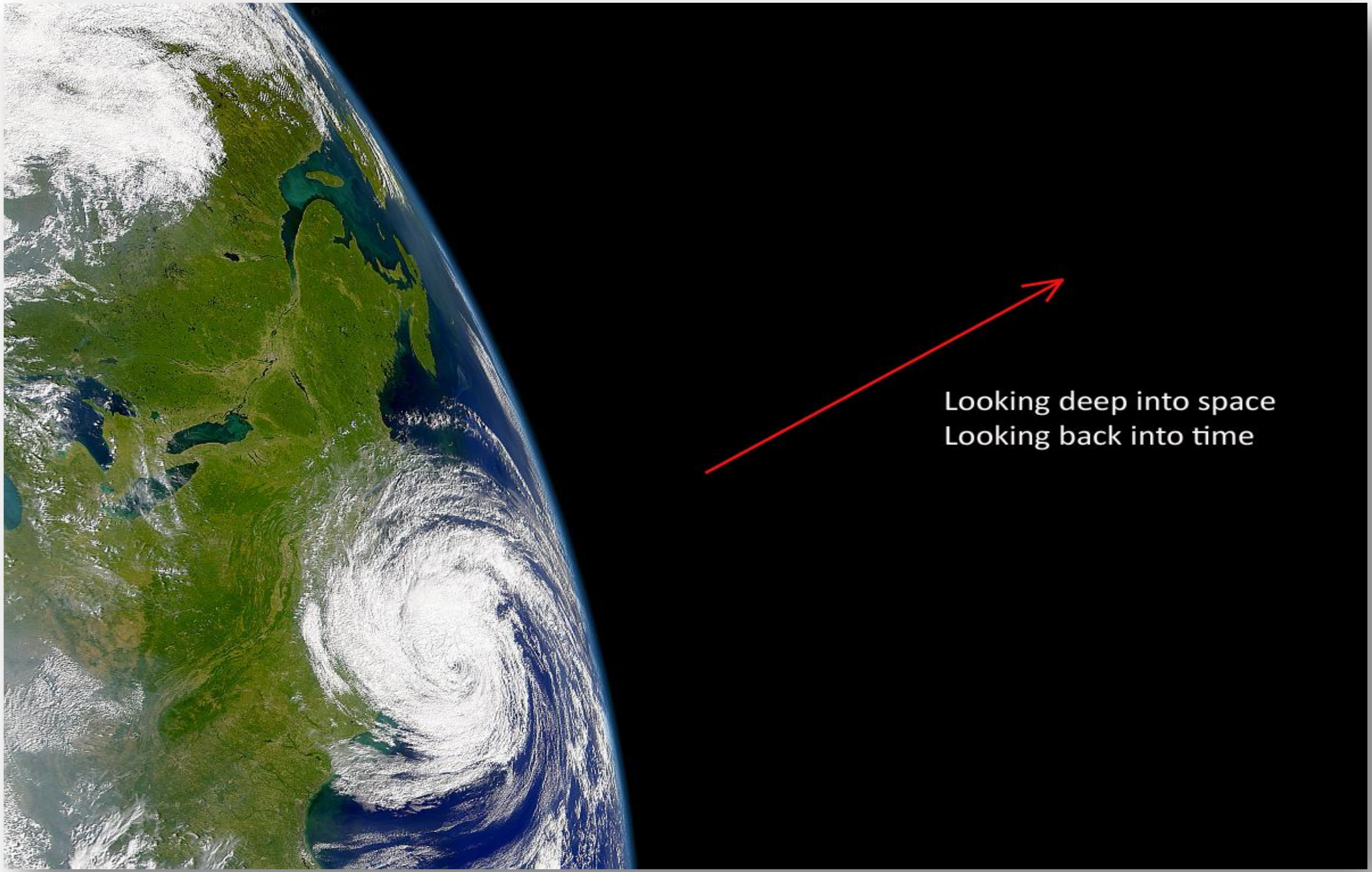
Astronomy 101

Astronomy 101

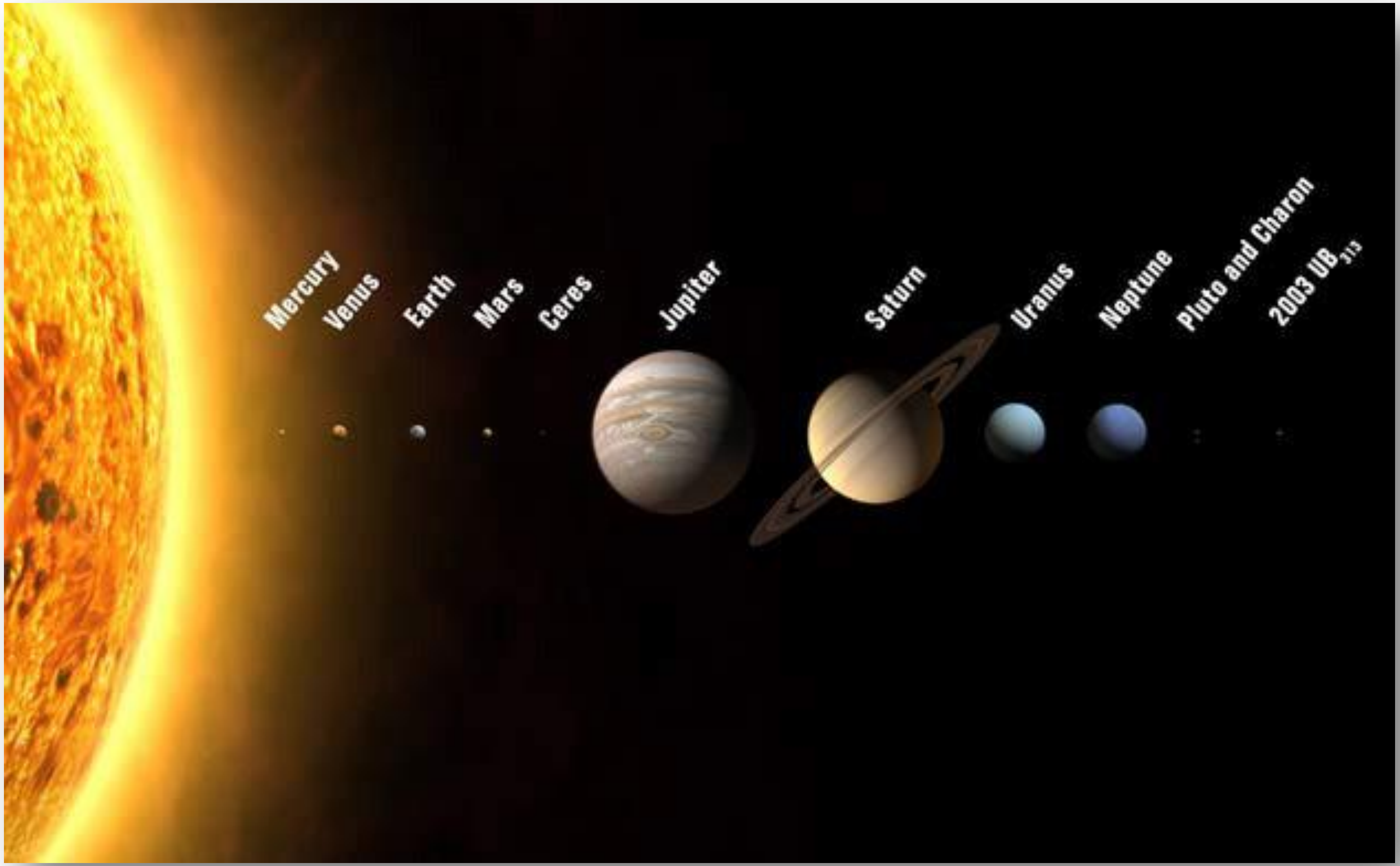
In approximate order of typical distances from us:

- Earth
- Moon
- Sun
- Planets & Asteroids
- Comets
- Stars
- Planetary Nebula
- Diffuse Nebula
- Globular Clusters
- Galaxies
- Clusters of Galaxies
- Quasars
- GRBs
- Other Exotic Stuff?

Astronomy 101

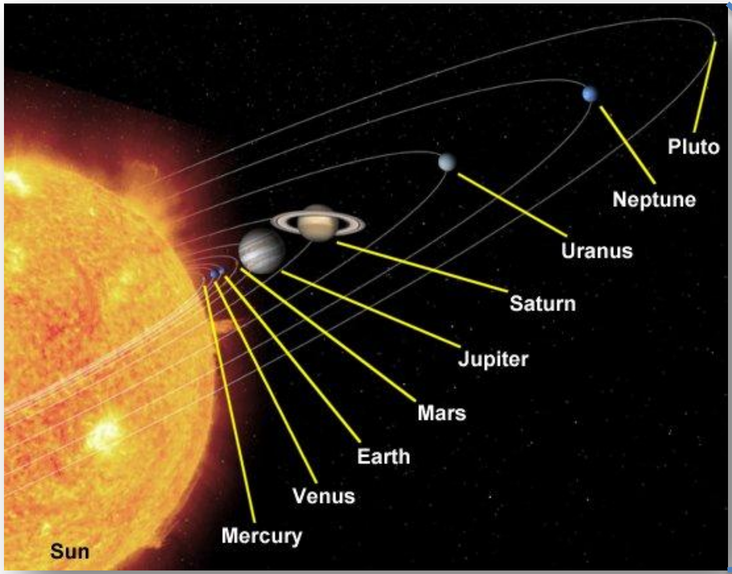


Astronomy 101

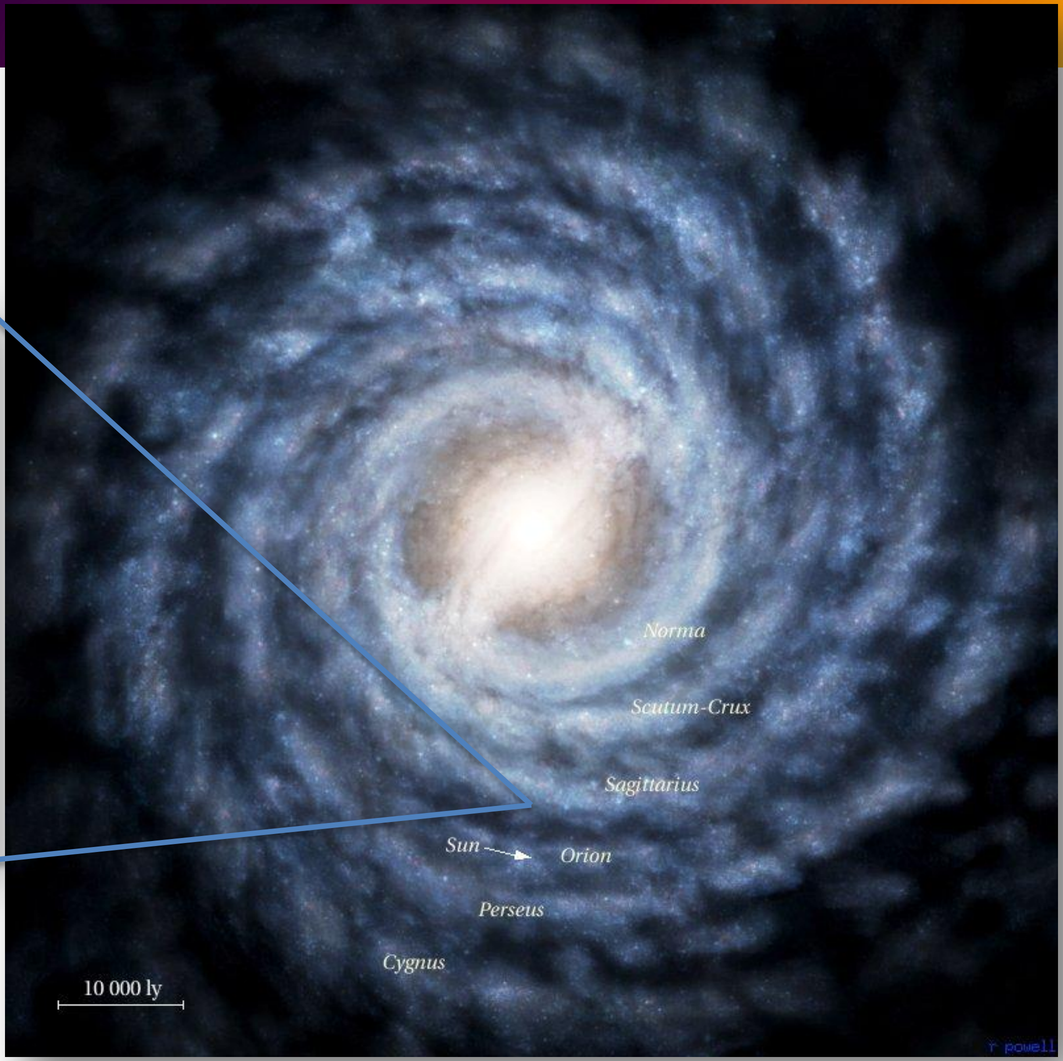


Astronomy 101

Light travels about 6 trillion miles in one year = 1 light year



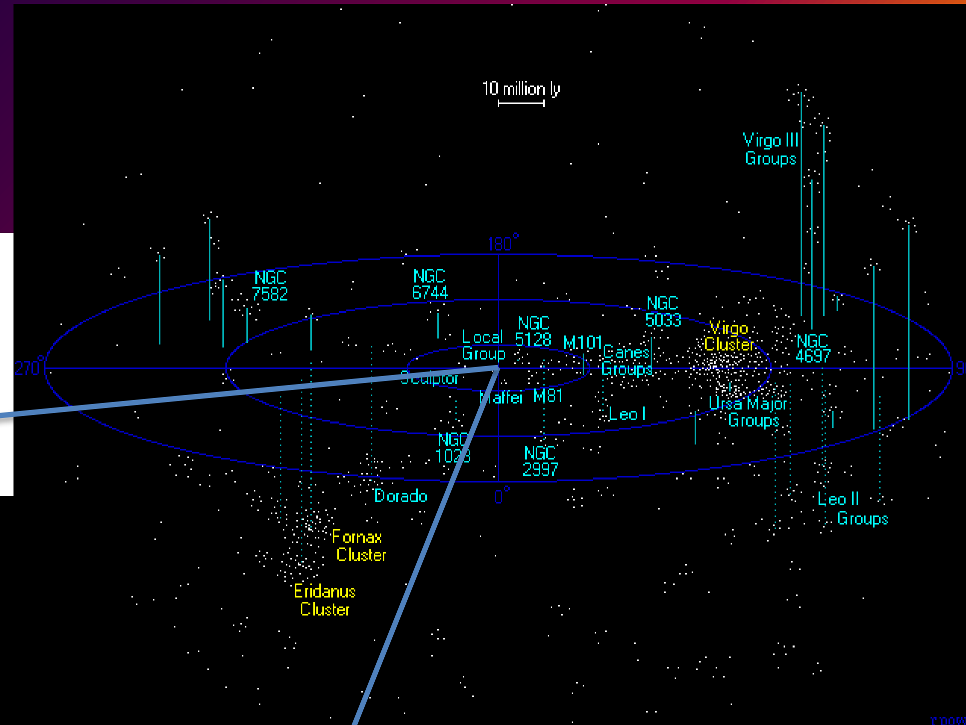
Our solar system spans about .0012 light years

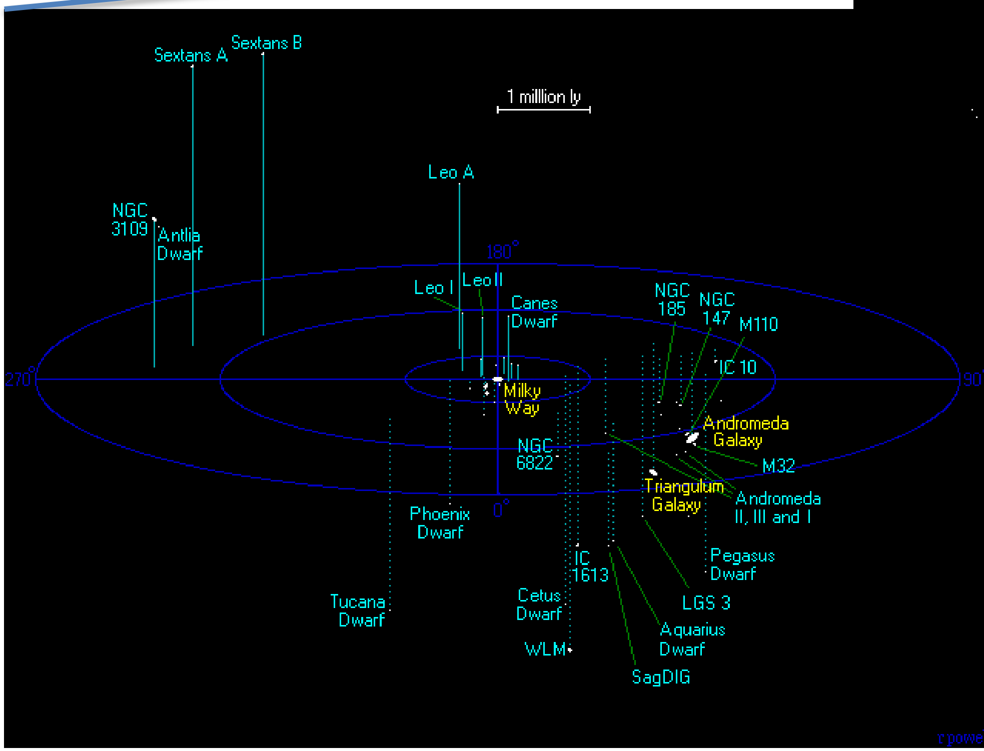


Our galaxy, the Milky Way is about 100,000 ly across

Astronomy 101

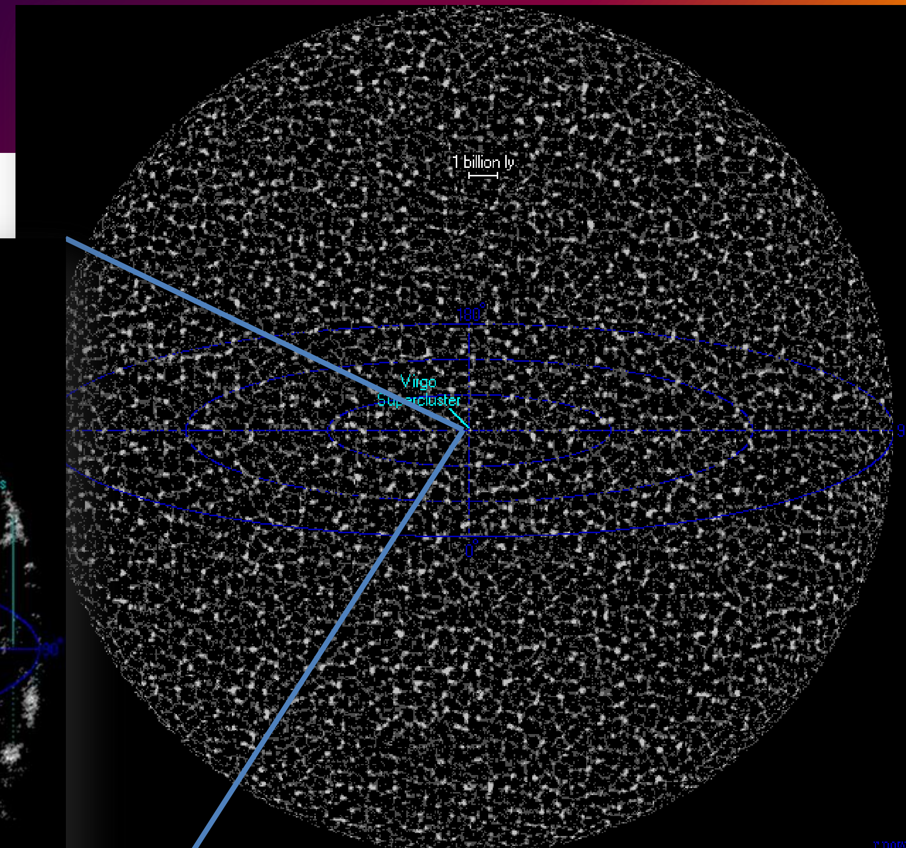
3. Our galaxy is part of a local group of galaxies that span about 10 million light years

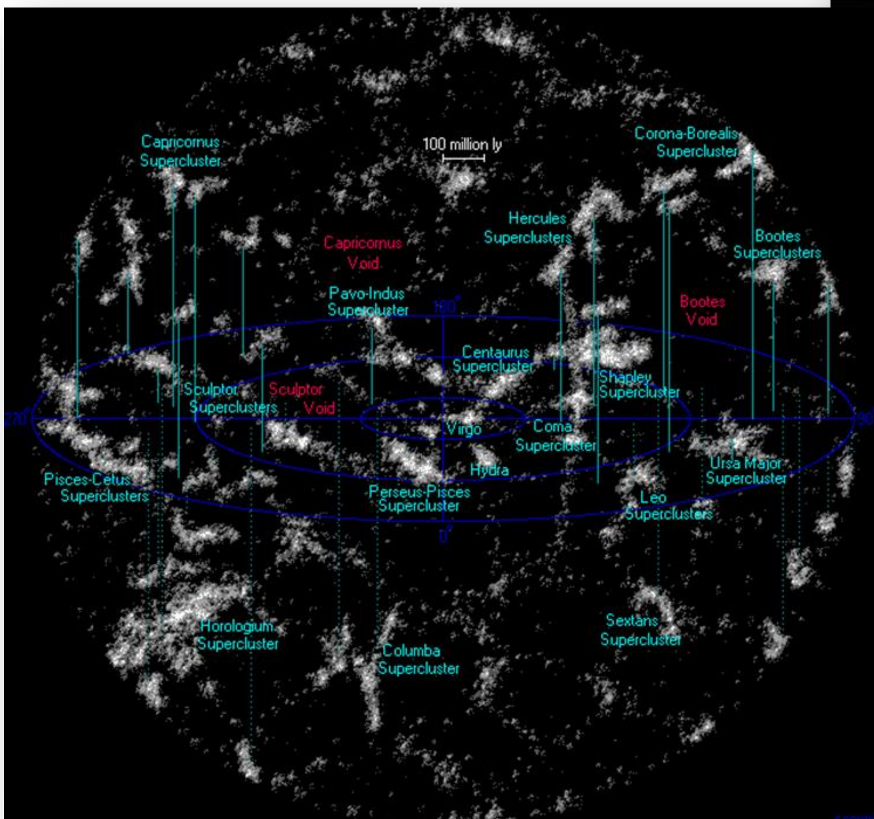




4. Our local group of galaxies is part of a larger cluster of galaxies that span about 200 million light years known as the Virgo Cluster.

Astronomy 101

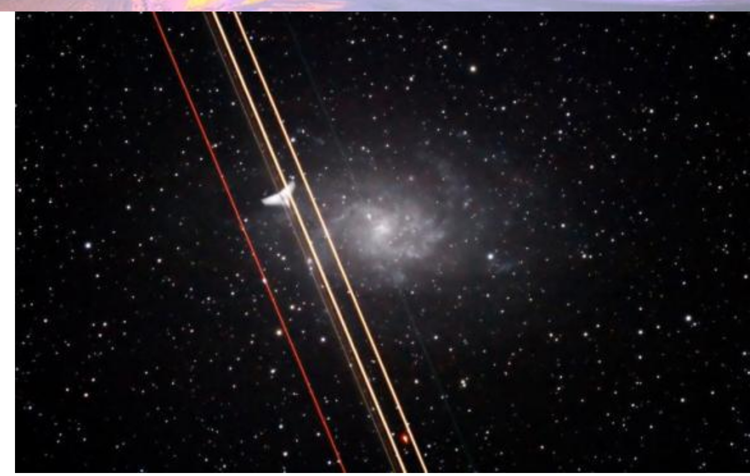




6. A web of super clusters spans the known universe – about 13.7 billion light years

5. The Virgo Cluster is part of a super-cluster of galaxies spanning about 2 billion light years

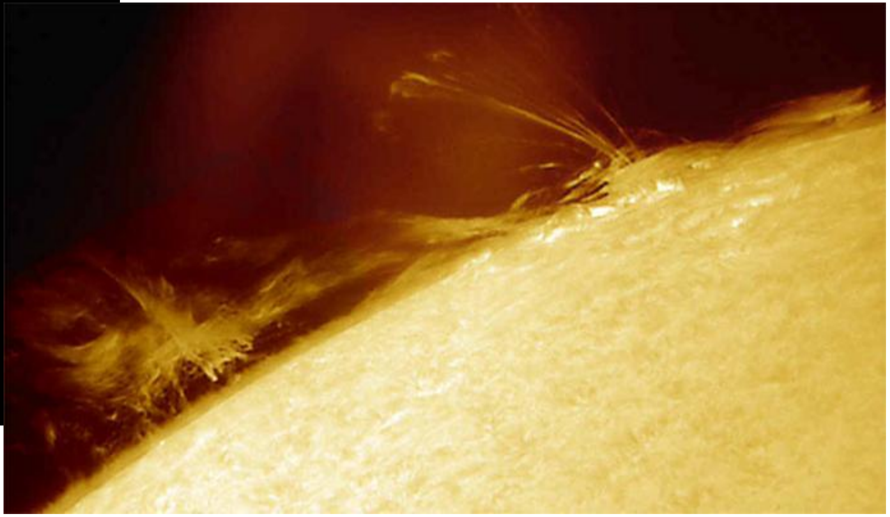
Astronomy 101



Earth

(Note: All images in this section except the aurora image above were taken with SBIG cameras)

Astronomy 101



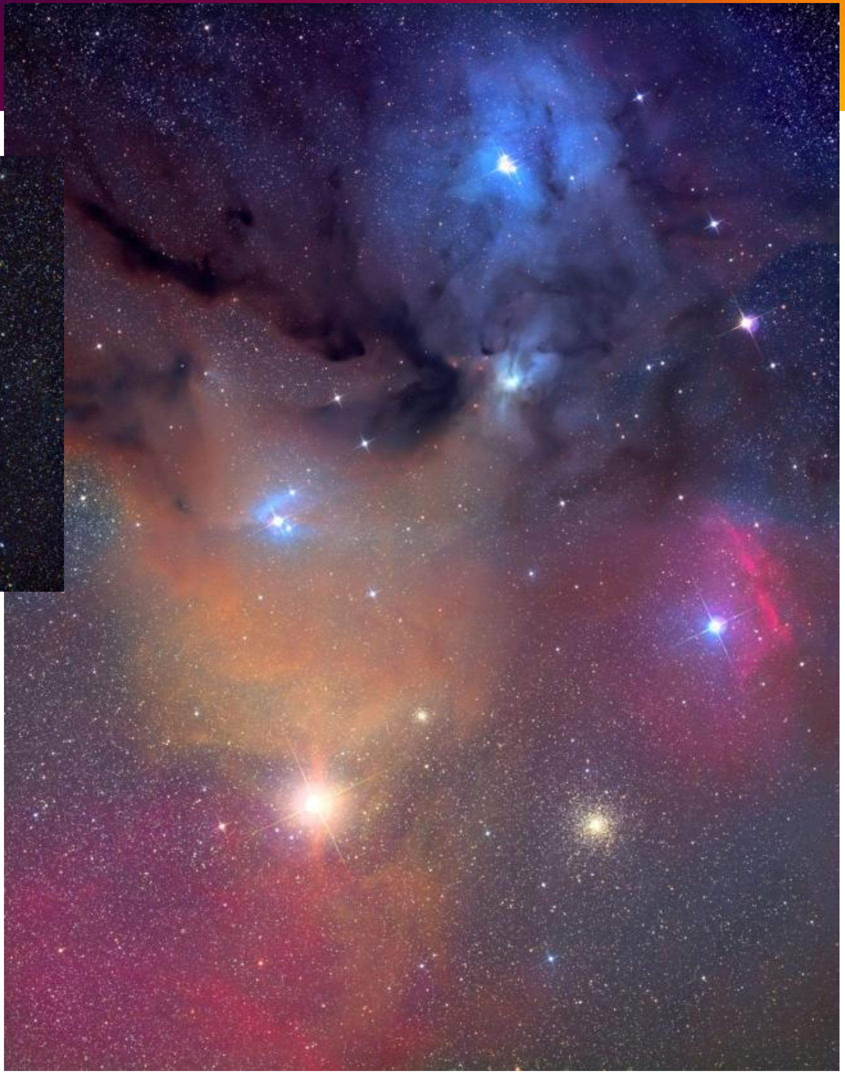
Sun, Moon, Planets

Astronomy 101

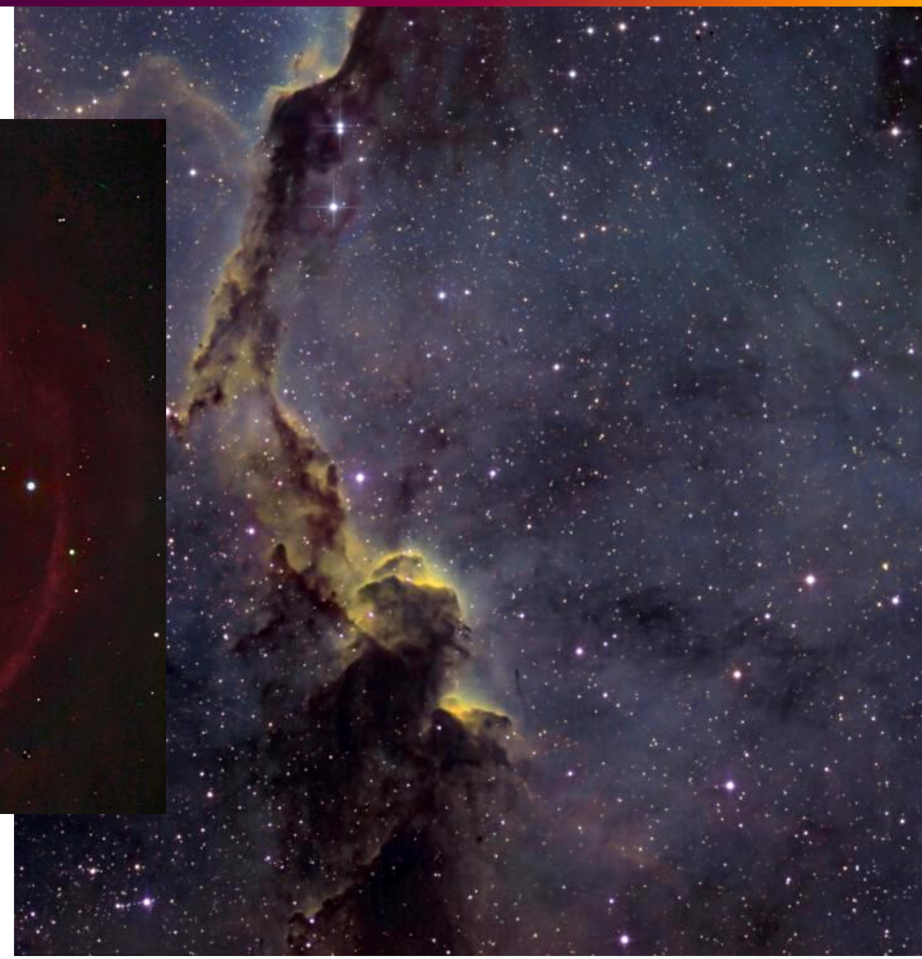
Comets

Stars

Nebula



Astronomy 101

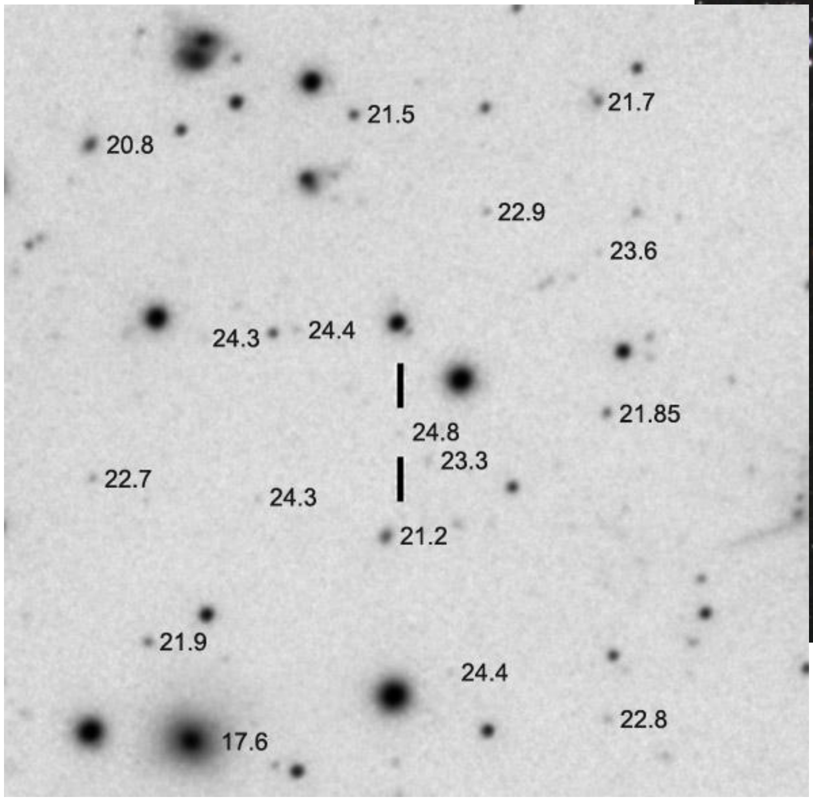


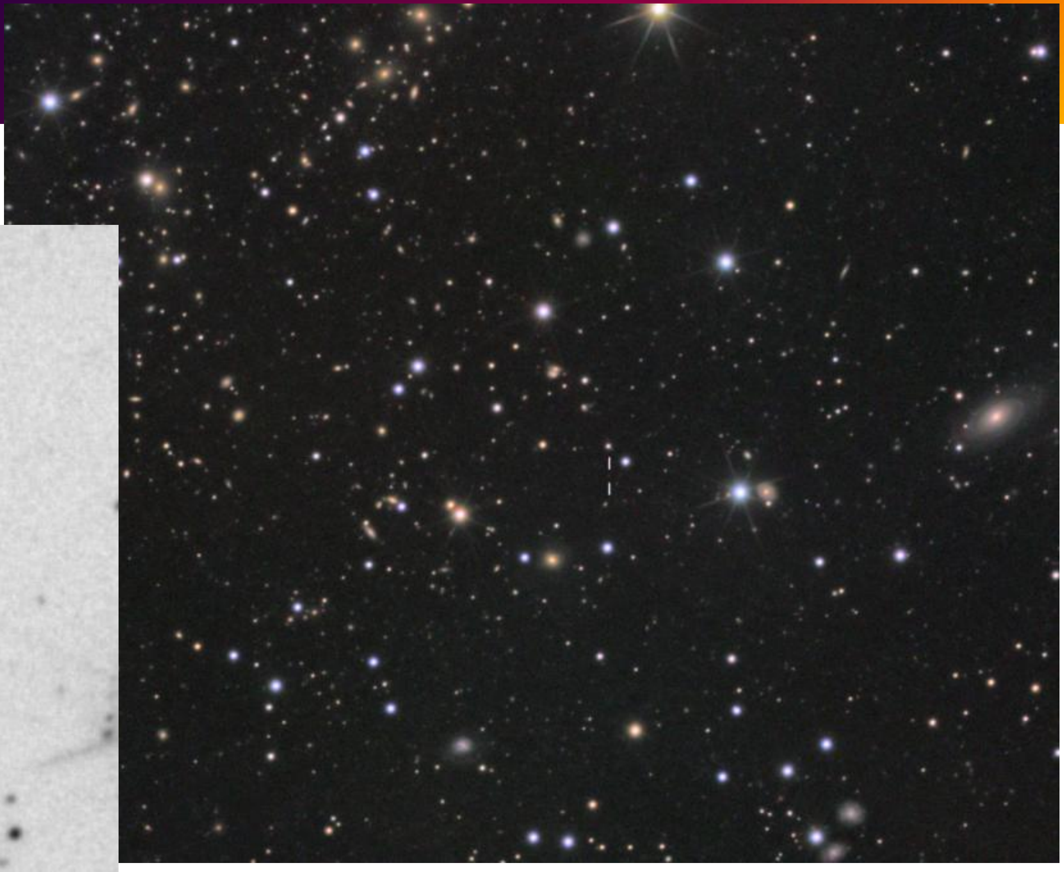
Planetary Nebula, Diffuse Nebula,
Globular Clusters

Astronomy 101

Galaxies, Clusters of Galaxies

Astronomy 101





Quasars, GRBs, Other Exotic Stuff

Astronomy 101

How far away are they? How bright are they?

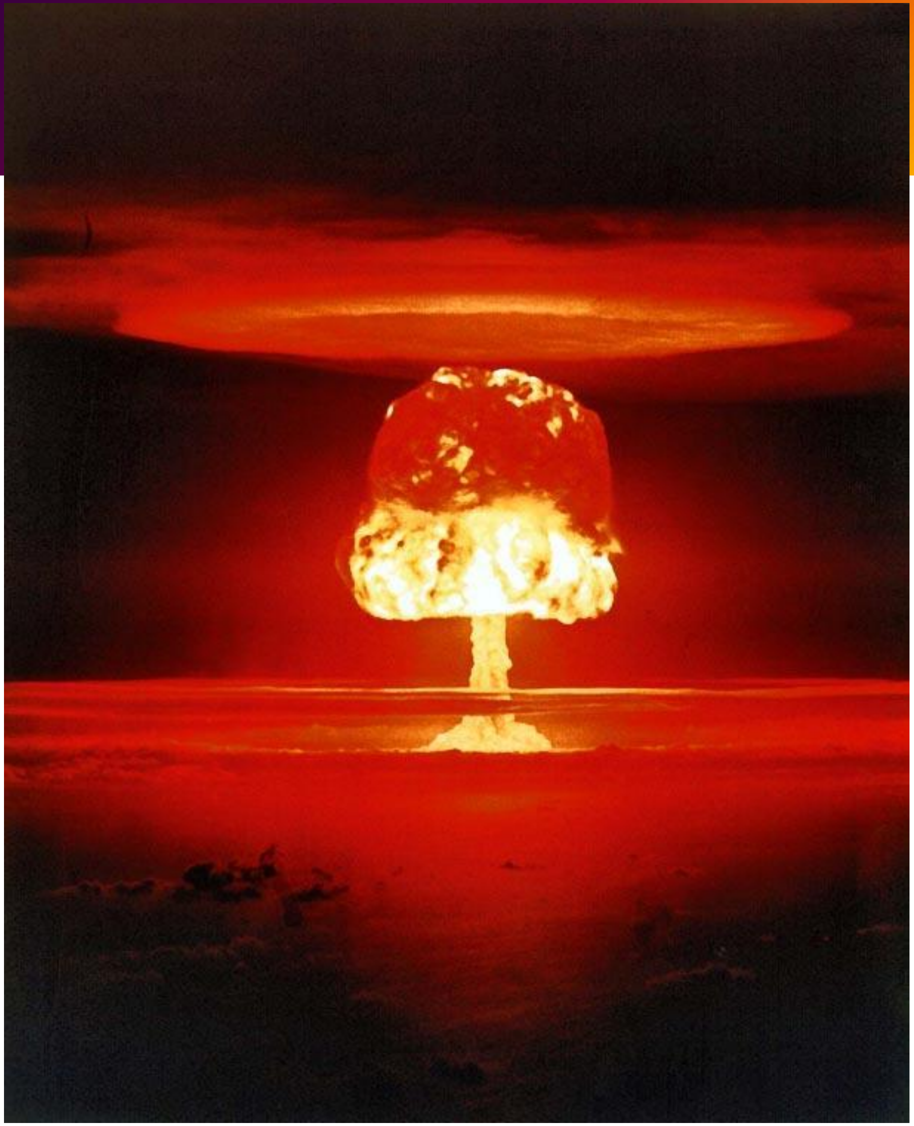
Object	Light Years	Miles	Magnitude	
Moon (~1 LS)	0.00000004	250,000	-13	
Sun (8.3 LM)	0.00001585	93,000,000	-27	
Jupiter	0.00006223	365,000,000	0	-2 to +2
Saturn (~1 LH)	0.00012667	743,000,000	1	
Pluto	0.00062600	3,671,925,696	15	
Proxima Centauri	4.2	24,635,923,200,000	5	
Deneb	1,500	8,798,544,000,000,000	1	
Planetary & Diffuse Nebula	2,500	14,664,240,000,000,000	10	
Globular clusters	25,000	146,642,400,000,000,000	6	
Milky Way Stars	250,000	1,466,424,000,000,000,000	-1 to 20	
Andromeda	2,500,000	14,664,240,000,000,000,000	3.4	
NGC Galaxies	50,000,000	293,284,800,000,000,000,000	9	
Quasars	10,000,000,000	58,656,960,000,000,000,000,000	20	13 to 25+
GRB	13,100,000,000	76,840,617,600,000,000,000,000	20	18 to 25+
Most Distant Galaxy	13,200,000,000	77,427,187,200,000,000,000,000	29	Hubble
Known Universe	13,700,000,000	80,360,035,200,000,000,000,000		

Note: Do not plan any trips using these figures – they are only approximations

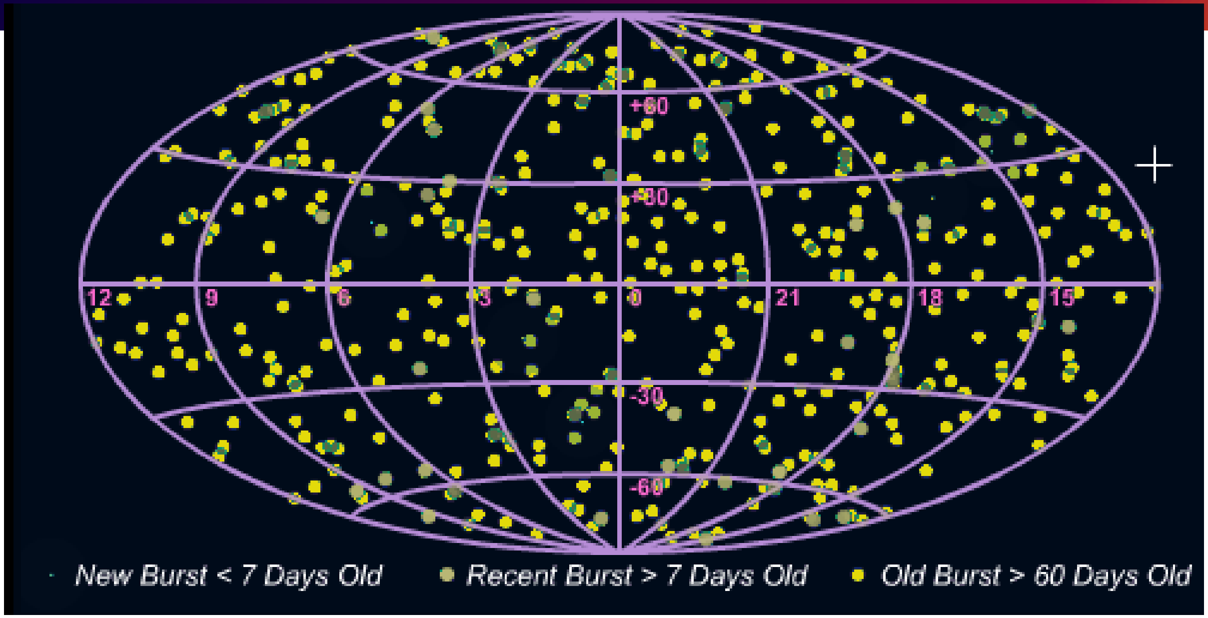
SBAG 1985 - 1989

SBAG 1985 - 1989

- GRBs were discovered by Earth monitoring satellites
- Only known sources of Gamma rays were thermonuclear explosions and the sun (star)
- Satellites were carefully made to look away from the sun when not looking at earth
- Alarms went off when Gamma Ray events were detected
- Satellites were looking into space

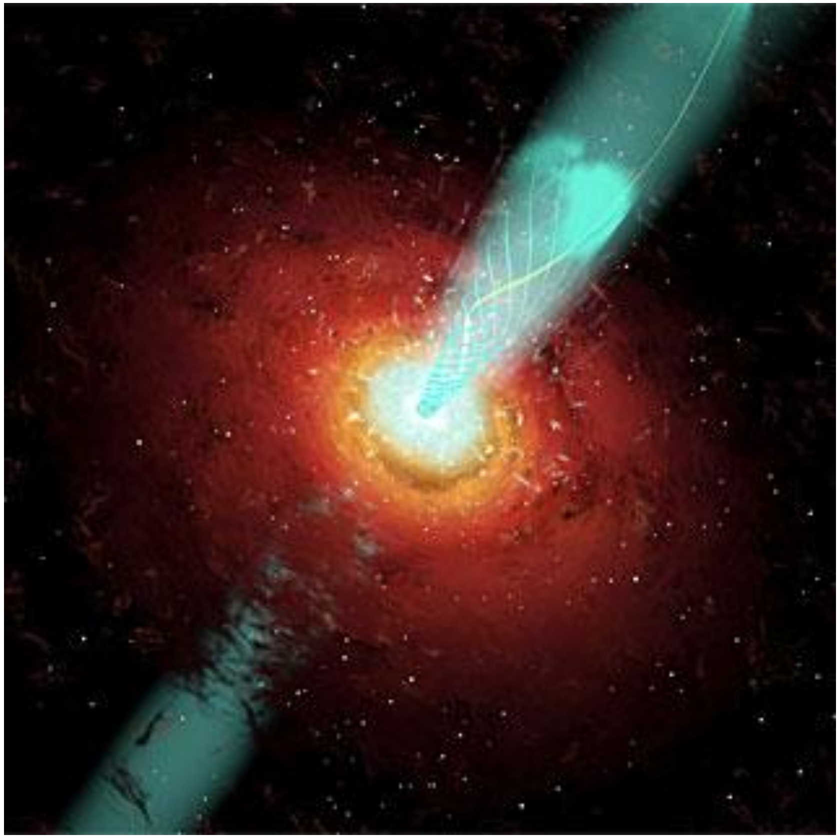


SBAG 1985 - 1989



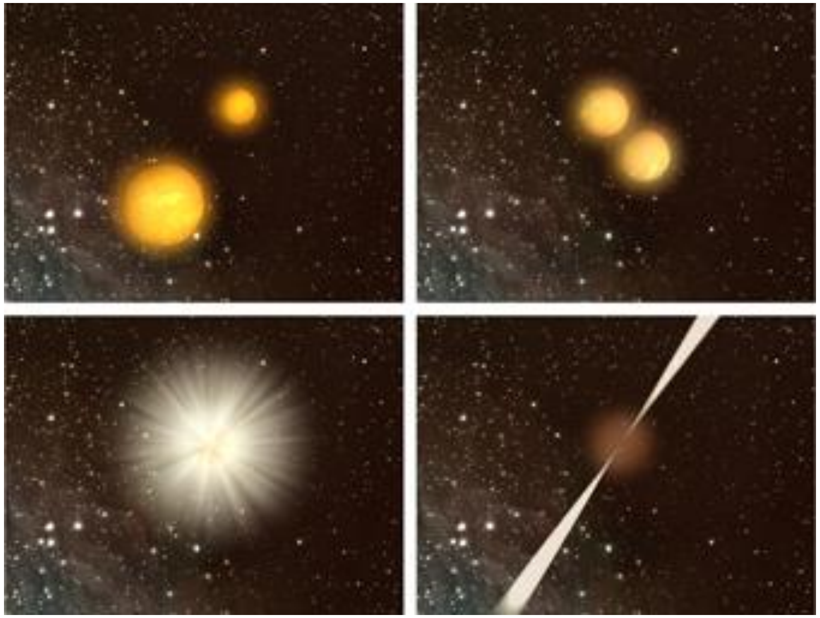
- If they were not from Earth or our sun, where did they originate?
- If they were outside our solar system, but in our own galaxy, GRB events should be clumped along our galactic plane (Milky Way).
- Further study showed the events were isotropic.
- They must be VERY far away, and therefore extremely powerful

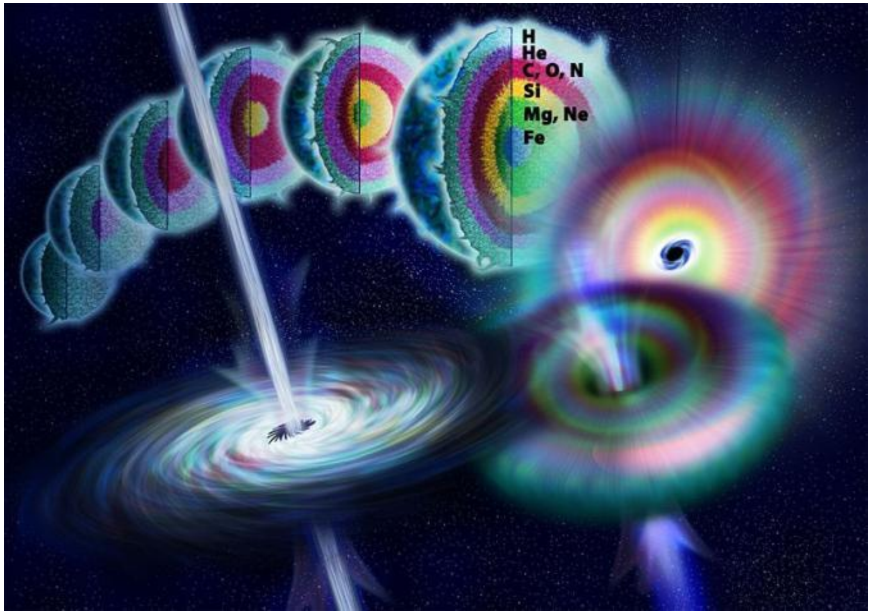
SBAG 1985 - 1989



- The most distant GRB was recently detected 13 billion light years away
- A light year is just under 6 trillion miles.
- The light left this GRB event when the universe was only a fraction of its present age.
- The energy released by the most energetic GRB in a few seconds is equal to all the energy released by 1,000 stars like the sun over their lifetime (10 billion years).

SBAG 1985 - 1989





Two current theories for GRBs. Short period events (millisecond bursts – less than 2 sec.) caused by two colliding neutron stars forming a black hole. Longer events (seconds to minutes) caused by a massive star’s collapse to form a black hole.

SBAG 1985 - 1989

When we capture the light from a GRB that is 13 billion light years away, we are witnessing an event that actually occurred 13 billion years ago (8 billion years before the earth was born) and lasted for only a few seconds !

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SBAG 1985 - 1989

Ogres: ‘84 – ‘85 Katz and others observed a series of optical flashes near the Aries/Perseus border, called the “Aries Flasher” or “Perseus Flasher”. One event was photographed. It was thought to be the Optical Gamma Ray Emitter, or Ogre.

Enter SBAG: Others including our group (SBAG = Santa Barbara Astronomy Group) working with Brad Schaefer were skeptical. To validate or invalidate the proposition about the Ogre, we monitor error boxes in pairs waiting for repetition of an event. We determined most observed events were satellite glints. Results published in Astrophysical Journal Sept. 1987 “The Perseus Flasher and Satellite Glints.”

SBAG 1985 - 1989

How we got here - Santa Barbara Astronomy Group

- All amateur astronomers with backyard telescopes
- All had day jobs
- Wanted to do more than look
- Worked with folks at NASA to moniotor GRB “error boxes” for an optical burst

SBAG 1985 - 1989

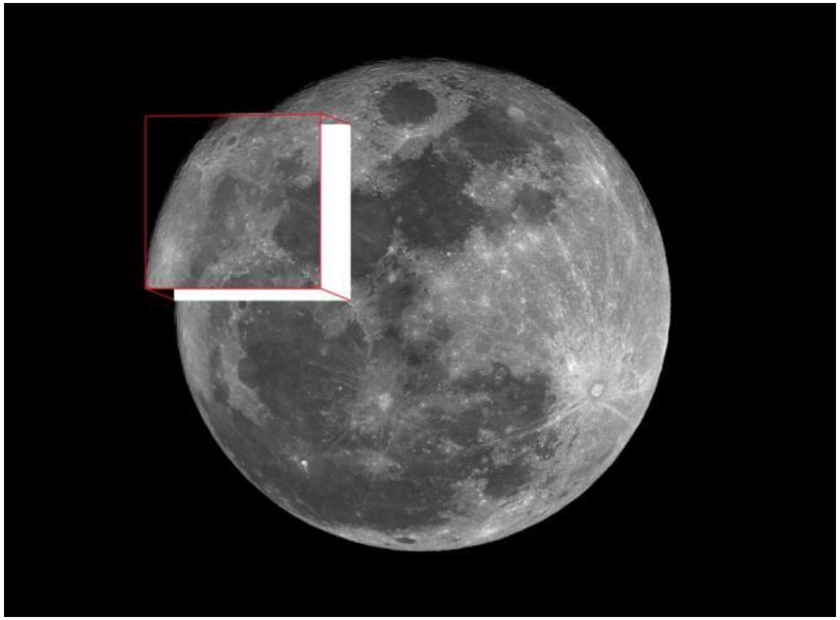
How we got here - Santa Barbara Astronomy Group

- We would monitor small areas of the sky where Gamma rays had been detected by satellite to see if they might repeat, and if so leave an optical signature

- So… of all the objects out there to study, we picked the ones that had never been seen (visually), that were the furthest from earth so if they could be seen would likely be extremely faint, and in any event lasted only a few seconds …. Why?

SBAG 1985 - 1989

Santa Barbara Astronomy Group



Typical size of error box

- We monitored error boxes - areas of the the sky about 10 arcminutes across
- To give a scale, the Moon is about 30 arcminutes in diameter
- We needed to monitor the area for as long as possible – all night on as many nights as we could
- But there was one big problem ….

SBAG 1985 - 1989

The Problem:

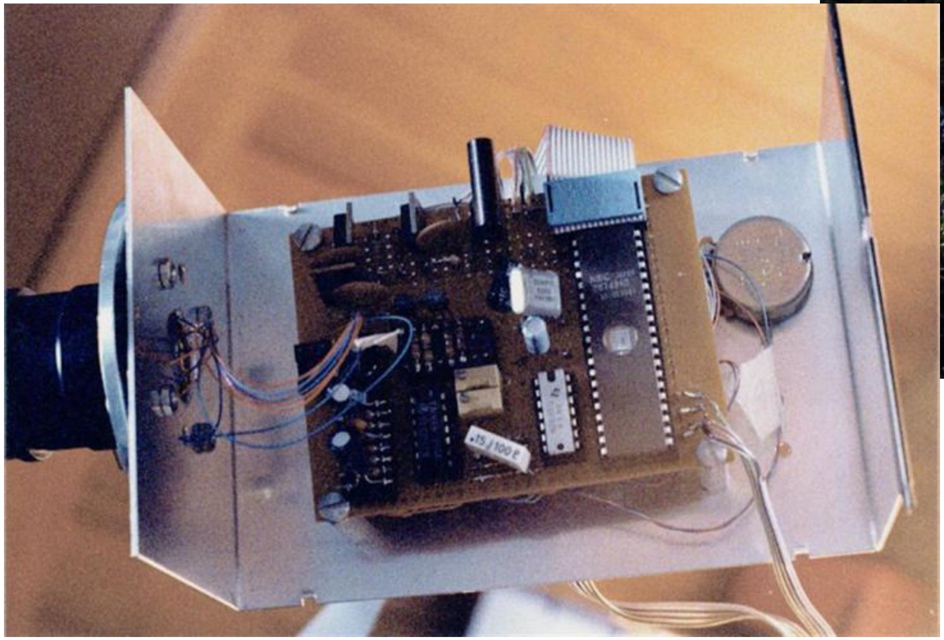
Everything is moving

SBAG 1985 - 1989

- Telescope periodic error in the range of +/- 20 arcseconds
- Telescope drift in the range of 10 arcminutes per hour
- We would lose the target frame in 1 – 2 hours so we had to manually adjust the scope every hour or two
- We needed a way to automatically correct an inexpensive telescope to keep the error box in the field of view all night
- One of us (Alan Holmes) had experience with the “new” technology of CCDs in his work at SBRC
- Alan designed and Alan and I tested the ST-1, ST-2, ST-3 and ST-4 at Mike Barber’s observatory.

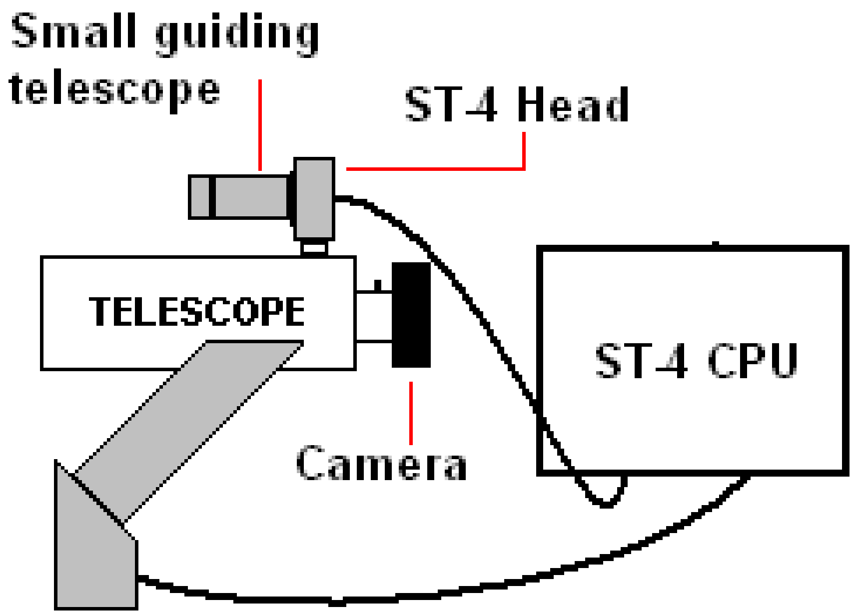
SBAG 1985 - 1989

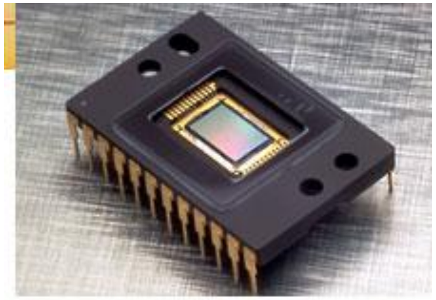
ST-1 First light in January 1988



SBAG 1985 - 1989

GRB monitoring – Solution - CCD based Autoguider

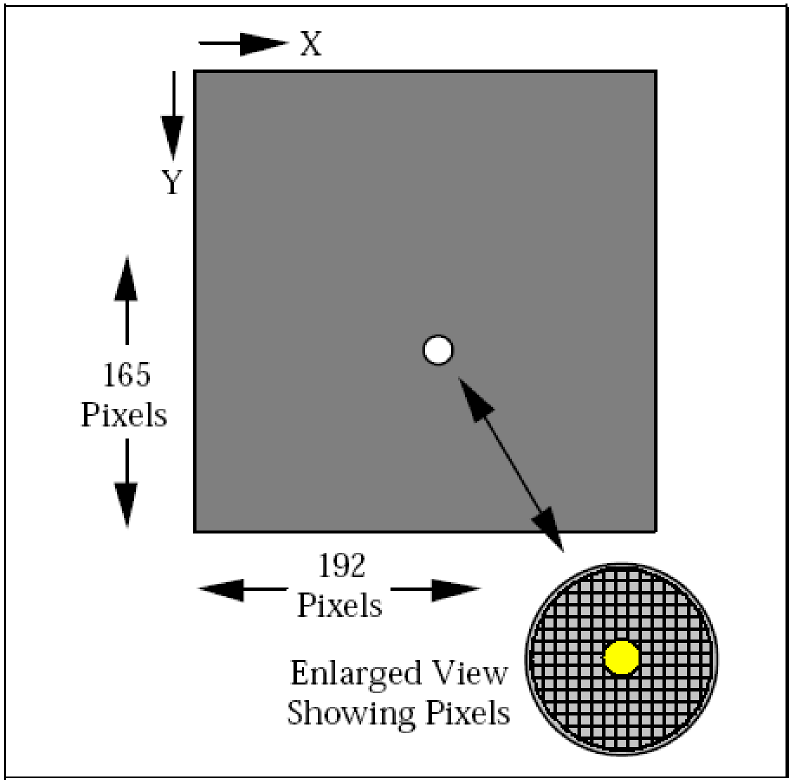




- CCD is Charge-Coupled Device
- Light sensitive “pixels”
- Individual pixels retain charge proportional to the light that strikes them and this charge is converted into digital data

SBAG 1985 - 1989

ST-4 GRB monitoring



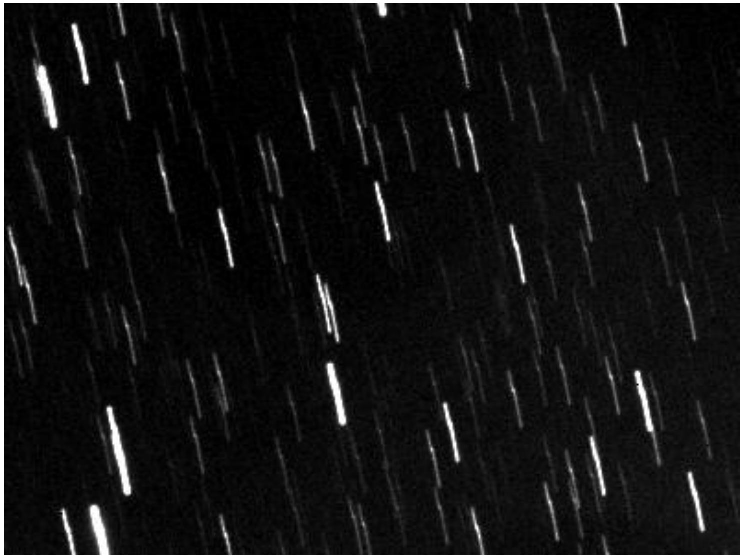
SBAG 1985 - 1989

ST-4

- IBM 286 with 640K memory
- 20 Meg hard drive
- 10 megahertz clock speed, and
- EGA graphics (16 "gray" levels)

SBAG -> SBIG 1989

No Guiding



Autoguiding

- We found that the guiding accuracy was better than we needed – down to 1 arc second or better and this was good enough for astrophotography. (penny at 2.5 miles)
- We set up a partnership (later a corporation) and went into business selling the ST-4 to astrophotographers. **SBAG became SBIG -> Santa Barbara Instrument Group**.
- Why not use the CCDs to IMAGE as well?

SBAG -> SBIG 1989

First commercial version of the ST-4

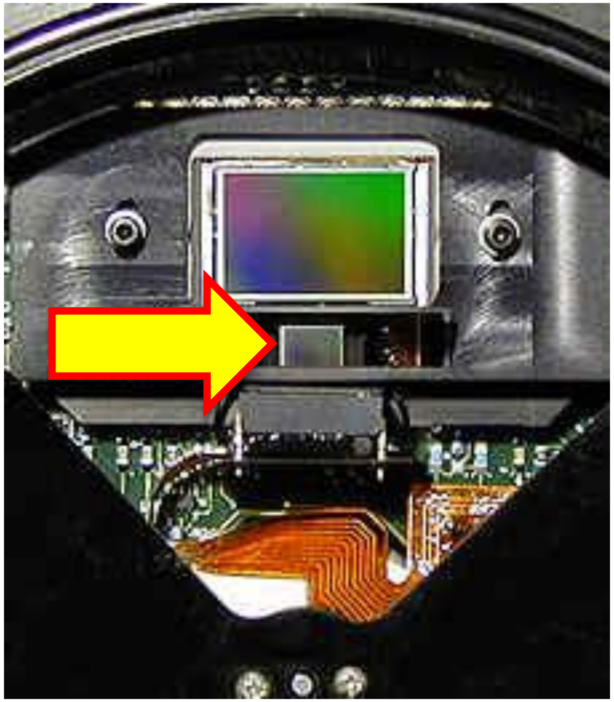
SBAG became SBIG, Inc. to sell the ST-4 commercially to astrophotpgraphers

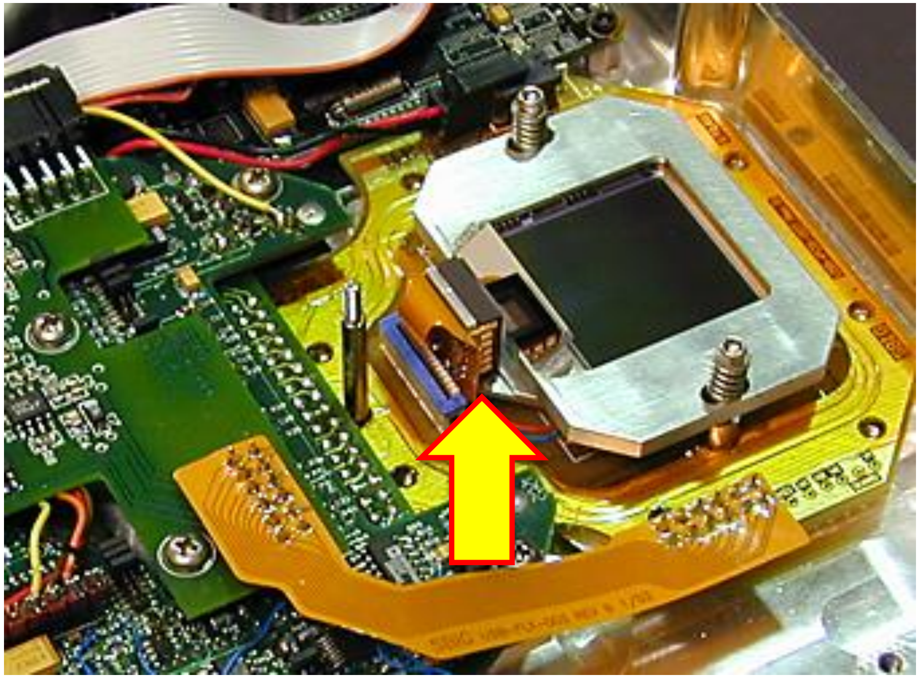
SBIG 1989 - 2014

Other guiding and imaging products followed next 25 years

SBIG 1989 - 2014

Self-guiding design combined guiding and imaging by using two CCDs in the same head. The smaller CCD is read out every second or so for guiding and the larger CCD is allowed to integrate for a long time to collect as much signal as possible. SBIG received a patent on this design in 1994





SBIG 1989 - 2014

“Hot Products” started 16 yrs ago

SBIG has received the award 17 times

SBIG 1989 - 2014

In 2013 Astronomy Magazine will began announcing a "Star Products" award with the September issue.

Astronomy
magazine
2013 Star Products

The SBIG Model STF-8300 was selected as one of the Star Products for this first issue.

SBIG 1989 - 2014

1989 ST-4 First Stand-Alone Autoguider
1992 ST-6 Track & Accumulate Patent
1994 ST-7/8 Self-Guiding Patent
1997 AO-7 First AO for amateurs imaging deep space
2000 STV First Stand-Alone Video Autoguider
2001 ST-10ME First camera for amateurs with ME CCD
2003 STL-11000 Introduced 35mm format CCD, ST-10XME
2004 AO-L Adaptive Optics for STL cameras
2006 Meteor Camera, Seeing Monitor
2008 AO-8 2nd Gen. AO for ST cameras – under $1000
2009 SG-4 Stand-alone “Smart” Autoguider
2010 ST-i Autoguider and Planetary imager, ST-8300 8.3 Mp < $2k
2011 STF Series cameras - Differential guiding patent granted
2011 STT Series cameras
2012 STXL Series cameras
2013 AO-X Adaptive Optics for STXL and STX cameras
2014 SBIG acquired by Diffraction Limited – SBS incorporated to handle production in California during asset and technology transfer to Canada