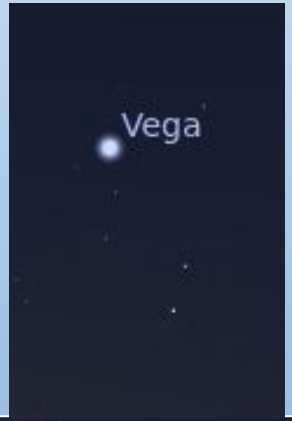
We will pretty much stick with Messier and NGC



M57 / NGC 6720

Ring Nebula





Images are after 2100 on Friday, May 20 BONUS! ISS has a visible pass that will be just below Lyra starting at about 2105!

M57 / NGC 6720

Ring Nebula

This is the image you can expect in most good scopes.

2570 Ly from Earth

Photographs taken over a period of 50 years show the rate of nebula expansion is roughly 1 arcsecond per century

Magnitude 8.8

Discovered by Messier in late 1779, later observed by Darquier who said it it was "*...as large as Jupiter and resembles a planet which is fading*"

This may be why we refer to some nebulae as “planetary nebulae” - though they have nothing to do with planets.

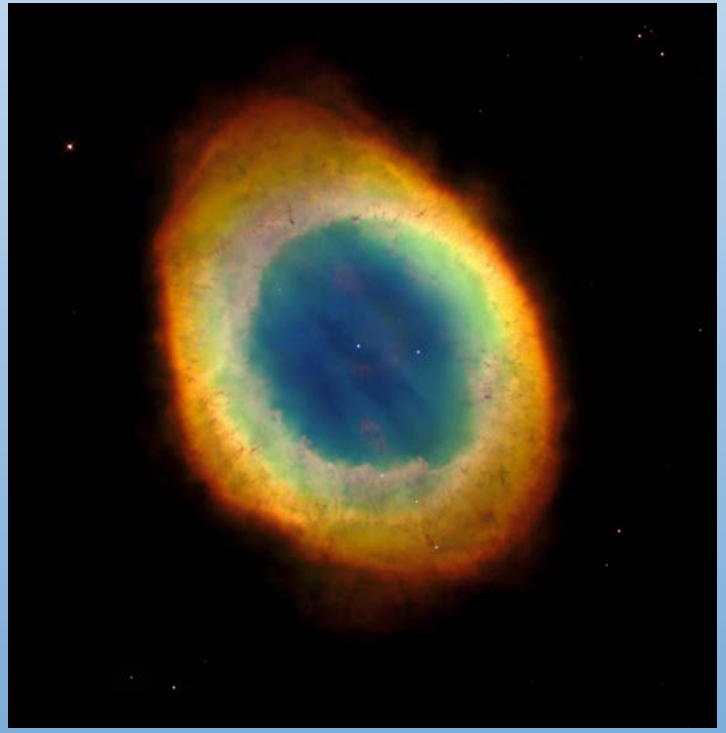
M57 / NGC 6720

Ring Nebula

This is what you may see with a Unisteller EVscope!

M57 / NGC 6720

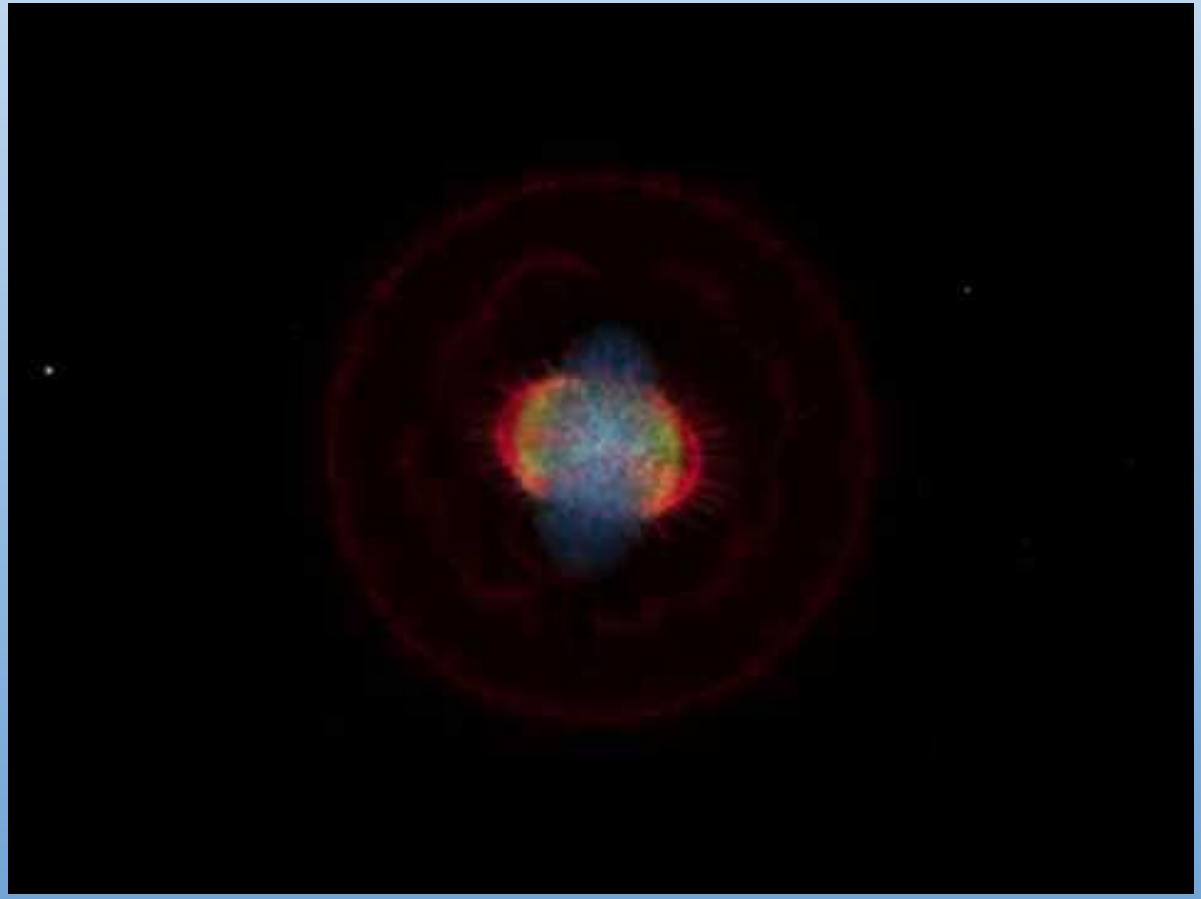
Ring Nebula

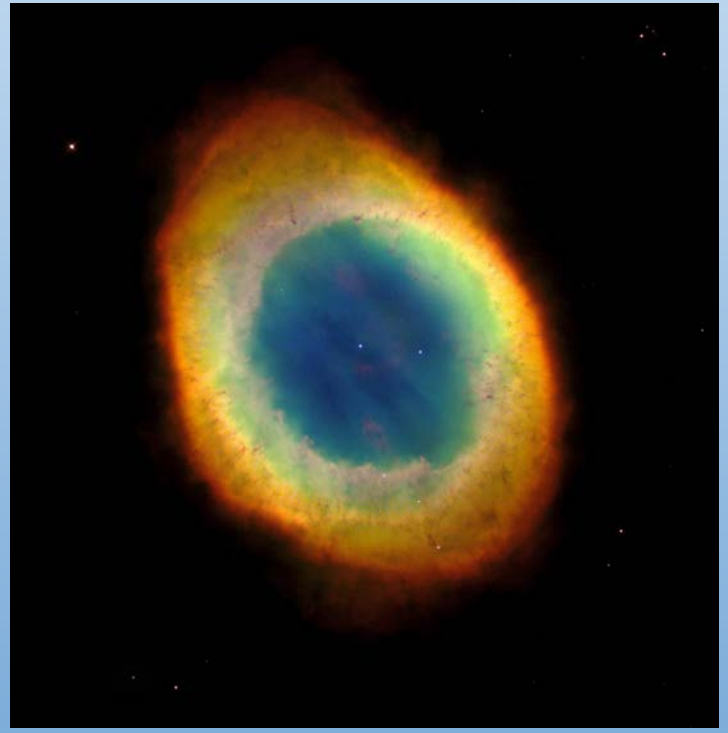


What Hubble sees

M57 / NGC 6720

Ring Nebula

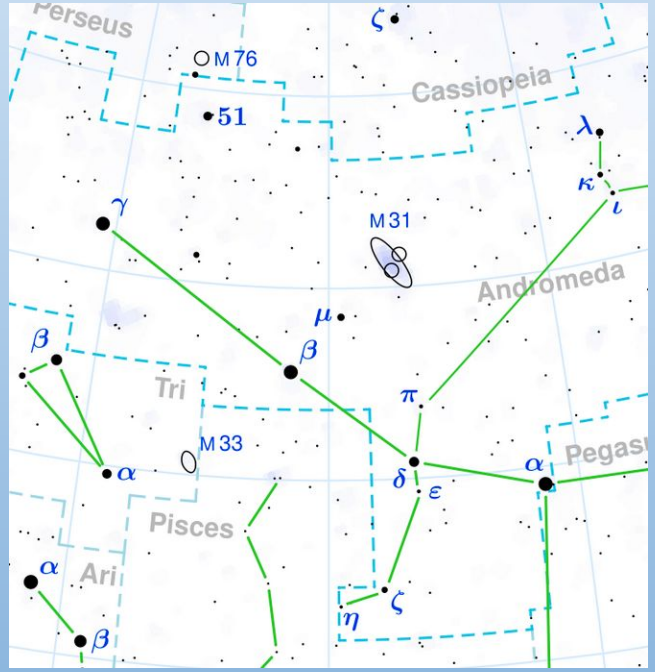


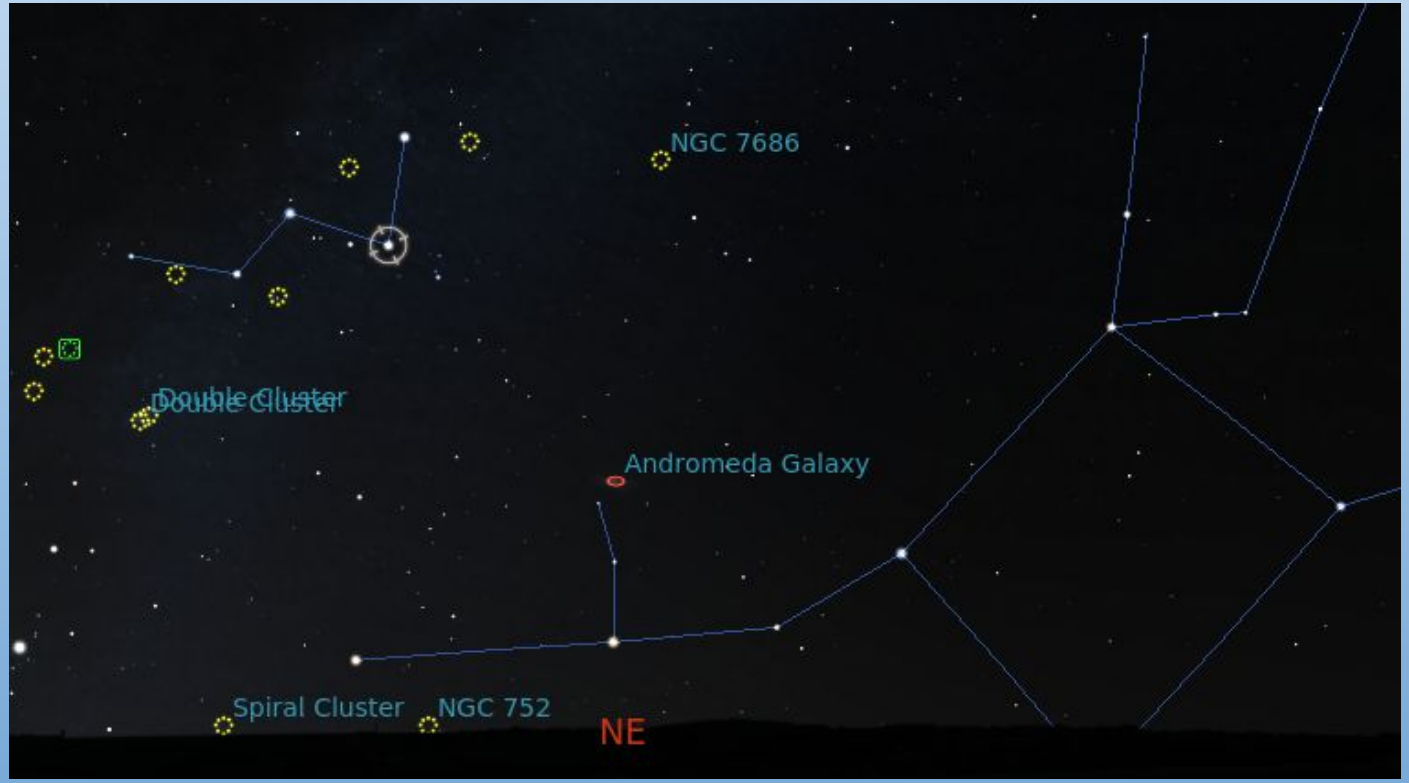


What Hubble sees

M31 / NGC 224

Andromeda galaxy





M31 / NGC 224

Andromeda galaxy

Image at 0200 on 5/21 looking NE

What you can expect to see - fuzzy, whiteish “blob”

first described in 964 by a Persian astronomer. Described as a “nebulous smear” or “small cloud”

2.5 Million Ly away

Approaching the Milky Way at about 68 miles per second.

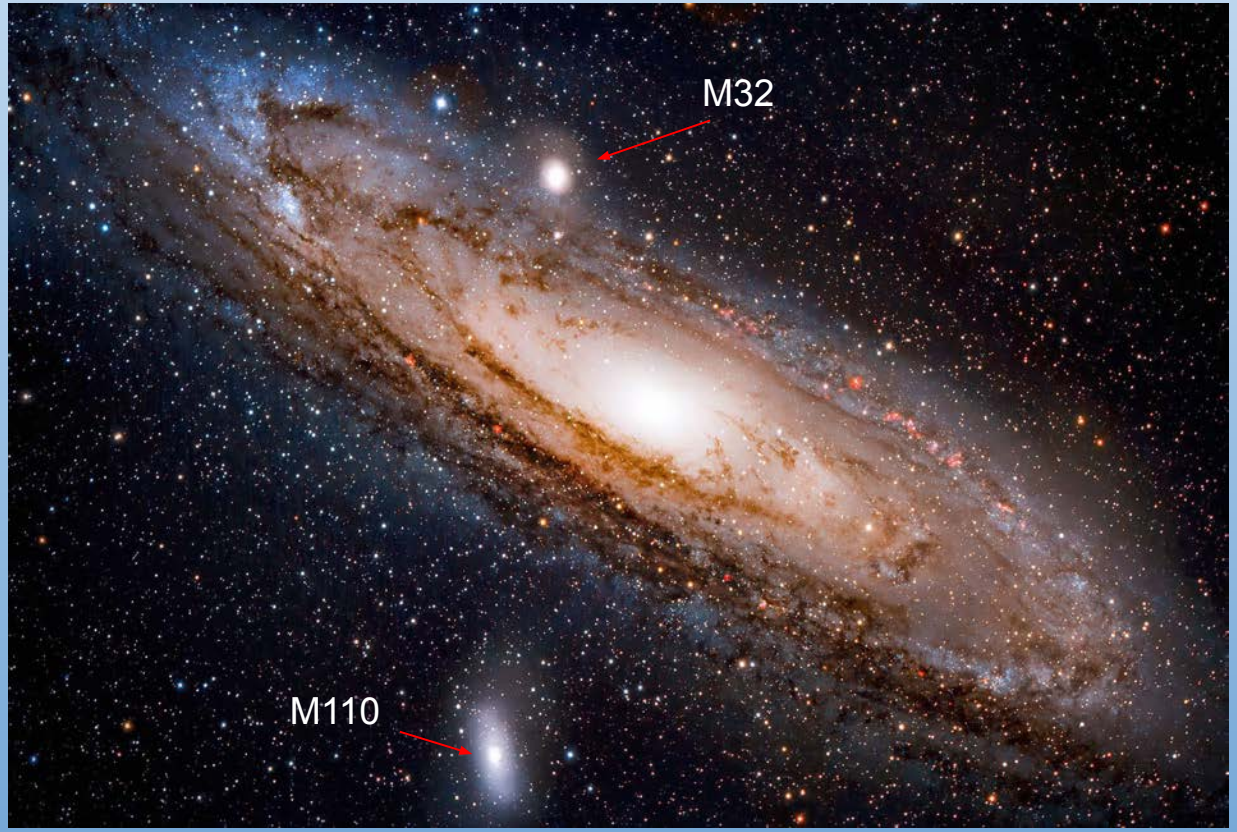
First described as a completely different galaxy (rather than a gaseous nebula) by Immanuel Kant in 1755.

In 1917, Heber Curtis observed a nova in M31, checked earlier photographs and found 11 more! Using these, he was able to determine that as they were 10 orders of magnitude dimmer than expected, they must lie well outside our galaxy.

Edwin Hubble resolved the issue when he discovered Cephid Variables with the object and accurately determined their distance.

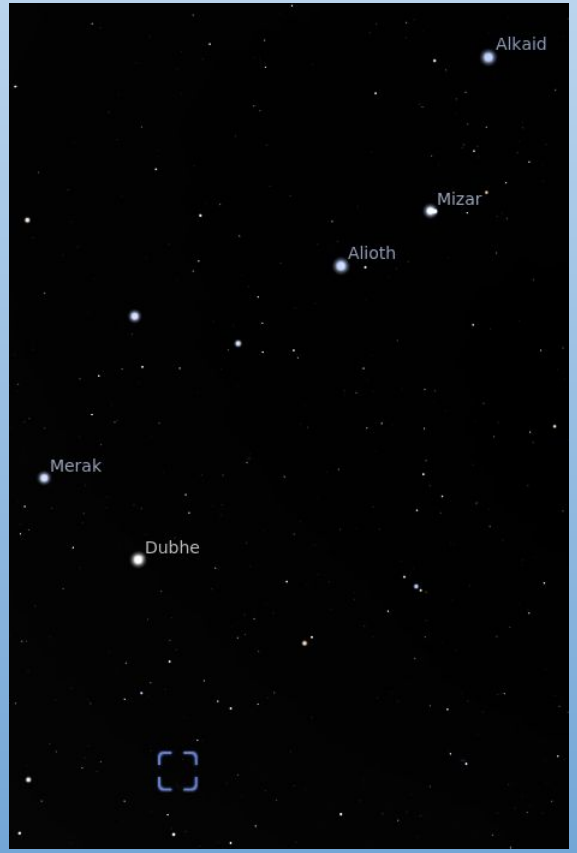
M31 / NGC 224

Andromeda galaxy



M81 / NGC 3031

Bode’s (Grand Design) Galaxy



Grand Design Galaxy, about 12Mly distant.

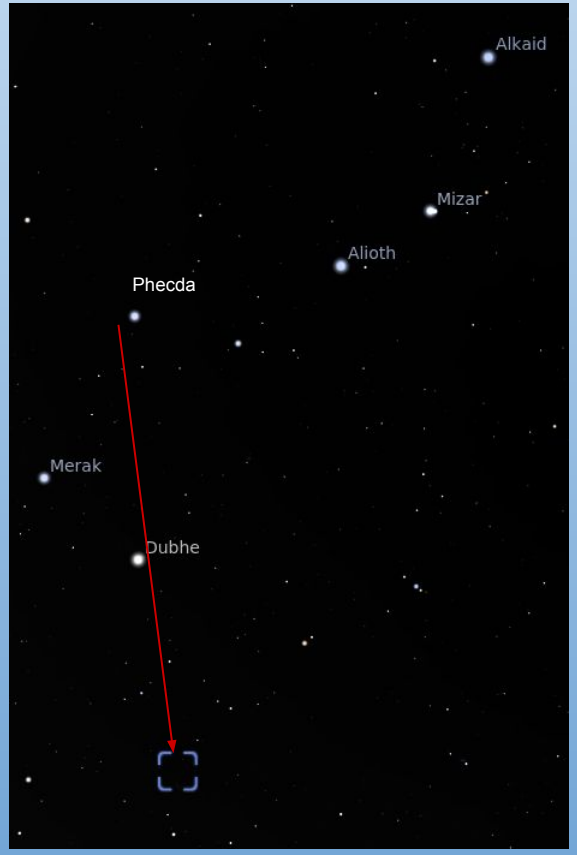
90,000 ly in diameter, Magnitude 6.9

First discovered by Bode in 1774 (31 Dec)

Good binocular or telescope target, though at least 8” aperture is needed to see the structure.

M81 / NGC 3031

Bode's (Grand Design) Galaxy



Grand Design Galaxy, about 12Mly distant.

90,000 ly in diameter, Magnitude 6.9

First discovered by Bode in 1774 (31 Dec)

Good binocular or telescope target, though at least 8" aperture is needed to see the structure.

Easily located near a line drawn from the two Big Dipper stars Phecda and Dubhe at about the same visual distance (~10 degrees) away.

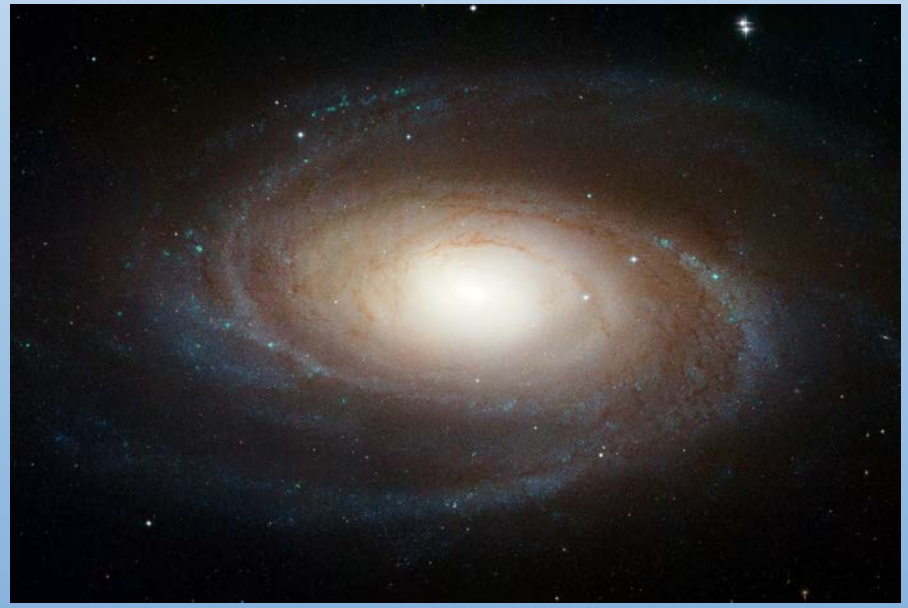
M81 / NGC 3031

Bode's (Grand Design) Galaxy

Spitzer Infrared

Copied from Wikipedia:

An infrared image of Messier 81 taken by the Spitzer Space Telescope. The blue colors represent stellar emission observed at 3.6 μm. The green colors represent 8 μm emission originating primarily from polycyclic aromatic hydrocarbons in the interstellar medium. The red colors represent 24 μm emission originating from heated dust in the interstellar medium.



M81 and friends

M81 group

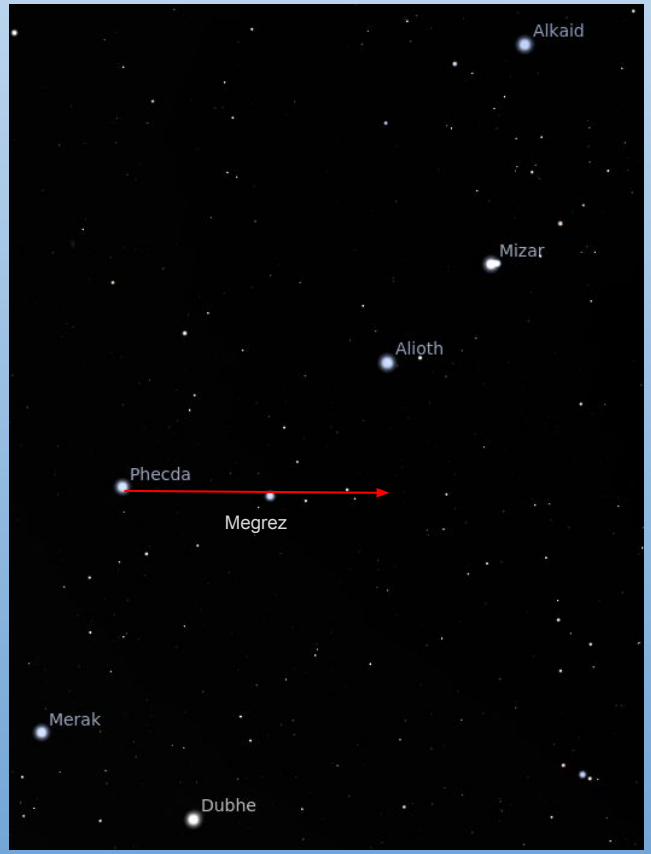
M81 is the main object in this slightly wider field.

M82 is to the right - the reddish object.

NGC 3077 is the fuzzy bit at the top - it is an elliptical galaxy.

This image (from Stellarium) spans about 1.5^{o} and is in the North-NorthWest around 10 pm.

And now for something completely different.



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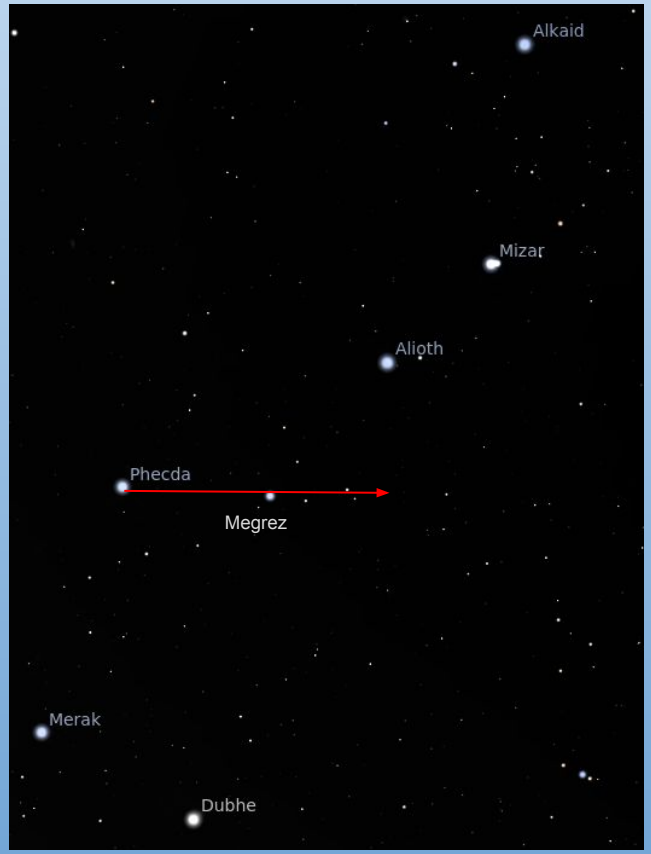

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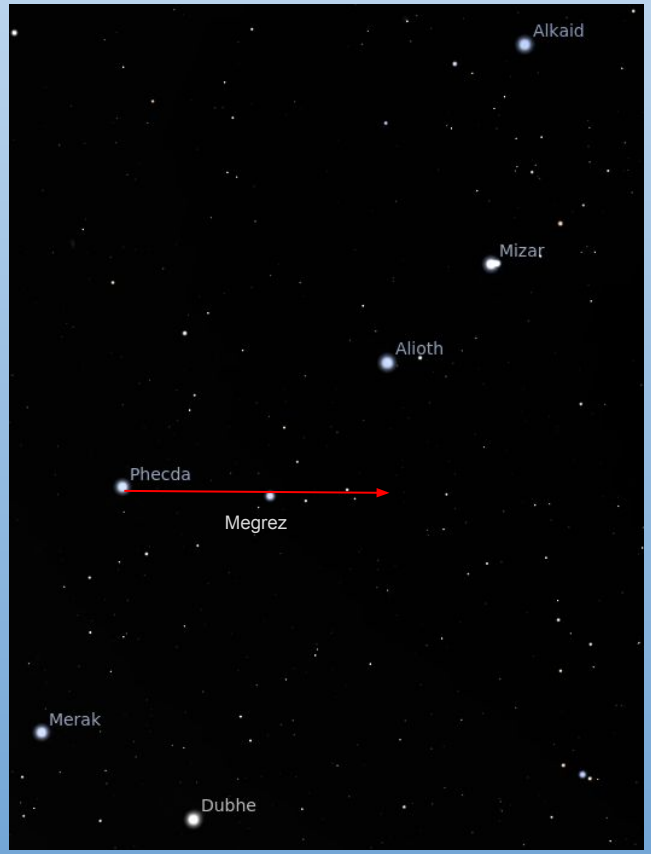

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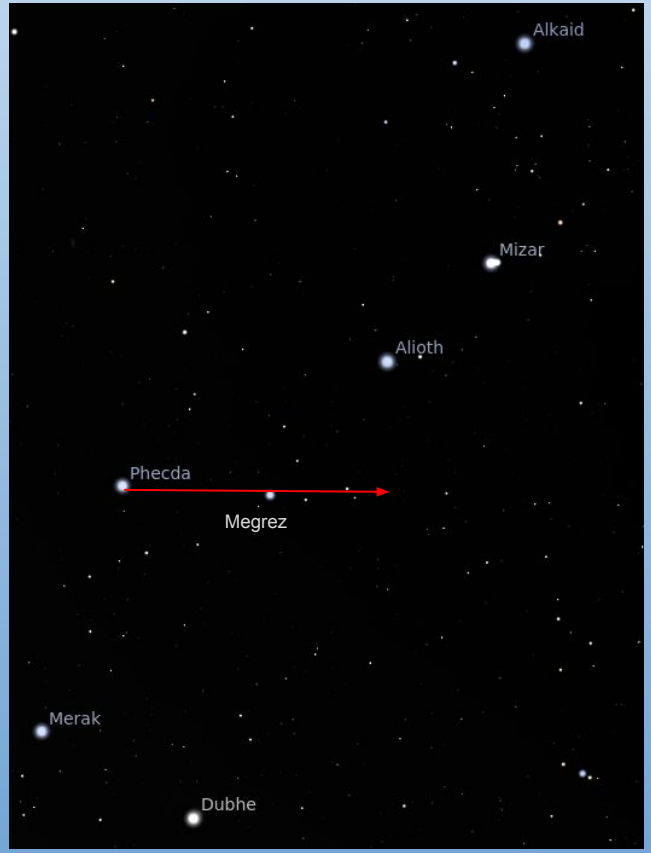
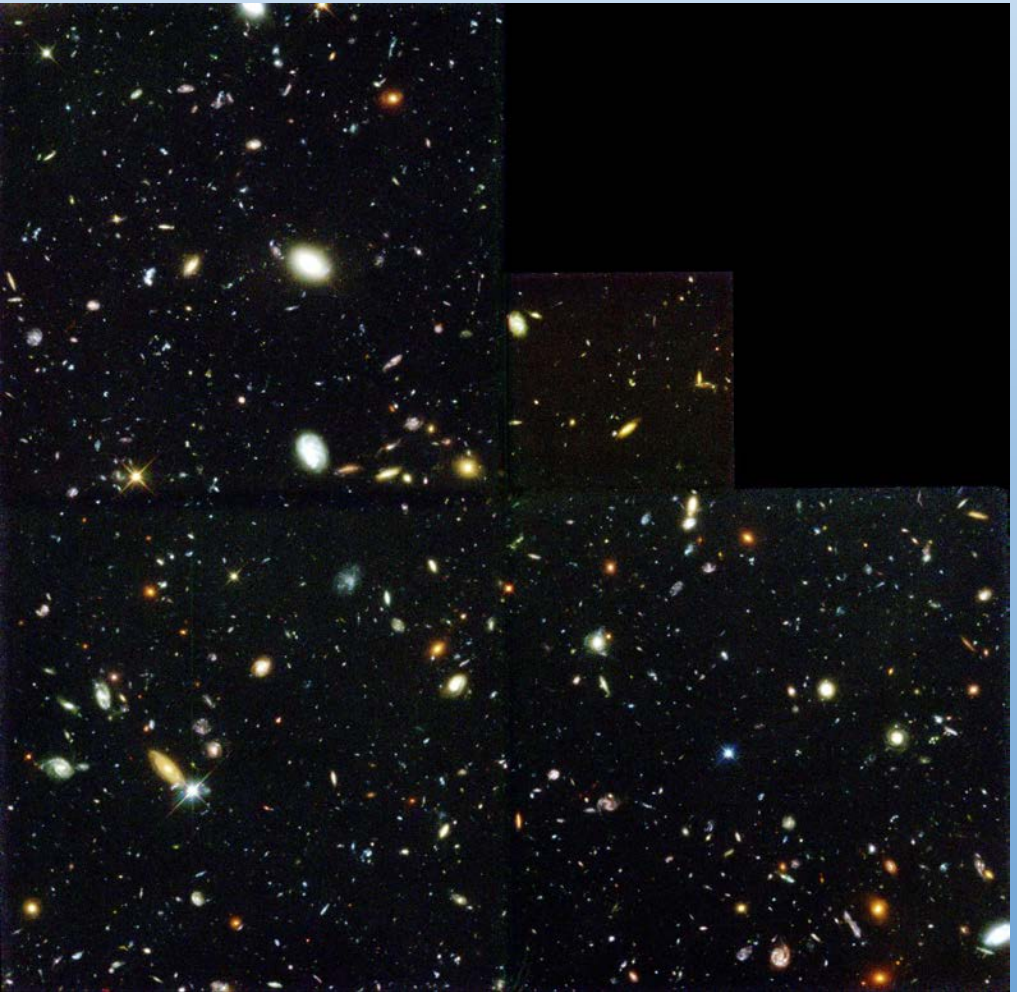


Where are we going with this? There’s NOTHING THERE!

And now for something completely different.



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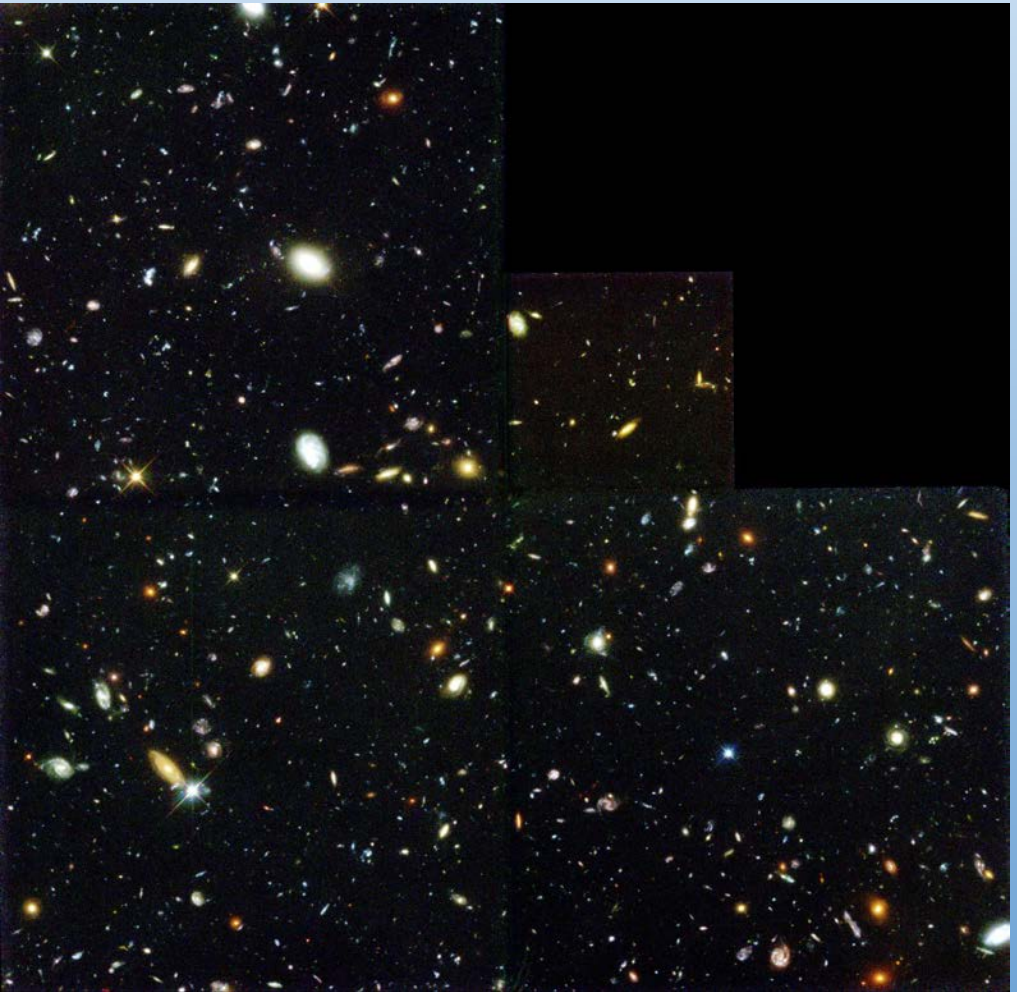
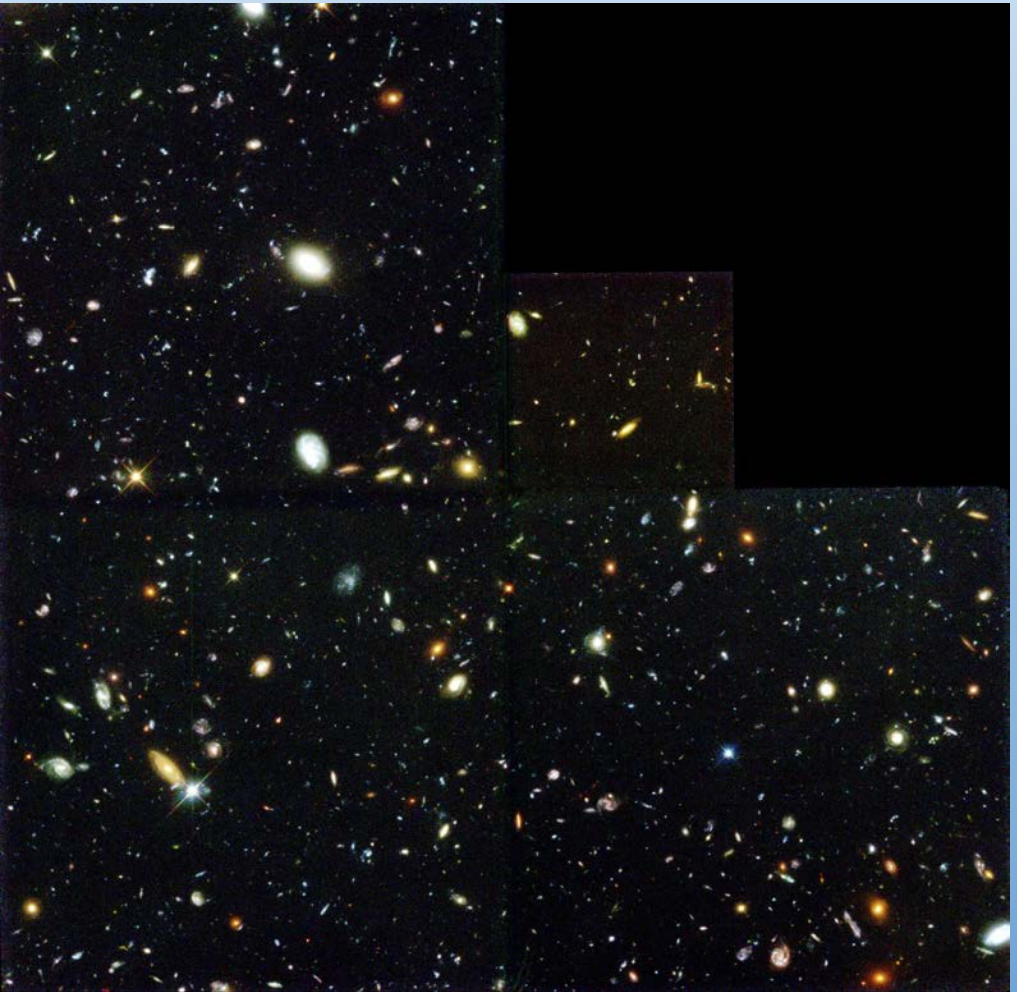


Taken over 10 days between Dec 18-28, 1995.

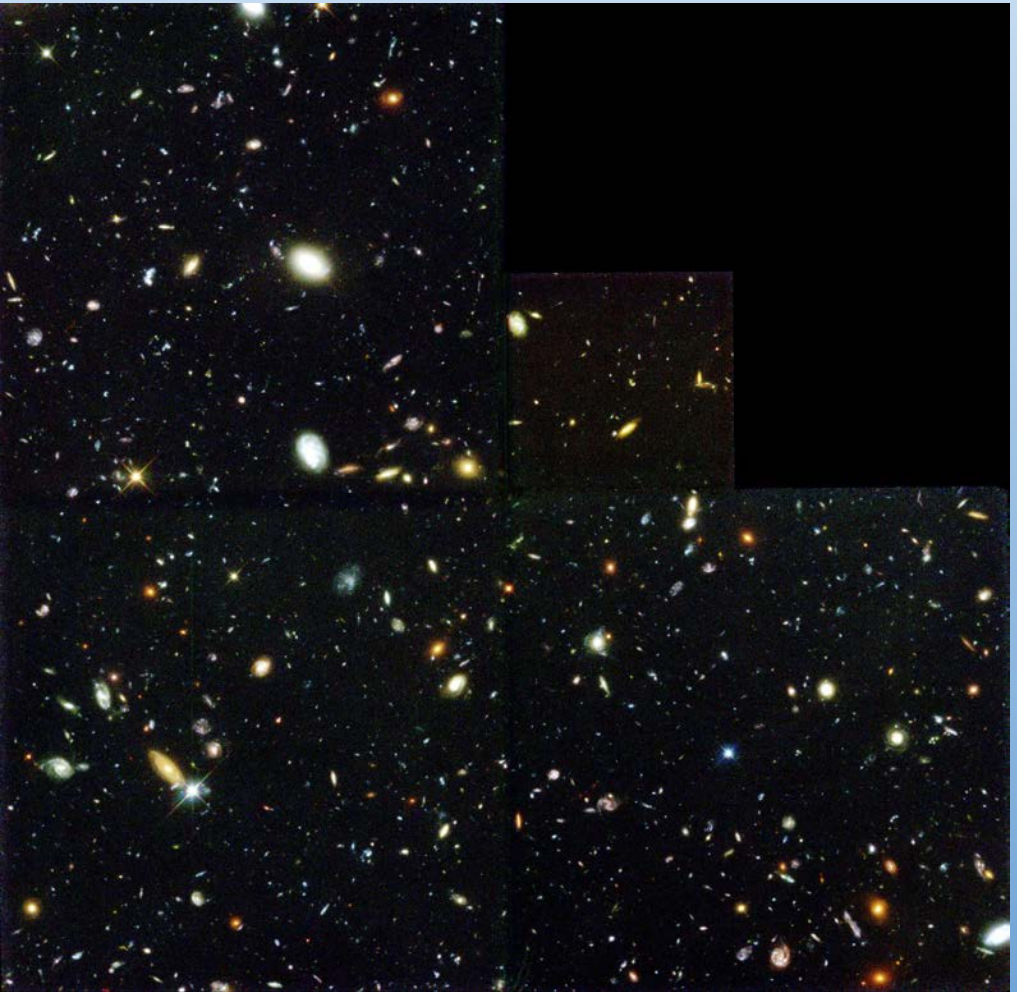
And now for something completely different.



Taken over 10 days between Dec 18-28, 1995.

150 orbits of Earth and 342 images, taken with 4 different filters.

And now for something completely different.



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150 orbits of Earth and 342 images, taken with 4 different filters.

The total exposure times at each wavelength were 42.7 hours (300 nm), 33.5 hours (450 nm), 30.3 hours (606 nm) and 34.3 hours (814 nm).

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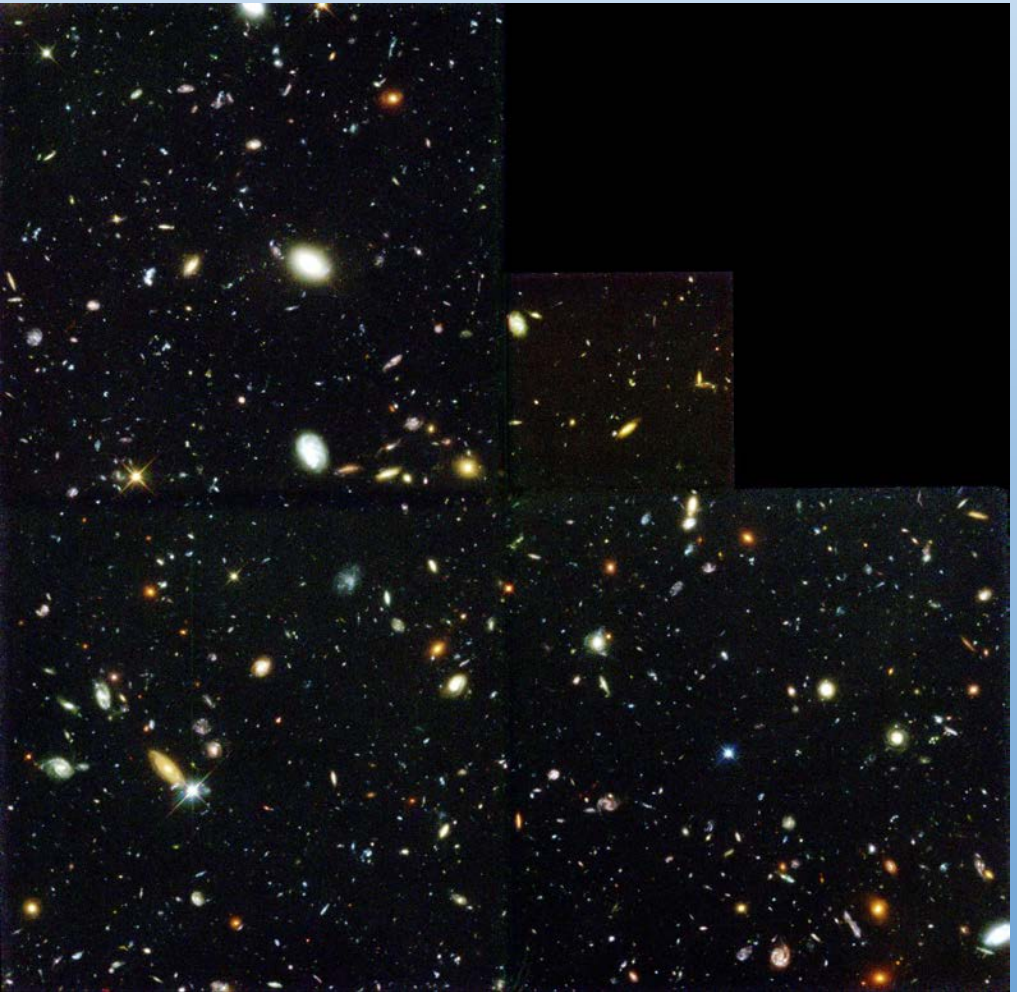

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Colours chosen for “Scientific Utility”, not what the human eye would actually see.

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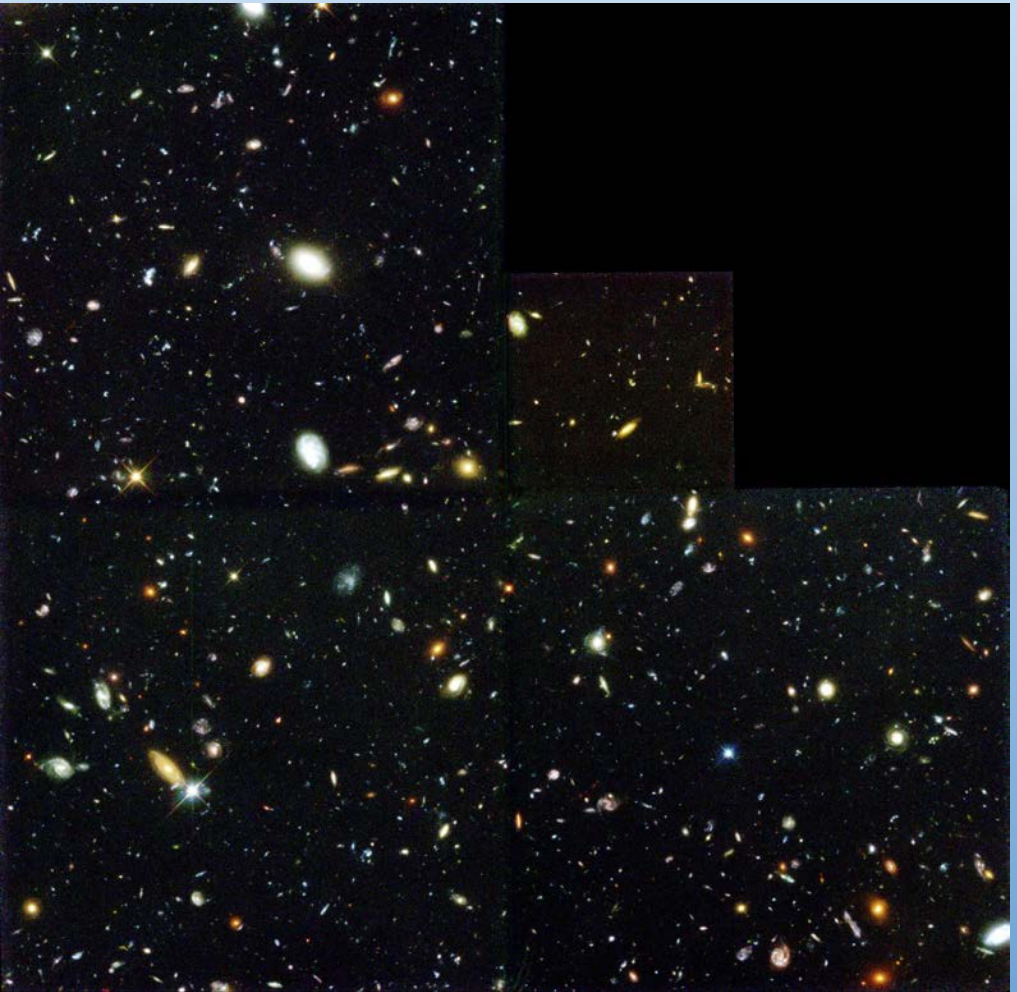

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About 3000 distant galaxies are identifiable.

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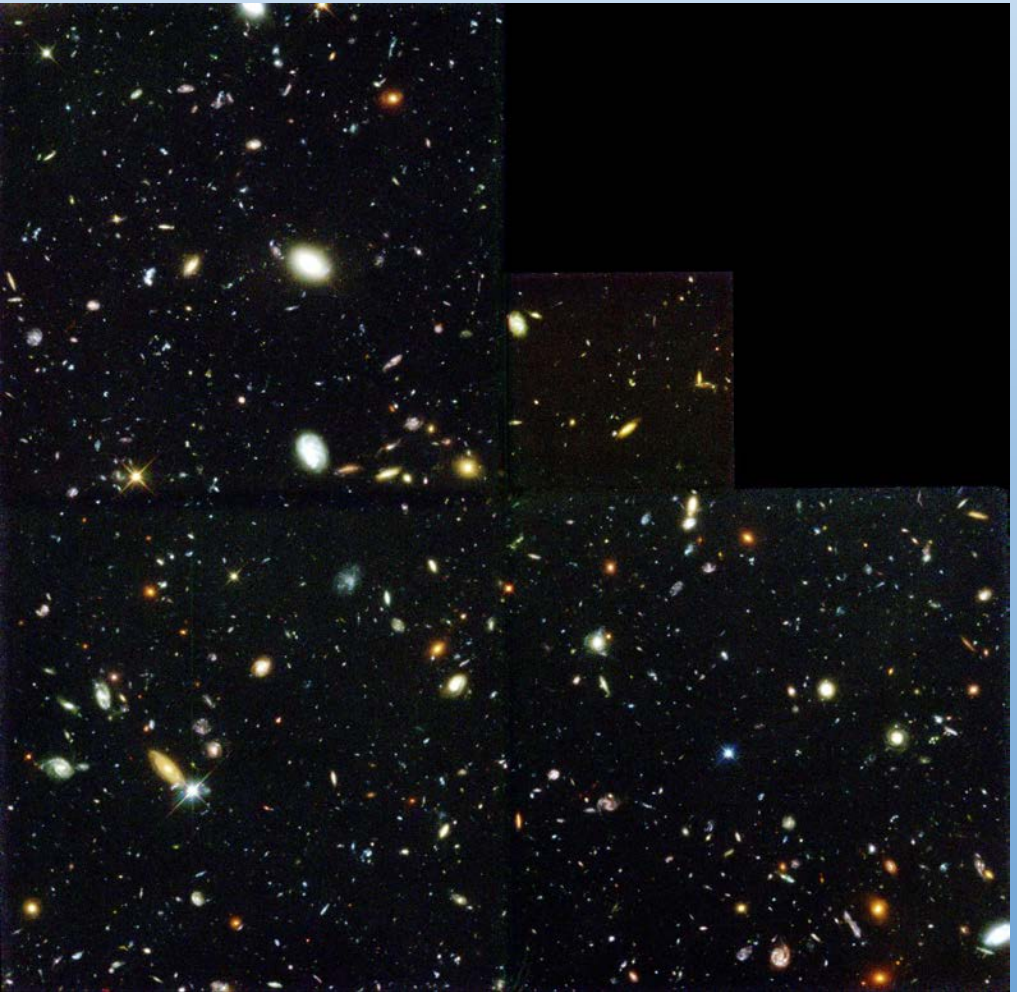

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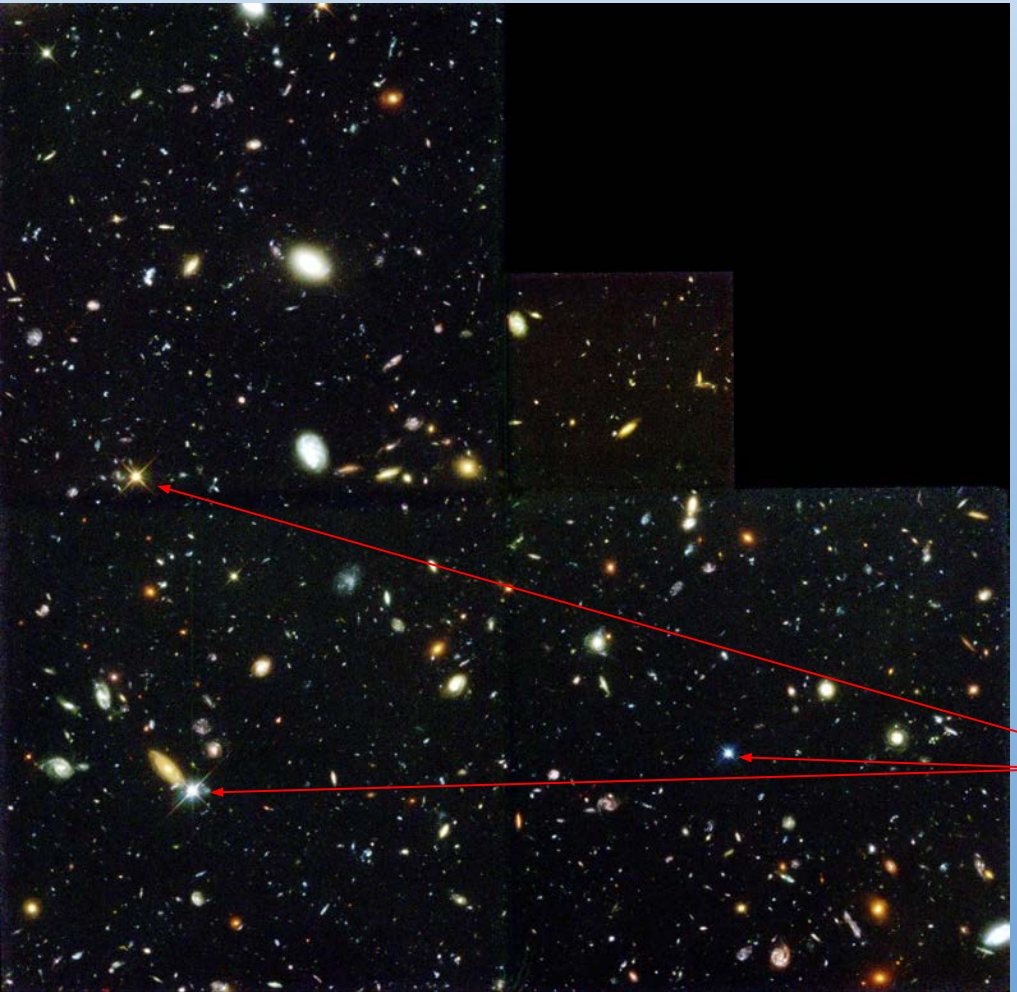
About 3000 distant galaxies are identifiable.

There are three stars within the Milky Way in this image.

And now for something completely different.



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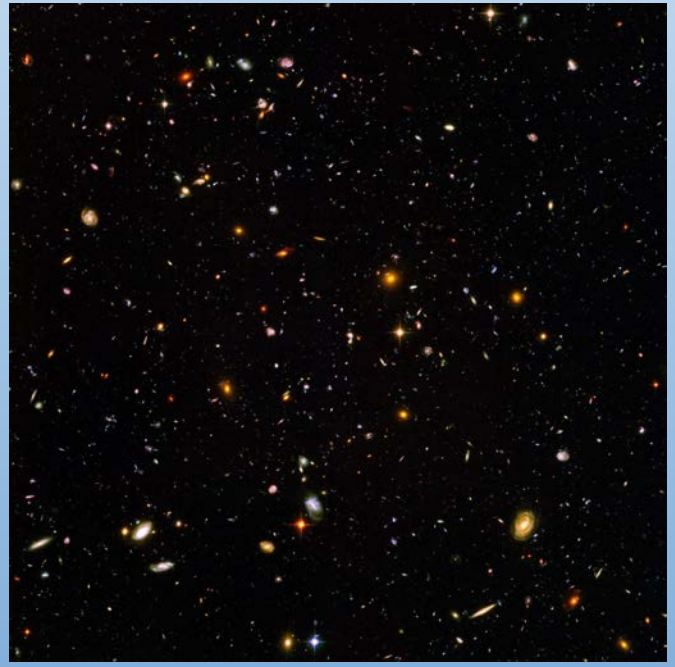
About 3000 distant galaxies are identifiable.

There are three stars within the Milky Way in this image.

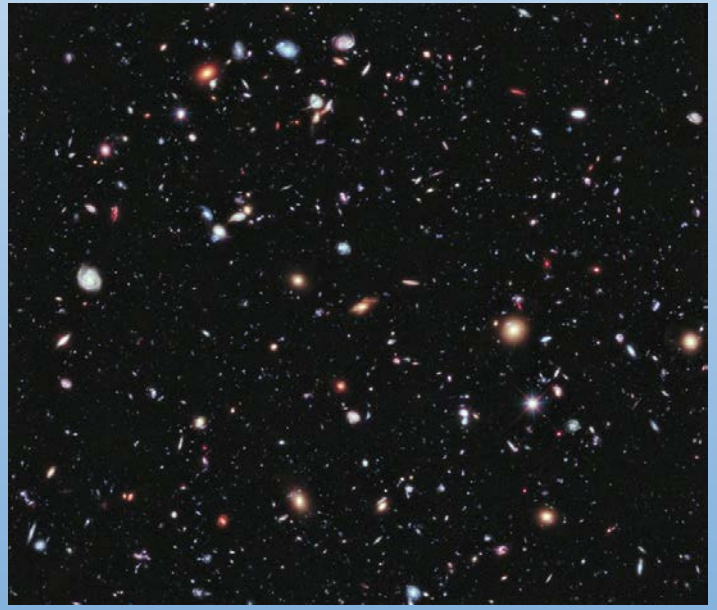
They are the ones with the diffraction spikes.

And now for something completely different.

HDF-South



Hubble Ultra-Deep Field



Hubble Extreme Deep Field

Next Week:

Astrophotography