FUNDAMENTOS PARA O ENSINO DE ASTRONOMIA

Semana 1 (aulas 1 a 4)

O nosso Universo

Prof. Renato Pugliese
renatopugliese.wordpress.com

IFSP/Pirituba
2017

I. Apresentação

- Recepção e boas vindas;
- Levantamento inicial;
- Apresentação do curso:

I. Apresentação

Semana	Data	Conteúdo	
1	9 e 11/8	O nosso Universo (sistema solar, estrelas próximas, nossa galáxia, universo) – Cap. 1	
2	16 e 18/8	Ferramentas do astrônomo (luz, telescópios, imagens, fotometria, espectroscopia) – Cap. 2	**At. 1**
3	23 e 25/8	Astronomia Clássica (origens, mov. aparente, coordenadas) – Cap. 3	**At. 2 (I)**
4	30/8 e 1/9	Astronomia Clássica e Mecânica (fases da Lua, estações, eclipses, cinemática) – Cap. 3 e 4	
5	6/9	Mecânica celeste (mecânica newtoniana, mec. einsteiniana, caos) – Cap. 4	
6	13 e 15/9	O Sol e o Sistema Solar (dados, estrutura interna, atmosfera, atividade solar) – Cap. 5 e 6	
7	20 e 22/9	Estrelas (Sol, outras estrelas, diagrama H-R, vida, nascimento, evolução e morte) – Cap. 7	**At. 2 (II)**
8	27 e 29/9	Objetos estelares compactos (anãs, supernovas, pulsares, nêutrons, buracos negros) – Cap. 8	**At. 3 (I)**
9	4 e 6/10	A Galáxia (histórico, estrutura, constituintes, Via Láctea) – Cap. 9 e 10	
10	11/10	Galáxias (morfologia, populações, quasares, NAGs, grupos) – Cap. 11 e 12	
11	18 e 20/10	Cosmologia (evolução do Universo, expansão, modelos, origem, Big Bang) – Cap. 13	
12	25 e 26/10	Apresentação dos trabalhos finais	**At. 3 (II)**
13	a ver	Atividade - Visita ao Observatório Abrahão de Moraes (OAM)	

I. Apresentação

Bibliografia básica:

1. FRIAÇA, Amâncio C. S.; DAL PINO, Elisabete; SODRÉ JR., Laerte; JATENCO-PEREIRA, Vera (orgs). **Astronomia: uma visão geral do Universo.** EDUSP, 2ª Ed., São Paulo, 2003.

2. NASA. **Astronomy Picture of the Day (APOD).** Página na internet: apod.nasa.gov

Materiais complementares:

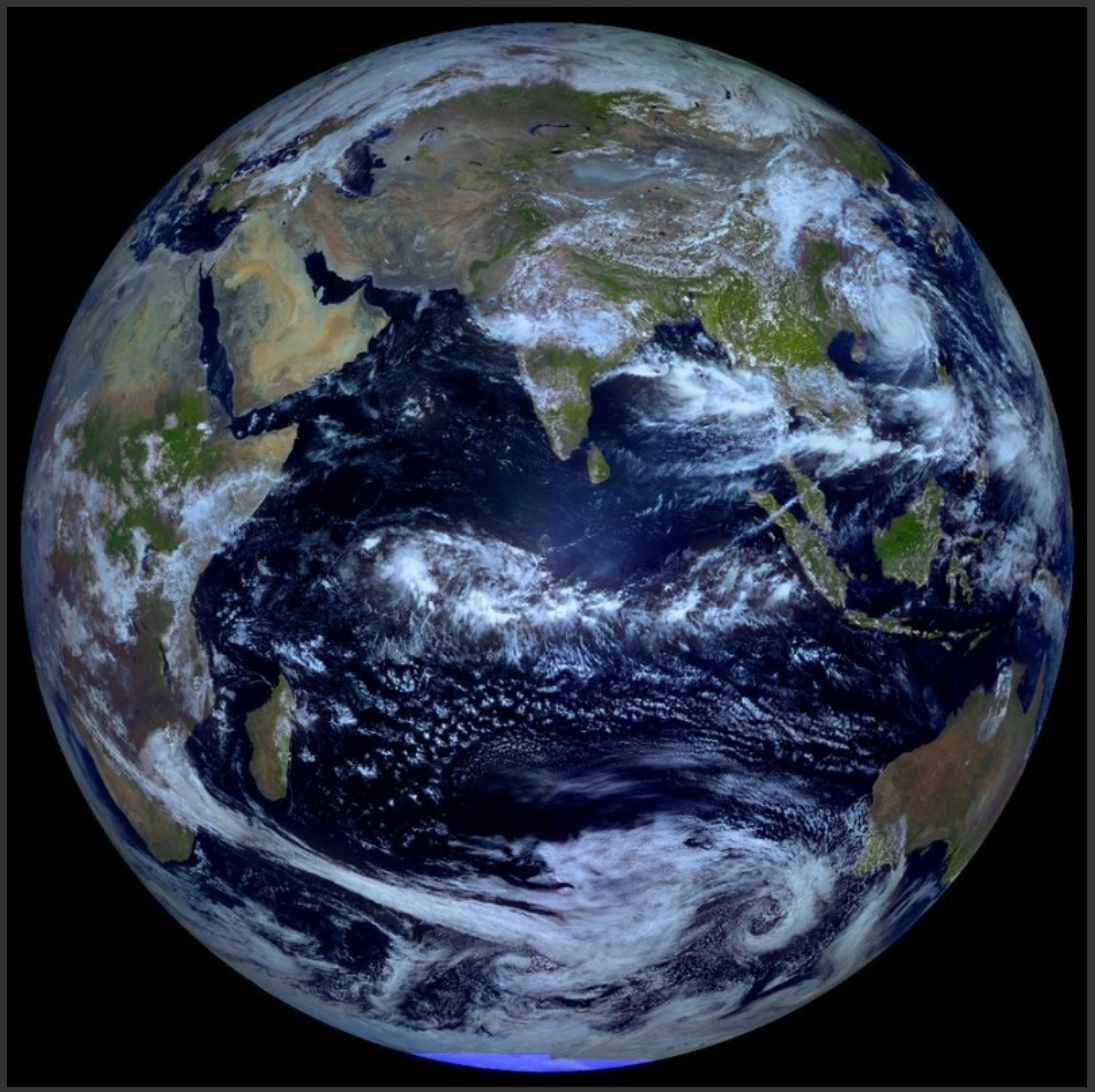
Sky Map. Aplicativo gratuito para celulares/smartphones.
Stellarium. Software gratuito para computadores.
WinStars. Software gratuito para computadores.
Carta Celeste (Star Chart). Aplicativo gratuito para celulares/smartphones.

Avaliação para certificação:

Participação e presença (mínima de 75 %);
Produção de espectroscópio (atividade 1 – semana 2);
Fotografia – Registro de posição relativa (atividade 2 – semanas 3 e 7);
Projeto de material didático (atividade 3 – semanas 8 e 12).

II. O sistema solar

Fig. 1: Equinócio terrestre



2013 September 28
Equinox Earth
Image Credit: Roscosmos / NTSOMZ / zelenyikot.livejournal.com Courtesy: Igor Tirsky, Vitaliy Egorov

Explanation: From a geostationary orbit 36,000 kilometers above the equator, Russian meteorological satellite Elektro-L takes high-resolution images of our fair planet every 30 minutes. But only twice a year, during an Equinox, can it capture an image like this one, showing an entire hemisphere bathed in sunlight. At an Equinox, the Earth's axis of rotation is not tilted toward or away from the Sun, so the solar illumination can extend to both the planet's poles. Of course, this Elektro-L picture was recorded on September 22nd, at the northern hemisphere's autumnal equinox. For a moment on that date, the Sun was behind the geostationary satellite and a telltale glint of reflected sunlight is seen crossing the equator, at the location on the planet with satellite and sun directly overhead (5MB animated gif).

II. O sistema solar

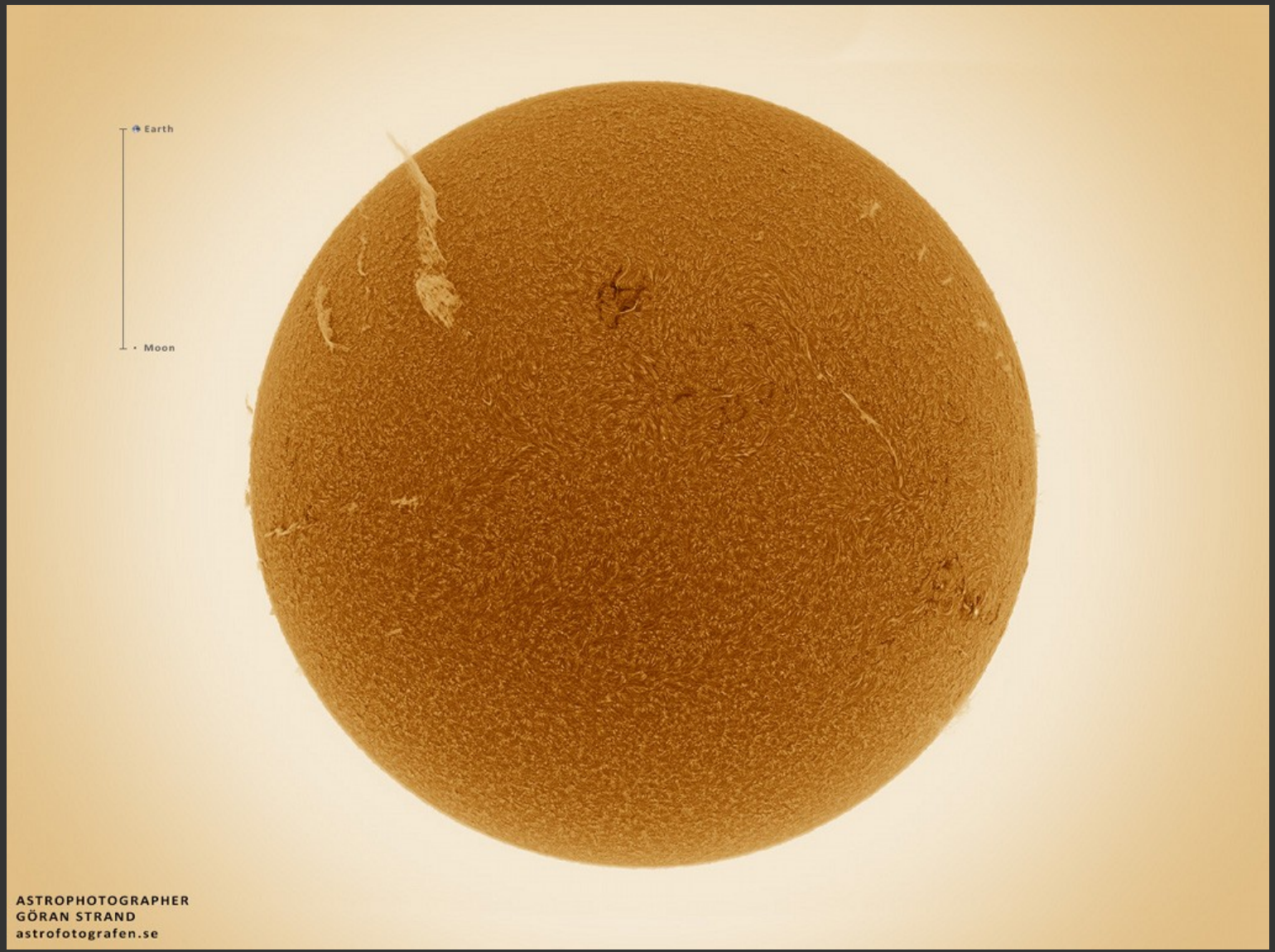
Fig. 2: Terra
Cheia, Lua
Cheia

2015 August 7
Full Moon, Full Earth
Image Credit: NASA, NOAA/DSCOVR

Explanation: The Moon was new on July 16. Its familiar nearside facing the surface of planet Earth was in shadow. But on that date a million miles away, the Deep Space Climate Observatory (DSCOVR) spacecraft's Earth Polychromatic Imaging Camera (EPIC) captured this view of an apparently Full Moon crossing in front of a Full Earth. In fact, seen from the spacecraft's position beyond the Moon's orbit and between Earth and Sun, the fully illuminated lunar hemisphere is the less familiar farside. Only known since the dawn of the space age, the farside is mostly devoid of dark lunar maria that sprawl across the Moon's perpetual Earth-facing hemisphere. Only the small dark spot of the farside's Mare Moscoviense (Sea of Moscow) is clear, at the upper left. Planet Earth's north pole is near 11 o'clock, with the North America visited by Hurricane Dolores near center. Slight color shifts are visible around the lunar edge, an artifact of the Moon's motion through the field caused by combining the camera's separate exposures taken in quick succession through different color filters. While monitoring the Earth and solar wind for space weather forcasts, about twice a year DSCOVR can capture similar images of Moon and Earth together as it crosses the orbital plane of the Moon.

II. O sistema solar

Fig. 3: Atravessando o Sol

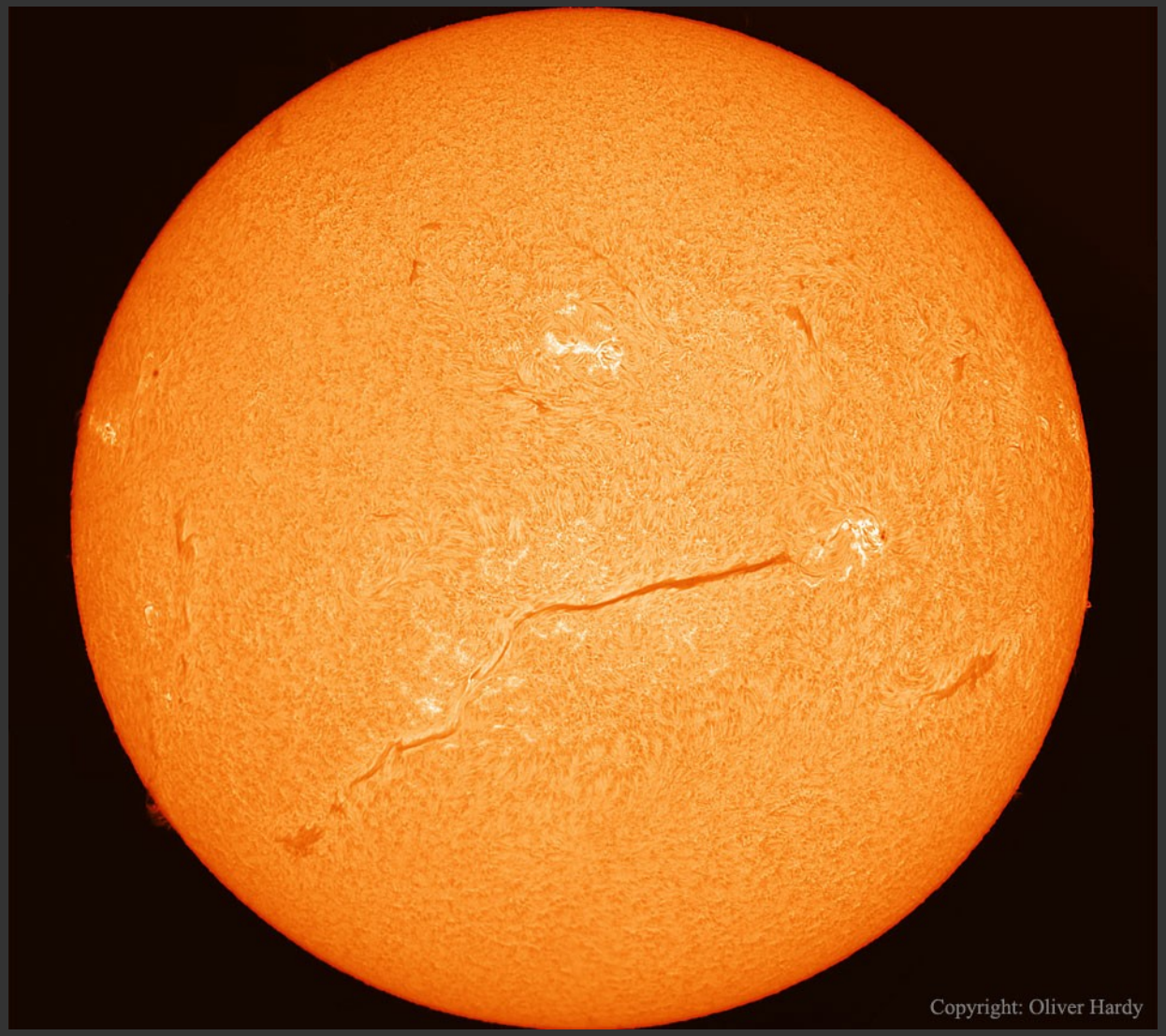


2015 April 30
Across the Sun
Image Credit & Copyright: Göran Strand

Explanation: A long solar filament stretches across the relatively calm surface of the Sun in this telescopic snap shot from April 27. The negative or inverted narrowband image was made in the light of ionized hydrogen atoms. Seen at the upper left, the magnificent curtain of magnetized plasma towers above surface and actually reaches beyond the Sun's edge. How long is the solar filament? About as long as the distance from Earth to Moon, illustrated by the scale insert at the left. Tracking toward the right across the solar disk a day later the long filament erupted, lifting away from the Sun's surface. Monitored by Sun staring satellites, a coronal mass ejection was also blasted from the site but is expected to swing wide of our fair planet.

II. O sistema solar

Fig. 4: Um filamento extremamente comprido sobre o Sol



2015 February 10
An Extremely Long Filament on the Sun
Image Credit & Copyright: Oliver Hardy

Explanation: Yesterday, the Sun exhibited one of the longest filaments ever recorded. It may still be there today. Visible as the dark streak just below the center in the featured image, the enormous filament extended across the face of the Sun a distance even longer than the Sun's radius -- over 700,000 kilometers. A filament is actually hot gas held aloft by the Sun's magnetic field, so that viewed from the side it would appear as a raised prominence. The featured image shows the filament in light emitted by hydrogen and therefore highlights the Sun's chromosphere. Sun-following telescopes including NASA's Solar Dynamics Observatory (SDO) are tracking this unusual feature, with SDO yesterday recording a spiraling magnetic field engulfing it. Since filaments typically last only from hours to days, parts of this one may collapse or erupt at any time, either returning hot plasma back to the Sun or expelling it into the Solar System. Is the filament still there? You can check by clicking on SDO's current solar image.

II. O sistema solar

Fig. 5: Uma Lua azul sangue

2015 October 03
A Blue Blood Moon
Image Credit & Copyright: Dominique Dierick

Explanation: This sharp telescopic snapshot caught late September's Harvest Moon completely immersed in Earth's dark umbral shadow, at the beginning of a total lunar eclipse. It was the final eclipse in a tetrad, a string of four consecutive total lunar eclipses. A dark apparition of the Full Moon near perigee, this total eclipse's color was a deep blood red, the lunar surface reflecting light within Earth's shadow filtered through the lower atmosphere. Seen from a lunar perspective, the reddened light comes from all the sunsets and sunrises around the edges of a silhouetted Earth. But close to the shadow's edge, the limb of the eclipsed Moon shows a distinct blue hue. The blue eclipsed moonlight is still filtered through Earth's atmosphere though, originating as rays of sunlight pass through layers high in the upper stratosphere, colored by ozone that scatters red light and transmits blue.

II. O sistema solar

Fig. 6: Buscando o homem na Lua

2016 February 1
Find the Man in the Moon
Image Credit & Copyright: Dani Caxete

Explanation: Have you ever seen the Man in the Moon? This common question plays on the ability of humans to see pareidolia -- imagining familiar icons where they don't actually exist. The textured surface of Earth's full Moon is home to numerous identifications of iconic objects, not only in modern western culture but in world folklore throughout history. Examples, typically dependent on the Moon's perceived orientation, include the Woman in the Moon and the Rabbit in the Moon. One facial outline commonly identified as the Man in the Moon starts by imagining the two dark circular areas -- lunar maria -- here just above the Moon's center, to be the eyes. Surprisingly, there actually is a man in this Moon image -- a close look will reveal a real person -- with a telescope -- silhouetted against the Moon. This featured well-planned image was taken in mid-January in Cadalso de los Vidrios in Madrid, Spain. Do you have a favorite object that you see in the Moon?

II. O sistema solar

Terra, Sol e Lua

D_{T-L} = 384.000 km = 1 segundo-luz

c = 300.000 km/s

D_{T-S} = 146.000.000 km = 8 min-luz = 1 U.A.

Outros...

Júpiter	$\Phi_J = 11.\Phi_T$	D_{J-S} = 5 U.A.
Saturno	$\Phi_{Sat} = 9.\Phi_T$	D_{Sat-S} = 10 U.A.
Plutão	D_{Plu-S} = 40 U.A. = 5,5 h-luz	

“Borda” do Sistema Solar, região de formação de cometas

$D_{borda-S}$ = 100.000 U.A. = 1,5 ano-luz

II. O sistema solar

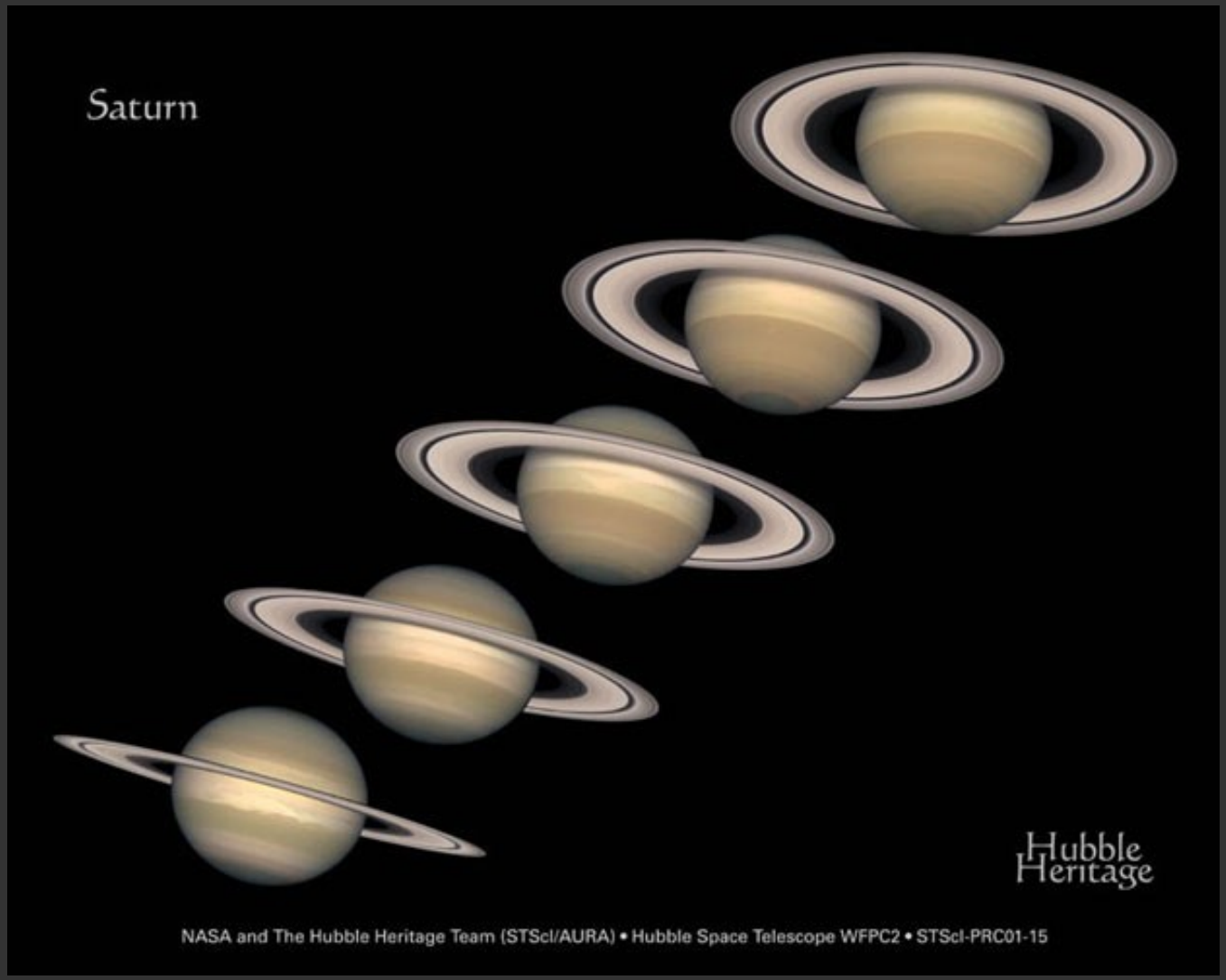
Fig. 7: Conjunção de três luas em Júpiter

2015 February 6
Jupiter Triple-Moon Conjunction
Image Credit: NASA, ESA, and the Hubble Heritage Team (STScI/AURA)

Explanation: Our solar system's ruling giant planet Jupiter and 3 of its 4 large Galilean moons are captured in this single Hubble snapshot from January 24. Crossing in front of Jupiter's banded cloud tops Europa, Callisto, and Io are framed from lower left to upper right in a rare triple-moon conjunction. Distinguishable by colors alone icy Europa is almost white, Callisto's ancient cratered surface looks dark brown, and volcanic Io appears yellowish. The transiting moons and moon shadows can be identified by sliding your cursor over the image, or following this link. Remarkably, two small, inner Jovian moons, Amalthea and Thebe, along with their shadows, can also be found in the sharp Hubble view. The Galilean moons have diameters of 3,000 to 5,000 kilometers or so, comparable in size to Earth's moon. But odd-shaped Amalthea and Thebe are only about 260 and 100 kilometers across respectively.

II. O sistema solar

Fig. 8: As estações de Saturno



2003 April 5
The Seasons of Saturn
Credit: R. G. French (Wellesley College) et al., Hubble Heritage Team (AURA / STScI / NASA)

Explanation: Since Saturn's axis is tilted as it orbits the Sun, Saturn has seasons, like those of planet Earth ... but Saturn's seasons last for over seven years. So what season is it on Saturn now? Orbiting the equator, the tilt of the rings of Saturn provides quite a graphic seasonal display. In fact, this month, Saturn's rings will reach their most "open" angle after appearing nearly edge on in the mid-1990s. The ringed planet is also well placed in evening skies providing a grand view as summer comes to Saturn's southern hemisphere and winter to the north. The Hubble Space Telescope took the above sequence of images about a year apart, starting on the left in 1996 and ending on the right in 2000. Although they look solid, Saturn's Rings are likely less than 50 meters thick and consist of individually orbiting bits of ice and rock ranging in size from grains of sand to barn-sized boulders.

II. O sistema solar

Fig. 9: Apresentando o Cometa Catalina

2015 August 18
Announcing Comet Catalina
Image Credit & Copyright: Ian Sharp

Explanation: Will Comet Catalina become visible to the unaided eye? Given the unpredictability of comets, no one can say for sure, but it seems like a good bet. The comet was discovered in 2013 by observations of the Catalina Sky Survey. Since then, Comet C/2013 US10 (Catalina) has steadily brightened and is currently brighter than 8th magnitude, making it visible with binoculars and long-duration camera images. As the comet further approaches the inner Solar System it will surely continue to intensify, possibly becoming a naked eye object sometime in October and peaking sometime in late November. The comet will reside primarily in the skies of the southern hemisphere until mid-December, at which time its highly inclined orbit will bring it quickly into northern skies. Featured above, Comet Catalina was imaged last week sporting a green coma and two growing tails.

III. As estrelas mais próximas

Fig. 10: Uma Noite Estrelada no Brasil

2009 May 9
A Starry Night in Brazil
Credit & Copyright: Babak Tafreshi (TWAN)

Explanation: This panoramic image tracing constellations in the southern sky shows off a beautiful vista toward the center of our Milky Way Galaxy. It was recorded just last month near the city of Campos in northeastern Rio de Janeiro state, Brazil. A sugar cane field from one of the historic region's local farms lies in the foreground. From left to right, the view sweeps across the Galactic Center in Sagittarius, bright stars in the tail of Scorpius, the South Celestial Pole above and right of the gap in the sugar canes, the dark Coalsack Nebula, and the Southern Cross. The closest star system, Alpha Centauri, and the giant Omega Centauri globular star cluster also shine in the starry night.

III. As estrelas mais próximas

Alfa de Centauro (α-Centauri)

$D_{\alpha\text{-Cen-S}}$ = 4 anos-luz = 20.000.$D_{Sat\text{-}S}$ = 200.000 U.A.

Sistema estelar triplo: α-Cen A e B (estrelas binárias) e Próxima Centauri

Nomenclatura clássica: Alfa, Beta, Gama, Delta... para cada constelação

Como medir a distância até a estrela?

Intensidade luminosa

Considerando α-Cen semelhante ao Sol, e sabendo que a intensidade luminosa diminui ao quadrado da distância, temos que:

Brilho aparente: $I_S = 40x10^9.I_{\alpha\text{-Cen}}$

Então: $d_{\alpha\text{-Cen}}^2 = 200.000^2 = 40x10^9$

$d_{\alpha\text{-Cen}}$ = 200.000.$D_{T\text{-}S}$ = 3 anos-luz (dados mais precisos – adiante - indicam 4,3 anos-luz)

Estrelas mais fracas visíveis a olho nu → 20 vezes mais distantes do que α-Cen (luz 400 vezes mais fraca).

III. As estrelas mais próximas

Paralaxe

Exemplo com braço-dedo-olho

Proporção inversa Ângulo-Distância

Este método funciona para estrelas a até 300 anos-luz do Sol, devido às restrições angulares.

Sirius ou Alfa de Cão Maior (α Canis Majoris)

Estrela mais brilhante no céu

$D_{T\text{-}sirius}$ = 8,6 anos-luz = 550.000.$D_{T\text{-}S}$

Se ela tivesse a mesma luminosidade do Sol, deveria ser vista 300.10^9 vezes menos brilhante que o Sol. Mas como é vista “apenas” 10.10^9 vezes mais fraca, então deve ser 30 vezes mais luminosa do que o Sol.

Conhecemos atualmente estrelas até 100.000 vezes mais brilhantes que o Sol, como estrelas 100.000 vezes menos brilhantes.

III. As estrelas mais próximas

Fig. 11: Pôr da Lua sobre simpática baía.

2010 March 29
Moonset Over Pleasant Bay
Credit & Copyright: A. Dunlap-Smith; Drawing Acknowledgement: J. Hevelius

Explanation: It was a sky for the imagination. In the early evening last week, the sky illuminating the unaided eye was perhaps even more illuminating to the mind's eye. The unaided eye saw clouds framing the Moon setting over a calm and reflective bay, spruce trees lining the nearby shores, the Pleiades open star cluster (M45) glowing prominently in the center of the sky, the Andromeda galaxy hovering just over the horizon on the right, and the belt stars of Orion lined up on the left, just below the bright orange star Betelgeuse. The bright star Sirius peeked out of the trees on the far left. The mind's eye might further imagine, however, some of the constellations coming to life, with Orion the Hunter taking up his sword and shield, followed into battle by his Big Dog (Canis Major, whose right eye is Sirius), and watched from across the sky by Cassiopeia, the Queen of Ethiopia, sitting on her Throne. The above image was taken over Pleasant Bay, Maine, USA, and digitally merged with constellations from Uranographicarum, drawn in the 17th century by J. Hevelius.

IV. A nossa Galáxia

Fig. 12: Via-Láctea sobre Agulhas na Austrália

2016 February 17
Milky Way over the Pinnacles in Australia
Image Credit: Michael Goh

Explanation: What strange world is this? Earth. In the foreground of the featured image are the Pinnacles, unusual rock spires in Nambung National Park in Western Australia. Made of ancient sea shells (limestone), how these human-sized picturesque spires formed remains unknown. In the background, just past the end of the central Pinnacle, is a bright crescent Moon. The eerie glow around the Moon is mostly zodiacal light, sunlight reflected by dust grains orbiting between the planets in the Solar System. Arching across the top is the central band of our Milky Way Galaxy. Many famous stars and nebula are also visible in the background night sky. The featured 29-panel panorama was taken and composed last September after detailed planning that involved the Moon, the rock spires, and their corresponding shadows. Even so, the strong zodiacal light was a pleasant surprise.

IV. A nossa Galáxia

O Sol e as estrelas próximas (α-Cen, por exemplo), encontram-se a 30.000 anos-luz do centro desse sistema estelar que forma nossa Galáxia, usualmente chamada de **Via-Láctea**, e que contém cerca de 100 bilhões de estrelas.

Forma de disco.

$V_{S\text{-}centro.galáxia}$ = 250 km/s (1 volta a cada 250 milhões de anos)

Δt(Sistema Solar) = 5 bilhões de anos-luz

$\Phi_{galáxia}$ = 100.000 anos-luz

Centro da Via-Láctea (visto da Terra) → Entre Escorpião e Sagitário

IV. A nossa Galáxia

Nebulosa de Órion (próxima das Três Marias):

$\Phi_{nebulosa}$ = 15 anos-luz;

$d_{S\text{-}nebulosa}$ = 1200 anos-luz.

Estrelas jovens, mais quentes, luminosas e maiores do que o Sol

Rigel (α-Ori): cor branca-azulada (13000 ºC); Supergigante Azul; $d_{T\text{-}Rigel}$ = 800 anos-luz.
Estrelas muito maiores do que o Sol acabam em uma **Supernova**.
Betelgeuse (β-Ori): cor avermelhada (3000 ºC); Gigante vermelha (mil vezes maior que o Sol).

2015 March 26
Orion Spring
Image Credit & Copyright: Bill Dickinson

Fig. 13: Primavera de Órion

Explanation: As spring comes to planet Earth's northern hemisphere, familiar winter constellation Orion sets in early evening skies and budding trees frame the Hunter's stars. The yellowish hue of cool red supergiant Alpha Orionis, the great star Betelgeuse, mingles with the branches at the top of this colorful skyscape. Orion's alpha star is joined on the far right by Alpha Tauri. Also known as Aldebaran and also a giant star cooler than the Sun, it shines with a yellow light at the head of Taurus, the Bull. Contrasting blue supergiant Rigel, Beta Orionis, is Orion's other dominant star though, and marks the Hunter's foot below center. Of course, the sword of Orion hangs from the Hunter's three blue belt stars near picture center, but the middle star in the sword is not a star at all. A slightly fuzzy pinkish glow hints at its true nature, a nearby stellar nursery visible to the unaided eye known as the Orion Nebula.

IV. A nossa Galáxia

Fig. 14: No coração de Órion

2015 January 2
At the Heart of Orion
Image Credit & Copyright: László Francsics

Explanation: Near the center of this sharp cosmic portrait, at the heart of the Orion Nebula, are four hot, massive stars known as the Trapezium. Tightly gathered within a region about 1.5 light-years in radius, they dominate the core of the dense Orion Nebula Star Cluster. Ultraviolet ionizing radiation from the Trapezium stars, mostly from the brightest star Theta-1 Orionis C powers the complex star forming region's entire visible glow. About three million years old, the Orion Nebula Cluster was even more compact in its younger years and a dynamical study indicates that runaway stellar collisions at an earlier age may have formed a black hole with more than 100 times the mass of the Sun. The presence of a black hole within the cluster could explain the observed high velocities of the Trapezium stars. The Orion Nebula's distance of some 1,500 light-years would make it the closest known black hole to planet Earth.

IV. A nossa Galáxia

Sirius B: Anã-branca → 10000 km de diâmetro (equiv. à Terra) ; massa equiv. ao Sol (!);

Entrela de nêutrons (~1967) ou Buracos Negros → Altíssima densidade.

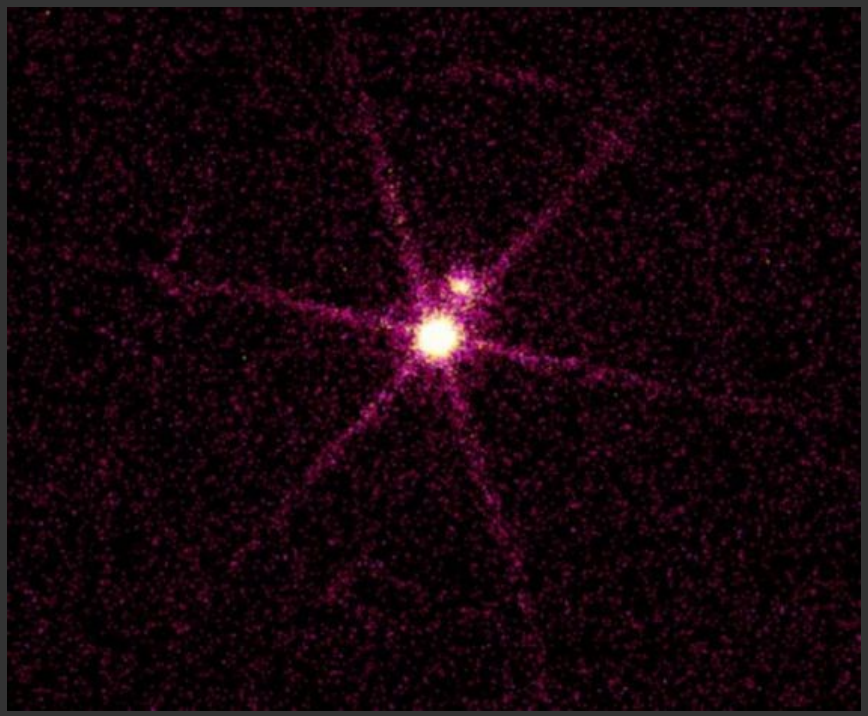


Fig. 15: Raio-X da Sírius B

2000 October 6
X-Rays From Sirius B
Credit: NASA/ CXC/ SAO

Explanation: In visible light Sirius A (Alpha Canis Majoris) is the brightest star in the night sky, a closely watched celestial beacon throughout recorded history. Part of a binary star system only 8 light-years away, it was known in modern times to have a small companion star, Sirius B. Sirius B is much dimmer and appears so close to the brilliant Sirius A that it was not actually sighted until 1862, during Alvan Clark's testing of a large, well made optical refracting telescope. For orbiting x-ray telescopes, the Sirius situation is exactly reversed, though. A smaller but hotter Sirius B appears as the overwhelmingly intense x-ray source in this Chandra Observatory x-ray image (lines radiating from Sirius B are image artifacts). The fainter source seen at the position of Sirius A may be largely due to ultraviolet light from the star leaking into the x-ray detector. With a surface temperature of 25,000 kelvins, the mass of the Sun, and a radius just less than Earth's, Sirius B is the closest known white dwarf star. Can you guess what makes Sirius B like Neptune, the Sun's most distant gas giant planet? While still unseen, the presence of both celestial bodies was detected based on their gravitational influence alone ... making them early examples of dark matter.

V. A Galáxia e suas vizinhas: o Grupo Local

Afastando-nos 50 vezes o tamanho da nossa Galáxia temos o Grupo Local, contendo pouco mais de 30 galáxias, incluindo as **Nuvens de Magalhães** (200.000 anos-luz) e a galáxia de **Andrômeda** (2 milhões de anos-luz).

Galáxias podem ser espirais, elípticas, entre outras. Em seu núcleo, em caso de atividade recente, podem ter quasares e buracos negros.

2015 August 30
M31: The Andromeda Galaxy
Image Credit & Copyright: Robert Gendler

Fig. 16: M31: A galáxia de Andrômeda

Explanation: What is the nearest major galaxy to our own Milky Way Galaxy? Andromeda. In fact, our Galaxy is thought to look much like Andromeda. Together these two galaxies dominate the Local Group of galaxies. The diffuse light from Andromeda is caused by the hundreds of billions of stars that compose it. The several distinct stars that surround Andromeda's image are actually stars in our Galaxy that are well in front of the background object. Andromeda is frequently referred to as M31 since it is the 31st object on Messier's list of diffuse sky objects. M31 is so distant it takes about two million years for light to reach us from there. Although visible without aid, the above image of M31 is a digital mosaic of 20 frames taken with a small telescope. Much about M31 remains unknown, including exactly how long it will before it collides with our home galaxy.

VI. Aglomerados de galáxias e o Universo

Fig. 17: HCG 87: um pequeno grupo de galáxias

Aglomerados de galáxias são comuns no Universo.

Não há uniformidade na distribuição de aglomerados. São espaços vazios e aglomerados aleatórios.

Há mais matéria (e energia) no Universo do que podemos identificar hoje. Cerca de 90% da energia no Universo é desconhecida, a qual chamamos **Energia (ou Matéria) Escura**.

Também é sabido que os aglomerados estão se afastando uns dos outros e, quanto mais distantes estão, mais velozmente se afastam, o que nos levou ao conceito do **Big Bang**, explosão ocorrida há uns 15 bilhões de anos.

2015 August 9
HCG 87: A Small Group of Galaxies
Image Credit: GMOS-S Commissioning Team, Gemini Observatory

Explanation: Sometimes galaxies form groups. For example, our own Milky Way Galaxy is part of the Local Group of Galaxies. Small, compact groups, like Hickson Compact Group 87 (HCG 87) shown above, are interesting partly because they slowly self-destruct. Indeed, the galaxies of HCG 87 are gravitationally stretching each other during their 100-million year orbits around a common center. The pulling creates colliding gas that causes bright bursts of star formation and feeds matter into their active galaxy centers. HCG 87 is composed of a large edge-on spiral galaxy visible near the image center, an elliptical galaxy visible to its right, and a spiral galaxy visible near the top. The small spiral near the center might be far in the distance. Several stars from our Galaxy are also visible in the foreground. Studying groups like HCG 87 allows insight into how all galaxies form and evolve.

VII. Retrospectiva

Terra, Lua, Sol...

Júpiter, Saturno...

Estrelas mais próximas...

Nossa Galáxia...

Aglomerados...

Quasares...

Limites do Universo conhecido.

E (n)o futuro?

VIII. Atividade

Durante a aula:

- Participar de levantamento de dados acerca da área de atuação e possíveis intervenções no ensino básico.

Após a aula:

- Observar no céu (9/8):

  18:30 h – Cruzeiro do Sul (40º; sudoeste), Júpiter (50º; oeste), Saturno (60º; leste);

  21:00 h – Lua ascendendo (20º; leste), Júpiter se pondo (20º; oeste), Saturno (75º; oeste).

- Ler capítulos 1 e 2 do texto base (disponível no blog renatopugliese.wordpress.com);

- Conhecer o site APOD e verificar como funciona o sistema de busca.