A LIVELY ELECTRONIC COMPENDIUM OF RESEARCH, NEWS, RESOURCES, AND OPINION

Astronomy Education Review

2009, AER, 8, 010303-1, 10.3847/AER2009060

A Topical Index to Astronomy Articles in *Scientific American* Magazine 1999–2009

Andrew Fraknoi
Foothill College, Los Altos, California 94022
Received: 10/7/09, Published: 12/10/09

Abstract

We present an annotated listing of astronomy articles in *Scientific American* magazine, organized by topic, for the past ten years. These articles are an excellent supplement for introductory astronomy courses, especially for students who do papers or oral reports, or for getting an overview of new developments.

1. INTRODUCTION

There is a wealth of resources in print and on the web for instructors or students who want to keep up with the latest developments in astronomy. Many of these, however, are narrowly focused, too technical, or somewhat out of date. *Scientific American*, a venerable magazine for the educated layperson, prides itself on presenting readable overviews of new ideas and discoveries. In the past decade, the old magazine has become more lively and colorful. With the addition of George Musser, the former editor of the Astronomical Society of the Pacific's *Mercury* magazine and an astronomy Ph.D., to its staff, *Scientific American* seems to have increased the variety and frequency of its coverage of astronomy.

Because astronomy articles are randomly scattered among the magazine's coverage of all other fields of science and engineering and because the sometimes too-cute titles of articles do not always provide a perfect guide to their contents, it can be hard for instructors or librarians to keep up with what *Scientific American* has already covered. As a service to the astronomy education community, we therefore provide a subject index to all astronomy articles in the magazine from the late summer of 1999 to the late summer of 2009, with brief descriptions of their contents.

2. THE SUBJECT INDEX

2.1. Asteroids and Impacts

Ardila, D., "The Hidden Members of Planetary Systems," April 2004, p. 62. On asteroids, comets and dust in our own solar system and around other stars.

Asphang, E., "The Small Planets," May 2000, p. 46. On asteroids, including results from the NEAR mission.

Becker, L., "Repeated Blows," March 2002, p. 76. Controversy about whether there have been several extinction impacts in Earth's history.

Gasperini, L. *et al.*, "The Tunguska Mystery," June 2008, p. 80. A more detailed exploration of the site of the 1908 impact over Siberia.

Kring, D. and Durda, D., "The Day the World Burned," December 2003, p. 98. On what happened to the environment and life on Earth after the Chicxulub impact 65 million years ago.

Nadis, S., "Keeper of the Objects," August 2003, p. 84. Brief profile on Brian Marsden and his work on keeping track of asteroids, including near-Earth ones.

Rubin, A., "What Heated the Asteroids?," May 2005, p. 80. Early heating by collisions and radio isotopes.

Schweickart, R. *et al.*, "The Asteroid Tugboat," November 2003, p. 54. A proposal to use gentle tugging to prevent an asteroid from hitting the Earth if we have lots of notice.

2.2. Astronomers

Appell, D., "Dark Forces at Work," May 2008, p. 100. A profile of Saul Perlmutter, the leader of one of the teams whose work with supernovae led to the discovery of the universe's acceleration.

Appell, D., "Father of Spirit and Opportunity," October 2004, p. 44. Short profile of Steven Squires, science leader for the Mars Exploration Rovers.

Gibbs, W., "Breaking the Mold," December 2005, p. 42. Profile of telescope maker Roger Angel and his work with large mirrors.

Grossman, D., "Richard Muller: One Disaster after Another," February 2001, p. 30. Brief profile of Richard Muller, whose work often deals with catastrophes that may affect our solar system.

Lightman, A., "Einstein and Newton: Genius Compared," September 2004, p. 108. Brief essay comparing their work and intellect.

Lubick N., "An Ear to the Stars," November 2002, p. 42. Profile of SETI researcher Jill Tarter.

Nadis, S., "Keeper of the Objects," August 2003, p. 84. Brief profile on Brian Marsden and his work on keeping track of asteroids, including near-Earth ones.

Wakefield, J. "Baruch Blumberg: The Search for Extreme Life," July 2000, p. 30. Brief profile of the head of the NASA Astrobiology Institute.

Wakefield, J., "Doom and Gloom by 2100," July 2004, p. 48. Brief discussion of the thoughts of Sir Martin Rees, astronomer and futurist.

2.3. Astronomy in General

Livio, M., "Hubble's Top Ten," July 2006, p. 42. Brief descriptions on the most important work being done by the Hubble Space Telescope.

Soter, S., "What is a Planet?," January 2007, p. 34. On the IAU's new definition of a planet and how it affects the line up of objects in our solar system.

2.4. Black Holes

Barger, A., "The Midlife Crisis of the Cosmos," January 2005, p. 46. On how our time differs from the early universe in terms of what galaxies are doing and what role supermassive black holes play.

Bekenstein, J., "Information in the Holographic Universe," August 2003, p. 58. On the thermodynamics of black holes and their implications for information storage.

Blaes, O., "A Universe of Disks," October 2004, p. 48. On accretion disks and jets around young stars and black holes.

Carr, B. and Giddings, S., "Quantum Black Holes," May 2005, p. 48. Mini black holes—how to make them and what we can learn from them.

Davies, P., "How to Build a Time Machine," September 2002, p. 50. On using wormholes for time travel.

Jacobson, T. and Parentani, R., "An Echo of Black Holes," December 2005, p. 68. Acoustic analogs to the structure of space-time, black holes, and Hawking radiation.

Joshi, P., "Naked Singularities," February 2009, p. 36. How stellar evolution may produce a black hole that has no event horizon.

Lloyd, S. and Ng, Y., "Black Hole Computers," November 2004, p. 52. Novel ideas about black holes and information and the laws of physics.

Maldacena, J., "The Illusion of Gravity," November 2005, p. 56. Holographic theory of quantum gravity and its implications for black holes and other topics in physics.

Tucker, W. *et al.*, "Black Hole Blowback," March 2007, p. 42. How supermassive black holes create giant bubbles in the intergalactic medium.

Weaver, K., "The Galactic Odd Couple," July 2003, p. 34. Why bursts of star formation and massive central black holes are seen to go together in galaxies.

2.5. Brown Dwarfs

Mohanty, S. and Jayawardhana, R., "The Mystery of Brown Dwarf Origins," January 2006, p. 38. Ideas about why these "failed stars" do not accrete larger masses and become stars.

Werner, M. and Jura, M., "Improbable Planets," June 2009, p. 38. On planets and debris disks around white dwarfs, neutron stars, and brown dwarfs.

2.6. Cosmology

Ambjorn, J. *et al.*, "The Self-Organizing Quantum Universe," July 2008, p. 42. On new ideas in quantum gravity and how the universe could assemble from quantum components; mostly physics.

Appell, D., "Dark Forces at Work," May 2008, p. 100. A profile of Saul Perlmutter, the leader of one of the teams whose work with supernovae led to the discovery of the universe's acceleration.

Arkani-Hamed, N. *et al.*, "The Universe's Unseen Dimensions," August 2000, p. 62. On grand unified theories of physics, dimensions, and parallel universes.

Barger, A., "The Midlife Crisis of the Cosmos," January 2005, p. 46. On how our time differs from the early universe in terms of what galaxies are doing, and what role supermassive black holes play.

Barrow, J. and Webb, J., "Inconstant Constants: Do the Inner Workings of Nature Change with Time?," June 2005, p. 56. Possible astronomical evidence that the fine-structure constant has changed over cosmic periods.

Bennett, C. *et al.*, "A Cosmic Cartographer," January 2001, p. 44. A brief preview of the MAP mission to examine details of the cosmic microwave background (later renamed WMAP).

Bojowald, M., "Follow the Bouncing Universe," October 2008, p. 44. On theories of quantum gravity, and a universe that may have had events before the big bang.

Burgess, C. and Quevedo, F., "The Great Cosmic Roller Coaster Ride," November 2007, p. 52. On inflation, brane theory, multiverses, string theory, and new ideas to help understand the properties of the cosmos.

Caldwell, R. and Kamionkowski, M., "Echoes from the Big Bang," January 2001, p. 38. On studying the details of the cosmic microwave background radiation.

Carroll, S., "The Comic Origins of Time's Arrow," June 2008, p. 48. The direction of time in the universe, entropy, and the notion of a much larger scope for the universe.

Chaboyer, B., "Rip Van Twinkle: The Oldest Stars Have Been Growing Younger," May 2001, p. 44. On measuring the ages of globular clusters and how new measurements find ages that fit comfortably with the age of the universe.

Clifton, T. and Ferreira, P., "Does Dark Energy Really Exist?," April 2009, p. 48. Posits another explanation for the Type Ia supernova observations: that the universe is seriously inhomogeneous.

Conselice, C., "The Universe's Invisible Hand," February 2007, p. 34. An introduction to dark energy and the effects it has on the structure and evolution of the universe.

Hu, W. and White, M., "The Cosmic Symphony," February 2004, p. 44. On oscillations in the early universe and how we can learn about them from the microwave background.

Kaiser, D., "When Fields Collide," June 2007, p. 62. A history of particle cosmology, the joining of particle physics with the study of the large-scale properties of the universe.

Krauss, L. and Turner, M., "A Cosmic Conundrum," September 2004, p. 70. On Einstein's cosmological constant, the acceleration of the universe, and dark energy.

Krauss, L. and Scherrer, R., "The End of Cosmology?," March 2008, p. 47. On how the acceleration of the universe's expansion wipes out cosmological information.

Krauss, L. and Starkman, G., "The Fate of Life in the Universe," November 1999, p. 58. Cosmology, thermodynamics, and the far future.

Larson, R. and Bromm, V., "The First Stars in the Universe," December 2001, p. 64. On the "dark ages" after the big bang and before stars formed and how they ended.

Lineweaver, C. and Davis, T., "Misconceptions about the Big Bang," March 2005, p. 36. Some basic ideas about modern cosmology, as seen using general relativity.

Loeb, A., "The Dark Ages of the Universe," November 2006, p. 47. Using radio arrays to look back to the period after the big bang faded.

Ostriker, J. and Steinhardt, P., "The Quintessential Universe," January 2001, p. 47. On dark energy and what might be the explanation for it.

Riess, A. and Turner, M., "From Slowdown to Speedup," February 2004, p. 62. On observations of supernovae and what they tell us about the acceleration of the universe's expansion.

Riordan, M. and Zajc, W., "The First Few Microseconds," May 2006, p. 34. Experiments to reproduce conditions right after the big bang.

Starkman, G. and Schwarz, D., "Is the Universe Out of Tune?," August 2005, p. 48. On discrepancies between the theory and observations of the harmonics of the cosmic microwave background radiation.

Strauss, M., "Reading the Blueprints of Creation," February 2004, p. 54. On large-scale surveys of galaxies and what they tell us about the organization of the early universe.

Tegmark, M., "Parallel Universes," May 2003, p. 40. Ideas about a "multiverse:" physical theories that permit or demand other universes.

Turner, M., "The Origin of the Universe," September 2009, p. 36. An introduction to modern cosmology.

Veneziano, G., "The Myth of the Beginning of Time," May 2004, p. 54. Ideas from string theory about space, time, and branes that predate the big bang.

2.7. Dark Energy (Also See Under Cosmology)

Appell, D., "Dark Forces at Work," May 2008, p. 100. A profile of Saul Perlmutter, the leader of one of the teams whose work with supernovae led to the discovery of the universe's acceleration.

Clifton, T and Ferreira, P., "Does Dark Energy Really Exist?," April 2009, p. 48. Posits another explanation for the Type Ia supernova observations: that the universe is seriously inhomogeneous.

Conselice, C., "The Universe's Invisible Hand," February 2007, p. 34. An introduction to dark energy and the effects it has on the structure and evolution of the universe.

Krauss, L. and Turner, M., "A Cosmic Conundrum," September 2004, p. 70. On Einstein's cosmological constant, the acceleration of the universe, and dark energy.

Krauss, L. and Scherrer, R., "The End of Cosmology?," March 2008, p. 47. On how the acceleration of the universe's expansion wipes out cosmological information.

Ostriker, J. and Steinhardt, P., "The Quintessential Universe," January 2001, p. 47. On dark energy and what might be the explanation for it.

2.8. Dark Matter

Cline, D., "The Search for Dark Matter," March 2003, p. 50. Experiments to identify the nature of dark matter.

Milgrom, M., "Does Dark Matter Really Exist?," August 2002, p. 42. On modified Newtonian dynamics, a controversial theory that changes gravity and does away with the need for dark matter.

2.9. Earth as a Planet

Bindeman, I., "The Secrets of Supervolcanoes," June 2006, p. 36. Supereruptions and volcanic winters; new clues from ash deposits.

Collins, W. *et al.*, "The Physical Science Behind Climate Change," August 2007, p. 64. Why scientists are now confident that human activities are changing our planet's climate.

Glatzmaier, G. and Olson, P., "Probing the Geodynamo," April 2005, p. 50. Experiments and modeling that tell us about the source and reversals of the Earth's magnetic field.

Gurnis, M., "Sculpting the Earth from Inside Out," March 2001, p. 40. On motions that lift and lower the continents.

Hansen, J., "Defusing the Global Warming Time Bomb," March 2004, p. 68. Consequences of and solutions to the global warming crisis.

Hodges, K., "Climate and the Evolution of Mountains," August 2006, p. 72. Climate and geology can be on a slow feedback loop.

Hoffman, P. and Shrag, D., "Snowball Earth," January 2000, p. 68. On deep ice ages and their effects on the Earth's climate.

Kastings, J., "When Methane Made Climate," July 2004, p. 78. About the possibility that methane was more abundant in our atmosphere long ago, producing its own greenhouse effect.

Keppler, F. and Rockmann, T., "Methane, Plants, and Climate Change," February 2007, p. 52. Plants produce methane, but it is not as significant for global warming as human activity.

King, M. and Herring, D., "Monitoring Earth's Vital Signs," April 2000, p. 92. The work of the Terra Earth Observing Satellite.

Kring, D. and Durda, D., "The Day the World Burned," December 2003, p. 98. On what happened to the environment and life on Earth after the Chicxulub impact 65 million years ago.

Ruddiman, W., "How Did Humans First Alter the Global Climate?," March 2005, p. 46. New idea about how the rise of agriculture may have affected our atmosphere.

Stein, R., "Earthquake Conversations," January 2003, p. 72. How large earthquakes can interact.

Sturm, M. *et al.*, "Meltdown in the North," October 2003, p. 60. Early results on warming and Arctic glaciers melting.

Traduno, J., “Hot Spots Unplugged,” January 2008, p. 88. New evidence that vertical flows of hot material from inside the Earth are not fixed in place.

Valley, J., “A Cool Early Earth,” October 2005, p. 58. Evidence that the Earth may have cooled earlier than we thought.

2.10. Galaxies

Barger, A., “The Midlife Crisis of the Cosmos,” January 2005, p. 46. On how our time differs from the early universe in terms of what galaxies are doing and what role supermassive black holes play.

Beck, S., “Dwarf Galaxies and Starbursts,” June 2000, p. 67. On small galaxies that light up with star formation.

Combes, F., “Ripples in a Galactic Pond,” October 2005, p. 42. On spiral density waves, how they evolve, and how their action explains galactic shapes.

Kaufmann, G. and van den Bosch, F., “The Life Cycle of Galaxies,” June 2002, p. 46. On the evolution of galaxies and how the different shapes of galaxies develop.

Scannapieco, E. *et al.*, “The Emptiest Spaces,” October 2002, p. 56. On intergalactic medium and its evolution over time.

Wambsganss, J., “Gravity’s Kaleidoscope,” November 2001, p. 65. On gravitational lenses and microlensing.

Zepf, S. and Ashman, K., “The Unexpected Youth of Globular Clusters,” October 2003, p. 46. What these clusters can teach us about a galaxy’s history.

Weaver, K., “The Galactic Odd Couple,” July 2003, p. 34. Why bursts of star formation and massive central black holes are seen to go together in galaxies.

2.11. Galaxy, The Milky Way

Combes, F., “Ripples in a Galactic Pond,” October 2005, p. 42. On spiral density waves, how they evolve, and how their action explains the shape of our galaxy and others.

Ibata, R. and Gibson, B., “The Ghosts of Galaxies Past,” April 2007, p. 40. About star streams in the galaxy, which are evidence of past mergers and collisions.

Wakker, B. and Richter, P., “Our Growing, Breathing Galaxy,” January 2004, p. 38. Evidence that our galaxy is still being built up by the addition of gas and smaller neighbors.

2.12. Gamma-ray Astronomy

Atwood, W. *et al.*, “Window on the Extreme Universe,” December 2007, p. 54. On the GLAST satellite and what it might teach us.

2.13. General Relativity

Bekenstein, J., “Information in the Holographic Universe,” August 2003, p. 58. On the thermodynamics of black holes and their implications for different kinds of universes.

Ford, L. and Roman, T., “Negative Energy, Wormholes, and Warp Drive,” January 2000, p. 46. The latest thinking about extremes in relativistic physics, including moving faster than the speed of light and time travel.

Gueron, E., “Adventures in Curved Spacetime,” August 2009, p. 38. On new ideas of “swimming” (motion) through spacetime.

Lineweaver, C. and Davis, T., “Misconceptions about the Big Bang,” March 2005, p. 36. Some basic ideas about modern cosmology, as seen using general relativity.

Maldacena, J., “The Illusion of Gravity,” November 2005, p. 56. Holographic theory of quantum gravity and its implications for black holes and other topics in physics.

Wambsganss, J., “Gravity’s Kaleidoscope,” November 2001, p. 65. On gravitational lenses and microlensing.

See also under “Black Holes” and “Gravity Waves.”

2.14. Gravity Waves

Gibbs, W., “Ripples in Spacetime,” April 2002, p. 62. On gravity waves in general and the LIGO project designed to try and observe them.

2.15. History of Astronomy

Dick S., “The Transit of Venus,” May 2004, p. 98. On earlier transits and what they taught us and the one in June 2004.

Schaeffer, B., “The Origin of the Greek Constellations,” November 2006, p. 96. Archaeological and historical evidence.

Sheehan, W. *et al.*, “The Case of the Pilfered Planet,” December 2004, p. 92. Argues that J. C. Adams should not receive equal credit for the discovery of Neptune.

2.16. History of Physics

Byrne, P., “The Many Worlds of Hugh Everett,” December 2007, p. 98. On the life and work of the father of the many-worlds interpretation of quantum mechanics.

2.17. Interstellar Matter

Balick, B. and Frank, A., “The Extraordinary Deaths of Ordinary Stars,” July 2004, p. 50. About planetary nebulae, the last gasps of low-mass stars.

Bernstein, M. *et al.*, “Life’s Far-flung Raw Materials,” July 1999, p. 42. On organic materials in comets and the interstellar medium, and the connection to the origin of life.

Greenberg, J., “The Secrets of Stardust,” December 2000, p. 70. The makeup and evolutionary role of solid particles between the stars.

Parker, E., “Shielding Space Travelers,” March 2006, p. 40. On the origin and flux of cosmic rays, their effects on space travel, and possible ways of shielding.

Reynolds, R., “The Gas Between the Stars,” January 2002, p. 34. On the structure of the interstellar medium.

Scannapieco, E. *et al.*, “The Emptiest Spaces,” October 2002, p. 56. On intergalactic medium and its evolution over time.

Tucker, W. *et al.*, “Black Hole Blowback,” March 2007, p. 42. How supermassive black holes create giant bubbles in the intergalactic medium.

2.18. Life in the Universe (and SETI)

Bernstein, M. *et al.*, “Life’s Far-flung Raw Materials,” July 1999, p. 42. On organic materials in comets and the interstellar medium, and the connection to the origin of life.

Blake, D. and Jenniskens, P., “The Ice of Life,” August 2001, p. 45. An amorphous form of ice in space may foster the formation of more complex molecules.

Crawford, I., “Where Are They?,” July 2000, p. 38. On the Fermi paradox and its resolutions, and on galactic colonization models.

Gonzales, G. *et al.*, "Refuges for Life in a Hostile Universe," October 2001, p. 60. Discusses galactic habitability zones and the many dangers to life. Controversially concludes that complex life must be rare in the universe.

Kiang, N., "The Color of Plants on Other Worlds," April 2008, p. 48. How would plants develop on planets orbiting cooler stars.

Krauss, L. and Starkman, G., "The Fate of Life in the Universe," November 1999, p. 58. Cosmology, thermodynamics, and life's far future destiny.

Lubick N., "An Ear to the Stars," November 2002, p. 42. Profile of SETI researcher Jill Tarter.

Shapiro, R., "A Simpler Origin of Life," June 2007, p. 46. New ideas about what kind of molecules formed first so life could begin.

Simpson, S., "Questioning the Oldest Signs of Life," April 2003, p. 70. On the difficulty of interpreting "biosignatures" in the rocks and the implications for the search for life on other worlds.

Sipper, M. and Reggia, J., "Go Forth and Replicate," August 2001, p. 35. On whether artificial (machine) intelligence is capable of reproduction.

Swenson, G., "Intergalactically Speaking," July 2000, p. 48. On methods and challenges of interstellar radio communication.

Tarter, J. and Chyba, C., "Is There Life Elsewhere in the Universe?," December 1999, p. 118. The searches for life in our solar system and beyond.

Wakefield, J., "Baruch Blumberg: The Search for Extreme Life," July 2000, p. 30. Brief profile of the head of the NASA Astrobiology Institute.

Warmflash, D. and Weiss, B., "Did Life Come From Another World?," November 2005, p. 64. Microorganisms may be able to survive a trip through space inside a rock.

Weisman, A. and Mirsky, S., "An Earth Without People," July 2007, p. 76. What life forms would thrive if humans were to disappear.

2.19. The Moon

Dingell, C. *et al.*, "To the Moon and Beyond," October 2007, p. 62. More astronautics than science: about future human missions to the Moon.

Schmitt, H., "From the Moon to Mars," July 2009, p. 36. The only scientist to walk on the Moon reflects on the science from the Apollo missions and future exploration of Mars.

Spudis, P., "The New Moon," December 2003, p. 86. A summary of what we know after recent missions and what we still seek to understand.

2.20. Neutron Stars

Kouveliotou, C. *et al.*, "Magnetars," February 2003, p. 34. On highly magnetic neutron stars and their outbursts.

Werner, M. and Jura, M., "Improbable Planets," June 2009, p. 38. On planets and debris disks around white dwarfs, neutron stars, and brown dwarfs.

2.21. Particle Physics Related to Astronomy

Arkani-Hamed, N. *et al.*, "The Universe's Unseen Dimensions," August 2000, p. 62. On grand unified theories of physics, dimensions, and parallel universes.

Barrow, J. and Webb, J., "Inconstant Constants: Do the Inner Workings of Nature Change with Time?," June 2005, p. 56. Possible astronomical evidence that the fine-structure constant has changed over cosmic periods.

Bousso, R. and Plchinsky, J., "The String Theory Landscape," September 2004, p. 78. Implications of string theory for our universe and the greater "landscape" of other dimensions.

Burgess, C. and Quevedo, F., "The Great Cosmic Roller Coaster Ride," November 2007, p. 52. On inflation, brane theory, multiverses, string theory, and new ideas to help understand the properties of the cosmos.

Collins, G., "Making Cold Antimatter," June 2005, p. 78. Making antiatoms and how we might cool them to do experiments with them.

Dvali, G., "Out of the Darkness," February 2004, p. 68. On how string theory might suggest another explanation for the acceleration of the universe.

Kaiser, D., "When Fields Collide," June 2007, p. 62. A history of particle cosmology, the joining of particle physics with the study of the large-scale properties of the universe.

Kane, G., "The Mysteries of Mass," July 2005, p. 40. On the Higgs field and completing the theory of particle physics to explain the existence of mass.

Kane, G., "The Dawn of Physics Beyond the Standard Model," June 2003, p. 68. Overview of the basic ideas and ten mysteries in our understanding of subatomic particles.

Maldacena, J., "The Illusion of Gravity," November 2005, p. 56. Holographic theory of quantum gravity and its implications for black holes and other topics in physics.

McDonald, A. *et al.*, "Solving the Solar Neutrino Problem," April 2003, p. 40. How underground experiments with neutrino detectors helped explain the seeming absence of neutrinos from the Sun.

Quigg, C., "The Coming Revolutions in Particle Physics," February 2008, p. 46. On how the Large Hadron Collider will affect our understanding of the standard model of particles and forces.

Veneziano, G., "The Myth of the Beginning of Time," May 2004, p. 54. Ideas from string theory about space, time, and branes that predate the big bang.

2.22. Planets Around Other Stars

Ardila, D., "The Hidden Members of Planetary Systems," April 2004, p. 62. On asteroids, comets, and dust in our own solar system and dusty disks around other stars that may be evidence of planet building.

Doyle, L. *et al.*, "Searching for the Shadows of Other Earths," September 2000, p. 58. On using transits to find extrasolar planets, and a preview of the Kepler mission to do this from space.

Lin, D., "The Genesis of Planets," May 2008, p. 50. On modern theories of how planets form in general, as informed by our knowledge of planets around many stars.

Malhotra, R., "Migrating Planets," September 1999, p. 56. On how orbits of planets can change over time, both in other star systems and in our own.

Werner, M. and Jura, M., "Improbable Planets," June 2009, p. 38. On planets and debris disks around white dwarfs, neutron stars, and brown dwarfs.

2.23. Pseudoscience (Responding to)

Branch, G. and Scott, E., "The Latest Face of Creationism," January 2009, p. 92. A report on what is happening in the schools and in the courts, by two scientists actively involved in responding to the creationist threat to science education.

Gibbs, W. and Fox, D., "The False Crisis in Science Education," October 1999, p. 86. On the periodic sense of crisis in U.S. science and math education, and what really might work to improve the scientific understanding of our young people.

Mirsky, S., "Teach the Science," February 2006, p. 36. Profile of Eugenie Scott, who defends evolution against the claims of the creationists and intelligent design proponents.

Rennie, J., "15 Answers to Creationist Nonsense," July 2002, p. 78.

Shermer, M., "Quantum Quackery," January 2005, p. 34. Review of a nonsensical film with new age ideas.

2.24. Quantum Mechanics

Ambjorn, J. *et al.*, "The Self-Organizing Quantum Universe," July 2008, p. 42. On new ideas in quantum gravity and how the universe could assemble from quantum components; mostly physics.

Bojowald, M., "Follow the Bouncing Universe," October 2008, p. 44. On theories of quantum gravity, and a universe that may have had events before the big bang.

Byrne, P., "The Many Worlds of Hugh Everett," December 2007, p. 98. On the life and work of the father of the many-worlds interpretation of quantum mechanics.

Smolin, L., "Atoms of Space and Time," January 2004, p. 66. The theory of quantum loop gravity and what it would mean for some of our fundamental ideas.

Tegmark, M., "Parallel Universes," May 2003, p. 40. Ideas about a "multiverse:" physical theories that permit or demand other universes.

Tegmark, M. and Wheeler, J., "One Hundred Years of Quantum Mysteries," February 2001, p. 68. On the history and current state of quantum mechanics.

2.25. Solar System

Albee, A., "The Unearthly Landscapes of Mars," June 2003, p. 44. Results from the Mars Global Surveyor and Mars Odyssey missions and an overview of our understanding.

Appell, D., "Father of Spirit and Opportunity," October 2004, p. 44. Short profile of Steven Squires, science leader for the Mars Exploration Rovers.

Atreya, S., "The Mystery of Methane on Mars and Titan," May 2007, p. 42. Finding possible sources for methane in the atmospheres of these two worlds.

Bell, J., "The Red Planet's Watery Past," December 2006, p. 62. Rovers are furnishing proof that ancient Mars was wet.

Blake, D. and Jenniskens, P., "The Ice of Life," August 2001, p. 45. An amorphous form of ice in space may foster the formation of more complex molecules.

Burns, J. *et al.*, "Bejeweled Worlds," February 2002, p. 64. On the rings throughout the solar system.

Catling, D., "The Planetary Air Leak," May 2009, p. 36. On how planets lose atmosphere to space and how this affects their chemistry.

Christensen, P., "The Many Faces of Mars," July 2005, p. 32. Results from the Rover mission; evidence that Mars was once wet in places.

Dick, S., "The Transit of Venus," May 2004, p. 98. On earlier transits and what they taught us and the one in June 2004.

Jewitt, D. *et al.*, "The Strangest Satellites in the Solar System," August 2006, p. 40. Small irregular moons in the outer solar system.

Johnson, T., "The Galileo Mission to Jupiter and Its Moons" February 2000, p. 40. Results about Jupiter, Io, Ganymede, and Callisto.

Lunine, J., "Saturn at Last!," June 2004, p. 56. Preview of the Cassini/Huygens mission and introduction to Saturn and its moons.

Malhotra, R., "Migrating Planets," September 1999, p. 56. On how orbits of planets can change over time, both in our solar system and in other star systems.

Musser, G., "The Spirit of Exploration," March 2004, p. 52. On the Mars Exploration Rovers and the early discoveries.

Musser, G., "Five Essential Things to do in Space," October 2007, p. 68. Goals for planetary science, based on National Research Council reports.

Nellis, E., "Making Metallic Hydrogen," May 2000, p. 84. On terrestrial experiments to make the substance that is responsible for the magnetic fields of the giant planets.

Pappalardo, R. *et al.*, "The Hidden Ocean of Europa," October 1999, p. 54. Long, excellent overview of findings about the moon of Jupiter's that may harbor liquid water under its ice crust.

Parker, E., "Shielding Space Travelers," March 2006, p. 40. On the origin and flux of cosmic rays, their effects on space travel, and possible ways of shielding.

Porco, C., "The Restless World of Enceladus," December 2008, p. 52. On the Cassini observations and the geysers.

Schmitt, H., "From the Moon to Mars," July 2009, p. 36. The only scientist to walk on the Moon reflects on the science from the Apollo missions and future exploration of Mars.

Smith, I. and Cutts, J., "Floating in Space," November 2009, p. 98. On balloons that can float in the atmospheres of giant planets or high above the Earth.

Soter, S., "What is a Planet?," January 2007, p. 34. On the IAU's new definition of a planet, and what happened to Pluto as a result. Concerns planets in our solar system.

Stern, S., "Journey to the Farthest Planet," May 2002, p. 56. On missions to Pluto and the Kuiper Belt.

Tarter, J. and Chyba, C., "Is There Life Elsewhere in the Universe?," December 1999, p. 118. The searches for life in our solar system and beyond.

Zorpette, G. *et al.*, "Why Go to Mars" "How to Go To Mars, etc." March 2000, p. 40. A sequence of articles on the justification, science, and technology of a human mission to Mars.

2.26. Star Clusters

Chaboyer, B., "Rip Van Twinkle: The Oldest Stars Have Been Growing Younger," May 2001, p. 44. On measuring the ages of globular clusters and how new measurements find ages that fit comfortably with the age of the universe.

Shara, M., "When Stars Collide," November 2002, p. 44. On collisions of stars in clusters.

Zepf, S. and Ashman, K., "The Unexpected Youth of Globular Clusters," October 2003, p. 46. Not all of these clusters are old, as once thought. They can evolve throughout a galaxy's history.

2.27. Stars and Stellar Evolution

Balick, B. and Frank, A., "The Extraordinary Deaths of Ordinary Stars," July 2004, p. 50. About planetary nebulae, the last gasps of low-mass stars, and the future of our own Sun.

Basir, G. "The Discovery of Brown Dwarfs," April 2000, p. 76. Finding them, surveying for more, and their life cycles.

Blaes, O., “A Universe of Disks,” October 2004, p. 48. On accretion disks and jets around young stars and black holes.

Hillebrandt, W. *et al.*, “How To Blow Up a Star,” October 2006, p. 42. On supernova mechanisms.

Larson, R. and Bromm, V., “The First Stars in the Universe,” December 2001, p. 64. On the “dark ages” after the big bang and before stars formed, and how they ended.

Ray, T. “Fountains of Youth: Early Days in the Life of a Star,” August 2000, p. 42. On outflows from young stars.

Shara, M. “When Stars Collide,” November 2002, p. 44. On how collisions of stars in dense clusters can alter the evolution of those stars.

Werner, M. and Jura, M., “Improbable Planets,” June 2009, p. 38. On planets and debris disks around white dwarfs, neutron stars, and brown dwarfs and how they fit with stellar evolution.

2.28. Sun

Burch, J., “The Fury of Space Storms” April 2001, p. 86. On solar storms and their effects on Earth.

Dwivede, B. and Phillips, K., “The Paradox of the Sun’s Hot Corona,” June 2001, p. 40. Why the Sun’s outer layer is hotter than layers further in.

Holman, G., “The Mysterious Origins of Solar Flares,” April 2006, p. 38. New ideas involving magnetic reconnection and new observations of flares.

McDonald, A. *et al.*, “Solving the Solar Neutrino Problem,” April 2003, p. 40. How underground experiments with neutrino detectors helped explain the seeming absence of neutrinos from the Sun.

Odenwald, S. and Green, J., “Bracing for a Solar Superstorm,” August 2008, p. 80. On a huge 1859 storm on the Sun and the dangers of solar hyperactivity.

Zweibel, K. *et al.*, “A Solar Grand Plan,” January 2008, p. 64. A proposal to increase significantly the amount of solar power the U.S. uses, and how it could be done.

2.29. Supernovae

Appell, D., “Dark Forces at Work,” May 2008, p. 100. A profile of Saul Perlmutter, the leader of one of the teams whose work with supernovae led to the discovery of the universe’s acceleration.

Gonzales, G. *et al.*, “Refuges for Life in a Hostile Universe,” October 2001, p. 60. Discusses galactic habitability zones and the many dangers to life, such as supernovae.

Riess, A. and Turner, M., “From Slowdown to Speedup,” February 2004, p. 62. On observations of supernovae and what they tell us about the acceleration of the universe’s expansion.

2.30. Telescopes

Doyle, L. *et al.*, “Searching for the Shadows of Other Earths,” September 2000, p. 58. A preview of the Kepler mission with an instrument to measure the brightnesses of stars and find planet transits.

Gibbs, W., “Breaking the Mold,” December 2005, p. 42. Profile of telescope maker Roger Angel and his work with large mirrors.

Gilmozzi, R., “Giant Telescopes of the Future,” May 2006, p. 64.

Hajian, A. and Armstrong, J., “A Sharper View of the Stars,” March 2001, p. 57. On optical interferometers and how they help astronomers obtain higher resolution.

2.31. Time

The September 2002 issue was devoted to the topic of time.

Carroll, S., "The Comic Origins of Time's Arrow," June 2008, p. 48. The direction of time in the universe, entropy, and the notion of a much larger scope for the universe.

Smolin, L., "Atoms of Space and Time," January 2004, p. 66. The theory of quantum loop gravity and what it would mean for some of our fundamental ideas.

Veneziano, G., "The Myth of the Beginning of Time," May 2004, p. 54. Ideas from string theory about space, time, and branes that predate the big bang.

2.32. X-Ray Astronomy

Hasinger, G. and Gilli, R., "The Cosmic Reality Check," March 2002, p. 60. On the cosmic x-ray background and the ideas that can be checked against its observations.

ÆR
010303-1–010303-13