

# Science Fiction Stories with Good Astronomy & Physics: A Topical Index

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This is a selective list of some short stories and novels that use reasonably accurate science and can be used for teaching or reinforcing astronomy or physics concepts. The titles of short stories are given in quotation marks; only short stories that have been published in book form or are available free on the Web are included. While one book source is given for each short story, note that some of the stories can be found in other collections as well. (See the *Internet Speculative Fiction Database*, cited at the end, for an easy way to find all the places a particular story has been published.) The author welcomes suggestions for additions to this list, especially if your favorite story with good science is left out.



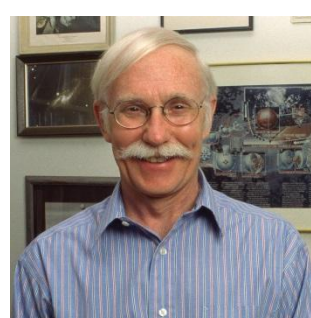
Gregory Benford



Octavia Butler



Geoff Landis



J. Craig Wheeler

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Useful Websites

## Anti-matter

Davies, Paul *Fireball*. 1987, Heinemann. Antimatter micrometeorites threaten Earth.

Niven, Larry "Flatlander" in *Neutron Star*. 1968, Ballantine. Two explorers find a high-speed protostar and a planet made of antimatter, passing through the Galaxy.

## Archaeoastronomy

Harrison, Harry & Stover, Leon *Stonehenge*. 1972, Scribners. A novel by a science fiction writer and an anthropologist.

## Asteroids

Baxter, Stephen "Pilot" in *Vacuum Diagrams*. 1997, Harper Prism. Future space travelers hollow out Chiron and use it as a spaceship to escape invading aliens. (Available on line at: <http://www.stephen-baxter.com/stories.html#pilot> )

Benford, Gregory "Dark Sanctuary" in *Matter's End*. 1994, Bantam. A prospector finds an interstellar spaceship hiding among the asteroids in the main belt.

Clarke, Arthur "Summertime on Icarus" in *The Nine Billion Names of God*. 1967, Signet. An astronaut is stranded on Icarus, the asteroid with the smallest perihelion distance, just as it is approaching the Sun.

Hoyle, Fred "Element 79" in *Element 79*. 1967, New American Library. An asteroid with significant amount of gold wreaks havoc with the Earth's economy.

Nordley, G. David "This Old Rock." 1997 story, in his collection *Prelude to the Stars*, 2015, Brief Candle. About a future when many asteroids in the belt are being outfitted as habitats for humans.

Preuss, Paul "Small Bodies" in Preiss, Byron, ed. *The Planets*. 1985, Bantam. A fundamentalist preacher and a scientist find fossils on an asteroid.

Reynolds, Alastair "Vainglory" in Strahan, J., ed. *Edge of Infinity*. 2012, Solaris. An artist and an industrialist sculpt an asteroid and then send it to hit the small innermost moon of Neptune's to break it up and make a new, more impressive ring around the planet.

See also under "Impacts"

## Astronomers

Banville, John *Doctor Copernicus*. 1976, Godine. A fictionalized biography of the astronomer.

Banville, John *Kepler: A Novel*. 1981, Godine. Fictionalization of Kepler's life.

Benford, Gregory *Timescape*. 1981, Bantam Spectra. *Eater*. 2000, Eos/HarperCollins. Many of the novels of physicist Benford portray what it is like to be a scientist. In these two books, some of the astronomer characters are based on real astronomers.

Benford, Gregory "Bow Shock" in Dozois, G., ed. *The Year's Best Science Fiction 24<sup>th</sup> Annual Collection*. 2007, St. Martin. A young astronomer at UC Irvine studying high-speed pulsars discovers an alien spaceship. (Available on line at: [https://www.baen.com/Chapters/1416521364/1416521364\\_4.htm](https://www.baen.com/Chapters/1416521364/1416521364_4.htm))

Bezzi, Tom *Hubble Time*. 1987, Mercury House. A fictional memoir of Hubble's life; gets some of the facts wrong, but an intriguing effort.

Brecht, Bertold *Galileo*. A 1938 stage play available alone (Grove Press) or in many collections; not historically accurate, but with strong political points to make.

Goldschmidt, Pippa *The Falling Sky*. 2013, Freight Books. A complex modern novel by a British astronomer/writer, about a post-doc grappling with her sexuality, her place in academic research, and family issues.

Gunderson, Lauren *Background*, in *Deepen the Mystery*. 2005, iUniverse. A play about Ralph Alpher on the day that Penzias and Wilson receive the Nobel Prize for discovering the cosmic background radiation and he is not included.

- Gunderson, Laura *Silent Sky*. 2015, Dramatist's Play Service. A play about the life and work of Henrietta Leavitt, her discovery of the Cepheid period-luminosity relationship, and her struggle with hearing impairment.
- McDevitt, Jack & Shara, Michael "Lighthouse" in *Cryptic: The Best Short Fiction of Jack McDevitt*. (2009, Subterranean Press) [also on the web at: [https://www.baen.com/Chapters/1596061958/1596061958\\_8.htm](https://www.baen.com/Chapters/1596061958/1596061958_8.htm)] A story about astronomical discovery told within the frame of a thesis defense colloquium; what it would be like if an astronomer discovered the existence of intelligent life out there by means of modifications they made to astronomical objects.
- McDevitt, Jack & Shara, Michael "Cool Neighbor" in *Cryptic: The Best Short Fiction of Jack McDevitt*. (2009, Subterranean Press) [also on line at: [https://www.baen.com/Chapters/1596061958/1596061958\\_9.htm](https://www.baen.com/Chapters/1596061958/1596061958_9.htm)] An astronomer with a giant infrared telescope in orbit discovers a brown dwarf 18 light-days away, with planets. Good discussion of how astronomers think.
- Newcomb, Simon *His Wisdom, the Defender*. 1900, available in reprint editions. Not so much about astronomers as about scientist in general -- as viewed by a distinguished astronomer in an earlier age. A scientist makes two discoveries that transform the world's technology and social organization. (Available at: <https://books.google.com/books?id=kuoxAQAAMAAJ> )
- Sagan, Carl *Contact*. 1985, Simon & Schuster. Main character is loosely based on astronomer Jill Tarter.
- Stover, Barrie *Lamp at Midnight*. 1966, Bantam Books. Revised edition of a 1942 play about Galileo and his conflict with the Church.
- Willis, Connie "Schwarzschild Radius" in Preiss, Byron & Fraknoi, Andrew, eds. *The Universe*. 1987, Bantam. Haunting story combines episodes from the life of Karl Schwarzschild and black hole images.

## Black Holes

- Anderson, Poul "Kyrie" in Jerry Pournelle, ed. *Black Holes*. 1978, Fawcett. Explores the distortion of time near a black hole.
- Asimov, Isaac "The Billiard Ball" in *Asimov's Mysteries*. 1968, Dell. Committing murder using general relativity.
- Baxter, Stephen "The Gravity Mine" in Dann, J. & Dozois, G., eds. *Beyond Flesh*. 2002, Ace. In the far future, life uses the energy of evaporating, super-massive black holes to survive. (Available on the Web at: <http://www.infinityplus.co.uk/stories/gravitymine.htm>)
- Baxter, Stephen "Pilot" in *Vacuum Diagrams*. 1997, Harper Prism. An asteroid space ship being chased by an enemy missile goes through the ergosphere of a rotating black hole, taking energy out and making the chasing missile fall in the event horizon. (Available on line at: <http://www.stephen-baxter.com/stories.html#pilot> )
- Benford, Gregory *Eater*. 2000, Eos/HarperCollins. An ancient intelligent black hole comes to our solar system.
- Brin, David "The Crystal Spheres" in *The River of Time*. 1987, Bantam. Advanced races use black holes to bear with the loneliness of a universe in which life is still rare. (Free on line at: <http://www.lightspeedmagazine.com/fiction/the-crystal-spheres/> )
- Brin, David *Earth*. 1990, Bantam. A mini black hole falls into the Earth's core.
- Haldeman, Joe *The Forever War*. 1974, Ballantine. An interstellar war is fought using black holes for travel between battles.
- Johnson, Bill "Meet Me at Apogee" in Carr, T., ed. *The Best Science Fiction of the Year 12*. 1983, Pocket Books. Posits a future in which people (with alien help) organize levels of descent near a black hole; so the two-month level is where one day of experienced time for the traveler equals two months in the outside universe. Prospectors and people with incurable disease hire pilots to take them down to lower levels.
- Landis, Geoffrey "Impact Parameter" in *Impact Parameter*. 2001, Golden Gryphon. A newly discovered

gravitational lens turns out to be a wormhole being used by an alien civilization to visit us.

Landis, Geoffrey "Approaching Perimelasma" in *Impact Parameter*. 2001, Golden Gryphon. In the far future, a virtual human is dropped into a black hole and makes an interesting discovery about space and time. On the web at: <http://www.infinityplus.co.uk/stories/perimelasma.htm>

Lowe, Sanford & Nordley, G. David *The Black Hole Project*. 2013, Variations on a Theme. A micro black hole is constructed using energy from several star systems.

McAuley, Paul "How We Lost the Moon" in Crowther, Peter, ed. *Moon Shots*. 1999, Daw. A glitch in a fusion experiment on the Moon creates a mini black hole that eats our satellite.

McDevitt, Jack & Shara, Michael "Lighthouse" in *Cryptic: The Best Short Fiction of Jack McDevitt*. (2009, Subterranean Press) [also on the web at: [https://www.baen.com/Chapters/1596061958/1596061958\\_8.htm](https://www.baen.com/Chapters/1596061958/1596061958_8.htm)] An alien race decides, as a public service, to mark the location of unaccompanied black holes in the Galaxy by putting very strange brown dwarfs around them that could not exist in nature. Shara is an astronomer.

Niven, Larry *World Out of Time*. 1976, Ballantine. Protagonist uses a supermassive black hole to travel into distant future.

Niven, Larry "The Hole Man" in *A Hole in Space*. 1974, Ballantine. How to commit murder using a mini-black hole.

Niven, Larry "The Borderland of Sol" in *Tales of Known Space*. 1975, Ballantine. Space pirates use a mini-black hole.

Pohl, Fred *Gateway*. 1977, Ballantine. Enjoyable novel with rotating black holes, event horizons, and "black hole guilt". (Has a series of sequels where the science gets too "far out" for inclusion on this list.)

Reynolds, Alastair *Revelation Space*. 2000, Ace. In this complex, film-noir style novel, ancient alien races use black holes and the slower time near them to hide from ancient machine intelligences called Inhibitors, whose purpose is to prevent organic life forms (deemed too war-like) from evolving in the Galaxy. Story continues in several other novels (including *Redemption Arc*) and short stories.

Sagan, Carl *Contact*. 1985, Simon & Schuster. The protagonists use a kind of black hole-wormhole "subway" system for interstellar travel. The system was designed for astronomer Sagan by astrophysicist Kip Thorne and his students and later shown to be scientifically plausible.

Sheffield, Charles "Killing Vector" in *Vectors*. 1979, Ace. Mini-black holes are used for space propulsion. Sheffield has a PhD in physics.

Steele, Allen *Spindrift*. 2007, Ace. A massive black hole from outside the Galaxy makes its destructive way among the stars in our spiral arm.

Varley, John *The Ophiuchi Hotline*. 1977, Dell. Complex novel, in which mini black holes are hunted as energy sources.

Varley, John "The Black Hole Passes" in *The Persistence of Vision*. 1978, Dell. A mini-black hole threatens two deep space outposts.

Wheeler, J. Craig *The Krone Experiment*. 1986, Pressworks. Mini black holes pose a threat to the Earth; written by an astronomer.

Willis, Connie "Schwarzschild Radius" in Preiss, Byron & Fraknoi, Andrew, eds. *The Universe*. 1987, Bantam. Haunting story combining episodes from the life of Karl Schwarzschild and black hole images.

## Comets

Anderson, Poul "Pride" in Asimov, Isaac, et al., eds. *Comets*. 1986, Signet/NAL. About "Nemesis," the hypothesized star whose interaction with the Oort Cloud is supposed to result in "comet showers" coming into the inner solar system.

Asimov, Isaac, et al., eds. *Comets*. 1986, Signet/NAL. A collection of stories about comets and their interaction with humanity.

Baxter, Stephen "Sunpeople" in *Vacuum Diagrams*. 1997, Harper Prism. A human expedition on a Kuiper Belt object finds a life-form made of ice with liquid helium for circulation.

Benford, Gregory "Backscatter" (available on the web at: <http://www.tor.com/stories/2013/04/backscatter>).

A stranded prospector in the Kuiper Belt discovers a kind “flower” that can exist on an “iceteroid” (a hybrid between a comet and an asteroid.)

- Benford, Gregory & Brin, David *Heart of the Comet*. 1986, Bantam. About a 2061 expedition to Halley's Comet.
- Benford, Gregory & Carter, Paul *Iceborn*. 1989, Tor. Proposes a form of life that can survive on Pluto and in the Oort Cloud.
- Hoyle, Fred *Comet Halley*. 1985, St. Martin's. Life is found in the famous comet.
- Latham, Philip "The Blindness" in Clarke, Arthur, ed. *Time Probe*. 1966, Dell. A 1946 story by astronomer Robert Richardson: Halley's Comet disrupts our ozone layer.
- Lunan, Duncan "The Comet, the Cairn, and the Capsule" in Asimov, Isaac, et al, eds. *Comets*. 1986, Signet/NAL. Several civilizations leave messages on the nucleus of an interstellar comet.
- Reynolds, Alastair *Pushing Ice*. 2005, Ace. Humanity in the future captures comets in the outer solar system and sends them inward.
- Sawyer, Robert *Illegal Alien*. 1997, Ace. Plot hinges on an alien race from a multiple star system being unaware of the existence of a close-in Kuiper belt, since theirs is cleared out.
- See also under "Impacts"*

### **Cosmology (The Origin and Evolution of the Universe as a Whole)**

- Asimov, Isaac *The Gods Themselves*. 1972, Fawcett. Ambitious novel that "solves" the origin of the big bang and quasars.
- Baxter, Stephen "The Gravity Mine" in Dann, J. & Dozois, G., eds. *Beyond Flesh*. 2002, Ace. In the far, far future, the energy of evaporating super-massive black holes is the last hope of living beings in an ever-expanding universe. Poetic description of the ultimate fate of matter and life. . (Available on the Web at: <http://www.infinityplus.co.uk/stories/gravitymine.htm>)
- Baxter, Stephen "Last Contact" in Dozois, G., ed. *The Year's Best Science Fiction, 25* 2008, St. Martin's. In the near future, the acceleration of the universe's expansion increases to such a degree that even stars in our own galaxy begin to be carried away very fast. The protagonist witnesses the Big Rip.
- Benford, Gregory *Cosm*. 1998, Avon/EOS. A Brookhaven physicist makes a universe in a particle accelerator and watches it evolve.
- Benford, Gregory "The Final Now" in *Anomalies*. 2012, Lucky Bat Books. Remarkable short story that envisions the "Big Rip" that would be the end of an accelerating open universe. Blends religious and scientific imagery in a very poetic way. (Available free on the Web at: <http://www.tor.com/stories/2010/03/the-final-now>)
- Benford, Gregory "Matter's End" in *Matter's End*. 1994, Bantam. Physicists in India find that protons do decay as predicted by some Grand Unified Theories, with dire consequences for reality.
- Brin, David "An Ever-Reddening Glow" in Hartwell, D. & Cramer, K., eds. *The Hard SF Renaissance*. 2002, Orb. Very clever parable, which posits that it is the stretching of space by the general relativistic “metric surfing” (travel near the speed of light) of countless intelligent species that is responsible for the expansion of the universe, and that no species is willing to give up the thrill. (Very nice parallel with the ecological damage we all do to the Earth.)
- Chiang, Ted "Exhalation" in Hartwell, D. & Cramer, K., eds. *Year's Best SF 14*. 2009, Eos. Fascinating parable about the heat death of the universe, described in terms of differences in pressure, instead of differences in temperature. Cosmological speculation by a protagonist who seems to be a mechanical being.
- Martin, Mark & Benford, Gregory *A Darker Geometry*. 1996, Baen. A convoluted, brilliant novel of multiple universe, in which ours is manipulated by advanced beings from another universe about to enter Big Crunch.
- Niven, Larry "Missing Mass" in *The Draco Tavern*. 2006, Tor. The acceleration of the expansion of the universe may be speeding up because an ancient advanced race is using up the vacuum energy.
- Sawyer, Robert *Calculating God*. 2000, Tor. Two alien races join humans in trying to understand a God that

survived the Big Crunch and Big Bang and is manipulating evolution for its own purposes.  
Updike, John *Roger's Version*. 1988, Fawcett Crest. A computer student and a professor of divinity grapple with questions of cosmology and religion.

## Dark Matter

Baxter, Stephen *Vacuum Diagrams*. 1997, HarperCollins. Dramatic, complex history and future of the battle between dark matter and regular matter life-forms in the universe.  
Brett, Alex *Cold Dark Matter*. 2005, Dundurn. A mystery novel whose plot turns on controversial observations of dark matter in a nearby galaxy.  
Sawyer, Robert *Starplex*. (1996, Ace) Complex hard-science novel by a Canadian amateur astronomer with intriguing ideas about dark matter and even dark matter life forms.

## Exoplanets (Planets Orbiting Other Stars)

Benford, Gregory "Think Big" in *Nature*, vol. 499, p. 3784 (18 Jul 2013). [On line at: <https://www.nature.com/articles/499374a>] In the future, astronomers discover planets that have been geo-engineered to deal with global warming and global cooling.  
Brotherton, Michael "Beyond 550 Astronomical Units" in *Nature*, vol. 528, p. 158 (3 Dec 2015). [Also on-line at: <https://www.nature.com/articles/528158a>] An AI probe using the Sun as a gravitational lens to do an exoplanet survey finds intelligent life and debates whether to interrupt its work and report.  
Gevers, Nick, ed. *Extrasolar*. 2017, PS Publishing. Stories that take place on planets around other stars, based on the latest discoveries about such exoplanets.  
Howell, Steve & Summers, David, eds. *A Kepler's Dozen: 13 Stories about Distant Worlds That Really Exist*. 2013, Hadrosaur. A scientist and a writer edited stories based on the Kepler mission discoveries.  
McDevitt, Jack & Shara, Michael "Cool Neighbor" in *Cryptic: The Best Short Fiction of Jack McDevitt*. (2009, Subterranean Press) [also on line at: [https://www.baen.com/Chapters/1596061958/1596061958\\_9.htm](https://www.baen.com/Chapters/1596061958/1596061958_9.htm)] An astronomer with a giant infrared telescope in orbit discovers a brown dwarf 18 light-days away, with planets. One of the planets shows evidence of oxygen and chlorophyll.

## Galaxies

Benford, Gregory "Exposures" in *Creations*, edited by Isaac Asimov, et al., 1983, Crown. A beautiful, multi-level story about an astronomer whose images of active galaxy NGC 1097 lead him to some important insights about the universe and himself.  
Benford, Gregory "Relativistic Effects" in *In Alien Flesh*. 1986, TOR. A ram-scoop spaceship accelerates very close to the speed of light and flies between two galaxies about to collide, able to remove some of the interstellar matter that would have flown between them, due to relativistic effects.  
Brett, Alex *Cold Dark Matter*. 2005, Dundurn. A mystery novel whose plot turns on astronomical observations of the effects of dark matter on the rotation of the Andromeda Galaxy.  
Niven, Larry *Ringworld*. 1970, Ballantine. A cowardly alien species flees an explosion in the Milky Way's core by taking five planets at high speed toward the Magellanic Clouds (our neighbor galaxies.)  
*See also:* Robert Reed's story "The Shape of Everything" under *Life Elsewhere*

## Galaxy (The Milky Way)

Benford, Gregory "Mandikini" in Preiss, Byron & Fraknoi, Andrew, eds. *The Universe*. 1987, Bantam. Humanity confronts the power of intelligent life consisting of machines, and the dangers of the black hole at the center of our Galaxy. (See next entry as well.)  
Benford, Gregory *Great Sky River*. 1987, Bantam; *Tides of Light*. 1989, Bantam; *Furious Gulf*. 1994,

Bantam; *Sailing Bright Eternity*. 1995, Bantam. All four books take place in the far future, near the super-massive black hole at the center of the Milky Way, with humanity being hunted by vast machine intelligences.

Benford, Gregory "The Hydrogen Wall" in Hartwell, D. & Cramer, K., eds. *Year's Best SF 9*. 2004, Eos. In the far future, as the Sun moves through the galactic plane, Earth leaves the Local Bubble and are overwhelmed by the plasma of the interstellar medium.

Egan, Greg "Riding the Crocodile" in Dozois, G., ed. *The Year's Best Science Fiction: 24<sup>th</sup> Annual Collection*. 2007, St. Martin's Griffin. Advanced life in the Galactic bulge remains aloof from the later life that evolves in the Galaxy's disk. (Available on-line at: <http://www.gregegan.net/INCANDESCENCE/00/Crocodile.html> )

Hoyle, Fred & Geoffrey *The Inferno*. 1973, Harper & Row. The Milky Way becomes an active galaxy, but life on Earth is saved by a higher intelligence. Hoyle is a well-known astronomer.

Niven, Larry "At the Core" in *Neutron Star*. 1962, Ballantine. An explosion at the galactic center transforms the Milky Way into an active galaxy.

Reynolds, Alistair "Beyond the Aquila Rift" in *Year's Best SF 11*, Hartwell, David & Cramer, Kathryn, eds. 2006, Eos. Wonderful story, about a network of ancient pathways that delineate the structure of the Galaxy and allow faster-than-light travel. Portrays a sense of "alien"-ness and vastness.

### **Gravitational Lenses**

Brotherton, Michael "Beyond 550 Astronomical Units" in *Nature*, vol. 528, p. 158 (3 Dec 2015). [Also on-line at: <https://www.nature.com/articles/528158a> ] An AI probe uses the Sun as a gravitational lens to do an exoplanet survey. Discusses how other probes do other work in the same region of space.

Landis, Geoffrey "Impact Parameter" in *Impact Parameter*. 2001, Golden Gryphon. A newly discovered gravitational lens turns out to be a wormhole being used by an alien civilization to visit us. Nice astronomical touches.

Shostak, Seth "In Touch at Last" in *Science*, vol. 286, p. 1872 (3 Dec 1999). Short story in which an astronomer uses the Sun as a gravitational lens to discover an alien transmission which turns out to be a time signal.

### **Impacts (Asteroid & Comet)**

Benford, Gregory & Rotsler, William *Shiva Descending*. 1980, Avon Books. A massive asteroid heads for our planet.

Bingle, Donald "Patience" in Rabe, J. & Greenberg, M., eds. *Sol's Children*. 2002, DAW. A mass murderer escapes from jail, flees to the Oort Cloud and, to earn the world record in how many people he kills, deflects some asteroids on a slow path towards Earth.

Carver, Jeff *Neptune Crossing*. 1994, Tor. An intelligent life-form on Neptune's moon Triton helps humans prevent a comet from crashing into the Earth.

Clarke, Arthur *The Hammer of God*. 1993, Bantam. An asteroid threatens to collide with the Earth.

Fodor, R. & Taylor, G. *Impact*. 1979, Leisure Books. A giant meteorite is headed our way; Taylor is a planetary scientist.

Gribbin, John & Chown, Marcus *Double Planet*. 1988, Avon Books. A comet heads for Earth; written by two scientists.

Morton, Oliver "The Albian Message" in *Year's Best SF 11*, Hartwell, David & Cramer, Kathryn, eds. 2006, Eos. 100 million years ago, predicting the K/T impact, aliens landed on Earth and preserved life on Earth at the time in a container on an asteroid at a jovian Trojan point, leaving a message about it coded in the human genome.

Niven, Larry & Pournelle, Jerry *Lucifer's Hammer*. 1977, Fawcett. A giant asteroid or comet collides with the Earth. Among the first of the scientifically reasonable impact stories.

Sawyer, Robert *Calculating God*. 2000, Tor. When aliens finally come to Earth, they reveal that mass

extinctions due to impacts happened simultaneously on three planets – which leads them to suspect that they were caused by a higher intelligence.

### **Interstellar Matter**

Benford, Gregory “The Hydrogen Wall” in Hartwell, D. & Cramer, K., eds. *Year’s Best SF 9*. 2004, Eos. Story hinges on the Sun leaving the Local Bubble in the far future, and the plasma of the interstellar medium posing a threat to human civilization.

### **Jupiter (and its Satellites)**

Benford, Gregory *Against Infinity*. 1983, Pocket Books. About terraforming Ganymede and trying to survive in that harsh environment.

Benford, Gregory "The Future of the Jovian System" in Preiss, Byron, ed. *The Planets*. 1985, Bantam. Story about settling the moons of Jupiter and exploiting their resources.

Benford, Gregory *The Jupiter Project*. A coming-of-age story with a Jupiter setting.

Cadigan, Pat “The Girl-Thing Who Went Out for Sushi” in Strahan, J., ed. *Edge of Infinity*. 2012, Solaris. Well-crafted, atmospheric story about how humans will be biologically re-engineered into forms like an octopus or a chambered nautilus to be more effective at surviving work conditions in the outer solar system. The protagonist joins a group using a future comet like Shoemaker-Levy 9 to enter and find a livable environment in the atmosphere of Jupiter. (Available on line at: [http://clarkesworldmagazine.com/cadigan\\_02\\_18\\_reprint/](http://clarkesworldmagazine.com/cadigan_02_18_reprint/) )

Clarke, Arthur *2010*. 1984, Ballantine. Sequel to *2001*, featuring life under the ice of Europa, Von Neumann probes, and more.

McAuley, Paul “Sea Change with Monsters” in Dozois, G., ed. *The Year’s Best Science Fiction: 16<sup>th</sup> Annual Collection*. 1999, St. Martin’s Griffin. An anti-war story that takes place on Europa, whose inner ocean is being seeded with genetically engineered organisms that can survive there.

Moffitt, Donald *The Jupiter Theft*. 1977, Ballantine. Aliens left homeless by a supernova explosion come to steal Jupiter's hydrogen for spaceship fuel.

Pohl, Fred & Carol *Jupiter*. 1973, Ballantine. A varied collection of stories about the giant planet, not all based on good science.

Reynolds, Alastair “A Spy in Europa” in his *Galactic North*. 2008, Ace. Clever spy story that suggests how Europa’s ocean might contain native life forms near hydrothermal vents, and how humans might be genetically modified to live in that ocean as well. (Available on the web at: <http://www.infinityplus.co.uk/stories/europa.htm>)

Steele, Allen “Angel of Europa” (2012) available on the web at: [https://subterraneanpress.com/magazine/spring\\_2012/angel\\_of\\_europa\\_by\\_allen\\_steele/](https://subterraneanpress.com/magazine/spring_2012/angel_of_europa_by_allen_steele/) (Realistic portrayal of a mission to explore Europa and the discovery of life in its oceans)

Stewart, Ian & Cohen, Jack *Whealers*. 2000, Aspect/Warner. A mathematician and a biologist have written a novel that suggests an intelligent life form that can live in Jupiter’s atmosphere.

Swanwick, Micheal “The Very Pulse of the Machine” in Dozois, W. & Williams, S., eds. *Isaac Asimov’s Solar System*. 1999, Ace. An explorer on Io may or may not be discovering a global form of life powered by electrical forces. Good portrayal of Io.

Wharton, Ken “Down and Out” in Brotherton, M., *Science Fiction by Scientists*. 2017, Springer. Imagines the perspective of a life-form in the underground ocean on Europa.

### **Life Elsewhere (Plausible Examples)**

Anders, Charlie Jane “The Fermi Paradox is Our Business Model” in Horton, R., ed. *Year’s Best Science Fiction and Fantasy 2011*. (2011, Prime.) (On the web at: <http://www.tor.com/stories/2010/08/the-fermi-paradox-is-our-business-model> ) An alien species depends for its wealth on the fact that all the



- planets they have seeded with life eventually turn out to make intelligent creatures who destroy themselves (what they call “Closure.”) Then they can come and harvest all the metals and rare and radioactive elements the species mined and refined.
- Anderson, Kevin & Beason, Doug “Reflections in a Magnetic Mirror” in *Full Spectrum*, ed. L. Aronica & S. McCarthy (1988, Bantam). A plasma physicist and science writer explore a life-form that can exist within plasma anomalies, but on a different time-scale. (On line at: [https://www.baen.com/Chapters/9781614750246/9781614750246\\_1.htm](https://www.baen.com/Chapters/9781614750246/9781614750246_1.htm) )
- Baxter, Stephen “Cilia-of-Gold” in Dozois, W. & Williams, S., eds. *Isaac Asimov’s Solar System*. 1999, Ace (and in *Vacuum Diagrams*, 1997, Harper Prism). Suggests a very clever ancient form of life that adapted (after crashing there) to live on Mercury. (Free on-line at: [http://clarkesworldmagazine.com/baxter\\_08\\_13\\_reprint/](http://clarkesworldmagazine.com/baxter_08_13_reprint/) )
- Baxter, Stephen “Sunpeople” in *Vacuum Diagrams*. 1997, Harper Prism. A human expedition on a Kuiper Belt object finds a life-form made of ice with liquid helium for circulation.
- Baxter, Stephen “Gossamer” in *Vacuum Diagrams*. 1997, HarperCollins. Suggests a life form that can thrive on and go between Pluto and Charon at perihelion. (Available on line at: <http://www.light-speedmagazine.com/fiction/gossamer/> )
- Benford, Gregory “The Hydrogen Wall” in Hartwell, D. & Cramer, K., eds. *Year’s Best SF 9*. 2004, Eos. Suggests that really advanced life in the galactic center could send a complex SETI message that includes an artificial intelligence (avatar) of their species to communicate and even trade information with us, even if the original senders have meanwhile died out.
- Benford, Gregory *In the Oceans of Night*. 1977, Dell. Physicist Benford postulates a universe in which advanced machine intelligences confront (and often overwhelm) organic life. The story continues in *Across the Sea of Suns* (1984, Bantam) and in his novels that take place at the galactic center (*Great Sky River*, 1987, Bantam; *Tides of Light*, 1989, Bantam; *Furious Gulf*; 1994, Bantam; *Sailing Bright Eternity*, 1995, Bantam.)
- Benford, Gregory “Dance to Strange Musics” in *Year’s Best Science Fiction 4*, ed. David Hartwell. 1999, Eos/HarperCollins. First expedition to Alpha Centauri finds a planet-wide, collective life form that takes energy from pizo-electric effects enhanced by tidal stresses.
- Brotherton, Mike *Star Dragon*. 2003, TOR. Suggests a life-form that lives in a cataclysmic binary star system.
- Butler, Octavia “Amnesty” in Hartwell, D. & Cramer, K., eds. *Year’s Best SF 9*. 2004, Eos/HarperCollins. Moving story of a race of advanced plant-like aliens, who have conquered Earth and can draw humans into a pleasurable symbiotic relationship. They are so much more advanced, there is no hope of rebelling against them; a remarkable allegory about slavery by a black writer.
- Clement, Hal *Mission of Gravity*. 1962, Pyramid. Life on a massive, rapidly rotating planet. Clement is a high-school science teacher. . (A new edition of all his stories about this planet was issued in 2002 by TOR, under the title *Heavy Planet*.)
- Clement, Hal “Uncommon Sense” in *Space Lash*. 1966, Dell. About life-forms with liquid metal blood that “see” by smell.
- Crichton, Michael *The Andromeda Strain*. 1969, Dell. Doctors & scientists battle an extra-terrestrial microorganism; by a doctor.
- Hoyle, Fred *The Black Cloud*. 1957, Signet. Intelligence develops in interstellar dust clouds which can move from star to star.
- LeGuin, Ursula *The Left Hand of Darkness*. 1969, Ace. Award-winning story of contact with aliens who are alternately one sex and then the other.
- Reed, Robert “Rwanda” in Hartwell, D. & Cramer, K., eds. *Year’s Best SF 12*. 2007, EOS. Poignantly told story of an invasion of Earth by millions of dust-mite sized spores sent on a small, slow interstellar probe, which enter a host human and take over the brain.
- Reed, Robert “The Shape of Everything” in his *The Dragons of Spacetime*. 1999, Golden Gryphon. An old astronomer in a space observatory tells his post-doc that he has discovered that the pattern of star formation in the earliest galaxies shows signs of intelligent arrangement; he believes that some plasma

life-forms evolved early in the universe, but, seeing their era about to come to an end, wanted to leave the imprint of their story in the pattern of newly developing stars.

Reynolds, Alastair *Pushing Ice*. 2005, Ace. Complex novel that includes a huge interstellar zoo that captures intelligent species; describes several intriguing alien races. The zoo, the story suggests, exists because its ancient builders, finding intelligent life rare and fragile, wanted to find an artificial way of bringing civilizations together.

Reynolds, Alastair *Revelation Space*. 2000, Ace. This remarkable, complex, and clever novel proposes a host of different life forms, all of which must contend with ancient machine-like intelligences called Inhibitors, who seek to destroy all new organic life forms lest they get into another huge war, like the one that took place after the first generation of intelligent species evolved in the Galaxy. Author is a PhD astronomer and the story continues in several other novels and short stories, which are jointly called his "Revelation Space Universe."

Rivera, Mercurio "Tethered" in Hartwell, D. & Cramer, K., eds. *Year's Best SF 17*. 2012, Harper Voyager. Proposes a species of aliens that mate by extruding tethers from their heads. Their tethers then become one, and the more passive partners is absorbed by the more active one through a kind of "macromeiosis."

Sawyer, Robert *Calculating God*. 2000, Tor. Suggests that most alien species will choose to upload themselves into a computer reality rather than deal with their own hostility and the isolation of the universe.

Sawyer, Robert *Illegal Alien*. 1997, Ace. Aliens with quadrilateral symmetry and the ability to hibernate for very long times come to Earth, to wipe out any threat to them while they sleep for 400,000 years.

Sawyer, Robert "Stream of Consciousness" in *Iterations*. 2004, Red Deer Press. An alien crashes to Earth whose body is just a vessel, but whose blood is intelligent, and makes itself known by forming a drawing of the Pythagorean theorem out of blood drops. Available free on the web at:

<http://sfwriter.com/ststream.htm>

Sheckley, Robert "Specialist" in Keyes, N., ed. *Contact*. 1963, Paperback Library. Proposes the idea that life in the universe is all specialized by function, except on Earth.

Sheffield, Charles *Between the Strokes of Night*. 1985, Baen Books. Proposes a life-form that can thrive in intergalactic space.

Sterling, Bruce "The Swarm" in Silverberg, R., ed. *The Nebula Awards 18*. 1983, Bantam. A form of life that absorbs other life forms and converts them to symbiotic components. Nice discourse on whether intelligence has value in the long run.

Stewart, Ian & Cohen, Jack *Whealers*. 2000, Aspect/Warner. A mathematician and a biologist have written a novel that suggests an intelligent life form that can live in Jupiter's atmosphere.

Swanwick, Michael "Slow Life" in Hartwell, David, ed. *Best SF 8*. 2003, Eos. Suggests a form of life that can survive deep under Titan's seas. Available on the Web at:

<http://www.lightspeedmagazine.com/fiction/slow-life/>

Tiptree, James "Love is the Plan the Plan is Death" in Goldin, Stephen, ed. *The Alien Condition*. 1973, Ballantine. Haunting, complex story of a truly alien life-form.

Varley, John *The Ophiuchi Hotline*. 1977, Dell. Ambitious novel about interstellar communication and the idea of a struggle between life-forms that develop on terrestrial and jovian planets throughout the universe.

*See also:* Alastair Reynolds' "A Spy in Europa" under Jupiter.

## **Light and Radiation**

Bester, Alfred "The Pi Man" in *Star Light, Star Bright*. 1976, Berkley/Putnam. Story of a man sensitive to many bands of the electro-magnetic spectrum (and much more); not very scientific, but can help students see how lucky we are that our senses filter out so much information.

## **Mars**

- Aldiss, Brian "The Difficulties Involved in Photographing Nix Olympica" in Dozois, Gardner & Williams, Sheila, eds. *Isaac Asimov's Solar System*. 1999, Ace. A poignant little story about a future army sergeant who longs to take Ansel Adams-like photos of Olympus Mons.
- Anderson, Kevin *Climbing Olympus*. 1994, Warner Books. A novel about Mars in the midst of being terraformed.
- Bova, Ben "Olympus Mons" in Hartwell, David & Cramer, Kathryn, eds. *The Hard SF Renaissance*. 2002, Orb/TOR. Astronauts explore the caldera of the giant volcano and make a surprising discovery about microscopic life on Mars. Has lots of realistic detail.
- Bova, Ben *Mars*. 1993, Bantam. Features scientifically realistic Mars exploration.
- Eklund, Gordon & Benford, Gregory "Hellas is Florida" in Van Gelder, G., ed. *Fourth Planet from the Sun*. 2005, Thunder's Mouth Press. The first humans to land on Mars (in the Hellas basin) search for a radiating point from which life seems to diverge, only to discover it is a secret Russian lander which was not sterilized before it left.
- Fraknoi, Andrew "Cave in Arsia Mons" in Cannon, Janet, ed. *Building Red: Mission Mars*. 2015, Walrus Publishing. An ancient painting in a martian cave provides evidence of life elsewhere in the Galaxy. Available free at: [https://www.researchgate.net/publication/282914928\\_The\\_Cave\\_in\\_Arsia\\_Mons](https://www.researchgate.net/publication/282914928_The_Cave_in_Arsia_Mons)
- Hartmann, William *Mars Underground*. 1997, TOR Books. Exploration of Mars in the next century, by a noted planetary astronomer.
- Hipolito, Jane & McNelly, Willis, eds. *Mars, We Love You*. 1971, Pyramid. Eclectic collection of fiction & nonfiction about Mars, some based on current science, some not.
- Landis, Geoffrey *Mars Crossing*. 2000, Tor Books. A trek across the martian surface, written by a NASA scientist.
- Nestvold, Ruth "Mars: A Traveler's Guide" (2008). Available on the web at: <https://www.smashwords.com/books/view/45103> (A future traveler, stranded on Mars, tries to communicate through a "web-based" guide program for visitors.)
- Nordley, G. David *After the Vikings: Tales of Future Mars*. 2001, Variations on a Theme. Short stories by an aeronautical engineer and award-winning science fiction writer.
- Pesek, Ludek *The Earth is Near*. 1970, Dell. About a realistic expedition to Mars and the problems they face.
- Pohl, Fred *Man Plus*. 1976, Bantam. Humans biologically engineered to survive on Mars.
- Pohl, Fred *Mining the Oort*. 1992, Ballantine. The Oort cloud of comets is mined for material to terraform Mars.
- Reynolds, Alastair "Angel of Ashes" in *Zima Blue and Other Stories*. 2006, Night Shade Press. A terraformed Mars with an atmosphere is the setting for a novel about a religion based on a supernova and a neutron star.
- Reynolds, Alastair "The Real Story" in *Zima Blue and Other Stories*. 2006, Night Shade Press. On Mars in the future with active tourism, diving from the cliffs of Valles Marineris is a sport.
- Robinson, Kim *Red Mars*. 1992, Bantam. *Green Mars*. 1993, Bantam. *Blue Mars*. 1995, Bantam. Complex 3-novel story involving a Mars of the future which is being made ready for increased human habitation.
- Sparhawk, Bud "Olympus Mons" in *Dancing with Dragons*. 2001, Wildside Press. About a race down the flanks of the giant martian volcano.
- Strahan, Jonathan, ed. *Life on Mars*. 2011, Viking. Anthology of stories based on our modern understanding of the red planet.
- Varley, John "In the Hall of the Mountain King" in *The Persistence of Vision*. 1978, Dell. Ingenious story about Mars adapting to Earth colonists.
- Weir, Andrew *The Martian*. 2014, Crown. The best-selling book (and the film made from it with NASA assistance) start with a serious error (winds impossibly strong), but then convey the challenge of being on Mars with careful attention to our current knowledge.

## Mercury

- Anderson, Poul "Life Cycle" in Silverberg, Robert, ed. *Earthmen and Other Strangers*. 1966, Manor Books. Suggestion of a lifeform that can survive on Mercury.
- Baxter, Stephen "Cilia-of-Gold" in Dozois, Gardner & Williams, Sheila, eds. *Isaac Asimov's Solar System*. 1999, Ace. Suggests a very clever ancient form of life that adapted (after crashing there) to live on Mercury. (Also appears in Baxter's *Vacuum Diagrams*. 1997, Harper Prism and on-line at: [http://clarkesworldmagazine.com/baxter\\_08\\_13\\_reprint/](http://clarkesworldmagazine.com/baxter_08_13_reprint/).)
- Nordley, G. "Crossing Chao Meng Fu" in Dozois, G., ed. *The Year's Best Science Fiction, Fifteenth Annual Collection*. 1998, St. Martin's. An expedition tries to cross (on foot) a large crater on Mercury whose floor is never reached by sunlight.
- Varley, John "Retrograde Summer" in *The Persistence of Vision*. 1978, Dell. Life on Mercury in an era of easy biological engineering.

## Meteorites

- Innes, Michael *The Weight of the Evidence*. 1943, Harper/Perennial. A somewhat ordinary murder mystery, but the murder was committed using a meteorite in a university setting.

## Moon, The

- Hartmann, William "Handprints on the Moon" in Preiss, Byron, ed. *The Planets*. 1985, Bantam. A touching story by an astronomer about international cooperation as the Moon is colonized.
- Landis, Geoffrey "Walk in the Sun" in his *Impact Parameter*. 2001, Golden Gryphon Press. An astronaut stranded on the Moon in a solar powered suit must keep walking to keep up with the Sun. On the web at: [https://www.baen.com/Chapters/0671878522/0671878522\\_1.htm](https://www.baen.com/Chapters/0671878522/0671878522_1.htm)
- Lowman, Paul "Regards from the Moon" in *Sky & Telescope*, Sep. 1992, p. 259. An astronomer writes a letter home from the Moon in 2017, describing some of the work being done there.
- McAuley, Paul "How We Lost the Moon" in Crowther, Peter, ed. *Moon Shots*. 1999, Daw. A glitch in a fusion experiment on the Moon creates a mini black hole that ultimately consumes our satellite.
- Weinberg, Gerald "The Moon is a Harsh Pig" in Brotherton, Mike, ed. *Diamonds in the Sky*. 2009, at [http://www.mikebrotherton.com/diamonds/?page\\_id=47](http://www.mikebrotherton.com/diamonds/?page_id=47) On another planet, two students make a bet about the cause for the phases of the moon, which leads to a surprise.

## Neptune (and its Satellites)

- Carver, Jeff *Neptune Crossing*. 1994, Tor. An intelligent life-form on Neptune's moon Triton helps humans prevent a comet from crashing into the Earth.
- Eklund, Gordon *A Thunder on Neptune*. 1989, Morrow. Exploring Neptune and Triton and finding a life form.
- McAulay, Paul "Second Skin" in Dozois, G., ed. *The Year's Best Science Fiction: Fifteenth Annual Collection*. 1998, St. Martin's. On Neptune's moon Proteus, feuding factions after an interplanetary war try to capture a leading genetic engineer through the actions of a spy who may or may not be her ex-husband.
- Reynolds, Alastair "Vainglory" in Strahan, J., ed. *Edge of Infinity*. 2012, Solaris. In a town built on stilts on Triton, an artist recalls how a former lover paid her to sculpt an asteroid and then send it to hit Naiad, the small innermost moon of Neptune's, to break it up and make a new more impressive ring around the planet.

## Neutrinos

- Clayton, Donald *The Joshua Factor*. 1986, Texas Monthly Press. A novel by an astronomer involving intrigue and neutrinos from the Sun.

## Neutron Stars (Remnants of Exploded Stars)

- Baxter, Stephen *Flux*. 1994, HarperCollins. Portrays life on a neutron star.
- Forward, Robert *Dragon's Egg*. 1981, Ballantine. Also proposes a life-form that can live on the surface of a neutron star. Sequel is called *Starquake* (1985, Ballantine).
- Niven, Larry "Neutron Star" in *Neutron Star*. 1986, Ballantine. A space traveler gets too close to a neutron star and experiences enormous tidal forces.
- Niven, Larry *The Integral Trees*. 1984, Ballantine. Takes place in a thick ring of gas, stripped from a Jovian planet, in orbit around a neutron star. Sequel is called *Smoke Ring* (1988, Ballantine.)
- Silverberg, Robert "The Iron Star" in Preiss, Byron & Fraknoi, Andrew, eds. *The Universe*. 1987, Bantam. Involves two supernova explosions, a neutron star, and a black hole.

## Physics, Particle and Nuclear

- Benford, Gregory "Matter's End" in *Matter's End*. 1994, Bantam. Physicists in India find that protons do decay as predicted by some Grand Unified Theories, with dire consequences for reality.
- Preuss, Paul *Broken Symmetries*. 1983, Pocket Books. A novel of science, politics, and intrigue surrounding the building of a giant particle accelerator in Hawaii. (A 1997 sequel is entitled *Secret Passages*.)
- Preuss, Paul "Half-Life" in Preiss, B. & Alschuler, W. *Microverse*. 1989, Bantam. Poignant story combining ideas about radioactivity and the pursuit of science with the story of the last days in the life of Marie Curie.

## Pluto

- Baxter, Stephen "Gossamer" in *Vacuum Diagrams*. 1997, HarperCollins. Stranded astronauts discover a life form that can thrive on Pluto and Charon at perihelion. (Available on line at: <http://www.lightspeedmagazine.com/fiction/gossamer/>)
- Benford, Gregory & Carter, Paul *Iceborn*. 1989, Tor. Proposes a form of life that can survive on Pluto and in the Oort Cloud.
- Niven, Larry "Wait it Out" in *Tales of Known Space*. 1975, Ballantine. Protagonist is marooned on Pluto and discovers a form of life that use superfluidity to survive.
- Silverberg, Robert "Sunrise on Pluto" in Preiss, Byron, ed. *The Planets*. 1985, Bantam. A form of life that could exist on Pluto.

## Quantum Mechanics

- Bear, Greg "Schrodinger's Plague" in *Tangents*. 1989, Warner. A scientist repeats the Schrodinger's Cat experiment in such a way that not just a cat but all of humanity is at risk.
- Brennert, Alan "Echoes" in Dozois, G., ed. *The Year's Best Science Fiction, 15<sup>th</sup> Annual Collection*. 1998, St. Martin's Griffin. Haunting tale of genetically engineered woman who can see and hear "echoes" of other selves that might have been, alternative probability paths or outcomes of the experiment she was and is.
- Coover, Robert *The Universal Baseball Association: J. Henry Waugh, Proprietor*. 1968, Random House. Works out some of the philosophical consequences of Einstein's remark about "God playing dice" with the universe.
- Egan, Greg *Quarantine*. 1992, Harper Prism. A sophisticated detective mystery that addresses serious ideas in the interpretation of quantum mechanics.
- Hoyle, Fred *October the First Is Too Late*. 1966, Fawcett. Fascinating working-out of the many-worlds interpretation of quantum mechanics.
- Lem, Stanislaw *The Investigation*. 1959, Avon. A novel that considers the philosophical implications of

- quantum mechanics: what if a mystery is unsolvable in principle?
- McCormach, Russell *Night Thoughts of a Classical Physicist*. 1982, Harvard U. Press. A fictional physicist muses on the transformation of classical physics in the early years of the twentieth century; written by a historian of science.
- Melko, Paul "Ten Sigmas" in Dozois, G., ed. *The Year's Best Science Fiction: 22<sup>nd</sup> Annual Collection*. 2005, St. Martin. [On line at: [https://www.baen.com/Chapters/9781625793003/9781625793003\\_2.htm](https://www.baen.com/Chapters/9781625793003/9781625793003_2.htm) ] Assuming the many-worlds interpretation, what if one person could be in touch with all his selves in all the worlds and they could help each other? What if the strongest probabilities belong to the largest number of selves?
- Niven, Larry "All the Myriad Ways" in *All the Myriad Ways*. 1971, Ballantine. Works out some of the implications of the many-worlds interpretation for solving murder mysteries.
- Niven, Larry "For a Foggy Night" in *N-Space*. 1990, TOR. Humorous story in which the fog in San Francisco turns out to be a blurring effect of meeting world lines in many-worlds quantum mechanics.
- Pohl, Fred *The Coming of the Quantum Cats*. 1986, Bantam. A novel of parallel universes based on the many-worlds view.
- Reynolds, Alastair "Angel of Ashes" in *Zima Blue and Other Stories*. 2006, Night Shade Press. A priest of a future religion loses faith when a miracle involving a supernova turns out to have a quantum mechanical explanation.
- Sawyer, Robert "You See, but You Do Not Observe" in *Nebula Awards 31*, ed. P. Sargent. 1997, Harvest. Proposes a quantum solution to Fermi's Paradox: the death of Sherlock Holmes at Reichenbach falls, and the subsequent rejection of that death by the public, leading to his return, left the Earth in a kind of Schrodinger's Cat quandary, from which we must be released before we can be in synch with the rest of the universe. (Free on the web at: <http://sfwriter.com/styousee.htm> )
- Schmidt, Stanley *Newton and the Quasi-Apple*. 1975, Popular Library. In another star system, Earth visitors introduce notions from 20th-century physics to an alien civilization just as their Newton publishes his ideas.

## Quasars

- Asimov, Isaac *The Gods Themselves*. 1972, Fawcett. Ambitious novel that "solves" the origin of the big bang and quasars.
- Martin, Mark & Benford, Gregory *A Darker Geometry*. 1996, Baen. Complex novel, suggests quasars are points through which another (closed) universe dumps excess energy into ours before its Big Crunch.

## Relativity (The Special Theory of )

- Benford, Gregory "Relativistic Effects" in *In Alien Flesh*. 1986, TOR. A ram-scoop spaceship accelerates very close to the speed of light and flies between two galaxies about to collide, able to remove some of the interstellar matter that would have flown between them, due to relativistic effects.
- Forward, Robert "Twin Paradox" in *Indistinguishable from Magic*. 1995, Baen. One twin travels to the stars at relativistic speed, the other stays on Earth but stops aging. So traveling twin gets to be older.
- Haldeman, Joe *The Forever War*. 1974, Ballantine. Award-winning novel of an interstellar war involving concepts from both special and general relativity.
- Haldeman, Joe "Tricentennial" in *Infinite Dreams*. 1978, St. Martin's. Traveling near speed of light and the effects of time dilation.
- Masson, David "Traveler's Rest" in Silverberg, Robert, ed. *Voyagers in Time*. 1967, Tempo. Intricate, brilliant story; relativistic time dilation becomes a function of latitude. (Available free at: <http://www.light-speed-magazine.com/fiction/travellers-rest/>)
- Sawyer, Robert "Relativity" in *Identity Theft and Other Stories*. 2008, Red Deer Press. A woman astronaut goes to another star at relativistic speeds and then deals with the effects on her family life.
- Sheffield, Charles "The Long Chance" in *Vectors*. 1979, Ace. Traveling into the future using relativistic

space travel and suspended animation.

Stith, John *Redshift Rendezvous*. 1990, Ace. Explores the effects of a voyage in a “hyperspace” where the speed of light is 30 meters per second.

Varley, John “The Pusher” in *Blue Champagne*. 1986, Berkley. Poignant story on loneliness of relativistic space travel; time dilation makes it difficult to have a family on Earth.

*Note: For stories involving the General Theory of Relativity, see under “Black Holes” and “Cosmology”*

### **Saturn (and its Satellites)**

Baxter, Stephen “Return to Titan” in Dozois, G., ed. *Year’s Best Science Fiction: 28<sup>th</sup> Annual Collection*. 2011, St. Martin’s Griffin. Intriguing forms of life that can survive on Titan form the backdrop to this story of Titan exploration.

Clarke, Arthur “Saturn Rising” in *Tales of Ten Worlds*. 1962, Signet. Story of a man who is driven by childhood trauma to build a hotel in Titan. (Dated science, but good for its time.)

McAuley, Paul “The Gardens of Saturn” in Dann, J. & Dozois, G., eds. *Space Soldiers*. 2001, Ace. [Also free on the web at: [https://www.baen.com/Chapters/9781625791535/9781625791535\\_2.htm](https://www.baen.com/Chapters/9781625791535/9781625791535_2.htm)]

Imagines a future where many of Saturn’s smaller moons are inhabited, Titan is being terraformed, and a genetic engineer is trying to turn Epimetheus into a living organism.

McDevitt, Jack “Melville in Iapetus” in *Cryptic: The Best Short Fiction of Jack McDevitt*. 2009, Subterranean Press. [also on the Web at:

[https://www.baen.com/Chapters/1596061958/1596061958\\_7.htm](https://www.baen.com/Chapters/1596061958/1596061958_7.htm) ] An alien statue is discovered on this moon of the ringed planet and a human expedition wonders at the motivation of the artist. Nice descriptions of Saturn as seen from a tidally locked satellite.

Reynolds, Alastair *Pushing Ice*. 2005, Ace. Saturn’s moon Janus turns out to be an alien craft, comes out of orbit, and takes a human spaceship on a remarkable interstellar adventure.

Rivera, Mercurio “Tethered” in Hartwell, D. & Cramer, K., eds. *Year’s Best SF 17*. 2012, Harper Voyager. Aliens help humans develop technology to let them survive on Titan. Protagonist goes swimming in the giant lake called Ontario Lacus. (Read aloud on line at:

<http://www.starshipsofa.com/blog/2013/05/01/starshipsofa-no-287-david-mercurio-rivera-part-2/> )

Swanwick, Michael “Slow Life” in Hartwell, David, ed. *Best SF 8*. 2003, Eos. [On line at:

<http://www.light-speed-magazine.com/fiction/slow-life/> ] About the first expedition to Titan. Suggests a form of life that can survive deep under Titan’s seas.

Varley, John “Gotta Sing, Gotta Dance” in *The Persistence of Vision*. 1978, Dell. Symbiotic humans and plants adapt to life in the rings of Saturn and make unearthly music.

Zelazny, Roger “Dreadsong” in Preiss, Byron, ed. *The Planets*. 1985, Bantam. Life forms that could live in Saturn’s atmosphere.

### **Science in General**

Benford, Gregory *Timescape*. 1981, Pocket Books. An excellent novel that is one of the best depictions of the nature and pressures of scientific research; features astronomers such as Fred Hoyle and Geoffrey and Margaret Burbidge as characters.

Benford, Gregory *Cosm*. 1998, Avon/EOS. A Brookhaven physicist makes a universe in a particle accelerator. Has excellent (and often caustic) portrayals of how big science is done today in physics and astronomy.

Chiang, Ted “Exhalation” in Hartwell, D. & Cramer, K., eds. *Year’s Best SF 14*. 2009, Eos. A scientist, who is a mechanical being, tries to reason out his own anatomy by applying the scientific method.

Sagan, Carl *Contact*. 1985, Simon & Schuster. Good portrayal of how astronomical research is carried out and an interesting attempt to work out some modern issues between science and religion.

Weinberg, Gerald “The Moon is a Harsh Pig” in Brotherton, Mike, ed. *Diamonds in the Sky*. 2009, at [http://www.mikebrotherton.com/diamonds/?page\\_id=47](http://www.mikebrotherton.com/diamonds/?page_id=47) On another planet, a bet about the cause for the

phases of the moon leads a graduate student in astronomy to think more about how science is done.

### **SETI: The Search for Extra Terrestrial Intelligence via Radio Surveys**

- Baxter, Stephen “Last Contact” in Dozois, G., ed. *The Year’s Best Science Fiction*, 25 2008, St. Martin’s. In the near future, the acceleration of the universe’s expansion increases to such a degree that even stars in our own galaxy begin to be carried away very fast. Suddenly, SETI scientists pick up many messages: civilizations need to say goodbye.
- Benford, Gregory “Dance to Strange Musics” in *Year’s Best Science Fiction 4*, ed. David Hartwell. 1999, Eos/HarperCollins. First expedition to Alpha Centauri finds a planet-wide, collective life form that is sending out huge, information-rich SETI messages to one star after another.
- Benford, Gregory “Dark Sanctuary” in *Matter’s End*. 1994, Bantam. This short story, written in 1979, is an early suggestion that alien civilizations may communicate via lasers rather than radio waves. It answers the Fermi Paradox by showing aliens in space colonies, living happily in the asteroid belt.
- Benford, Gregory “The Hydrogen Wall” in Hartwell, D. & Cramer, K., eds. *Year’s Best SF 9*. 2004, Eos. In the far future, humans have set up a giant library just to handle all the SETI messages that have been received, especially from civilizations that arose earlier in parts of the Galaxy closer to the center.
- Benford, Gregory “SETI for Profit” (published in *Nature* 24 Apr 2008; available on the Web at: <http://www.nature.com/nature/journal/v452/n7190/pdf/4521032a.pdf>) A billionaire funds private SETI searches, and when he finds a signal refuses to give out details. Angry scientists and governments then sponsor a huge SETI effort and find a signal, after which the first detection is revealed to be a hoax, designed to spur more SETI work after the field became moribund.
- Bisson, Terry “They’re Made out of Meat” in Morrow, James, ed. *Nebula Awards 27*. 1993, Harcourt Brace. Machine intelligences are picking up our SETI signals, but are unable to deal with the disgusting fact that we are life-forms made entirely of “meat.” (Audio version at: <https://www.wnyc.org/story/168264-theyre-made-out-of-meat/> )
- Brin, David “Lungfish” in *The River of Time*. 1987, Bantam. Interesting contemplation of the many purposes to which alien civilizations might put self-replicating “von Neumann probes” and how conflicts between probes from different civilizations might arise.
- Brin, David “Reality Check” in *Nature* 16 Mar 2000. Proposes an intriguing solution to the Fermi Paradox and why we seem to be alone in the cosmos. (Available free on line at: <https://www.nature.com/articles/35005182> )
- Gunn, James *The Listeners*. 1972, Signet. Good early portrayal of a scientifically reasonable search. (Note that the author is not the James Gunn who is an astronomer.)
- McDevitt, Jack *The Hercules Text*. 1986, Ace. Flawed, but interesting novel about radio communication with a distant civilization.
- McDevitt, Jack “Nothing Ever Happens in Rock City” in *Nebula Awards Showcase 2004*, ed. Vonda McIntyre. 2004, ROC/Penguin. The first radio SETI discovery as seen from the perspective of the owner of the liquor store closest to the observatory.
- Morton, Oliver “The Albion Message” in *Year’s Best SF 11*, Hartwell, David & Cramer, Kathryn, eds. 2006, Eos. Suggests that the place to search for alien messages is in the human genome.
- Reynolds, Alastair “Feeling Rejected” in *Deep Navigation*. 2010, NESFA Press. Brief, clever story in the form of a referee’s report, at a time when our SETI efforts have picked up so many messages, it’s possible to be bored by yet another discovery.
- Sagan, Carl *Contact*. 1985, Simon & Schuster. The discovery of radio signals from extra-terrestrial intelligence leads humanity to re-evaluate its self-image.
- Sawyer, Robert *Factoring Humanity*. 1998, Tor. A radio message from Alpha Centauri helps humanity get in touch with another civilization and itself.
- Sawyer, Robert “Flashes” in *Identity Theft and Other Stories*. 2008, Red Deer Press. The receipt of an encyclopedic radio message from an advanced civilization full of information leads to depression, violence, and suicides on Earth.



- Sawyer, Robert *Rollback*. (2007, TOR) A message from a civilization 19 LY away is received by SETI scientists, and turns out to be a survey on issues of morality for which they want many answers. We send a reply, and then their reply is eventually received, with instructions for incubating two baby aliens. Considers some of the issues of altruism and message construction that SETI researchers have been debating.
- Sawyer, Robert “You See, but You Do Not Observe” in *Nebula Awards 31*, ed. P. Sargent. 1997, Harvest. Proposes that the solution to Fermi’s Paradox is that the death of Sherlock Holmes at Reichenbach falls, and the subsequent rejection of that death by the public, leading to his return, left the Earth in a kind of Schroedinger’s Cat quandary, from which we must be released before we can be in synch with the rest of the universe and detect radio messages. (Free on the web at: <http://sfwriter.com/styousee.htm> )
- Shostak, Seth “In Touch at Last” in *Science*, vol. 286, p. 1872 (3 Dec 1999). Short story in which an astronomer uses the Sun as a gravitational lens to discover an alien transmission which turns out to be a time signal.
- Spinrad, Norman “The Helping Hand” in *Full Spectrum 3*, ed. Lou Aronica, et al., 1991, Bantam. An alien message unites humanity, but turns out to be a benevolent lie.
- Walker, John “We’ll Return, After This Message” in *Microtimes*, Aug. 23, 1993, p. 80. On line at: <https://www.fourmilab.ch/documents/sftriple/gpic.html> A programmer discovers a SETI message in the human genome.
- Zerwick, C. & Brown H. *The Cassiopeia Affair*. 1968, Curtis. An exploration of the effects that an alien radio message might have on Earth. One of the authors is a geochemist.

### **Solar System: General**

- Asimov, Isaac, et al., eds. *The Science Fictional Solar System*. 1979, Panther/Granada. A collection of short stories set on the planets and satellites of our solar system.
- Hoyt, Daniel “Squish” in Brotherton, M. *Diamonds in the Sky*. 2009, on the web at: [http://www.mikebrotherton.com/diamonds/?page\\_id=126](http://www.mikebrotherton.com/diamonds/?page_id=126) An awkward, but clever story which sends the protagonist from planet to planet, always with a quick description of the scenery and conditions on each world.
- McAuley, Paul *The Quiet War*. 2009, Pye/Prometheus. First novel in a series about a future war between the Earth and the outer satellites in the solar system, and the complex aftermath of the fighting. Followed by *Gardens of the Sun* (2010) and collections of stories. Includes many realistic descriptions of colonies and life on the satellites of the giant planets. (One story in this sequence can be read free on-line at: [http://www.baen.com/Chapters/9781625791535/9781625791535\\_2.htm](http://www.baen.com/Chapters/9781625791535/9781625791535_2.htm) )
- Preiss, Byron, ed. *The Planets*. 1985, Bantam. A collection of essays by noted astronomers about the planets in the solar system and science fiction stories inspired by our current understanding of each world.
- Reed, Robert “A History of Terraforming” in Dozois, G., ed. *Year’s Best Science Fiction: 28<sup>th</sup> Annual Collection*. 2011, St. Martin’s Griffin. Suggests many imaginative ways that the planets and moons could be made habitable and Earth life could be refashioned in the future.

### **Space Flight**

- Garn, Jake & Cohen, Stephen *Night Launch*. 1989, William Morrow. A techno-thriller about the hijacking of the Space Shuttle in space, written by the first Senator to fly on the Shuttle.

### **Space Travel (Realistic)**

- Anderson, Poul *Tau Zero*. 1970, Berkley. While the ending is fanciful, this novel very nicely portrays some of the issues involving relativistic space travel.
- Benford, Gregory “Relativistic Effects” in *In Alien Flesh*. 1986, TOR. A ram-scoop spaceship accelerates

- very close to the speed of light and flies between two galaxies about to collide.
- Brin, David “An Ever-Reddening Glow” in Hartwell, D. & Cramer, K., eds. *The Hard SF Renaissance*. 2002, Orb. Suggests that it is the stretching of space by the general relativistic “metric surfing” (travel near the speed of light) of countless intelligent species that is responsible for the expansion of the universe, and that no species is willing to give up the thrill. (Very nice parallel with the ecological damage we all do to the Earth.)
- Haldeman, Joe “Tricentennial” in *Infinite Dreams*. 1978, St. Martin’s. Traveling near the speed of light and the effects of time dilation for the traveler.
- Landis, Geoffrey “The Long Chase” in Ashley, M., ed. *The Mammoth Book of Extreme Science Fiction*. 2006, Carroll & Graf. Two human minds, downloaded aboard quantum computers in ion-drive ships, engage in a race, where the protagonist tries to escape her pursuer, which eventually brings them to 90% the speed of light, with neither having enough fuel to come to a stop. Available on the web at: <http://www.lightspeedmagazine.com/fiction/the-long-chase/>
- Reynolds, Alastair “Beyond the Aquila Rift” in *Year’s Best SF II*, Hartwell, David & Cramer, Kathryn, eds. 2006, Eos. Proposes a network of ancient pathways like black holes that allow faster-than-light travel. Local stations can be reached fast, but the protagonist winds up in the Magellanic Clouds.
- Varley, John “The Pusher” in *Blue Champagne*. 1986, Berkley. Poignant story about the loneliness of relativistic space travel; time dilation makes it difficult to have a family on Earth.

## Star Clusters

- Anderson, P. “Starfog” in *Beyond the Beyond*. 1969, Signet. What life might be like in the middle of dense star cluster.

## Stars

- Asimov, Isaac “Nightfall” in *Nightfall & Other Stories*. 1969, Fawcett. On a planet in a multiple star system, night comes only once every 2000 years. (Audio version at: <http://escapepod.org/2007/04/05/ep100-nightfall/>)
- Benford, Gregory “Dance to Strange Musics” in *Year’s Best Science Fiction 4*, ed. David Hartwell. 1999, Eos/HarperCollins. First expedition to Alpha Centauri finds a planet-wide, collective life form that takes energy from electric effects caused by the nature of the star system.
- Brotherton, Mike *Star Dragon*. 2003, TOR. Story involves SS Cygni, a complex, violent binary star system. Brotherton is an astronomer.
- Hoyle, Fred *Ossian’s Ride*. 1959, Harper. Aliens come to Earth fleeing the disaster of their star having become a red giant.
- McAuley, Paul “Rats of the System” in Crowther, Peter, ed. *Constellations*. (2005, DAW). Enigmatic advanced artificial intelligences dismantle and alter binary star systems with white dwarfs in them.
- McDevitt, Jack & Shara, Michael “Lighthouse” in *Cryptic: The Best Short Fiction of Jack McDevitt*. (2009, Subterranean Press) [on-line at: [https://www.baen.com/Chapters/1596061958/1596061958\\_8.htm](https://www.baen.com/Chapters/1596061958/1596061958_8.htm)] A deep survey of brown dwarfs (failed stars) reveals a large number whose composition defies all the rules of how stars work. They turn out to be artificial markers around single black holes that would have been a danger to travelers in the Galaxy. Shara is an astronomer.
- Niven, Larry “Flare Time” in *Limits*. 1984, Ballantine. Life on a planet in a binary star system with a flare star.
- Niven, Larry *Ringworld*. 1970, Ballantine. In this complex novel featuring an adaptation of a Dyson sphere, one element of the plot hinges on the motivations of a race of cowardly aliens whose star had earlier become a red giant.
- Sawyer, Robert *Illegal Alien*. 1997, Ace. An alien race on a planet around Alpha Centauri A has to deal with a gravitational interaction among the three stars in the system that hands their planet off to a dimmer star.

See also: "Star Clusters," "Supernovae," "Neutron Stars", "Black Holes"

## Sun, The

- Benford, Gregory & Eklund, Gordon *If the Stars Are Gods*. 1977, Berkley. Proposes that the Sun might have an intelligence within.
- Brin, David *Sundiver*. 1980, Bantam. Involves a trip into the Sun. Brin has a PhD in astrophysics.
- Clarke, Arthur "The Wind from the Sun" in *The Wind from the Sun*. 1973, Signet. About the effect of a solar flare on a solar wind "sailing race" of the future. (Free on line at: [https://www.baen.com/Chapters/9781625791443/9781625791443\\_2.htm](https://www.baen.com/Chapters/9781625791443/9781625791443_2.htm) )
- Clayton, Donald *The Joshua Factor*. 1986, Texas Monthly Press. A novel by an astronomer involving intrigue and neutrinos from the Sun.
- Clement, Hal "Proof" in Asimov, Isaac, ed. *Where Do We Go from Here?* 1971, Fawcett. About possible life-forms within the Sun.
- Niven, Larry "Inconstant Moon" in *All The Myriad Ways*. 1971, Ballantine. A giant flare on the Sun wreaks havoc with civilization.

## Supernovae (Exploding Stars)

- Allen, Roger & Kotani, Eric *Supernova*. 1991, Avon. An exploding star threatens the Earth. (Kotani is the pen-name of a NASA astrophysicist; this book is the only science fiction story I have seen which actually features an H-R diagram.)
- Anderson, Poul "Day of Burning" in *Beyond the Beyond*. 1969, Signet. An advanced race tries to mobilize the still feudal inhabitants of a planet whose star is about to go supernova.
- Clarke, Arthur "The Star" in *The Nine Billion Names of God*. 1967, Signet. Classic story about a supernova that becomes the star of Bethlehem. (Read aloud free at: <https://www.drabblecast.org/2011/12/24/drabblecast-227-the-star/> -- it starts at 2:45 in)
- Cowper, Richard *The Twilight of Briarius*. 1974, John Day. An alien intelligence rides the shock wave of a supernova explosion to Earth.
- Fraknoi, Andrew "Supernova Rhythm" in Brotherton, M. *Science Fiction by Scientists*. 2016, Springer. An astronomer finds a pattern in supernova explosions in a galaxy that hints at the work of an advanced civilization.
- Latner, Alexis "Listening Glass" in Brotherton, M. *Diamonds in the Sky*. 2009, on the web at: ([http://www.mikebrotherton.com/diamonds/?page\\_id=99](http://www.mikebrotherton.com/diamonds/?page_id=99)) A supernova goes off in a nearby galaxy, and the star that explodes happens to orbit a fast-pulsing pulsar.
- Reynolds, Alastair "Angel of Ashes" in *Zima Blue and Other Stories*. 2006, Night Shade Press. A nearby supernova that was just asymmetric enough to miss the inner solar system and spare life on Earth becomes the basis of a new religion.
- Sawyer, Robert *Calculating God*. 2000, Tor. The star Betelgeuse goes supernova, apparently through the actions of an advanced race of beings, and threatens the Earth.
- Sheffield, Charles *Aftermath*. 1998, Bantam. Alpha Centauri A goes supernova, even though that kind of star is not supposed to. But the book has a good description of how the electro-magnetic pulse from the explosion wreaks havoc with modern civilization, especially computer chips. Written by a scientist. (A sequel, called *Starfire*, was published by Bantam in 1999.)
- Silverberg, Robert "The Iron Star" in Preiss, Byron & Fraknoi, Andrew, eds. *The Universe*. 1987, Bantam. Involves two supernova explosions, a neutron star, and a black hole.

## Telescopes

- Brett, Alex *Cold Dark Matter*. 2005, Dundurn. A mystery novel whose plot turns on astronomical research; much of it takes place at the Mauna Kea observatories.

- Brotherton, Michael “Beyond 550 Astronomical Units” in *Nature*, vol. 528, p. 158 (3 Dec 2015). [Also on-line at: <https://www.nature.com/articles/528158a> ] An AI probe uses the Sun as a gravitational lens to do an exoplanet survey, while other probes use the Sun’s gravity as a telescope to study the galactic center, supernova remnants, etc. In a cute touch, the probes are given first names of key astronomers working in each field.
- Ehrlich, Max *The Big Eye*. 1949, Doubleday. Parts of this early novel about the threat of the end of the world from a planetary collision take place at the Palomar observatory; written just after the 5-meter (200-inch) telescope was finished.
- Latner, Alexis “Listening Glass” in Brotherton, M. *Diamonds in the Sky*. 2009, on the web at: [http://www.mikebrotherton.com/diamonds/?page\\_id=99](http://www.mikebrotherton.com/diamonds/?page_id=99)) A radio telescope on the Moon is damaged and then repaired in time to observe radio waves from a supernova.
- Landis, Geoffrey “Impact Parameter” in *Impact Parameter*. 2001, Golden Gryphon. Orbiting telescopes in the near future discover that a group of stars are out of place. Nice descriptions of how astronomy is done.
- McDevitt, Jack & Shara, Michael “Lighthouse” in *Cryptic: The Best Short Fiction of Jack McDevitt*. (2009, Subterranean Press) [also on the web at: [https://www.baen.com/Chapters/1596061958/1596061958\\_8.htm](https://www.baen.com/Chapters/1596061958/1596061958_8.htm)] Fascinating story of future astronomical discovery using new kinds of telescopes in space and a space elevator to get to them. Shara is an astronomer.
- McDevitt, Jack & Shara, Michael “Cool Neighbor” in *Cryptic: The Best Short Fiction of Jack McDevitt*. (2009, Subterranean Press) [also on line at: [https://www.baen.com/Chapters/1596061958/1596061958\\_9.htm](https://www.baen.com/Chapters/1596061958/1596061958_9.htm) ] An astronomer uses a giant infrared telescope in orbit to discovers a brown dwarf 18 light-days away, with planets. Lots on possible telescopes of the future.
- Sagan, Carl *Contact*. 1985, Simon & Schuster. Main character is loosely based on radio-astronomer Jill Tarter; has lots of good descriptions of how astronomers use radio telescopes to search for signals from civilizations out there.

## Thermodynamics

- Chiang, Ted “Exhalation” in Hartwell, D. & Cramer, K., eds. *Year’s Best SF 14*. 2009, Eos. A wonderful parable about the second law of thermodynamics, expressed in terms of changes in air pressure in a closed-system world inhabited by mechanical creatures.
- Pynchon, Thomas *The Crying of Lot 49*. 1966, Lippincott. A complex mainstream novel that interweaves ideas about the second law of thermodynamics with the story of a quest. Pynchon briefly studied engineering-oriented physics at Cornell, before turning to English and writing.
- Zoline, Pamela “The Heat Death of the Universe” in *The Heat Death of the Universe and Other Stories*. 1988, McPherson. [on-line at: [http://producer.csi.edu/cdraney/2012/278/resources/zoline\\_heat-death.pdf](http://producer.csi.edu/cdraney/2012/278/resources/zoline_heat-death.pdf) ] A day in the life of a housewife and the second law of thermodynamics.

## Time (The Nature of and Travel Through)

- Benford, Gregory “Caveat Time Traveler” in *Nature*, 2 Apr 2009; *Anomalies* (2012, Lucky Bat Books). Time travel into the future is possible; but you get snapped back with no memories or souvenirs of your trip. (Available on line at: <http://www.nature.com/nature/journal/v458/n7238/pdf/458668a.pdf>)
- Benford, Gregory *Timescape*. 1981, Pocket Books. A superbly crafted book about time communication using tachyons (faster-than-light particles,) written by a physicist.
- Chiang, Ted “Story of Your Life” in *The Year’s Best Science Fiction 4*, ed. David Hartwell. 1999, Eos/HarperCollins. Describes an alien approach to linguistics and thought which can alter one’s perception of time, and see all of one’s life at the same time. Interesting allegorical story, made into a science fiction film called *Arrival*.

- Heinlein, Robert "All You Zombies" in *6 x H*. 1961, Pyramid. Not realistic science, but this famous story is perhaps the most outrageous exploration of what might happen if we *could* travel backward in time: a man becomes his own father and mother.
- Lightman, Alan *Einstein's Dreams*. 1993, Random House. A fugue and meditation on the many different interpretations of time; portrayed as dreams a young Einstein is having.
- Niven, Larry *World Out of Time*. 1976, Ballantine. Using the gravitational time dilation near a supermassive black hole to travel into the distant future.

### **Uranus (and its Satellites)**

- Landis, Geoffrey "Into the Blue Abyss" in Dozois, Gardner & Williams, Sheila, eds. *Isaac Asimov's Solar System*. 1999, Ace. An expedition descends into the deep atmosphere and ocean of Uranus and discovers life there. Written by a NASA scientist.
- McAuley, Paul "Dead Men Walking" in Hartwell, David & Cramer, Kathryn, eds. *Year's Best SF 12*. 2007, Eon. Story of an android assassin on Ariel, Uranus' moon, which houses cities and a prison farm.
- Nordley, G. David "Into the Miranda Rift" in Dozois, Gardner, ed. *The Year's Best Science Fiction, 11<sup>th</sup> Annual*. 1994, St. Martin's. Harrowing chronicle of trapped explorers on and in the jigsaw-puzzle satellite Miranda.
- Sheffield, Charles "Dies Irae" in Preiss, Byron, ed. *The Planets*. 1985, Bantam. About adapting life to survive in Uranus' atmosphere.

### **Venus**

- Landis, Geoffrey "The Sultan of the Clouds" in Dozois, G., ed. *Year's Best Science Fiction: 28<sup>th</sup> Annual Collection*. 2011, St. Martin's Griffin. Imagines floating cities in the upper cloud layers of Venus, and schemes to alter the Venus atmosphere. (Audio version at: <http://www.starshipsofa.com/blog/2011/08/30/starshipsofa-no-201-geoffrey-a-landis-pt1/>)
- Niven, Larry "Becalmed in Hell" in *All the Myriad Ways*. 1971, Ballantine. An astronaut gets stranded in the Venus atmosphere.
- Sheffield, Charles "Dinsdale Dissents" in *Vectors*. 1979, Ace. Story involving the terraforming of Venus using algae. Sheffield is a scientist.
- Varley, John "In the Bowl" in *The Persistence of Vision*. 1978, Dell. The discovery of a form of crystalline life that can survive on Venus.

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*See last page for general references*

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### A Few Collections of Stories with Good Science in Many Areas:

Asimov, Isaac, *et al*, eds. *Great Science Fiction by the World's Great Scientists*. 1985, Primus. Twenty-one stories by writers with advanced degrees in science or engineering.

Bova, Ben & Choi, Eric *Carbide Tipped Pens*. 2014, Tor. Stories by authors who try to keep their science reasonable.

Brotherton, Michael *Diamonds in the Sky*. An on-line collection of astronomy fiction, edited by an astronomer-writer: <http://www.mikebrotherton.com/diamonds/>

Brotherton, Michael *Science Fiction by Scientists*. 2016, Springer. A recent collection of stories by scientists in a number of fields.

Conklin, Groff *Great Science Fiction by Scientists*. 1962, Crowell Collier. Stories by scientists in many areas, not just astronomy.

Dozois, Gardner & Williams, Sheila *Isaac Asimov's Solar System*. 1999, Ace. Stories about different worlds in our planetary system.

Hartwell, David & Cramer, Katherine, eds. *The Ascent of Wonder: The Evolution of Hard SF*. 1994, TOR. Large-scale collection of stories, many with good science.

Hartwell, David & Cramer, Katherine, eds. *The Hard SF Renaissance*. 2002, ORB/TOR. Another collection, like the above, but with more recent stories.

Preiss, Byron & Fraknoi, Andrew, eds. *The Planets*. 1985, Bantam. Collection of science essays on each planet, followed by a science fiction story based on current science.

Preiss, Byron & Fraknoi, Andrew, eds. *The Universe*. 1987, Bantam. Collection of essays by leading astronomers and science fiction stories inspired by the science they describe.

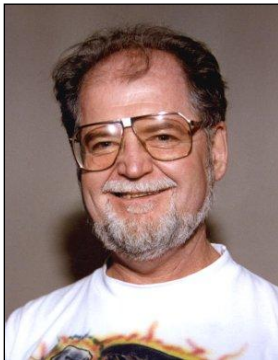
### Some Useful Web Sites:

The Internet Speculative Fiction Database: <http://www.isfdb.org/cgi-bin/index.cgi> (A remarkable site which indexes most stories and novels in science fiction. You can see what any author has written or find all the places a story you are interested in has been published.)

Free Speculative Fiction On-Line: <http://www.freesfonline.de/index.html> (A nice listing of short stories that are available on line without charge, organized by author.)

Teaching Astronomy with Science Fiction: <http://dx.doi.org/10.3847/AER2002009>

Additional Resources: <http://www.fraknoi.com/science-fiction-with-good-astronomy/>



Larry Niven



Paul McAuley



David Brin



Stephen Baxter