SUBJECT

A

Abell 31 (PN G219.1 + 31.2; Sharpless 2-290) (planetary nebula), 1:72 Abell 33 (planetary nebula), 12:73 Abell 66 (planetary nebula), 11:71 Abell 1656 (Coma galaxy cluster), 10:73 Abell 1689 (galaxy cluster), 5:15 Abell 2744 (Pandora's Cluster) (galaxy cluster), 12:9 Acrturus (Alpha Boötis) (star), 2:70 active galactic nuclei (AGNs), 5:50-51 Advanced Telescope for High Energy Astrophysics (ATHENA), 10:19 air glow, 12:72 AL (Astronomical League), 8:17 ALMA. See Atacama Large Millimeter/submillimeter Array (ALMA) Alpha Boötis (Acrturus) (star), 2:70 Alpha Ursae Minoris. See Polaris (Alpha Ursae Minoris; North Star) Alpha Virginis (Spica) (star), 12:28–29 ALTASGAL survey, 9:17 Amalthea (moon of Jupiter), 12:22 amateur astronomy accessories for, 2:18 clubs, 11:14 observatory construction, 3:54-56 Amateur Telescope Makers of Boston (ATMoB), 11:14 Andromeda Galaxy (M31) distance to Milky Way, 6:20 observing, 10:19 Andromeda II (dwarf galaxy), 6:20 Antares (star), 8:73, 10:73 antihydrogen, 10:13 antimatter, annihilation and dark energy, 2:34-35 argon, in nebulae, 4:15 arXiv.org website, 8:12 asteroids See also names of specific asteroids centaurs, 1:19, 7:11 collision between, 12:14 crowdsourcing of detection of, 3:13 effect on early Earth, 12:9 gravitational effect of Mars on, 3:11 held together by van der Waals force, 12:12 occultations by, 3:16 regolith layer, 8:12 retrieval of, 3:22-27 "rock comets", 1:18 sketching, 5:66 triple, 2:20 astroimaging colorful images, 8:68 comets, 4:64 contrast, 3:20 double color layer, 9:82

lightening/darkening image layers, 5:67 luminance images, 10:68 masking, 1:66, 11:66, 12:68 Moon, 10:58–61 nebulae, 2:52-55 processing operators, 7:66 profiles of astroimagers, 4:58-61, 7:46-51, 8:60-63 reinventing, 2:66 astronauts account of first manned lunar landing, 8:22-27 interview with, 9:52-55 Astronomical League (AL), 8:17 astronomical sketching See also subjects of sketches by name animating sketches of Moon's phases, 9:70-73 asteroids, 5:66 blending stumps, 6:66 comparing sketches with different magnifications, 9:84 globular clusters, 11:64 Horsehead Nebula, 1:68 Jupiter's atmosphere, 3:68 lunar eclipse, 10:66 Messier marathons, 3:60-63 open clusters, 12:66 processing with photo-editing tools, 4:66 realistic eyepiece sketches, 2:65 Rosette Nebula, 1:68 supernovae, 7:68 using tortillons, 11:64 astronomy See also amateur astronomy average number of clear days in March by state, 3:13 average number of clear days in July by state, 7:13 average number of clear days in October by state, 10:19 celestial rhythms, 1:11 contentious subjects and disputes in. 9:11 effects of U.S. government shutdown on, 1:13 enhancing observation with filters, 7:52-55 exposure times, 7:44 forecasts on future of, 9:24-31 free tools on Internet for, 1:20, 12:20 "goosebump" moments in, 11:56-59 near-Earth, 3:15 observations in fall, 8:56-59 observations near North Celestial Pole, 5:56-59 observatories in Chile, 12:58-63 perception of beauty and reaction to celestial objects, 5:11 perception of color, 8:18 popular Google search terms, 2:12 remote observing, 6:60-63 sustainable technology and, 4:55-57 top ten stories of 2013, 1:24-33 astronomy clubs, 11:14 Astronomy magazine Out-of-this-world Award, 1:16 Star Products, 9:74-81

Tucson Public Star Party, 9:60-65 Atacama Large Millimeter/submillimeter Array (ALMA) black holes, 2:15 Boomerang Nebula, 2:19 final antenna for, 2:21 overview of, 6:28-33 protoplanetary disks, 2:15 visit to, 12:58-63 ATHENA (Advanced Telescope for High Energy Astrophysics), 10:19 ATLASGAL survey, 11:22 ATMoB (Amateur Telescope Makers of Boston), 11:14 aurorae black, 6:14 images of, 4:72, 9:89 on Saturn, 6:9, 9:13 studying Earth's magnetic field, 10:16 viewing from the Arctic, 7:56-59

В

Baby Nebula (IC 1848), 12:73 Background Imaging of Cosmic Extragalactic Polarization (BICEP) 2 instrument, 6:12, 10:12 Barnard 33. See Horsehead Nebula (Barnard 33) Barnard 343 (dark nebula), 5:73, 9:18 baryon acoustic oscillations (BAOs), 5:19, 11:44-49 Baryon Oscillation Spectroscopic Survey (BOSS), 11:44-49 Bauer, James, 1:19 Beehive Cluster (M44), 3:12 Beta Pictoris b (exoplanet) image of, 4:9 opportunity to study atmosphere of, 9:12 rotation of, 8:13 Beta Pictoris (star), 7:16 Betelgeuse (red giant star), 12:29-31 BICEP (Background Imaging of Cosmic Extragalactic Polarization) 2 instrument, 6:12, 10:12 binary star systems See also names of specific binary star systems with misaligned planet-forming disks, 11:22 radio wave bursts from, 4:14 Struve catalog of, 10:18 binocular astronomy observations in fall, 10:62-63 observations in summer, 7:60-61 Virgo cluster, 3:64–65 black holes at center of dwarf galaxies, 5:13 at center of Milky Way, 1:18, 28, 5:16, 22 clouds orbiting, 6:13 clusters of, 9:13, 10:13 gas outflows from, 10:17 hydrogen cyanide around, 2:20 idea of "universes" existing within, 8:9 kinetic wind beyond Eddington limit, 6:17 learning about from brown dwarfs, 5:16 metals in jets from, 3:10 midsized, 12:12

molecular gas warmed by jets from, 11:13 observed by ALMA, 2:15 overview of. 10:22-27 part of system with Be-type star, 5:13 particle and radiation jets streaming from, 1:26, 3:11 periods of high and low activity, 10:35 primordial (PBHs), 8:34-35 seeding of supermassive, 5:16 spin of, 3:34-35, 6:35, 7:12 two near center of galaxy, 8:12 ultraluminous X-ray source, 3:14 X-rays from corona of, 12:12 Blue Horsehead Nebula (IC 4592), 8:73 Boomerang Nebula, 2:19 BOSS (Baryon Oscillation Spectroscopic Survey), 11:44-49 brown dwarfs coldest, 3:14, 8:12 difference between planets and, 4:51 dividing line between stars and, 4:15 fast-moving, 3:10 image of, 5:9 learning about black holes from, 5:16 storm systems on, 5:15 temperature of coldest known, 1:13

С

Calabash Nebula, 6:20 calcium-rich transients, 12:18 California Nebula (NGC 1499), 12:16 Callisto (moon of Jupiter), 12:22 cameras, charged coupled devices, 1:35, 3:66-67 Carina Nebula (NGC 3372), 1:72, 9:90 Carme (moon of Jupiter), 12:22 Cassini spacecraft cloud formation on Titan, 12:13 image of Saturn eclipsing Sun, 2:21 internal ocean on Enceladus, 8:12 possible birth of new moon, 8:13 Cassiopeia A (supernova remnant), 3:11, 4:15, 6:16, 10:44-49 CCDs (charged coupled devices), 1:35, 3:66-67 Celestron NexStar Evolution 8 telescope, 12:64–65 Skyris charge-coupled device (CCD) cameras, 3:66-67 StarSense AutoAlign telescope mount alignment accessory, 7:62-63 centaurs research into, 1:19 rings around, 7:11 Centaurus A (NGC 5128) (galaxy), 8:73 Cepheid variable stars, 4:10, 9:20 Ceres (dwarf planet) Dawn spacecraft, 3:44-49 observing, 5:52-53 water vapor on, 5:12 Chandra X-ray Observatory causes of type Ia supernovae, 12:13

extension of mission, 9:21 new head of, 7:13 observations of Whirlpool Galaxy, 10:13 research into M87, 5:24-29 top 10 discoveries by, 7:24-29 Chang'e-3 mission, 4:18 Characterising ExOPlanet Satellite (CHEOPS), 11:18 charged coupled devices (CCDs), 1:35, 3:66-67 Chicxulub asteroid, 7:16 Christmas Tree Cluster (NGC 2264), 9:88 Cigar Galaxy (M82), 4:9, 5:16, 72 Circinus (galaxy), 7:7 citizen science, 7:12 CMB. See cosmic microwave background (CMB) Coalsack region, 9:90 Cocoon Galaxy (NGC 4490), 7:73 Coma galaxy cluster (Abell 1656), 10:73 Comet 9P/Tempel, 1:12 Comet 67P/Churyumov-Gerasimenko, 5:12, 11:26-31 Comet 81P/Wild 2, 1:9 Comet C/2011 L4 (PANSTARRS), 1:30 Comet C/2012 S1 (ISON) break up of, 3:11, 11:22 Earth's passage through debris field, 8:34 image taken by Hubble, 1:74 images of, 2:50-51 overview of, 1:30, 56-61, 3:50-53 photo contest winners, 6:72-73 Comet C/2012 V2 (LINEAR), 2:69 Comet C/2013 R1 (LOVEJOY), 4:72 Comet C/2014 E2 (JACQUES), 12:73 comets See also names of specific comets around Beta Pictoris, 7:16 asteroid with comet-like tails, 3:18 Charles Messier and, 2:9 fragment of nucleus of, 2:13 organic molecules in, 12:18 origin of life and, 1:9, 12 computer models, defined, 4:50-51 Cone Nebula, 9:88 constellations See also names of specific constellations brightness of, 11:12 relative sizes of, 4:22 upside-down appearance in Southern Hemisphere, 4:50 Cordiner, Martin, 12:18 Cortese, Luca, 8:16 cosmic dust amount falling to Earth, 9:56 artificially-created grains, 9:13 collecting and studying, 2:56-59 newly-found rare particles, 12:14 research into, 8:16 supernovae as source of, 5:21, 11:13 cosmic inflation, 6:12

cosmic microwave background (CMB) cosmic inflation, 6:12 origin of, 6:34 research into, 1:31 cosmic rays accelerated by supernovae, 1:32 coming from Ursa Major, 11:17 research into origin of, 4:30-35 Cosmos (PBS series), 4:12-13, 8:9, 11 Crab Nebula (M1), 4:15 craters See also names of specific craters on Mars, 6:10, 8:9 on Moon, 1:14, 3:19 Crescent Nebula (NGC 6888), 2:68, 11:73 Crimson Butterfly Nebula (NGC 2346), 2:14 Csengeri, Timea, 11:22 Curiosity rover analysis of soil, 1:30-31 lack of methane in martian atmosphere, 2:13 latest findings, 1:44-49 meteorites from Mars, 2:16 wear and damage after two years, 12:13 Cygnus the Swan (constellation), 10:50-53 Cygnus X-1 (binary system), 9:10

D

Dactyl (moon of Ida), 6:27 Daphnis (moon of Saturn), 6:24 dark energy, matter-antimatter annihilation and, 2:34-35 dark flow, 3:35 dark matter at center of Milky Way, 8:16 density of, 1:9 "missing mass" problem and, 4:24-29 origin of idea, 12:9 primordial black holes as possible source of, 8:34 dark nebulae, 10:73 Dawn spacecraft, 3:44-49 Deep Impact spacecraft, 1:12 density of materials, 2:11 Discovery Channel Telescope (DCT), 5:44-49 Double Bubble Nebula (NGC 2371-2), 2:14 double stars. See binary star systems; names of specific binary star systems Dreyer's Nebula (IC 2169), 11:71 dual-personality pulsars, 1:16 Dupuy, Trent J., 3:14 dwarf galaxies discovery of, 11:13 observing, 11:20 ultra-compact, 1:12 ultraviolet radiation from, 11:12 X-ray emissions from central black hole of, 5:13 dwarf planets, argument against Pluto's status as, 9:9

E

Earth amount of cosmic dust falling to, 9:56 amount of solar energy reaching, 12:12 center of, 10:11 comparison of dry surface area with other solar system bodies, 11:23 composition of atmosphere at sea level, 10:17 distance to Milky Way's center, 7:11 effect of asteroids on, 12:9 effect of solar wind on lightning strikes, 9:13 energy produced by core of, 3:19 highest ultraviolet radiation index measured on, 11:17 Lagrangian points, 1:34-35 magnetic field of, 10:16 oldest known continental crust, 6:17 passage through debris field of Comet ISON, 8:34 precession cycle, 6:34-35, 12:52-53 radiation blocked by atmosphere of, 6:16 role of plasma in magnetosphere, 7:12 seasons and axial tilt, 5:22 size of, compared to solar prominences, 7:16 sunrise duration, 5:12 Trojan asteroids, 9:12 Van Allen radiation belts, 1:27-28 eclipses of Epsilon Aurigae, 5:50 lunar, 4:16, 52-54, 10:54-57, 66 solar, 2:21, 6:54-57, 10:16, 54-57 Eden Patera Basin (feature on Mars), 2:9 E-ELT. See European Extremely Large Telescope (E-ELT) Elara (moon of Jupiter), 12:22 electrons mass of, 6:13 quark/antiquark interactions, 7:44 elliptical galaxies, cold gas in, 6:9. See also names of specific elliptical galaxies emission nebulae. See names of specific emission nebulae Enceladus (moon of Saturn) geysers on, 11:18 internal ocean on, 8:12 overview of, 6:24-26 Endymion crater (feature on Moon), 1:14 Epimetheus (moon of Saturn), 6:24 Epsilon Aurigae (star), 5:50 Epsilon-1 rocket, 1:18 ESA (European Space Agency), future mission themes, 3:7. See also names of specific spacecraft and missions ESO 137-001 (spiral galaxy), 7:8 Europa (moon of Jupiter) overview of, 6:23-24 possible mission to, 8:13, 11:13 recreation of surface of, 7:11 relative size of, 12:22 water vapor erupting from, 4:14 European Extremely Large Telescope (E-ELT) mountain peak removal in preparation for, 10:13 road construction for, 4:15

European Space Agency (ESA), future mission themes, 3:7. See also names of specific spacecraft and missions exoplanets. See extrasolar planets (exoplanets) extrasolar planets (exoplanets) See also names of specific exoplanets angled orbit of, 2:15 distantly-orbiting, 5:13 with Earth-like composition, 2:16 examining atmospheres of with light scattering, 12:13 formation of in star clusters, 5:20 gas dwarfs, 9:17 gas giants, 1:18 in "Goldilocks" zone, 7:13 habitability of, 2:19 illustration of systems, 12:44-45 lacking water vapor, 11:13 lone-wolf, 2:12 most precise measurement of, 11:12 number of candidates in newly analyzed data, 3:19 rapidly orbiting, 2:13 rate of discovery of, 3:10 search for Earth-like worlds among, 4:44-49 Sun-like stars with, 3:11 super-Earths and mini-Neptunes, 5:20 twice Earth's mass, 11:13 "verification by multiplicity" technique, 6:20 water on remnants of, 2:13 extraterrestrial life examining exoplanet atmospheres with light scattering, 12:13 implication of microbes found beneath Antarctic surface, 12:13 search for on planets orbiting red dwarfs, 2:28-33 search for through detection of photosynthesis, 6:46-49 search for through detection of pollution, 11:13 theory of "habitable zones" as limiting concept, 6:11 "Wolf trap" instrument, 8:34

F

Fata Morgana effect, 7:14 Fermi Gamma-ray Space Telescope extension of mission, 9:21 gamma-ray flash from hurricane, 12:13 unprecedented GRB, 3:13 Flame Nebula (NGC 2024), 9:20 Formalhaut (triple star system), 4:14 47 Tucanae (NGC 104) (globular cluster), 7:18–23, 9:66–69 4 Vesta (asteroid), 11:12 Foxfur Nebula (Sh 2-273), 9:88 Frontier Fields program, 2:12 fullerene, 2:15 fusion neutrinos created in process, 12:22 source of energy for, 11:50–51

G

G2 (gas and dust cloud), 5:22 Gaia spacecraft

beginning of mission, 11:13 calibration of, 6:20 launch and mission of, 4:18 overview of, 12:32-35 GAL 110-13 (molecular cloud), 9:89 galaxies See also names of specific galaxies; names of specific types of galaxies alignment of, 11:16 discovery of nature of, 7:7 early mature, 7:11 early "normal", 5:13 early versus those of today, 7:45 effect of orbital motion on redshift, 1:34 growth of central bars, 5:15 infrared survey of dusty, 7:7 lanes of hydrogen falling onto, 2:12 least chemically evolved known, 9:12 "life span" of, 4:50 magnetic fields of, 10:12 merging, 12:9 most distant, 2:21 "red nugget", 1:18 star formation and size of central bulge, 10:16 unexpected strings of, 7:17 unexpectedly bright, from early universe, 5:13 galaxy clusters See also names of specific galaxy clusters discovery of, 6:13 Frontier Fields program, 2:12 mapping of, 11:13 "missing", 6:12 Galaxy Evolution Explorer (GALEX), 6:16 Gamma Cygni (Sadr) (star), 9:18, 11:73 Gamma² Velorum (binary system), 12:31 gamma-ray bursts (GRBs) See also Fermi Gamma-ray Space Telescope circular polarization in, 9:15 dark, 10:13 from death of supermassive stars, 5:30-35 detection of, 3:13 gravitationally-lensed, 5:13 novae as source of, 11:12 research into, 4:19 Ganymede (moon of Jupiter) geological map of, 6:13 layered composition of, 9:13 relative size of, 12:22 gas filaments, 5:9, 16 Gemini South Telescope, 4:9 Giant Magellan Telescope, 7:11 Gliese 667C (star system), 12:44–45 Gliese 687 (star system), 12:44-45 Gliese 832 (star system), 12:44-45 Gliese 876 (star system), 12:44-45 Global Precipitation Measurement Core Observatory, 9:13 global warming, solar activity and, 3:10

globular star clusters See also names of specific globular clusters best month for observing, 7:13 classifications of, 1:62-65 effect of mass on contents of, 12:18 Harlow Shapley and, 3:7 hypothetical planet within, 7:18-23 marathon observations of, 3:57-59 rotation of stars within, 9:9 Golden Goose Award, 6:13 GRAIL (Gravity Recovery and Interior Laboratory) spacecraft, 8:44-49 gravitational lensing galaxies revealed by, 5:15, 12:9 gamma-ray bursts, 5:13 most distant, 2:17 gravitational waves, 8:28-33 Gravity Recovery and Interior Laboratory (GRAIL) spacecraft, 8:44-49 GRB 121024A (gamma-ray source), 9:15 GRBs. See Fermi Gamma-ray Space Telescope; gamma-ray bursts (GRBs) Great Red Spot (feature on Jupiter), 3:11, 9:14 Green Bank Telescope, 5:16 Gum 41 (emission nebulae), 11:74 Gyulbudaghian's Nebula (HH 215), 2:69

Η

Hadfield, Chris Austin, 9:52-55 Haumea (dwarf planet), 6:27 Hawking, Stephen, 12:19 Hayabusa spacecraft, 6:17 HD 19467 (star), 5:9 HD 20782 (star system), 12:44-45 HD 80606 (star system), 12:44-45 HD 142527 (star), 5:13 HD 162826 (star), 9:9 Heart Nebula (IC 1805), 12:73 Heat Shield Rock meteorite, 2:34 Hebes Chasma fissure (feature on Mars), 2:17 heiligenschein, 5:14 helium, 1:16 Henize 70, 3:71 Herbig, George H., 2:13 Herschel Space Observatory infrared survey of dusty galaxies, 7:7 survey of cosmic dust, 8:16 water vapor on Ceres, 5:12 Hewish, Antony, 12:46-51 HH 215 (Gyulbudaghian's Nebula), 2:69 Higgs boson, 10:13 Hi'iaka (moon of Haumea), 6:27 Himalia (moon of Jupiter), 12:22 Himiko (star-forming galaxy), 4:15 Hind's Variable Nebula (NGC 1554/5), 3:70 holographic noise, 12:22 Horsehead Nebula (Barnard 33) image of, 6:74

sketching, 1:68 HOTECH Advanced CT Laser Collimator, 5:60-61 HR 8799 (star system), 12:44-45 Hubble Space Telescope distance-determining mechanism, 8:12 effect of mass on contents of globular clusters, 12:18 extension of mission, 9:21 image of Comet ISON, 1:74 image of lenticular galaxy, 3:8 image of Proxima Centauri, 3:7 ionized sulfur filter, 2:35 papers based on archived data from, 6:12 Hubble Ultra Deep Field (HUDF), 10:74 Hubble's Variable Nebula, 9:88 Humboldt's Sea (Mare Humboldtianum) (feature on Moon), 3:70 hydrogen bridge of in Virgo cluster, 12:14 cloud of around red supergiant star, 2:13 lanes of falling onto galaxy, 2:12 Hyperion (moon of Saturn), 6:26 hypervelocity stars, 9:13

I

Iapetus (moon of Saturn), 6:26 IC 410 (emission nebula), 11:72 IC 417 (Spider Nebula), 5:73 IC 443 (Jellyfish Nebula), 3:69 IC 1318 (nebula complex), 9:18 IC 1805 (Heart Nebula), 12:73 IC 1848 (Baby Nebula), 12:73 IC 2165 (planetary nebula), 2:14 IC 2167 (reflection nebula), 11:71 IC 2169 (Dreyer's Nebula), 11:71 IC 4499 (globular cluster), 12:18 IC 4592 (Blue Horsehead Nebula), 8:73 IC 5063 (galaxy), 11:9 IC 5070 (Pelican Nebula), 12:73 Ida (asteroid), 6:27 IK Pegasi (binary system), 12:27-28 Illustris simulation system, 9:16 Interior Exploration Using Seismic Investigations, Geodesy, and Heat Transport (InSight) lander, 9:12 International Space Station (ISS), cargo delivery to, 1:18 interstellar medium, composition of, 12:22 interstellar wind, interaction with heliosphere, 1:17 Io (moon of Jupiter), 6:23, 12:13, 22 iron in Perseus galaxy cluster, 2:9 in Sun, 5:51 Ishida Weinberger 2 (planetary nebula), 7:73 ISON. See Comet C/2012 S1 (ISON) ISS (International Space Station), cargo delivery to, 1:18 iTelescope.Net service, 6:60-63

J

J0738-4042 (pulsar), 6:13

Jacob's Ladder region, 4:73 JACOUES (Comet C/2014 E2), 12:73 James Webb Space Telescope backplane support structure, 3:11 construction and mission of, 8:50-55 power, communications, and pointing control systems, 5:12 sunshield for, 11:13 Janus (moon of Saturn), 6:24 Japan Aerospace Exploration Agency, 1:18 Jaws asterism, 5:18 Jellyfish Nebula (IC 443), 3:69 JKCS 041 (galaxy cluster), 9:21 Jonathan Eberhart Planetary Sciences Journalism Award, 10:13 Juno spacecraft, 2:13 Jupiter See also names of moons orbiting alignment of moons of, 9:56–57 amount of solar energy reaching, 12:12 discovery of moons of, 12:19 Great Red Spot, 3:11, 9:14 image of transit of three moons, 2:69 relative sizes of moons of, 12:22 sunrise duration, 5:12 Trojan asteroids, 9:12

K

Kapteyn's star, 10:13 Kavli, Fred, 3:16 Kavli Prize in Astrophysics, 9:16 KBOs (Kuiper Belt objects), 3:35 Kepler spacecraft confirming candidate exoplanets from archival data, 5:20 end of mission, 1:29 extension of mission, 9:21 orbit adjustment, 4:14 possible extension of mission, 3:10 "verification by multiplicity" technique, 6:20 Kepler-7b (exoplanet), 1:9 Kepler-10c (exoplanet), 2:21 Kepler-11 (star system), 12:44–45 Kepler-16 (star system), 12:44-45 Kepler-56 (planetary system), 2:15 Kepler-78b (exoplanet), 2:16 Kepler-90 (star system), 12:44-45 Kepler-93b (exoplanet), 11:11 Kepler-186f (exoplanet), 7:13 Kepler-421b (exoplanet), 11:13 kinetic energy, 3:9 Kuiper Belt objects (KBOs), 3:35

L

L1527 (baby star), 6:9 LADEE (Lunar Atmosphere and Dust Environment Explorer) space craft, 8:16 Lagoon Nebula (M8), 5:10 Lagrangian points, 1:34–35 Large Magellanic Cloud (LMC) images of, 4:74, 9:90 velocity of stars orbiting center of, 6:16 Large Synoptic Survey Telescope (LSST), 12:13 laser pointers, proper use of, 7:64 Laughing Skull Nebula (LBN 406) (molecular cloud), 7:73 lawrencium, 9:13 LBN 406 (Laughing Skull Nebula) (molecular cloud), 7:73 LBN 438 (nebula), 5:73 LBN 704 (NGC 1491; Sharpless 2-206) (emission nebula), 7:73 Leonids (meteor shower), 11:60-61 Levenhuk Ra R110 ED Doublet Optical Tube Assembly (OTA) apochromatic refractor, 2:60-61 life, origin of See also extraterrestrial life comets and, 1:9, 12 controversy surrounding anthropic principle, 11:11 light filtering, 7:52–55 identifying compounds through spectral line analysis, 7:45 perception of color, 8:18 polarization, 7:11, 11:51 travelling through expanding universe, 12:52 lightning effect of solar wind on lightning strikes on Earth, 9:13 on other planets, 1:34 LINEAR (Comet C/2012 V2), 2:69 LMC. See Large Magellanic Cloud (LMC) LOFAR radio array, 8:13 Lost Galaxy (NGC 4526), 9:89 LOVEJOY (Comet C/2013 R1), 4:72 Lowell Observatory, 5:44-49 Low-Frequency Array, 3:11 LSST (Large Synoptic Survey Telescope), 12:13 Lunar Atmosphere and Dust Environment Explorer (LADEE) space craft, 8:16 lunar eclipses April 2014, 4:52–54 October 2014, 10:54-57, 66 overview of, 4:16 Lunar Reconnaissance Orbiter, 8:44-49

Μ

M1 (Crab Nebula), 4:15 M4 (globular cluster), 8:73 M8 (Lagoon Nebula), 5:10 M15 (globular star cluster), 2:9 M17 (Swan Nebula), 2:70 M31. *See* Andromeda Galaxy (M31) M33 (Pinwheel Galaxy), 6:9, 10:19, 11:50–51, 12:10 M36 (Pinwheel Cluster) (open star cluster), 8:73 M42 (Orion Nebula), 7:72, 9:20 M44 (Beehive Cluster), 3:12 M49 (elliptical galaxy), 9:89 M51. *See* Whirlpool Galaxy (M51) M56 (globular cluster), 8:14 M60-UCD1 (ultra-compact dwarf galaxy), 1:12 M67 (open cluster), 1:72, 5:20 M78 (reflection nebula), 5:72 M82 (Cigar Galaxy), 4:9, 5:16, 72 M82 X-1 (black hole), 12:12 M83 (NGC 300) (Southern Pinwheel Galaxy), 10:73 M87 (elliptical galaxy), 3:71, 5:24-29 M99 (NGC 4254) (spiral galaxy), 11:72 M101 (spiral galaxy), 11:13 M104 (Sombrero Galaxy), 5:18 magnetars formation of, 9:12 supernovae and, 4:15 magnetic fields of Earth, 10:16 effect of on flybys, 8:35 of galaxies, 10:12 of gas giant planets, 1:18 of Milky Way, 9:13 of neutron stars, 9:20, 57 of Sun, 7:7, 10:20 MallinCam Jr PRO Video CCD Observational System, 8:66-67 Mann Terry, 4:58-61 Marchis, Franck, 2:20 Mare Humboldtianum (Humboldt's Sea) (feature on Moon), 3:70 Mars See also names of specific missions to analysis of soil, 1:30-31 channel formation on, 7:17 cloud formation on, 2:13 cold and dry nature of, 4:9 conjunction of with Saturn, 8:18 detailed map of, 11:18 discovery of moons of, 12:19 Eden Patera Basin, 2:9 evidence of liquid water in distant past, 3:11 feldspar-rich rocks on, 3:10 future oppositions of, 1:17 gravitational effect on asteroids, 3:11 Heat Shield Rock meteorite, 2:34 Hebes Chasma fissure, 2:17 lack of methane in atmosphere of, 2:13 latest findings by Curiosity rover, 1:44-49 meteorites from, 2:16, 3:19, 7:11, 8:13 new crater on, 6:10 rock fall on, 12:9 signs of past habitable environment, 5:12 size of craters, 8:9 sulfur reactions, 8:13 sunrise duration, 5:12 Trojan asteroids, 9:12 Mars 2020 Rover mission (working name), 11:16 Mars Atmosphere and Volatile Evolution (MAVEN) spacecraft, launch of, 2:13, 3:18 Mars Odyssey spacecraft, new orbit for, 6:17 Mars Orbiter Mission (MOM), launch of, 3:18 Mars Reconnaissance Orbiter (MRO) channel formation, 7:17

new crater, 6:10 ten-year anniversary, 5:12 MAVEN (Mars Atmosphere and Volatile Evolution) spacecraft, launch of, 2:13, 3:18 MBM 159 (Sharpless 2-63) (molecular cloud), 5:73 MCS J0416.1-2403 (galaxy cluster), 11:13 Meade LX850 telescope package, 4:62-63 MeerKAT telescope, 6:13 Mercury amount of solar energy reaching, 12:12 best conditions for viewing, 1:12 stars as seen from, 11:18 sunrise duration, 5:12 volcanism on, 8:9 MESSENGER (MErcury Surface, Space ENvironment, GEochemistry, and Ranging) mission 3,000th orbit of Mercury, 8:13 neutrons in Solar atmosphere, 11:13 Messier, Charles, 2:9 Messier catalog, sketching marathon, 3:60-63 meteor showers Leonids, 11:60-61 Orionids, 10:14 satellites and, 10:34-35 meteorites Heat Shield Rock, 2:34 from Mars, 2:16, 3:19, 7:11, 8:13 from Moon, 12:14 meteroids, explosion of over Russia, 1:33, 3:11 Milky Way Galaxy black hole at center of, 1:18, 28, 3:11, 5:16 chance of supernovae in, 2:19 dark matter at center of, 8:16 distance from Earth to center of, 7:11 distance to Andromeda Galaxy, 6:20 formation of, 4:22 images of, 3:69, 9:89, 10:9 magnetic field of, 9:13 mapping distances using Cepheid variable stars, 9:20 most distant stars in, 11:12 movement of stars within, 2:21 piecing together history of, 5:9 radio-emitting condensed dust clouds in plane of, 9:17 shape of inner region, 1:9 spiral arms of, 4:14 3-D map project, 6:20 millisecond pulsars, 12:53 Mimas (moon of Saturn), 6:24 Miranda (moon of Uranus), 6:26-27 Modified Newtonian Dynamics (MOND) theory, 4:24-29 molecular clouds lowest concentration of hydrogen molecules needed to form stars in, 8:15 in Whirlpool Galaxy, 4:14 molecules size and rarity of, 2:15 smallest aromatic, 12:13 MOM (Mars Orbiter Mission), launch of, 3:18 MOND (Modified Newtonian Dynamics) theory, 4:24-29

Monet, Claude, 12:19 Monkey Head Nebula (NGC 2174), 8:10 Moon (Earth's) account of first manned lunar landing, 8:22-27 animating sketches of phases of, 9:70-73 center of, 10:11 collision leading to creation of, 8:13, 10:17 development of impact craters on opposite sides of, 3:19 effects of moonlight during Revolutionary War, 4:20 Endymion crater, 1:14 image of, 1:73 impact flash on, 6:12 LADEE space craft, 8:16 lunar eclipses, 4:16, 52-54, 10:54-57, 66 Mare Humboldtianum (Humboldt's Sea), 3:70 meteorite from, 12:14 occultation of Saturn, 12:73 orbit of, 1:11 photographing, 10:58-61 research into formation, interior, and opposing faces of, 8:44-49 Sinus Iridum, 10:72 subsurface geology of, 9:9 Super Moon, 8:64-65, 11:73 upside-down appearance in Southern Hemisphere, 4:50 water on. 1:50-55 moons See also names of specific moons discovery of, 12:19 of gas giant planets, 1:18 overview of, 6:22-27 of Trojan asteroid, 6:12 MQ1 (black hole microquasar), 6:17 MRO. See Mars Reconnaissance Orbiter (MRO) Mundell, Carole G., 4:19

Ν

N103B (supernova remnant), 10:12 Namaka (moon of Haumea), 6:27 NASA (National Aeronautics and Space Administration) See also names of specific spacecraft and missions analysis of, 9:32-37 centers and employees of, 4:18 plans to retrieve asteroids, 3:22-27 review of funding for space telescopes, 9:21 wavelengths studied by satellites of, 9:16 near-Earth asteroids (NEAs), 3:15 nebulae See also names of specific nebulae gas jets from preplanetary, 6:20 inward growth of, 9:20 photographing, 2:52-55 Neptune amount of solar energy reaching, 12:12 discovery of moons of, 12:19 sunrise duration, 5:12

Trojan asteroids, 9:12 neutrinos created in solar fusion process, 12:22 discovery of non-atmospheric, 3:11 suppression of galaxy growth, 6:12 neutron stars, magnetic fields of, 9:20, 57 New Horizons spacecraft Kuiper Belt objects, 3:35 passes Neptune's orbit, 12:13 NexStar Evolution 8 telescope, 12:64-65 NGC 104 (47 Tucanae) (globular cluster), 7:18-23, 9:66-69 NGC 300 (M83) (Southern Pinwheel Galaxy), 10:73 NGC 602 (open cluster), 5:13 NGC 1097 (galaxy), 2:20 NGC 1261 (globular cluster), 5:73 NGC 1316 (galaxy), 8:74 NGC 1317 (galaxy), 8:74 NGC 1333 (reflection nebula), 8:73 NGC 1433 (spiral galaxy), 2:15, 3:74 NGC 1491 (Sharpless 2-206; LBN 704) (emission nebula), 7:73 NGC 1499 (California Nebula), 12:16 NGC 1554/5 (Hind's Variable Nebula), 3:70 NGC 1778 (open cluster), 2:65 NGC 1931 (emission nebula), 2:65 NGC 2014 (open cluster), 1:10, 7:72 NGC 2020 (emission nebula), 1:10, 7:72 NGC 2024 (Flame Nebula), 9:20 NGC 2032 (Seagull Nebula), 7:72 NGC 2035 (nebula), 7:72 NGC 2070 (Tarantula Nebula), 5:13 NGC 2174 (Monkey Head Nebula), 8:10 NGC 2237-9/46 (Rosette Nebula), 1:68 NGC 2245 (reflection nebula), 11:71 NGC 2247 (reflection nebula), 11:71 NGC 2264 (Christmas Tree Cluster), 9:88 NGC 2346 (Crimson Butterfly Nebula), 2:14 NGC 2371-2 (Double Bubble Nebula), 2:14 NGC 2626 (nebula complex), 9:89 NGC 3293 (star cluster), 11:10 NGC 3372 (Carina Nebula), 1:72, 9:90 NGC 3718 (spiral galaxy), 8:72 NGC 3729 (spiral galaxy), 8:72 NGC 4254 (M99) (spiral galaxy), 11:72 NGC 4490 (Cocoon Galaxy), 7:73 NGC 4517 (spiral galaxy), 3:71 NGC 4517A (spiral galaxy), 3:71 NGC 4526 (Lost Galaxy), 9:89 NGC 4535 (spiral galaxy), 9:89 NGC 4712 (galaxy), 1:73 NGC 4725 (spiral galaxy), 1:73 NGC 4747 (galaxy), 1:73 NGC 5128 (Centaurus A) (galaxy), 8:73 NGC 5548 (galaxy), 10:17 NGC 6888 (Crescent Nebula), 2:68, 11:73 NGC 6934 (globular cluster), 11:64 NGC 6946 (spiral galaxy), 5:16

NGC 6960 (Witch's Broom), 3:71 NGC 6984 (galaxy), 5:22 NGC 7000 (North America Nebula), 12:73 NGC 7006 (globular cluster), 11:64 NGC 7098 (galaxy), 12:73 NGC 7331 (galaxy), 5:73 NGC 7497 (spiral galaxy), 1:73 NGC 7640 (barred spiral galaxy), 2:68 Nichols, Jonathan, 10:16 Nobel Prize, in physics (2013), 2:12 North America Nebula (NGC 7000), 12:73 North Star. See Polaris (Alpha Ursae Minoris; North Star) Nova Centauri 2013 (V1369 Cen), 4:73 novae, as source of gamma rays, 11:12. See also names of specific supernovae; supernovae Nu Scorpii (star system), 6:18 Nuclear Spectroscopic Telescope Array (NuSTAR) corona of black hole, 12:12 extension of mission, 9:21 overview of, 7:30-35 supernova, 6:16 unprecedented GRB, 3:13 NWA 7533 (meteorite), 3:19

0

Oberg, James, 10:13 observatories, in Chile, 12:58-63. See also names of specific observatories 10199 Chariklo (centaur), 7:11 163 Erigone (asteroid), 3:16 open clusters See also names of specific open clusters classification of, 2:62-64 observing in winter, 12:54-57 sketching, 12:66 Ophiuchus 11 (star system), 12:44-45 Opportunity rover rock run over by, 6:13 ten-year anniversary, 2:13, 5:12 Orbital Sciences, 1:18 Origins Spectral Interpretation Resource Identification Security Regolith Explorer, 8:13 Orion (constellation), 4:11 Orion Nebula (M42), 7:72, 9:20 Orionids (meteor shower), 10:14 Ou4 (bipolar nebula), 3:71

Р

P/2013 PS (asteroid), 3:18
P/2013 R3 (asteroid), 7:74
Palomar Mountain Observatory, 1:73
Pandora (moon of Saturn), 6:24
Pandora's Cluster (Abell 2744) (galaxy cluster), 12:9
PANSTARRS (Comet C/2011 L4), 1:30
Pasiphaë (moon of Jupiter), 12:22
Pelican Nebula (IC 5070), 12:73
Perseus galaxy cluster, 2:9
PGC 6240 (galaxy), 2:74

PGC 10922 (lenticular galaxy), 3:8 PGC 86434 (galaxy), 1:73 Phaethon asteroid, 1:18 Philae lander, 11:26-31 Phoebe (moon of Saturn), 3:28–33 phosphorus, in supernova remnants, 4:15 Pinwheel Cluster (M36) (open star cluster), 8:73 Pinwheel Galaxy (M33), 6:9, 10:19, 11:50-51, 12:10 Planck satellite, 2:19 planetary nebulae See also names of specific planetary nebulae shape of, 1:18 in Winter Hexagon asterism, 2:14 Planetary Resources, 3:13 The Planetary Society, 7:11 Planetary Transits and Oscillations of Stars (PLATO) mission, 6:10, 7:11 planets See also extrasolar planets (exoplanets); names of specific planets celestial rhythms, 1:11 compressing diamond to understand cores of, 11:12 determining if stars have ingested, 9:12 determining mass of, 4:22 difference between brown dwarfs and, 4:51 effect of magnetic fields on flybys, 8:35 layering of gas giants, 2:35 origin of term, 11:23 sunrise duration by planet, 5:12 plasma, role of in Earth's magnetosphere, 7:12 PLATO (Planetary Transits and Oscillations of Stars) mission, 6:10, 7:11 Pleiades (Seven Sisters) open star cluster (M45), 12:19 Pluto amount of solar energy reaching, 12:12 argument against dwarf planet status, 9:9 image of, 9:88 sunrise duration, 5:12 PN G219.1 + 31.2 (Abell 31; Sharpless 2-290) (planetary nebula), 1:72 Polaris (Alpha Ursae Minoris; North Star) brightness of, 2:16 movement of, 2:16 polarization, 11:51 precession cycle, 6:34-35 Prometheus (moon of Saturn), 6:24 protoplanetary disks abrupt chemical change in, 6:9 gas within, 2:15 Proxima Centauri (star) distance to Sun, 6:20 image of, 3:7 PS1-10afx (supernova), 8:17 PSO J318.5-22 (lone-wolf exoplanet), 2:12 PSR 1719-14 (star system), 12:44-45 PSR J1023+0038 (pulsar), 11:18 pulsars center of, 10:11 changes in the spin rates of, 8:9 discovery of, 3:11

dual personality, 1:16 exotic, 6:21 first discovered, 10:12 formation of accretion disk, 11:18 millisecond, 12:53 part of triple system with white dwarfs, 5:13 rotation speed of, 10:12

Q

quantum mechanics, 8:35, 10:28–33 quark/antiquark interactions, 7:44–45 quasars, why only observed at great distances, 5:50–51

R

radio astronomy Atacama Large Millimeter/submillimeter Array, 6:28-33 detecting weak signals using lasers, 7:11 profile of Antony Hewish, 12:46-51 Ransom, Scott, 6:21 red clump stars, 1:9 red dwarfs, search for life on planets orbiting, 2:28-33 Red Hood Nebula, 1:72 "red nugget" galaxies, 1:18 reflection nebulae. See names of specific reflection nebulae Regulus (star), 3:16 Reines, Amy, 5:16 relativity, general theory of, 8:35 religion and science, 8:11 Reynolds, Mark T., 7:12 Rhea (moon of Saturn), 5:74 Rhemann, Gerald, 7:46–51 ring systems, around centaurs, 7:11 Roche limit, 12:53 Rosetta spacecraft overview of, 11:26-31 wake-up call, 5:12 Rosette Nebula (NGC 2237-9/46), 1:68 RS Ophiuchi (binary system), 12:31 RS Puppis (Cepheid variable star), 4:10

S

Sadr (Gamma Cygni) (star), 9:18, 11:73 Sagittarius A* (Sgr A*) (black hole), 1:18, 28, 5:16, 22 satellites. *See* also *names of specific satellites* cubesats, 3:14 inflatable antennas for, 1:18 meteor showers and, 10:34–35 wavelengths studied by, 9:16 Saturn *See also* Cassini spacecraft; *names of moons orbiting* amount of solar energy reaching, 12:12 atmosphere of, 1:12 aurorae, 6:9, 9:13 conjunction of with Mars, 8:18 discovery of moons of, 12:19

hexagonal jetstream, 4:9 image of, 2:21 observing, 5:62-64 occulted by Moon, 12:73 opposition of, 5:14 possible birth of new moon, 8:13 sunrise duration, 5:12 scientific papers, popular words in, 8:12 SDO. See Solar Dynamics Observatory (SDO) SDSS. See Sloan Digital Sky Survey (SDSS) SDSS J1531+3414 (galaxy cluster), 11:17 SDSS J120136.02+300305.5 (galaxy), 8:12 Seagull Nebula (NGC 2032), 7:72 Segue 1 (dwarf galaxy), 9:12 Seven Sisters (Pleiades) (M45) (open star cluster), 12:19 Sgr A* (Sagittarius A*) (black hole), 1:18, 28, 5:16, 22 Shapley, Harlow, 3:7 Sharpless 2-63 (MBM 159) (molecular cloud), 5:73 Sharpless 2-126 (nebula), 5:73 Sharpless 2-129 (emission nebula), 3:71, 4:73 Sharpless 2-202 (emission nebula), 12:72 Sharpless 2-206 (LBN 704; NGC 1491) (emission nebula), 7:73 Sharpless 2-273 (Foxfur Nebula), 9:88 Sharpless 2-290 (Abell 31; PN G219.1 + 31.2) (planetary nebula), 1:72 Sharpless 2-305 (nebula), 8:73 Sharpless 2-306 (nebula), 8:73 Sharpless 2-307 (nebula), 8:73 Sharpless 2-309 (nebula), 8:73 Sinus Iridum (feature on Moon), 10:72 Sirius A (star), 6:15 Sirius B (white dwarf), 6:15 624 Hektor (Trojan asteroid), 6:12 SKA (Square Kilometre Array) telescope, 3:11, 7:11 Skyris charge-coupled device (CCD) cameras, 3:66-67 Sky-Watcher USA ProED 120mm Doublet Apochromatic Refractor telescope, 6:64-65 SL 17 (dark nebula), 11:72 Sloan Digital Sky Survey (SDSS) Baryon Oscillation Spectroscopic Survey (BOSS), 5:19 fourth survey phase, 11:16 SLS (Space Launch System), 12:18 SM0313 (SMSS J031300.36-670839.3) (star), 6:16 Small Magellanic Cloud (SMC), 9:90 "Smith Cloud", 2:9 SMSS J031300.36-670839.3 (SM0313) (star), 6:16 SN 1987A (supernova), 5:21 SN 2014J (supernova), 5:16, 72 SN iPTF13bvn (supernova), 2:16 Solar Dynamics Observatory (SDO) calibration of, 2:19 coronal eruptions, 10:10 solar eclipses November 2013, 6:54-57 October 2014, 10:54-57 August 2017, 10:16 April 2024, 10:16 image of Saturn eclipsing Sun, 2:21

Solar Probe Plus mission, 7:12 solar system amount of solar energy reaching surface of planets in, 12:12 celestial rhythms, 1:11 density of bodies within, 11:17 dry surface area of bodies within, 11:23 effect of death of Sun on outer planets, 6:35 formation of planetary cores, 10:13 moons of, 4:15, 6:22-27, 12:19 separation from galactic neighborhood, 12:13 sunrise duration by planet, 5:12 visualizing size of, 11:9 Sombrero Galaxy (M104), 5:18 Southern Pinwheel Galaxy (M83; NGC 300), 10:73 Space Launch System (SLS), 12:18 spacecraft, effect of magnetic fields on flybys, 8:35. See also names of specific spacecraft Spica (Alpha Virginis) (star), 12:28-29 Spider Nebula (IC 417), 5:73 spiral galaxies See also names of specific spiral galaxies evolution into disk shape, 1:12 measuring rotation of, 6:13 Square Kilometre Array (SKA) telescope, 3:11, 7:11 star clusters See also names of specific star clusters formation of, 12:13 formation of exoplanets in, 5:20 Stardust (and Stardust-NExT [New Exploration of comet Tempel 1]) mission, 12:14 Stargate asterism, 5:18 Starmus Festival, 6:58-59, 9:58-59 stars See also names of specific stars; names of specific types of stars Be-type, in system with black hole, 5:13 debris disks surrounding, 8:13 determining if planets have been ingested by, 9:12 energy produced by, 3:19 formation of, 8:15 formation of and size of galaxy's central bulge, 10:16 formation of massive, 11:22 gas jets from, 6:20 growth of, 4:14 hypervelocity, 5:12, 9:13 images of, 2:70, 9:90, 10:73 influence of location on mass and development, 3:15 most distant in Milky Way, 11:12 most iron-poor, 6:16 organic molecules surrounding newly forming, 12:18 red clump, 1:9 stellar nursery, 6:13 supermassive, 5:30-35 StarSense AutoAlign telescope mount alignment accessory, 7:62-63 Stonehenge, 6:34–35 Struve, Friedrich Georg Wilhelm, 10:18 Sun amount of energy reaching surface of planets, 12:12 center of, 10:11

composition of, 10:34 coronal eruptions, 10:10 death of, and effect on outer planets, 6:35 density of, 11:17 distance to Proxima Centauri, 6:20 effect of magnetic waves on corona, 2:12 effect of solar wind on lightning strikes on Earth, 9:13 extension of corona, 10:13 future of, 2:44-49 global warming and, 3:10 magnetic field lines on, 7:7 neutrinos created in fusion process, 12:22 neutrons in upper atmosphere of, 11:13 prominences, 4:73, 8:72, 12:73 relative size of solar prominences, 7:16 solar eclipses, 2:21, 6:54-57, 10:16, 54-57 source of iron in, 5:51 spring equinox, 3:9 sunrise duration by planet, 5:12 temperature of corona, 10:12, 20 X-ray emissions and, 11:9 Sund, Tanja, 8:60-63 superclusters, 11:17 supernovae See also names of specific supernovae chance of in Milky Way, 2:19 classes of, 12:29 converting electromagnetic data from into sound, 11:32-35 cosmic dust formed by, 5:21 cosmic rays accelerated by, 1:32 from death of supermassive stars, 5:30-35 magnetars and, 4:15 related, 5:22 responsible for most of calcium in universe, 12:18 sketching, 7:68 as source of cosmic dust, 11:13 stars with potential to become, 12:27-31 superluminous, 8:17 three-dimensional map of remnant, 10:44-49 type Ia, 6:15, 11:51, 12:13 Sutter's Mill meteorite, 1:18 Suzaku X-ray observatory, 9:21 Swan Nebula (M17), 2:70 Swift satellite extension of mission, 9:21 SN 2014J supernova, 5:16 unprecedented GRB, 3:13 X-ray emissions point sources detected by, 4:15

Т

Tarantula Nebula (NGC 2070), 5:13 Tau Boötis b (exoplanet), 6:13 telescopes See also names of specific telescopes light shields for, 9:14

NASA review of funding for space telescopes, 9:21 protecting stored eyepieces from mildew, 10:34 temperature of coldest known brown dwarf, 1:13 of Sun's corona, 10:12, 20 upper limit of, 3:34 Thales of Miletus, 6:9 Thebe (moon of Jupiter), 12:22 The Theory of Everything (film), 12:19 Thorne-Zytkow objects, 10:20 time, concept of, 12:11 Titan (moon of Saturn) cloud formation on, 12:13 efforts to discover liquid methane on, 2:22-27 image of, 5:74 origin of nitrogen in atmosphere of, 10:13 propylene on, 1:18 salty ocean on, 11:13 short-lived structures atop seas of, 10:12 Trans-Iron Galactic Element Recorder, 5:20 Triton (moon of Neptune), 5:9, 6:27, 12:12 Trojan asteroids moon orbiting, 6:12 overview of, 9:12 Trumpler, Robert Julius, 2:62-64 Tucson Public Star Party, 9:60-65 25143 Itokawa (asteroid), 6:17 2012 VP113 (dwarf planet), 7:16 Tycho supernova remnant, 3:7

U

UGC 10822 (dwarf spheroidal galaxy), 10:72 ultra-compact dwarf galaxies (UCDs), 1:12 ultraviolet (UV) radiation from dwarf galaxies, 11:12 highest measured on Earth's surface, 11:17 universe cosmic inflation, 6:12 cosmic microwave background radiation, 1:31 end of, 9:38-43 inflation of, 10:12 light and expansion of, 12:52 measuring, 11:44-49 motion in, 7:9 rate of expansion of, 8:15 simulation of evolution of, 9:16 ununseptium, 9:13 Uranus amount of solar energy reaching, 12:12 day and year on, 11:50 discovery of moons of, 12:19 image of, 2:69 sunrise duration, 5:12 Trojan asteroids, 9:12 Ursa Major constellation, 11:17

UV. See ultraviolet (UV) radiation

V

V766 Centauri (yellow hypergiant star), 7:17 V1369 Cen (Nova Centauri 2013), 4:73 Van Allen radiation belts, 1:27-28 van den Bergh 15 (reflection nebula), 12:72 van den Bergh 93 (emission and reflection nebulae), 7:73 van den Bergh 135 (reflection nebula), 2:69 van den Bergh 140 (reflection nebula), 4:73 van den Bergh 158 (reflection nebula), 9:89 van der Waals force, 12:12 variable nebulae, 6:50-53. See also names of specific variable nebulae Venus amount of solar energy reaching, 12:12 atmospheric waves, 11:9 brightest appearance of, 5:50 "hot flow anomalies" on, 6:13 sunrise duration, 5:12 Very Large Array (VLA), 5:24-29 Very Large Telescope (VLT), 7:11 Vesta (asteroid) Dawn spacecraft's exploration of, 3:44-49 observing, 5:52-53 olivine on, 3:10 Virgo cluster hydrogen bridge, 12:14 observing through binoculars, 3:64-65 Vixen Optics VSD100F3.8 astrograph, 10:64-65 VLA (Very Large Array), 5:24–29 VLT (Very Large Telescope), 7:11 volcanoes image of Milky Way over, 9:89 on Io, 12:13 on Mercury, 8:9 Voyager 1 spaceprobe, 1:27

W

W26 (red supergiant star), 2:13 W49 (star-forming region), 4:15 water in exoplanet atmosphere, 6:13 on exoplanet remnants, 2:13 on Mars in distant past, 3:11 on Moon, 1:50–55 vapor on Ceres, 5:12 vapor on Europa, 4:14 WD 0806-661B (brown dwarf), 1:13 weakly interacting massive particles (WIMPs), 4:24-29 Whirlpool Galaxy (M51) map of molecular gas clouds in, 4:14 X-ray sources within, 10:13 white dwarfs coldest known, 10:13 elements in atmospheres of, 7:17

habitable zones around, 9:57
part of triple system with pulsar, 5:13
Wide-field Infrared Survey Explorer (WISE) space telescope
near-Earth objects discovered in first 25 days of reactivation, 5:20
NEOWISE mission, 1:19, 4:22
William Optics GT102 102mm f/6.9 Apo Refractor, 11:62–63
WIMPs (weakly interacting massive particles), 4:24–29
WISE. *See* Wide-field Infrared Survey Explorer (WISE) space telescope
WISE J085510.83-071442.5 (brown dwarf), 8:12
Witch's Broom (NGC 6960), 3:71

Х

X-ray emissions from central black hole of dwarf galaxy, 5:13 from corona of black hole, 12:12 NuStar satellite, 7:30–35 point sources detected by Swift satellite, 4:15 Sun and, 11:9 from Whirlpool Galaxy, 10:13 X-ray Multi-Mirror Mission-Newton, 9:21

Y

Y dwarfs, 12:12

Ζ

z8_GND_5296 (galaxy), 2:21 Zwicky, Fritz, 12:9

TITLE

A

All about 47 Tucanae, 9:66-69 ALMA watches black hole in action. 2:15 The animated universe, 7:9 Animating the Moon, 9:70–73 The Archer's baby boom, 5:10 Are distant galaxies hiding?, 2:21 Asteroid anatomy surprises scientists, 6:17 Asteroid dresses up as six-tailed comet, 3:18 Asteroid occultation, 3:16 Astrobiologists hail Antarctic life find, 12:13 Astro-freebies, 1:20 Astronomers capture Milky Way's magnetic field, 9:13 Astronomers confirm hundreds of Kepler discoveries, 6:20 Astronomers map 1,500 clouds--in another galaxy, 4:14 Astronomers map largest moon in the solar system, 6:13 Astronomers precisely measure cosmic expansion, 8:15 Astronomers watch the Sun's corona heat up, 10:20 Astronomy and God, 8:11 Astronomy tests a great new collimator, 5:60-61 Astronomy tests Celestron's NexStar Evolution, 12:64-65 Astronomy tests Celestron's StarSense, 7:62-63 Astronomy tests Levenhuk's new refractor, 2:60-61 Astronomy tests Meade's new 10-inch SCT, 4:62-63 Astronomy tests Vixen's widefield refractor, 10:64-65 Astronomy tests William Optics' new refractor, 11:62-63 Astronomy's fifth annual Star Products, 9:74-81 ATHENA chosen for 2028 launch, 10:19

В

Balls of crushed fire, 2:11 Beautiful Endymion, 1:14 The Belt of Orion, 4:11 The bewitching Fata Morgana, 7:14 Big bulges mean no new stars, 10:16 Binary found with misaligned planet-forming disks, 11:22 Bipedal satellite, 4:14 Black aurorae, 6:14 Black hole blur, 12:12 Black hole has no-holds-barred wind, 6:17 Black hole jets full of metal, 3:10 Black hole realities, 8:9 Black holes might be wrong, 10:22-27 Blues on the Red Planet, 6:10 Bright heart of darkness, 9:10 Bringing a star's death to life, 10:44-49

С

California dreamin', 12:16 Can the cosmos test quantum entanglement?, 10:28–33 Carina's colorful cluster, 11:10 Cassini captures possible birth of new moon, 8:13 Cassini data reveals Enceladus internal ocean, 8:12 Cassini takes extraordinary Saturn portrait, 2:21 Catch the sounds of exploding stars, 11:32-35 Chandra spies black holes in the Whirlpool, 10:13 Chandra's 10 biggest discoveries, 7:24-29 Charles Messier and comets, 2:9 Chasing the Moon's shadow through Africa, 6:54-57 Chile: Visiting the astronomer's paradise, 12:58-63 Civil War star, 6:18 Clouds orbit and dim eight active black holes, 6:13 Cold and brown, 3:10 Cold snap, 8:12 Colorful connections, 8:68 A colorful menagerie, 2:10 Comet construction, 4:64 Comet ISON's final hurrah, 3:50-53 Comet ISON's final stab at glory, 1:56-61 Comet ISON's opening act, 2:50-51 Comets and human beings, 1:9 Comparing magnifications, 9:84 Compelling contrast, 3:20 The cosmic distance scale, 11:9 Cosmic dust creator possibly confirmed, 11:13 Cosmic food fights, 9:11 Cosmic inflation happened, according to BICEP2 results, 6:12 Cosmos: A SpaceTime Odyssey, 4:12-13 Creating a universe like ours, 9:16 Creating unresolved stars, 11:64 Curiosity smells no methane on Mars, 2:13 Curiosity takes a beating, 12:13 Curiosity's latest findings from Mars, 1:44-49

D

A dark burst and its dusty environment, 10:13 The dawn of dark matter, 12:9 A deep canyon on the Red Planet, 2:17 Defining the boundary between stars and brown dwarfs, 4:15 Densest galaxy provides origin clues, 1:12 Desktop downloads, 12:20 Devious duo in Dorado, 1:10 Different masses, same result?, 6:15 Disrespected globular, 8:14 Does methane flow on Titan?, 2:22–27 Double color, 9:82 Double-dip asteroid, 6:12 A dream night with the Discovery Channel Telescope, 5:44–49

Е

Earth-sized world in "Goldilocks" zone, 7:13 Echoes of an aging star, 4:10 Eclipse escapades, 4:16 Enhance your observing with filters, 7:52–55 Equinox energy and emptiness, 3:9 Europa spews water, 4:14 Everyday accessories, 2:18 An evolutionary link for pulsars, 1:16 Exoplanet systems illustrated, 12:44–45 Explore the Trumpler classes of clusters, 2:62–64 Explore the Virgo cluster through binoculars, 3:64–65 Exploring the biggest asteroids, 3:44–49

F

Faceoff! The Moon's oddly different sides, 8:44–49 Fast flares, 4:14 The final chapter, 2:66 Five stars that could go bang, 12:27–31 Forming a picture of Milky Way growth, 4:22 Found: unexpected light signature, 9:15 Fueling up, 2:12

G

G2 has a date with a black hole, 5:22 Gaia launches to catalog and map the stars, 4:18 Gaia watches every move stars make, 6:20 Galaxies discovered, 7:7 Galaxy cluster mass mapped, 11:13 A galaxy of super-Earths and mini-Neptunes, 5:20 Gerald Rhemann imaging from near and far, 7:46–51 Get stumped!, 6:66 The golden age of radio astronomy, 12:46–51 Gravity-defying asteroid, 12:12 Great Red Spot not so great?, 9:15 A great year for the Leonids, 11:60–61 The greatest sky on Earth, 10:9 Green Bank Telescope spots a hydrogen river, 5:17

Η

Has NASA lost its edge?, 9:32–37 A hat, a shark, and time travel, 5:18 Herschel finds water vapor at Ceres, 5:12 Hiding from the light, 9:14 High-energy cosmic rays from the Great Bear, 11:17 Hot planet, cool star, 12:12 How Astro Tanja captures the southern sky, 8:60-63 How astronomers measure the cosmos, 11:44-49 How Gaia will map a billion stars. 12:32–35 How I made my dream observatory, 3:54-56 How much water is on the Moon?, 1:50-55 How one small step became a giant leap, 8:22–27 How Terry Mann captures Earth and sky, 4:58-61 How the universe will end, 9:38-43 How to observe variable nebulae, 6:50-53 How to view October's two spectacular eclipses, 10:54-57 Hubble reveals cluster properties, 12:18 Hubble's precise eye, 8:12 Hunting aurorae in the Arctic, 7:55-59 Hunting for the glorious, 5:11

I

Image the solar system with Celestron's Skyris, 3:66–67 Important dwarf galaxies, 11:12 In the exact center, 10:11 Inflation retraction?, 10:12 Interaction needed to launch jets, 6:20 Intergalactic tug of war, 11:17 Is the universe depressed?, 11:11 ISON fails to survive Sun encounter, 3:11 It's about time, 12:11

J

The James Webb Space Telescope takes shape, 8:50–55 Jet shows how planetary nebulae get their shape, 1:18

K

A kingdom of dwarfs, 11:20

L

Laser pointer debate, 7:64 Lessons from the red and gold, 8:18 Life inside a globular cluster, 7:18–23 Lighten up!, 5:68 Logged: the interstellar wind's 40-year change, 1:16 The loneliest supernovae, 12:18 Lunar farside tells more accurate history, 3:19

Μ

MallinCam Jr Pro, 8:66-67 Mapping the Milky Way using Cepheids, 9:20 Mars mapped at night, 11:18 Mars: more complicated, 3:10 Masking the stars, 1:66 Massive and medium stars grow the same way, 4:14 Mastering Jupiter's atmosphere, 3:68 Meet astronaut Chris Hadfield, 9:52-55 Meteorite from Mars' crust found, 3:19 Midsize black hole confirmed, 12:12 The Milky Way wobbles, 2:20 Milky Way's black hole flared 2 million years ago, 1:18 Milky Way's structure, 4:14 Missing minerals?, 3:10 The missing universe, 4:24–29 Monkey see, monkey do, 8:10 Moon mission makes an impact, 8:16 Moonlight and Paul Revere, 4:20 More evidence for Moon impactor, 10:17 More material, bigger sun, 3:15 Morphing galaxies, 1:12 Most iron-poor star found, 6:16

Ν

NASA releases project rankings, 9:21 NASA reveals its Mars 2020 rover, 11:16 Nearby dust factory, 5:21 New "dwarf planet" found, 7:16 New film focuses on Hawking's life, 12:18 New gamma-ray source found, 11:12 New light on our Sun's fate, 2:44–49 New Mars gully channel appears, 7:17 New missions to the Red Planet, 3:18 A new outflow from a supermassive black hole, 10:17 New shape to the coldest place in space, 2:19 New structure seen, 7:17 New type of exoplanet?, 9:17 A new way to search for life in space, 6:46–49 The newest big thing in radio astronomy, 6:28–33 The next search for Earth-like worlds, 4:44–49 NuSTAR reveals lopsided stellar explosion, 6:16

0

Observe April's spectacular lunar eclipse, 4:52–54 Of star parties and star seekers, 9:60–65 100 Enceladus plumes, 11:18 Opportunity's Endeavour report, 5:12 The origins of science, 6:9 The Orionids' surprising afterglow, 10:14 Outcast orb, 2:12

Р

Particle prize, 2:12 Particles pack punch, 6:12 Peering inside a monster galaxy, 5:24-29 Phoebe feeds Saturn's most distant ring, 3:32 Picture perfect, 9:12 A pile of corpses, 3:12 Pinning down an exoplanet's size, 11:12 Planck mission over, 2:19 Planet with Earth-like composition found, 2:16 Planet-eating stars, 9:12 Planets are born in hybrid disks, 2:15 Planets weighed by starlight, 4:22 Plasma protects Earth, 7:12 PLATO to find planets, 6:12 Polluted stellar remnants, 7:17 Portrait of a weird moon, 5:9 Precise distances to 1 million galaxies, 5:19 Preferential galactic alignments found, 11:16 Probing space with Earth-based labs, 11:12 Probing the cosmos with gravitational waves, 8:28-33 Processing your sketch, 4:66 Proper luminance, 10:68 Puff the magic Sun, 10:10 Pulsar lives in triple system, 5:13

R

Race to outer space, 5:12 Realistic eyepiece sketches, 2:65 Remains scattered, 10:12 Remnant rocks, 8:12 Remote observing takes a giant leap forward, 6:60–63 Rhythms of the sky, 1:11 Ring around a...centaur?, 7:11 Rosetta sets its sights on comet mysteries, 11:26–31 Run a globular cluster marathon, 3:57–59

S

Saturnian atmosphere, 1:12 Saturn's opposition effect, 5:14 Scientists detect extraterrestrial neutrinos, 3:11 Scientists find possible waves in Titan sea, 10:12 Scientists witness a pulsar transformation, 11:18 The search for life, 6:11 Searching for smart life around small stars, 2:28-33 Secret lives of supermassive stars, 5:30–35 Secrets of the Pinwheel Galaxy, 11:52-55 See SATURN in prime time, 5:62-64 Segue 1 is a fossil, 9:12 Shocked ice creates life precursors, 1:12 Shoot the Moon in high resolution, 10:58-61 Sketch the Messier objects in one night, 3:60-63 Sketching a lunar eclipse, 10:66 Skyjacked!, 3:22-27 Society support, 11:14 Solar neutrino discovery cuts to Sun's core, 12:22 Solar structure, 10:12 Solving a magnetar mystery, 9:12 Solving the mystery of cosmic rays, 4:30–35 Spiral masterpiece, 12:10 Spiral or elliptical?, 3:8 Spiral's gas blows away, 7:8 Star clusters grow from the outside in, 9:20 Star clusters harbor planets, 5:20 Star death, 7:68 Star stuff mixed early on in formation, 12:13 Stardust team finds interstellar dirt, 12:14 Starmus Festival takes off!, 9:58-59 Starmus rocks astronomy!, 6:58-59 Star-rich views, 12:66 Struve's stars, 10:18 Students and Swift see a new supernova, 5:16 Study challenges black hole theory, 9:13 Superluminous supernova solved, 8:17 Supernova's original star confirmed, 2:16

Т

Target 12 kinds of globular clusters, 1:62–65 Target 20 treats in Cygnus, 10:50–53 Target winter's best open clusters, 12:54–57 Testing Sky-Watcher USA's new refractor, 6:64–65 This black hole is too bright, 3:14 Three little planetaries, 2:14 Three space telescopes witness unprecedented gamma-ray burst, 3:13 Titan's history doesn't fit with Saturn, 10:13 Top 10 space stories of 2013, 1:24–33 Tough travels, 12:14 Tour 10 autumn binocular highlights, 10:62–63 Tracking asteroids, 5:66 The truth behind the Super Moon, 8:64–65 12 sweet summer bino treats, 7:60–61 24 gems near the North Celestial Pole, 5:56–59 Twinkle, twinkle, giant star, 7:17 Two subtle wonders near Gamma Cygni, 9:18

U

Unexpectedly bright galaxies found in the early universe, 5:13 The universe in X-rays, 7:30–35 Unraveling the mysteries of interstellar material, 12:22 U.S. government shuts down astronomy, 1:13 Use processing operators, 7:66 Using masks, part 1, 11:66 Using masks, part 2, 12:68 Using solar power to view the stars, 4:55–57

V

Very faint nebulae, 1:68 Vesta's surprising structure, 11:12 View Ceres and Vesta at their best, 5:52–55

W

Wakey wakey, Rosetta, 5:12 Wander fall's deep sky, 8:56–59 Water found in exoplanet remnants, 2:13 Waves warm the Sun's corona, 2:12 Weather forecasts on brown dwarfs, 5:15 Weird moons of the solar system, 6:22–27 The weird world of Phoebe, 3:28–33 What are we learning from cosmic dust?, 2:56–59 What to do with all the citizens' science?, 7:12 When astronomy gives you goosebumps, 11:56–59 Where is astronomy going?, 9:24–31 Where other astrophotographers fear to tread, 2:52–55 Why did Mars go cold and dry?, 4:9 Why isn't Pluto a planet?, 9:9

Y

Young planetary system may host colliding comets, 7:16 Young world around Beta Pictoris spins madly, 8:13

AUTHOR

В

Bakich, Michael E. Comet ISON's opening act, 2:50-51 Cosmos: A SpaceTime Odyssey, 4:12-13 Enhance your observing with filters, 7:52-55 Explore the Trumpler classes of clusters, 2:62-64 A great year for the Leonids, 11:60–61 Meet astronaut Chris Hadfield, 9:52-55 Observe April's spectacular lunar eclipse, 4:52-54 See SATURN in prime time, 5:62-64 Target 20 treats in Cygnus, 10:50-53 Target winter's best open clusters, 12:54-57 The truth behind the Super Moon, 8:64–65 24 gems near the North Celestial Pole, 5:56–59 The universe in X-rays, 7:30-35 Wander fall's deep sky, 8:56-59 When astronomy gives you goosebumps, 11:56-59 Barbree, Jay How one small step became a giant leap, 8:22-27 Berman, Bob The animated universe, 7:9 Astronomy and God, 8:11 Balls of crushed fire, 2:11 The Belt of Orion, 4:11 Black holes might be wrong, 10:22-27 Cosmic food fights, 9:11 Equinox energy and emptiness, 3:9 In the exact center, 10:11 Hunting for the glorious, 5:11 Is the universe depressed?, 11:11 It's about time, 12:11 The missing universe, 4:24–29 Rhythms of the sky, 1:11 The search for life, 6:11 Betz, Eric Astrobiologists hail Antarctic life find, 12:13 Black hole blur, 12:12 Curiosity takes a beating, 12:13 Gravity-defying asteroid, 12:12 Hot planet, cool star, 12:12 Intergalactic tug of war, 11:17 The loneliest supernovae, 12:18 Mars mapped at night, 11:18 New film focuses on Hawking's life, 12:18 Solar neutrino discovery cuts to Sun's core, 12:22 Stardust team finds interstellar dirt, 12:14 Tough travels, 12:14 Bilton, Jacqueline The golden age of radio astronomy, 12:46-51 Block, Adam Colorful connections, 8:68 Comet construction, 4:64

Compelling contrast, 3:20 Double color, 9:82 Lighten up!, 5:68 Proper luminance, 10:68 Use processing operators, 7:66 Using masks, part 1, 11:66 Using masks, part 2, 12:68 Brown, Anthony G. A. How Gaia will map a billion stars, 12:32–35 Burchell, Tania The newest big thing in radio astronomy, 6:28–33

С

Carroll, Michael The weird world of Phoebe, 3:28-33 Cendes, Yvette Secret lives of supermassive stars, 5:30–35 Chaple, Glenn Asteroid occultation, 3:16 Astro-freebies, 1:20 Civil War star, 6:18 Desktop downloads, 12:20 Disrespected globular, 8:14 Eclipse escapades, 4:16 Everyday accessories, 2:18 A hat, a shark, and time travel, 5:18 Hiding from the light, 9:14 Laser pointer debate, 7:64 Society support, 11:14 Struve's stars, 10:18

D

Davis, Thomas V. Where other astrophotographers fear to tread, 2:52–55 Dorminey, Bruce A new way to search for life in space, 6:46–49 Probing the cosmos with gravitational waves, 8:28–33

E

Eicher, David J. Black hole realities, 8:9 Charles Messier and comets, 2:9 Chile: Visiting the astronomer's paradise, 12:58-63 Comets and human beings, 1:9 The cosmic distance scale, 11:9 The dawn of dark matter, 12:9 Galaxies discovered, 7:7 The greatest sky on Earth, 10:9 Harlow Shapley and globular clusters, 3:7 The origins of science, 6:9 Portrait of a weird moon, 5:9 Of star parties and star seekers, 9:60-65 Starmus Festival takes off!, 9:58-59 Starmus rocks astronomy!, 6:58–59 Why did Mars go cold and dry?, 4:9

Why isn't Pluto a planet?, 9:9 Emspak, Jesse Faceoff! The Moon's oddly different sides, 8:44–49

F

Ferron. Karri Asteroid anatomy surprises scientists, 6:17 Astronomers map largest moon in the solar system, 6:13 Binary found with misaligned planet-forming disks, 11:22 Cassini captures possible birth of new moon, 8:13 Cassini data reveals Enceladus internal ocean, 8:12 Defining the boundary between stars and brown dwarfs, 4:15 Densest galaxy provides origin clues, 1:12 Forming a picture of Milky Way growth, 4:22 Galaxy cluster mass mapped, 11:13 Great Red Spot not so great?, 9:15 Herschel finds water vapor at Ceres, 5:12 Hubble reveals cluster properties, 12:18 Hunting aurorae in the Arctic, 7:58-59 ISON fails to survive Sun encounter, 3:11 Jet shows how planetary nebulae get their shape, 1:18 Lunar farside tells more accurate history, 3:19 Midsize black hole confirmed, 12:12 More evidence for Moon impactor, 10:17 New Mars gully channel appears, 7:17 A new outflow from a supermassive black hole, 10:17 New shape to the coldest place in space, 2:19 NuSTAR reveals lopsided stellar explosion, 6:16 Pinning down an exoplanet's size, 11:12 Planck mission over, 2:19 Ring around a...centaur?, 7:11 Scientists witness a pulsar transformation, 11:18 Solving a magnetar mystery, 9:12 Star clusters harbor planets, 5:20 Star stuff mixed early on in formation, 12:13 Study challenges black hole theory, 9:13 Titan's history doesn't fit with Saturn, 10:13 Unexpectedly bright galaxies found in the early universe, 5:13 Unraveling the mysteries of interstellar material, 12:22 Water found in exoplanet remnants, 2:13 Fesen, Robert A. Bringing a star's death to life, 10:44-49

Friedman, Andrew

Can the cosmos test quantum entanglement?, 10:28-33

G

Grusauskas, Maria How Astro Tanja captures the southern sky, 8:60–63

Η

Hallas, Tony Astronomy tests Vixen's widefield refractor, 10:64–65 The final chapter, 2:66 Masking the stars, 1:66 Harrington, Phil Astronomy tests Celestron's StarSense, 7:62–63 Astronomy's fifth annual Star Products, 9:74–81 Explore the Virgo cluster through binoculars, 3:64–65 Testing Sky-Watcher USA's new refractor, 6:64–65 Tour 10 autumn binocular highlights, 10:62–63 12 sweet summer bino treats, 7:60–61 Harris, William Life inside a globular cluster, 7:18–23

J

Jakiel, Richard How to observe variable nebulae, 6:50–53 James, C. Renée How astronomers measure the cosmos, 11:44–49 Johnson, Rick Exoplanet systems illustrated, 12:44–45

Κ

Kalirai, Jason New light on our Sun's fate, 2:44-49 Kelly, Roen Exoplanet systems illustrated, 12:44-45 Kruesi, Liz Are distant galaxies hiding?, 2:21 Astronomers capture Milky Way's magnetic field, 9:13 Astronomers precisely measure cosmic expansion, 8:15 Astronomers watch the Sun's corona heat up, 10:20 ATHENA chosen for 2028 launch, 10:19 Cassini takes extraordinary Saturn portrait, 2:21 Chandra spies black holes in the Whirlpool, 10:13 Chandra's 10 biggest discoveries, 7:24-29 Chasing the Moon's shadow through Africa, 6:54-55 Clouds orbit and dim eight active black holes, 6:13 Cold and brown, 3:10 Cosmic dust creator possibly confirmed, 11:13 Creating a universe like ours, 9:16 A dark burst and its dusty environment, 10:13 A deep canyon on the Red Planet, 2:17 Different masses, same result?, 6:15 Earth-sized world in "Goldilocks" zone, 7:13 Europa spews water, 4:14 An evolutionary link for pulsars, 1:16 Found: unexpected light signature, 9:15 Gaia launches to catalog and map the stars, 4:18 A galaxy of super-Earths and mini-Neptunes, 5:20 Has NASA lost its edge?, 9:32-37 High-energy cosmic rays from the Great Bear, 11:17 Hunting aurorae in the Arctic, 7:55–57 Important dwarf galaxies, 11:12 Inflation retraction?, 10:12 Interaction needed to launch jets, 6:20 Logged: the interstellar wind's 40-year change, 1:16 Mapping the Milky Way using Cepheids, 9:20 Mars: more complicated, 3:10 Milky Way's structure, 4:14

Missing minerals?, 3:10 Moon mission makes an impact, 8:16 More material, bigger sun, 3:15 Morphing galaxies, 1:12 Most iron-poor star found, 6:16 NASA releases project rankings, 9:21 NASA reveals its Mars 2020 rover, 11:16 Nearby dust factory, 5:21 New "dwarf planet" found, 7:16 New gamma-ray source found, 11:12 New missions to the Red Planet, 3:18 New structure seen, 7:17 New type of exoplanet?, 9:17 The next search for Earth-like worlds, 4:44-49 100 Enceladus plumes, 11:18 Opportunity's Endeavour report, 5:12 Phoebe feeds Saturn's most distant ring, 3:32 Picture perfect, 9:12 Planet with Earth-like composition found, 2:16 Planet-eating stars, 9:12 Polluted stellar remnants, 7:17 Precise distances to 1 million galaxies, 5:19 Preferential galactic alignments found, 11:16 Probing space with Earth-based labs, 11:12 Race to outer space, 5:12 Remains scattered, 10:12 Saturnian atmosphere, 1:12 Scientists detect extraterrestrial neutrinos, 3:11 Scientists find possible waves in Titan sea, 10:12 Segue 1 is a fossil, 9:12 Shocked ice creates life precursors, 1:12 Solar structure, 10:12 Superluminous supernova solved, 8:17 Supernova's original star confirmed, 2:16 This black hole is too bright, 3:14 Top 10 space stories of 2013, 1:24–33 Twinkle, twinkle, giant star, 7:17 Vesta's surprising structure, 11:12 Wakey wakey, Rosetta, 5:12 Weather forecasts on brown dwarfs, 5:15 Young planetary system may host colliding comets, 7:16

Μ

Mann, Terry How Terry Mann captures Earth and sky, 4:58–61 Margutti, Raffaella Catch the sounds of exploding stars, 11:32–35 Midkiff, Alan H. Using solar power to view the stars, 4:55–57 Milisavljevic, Dan Bringing a star's death to life, 10:44–49

Ν

Nadis, Steve Peering inside a monster galaxy, 5:24–29

0

Olinto, Angela Solving the mystery of cosmic rays, 4:30–35 O'Meara, Stephen James Beautiful Endymion, 1:14 The bewitching Fata Morgana, 7:14 Black aurorae, 6:14 California dreamin', 12:16 A kingdom of dwarfs, 11:20 Lessons from the red and gold, 8:18 Moonlight and Paul Revere, 4:20 The Orionids' surprising afterglow, 10:14 A pile of corpses, 3:12 Saturn's opposition effect, 5:14 Three little planetaries, 2:14 Two subtle wonders near Gamma Cygni, 9:18

P

Peach, Damian
Image the solar system with Celestron's Skyris, 3:66–67
Remote observing takes a giant leap forward, 6:60–63
Polakis, Tom

A dream night with the Discovery Channel Telescope, 5:44–49
Run a globular cluster marathon, 3:57–59
Pommier, Rod

Secrets of the Pinwheel Galaxy, 11:52–55
Target 12 kinds of globular clusters, 1:62–65
Probst, Bert

How I made my dream observatory, 3:54–56

R

Redd, Nola Taylor The James Webb Space Telescope takes shape, 8:50-55 Reddy, Francis Five stars that could go bang, 12:27-31 How the universe will end, 9:38-43 Reeves, Robert Shoot the Moon in high resolution, 10:58-61 Regas, Dean Weird moons of the solar system, 6:22-27 Rhemann, Gerald Gerald Rhemann imaging from near and far, 7:46-51 Rix. Erika Animating the Moon, 9:70–73 Comparing magnifications, 9:84 Creating unresolved stars, 11:64 Get stumped!, 6:66 Mastering Jupiter's atmosphere, 3:68 Processing your sketch, 4:66 Realistic eyepiece sketches, 2:65 Sketch the Messier objects in one night, 3:60-63 Sketching a lunar eclipse, 10:66 Star death, 7:68 Star-rich views, 12:66

Tracking asteroids, 5:66 Very faint nebulae, 1:68

S

Scoles, Sarah ALMA watches black hole in action, 2:15 Asteroid dresses up as six-tailed comet, 3:18 Astronomers confirm hundreds of Kepler discoveries, 6:20 Astronomers map 1,500 clouds--in another galaxy, 4:14 Big bulges mean no new stars, 10:16 Bipedal satellite, 4:14 Black hole has no-holds-barred wind, 6:17 Black hole jets full of metal, 3:10 Cold snap, 8:12 Cosmic inflation happened, according to BICEP2 results, 6:12 Curiosity smells no methane on Mars, 2:13 Curiosity's latest findings from Mars, 1:44-49 Double-dip asteroid, 6:12 Exploring the biggest asteroids, 3:44–49 Fast flares, 4:14 Fueling up, 2:12 G2 has a date with a black hole, 5:22 Gaia watches every move stars make, 6:20 Green Bank Telescope spots a hydrogen river, 5:17 Hubble's precise eye, 8:12 Massive and medium stars grow the same way, 4:14 Meteorite from Mars' crust found, 3:19 The Milky Way wobbles, 2:20 Milky Way's black hole flared 2 million years ago, 1:18 Outcast orb, 2:12 Particle prize, 2:12 Particles pack punch, 6:12 Planets are born in hybrid disks, 2:15 Planets weighed by starlight, 4:22 Plasma protects Earth, 7:12 PLATO to find planets, 6:12 Pulsar lives in triple system, 5:13 Remnant rocks, 8:12 Students and Swift see a new supernova, 5:16 Three space telescopes witness unprecedented gamma-ray burst, 3:13 U.S. government shuts down astronomy, 1:13 Waves warm the Sun's corona, 2:12 What to do with all the citizens' science?, 7:12 Where is astronomy going?, 9:24-31 Young world around Beta Pictoris spins madly, 8:13 Shostak, Seth Searching for smart life around small stars, 2:28-33 Shubinski, Raymond All about 47 Tucanae, 9:66-69

Т

Talcott, Richard Chasing the Moon's shadow through Africa, 6:56–57 Comet ISON's final hurrah, 3:50–53 Comet ISON's final stab at glory, 1:56–61

How to view October's two spectacular eclipses, 10:54-57 Rosetta sets its sights on comet mysteries, 11:26-31 Star clusters grow from the outside in, 9:20 View Ceres and Vesta at their best, 5:52-55 Temple, Craig Astronomy tests Celestron's NexStar Evolution, 12:64-65 Astronomy tests Meade's new 10-inch SCT, 4:62-63 MallinCam Jr Pro, 8:66-67 Temple, Tammy Astronomy tests Celestron's NexStar Evolution, 12:64-65 Astronomy tests Meade's new 10-inch SCT, 4:62-63 MallinCam Jr Pro, 8:66-67 Trusock, Tom Astronomy tests a great new collimator, 5:60-61 Astronomy tests Levenhuk's new refractor, 2:60-61 Astronomy tests William Optics' new refractor, 11:62-63

V

Villard, Ray Skyjacked!, 3:22–27

W

Wadhwa, Meenakshi What are we learning from cosmic dust?, 2:56–59 Webb, Jeremy Life inside a globular cluster, 7:18–23

Ζ

Zimmerman, Robert Does methane flow on Titan?, 2:22–27 How much water is on the Moon?, 1:50–55