

Tolimesni dangaus kūnai

Žvaigždės, ūkai, galaktikos

Kokie nauji atradimai?

Ką šioje srityje nuveikė Lietuvos
mokslininkai?

Kas nepaminėta, pasakojant apie Saulės sistemą?

- Lietuvos astronomai atrado nemažą skaičių asteroidų ir kometų.
 - Šios srities pionierius K. Černis
 - Pavyzdžiui, vien 2004 metais jis atrado 54 asteroidus ir 3 kometas
 - 2006 metais atrastas pirmasis pavojingas Žemei asteroidas 2006 SF77 (K. Černis, J. Zdanavičius, K. Zdanavičius), 200 m diametro Atonų grupei priklausantis asteroidas skrieja orbita tarp Žemės ir Saulės ir apie Saulę apsisuka per 325 d.
 - 2007 m. egzoplanetos atradimas, prie kurio pirmą kartą prisidėjo Lietuvos mokslininkas. Rimvydas Janulis, naudodamas Molėtų astronomijos observatorijos 165 cm teleskopą, su bendraautoriais atrado planetą prie subnykštukės V391 Pegasi.
 - 2007 m. pirmą kartą pagal didelės skiriamosios gebos spektrus ištirta netaisyklingoji nykštukinė Vietinės grupės galaktika IC 1613. Tai ketvirtoji tokio tipo galaktika, ištirta detalių spektrų metodu.
 - 2008 m. atrastas pavojingas Žemei Apolono grupės NEO asteroidas 2008 OS9.

Klausimėliai!

- Ar ieškome atsakymo į klausimą:
 - koks yra pasaulis (kokie objektai jį sudaro)
 - kaip jis tokis susikūrė (ir kaip jis kito, kinta)?
- Mes – kosmoso dalis.
 - Kokie procesai vyksta kosmose?
 - Kokios vyksmai, virstantys kosminėmis katastrofomis gali paliesti (jutraukti) Žemę?
 - Ar yra būdai, kaip jų išvengti ar apsisaugoti?
 - Ar yra ankstesnių katastrofų pėdsakų?

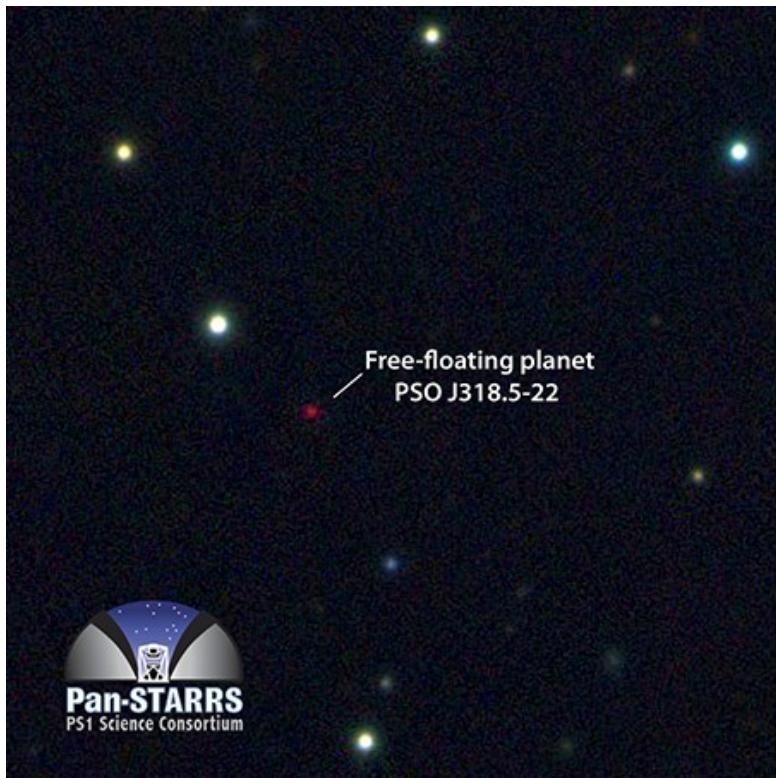
Gal naujausias atradimas?

(paskelbtas 2013.10.01)

(Lietuvoje apie tai delfi.lt informavo 2013.10.11)

Planeta, ar supermaža neįsižiebusi žvaigždutė:

PSO J318.5-22



Už 80 šviesmečių laisvai skriejantis dangaus kūnas, atrastas IR spinduliais *NASA Infrared Telescope Facility and the Gemini North Telescope*



Taip ją išsivaizduoja dailininkas
(Credit: MPIA/V. Ch. Quetz)



FPI, prof.J.Vaitkus

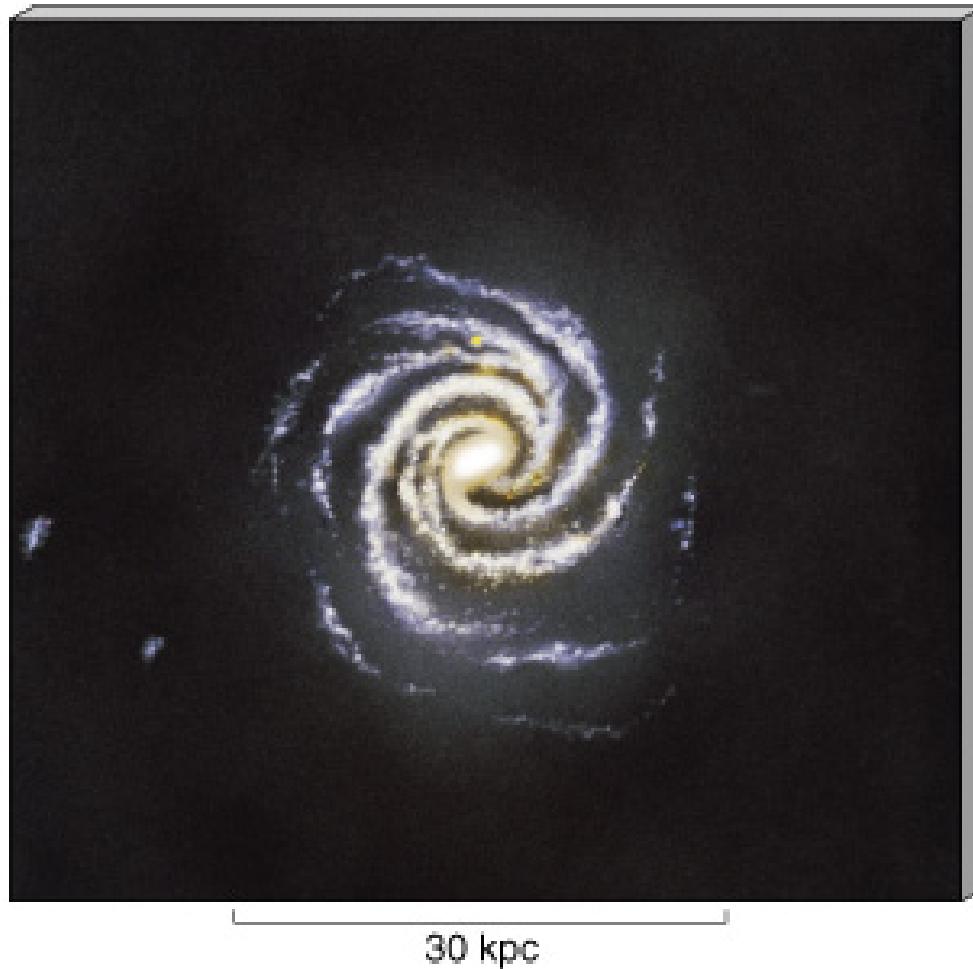
Žvaigždžių tyrimas

- Spektrai ir fotometrija
 - Lietuvos astronomų indėlis:
 - Sukurta Vilniaus fotometrinė sistema leidžianti tirti silnus šviesos šaltinius (kurių nepajégiamą tirti spektriniais metodais).
 - 2008 m. nustatytas 609 Didžiojo Magelano Debesies galaktikos spiečių fotometrinis metalingumas. Ištarta, kad šiaurinėje Didžiojo Magelano Debesies disko dalyje spiečių metalingumo pasiskirstymas skiriasi nuo stebimo kitose šios galaktikos vietose.
 - prof. habil. dr. Vytauto Straižio ir habil dr. Gražinos Tautvaišienės - rekomendacijos dėl naudotinų fotometrinių sistemų priimtos ir patvirtintos Europos kosminės agentūros orbitinės observatorijos GAIA moksliniame komitete.

Kas toliau?

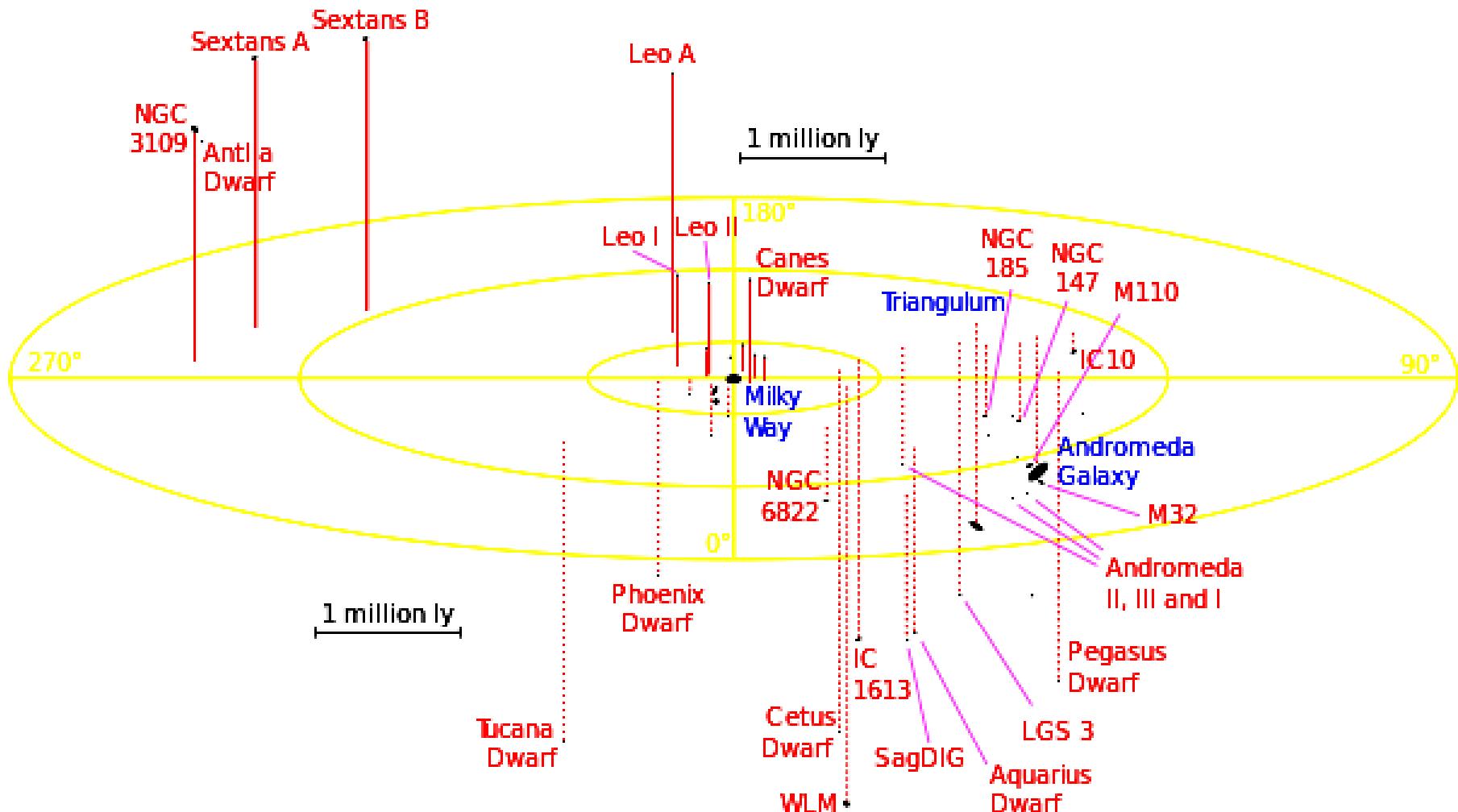
- Truputis naujovių, kas šiek tiek dramatizuojant Žemės situaciją,
- O toliau – bendrojo lavinimo dalykai, todėl stengsiuosi prašokti tiek greitai, kiek jūs leisite ...

Mūsų galaktika – nesenas įvaizdis

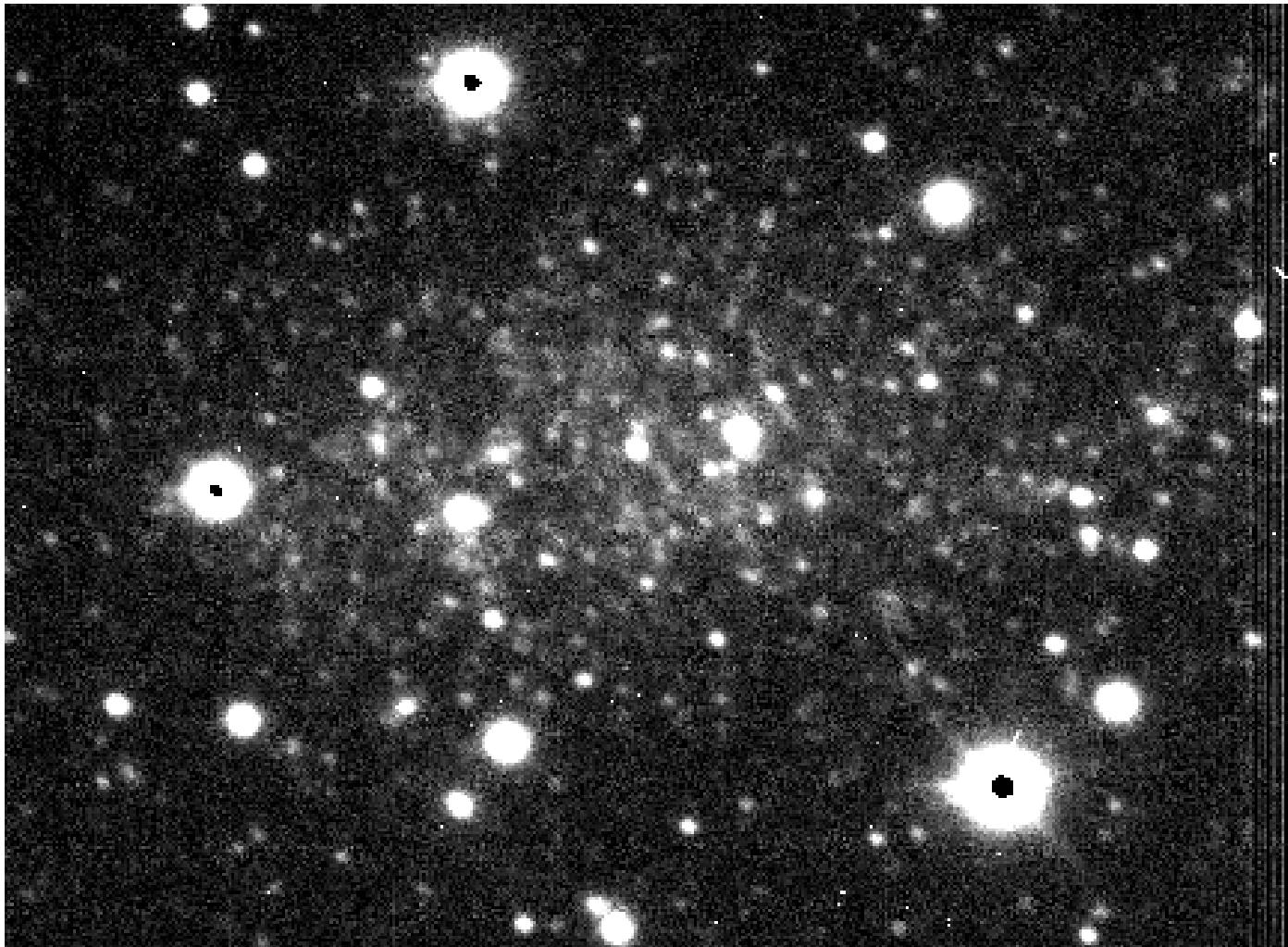


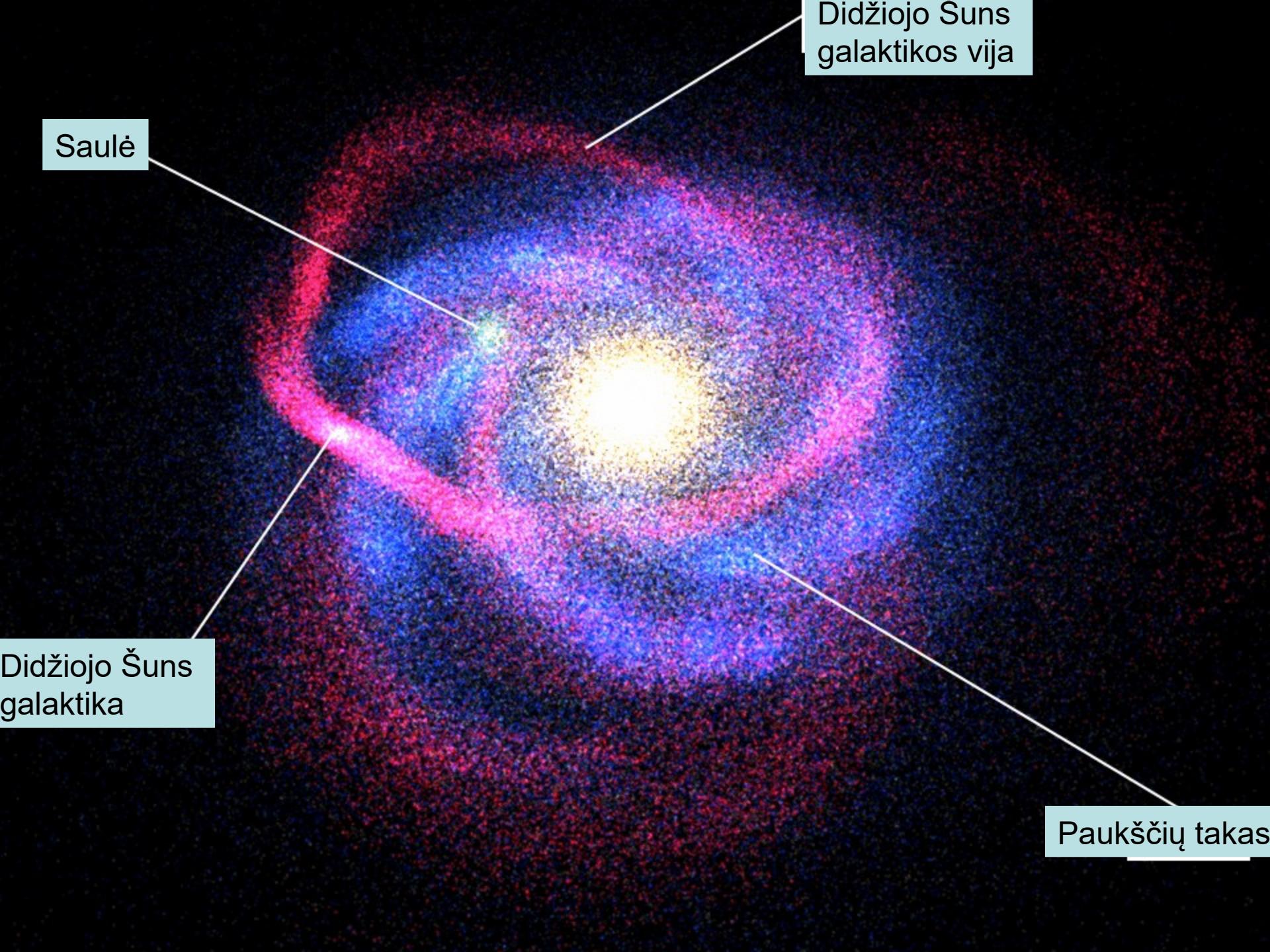
Artimiausios galaktikos (Vietinė grupė)

Local group (clickable map)



Artimiausia mažoji galaktika -Sagdwarf -1996



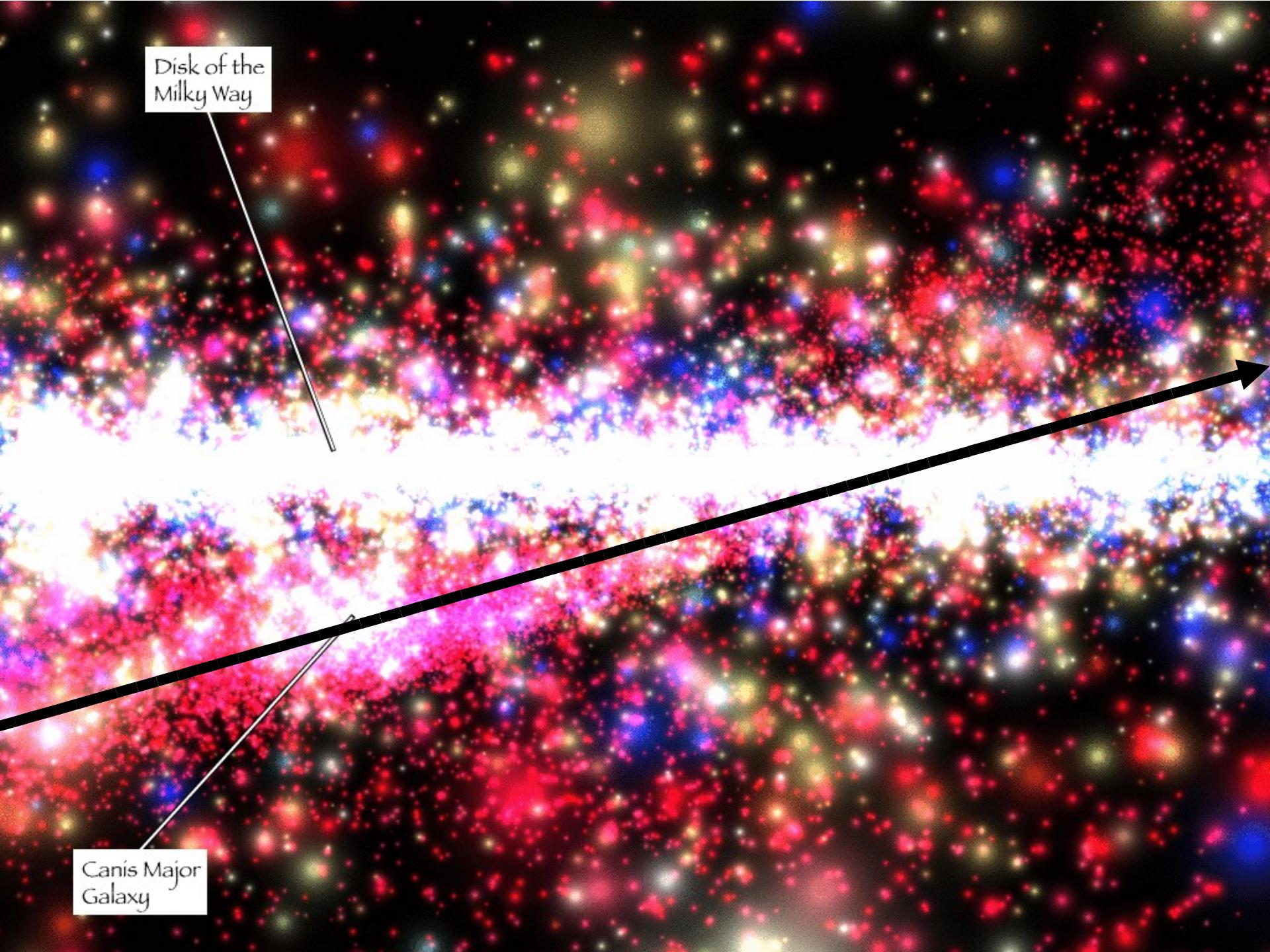


Didžiojo Suns
galaktikos vija

Saulė

Didžiojo Šuns
galaktika

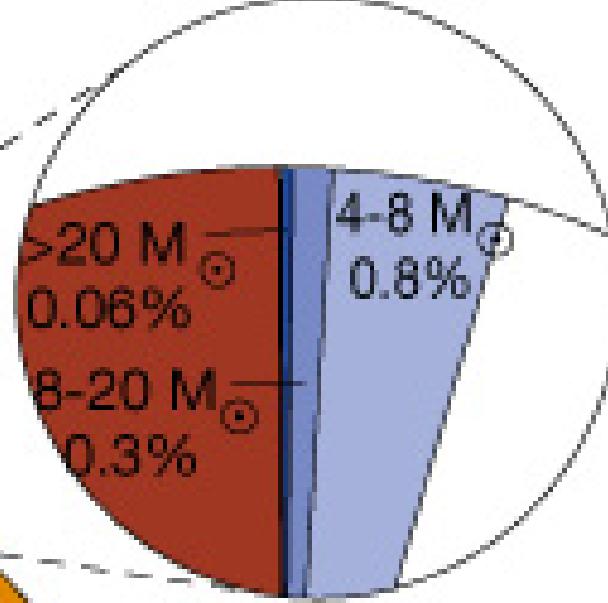
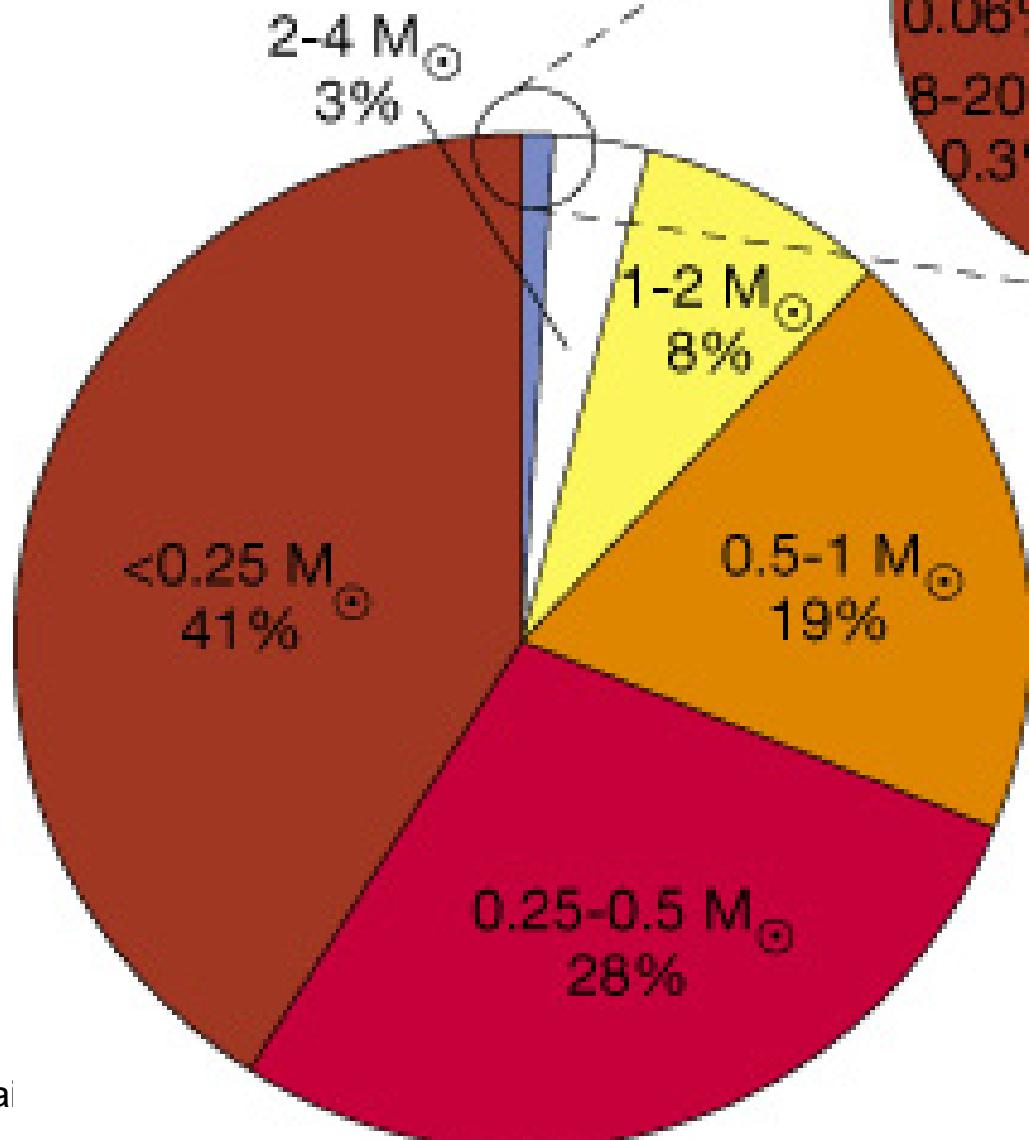
Paukščių takas



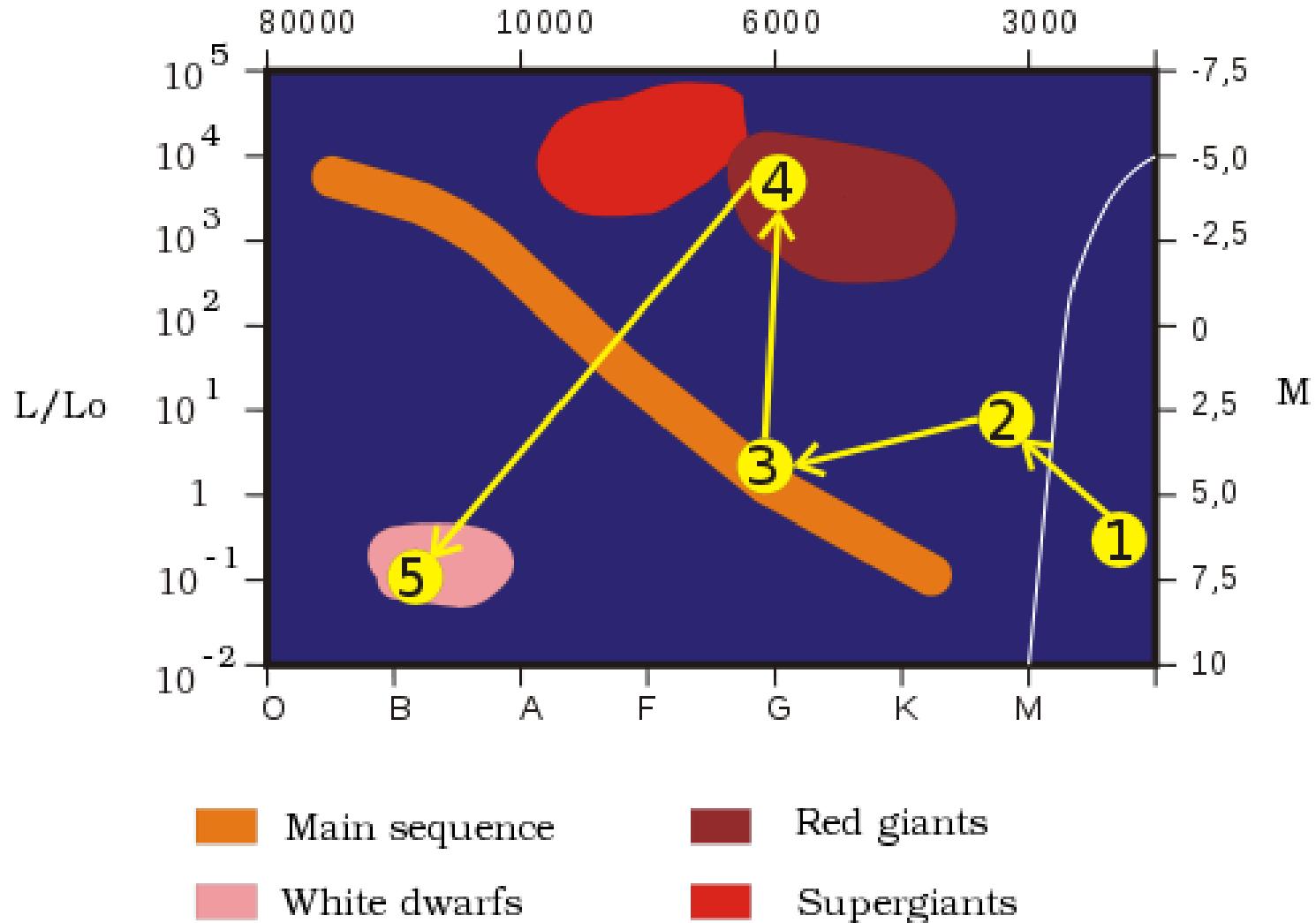
Disk of the
Milky Way

Canis Major
Galaxy

Žvaigždžių statistika

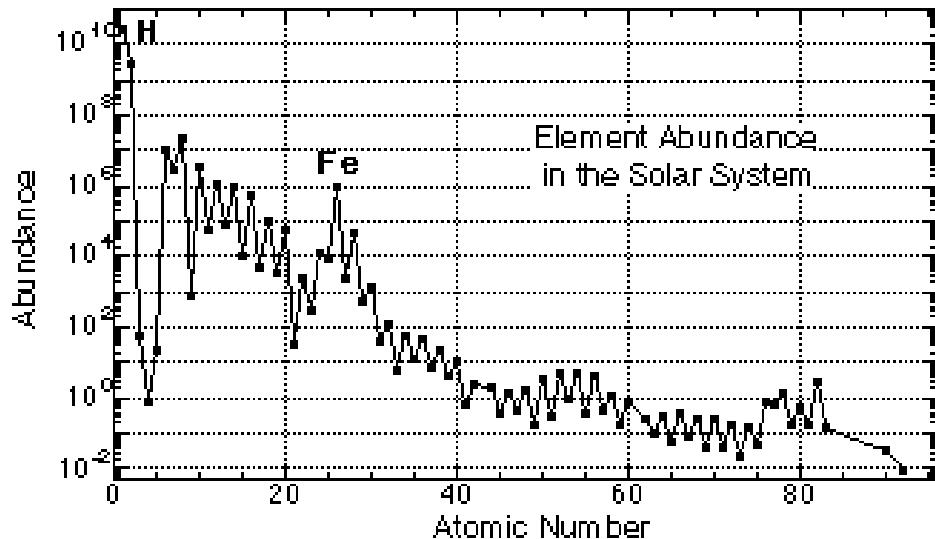


Žvaigždžių “statistika”



Cheminis dangaus kūnų sąstatas

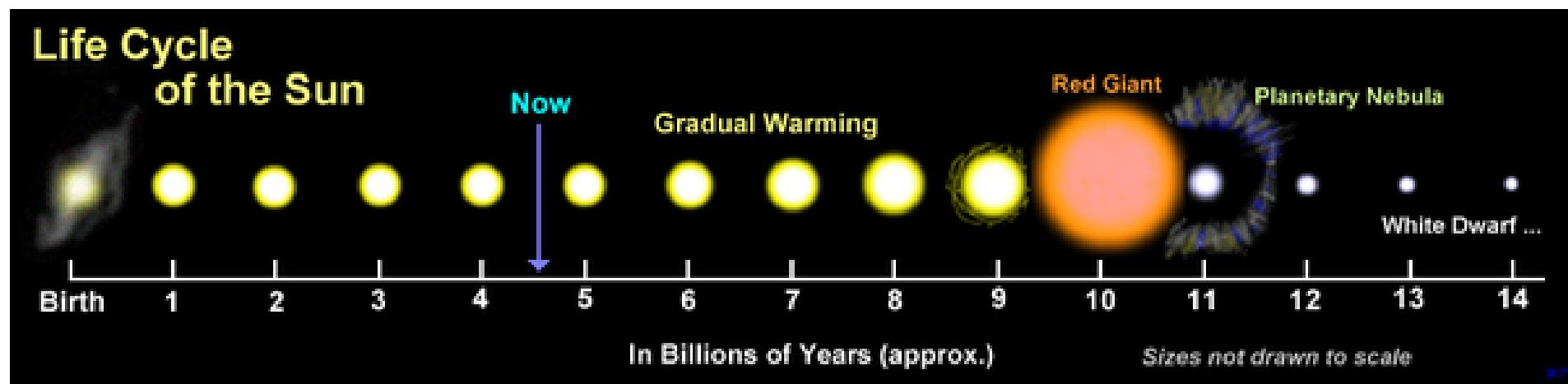
- Seniausiųose objektuose
 - Vandenilis ir helis,
 - *Pédsakai* ličio ir berilio
- Visata:
 - Vandenilio ~ 80%,
 - helio ~ 20%,
 - Visi kiti < 1%



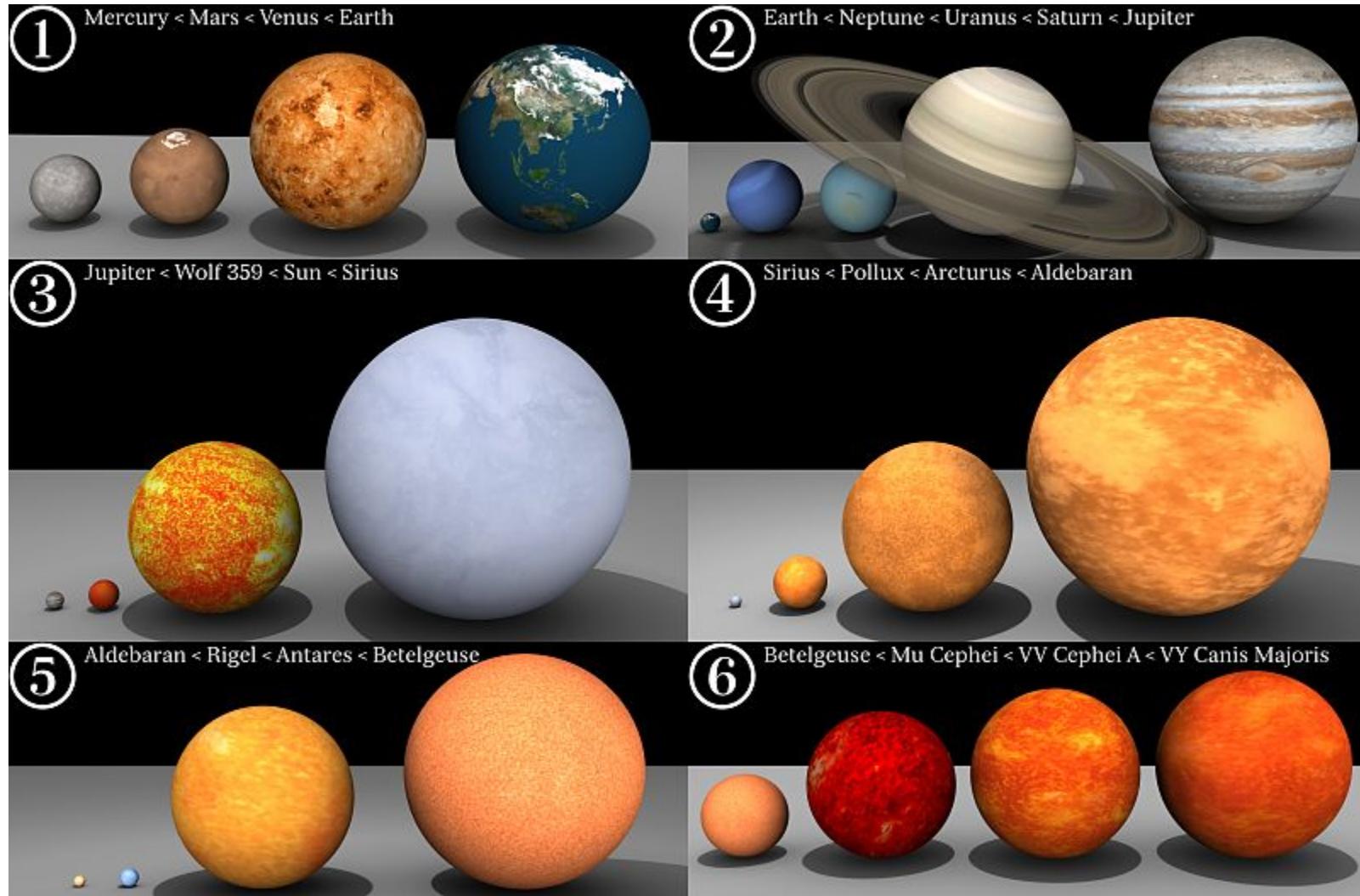
Saulė:

–Vandenilio	73%,
–helio	25%,
–deguonies	0.8%,
–anglies	0.36%,
–Geležies	0.16%
–Neono	0.12%,
–Azoto	0.09%,
–Silicio	0.07%,
–Magnio	0.05%,
–Siera	0.04%
–Visa kita	0.04%

Saulės priešistorija, dabartis ir ateitis

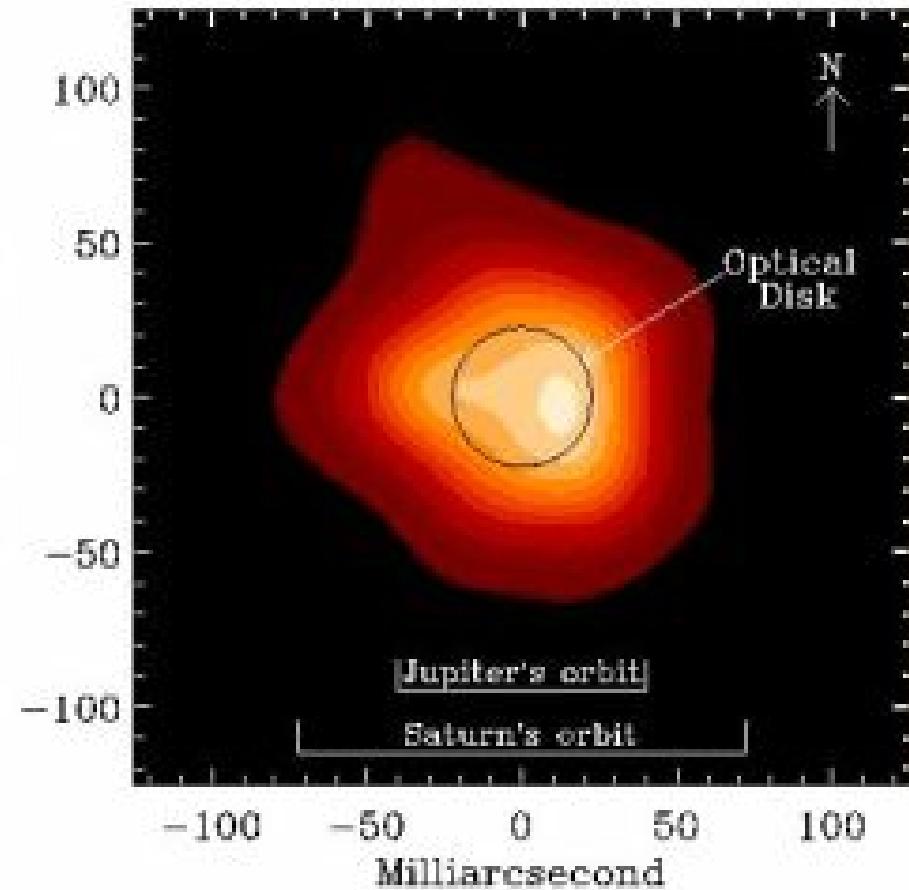
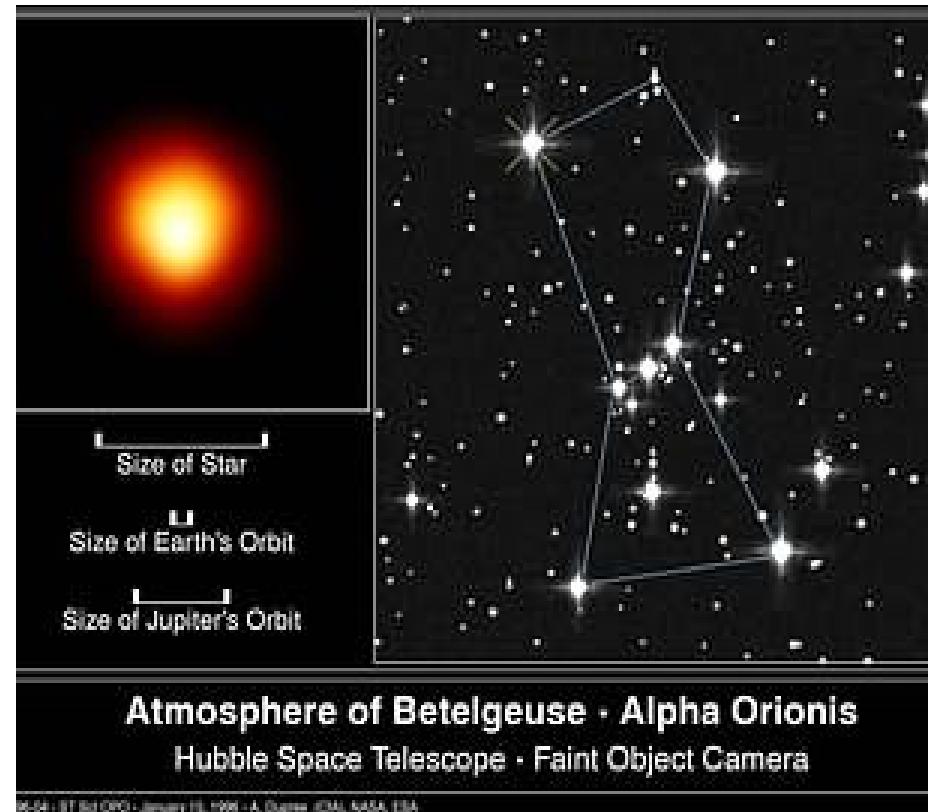


Dangaus kūnų dydžių palyginimas



Betelgeuzé

7mm Radio Image of
Betelgeuse's Atmosphere



Courtesy of J. Hiri, C. Carilli, S. M. White,
A. J. Beasley, & R. G. Marsden

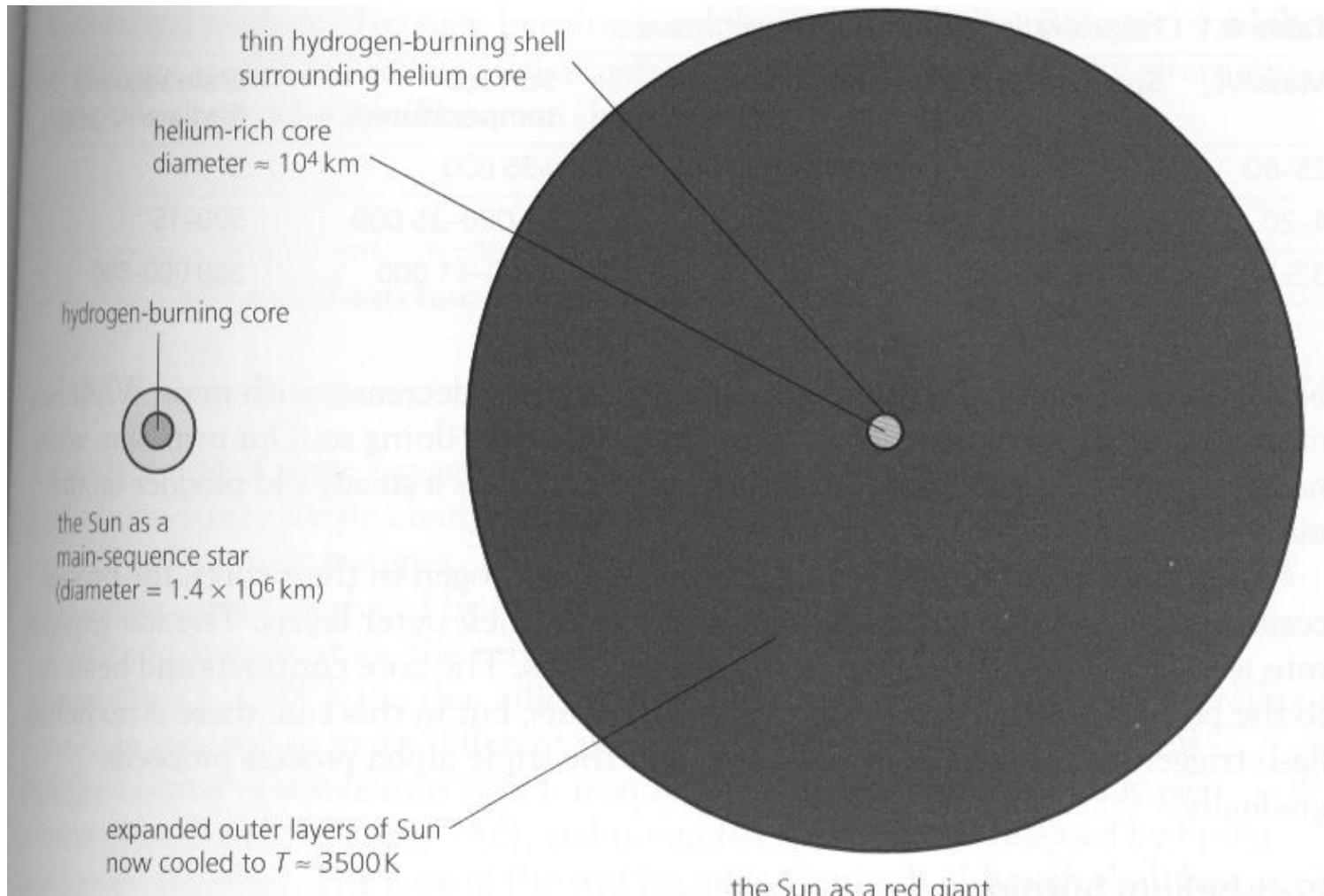
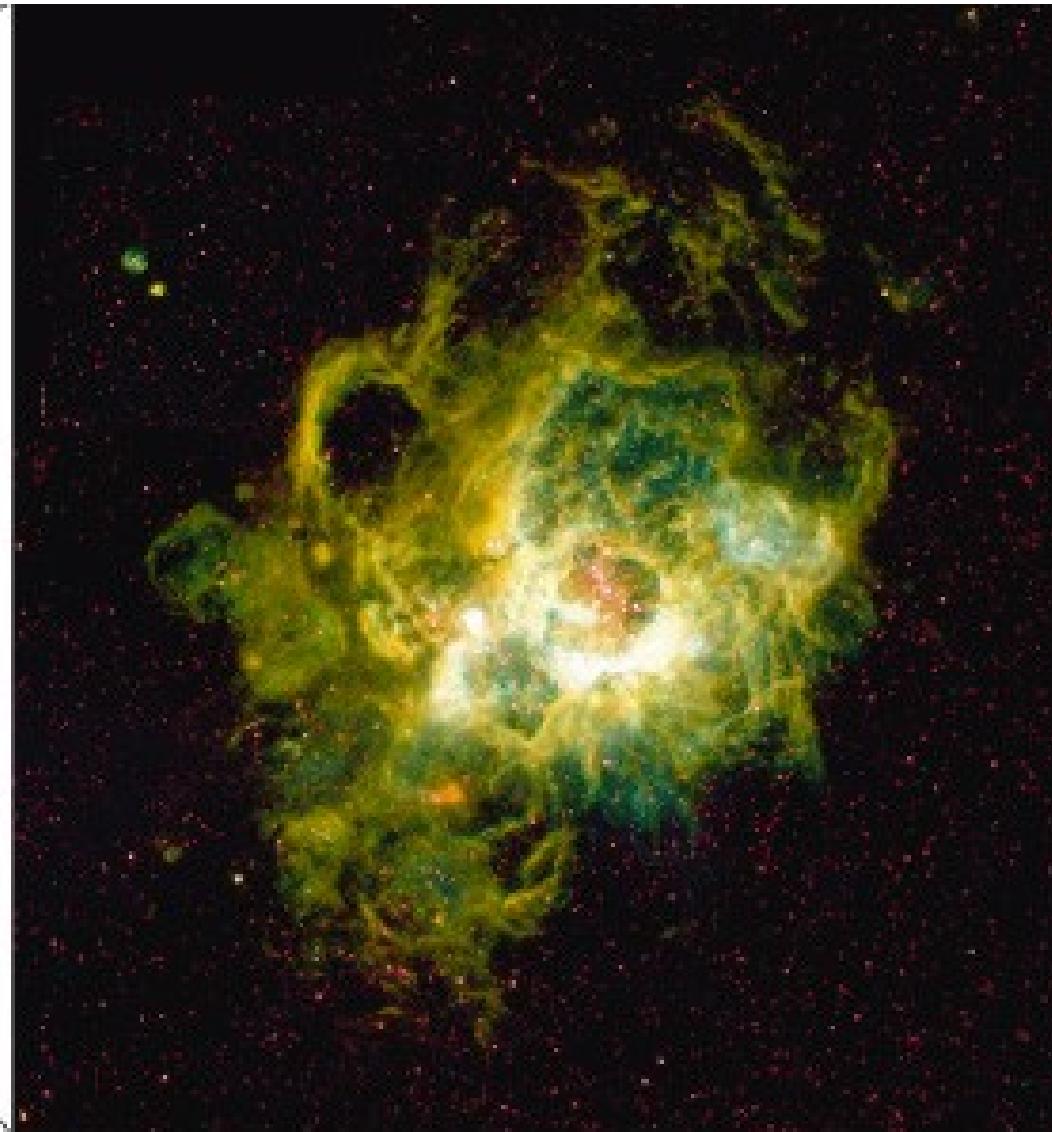
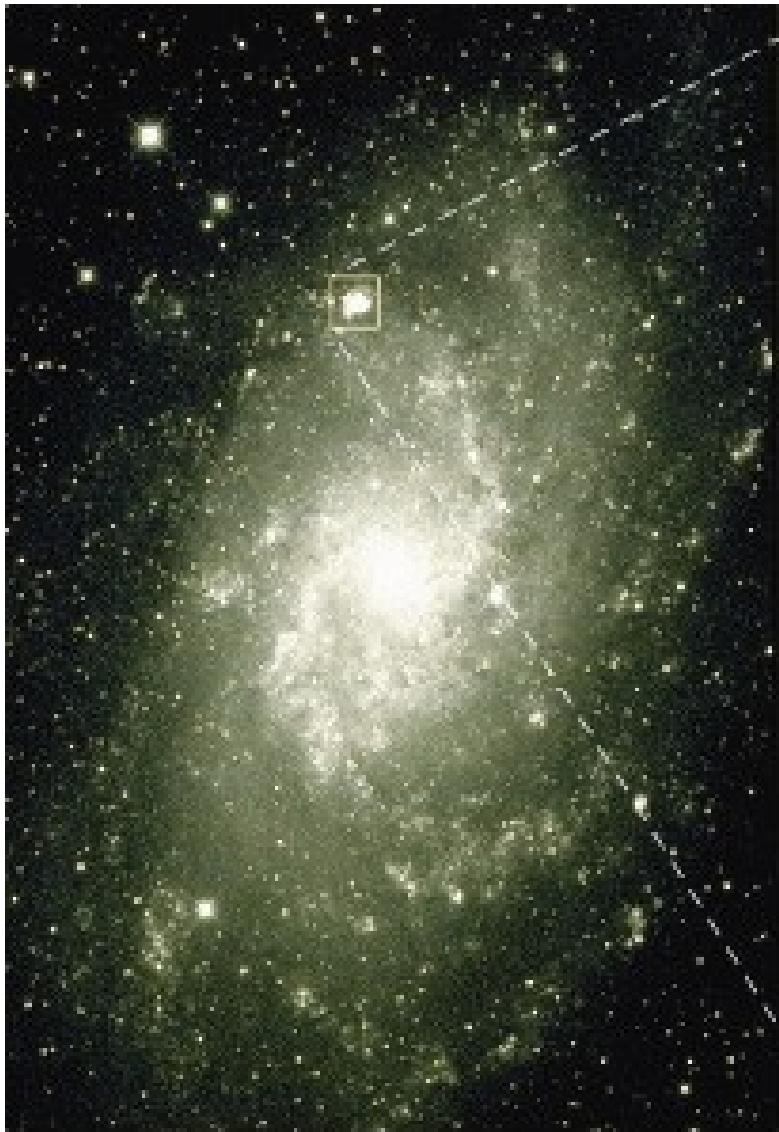


Figure 8.2 The interior of an old low mass star. Near the end of its life a low mass star becomes a red giant. Its internal structure consists of a helium-rich core with concentric shells of helium and hydrogen nuclear burning, all contained in a volume about the same size as the Earth

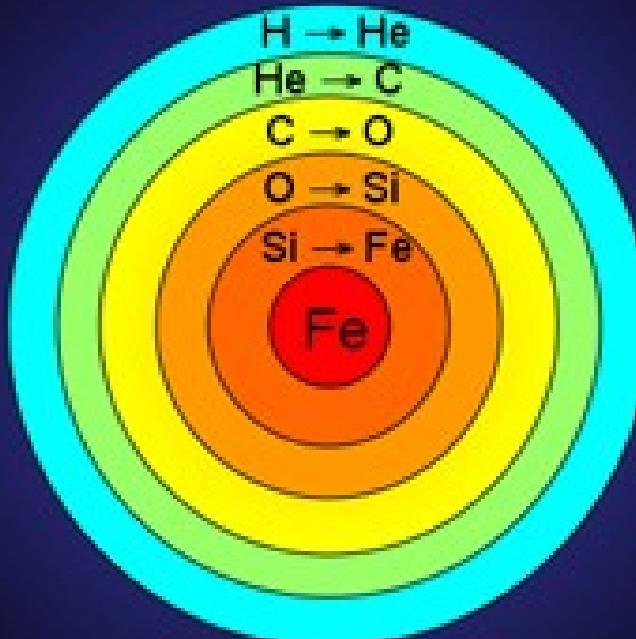
Procesai ūkuose



Supernovos

- 185, 393, 369, 386, 437, 827, 902 NE metais kinų astronomai pažymėjo, kad atsirado ryškios žvaigždės (šviesdavo iki 8 mén ar trumpiau).
- 1006 m. supernova pastebėta Vilko žvaigždyne. Ją matė Kinijos, Egipto, Irako, Italijos, Japonijos, Šveicarijos, gal ir Prancūzijos, Sirijos ir Šiaurės Amerikos stebėtojai.
 - Egiptietis astrologas Ali bin Ridwan nustatė, kad šios žvaigždės ryškis prilygo $\frac{1}{4}$ Ménulio ryškio.
 - Dabartiniai astronomai nustatė, kad ši supernova sprogo „arti mūsų“, tik 7,100 šviesmečių atstumu
- Supernovą 1054 m. stebėjo **arbai, kinai ir japonai**. Ją matė Tauro žvaigždyne, sutapatinama su Krabo ūku. Jos ryškis buvo 4 kartus didesnis už Veneros ir buvo matoma 23 dienas. (Wikipedia)

Didelės žvaigždės: elementų sintezė

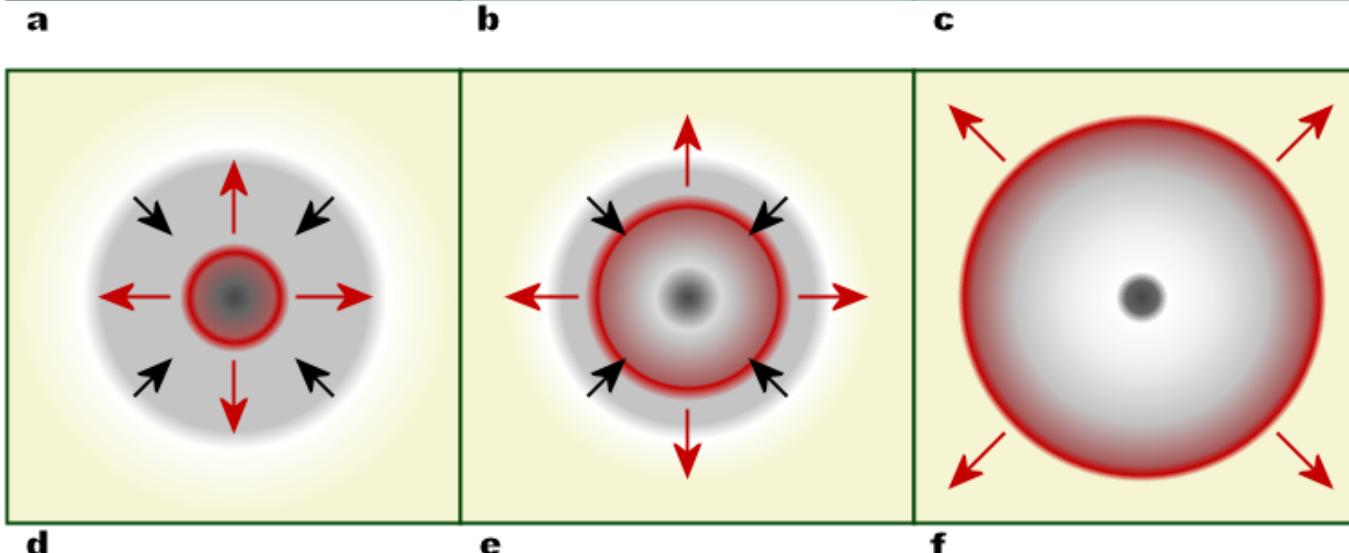
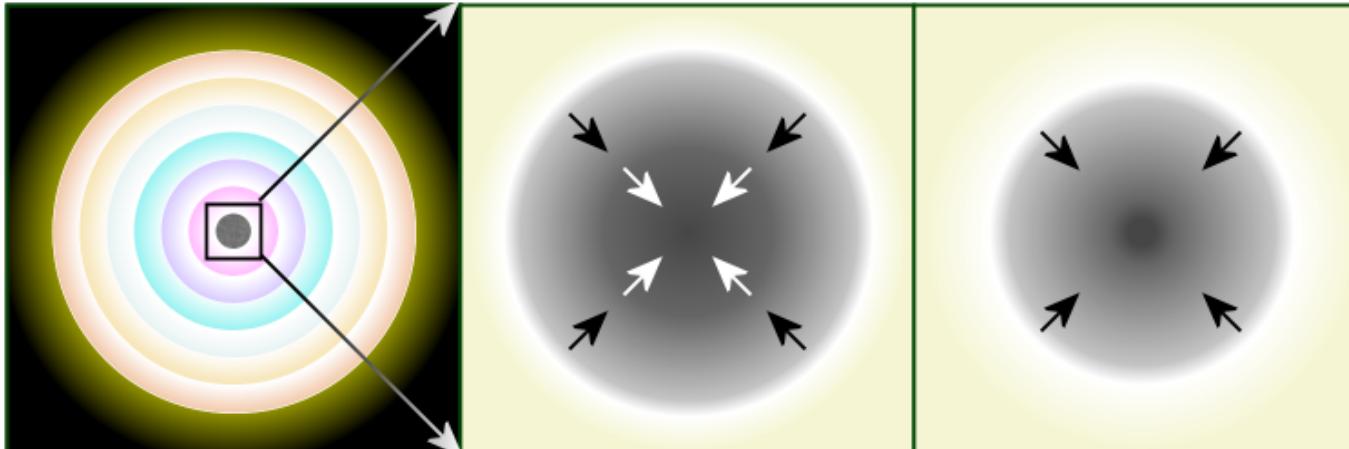


For a 25 solar mass star:

Stage	Duration
$H \rightarrow He$	7×10^6 years
$He \rightarrow C$	7×10^5 years
$C \rightarrow O$	600 years
$O \rightarrow Si$	6 months
$Si \rightarrow Fe$	1 day
Core Collapse	1/4 second

Supernova

Viduje besiplečiančios masyvos žvaigždės (a)

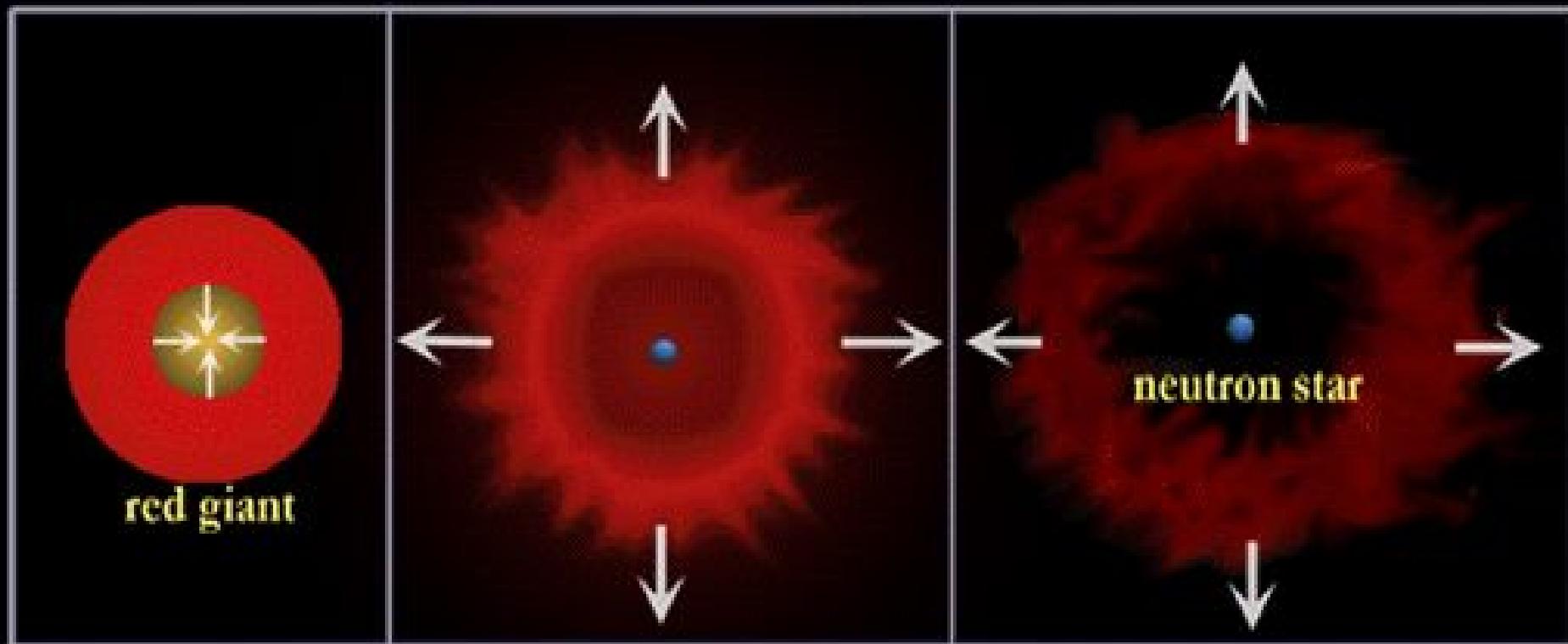


“svogūno” tipo sluoksniuose vyksta termobranduolinės reakcijos, link geležies branduolio susiformavimo (b), o pasiekus kritinę Chandrasekhar'o masę, prasideda kolapsas. Vidinė dalis suspaudžiama ir virsta neutronais (c).

Apvalkalas atšoka (d) ir sukuria besiplečiančią smūgio bangą (raudona). Ši smūginė banga lyg ir linkusi lėtėti (e), tačiau jai suteikia energiją sąveika su neutrinaliais. Išorinė medžiaga nulekia ir lieka tik “išsigimės” likutis (f).

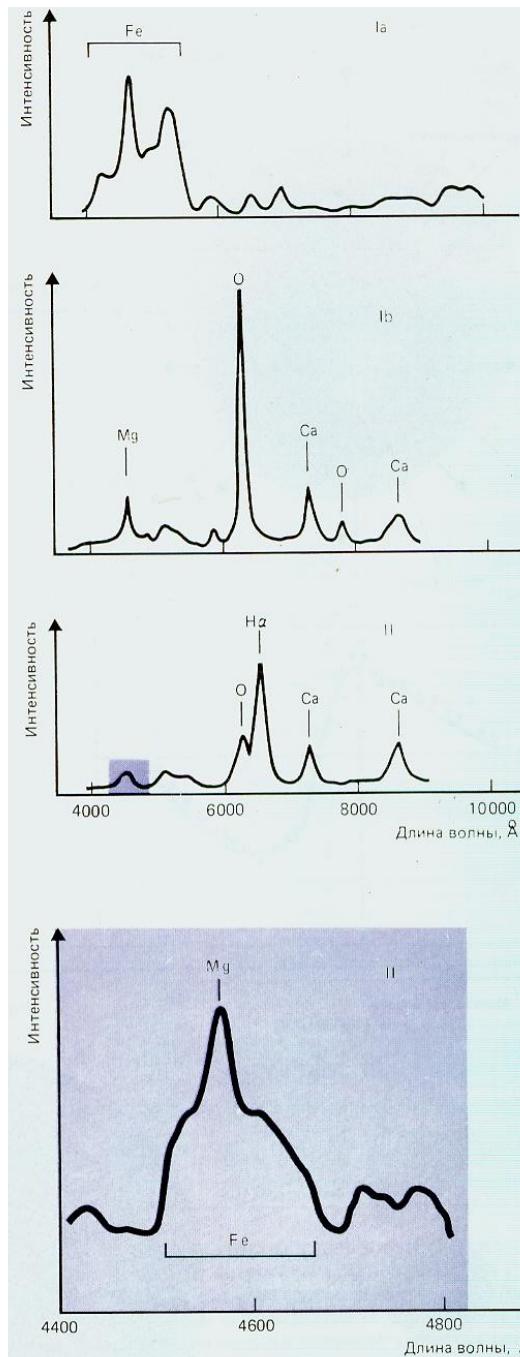
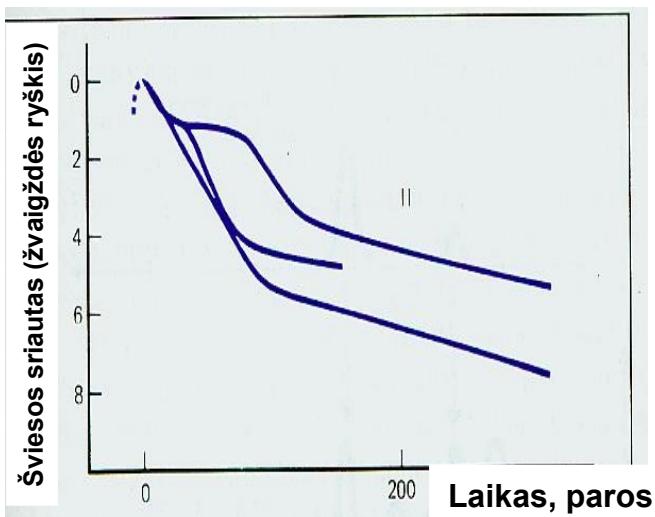
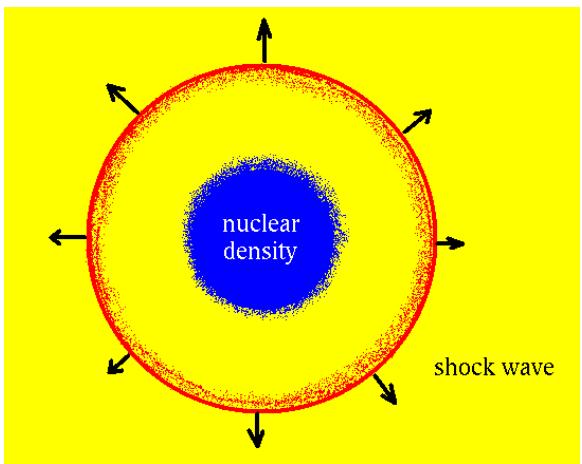
Supernovos liekana – neutroninė žvaigždė arba juodoji skylė

Birth of a Neutron Star and Supernova Remnant
(not to scale)



Core Implosion → Supernova Explosion → Supernova Remnant

Supernova



Supernovos sprogimo metu suformuojami elementai “geležies grupės”, dėka smūgio bangos sukuriams elementai iki Ni, o sunkesni formuojasi dėka neutronų srauto, kuriuos paguna sunkieji branduoliai, o neutrinali, dėka silpnosios sąveikos neutronus verčia protonais.

Sunkių elementų, kaip ^{209}Bi , atveju neutronų pagavimas vyksta vienas po kito labai greitai, kad tarpiniai produktai nesuspėja suskilti

Pulsaras – neutroninė žvaigždė

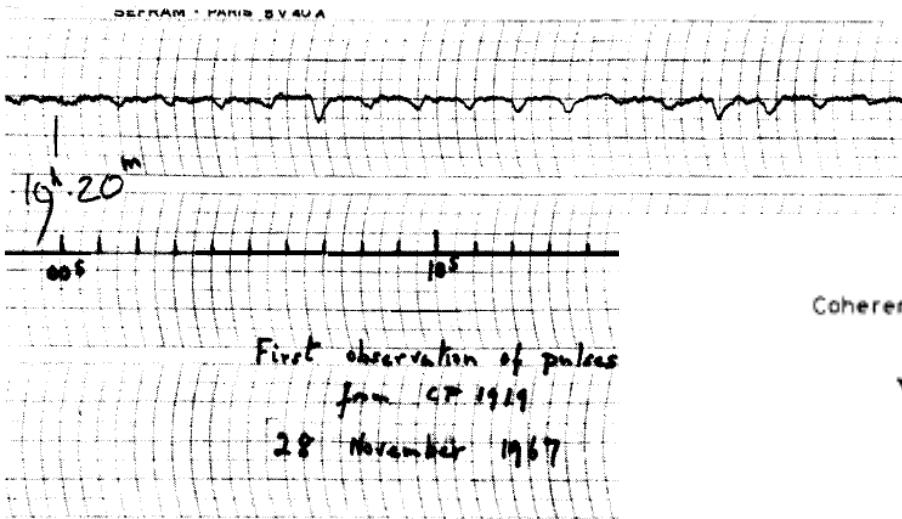


Fig. 2. The first indication of pulsed radio emission from CP 1919.

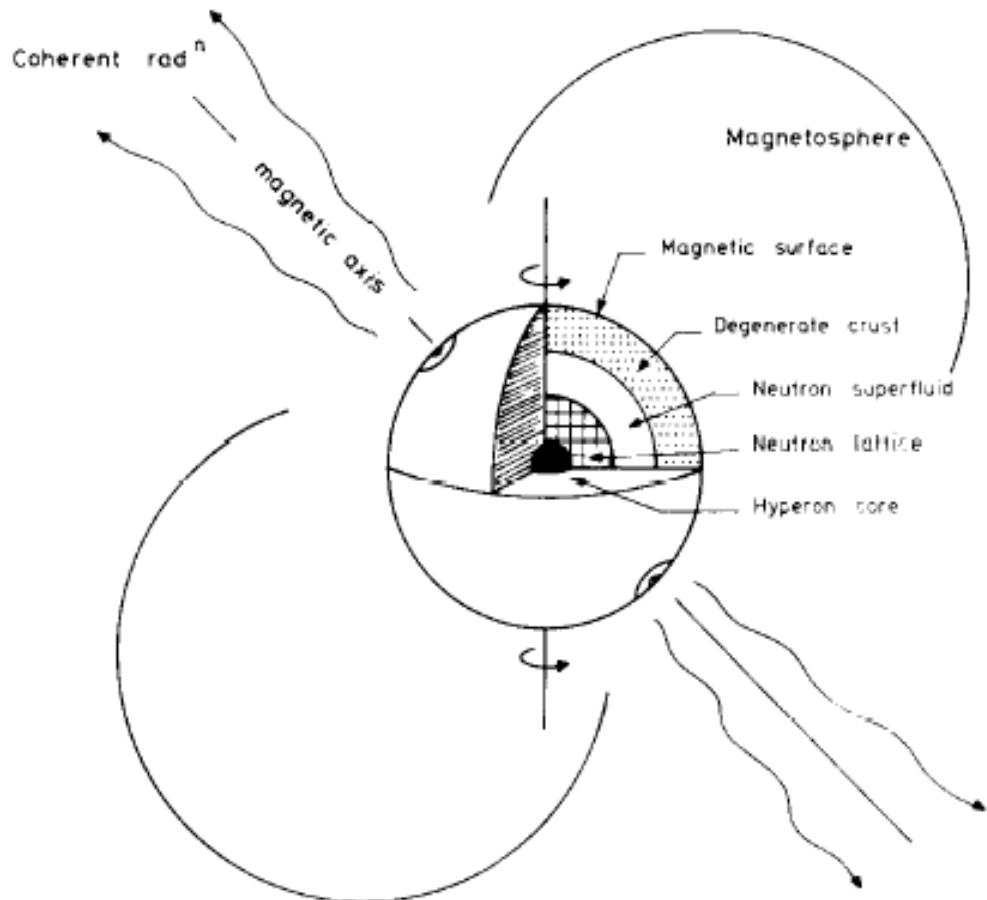
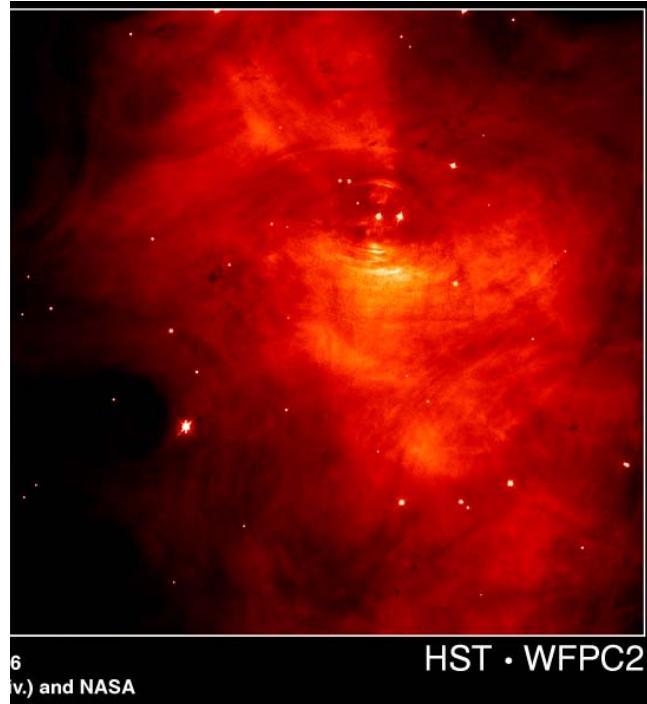
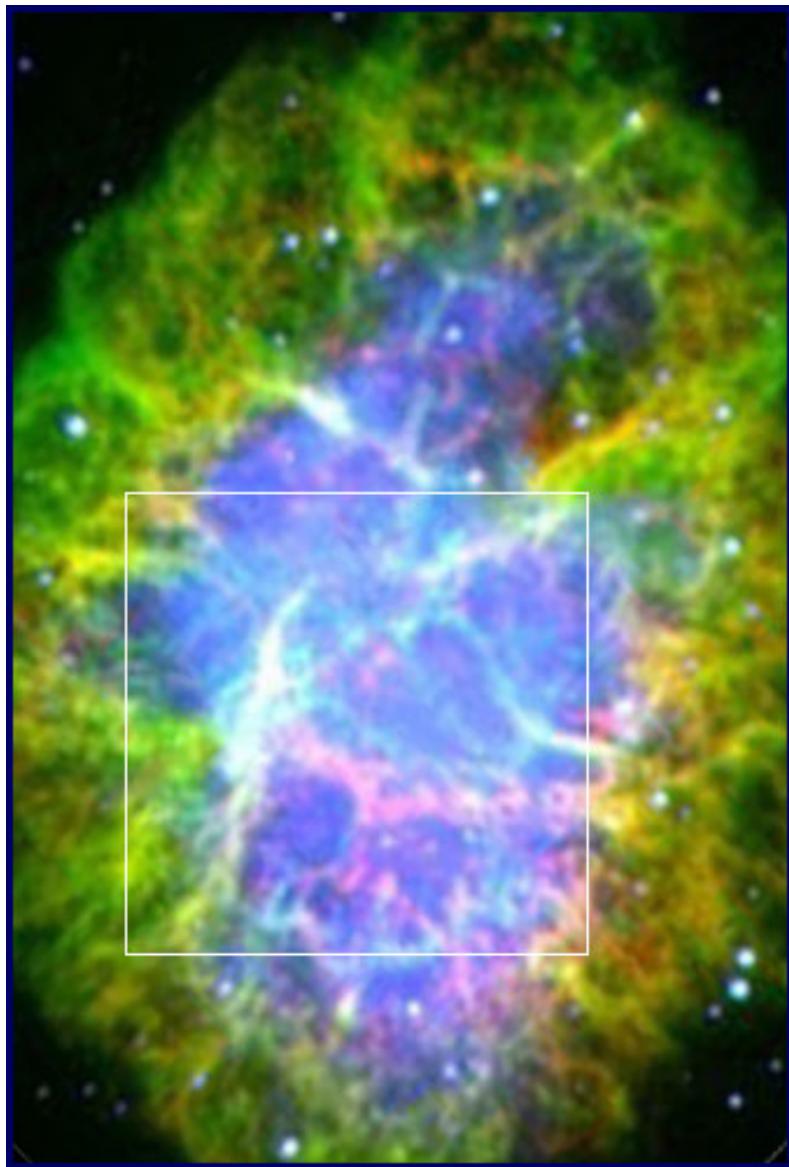


Fig. 5. Model of a neutron star.

Krabo ūkas

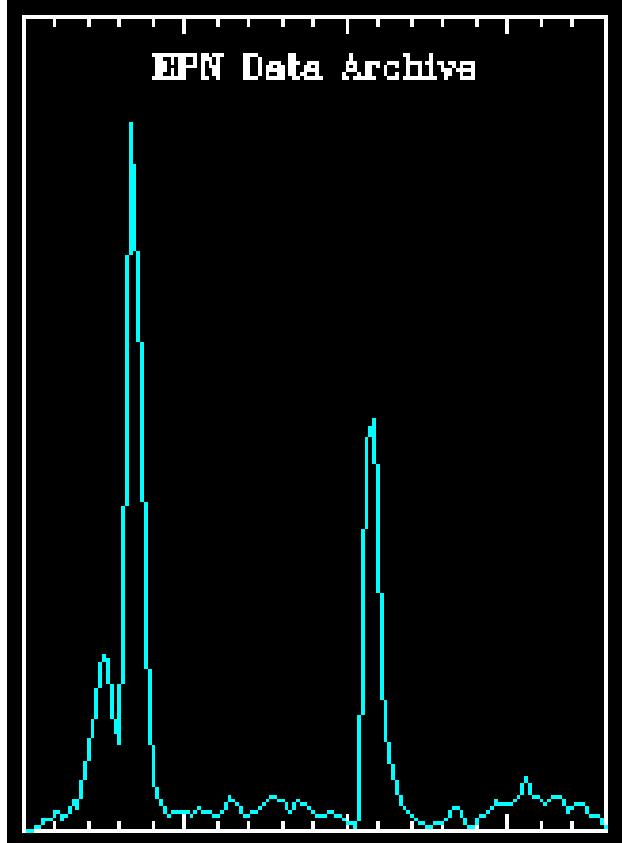


6
iv.) and NASA

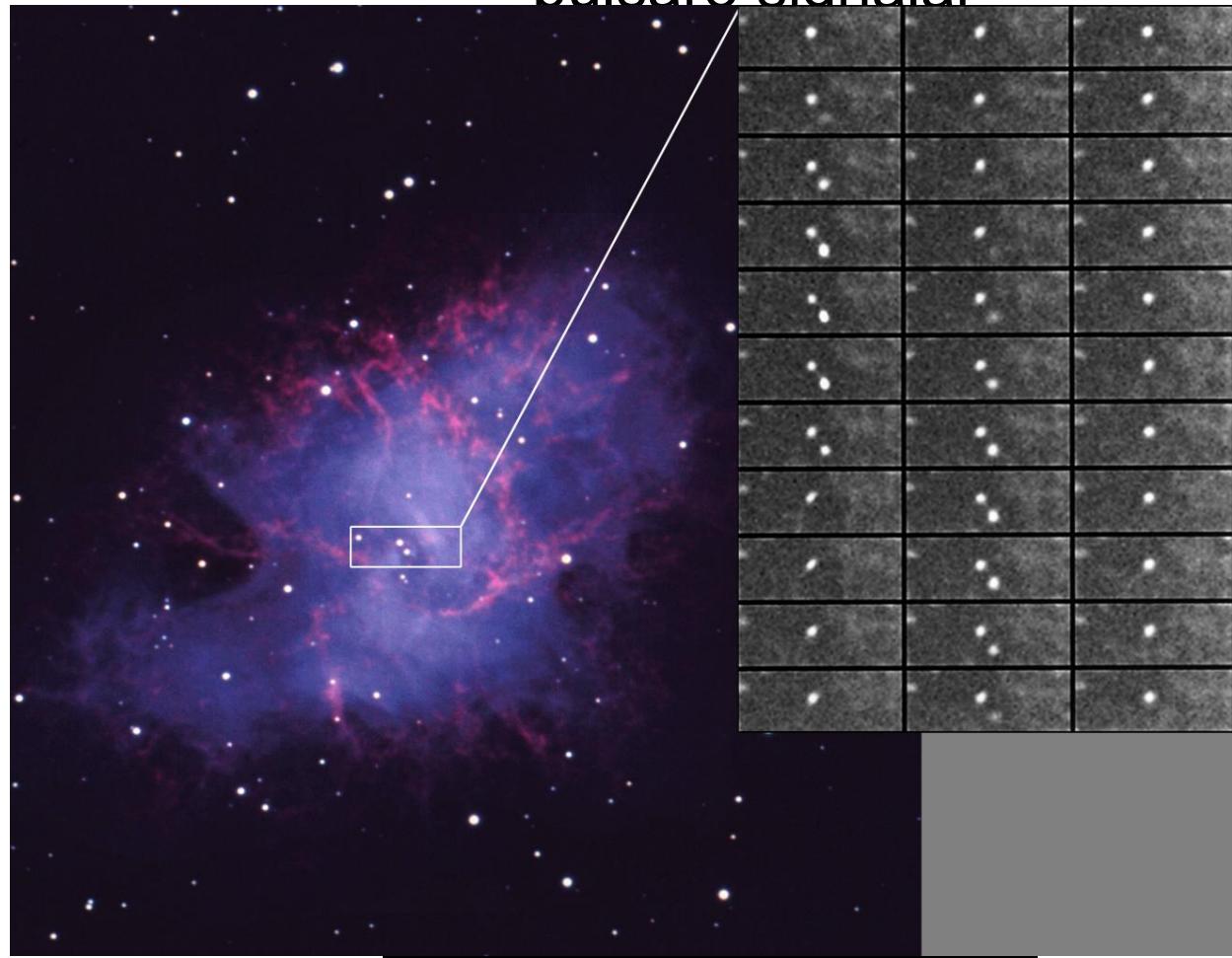
HST • WFPC2



Krabo pulsaro signalai



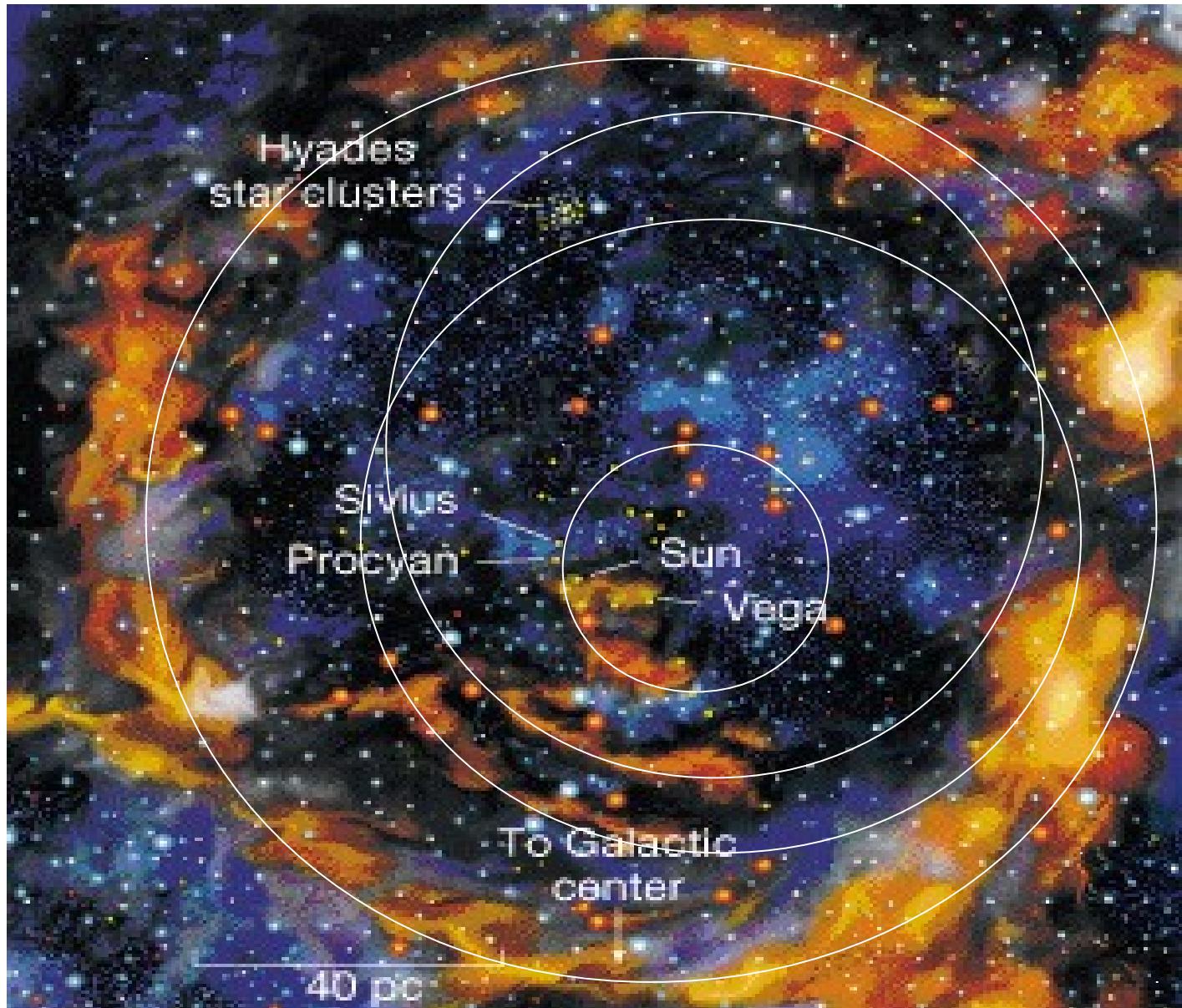
Neseniai atrasto milisekundinio pulsaro signalai



30 x per sekundę, nutolęs nuo mūsų
per 6300 šviesmečių

174 x per sekundę

Saulės aplinka



Papildymas apie supernovas

Supernovos arti Žemės yra mažai tikimos, tačiau Plioceno eroje (prieš 5,3-2,6 mln. Metų), kada gyveno **Australopitekai (3.9 -2.9 mln. metų atgal) supernovos sproginėjo dažniau.**

Jų šaltinis – tarpžvaigždiniis debesis "ScoCen", kurio kraštą užkliudė skiejanti pro šalį Saulės sistema. To dėka formavosi trumpai gyvuojančios masyvios žvaigždės, kurios sproginėjo supernovomis (like a popcorn). Prieš 5 mln. metų tas debesis buvo arčiausiai (už 130 šviesmečių).

Tas debesis iki šiol matomas už 450 šviesmečių nuo Žemės ir lekiantis Skorpiono ir Kentauro žvaigždynų link. (Scorpius and Centaurus – todėl ir jo vardas - "Sco-Cen").

Papildymas apie supernovas

Tyrėjai apskaičiavo, kad jei sprogtų supernova arčiau negu 27 šviesmečiai, tai jos debesies srautas ženkliai pakenktų gyvybei Žeméje.

Šis medžiagos srautas nesudegintų Žemės, bet sunaikintų apsauginį ozono sluoksnių, ir Saulės ultravioletiniai spinduliai būtų mirtini. Pliocene laiku sprogo toliau esanti supernova.

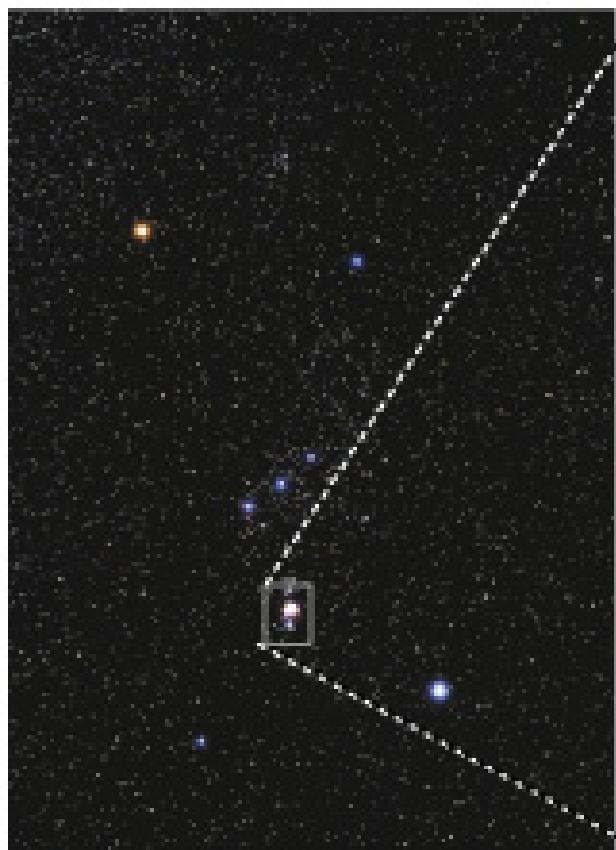
Sco-Cen poveikyje prieš 2 mln. metų daug planktono, moliuskų ir kitų UV jautrių jūros gyvių paslaptingesnai Žeméje žuvo.

Paleontologai pažymi tai kaip Pliocene ir Pleistocene epochų ribą. Tuo pačiu metu Pliocene eros metu, (ką nustatė vokiečių mokslininkai), Žemė buvo pribarstyta ^{60}Fe izotopu, sukuriamu supernovos sprogimo metu.

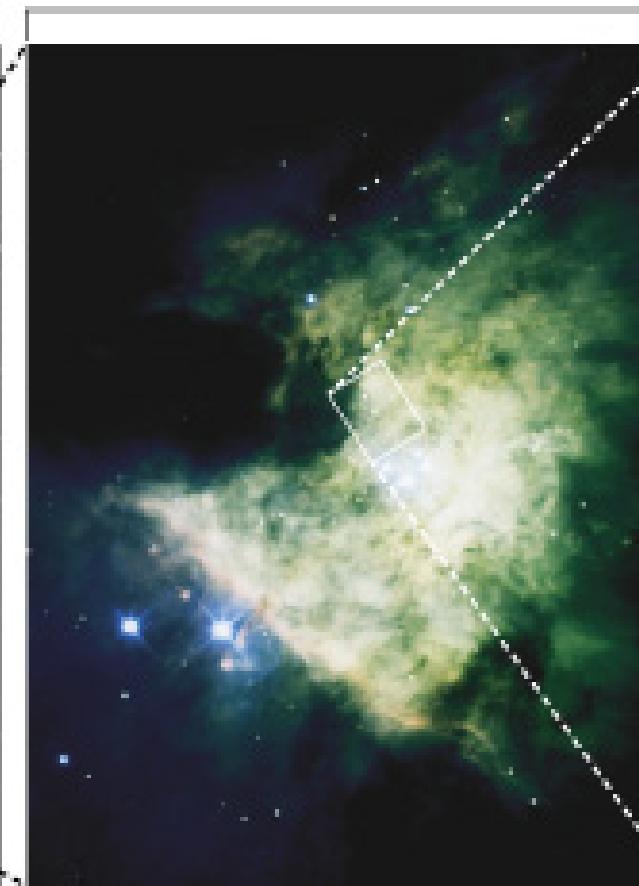
Todėl yra prasmė tirti, ar Žemei negresia supernovos sprogimas.

Atstumai iki artimiausių žvaigždžių

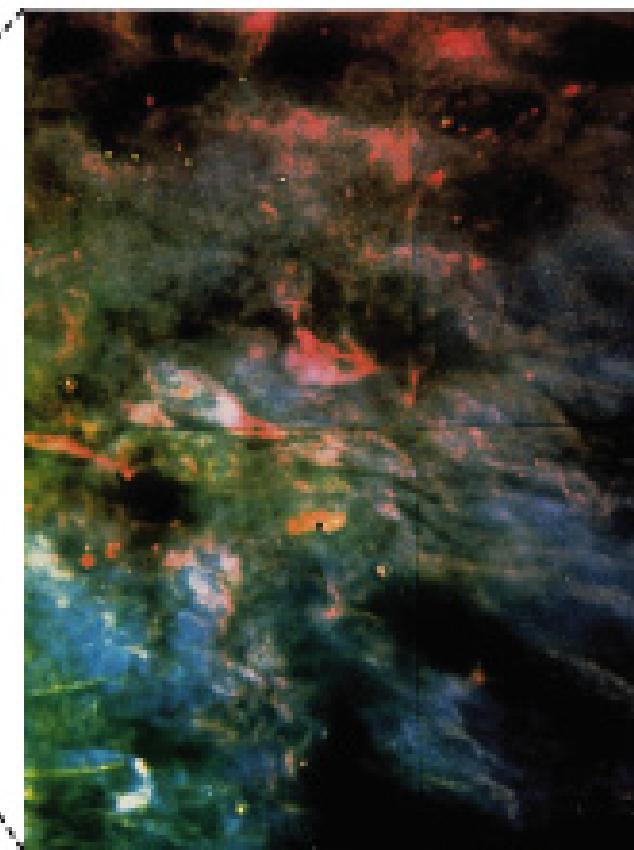
	Vardas	Atstumas parsekais	Atstumas šviesmečiais	Matomas ryškis	Absoliutus ryškis	Žvaigždynas
1	Proxima Centauri	1,30	4,24	11,10	15,53	Kentauro
2	Alpha Centauri A	1,33	4,35	-0,01	4,37	Kentauro
3	Alpha Centauri B	1,33	4,35	1,34	5,72	Kentauro
4	Barnard's Star	1,83	5,98	9,54	13,23	Gyvatnešio
5	Wolf 359	2,39	7,78	13,46	16,57	Liūto
6	Lalande 21185	2,53	8,26	7,48	10,46	D.Grižulo ratu
7	Sirius A	2,62	8,55	-1,46	1,45	Didžiojo šuns
8	Sirius B	2,62	8,55	8,44	11,34	Didžiojo šuns
9	Luyten 726-8A	2,68	8,73	12,56	15,42	Didžiojo šuns
10	Luyten 726-8B	2,68	8,73	12,52	15,38	-----
11	Ross 154	2,90	9,45	10,45	13,14	Šaulio
12	Ross 248	3,16	10,32	12,27	14,77	Andromedos
13	Epsilon Eridani	3,28	10,70	3,73	6,15	Eridano
14	Ross 128	3,35	10,94	11,11	13,48	Mergelės
15	Luyten 789-6	3,45	11,27	12,32	14,63	Vandenio
16	Epsilon Indi	3,46	11,27	4,69	7,00	Indēno
17	61 Cygni A	3,49	11,37	5,21	7,50	Gulbės
18	61 Cygni B	3,49	11,37	6,03	8,33	Gulbės
19	Procion A	3,49	11,38	0,38	2,67	Mažojo šuns
20	Procion B	3,49	11,38	10,70	13,00	Mažojo šuns



(a)

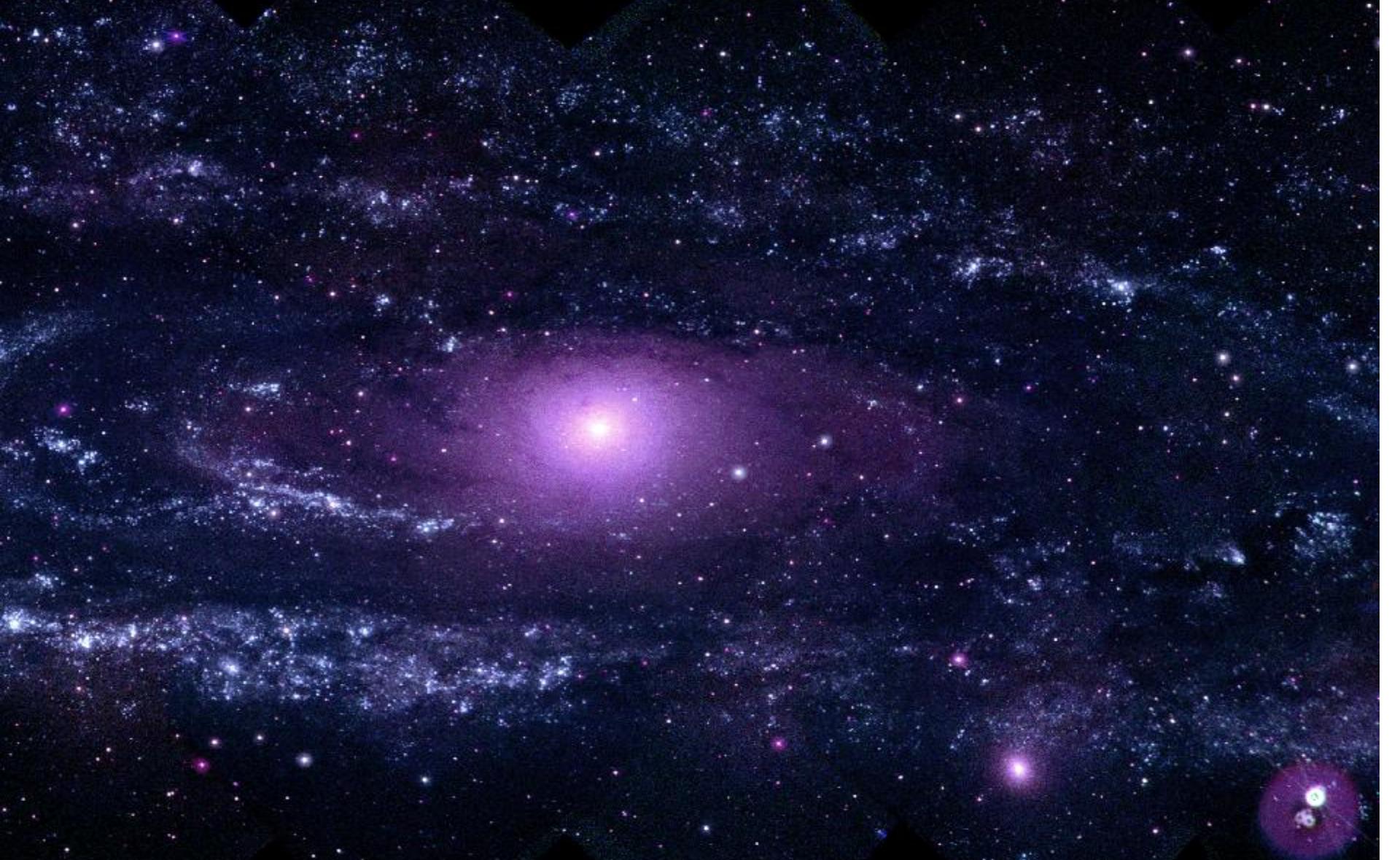


(b)



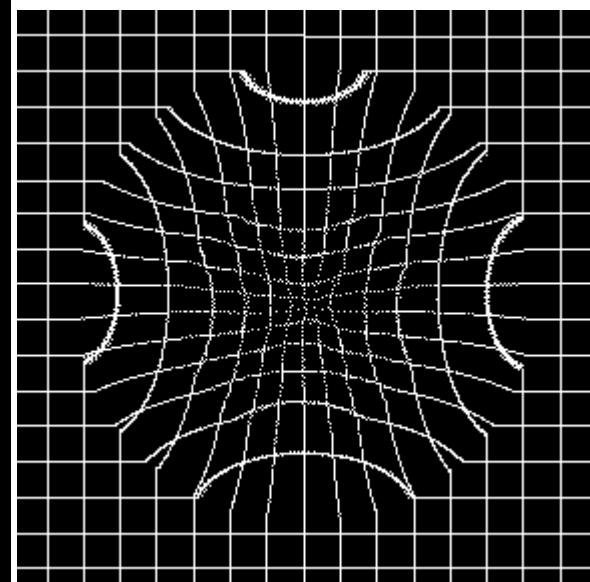
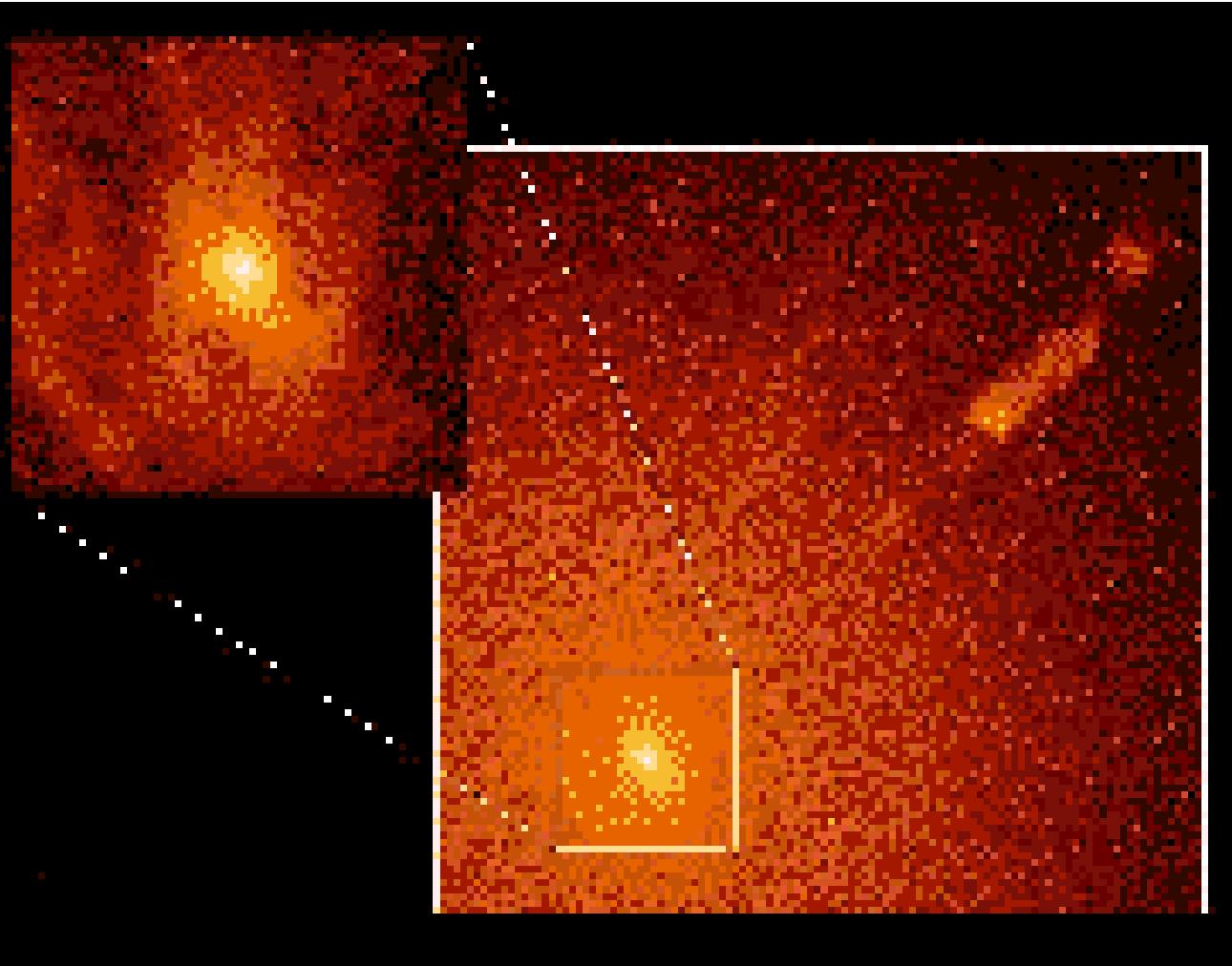
(c)



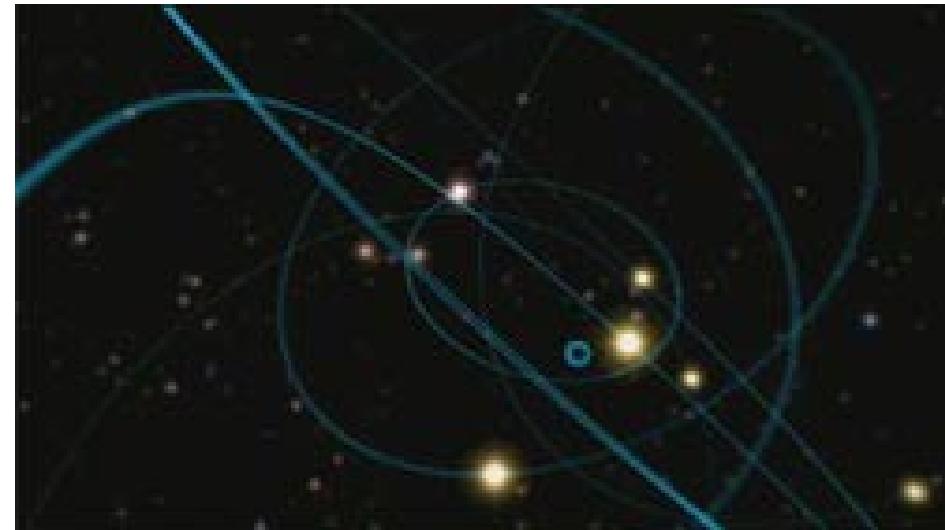


Andromeda (UV)

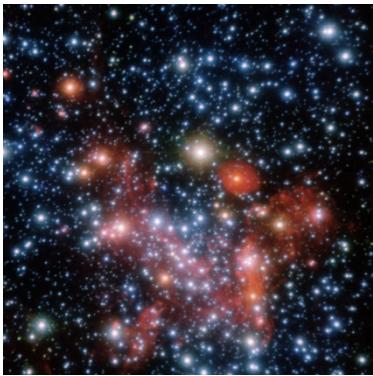
Galaktikos centras



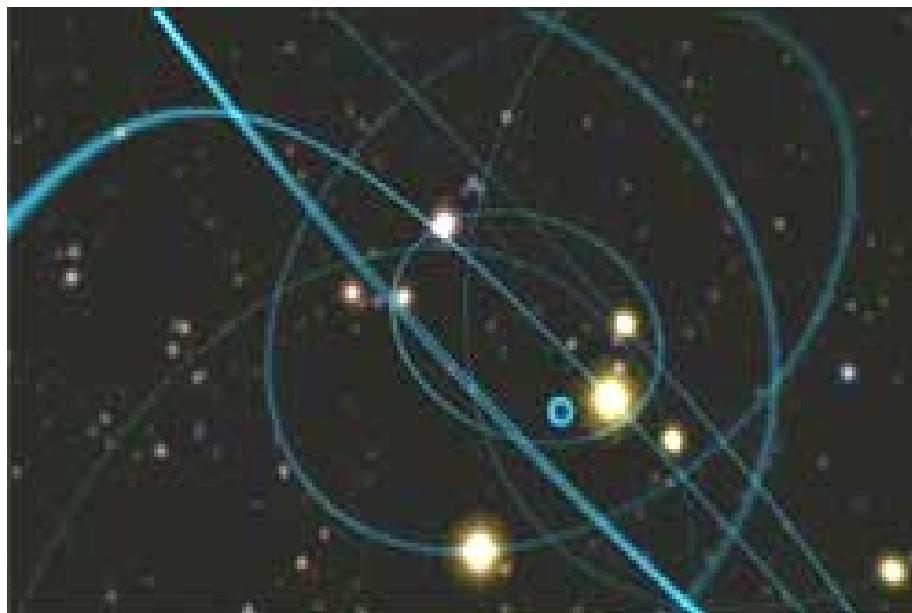
16 metų tyrimų rezultatas



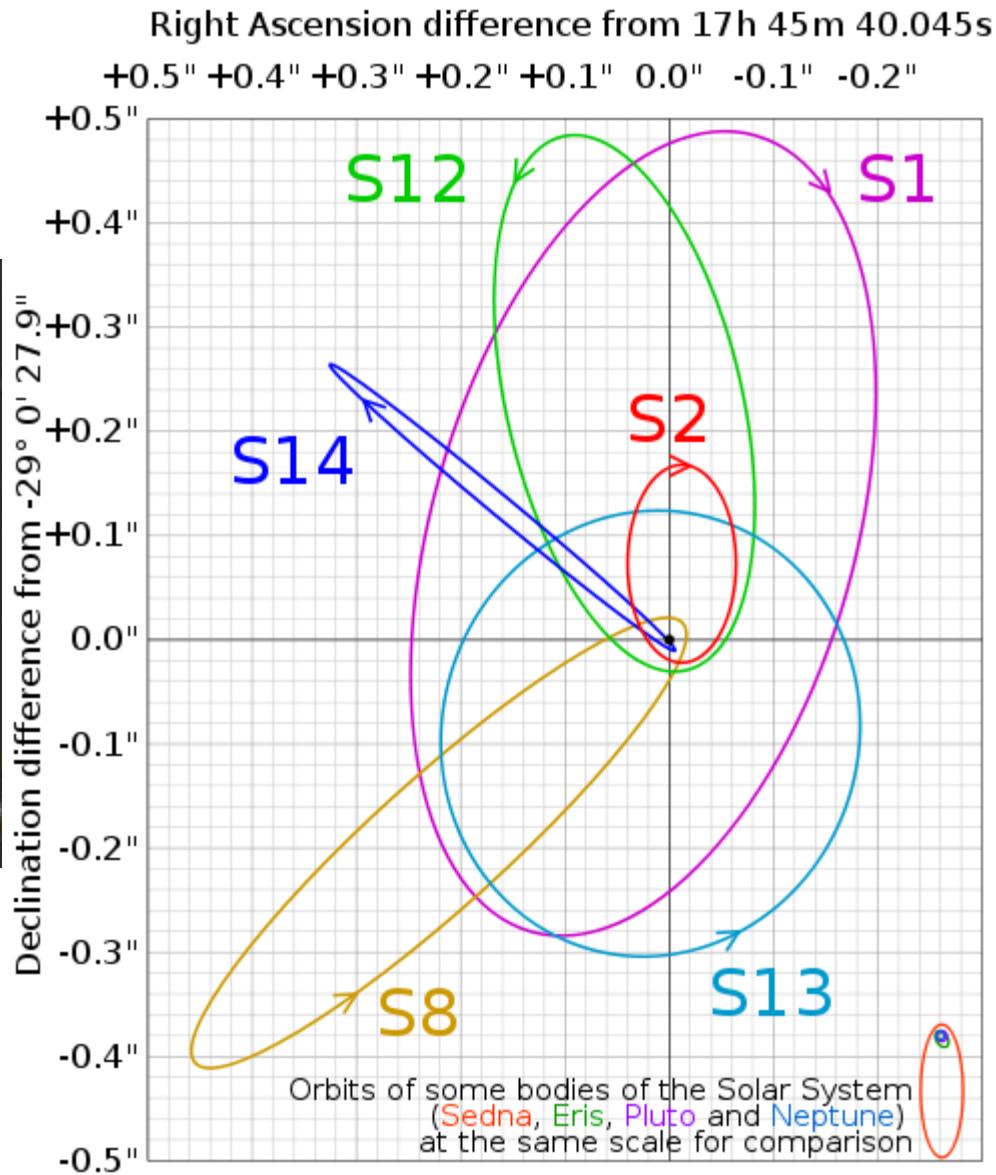
**Centre ~ 4 mln Saulės masių
gigantiška juodoji skylė**



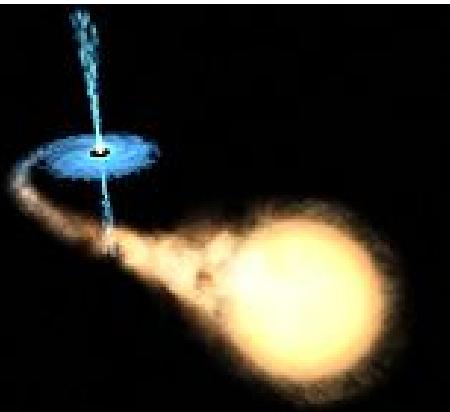
16 metų tyrimų rezultatas



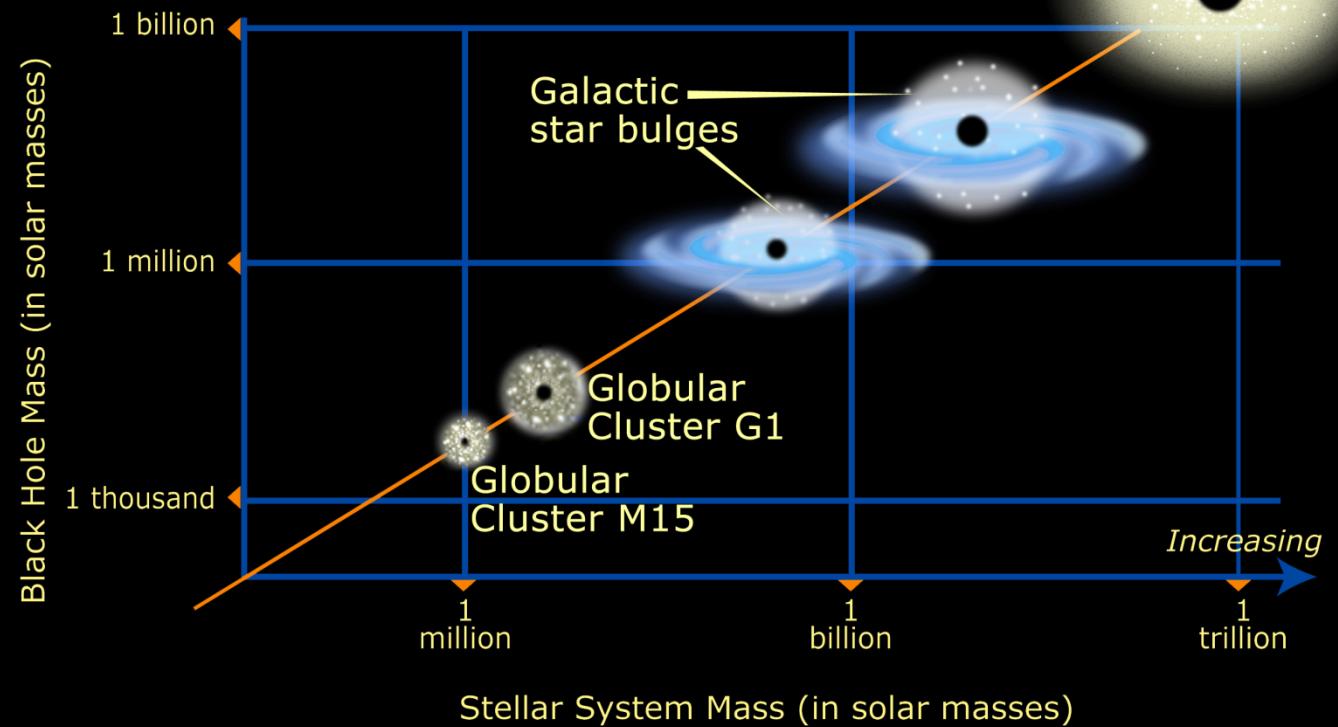
Centre ~ 4 mln Saulės masių
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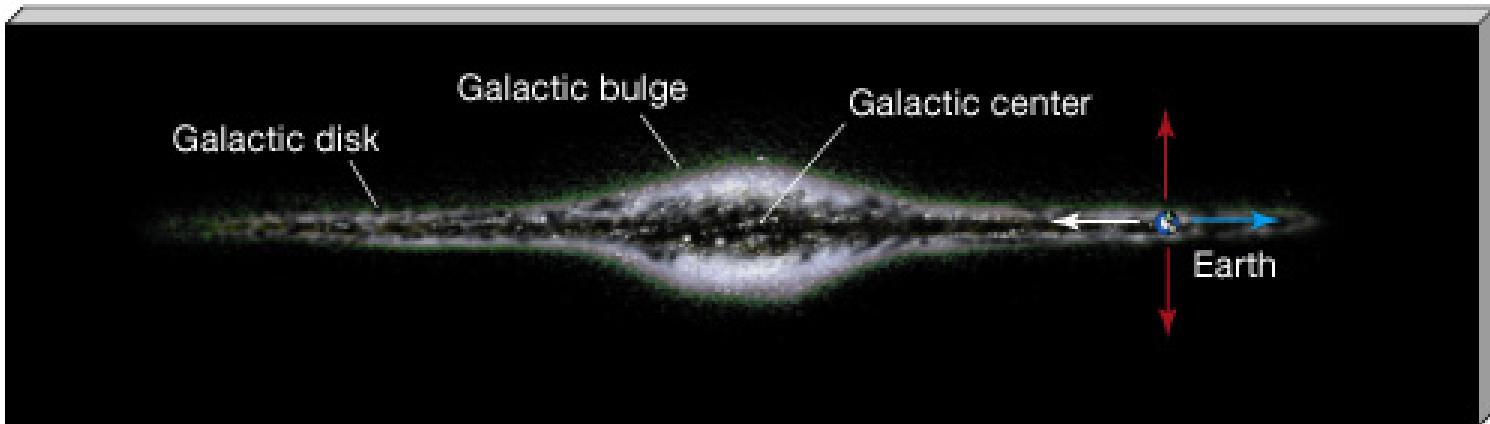


Juodos skylės

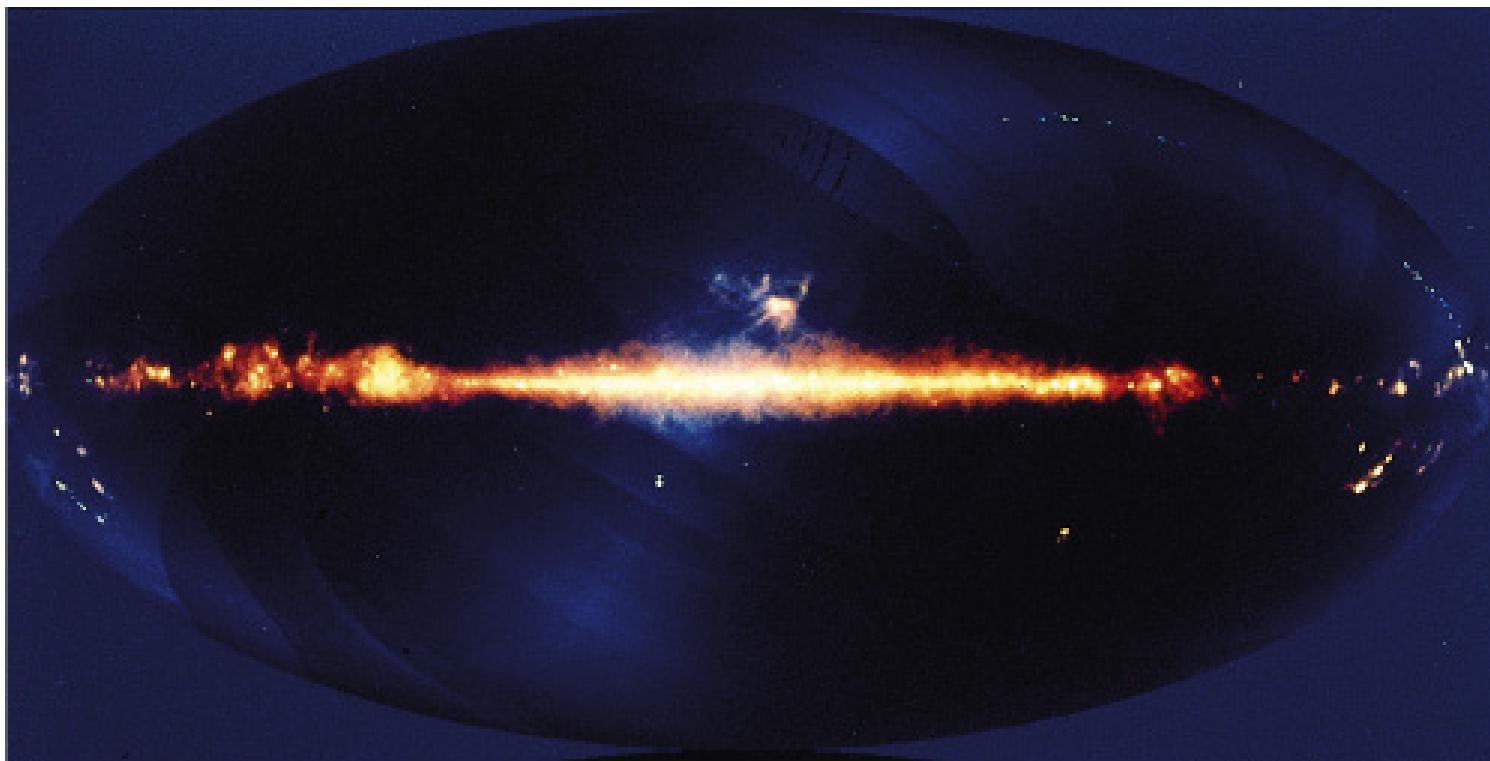


Correlating Black Hole Mass
to Stellar System Mass





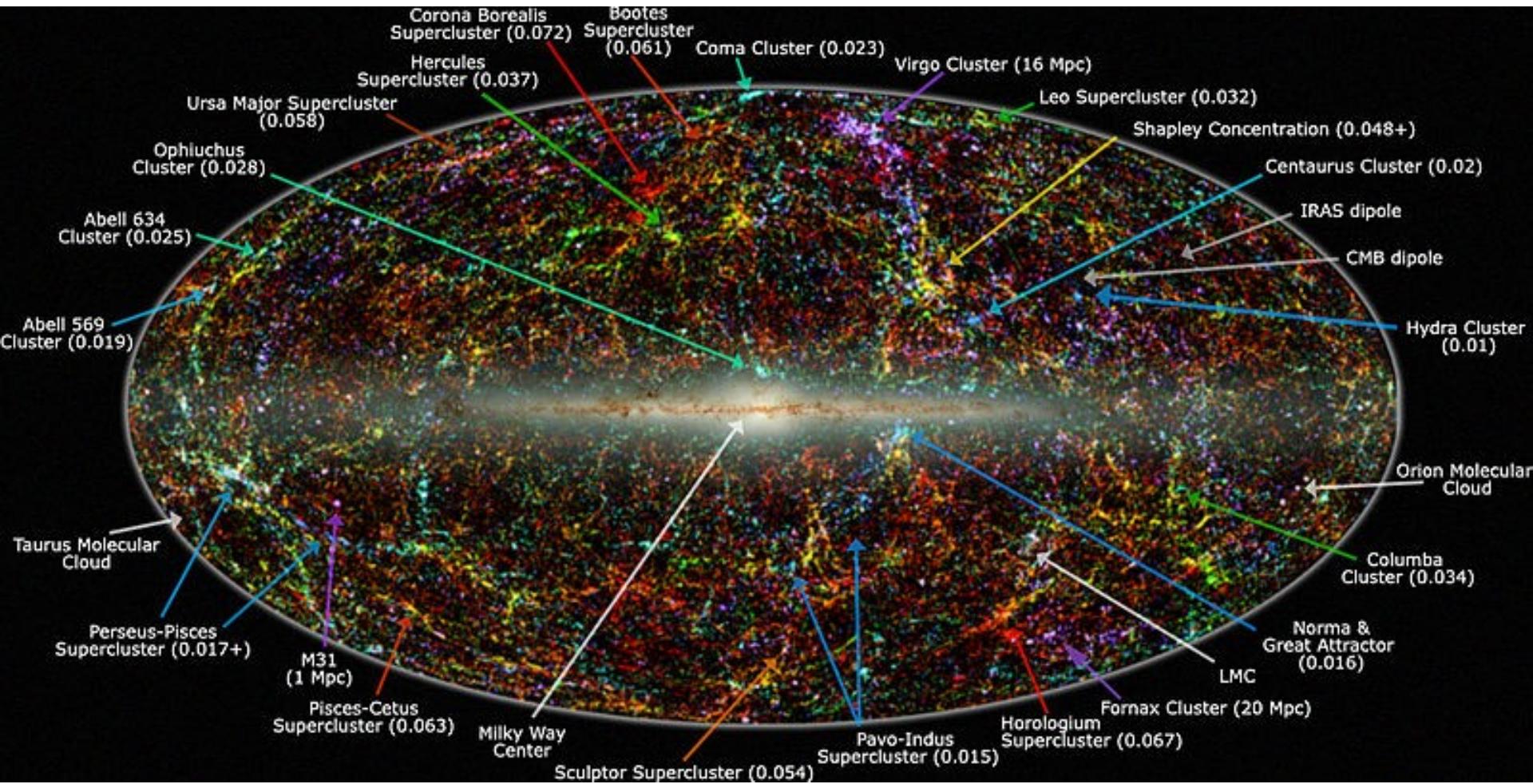
(a)



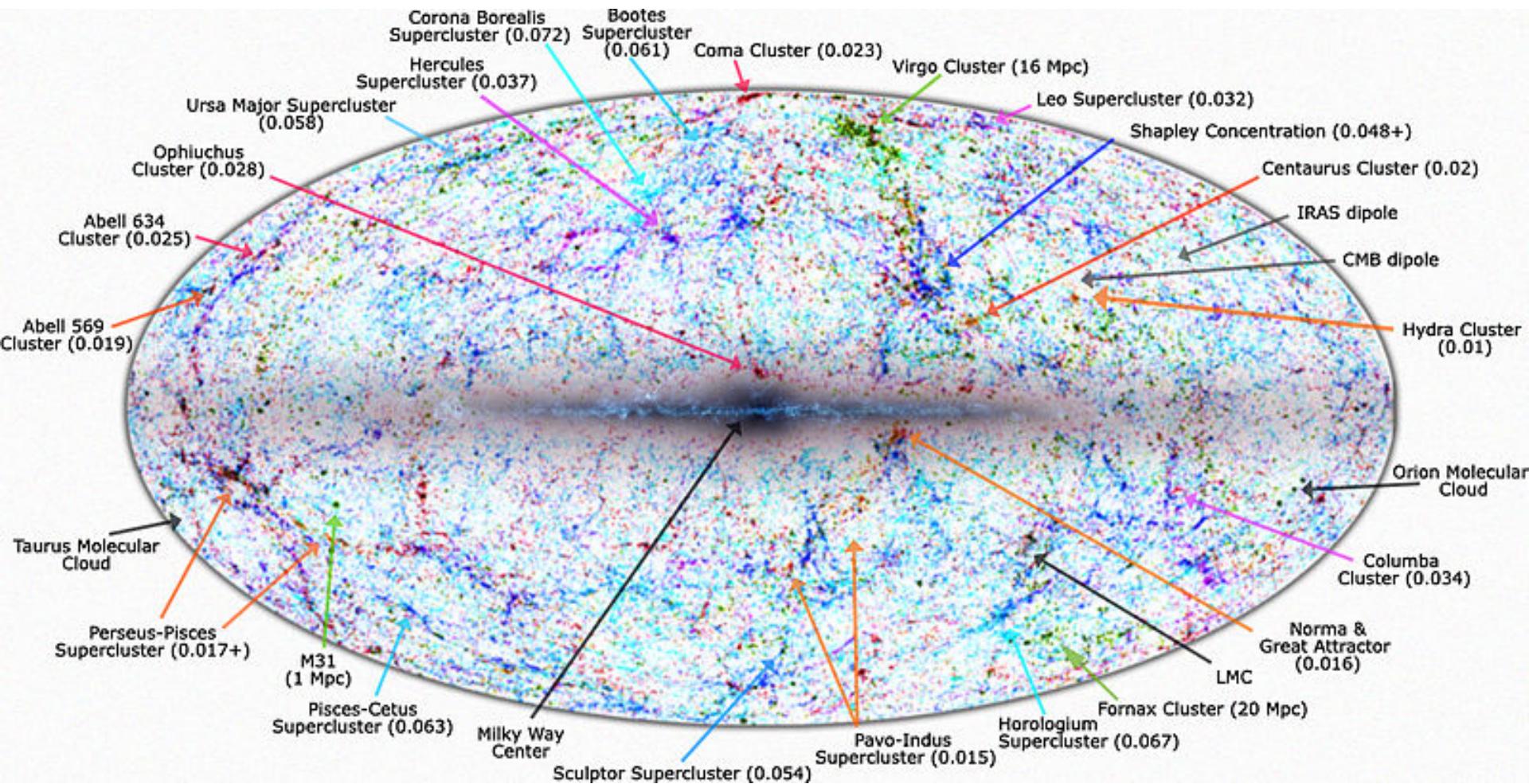
(b)



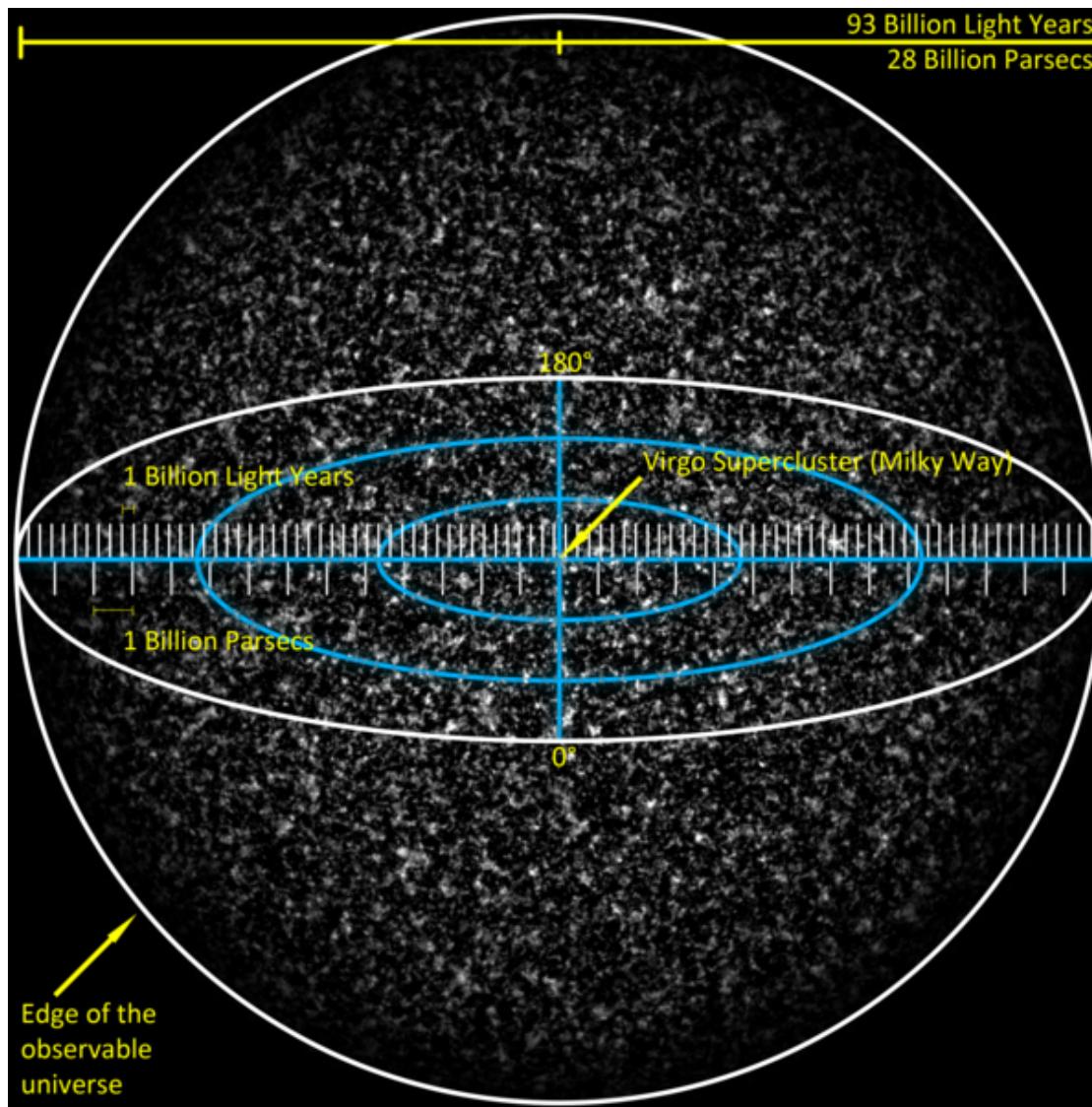
Mūsų galaktikos apsuptis

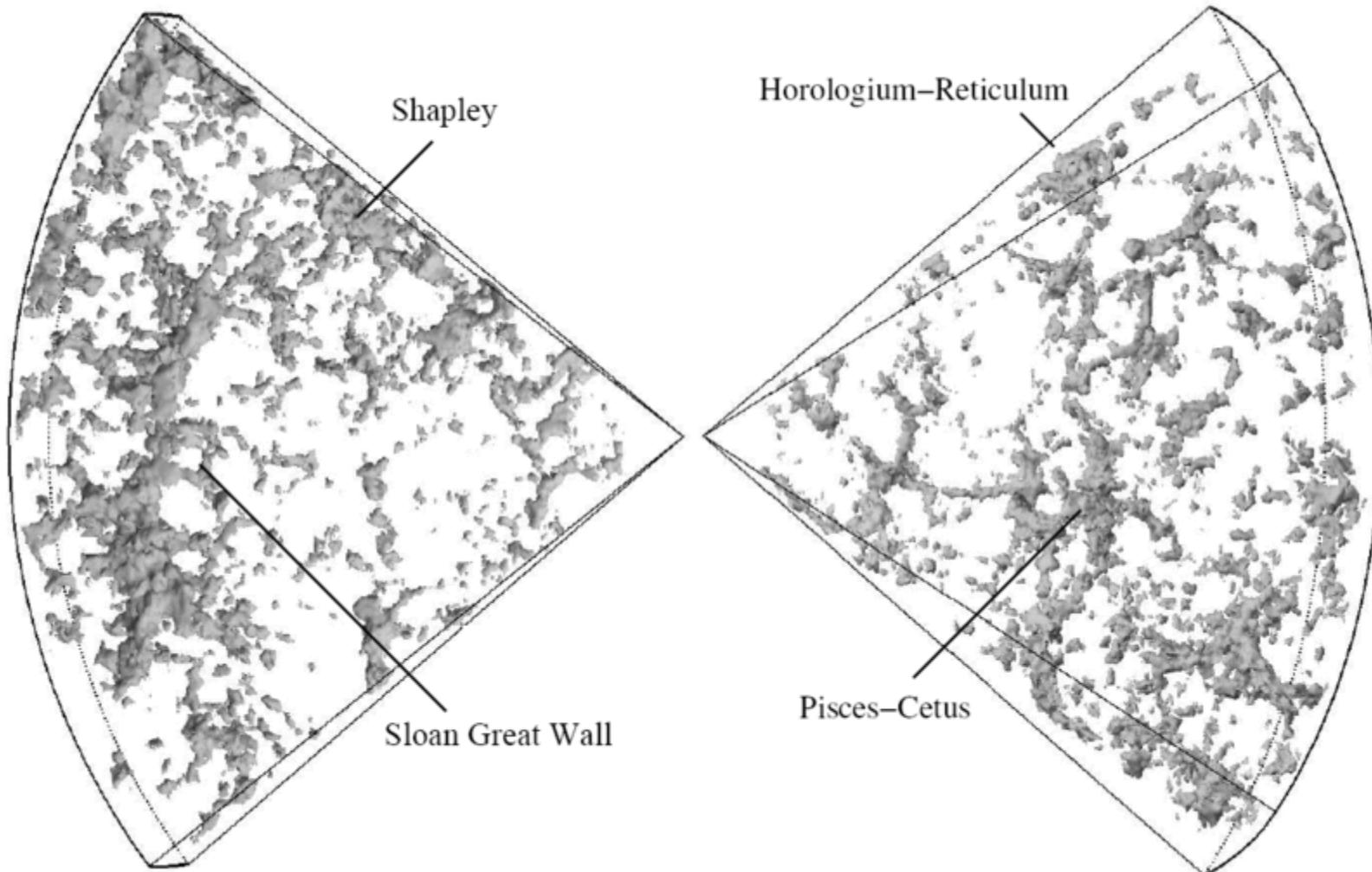


Mūsų galaktikos apsuptis



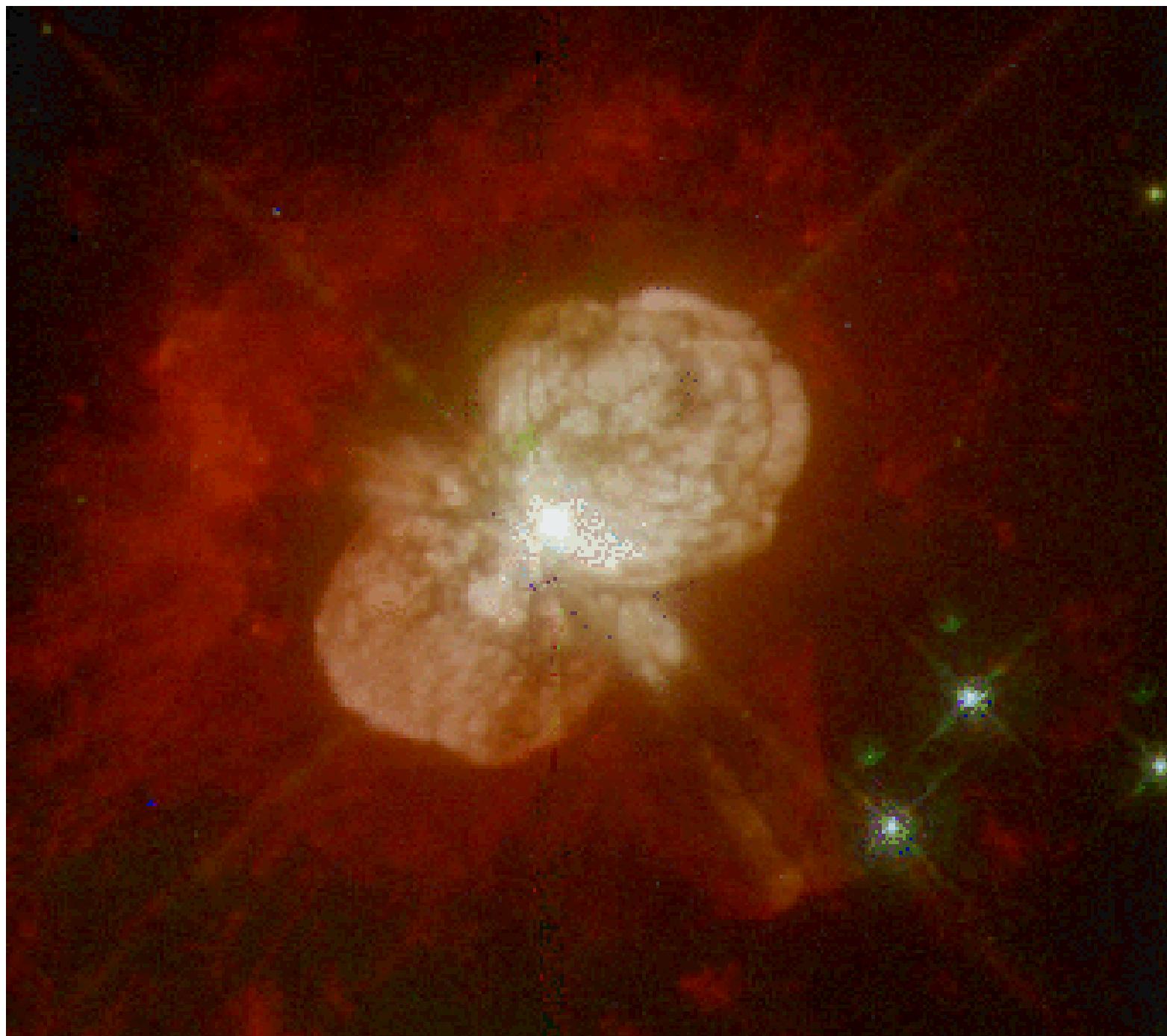
O jei žvelgti į visą visatą ...







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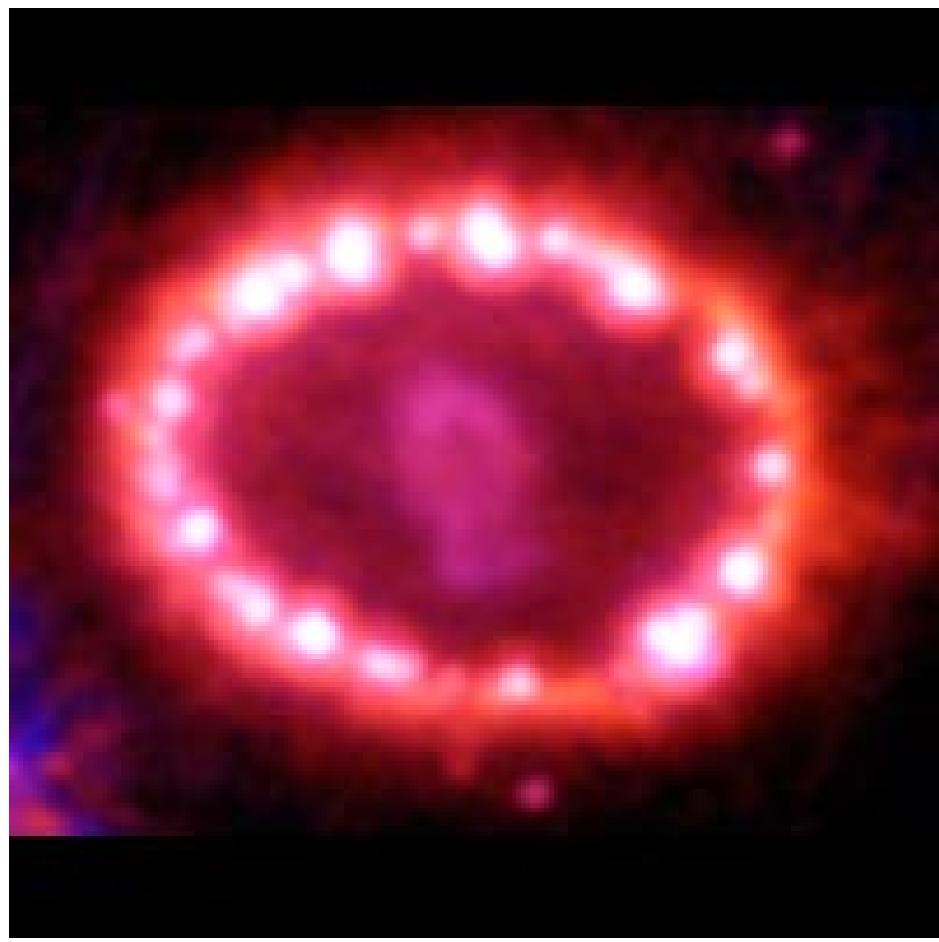




Šalčiausia vieta
Visatoje

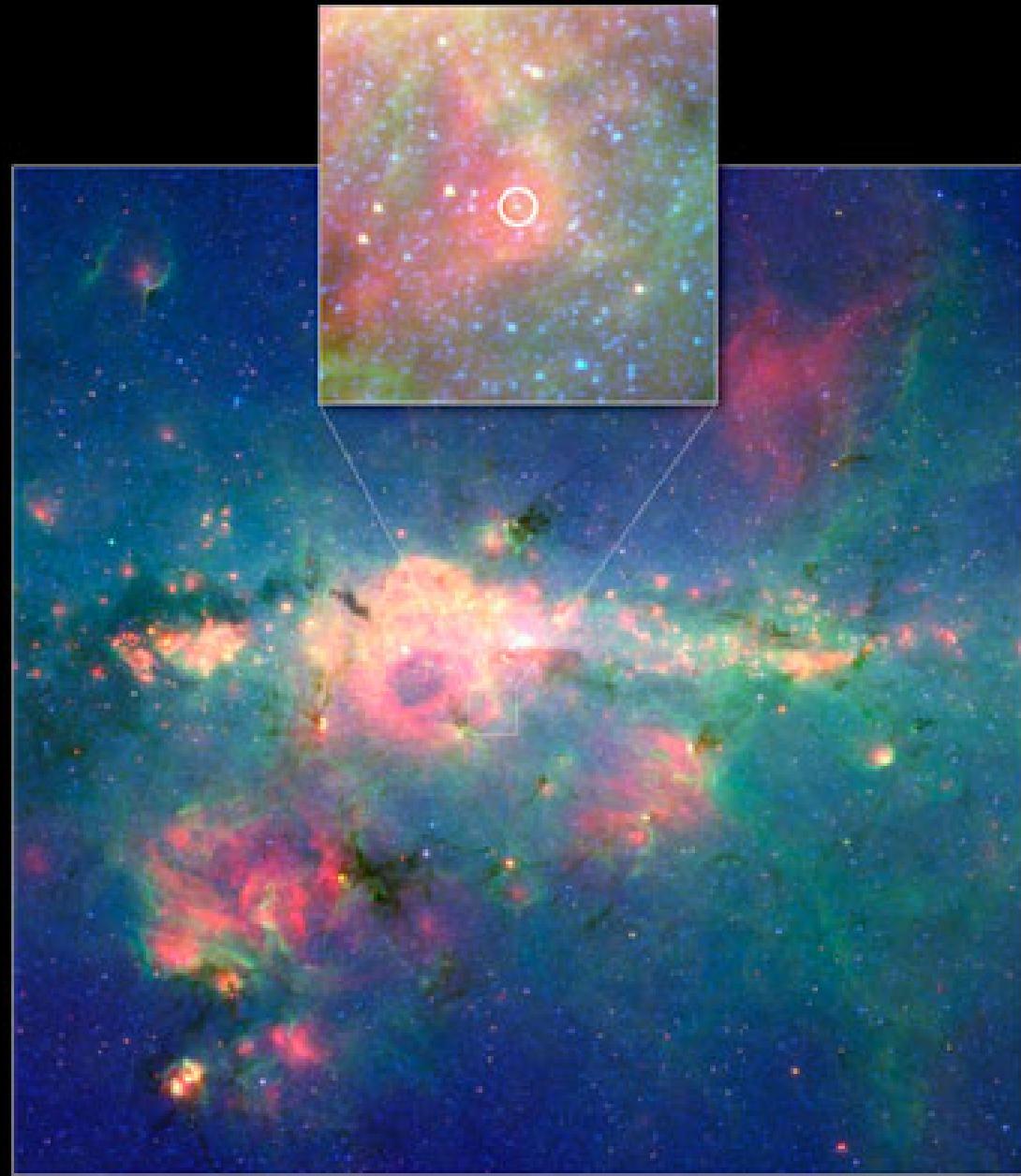


Supernova- sprogo prieš
17 metu (Foto 2004-09)



Vėjo malūnėlio (Pinwheel) galaktika





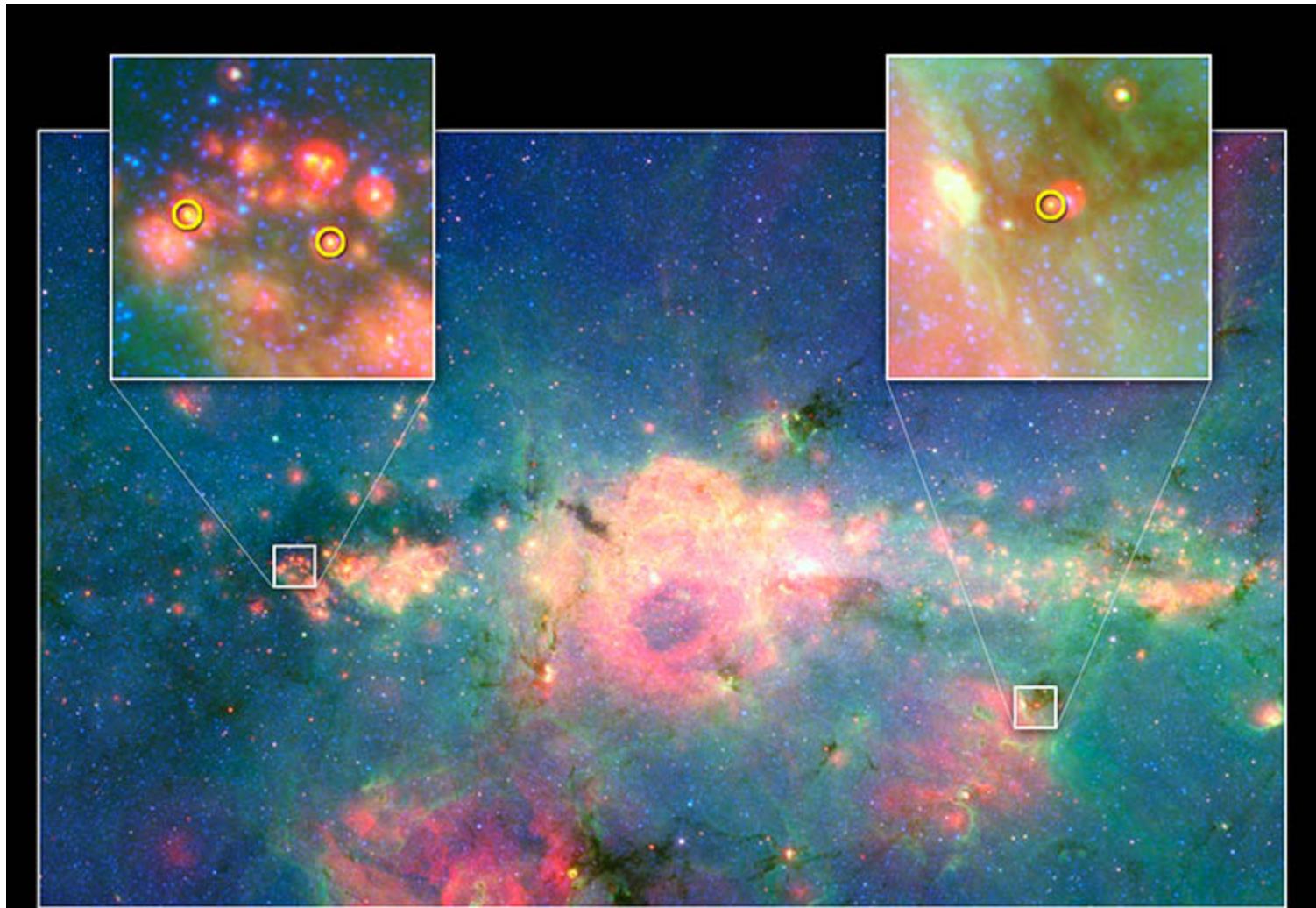
The Brightest Star?

NASA / JPL-Caltech / L. Oskinova (Potsdam Univ., Germany)

Spitzer Space Telescope • IRAC • MIPS

ssc2008-13a

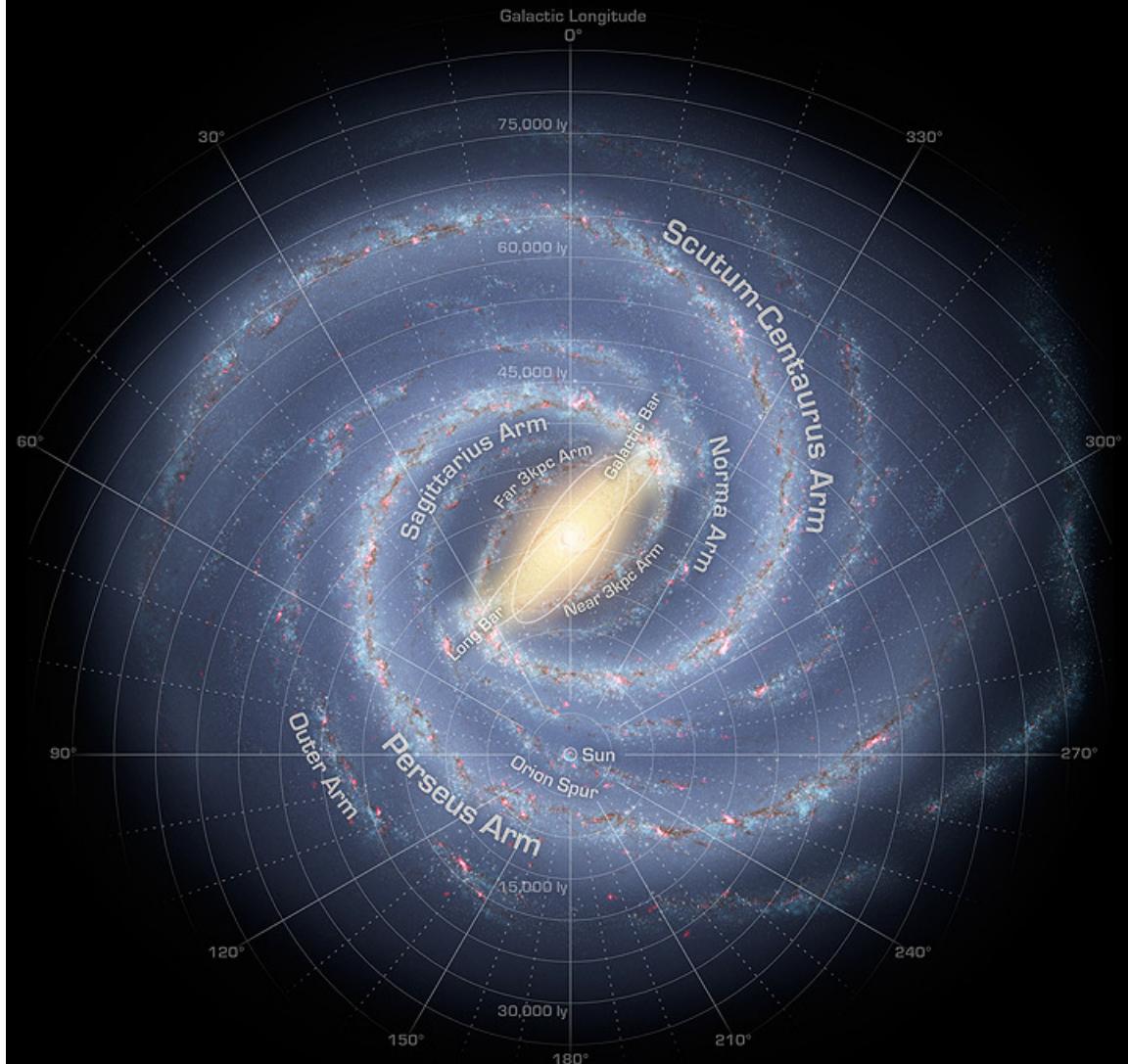
Žvaigždžių “darželis” ties galaktikos centru



Young Stars Forming in the Galactic Center
NASA / JPL-Caltech / S. V. Ramirez (NExScl / Caltech)

Spitzer Space Telescope • IRAC • MIPS • IRS
ssc2009-13a

Patikslinta
Paukščių tako
galaktikos
struktūra:
dviem spiralės
vijomis mažiau



Annotated Roadmap to the Milky Way
(artist's concept)

Dvi susijungiančios galaktikos

(NGC 2207 ir IC 2163)

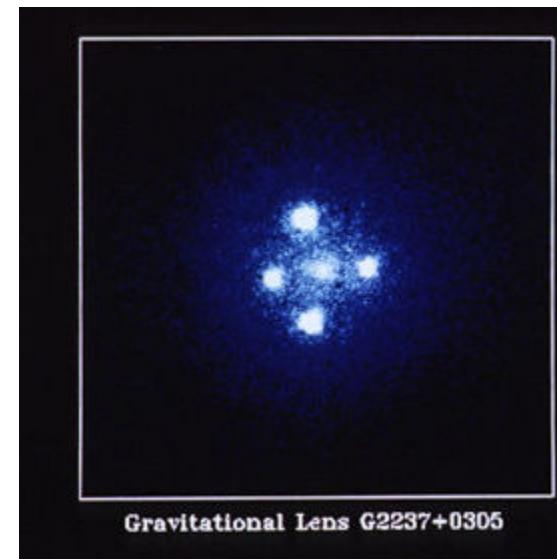
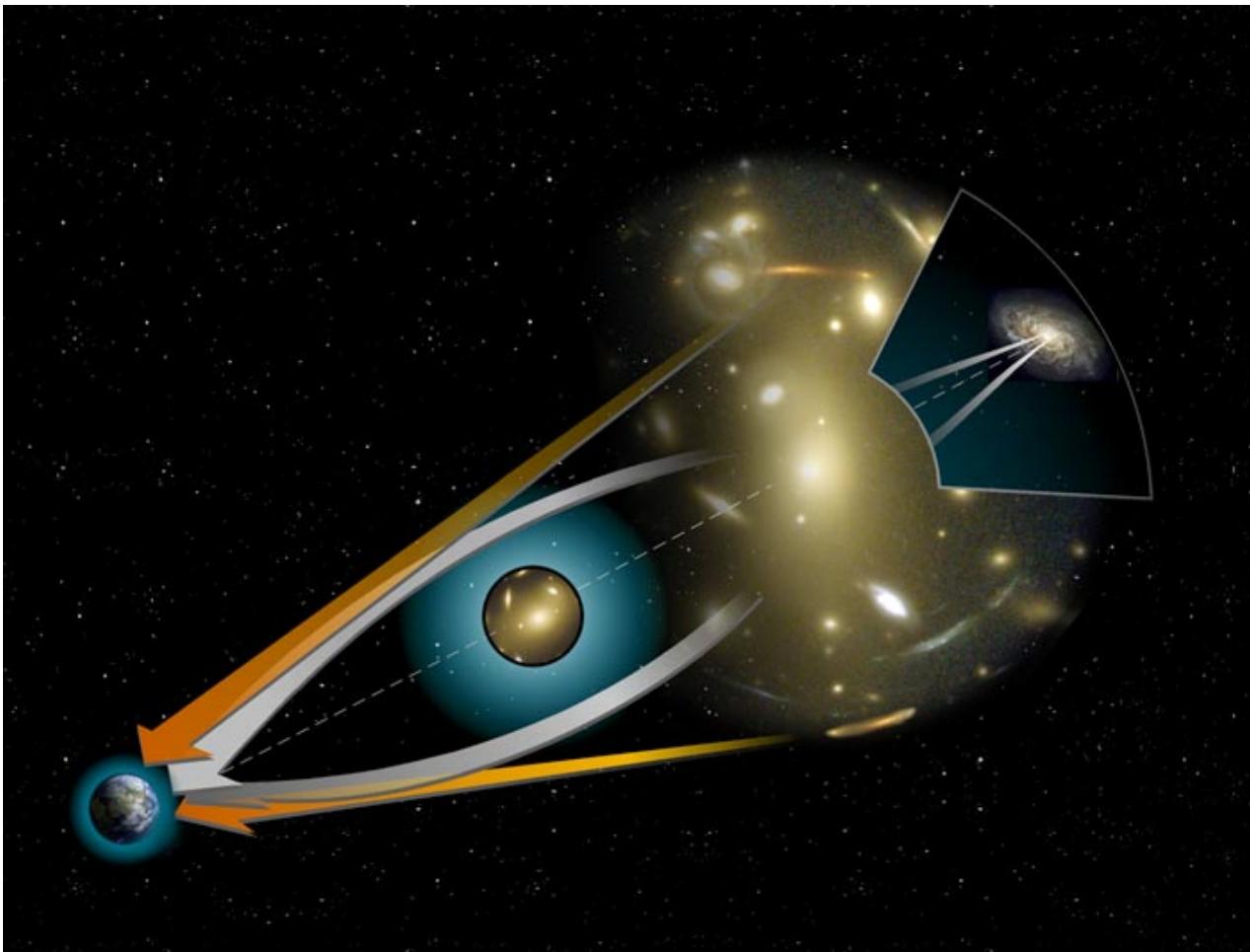


Spitzer/Hubble View of NGC 2207 & IC 2163
NASA, ESA / JPL-Caltech / STScI / D. Elmegreen (Vassar)

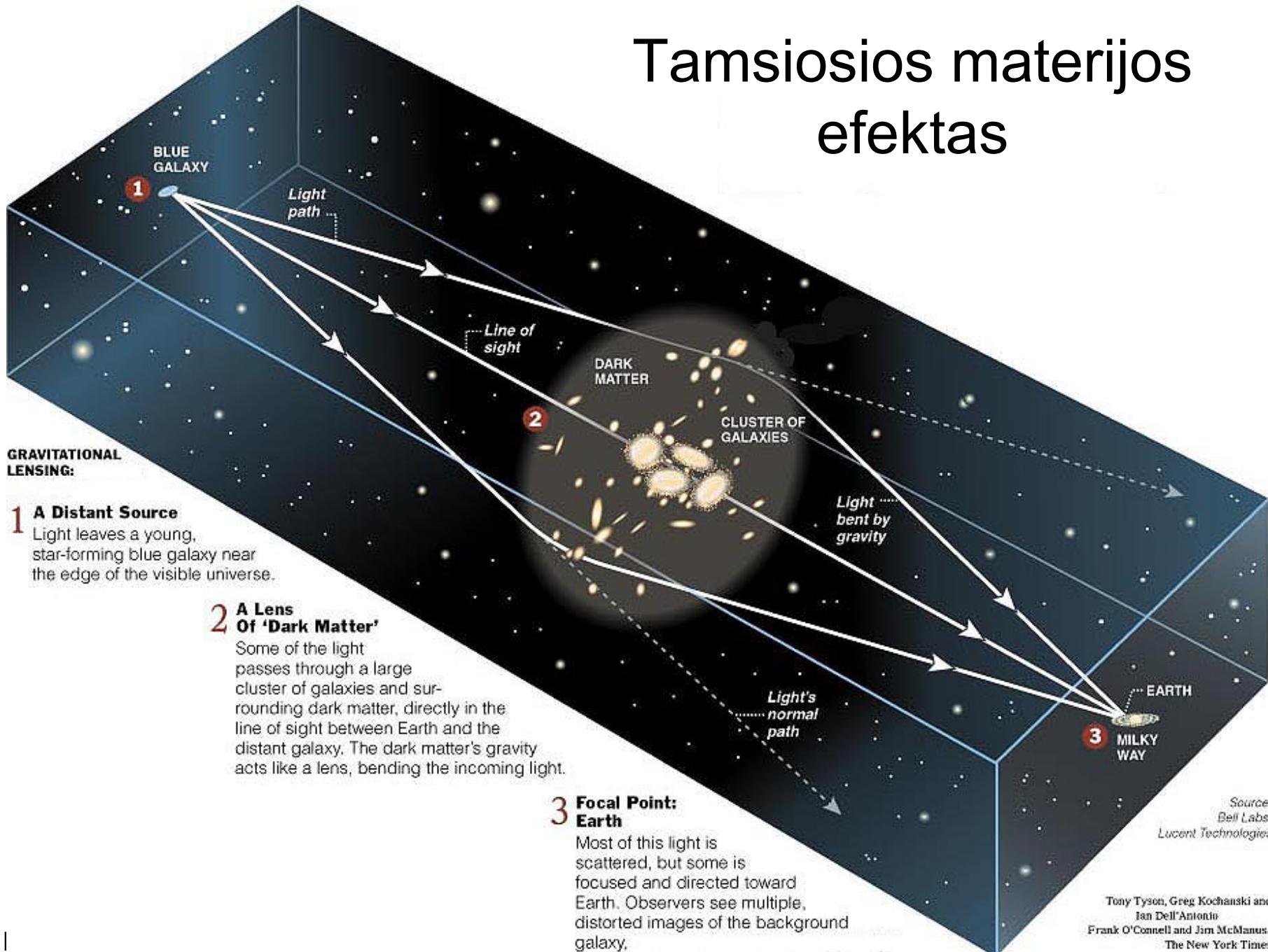
Spitzer Space Telescope • IRAC
ssc2006-11b

Kas dar naujo? –

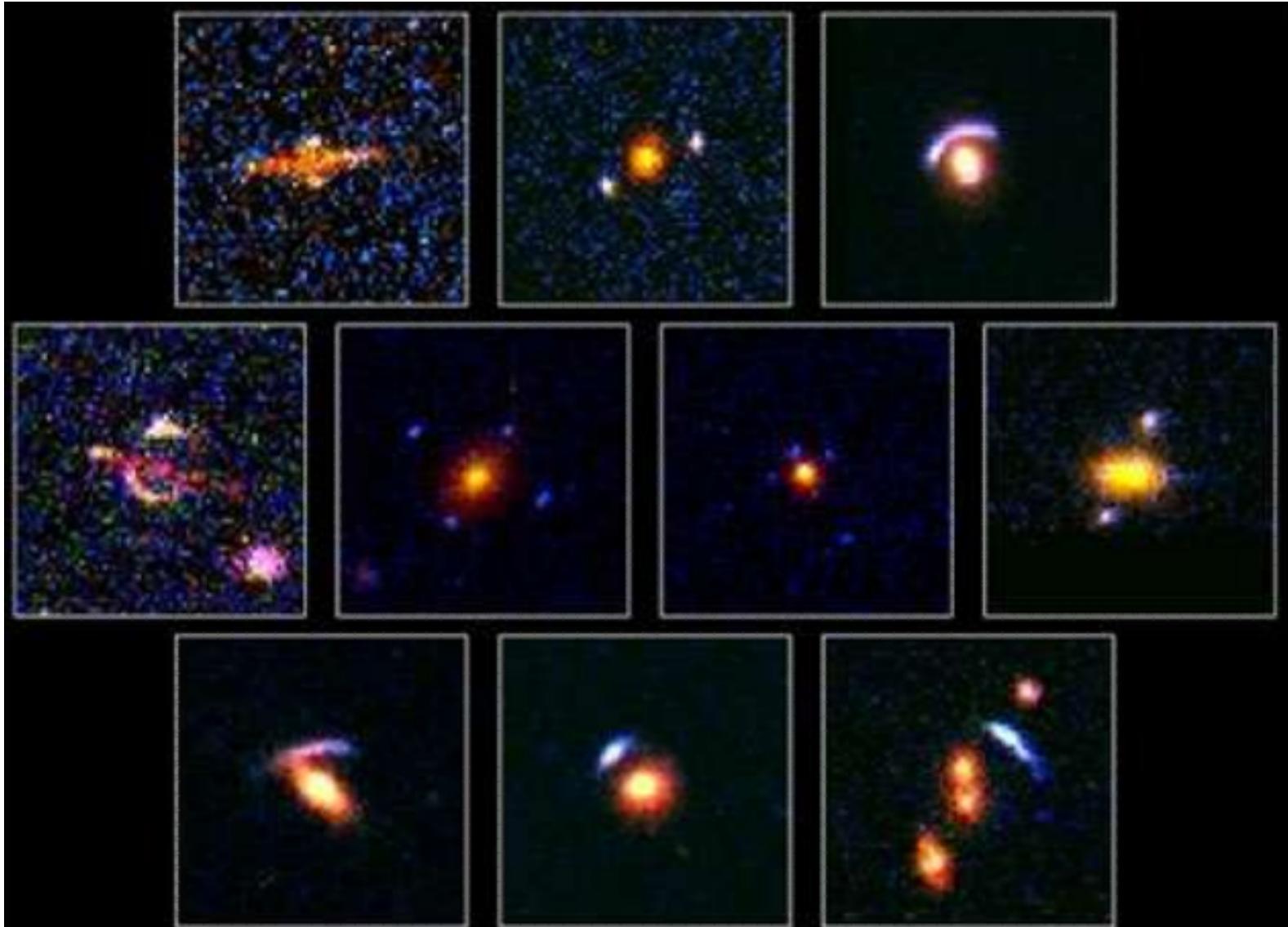
“Netikros” galaktikos – graviaciniai lęšiai



Tamsiosios materijos efektas



Pavyzdžiai



Gallery of Gravitational Lenses

Pasižvalgėme po megapasaulį, apžiūrėjome kelis objektus.

Kaip iš šių fragmenų buvo kuriamas Visatos modelis?

Visatos evoliucija

Tezė I: jei galaktikos išsilaksto ir šviesos greitis yra baigtinis, tai žvelgdami į tolimesnes galaktikas matome praeitį.

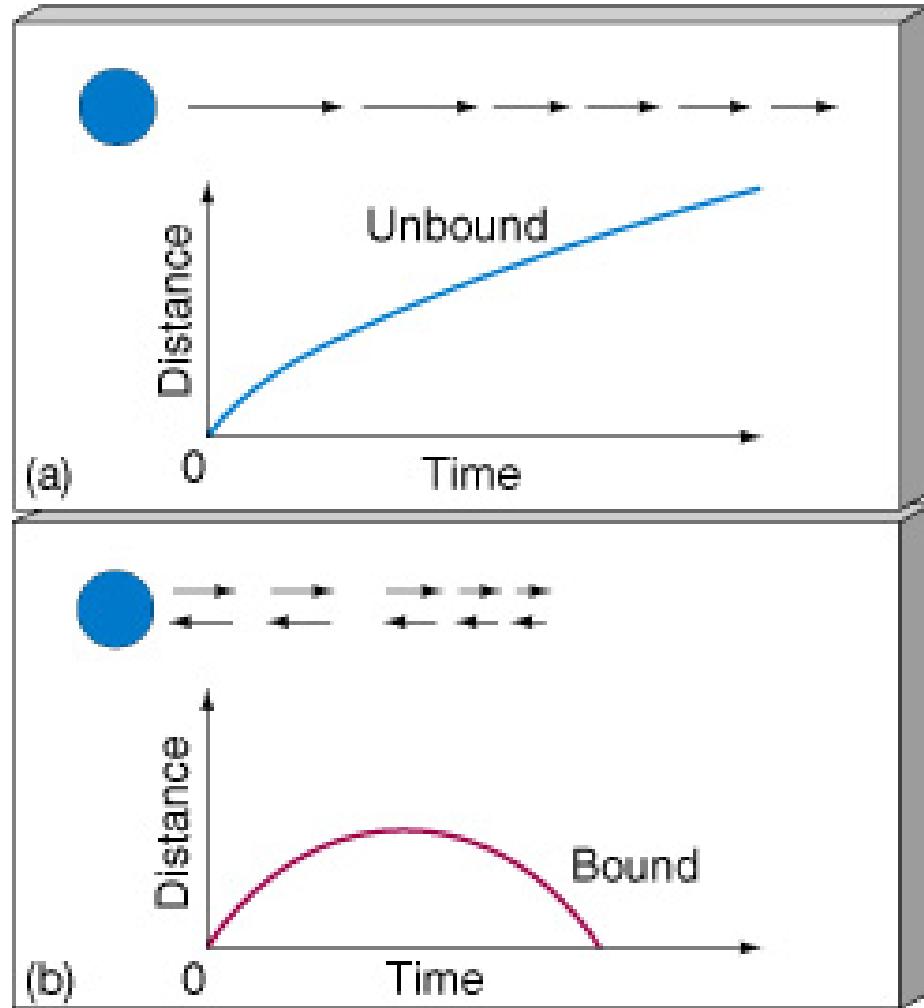
Tezė II: jei galaktikos išsilaksto, tai galima bandyti “atsukti” istorijos ratą atgal ir analizuoti, koks pasaulis buvo praeityje, bei numatyti, koks jis turi būti ateityje.

Tezė III: (**reikalaujanti žinių apie mikropasaulį**) ar elementariosios dalelės stabilios: neutronas – ne; protonas – gal? Gali nutikti taip, kad po 10^{100} metų išnyks paskutinis atomas (jei protono gyvavimo trukmė bus tokia, kokia dabar yra nustatyta kaip mažiausia galima).

Kas esminio šioje dalyje?:

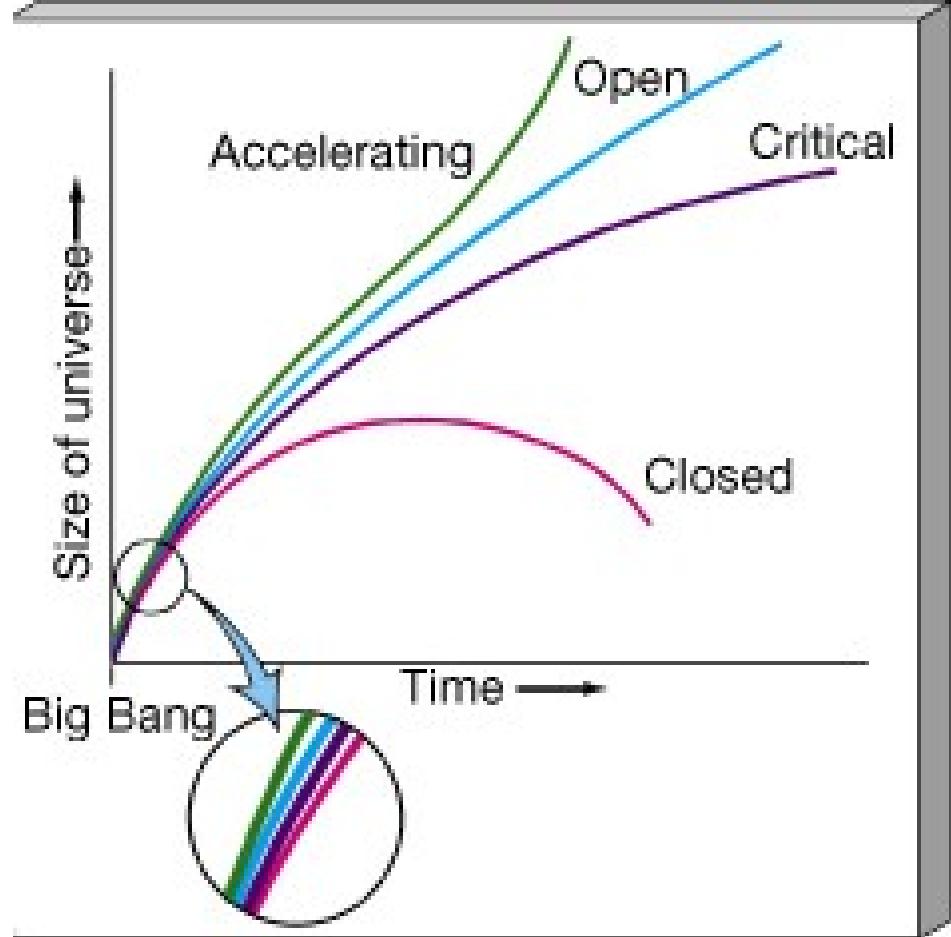
- Mūsų Galaktikos sandara dar vis tikslinama (“Paukščių tako” galaktika – “kanibalas”).
- Visatos seniausi kūnai sudaryti beveik tik iš H ir He.
- Žvaigždžių istorija priklauso nuo jų masės (H debesies, kuriame ji susiformavo, dydžio). (Neutroninės žvaigždės ir “juodosios skylės” – didžiujų žvaigždžių istorijos baigiamoji fazė).
- Supernovos – sunkiujų cheminių elementų gamybos “įrenginys”.
- Visatos mīslės – tamsioji medžiaga, neigiamo energija?

Kadangi tolimesnės galaktikos lekia didesniu greičiu negu artimesnės, tai reiškia, kad jų judėjimas yra stabdomas. Stabdyti gali visuotinė trauka, todėl tolesnė istorija turi lemти Visatos masę.



Visatos plėtimasis

Naujos hipotezės: kadangi yra įtarimai, kad galaktikos yra sunkesnės negu matomų žvaigždžių ir ūkų masė, todėl prognozuojama, kad egzistuoja "tamsioji medžiaga" ir "neigiamą energiją", kurios gali versti galaktikas stumti vieną nuo kitos, todėl jos gali išsilakstyti greitėdamos. Tai diskusijų objektas, nes tie patys efektai gali būti ir kitaip paaiškinami.

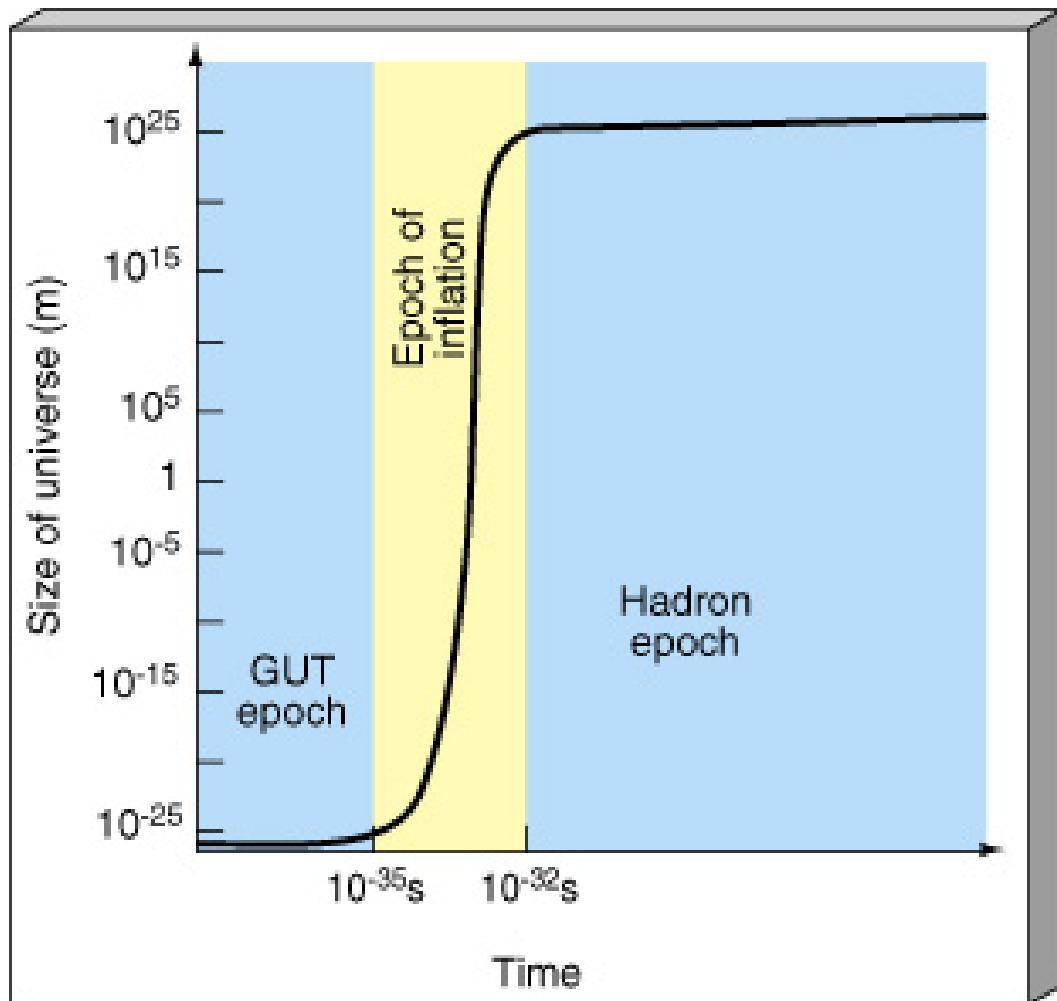


Visatos plėtimasis

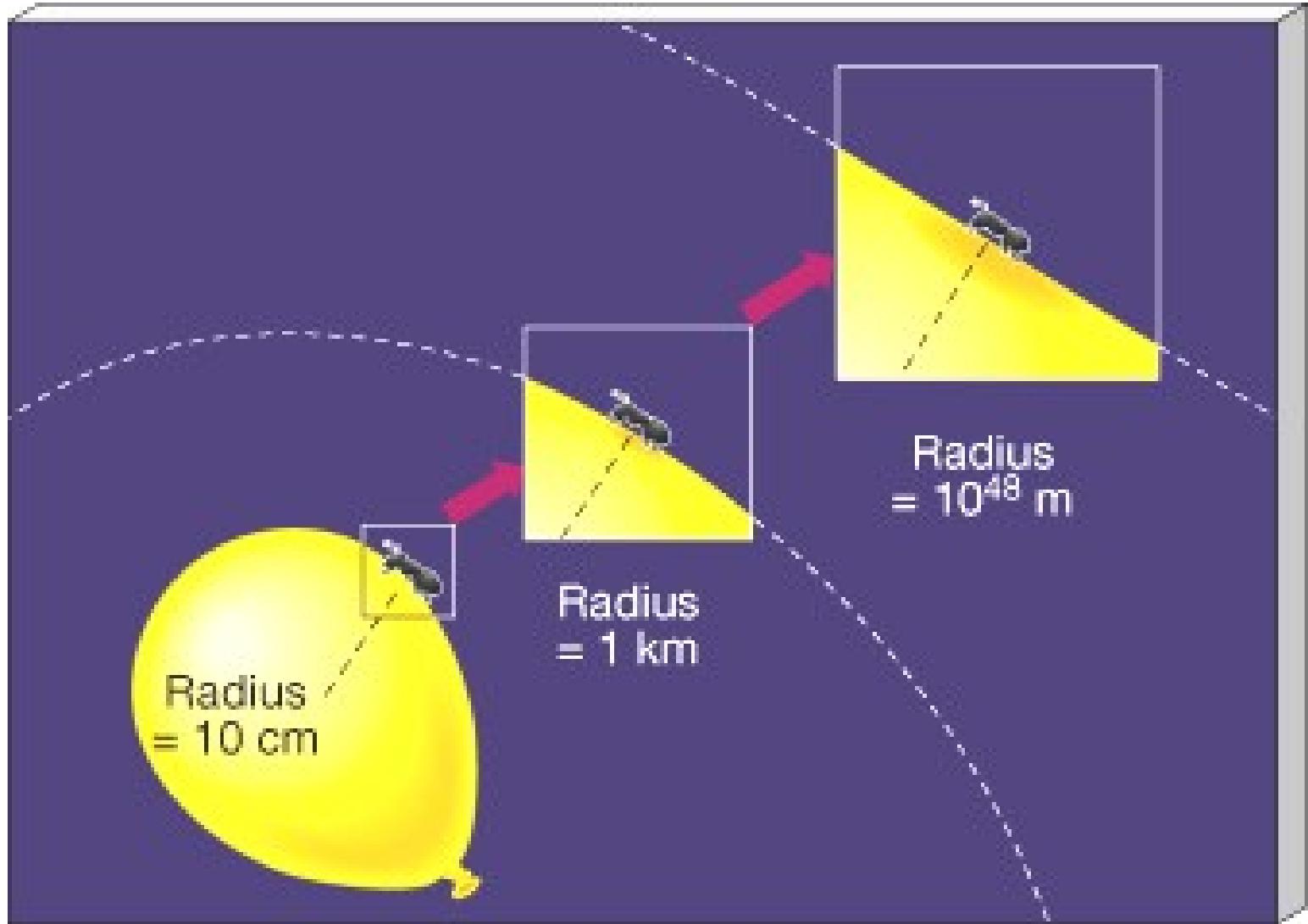
A. Einšteinas:

masė iškreivina erdvę,
todėl pradiniu metu
Visatos erdvė turėjo
būti uždara.

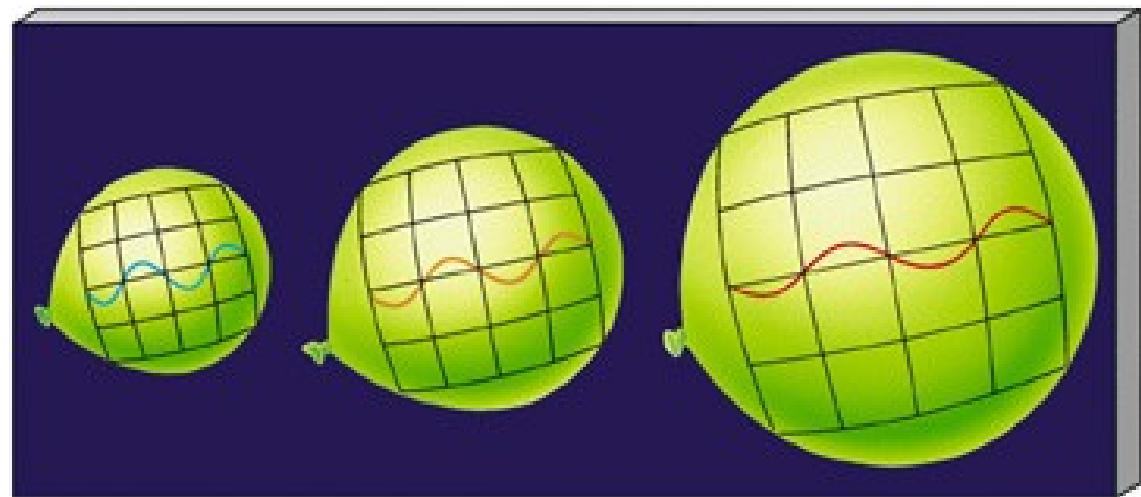
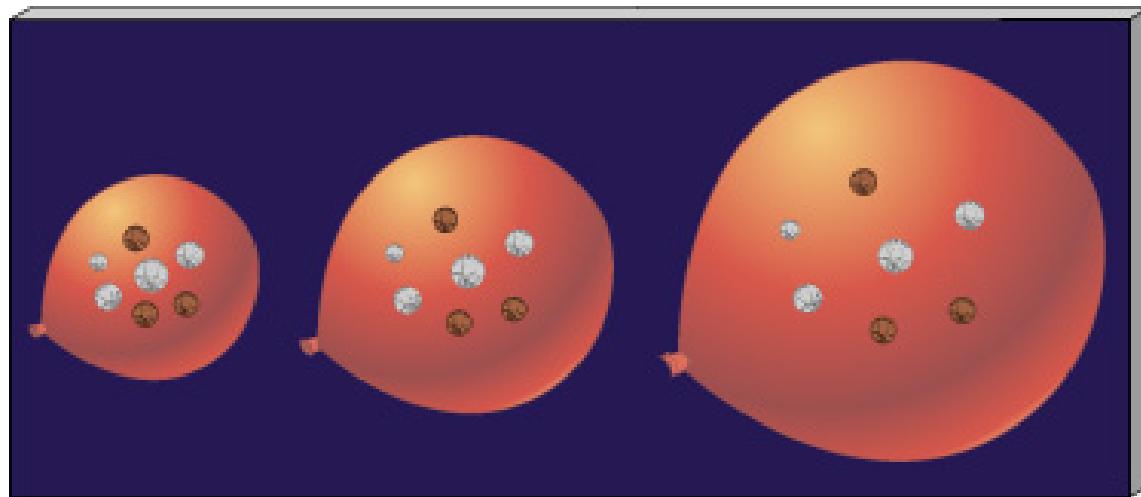
(GUT – Grand Unified Theory)



Visatos plėtimasis

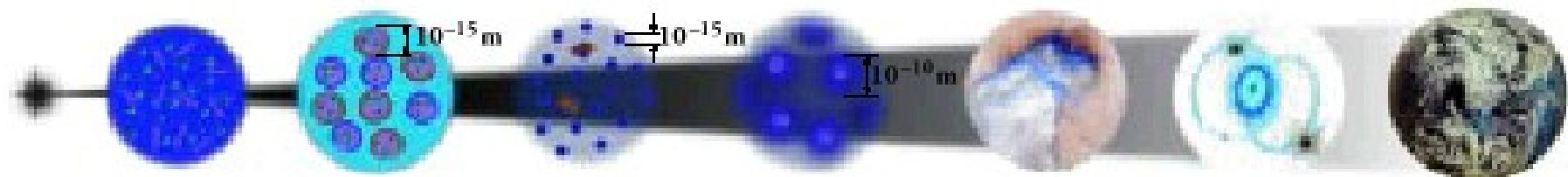


Visatos plėtimasis

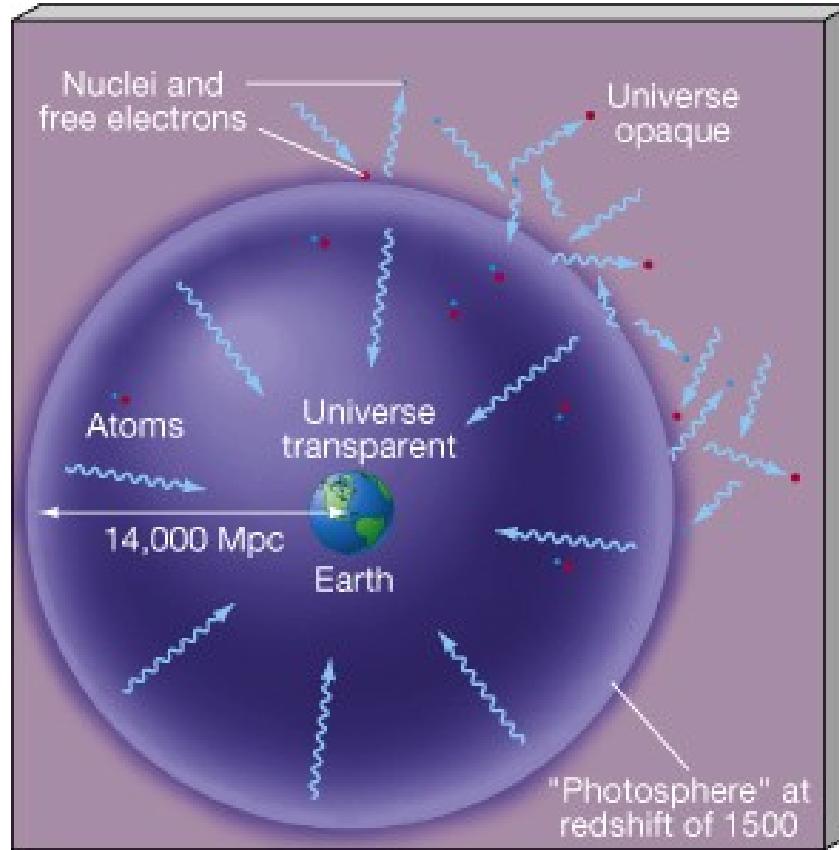


Expansion of the Universe

After the Big Bang, the universe expanded and cooled. At about 10^{-6} second, the universe consisted of a soup of quarks, gluons, electrons, and neutrinos. When the temperature of the Universe, $T_{universe}$, cooled to about 10^{12} K, this soup coalesced into protons, neutrons, and electrons. As time progressed, some of the protons and neutrons formed deuterium, helium, and lithium nuclei. Still later, electrons combined with protons and these low-mass nuclei to form neutral atoms. Due to gravity, clouds of atoms contracted into stars, where hydrogen and helium fused into more massive chemical elements. Exploding stars (supernovae) form the most massive elements and disperse them into space. Our earth was formed from supernova debris.

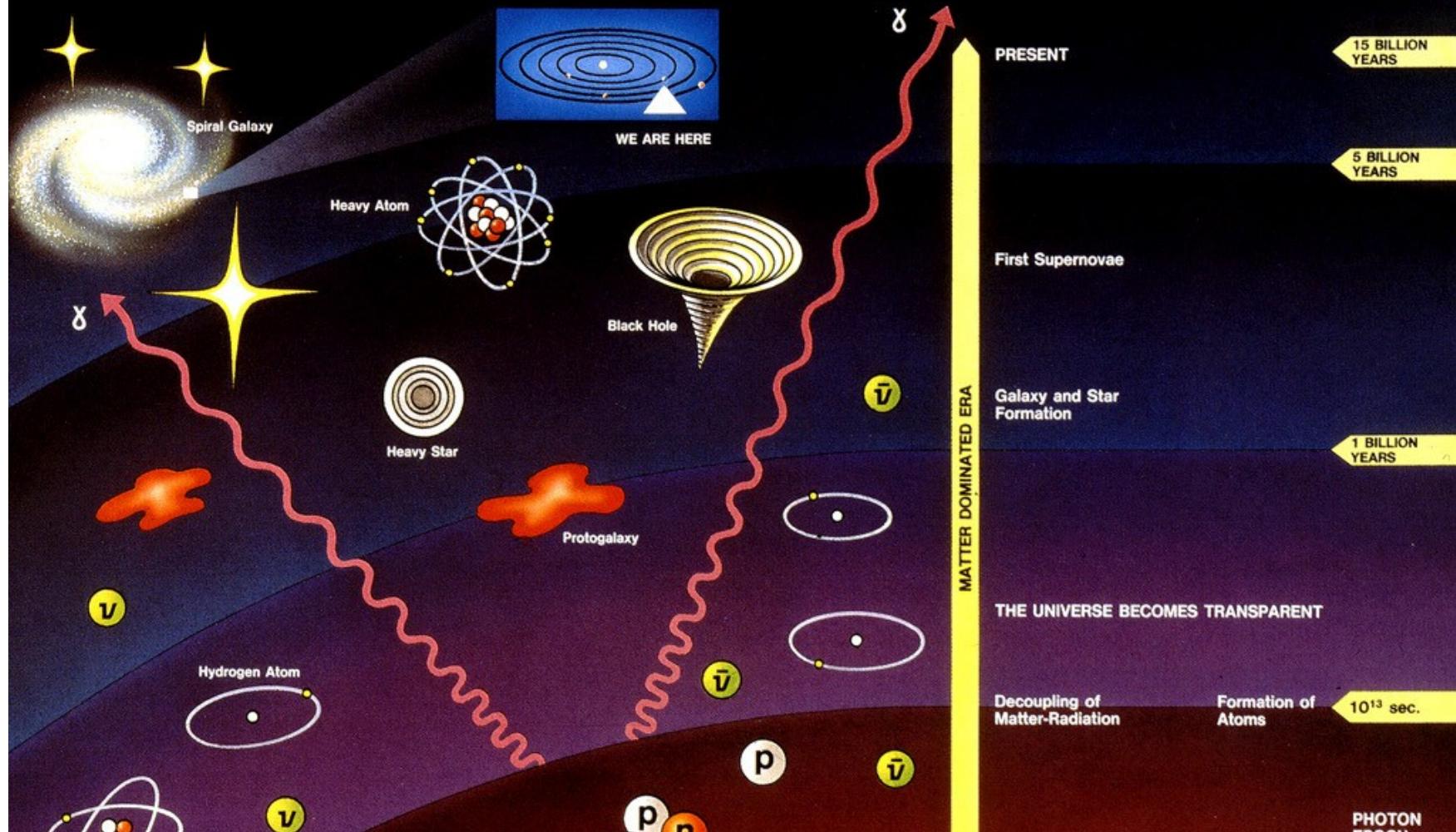


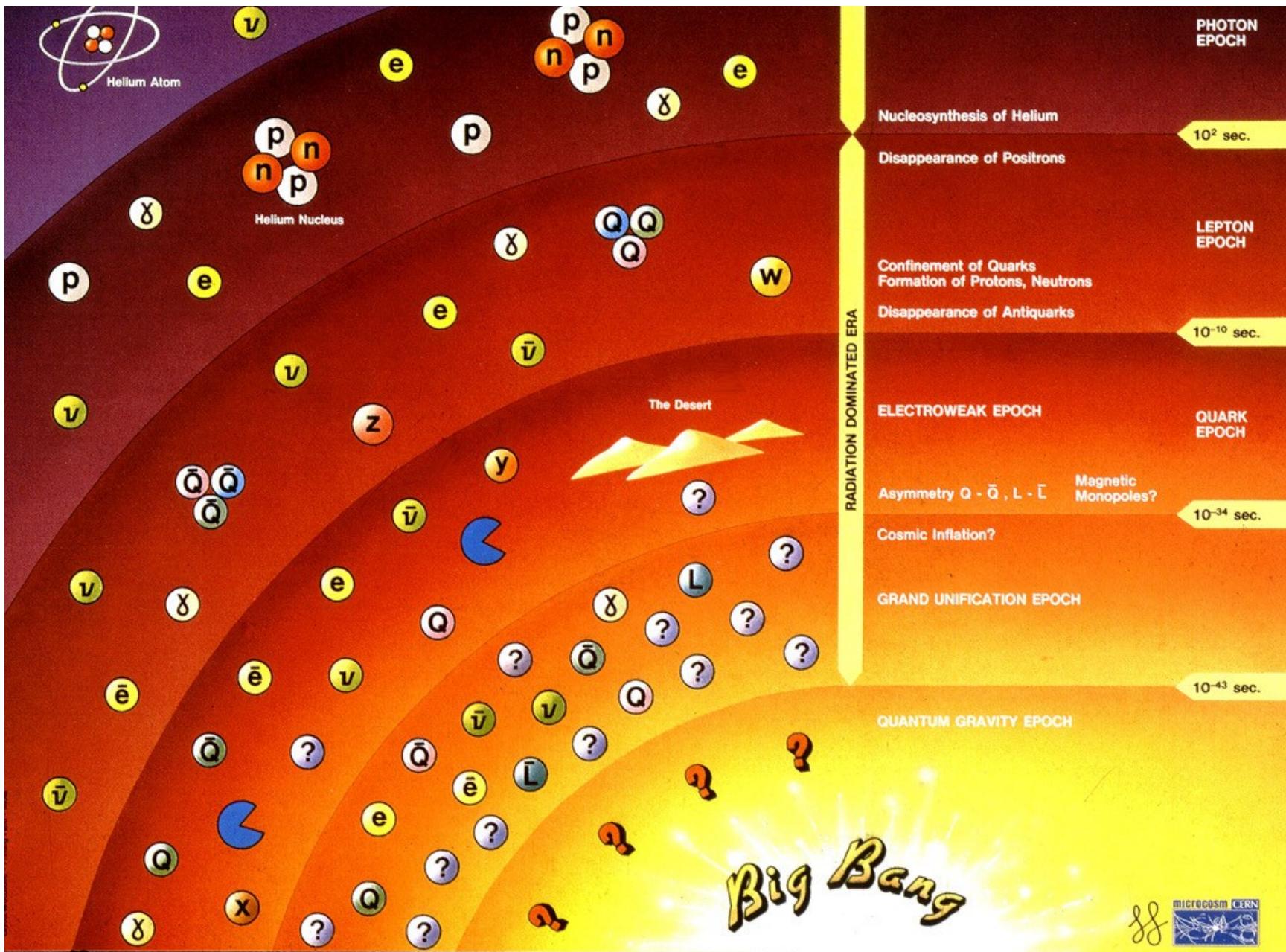
	Big Bang	quark-gluon plasma	proton & neutron formation	formation of low-mass nuclei	formation of neutral atoms	star formation	dispersion of massive elements	today
Universe time	$>10^{12}$ K 10^{-6} s	10^{12} K 10^{-4} s	10^9 K 3 min	$4,000$ K 400,000 yr	20 K– 3 K 1×10^9 yr	<20 K– 3 K $>1 \times 10^9$ yr	3 K 15×10^9 yr	



Radiation-Matter Decoupling. When atoms formed, the universe became virtually transparent to radiation. Thus, observations of the cosmic background radiation allow us to study conditions in the universe around a time at a redshift of 1500, when the temperature dropped below about 4500 K. For an explanation of how we can see a region of space 14,000 Mpc (47 billion light-years) away when the universe is just 15 billion years old

History of the Universe







The Center for Astrophysical Thermonuclear Flashes

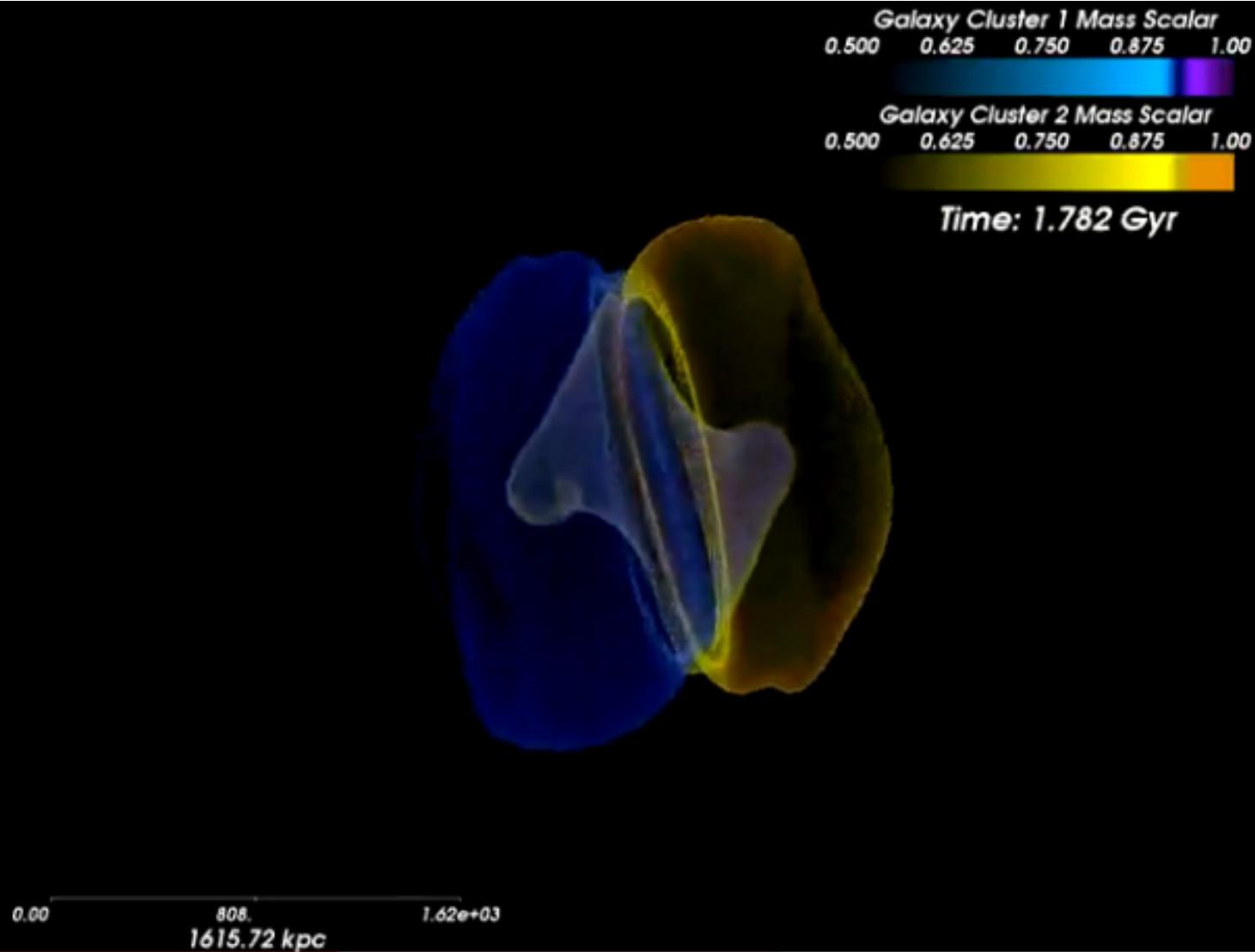
Binary Galaxy Cluster Merger Simulated using the Flash Code Mass Ratio 1:1, with an Offset Impact

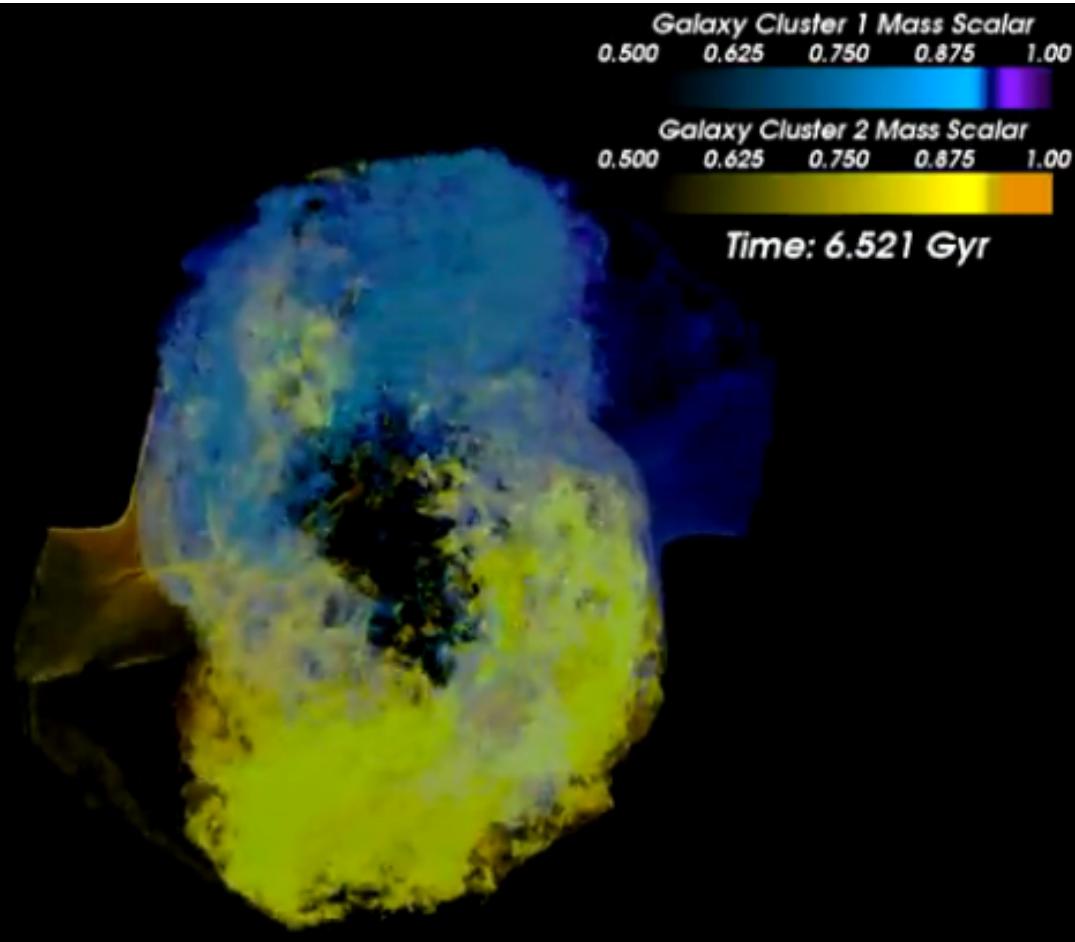
This work was supported in part by the DOE NNSA ASC ASAP and by the NSF. This work also used computational resources at the ALCF at ANL awarded under the INCITE program, which is supported by the DOE Office of Science.



An Advanced Simulation and Computation (ASC)
Academic Strategic Alliances Program (ASAP) Center
at The University of Chicago

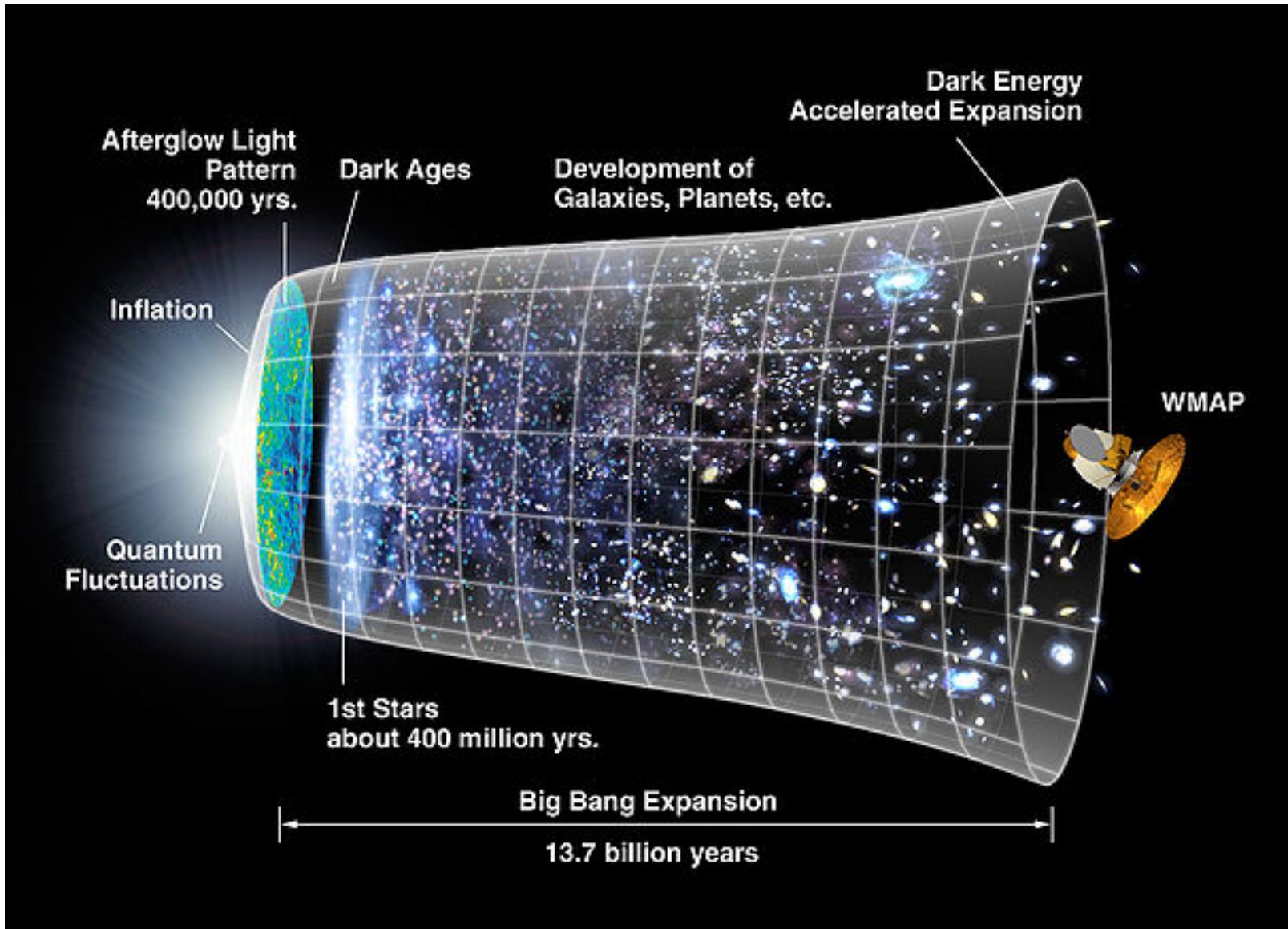






0.00 808. 1.62e+03
1615.72 kpc

Greitejantis plētimasis



“Super”-mūslės:

- Kas tai yra “tamsioji materija”?
Mikropasaulio tyrėjai turi įdėjų
- Kas tai yra “tamsioji, neigama energija”?
- Idėjų nėra, bet gal kas nors sugalvos.
 - O gal pasirodys, kad supernovų panaudojimas Visatos amžiui ir atstumams nustatinėti nėra teisingas, tada gal ši (greitėjančiai besiplečiančios Visatos) versija bus peržiūrėta

Išvados iš megapasaulio kūnų tyrimų:

- Žemei kelia pavojų Saulė (po 4-5 mlrd. metų);
- Žemei kelia pavojų asteroidai ir kometos (Saulės sistemos dariniai)
- Žemei kelia pavojų iš kitų sistemų atlekiantys kūnai;
- Žemei kelia pavojų supernova, jei ji sprogtų arti (<25 šviesmečius)

Baisu ...



"The Lord of the Rings," but this fiery swirl is actually a planetary nebula known as ESO 456-67. Set against a backdrop of bright stars, the rust-colored object lies in the constellation of Sagittarius (The Archer), in the southern sky.

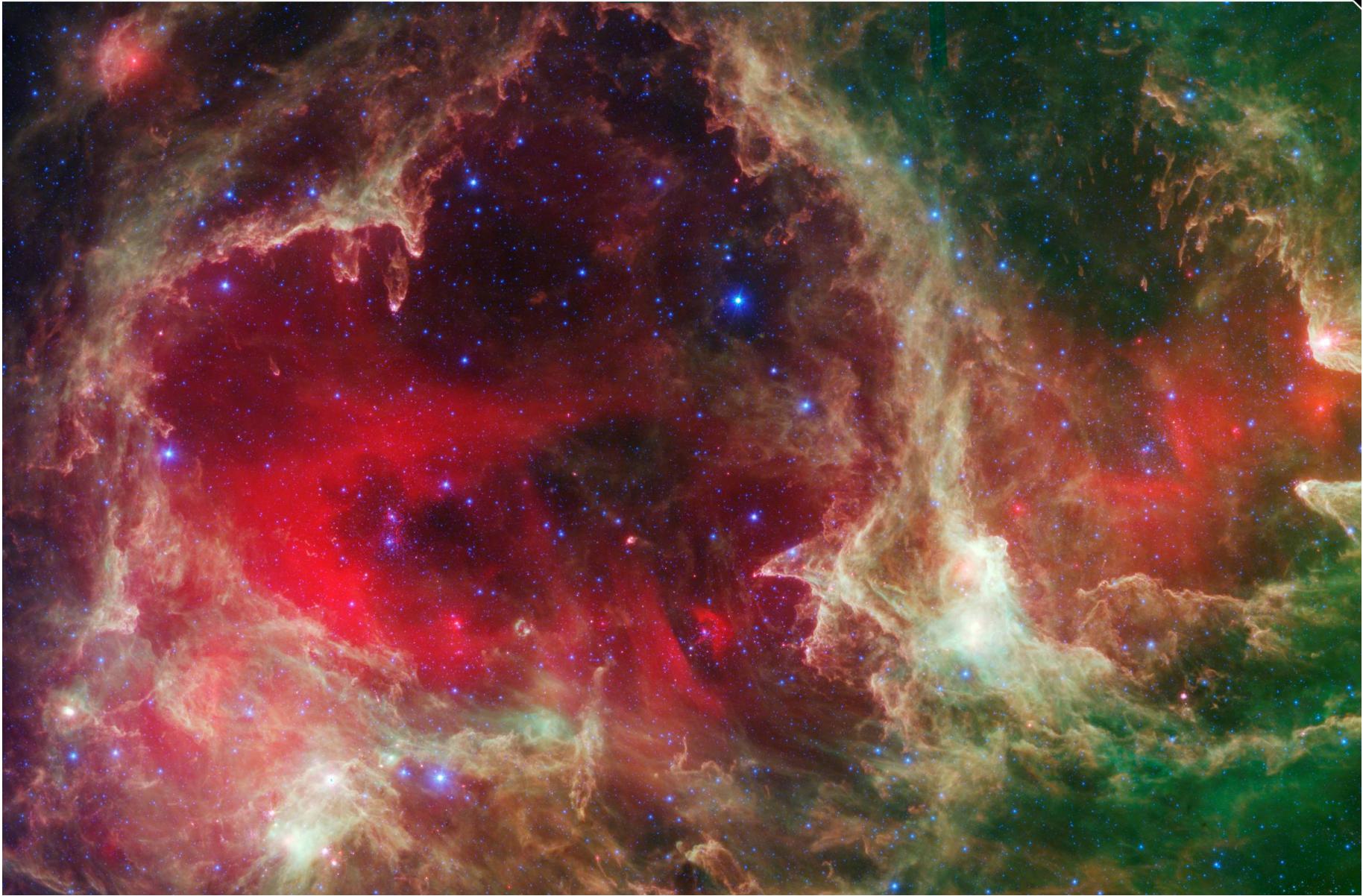
In this image of ESO 456-67, it is possible to see the various layers of material expelled by the central star. Each appears in a different hue - red, orange, yellow, and green-tinted bands of gas are visible, with clear patches of space at the heart of the nebula. It is not fully understood how planetary nebulae form such a wide variety of shapes and structures; some appear to be spherical, some elliptical, others shoot material in waves from their polar regions, some look like hourglasses or figures of eight, and others resemble large, messy stellar explosions - to name but a few.

Image Credit: ESA/Hubble and NASA



The Whirlpool Galaxy is a classic spiral galaxy. At only 30 million light years distant and fully 60 thousand light years across, M51, also known as NGC 5194, is one of the brightest and most picturesque galaxies on the sky. This image is a digital combination of a ground-based image from the 0.9-meter telescope at Kitt Peak National Observatory and a space-based image from the Hubble Space Telescope highlighting sharp features normally too red to be seen. *Image Credit: NASA/Hubble*

FPI, prof.J.Vaitkus



Generations of stars can be seen in this infrared portrait from NASA's Spitzer Space Telescope. In this wispy star-forming region, called W5, the oldest stars can be seen as blue dots in the centers of the two hollow cavities (other blue dots are background and foreground stars not associated with the region). Younger stars line the rims of the cavities, and some can be seen as pink dots at the tips of the elephant-trunk-like pillars. The white knotty areas are where the youngest stars are forming. Red shows heated dust that pervades the region's cavities, while green highlights dense clouds. *Image Credit: NASA/JPL-Caltech/Harvard-Smithsonian FPI, prof.J.Vaitkus*



FPI, prof.J.Vaitkus



This esthetic close-up of cosmic clouds and stellar winds features LL Orionis, interacting with the Orion Nebula flow. Adrift in Orion's stellar nursery and still in its formative years, variable star LL Orionis produces a wind more energetic than the wind from our own middle-aged Sun. As the fast stellar wind runs into slow moving gas a shock front is formed, analogous to the bow wave of a boat moving through water or a plane traveling at supersonic speed. The small, arcing, graceful structure just above and left of center is LL Ori's cosmic bow shock, measuring about half a light-year across. The slower gas is flowing away from the Orion Nebula's hot central star cluster, the Trapezium, located off the upper left corner of the picture. In three dimensions, LL Ori's wrap-around shock front is shaped like a bowl that appears brightest when viewed from the "bow" edge. The beautiful picture is part of a large mosaic view of the complex stellar nursery in Orion, filled with a myriad of fluid shapes associated with star formation. *Image Credit: NASA, ESA and the Hubble Heritage Team*



Andromeda's Colorful Rings

The ring-like swirls of dust filling the Andromeda galaxy stand out colorfully in this new image from the Herschel Space Observatory, a European Space Agency mission with important NASA participation.

The glow seen here comes from the longer-wavelength, or far, end of the infrared spectrum, giving astronomers the chance to identify the very coldest dust in our galactic neighbor. These light wavelengths span from 250 to 500 microns, which are a quarter to half of a millimeter in size. Herschel's ability to detect the light allows astronomers to see clouds of dust at temperatures of only a few tens of degrees above absolute zero. These clouds are dark and opaque at shorter wavelengths. The Herschel view also highlights spokes of dust between the concentric rings.

The colors in this image have been enhanced to make them easier to see, but they do reflect real variations in the data. The very coldest clouds are brightest in the longest wavelengths, and colored red here, while the warmer ones take on a bluish tinge.

These data, together with those from other observatories, reveal that other dust properties, beyond just temperature, are affecting the infrared color of the image. Clumping of dust grains, or growth of icy mantles on the grains towards the outskirts of the galaxy, appear to contribute to these subtle color variations.

These observations were made by Herschel's spectral and photometric imaging receiver (SPIRE) instrument. The data were processed as part of a project to improve methods for assembling mosaics from SPIRE observations. Light with a wavelength of 250 microns is rendered as blue, 350-micron is green, and 500-micron light is red. Color saturation has been enhanced to bring out the small differences at these wavelengths. Image credit: ESA/NASA/JPL-Caltech/NHSC

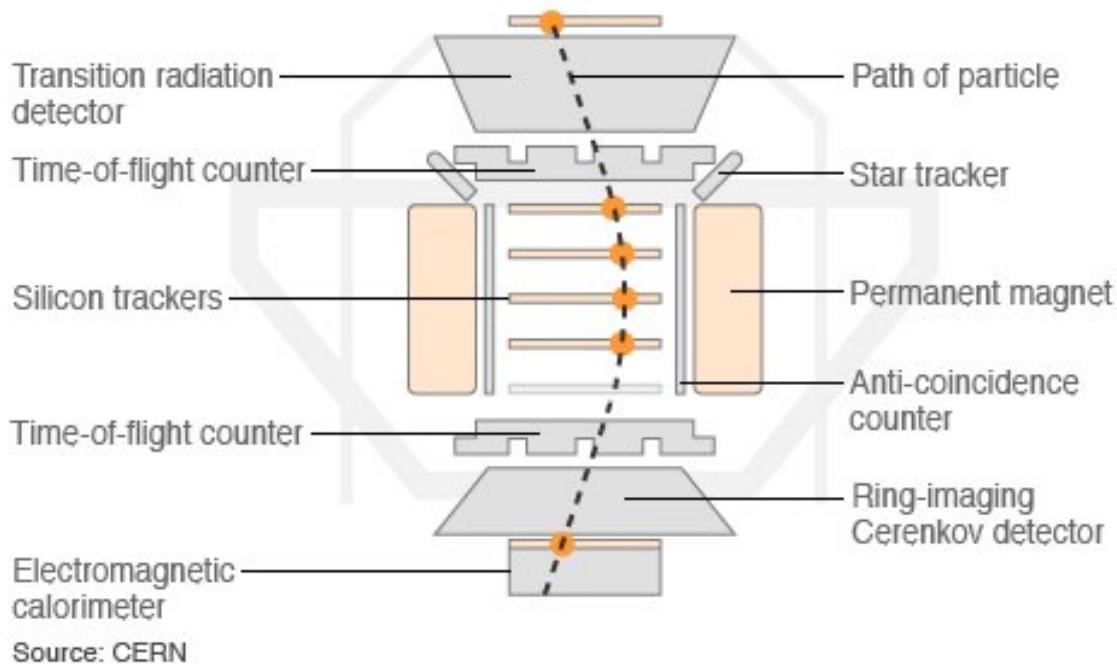


This new view of spiral galaxy IC 342, also known as Caldwell 5, includes data from NASA's Nuclear Spectroscopic Telescope Array (NuSTAR). High-energy X-ray data from NuSTAR have been translated to the color magenta, and superimposed on a visible-light view highlighting the galaxy and its star-studded arms. NuSTAR is the first orbiting telescope to take focused pictures of the cosmos in high-energy X-ray light; previous observations of this same galaxy taken at similar wavelengths blurred the entire object into one pixel.

The two magenta spots are blazing black holes first detected at lower-energy X-ray wavelengths by NASA's Chandra X-ray Observatory. With NuSTAR's complementary data, astronomers can start to home in on the black holes' mysterious properties. The black holes appear much brighter than typical stellar-mass black holes, such as those that pepper our own galaxy, yet they cannot be supermassive black holes or they would have sunk to the galaxy's center. Instead, they may be intermediate in mass, or there may be something else going on to explain their extremely energetic state. NuSTAR will help solve this puzzle.

IC 342 lies 7 million light-years away in the Camelopardalis constellation. The outer edges of the galaxy cannot be seen in this view. This image shows NuSTAR X-ray data taken at 10 to 35 kiloelectron volts. The visible-light image is from the Digitized Sky Survey. NuSTAR data only Image credit: NASA/JPL-Caltech/DSS

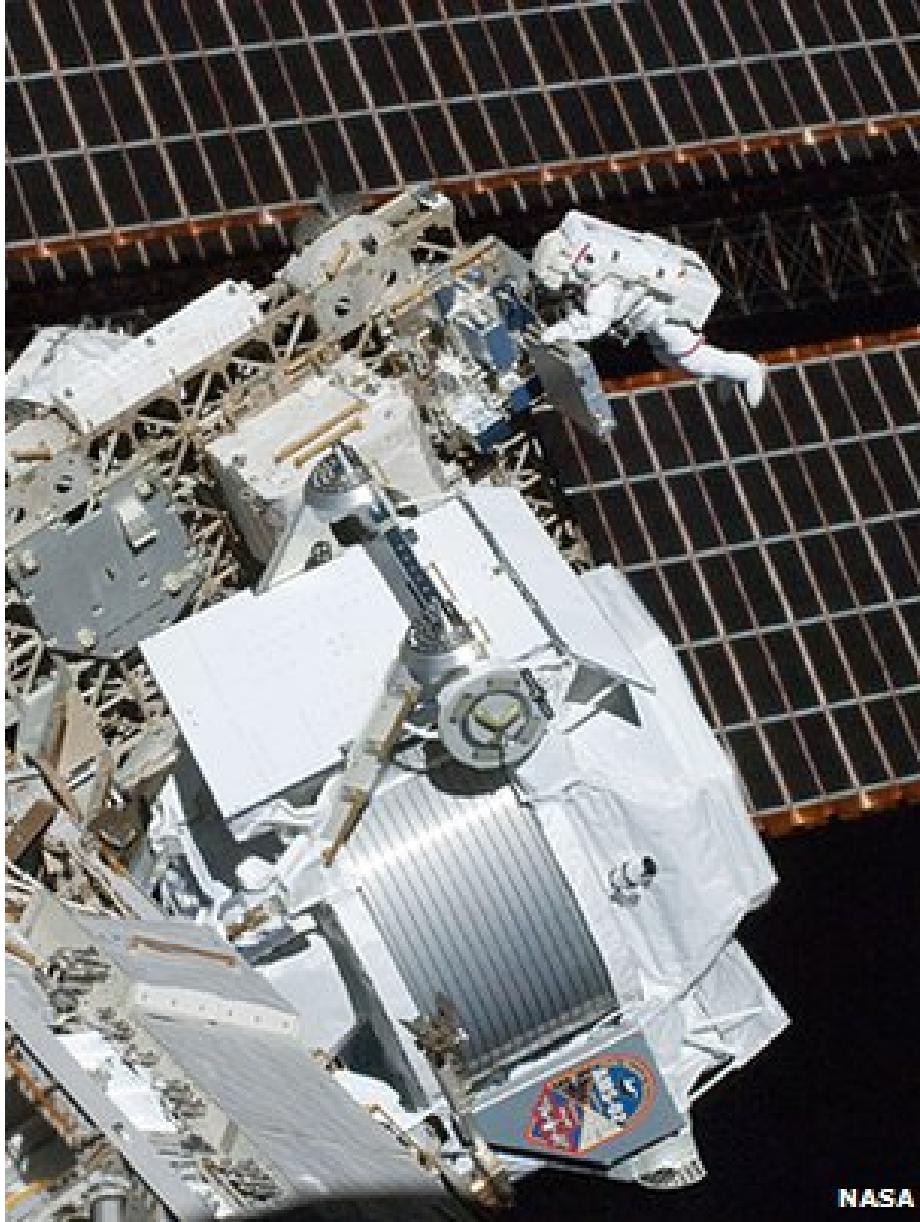
THE ALPHA MAGNETIC SPECTROMETER (AMS-02)



At the heart of the seven-tonne, \$2bn machine is a giant, specially designed magnet which bends the paths of extraordinarily high-energy charged particles called cosmic rays onto a series of detectors, giving hints of what the particles are. A series of ever-larger particle accelerators built here on Earth aim to drive particles to ever-higher energies, smashing them into one another to simulate the same processes that create them elsewhere in the cosmos. But no Earth-bound experiment can match nature's power as a particle accelerator - and Earth's atmosphere absorbs incoming cosmic rays - so the AMS will catch some of these high-energy particles "from the source", as a kind of complement to the likes of the Large Hadron Collider. In scientific terms, the stakes could not be higher. The AMS should be able to spot the results of collisions of the mysterious dark matter that makes up most of the mass of our Universe, catch completely new forms of matter that include the aptly named "strange" quark, or resolve why the Universe we see is made mostly of matter rather than antimatter.

Transition Radiation Detector determines highest-energy particle velocities. Silicon Trackers follow particle paths; how they bend reveals their charge
Permanent Magnet is core component of AMS and makes particles curve. Time-of-flight Counters determine lowest-energy particle velocities
Star Trackers scan star fields to establish AMS's orientation in space. Cerenkov Detector makes accurate velocity measurements of fast particles
Electromagnetic Calorimeter measures energy of impacting particles. Anti-coincidence Counter filters signal from unwanted side particles

THE ALPHA MAGNETIC SPECTROMETER (AMS-02)



Nobel Laureate Sam Ting said the scholarly paper to be published in a few weeks would concern dark matter.

This is the unseen material whose gravity holds galaxies together. Researchers do not know what form this mysterious cosmic component takes, but one theory points to it being some very **weakly interacting massive particle** (or Wimp for short).

Although telescopes cannot detect the Wimp, there are high hopes that AMS can confirm its existence and describe some of its properties from indirect measures.



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The largest-ever experiment in space has reported the collection of some 18 billion "cosmic ray" events that may help unravel the Universe's mysteries. The data haul is far greater than the total number of cosmic rays recorded in a full century of looking to date. Run from a centre at Cern, the Alpha Magnetic Spectrometer (AMS) aims to spot dark matter and exotic antimatter.

The astronauts who installed it on the space station in 2011 are in Geneva to see an update on how it is performing. Mission commander Mark Kelly told reporters that AMS was "the pinnacle of the science that the ISS will do". The huge number of events seen by the experiment includes some of the highest-energy particles from the cosmos that we have ever seen. Kelly's flight - the STS-134 mission - was the last for the shuttle Endeavour before it was retired from the Nasa fleet.