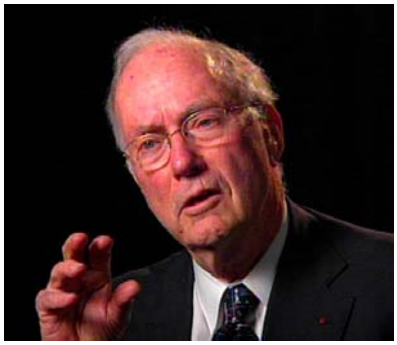
2010 SPIE *LIFE IN THE COSMOS PANEL*

In 1960, a single radio channel was used in the first search for signals from intelligent life elsewhere in the cosmos. Presently, scientists at the Allen Telescope Array are overcoming the enormous computing challenges of operating a large multi-dish array and are sweeping the skies with the potential of monitoring hundreds of millions of radio channels simultaneously. The 2010 SPIE *Life in the Cosmos Panel* is held in commemoration of the 50th Anniversary of SETI and features pioneers in the field of microwave astronomy and SETI. Astrobiologists, biochemists, microbiologists and paleontologists continue to explore the origin of pre-biotic and chiral biomolecules and the spatial, temporal, and environmental limitations of life on Earth. This knowledge is essential to understand where and how to search for the signatures of life elsewhere in the Universe and to investigate the possibility that a previously undiscovered "Shadow Biosphere" may exist on Earth today. The Panelists will review recent discoveries and provide their own insights about Life in the Cosmos -- followed by a question and answer session with the audience. All participants in the 2010 SPIE Symposium and the general public are invited to attend the SPIE *Life in the Cosmos Panel* on August 3, 2010 from 8:00 – 10:00 P.M. in the Marriott Marina F Ballroom.

Convener:

Richard B. Hoover is Astrobiology Group Lead at the NASA Marshall Space Flight Center. His initial research at NASA was in Solar Physics and grazing incidence/multilayer x-ray/EUV telescopes and microscopes. He was MSFC Inventor of the Year (1991 & 1992) and NASA Inventor of the Year in 1992. Since 1996, his Astrobiology research at NASA has concerned microbial extremophiles and the search for chemical biomarkers and microfossils in ancient terrestrial rocks and carbonaceous meteorites. He has led scientific expeditions to search for microbial extremophiles in the ice caps, glaciers, permafrost, alkaline lakes and geysers of *Alaska, Antarctica, California, Iceland, Patagonia* and *Siberia*. He was Science Team Lead of the *Antarctica 2000 Expedition* with Astronaut James A. Lovell *(Gemini 7 & 12; Apollo 8 & 13* to search for meteorites and extremophiles in the Patriot Hills, Thiel Mountains, and South Pole of Antarctica. This expedition recovered 20 meteorites (now in the *Field Museum, Chicago*). He was Science Team Lead for the *2008 International Tawani Expeditions* to explore the Schirmacher Oasis and Lake Untersee of Antarctica. These expeditions resulted in the discovery and valid publication of two new genera (*Anaerovirgula* and *Proteocatella*) and nine new species of bacteria and archaea. For these contributions, he was elected Fellow National of the *Explorers Club* in 2001 and made a Life Member of the *Planetary Studies Foundation* in recognition of his research on microfossils in meteorites,. Richard B. Hoover is author/editor of 38 books and over 300 scientific papers. His research has been featured in films by the *National Science Foundation, BBC; Discovery Channel* and *National Geographic*. He has Chaired 30 SPIE Conferences on X-Ray/EUV Optics and Astrobiology. He is a Fellow of SPIE (1991); served as President of SPIE in 2001 and was the 2009 recipient of the SPIE Gold Medal of the Society.

Moderator:



Charles H. Townes received the Ph.D. degree in physics at the California Institute of Technology in 1939. He was a staff member of Bell Laboratories (1939-1947); Associate Professor of Physics, Professor, and Chairman of the Physics Department at Columbia University (1948-1961); Vice-President and Director of Research of the Institute for Defense Analysis (1959-1961); Provost and Institute Professor at MIT (1961-1965), and Professor at

the University of California from (1967- present). Dr. Townes' principal scientific work is in microwave spectroscopy, nuclear and molecular structure, quantum electronics, radio astronomy and infrared astronomy. He holds the original patent for the maser and with Arthur Schawlow, the original laser patent. He received the Nobel Prize in 1964 *"for fundamental work in quantum electronics which has led to the construction of oscillators and amplifiers based on the maser-laser principle."* At the University of California, Townes returned to full-time research and teaching, and pursued new interests in astrophysics. His work in radio astronomy resulted in the first detection of polyatomic molecules in interstellar clouds and the use of molecular spectra to characterize these dark clouds. In the infrared region, he has worked primarily on high spectral and spatial resolution for astronomical observations, largely directed towards understanding the galactic center. Since 1988, he has been using a pair of moveable telescopes for obtaining very high angular resolution of astronomical objects at infrared wavelengths by spatial interferometry. A third telescope for this system has now been installed and provides phase closure. He was a member of the President's Science Advisory Committee (1965-1969) and President of the American Physical Society (1967) and chairman of the technical advisory committee for the Apollo Program. More recently, he chaired committees on Strategic Weapons and the MX missile. He has been active in the National Academy of Science's contacts with China, work on Arms Control, and meetings with representatives of the Soviet Academy He has also helped formulate advice given by the Papal Academy to the Pope on issues of peace and the control of nuclear weapons. Townes is a member of the National Academy of Sciences, the National Academy of Engineering, the Royal Society of London, the Max Planck Society, the National Inventors Hall of Fame, and the Engineering and Science Hall of Fame. He has received the National Academy of Sciences' Comstock Prize and the John J. Carty Medal, the National Academy of Engineers' Founders Award, and the Stuart Ballentine Medal of the Franklin Institute (twice). Other awards include the Rumford Premium of the American Academy of Arts and Sciences, the C.E.K. Mees Medal of the Optical Society of America, the Medal of Honor of the Electrical and Electronics Engineers, the Plyler Prize of the American Physical Society, NASA's Distinguished Public Service Medal, the Russell Lectureship of the American Astronomical Society, along with many others. Among Dr. Townes' international awards are the Thomas Young Medal and Prize of the Institute of Physics and the Physical Society (England), the Wilhelm Exner Award (Austria), the 1979 Niels Bohr International Gold Medal, the Lomonosov Medal of the Russian Academy of Sciences, the Rabindranath Tagore Award of India, the Karl Schwarzschild Medal of German-speaking countries, the 2001 SPIE Award; the 2005 Templeton Prize and the 2006 Vannevar Bush medal. Dr. Townes received the 1982 National Medal of Science and has received twenty-nine honorary degrees. He is a Fellow of SPIE (2010) and is the 2010 recipient of the SPIE Gold Medal of the Society.

Panelists:

Jill Cornell Tarter holds the *Bernard M. Oliver Chair* for SETI (Search for Extraterrestrial Intelligence) and is Director of the Center for SETI Research at the SETI Institute in Mountain View, California. Tarter received her Ph.D. in Astronomy from the University of California, Berkeley. She served as Project Scientist for NASA's SETI program, the High Resolution Microwave Survey, and has conducted numerous observational programs at radio observatories worldwide. She is on the management board for the Allen Telescope Array, a joint project between the SETI Institute and the UC Berkeley Radio Astronomy Laboratory. When this innovative array of 350 6-m antennas begins operations at the UC's Hat Creek Radio Observatory, it will simultaneously survey the radio universe for known and unexpected sources of astrophysical emissions, and speed up the search for radio emissions from other distant technologies by orders of magnitude. She received the Lifetime Achievement Award from Women in Aerospace, two Public Service Medals from NASA, Chabot Observatory's Person of the Year award (1997), Women of Achievement Award in the Science and Technology category by the Women's Fund and the San Jose Mercury News (1998), and the Tesla Award of Technology at the Telluride Tech Festival (2001). She was elected an AAAS Fellow in 2002 and a California Academy of Sciences Fellow in 2003 (and CAS Scientific Trustee in 2007). In 2004 Time Magazine named her one of the Time 100 most influential people in the world, and in 2005 Tarter was awarded the Carl Sagan Prize for Science Popularization. In 2006 Tarter became a National Advisory Board member for the Center for Inquiry's Office of Public Policy in Washington, DC. She is CSICOP Fellow and was one of three Technology, Education, Design (TED) prize winners in 2009. In addition to her scientific leadership at NASA and SETI Institute, she was Principal Investigator for the *Life in the Universe* series. Her *Voyages Through Time*, project, *i*s an integrated high school science curriculum on the fundamental theme of evolution in six modules: Cosmic Evolution, Planetary Evolution, Origin of Life, Evolution of Life, Hominid Evolution and Evolution of Technology (published 2003). Tarter is a frequent speaker for science

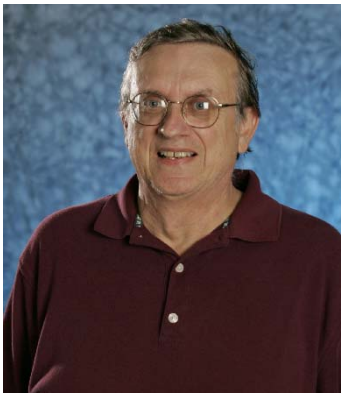
teacher meetings and at museums and science centers, bringing her commitment to science and education to both teachers and the public. Many people are now familiar with her work as portrayed by Jodie Foster in the movie *Contact.*

Gilbert V. Levin, Adjunct Professor, Beyond Center, Arizona State University, Tempe, AZ. Dr. Levin has B.E., M.S. and PhD degrees in civil engineering, sanitary engineering and public health, and environmental engineering from Johns Hopkins University. He is Honorary Professor at Cardiff University, UK. He served as public health engineer in state health departments from 1948 to 1955. From 1955 to 1961, he was Adjunct Professor, Georgetown University, Schools of Medicine and Dentistry. In 1955, he co-founded Resources Research, where he began his space biology research. He headed a NASA-appointed committee to recommend experiments for the BioSatellite Mission, and served on the American Institute for Biological Science's Planetary Quarantine Advisory Panel sponsored by NASA. He was Principal Investigator for a study of NASA's Mars Sample Return Mission. After his company was acquired by Hazelton Laboratories in 1963, he founded its Life Systems Division and continued his development of novel microbial detection methods. In 1967, he founded Spherix Inc. (NASDAQ SPEX) serving as CEO, President and Chair. Co-Investigator on the IRIS experiment flown on the 1971 Mariner Mission to Mars, he was Principal Investigator for the Viking Labeled Release life detection experiment landed on Mars in 1976. Positive results were obtained at both landing sites. After years of study, Levin concluded, in 1997, that the experiment had detected living microorganisms. He was a Team member of NASA's MOx experiment on the ill-fated Russian '96 Mission to Mars. Levin has published 130 scientific papers and received over 50 patents. His inventions include low-calorie sweeteners, therapeutic drugs (one currently under test for type 2 diabetes), radioisotopic methods for rapid detection and identification of microorganisms, the firefly bioluminescent ATP assay for detection and measurement of biomass, safe-for-humans pesticides, and biological nutrient removal from municipal wastewater. He is Trustee Emeritus of the Johns Hopkins University and a member of its National Advisory Council for the Whiting School of Engineering. He has served on Hopkins' National Library and National Industrial Advisory Councils. His awards include the Distinguished Alumnus Medal from Johns Hopkins, the Public Service Medal from NASA, the Newcomb-Cleveland Award from the AAAS and the IR-100 Award from Industrial Research Magazine. He is a Member of the *Sigma Xi*, is listed in Who's Who, and is a member of the Cosmos Club. He has Co-chaired several SPIE Astrobiology Conferences.

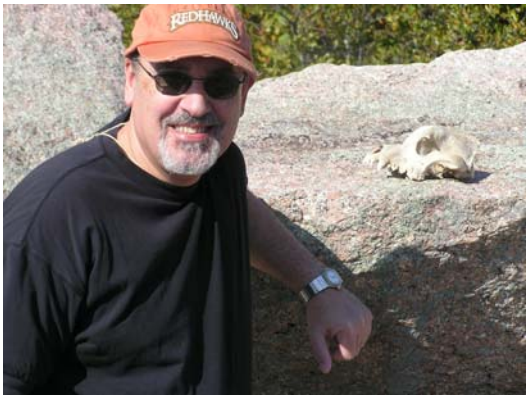
Chandra Wickramasinghe is currently Professor of Astrobiology and Director of the Cardiff Centre for Astrobiology at Cardiff University. His research main interests are comets, interstellar dust and astrobiology. He has made many contributions in these fields, publishing 28 books, over 350 papers in major scientific journals, over 75 in the journal *Nature*. In 1974 he first proposed the theory that dust in interstellar space and in comets was largely organic, a theory that has now been vindicated. Jointly with the late Sir Fred Hoyle he was awarded the International Dag Hammarskjold Gold Medal for Science in 1986. In 1992 he was decorated by the President of Sri Lanka with the highest national honour of *Vidya Jyothi* for his achievements in science. Together with the late Sir Arthur Clarke was awarded the International Sahabdeen Prize for Science in 1996. He was a Fellow of Jesus College, Cambridge from 1962-1973. In 1973 he was appointed Professor and Head of the Department of Applied Mathematics and Mathematical Physics at University College, Cardiff, being the youngest Professor appointed at the University up to that time. He was responsible for starting an Astrophysics research group in Cardiff under the auspices of a new Department formed under his headship, the Department of Applied Mathematics and Astronomy. In recognition of his contributions to science and culture he was awarded an honorary doctorate by the Soka University of Tokyo, Japan in 1996. He was awarded the degree of Doctor of Science (Honoris Causa) by the Unversity of Ruhuna, Sri Lanka in 2004.

Stanley Awramik is Professor of Biogeology in the Department of Earth Science at the University of California, Santa Barbara, where he's been a faculty member since 1974. He did his undergraduate work in geology at Boston University and received his PhD from Harvard. His research interests focus on the early history of life on Earth, in particular fossil microbes, sedimentary constructions by microbes (stromatolites), and the nature of the Earth's surface billions of years ago. His field work has taken him all over the globe, but the main work has been in Australia, China, Canada, eastern California, and Wyoming. He has found some of the oldest evidence of life on Earth – fossil bacteria about 3.48 billion years old. His work on stromatolites covers almost the entire geological record, from 3.48 billion years ago to the present. Current research projects include life and ancient environments in 2.7 billion-year-old lake deposits in Australia, early records of eukaryotes (organisms with a nucleus) from rocks ~1800 million-years-old in north China, the records of microbial life and stromatolites just before, during, and right after a < 740 million-year-old global glacial event (snowball Earth) in eastern California, evidence of some of the oldest animals and associated organisms from ~560 million-year-old rocks in south China, 50 million-year-old stromatolites in Wyoming, and growing stromatolites in the lab.

Steven Benner is a Distinguished Fellow at the Foundation for Applied Molecular Evolution and The Westheimer Institute for Science and Technology. His research seeks to combine two broad traditions in science, the first from natural history, the second from the physical sciences. Towards this goal, his group works in fields such as organic chemistry, biophysics, molecular evolution, bioinformatics, geobiology, and planetary science. He contributed to the founding of several new fields, including synthetic biology, paleogenetics, and computational bioinformatics. He co-chaired with John Baross the National Research Committee's 2007 panel on the "Limits to Organic Life in the Solar System", advised the design of missions to Mars, and invented technology that improves the medical care of some 400,000 patients each year suffering from infectious diseases and cancers.



George E. Fox received his Ph.D. in chemical engineering from Syracuse University. He is currently *John and Rebecca Moores* Professor of Biology, Biochemistry and Chemical Engineering at the University of Houston. His primary research interest is in RNA structure and evolution. Within this context, he is focusing his attention on the structure of real RNA sequence spaces using 5S rRNA as a model system and exploring the early history of the ribosome in order to understand the origins of life as we know it. He also is examining the adaptation of bacteria to microgravity and/or radiation. He was co-discover of the Archaea, a breakthrough that was proclaimed by the Science Channel to be the greatest discovery in Biology in the 20th century. The Archaea have revolutionized the way scientists think about the history of life on the Earth. He also pioneered the use of comparative analysis in the determination of RNA secondary structure and has made numerous contributions to bacterial phylogeny. He was chair of the 2010 Origins of Life Gordon Conference and has served on various panels including the USRA Division of Life Sciences Advisory Council, the USCF J. Roger Porter Award Nominating Committee, the American Society of Microbiology Governing Council, and the National Research Council Space Science Board Committee on Planetary Biology and Chemical Evolution. In collaboration with the Houston Museum of Natural Sciences he has assisted in the development of three planetarium shows with Astrobiology themes that have been shown to national and international audiences. He is an elected fellow of the American Academy of Microbiology, the American Association for the Advancement of Science, and the American Institute of Medical and Biological Engineering.



Michael H. Engel holds the *Clyde Becker Chair* in Geochemistry in the School of Geology and Geophysics at The University of Oklahoma. He received his bachelor's degrees in Geology and Anthropology from Binghamton University and his master's and doctoral degrees in Geosciences from The University of Arizona. He was the recipient of the *Philip and Neva Abelson Postdoctoral Fellowship* in Geochemistry at the Geophysical Laboratory, Carnegie Institution of Washington. Professor Engel was one of the first geoscientists to receive an NSF Presidential Investigator Award for his work on carbonaceous meteorites. One of his primary research interests continues to be the origin, distribution and stereochemistry of amino acids in carbonaceous meteorites. Professor Engel and his colleagues were the first to report the occurrence of non-racemic protein amino acids (L-enantiomer excess) in carbonaceous meteorites and to subsequently confirm their authenticity based on their stable isotope compositions. He is currently investigating pathways for the asymmetric amplification of amino acid stereoisomers on meteorite parent bodies and their implications for the origin of life in the solar system.