s c a t t e r i n g s

Stories by Senior Writer
Tyler J. Krupa

Member News

Gary Bjorklund Named Chief Technology Officer At Nanovation Technologies

Former OSA President Dr. Gary Bjorklund, an OSA Fellow, has been named chief technology officer and senior vice president of Nanovation Technologies in Miami. In this capacity, Bjorklund will be responsible for identifying and evaluating technology companies for strategic investment, partnership, and acquisition. Nanovation Technologies is active in the fields of optical semiconductors, systems and components. Bjorklund previously worked as a consultant to Nanovation.


Former OSA President Dr. Gary Bjorklund.

Bjorklund received a BS in physics from the Massachusetts Institute of Technology, and an MS and a PhD in applied physics from Stanford University. An industry veteran with particular expertise in the field of optical networks, his previous professional positions include: director of advanced development for Optivision/Optical Networks (Palo Alto, CA); manager of organic optoelectronic materials for IBM Corporation's research labs (San Jose, CA); and member of the technical staff of Bell Laboratories (Murray Hill, NJ). At Bell Labs, Bjorklund carried out research in quantum electronics and nonlinear optics.

Bjorklund has published more than 100 technical papers and received over 20 patents for co-inventions. He was president of OSA in 1998. In 1996, he was president of the IEEE Lasers and Electro-Optics Society. He is also a Fellow of IEEE. Bjorklund has served as program co-chair (1984) and general co-chair (1986) of the Conference on Lasers and Electro-Optics (CLEO), and chairman of the OSA Annual Meeting. He has also been a member of several advisory committees, including the National Research Council Committee on Optical Science and Engineering (1995-1998).

Nanovation Technologies designs and develops integrated optical devices based on patented microcavity lasers and resonators. The company will offer components to telecommunication and data networking equipment manufacturers, as well as to original equipment manufacturers that supply subsystems. Its product line will include optical cross-connect switches, add/drop switches and wave division multiplexers. It will also develop and deliver photonic devices with the ability to integrate laser sources and optical switches on the same device.

New Topical Editor for *Optics Letters*

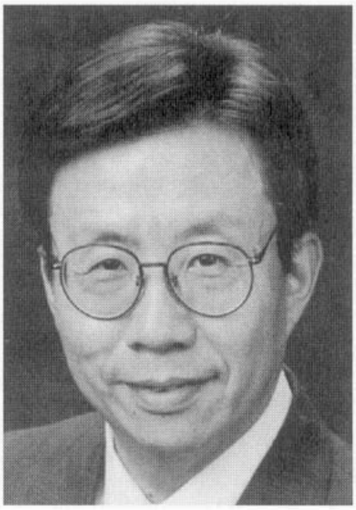
W. Andrew Clarkson (University of Southampton, UK) has been named topical editor for *Optics Letters*. Clarkson will assist the journal editor Anthony Johnson with manuscripts pertaining to lasers. His term will run through the end of 2002.

OSA Members Form "New Incubator"

OSA members Milton Chang, Bill Nighan, and Tom Baer have teamed up to form "New Incubator"—a project that will provide initial capital and management resources to help launch companies in telecommunication, biotech, and other laser/optic applications.

According to Nighan, "Many Internet startups have benefited from dedicated incubators; we saw a need to do the same in photonics. We've put together [Chang's] respected business experience, my own in product development and management, and [Baer's] tremendous knowledge, especially on the biotech side. Our team can avoid typical startup pitfalls and significantly increase the chance to succeed."

Outlining the specifics of this partnership, Chang indicates that "once we decide an idea is viable, we provide all the capital needed to develop a business model, put together a management team, and develop the product and business to a point when we can bring in additional investors. We can get follow-on investments quickly because we have a lot of credibility with a network of angel investors and venture capital funds."


OSA Fellow and "New Incubator" Co-founder Milton Chang.

Chang is chairman of New Focus, and

has incubated more than a dozen companies without a single failure. Nighan was the director of engineering with Spectra-Physics, where he invented the award-winning "Millennia" and developed over 50 photonic system products. Baer is the president and CEO of Arcturus Engineering, a manufacturer of photonic biomedical instrumentation.

Fred Billmeyer Receives Color and Appearance Award

Professor Fred Billmeyer, OSA Fellow and a member since 1958, received the first color and appearance award from the American Society for Testing and Materials (ASTM). The award was given by Committee E-12, one of 129 ASTM technical standards writing committees. Named in his honor, the Fred W. Billmeyer, Jr. E-12 Certificate of Appreciation is presented for outstanding service to the Committee.

Involved with ASTM since the 1940s, Billmeyer was the first chairman of E12.01 on Terminology and, while serving as technical liaison, was very influential in defining nomenclature for color and appearance on most practices found in E12.02 and E12.04. As current chair of the E-12 Editorial Subcommittee, Billmeyer verifies that the committee's standards are written clearly and understandably.

Billmeyer (middle) is presented with the ASTM Color and Appearance Award.

Corporate News

Coherent Laser Group and Picometrix Join to Develop Terahertz System

Coherent, Inc. (Santa Clara, CA) and Picometrix (Ann Arbor, MI) are collaborating to develop and commercialize a time-domain, terahertz (T-Ray™) system. Terahertz instruments involve the use of laser pulses, each lasting only 100 fs, to generate, detect, and measure electromagnetic pulses (T-Rays) which last a picosecond. T-Ray technology has a variety of potential applications that include: materials inspection; fault detection; moisture sensing and control; package inspection; chemical reaction analysis; and pollution control.

Scatterings in Brief

Optical Sensor Protects Nation's Historical Documents

An optical device developed by Aerodyne (Billerica, MA) is helping to preserve the original U.S. "Charters of Freedom." These documents, including the Constitution, the Declaration of Independence, and the Bill of Rights, are currently on display in Washington, DC.

The instrument, which is based on differential infrared absorption spectroscopy, provides a single, non-invasive optical sensor that can monitor both the humidity and the presence of trace amounts of oxygen within the sealed enclosures.

In the Aerodyne instrument, water vapor and molecular oxygen are monitored using a differential absorption technique. Since both species absorb light at certain wavelengths in the near infrared region of the electromagnetic spectrum, emission lines from a compact discharge lamp are magnetically tuned so that they coincide with absorption features of the water vapor and oxygen molecules.

The sensor first measures the amount of light transmitted through the oxygen and water vapor in the enclosures with these particular lines. Using a polarization filter, the sensor then switches to a second set of lamp emission lines that are close to the first set of lines in wavelength, but which are not absorbed by the oxygen and water vapor. The difference in transmitted light intensity is proportional to the concentration of ambient water vapor and oxygen. Water vapor can be measured down to a sensitivity of 25 parts per million, while oxygen can be measured to one part in a thousand.

In addition, the light beam is very low intensity and passes above the documents rather than onto them, eliminating the risk of photodamage.

Lights Without Bulbs?

The future of lighting may have nothing to do with light bulbs. Recently, George Mueller and Ihor Lys, (Color Kinetics, Boston), received a patent for a digital lighting technology that they contend may ultimately replace conventional lighting that's been around in one form or another—from incandescent to halogen—for

Continued on page 8

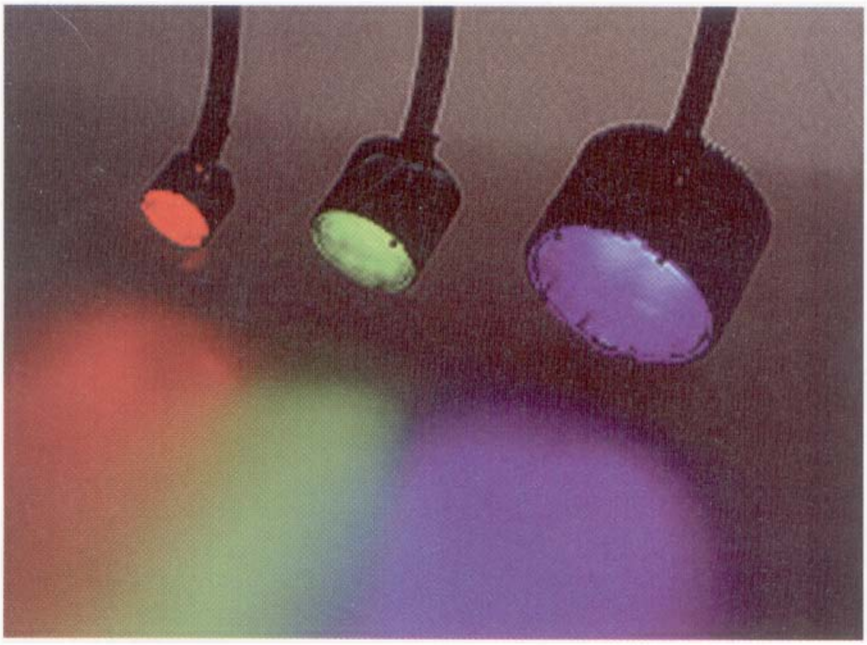
"Scatterings in Brief," continued

over a century.

Investors, including Deutsche Bank, plunged $13 million in financing into the new technology. Such illumination could instantly change the hue of a wall, from muted eggshell to splashy pigments throbbing chromatically with the beat of whatever music happens to be playing.

Light-emitting diodes (LEDs) drive digital lighting. According to Kevin Dowling, Color Kinetics' director of engineering, the ever-increasing brightness of LEDs over the last decade has enabled the inventors to bunch many diodes together for a new type of color lighting. "The LEDs are very small and you can package them into any conceivable two-dimensional shape," said Dowling.

This lighting technology employs a microprocessor to control variable intensity, super bright LEDs to generate colors, and colored lighting effects through additive RGB color mixing. The approach is different from the traditional method of creating colored light, which is to put a filter or gel in front of a white-light source so that only certain colors of the spectrum shine through. Other advantages to LED lights include: no ultraviolet light, so they will not fade fabrics or artwork; a very low temperature light source, so they won't burn the skin if touched; and long lifetime. If the LED lights are run continuously 24 hours a day, the company says they'll last 11 years.



Color Kinetics makes computer-controlled lights that change color.

Breast Cancer Detection

A group at the City University of New York has discovered a non-invasive method to detect cancers in breast tissues using DNA and protein fingerprints in Kubelka-Munk Spectral Function (KMSF).

The Kubelka-Munk theory is a two-flux theory in which the radiation is assumed to be composed of two oppositely directed radiation fluxes through a continuous medium. The theory has been widely used to relate the total diffuse reflection from a material to its scattering and absorption.

During the study, normal, fibroadenoma, malignant, and adipose breast tissues were investigated using KMSF. The spectral features in KMSF were identified. A specified spectral feature measured in adipose tissue was assigned to β-carotene, which can be used to separate fat from other molecular components in breast tissues.

The peaks of KMSF at 260nm and 280nm were attributed to DNA and proteins, respectively. Signal amplitude over 255nm to 265nm, and 275nm to 285nm, was found to be different for malignant, fibroadenoma, and normal tissues.

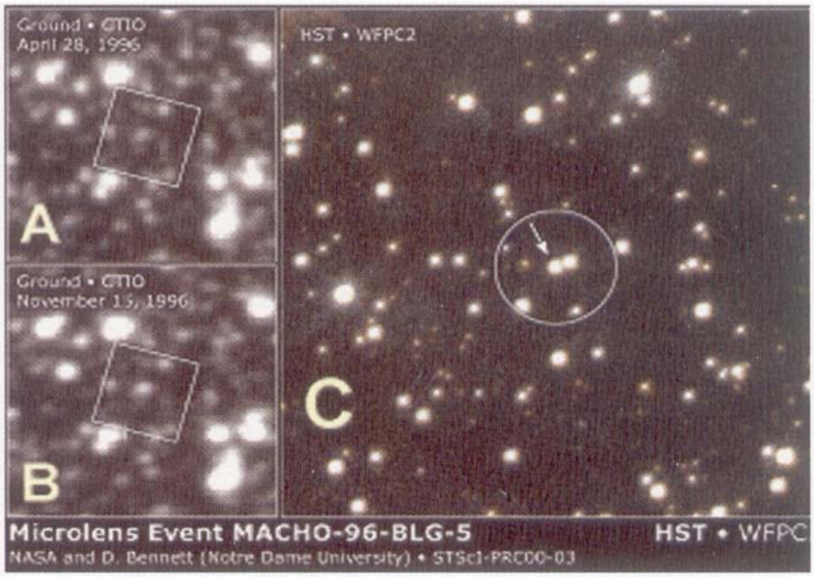
Laser Collaboration Reached

Under a $2 million cooperative agreement, the Air Force Research Laboratory's Directed Energy Directorate and Applied Optoelectronics Inc. (Sugar Land, TX), will work together to develop a compact, low-cost, highly efficient, semiconductor laser for military and civilian uses. Operating at 2 to 5 μm, the laser can be used for a variety of military purposes, including infrared countermeasures and chemical weapon sensing. Civilian uses include commercial environmental monitoring.

This agreement was made possible under the Department of Defense Dual Use Science and Technology Program—a congressionally mandated, tri-service program that shares the costs of Defense research projects with industry.

Isolated Black Holes Identified

Albert Einstein first showed that the gravitational field of a star distorts space so that light passing near is deflected, much like an optical lens deflects light. In 1936 Einstein predicted what an observer would see if a very faint object with a strong gravitational field such as a black hole passed in front of a faint star. Acting like a powerful lens, the gravity of the black hole would split the star's image into multiple images, making the star appear brighter. In some cases, the images would blend into a perfect ring of light. This phenomenon is known as gravitational lensing; in the case of stars, it is called microlensing.



(a) and **(b)**. Two images of a crowded starfield as seen through a ground-based telescope show the subtle brightening of a star due to the effect of gravitational microlensing, where an invisible but massive foreground object passes in front of the star and amplifies its light. The dark lensing object is estimated to be a six-solar-mass black hole that is drifting alone among the stars. **(c)**. A NASA Hubble Space Telescope image of the same field clearly resolves the lensed star and yields its true brightness.

Using gravitational lensing, two international teams have discovered the first examples of isolated stellar-mass black holes adrift among the stars in our galaxy.

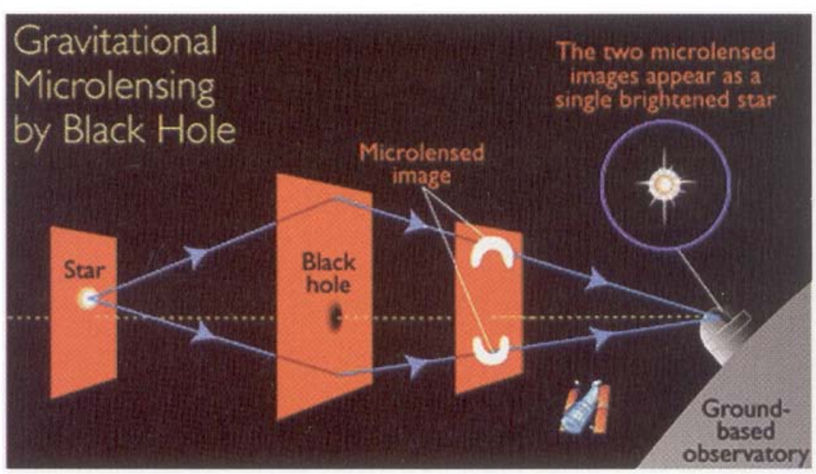
All previously known stellar black holes have been detected in orbit around normal stars, with their presence determined by the effect on the companion star. The two isolated black holes were detected indirectly by the way their extreme gravity bent the light of a more distant star behind them.

This summer David Bennett (University of Notre Dame) and colleagues used the Hubble Space Telescope and observations by the Mt. Stromlo Observatory in Australia and the National Science Foundation's Cerro Tololo Inter-American Observatory in Chile to examine a 1996 microlensing event. The Hubble frame indicated that the lensed object was blended with two neighboring objects of similar brightness that could not be separated in the poorer-resolution, ground-based images. Hubble's identification of the lensed object allowed for an accurate estimate of the mass of a black hole. The team examined another microlensing event that occurred in 1998 and found it was brighter by modeling the ground-based measurements to determine the brightness of the lensed star. However, this determination awaits confirmation from future Hubble images.

"These results suggest that black holes are common and that many massive but normal stars may end their lives as black holes instead of neutron stars," said Bennett, a member of the international team who presented the findings at the American Astronomical Society meeting in January.

The findings also suggest that stellar-mass black holes do not require interaction in a double-star system to form, but, as long proposed by stellar theorists, may

Continued on page 11

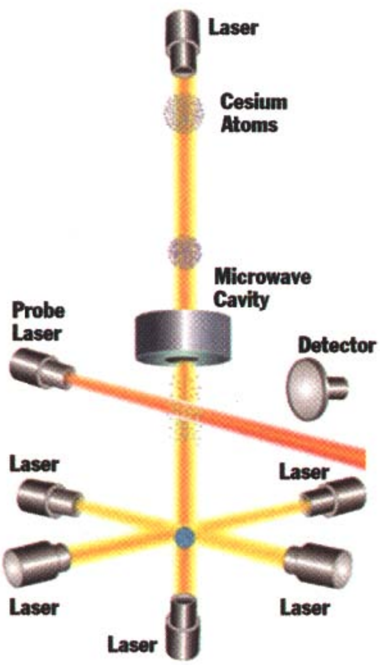


Gravitational microlensing by black hole.

The 20 Million Year Clock

Forget cogs, lithium batteries, and quartz crystals. Laser-cooled atoms can keep accurate time for 20 million years. A laser system for cooling cesium atoms makes the National Institute of Standards and Technology's new atomic clock the most accurate clock ever made. The NIST F-1 is now three times as accurate as the NIST-7, a cesium clock invented in 1993 by the standards agency. Since its inception, the NIST-7 was the primary atomic time standard for the U. S. and was among the best standards in the world.

Laser cooling of atoms, the main innovation in the NIST F-1, is a technique that resulted from the work of Dr. Steven Chu (Stanford), Dr. Claude Cohen-Tannoudji (École Normale Supérieure, France), and Dr. William D. Phillips (NIST). Their contributions in the field of laser cooling and trapping have meant a breakthrough for both theory and experiment and have led to a deeper understanding of the interaction between light and matter. The three shared the 1997 Nobel Prize in Physics for their achievement.



The NIST F-1 Cesium Fountain Clock.

At room temperature an atom flies around at speeds up to 2,500 miles per hour and likewise is difficult to measure. However, if six laser beams are directed at it from opposite directions, the atom must lose energy in any direction it turns and is soon brought almost to a stop. The temperature of an atom in such a trap is very close to absolute zero.

NIST F-1 is referred to as a fountain clock because it uses a fountain-like movement of atoms to obtain its improved reckoning of time. First, a gas of cesium atoms is introduced into the clock's vacuum chamber. Six infrared laser beams gently push the atoms together into a ball. In the process of creating this ball, the lasers slow down the movement of the atoms and cool them to near absolute zero.

Two vertical lasers are used to gently toss the ball upward (the "fountain" action), and then all of the lasers are turned off. This little push is just enough to loft the ball about a meter high through a microwave-filled cavity. Under the influence of gravity, the ball then falls back down. As the atoms interact with the microwave signal—depending on the frequency of that signal—their atomic states might be altered. The entire round trip for the ball of atoms takes about a second.

At the finish point, another laser is directed at the atoms. Only those atoms whose atomic states are altered by the microwaves are induced to emit light. The emitted photons (tiny packets of light) are measured by a detector. This procedure is repeated many times while the microwave energy is tuned to different frequencies. Eventually, a frequency is achieved that alters the states of most of the cesium atoms and maximizes their fluorescence. This frequency is the natural resonance frequency for the cesium atom. From this information, it is comparatively simple to mark off a precisely measured second, which can then be used for setting ordinary clocks.

Builders of this new fountain clock stated in a news conference held in Boulder, Colorado that research uses for the NIST F-1 might not be found for a decade or so. However, one present day important function of atomic clocks is correcting the errors in clock time that result from the wobbling of the Earth's orbital motions through space.

Doctoral Students Survey

The National Association of Graduate-Professional Students (NAGPS) recently received a grant from the Alfred P. Sloan Foundation to conduct a survey of doctoral students on their graduate school experiences. Current and recent doctoral students can complete the survey on the Web <http://survey.nagps.org/> between January and May 2000. All results will be made publicly available on the Web on a department-specific basis in September 2000. This effort is a follow-up to a more limited survey this past Spring, aimed at science and engineering doctoral students. The new survey is unique in that it collects information on a department-specific basis. As a result, it will be possible to look at, for instance, responses from individual physics programs, or to rank history departments based on faculty mentoring.

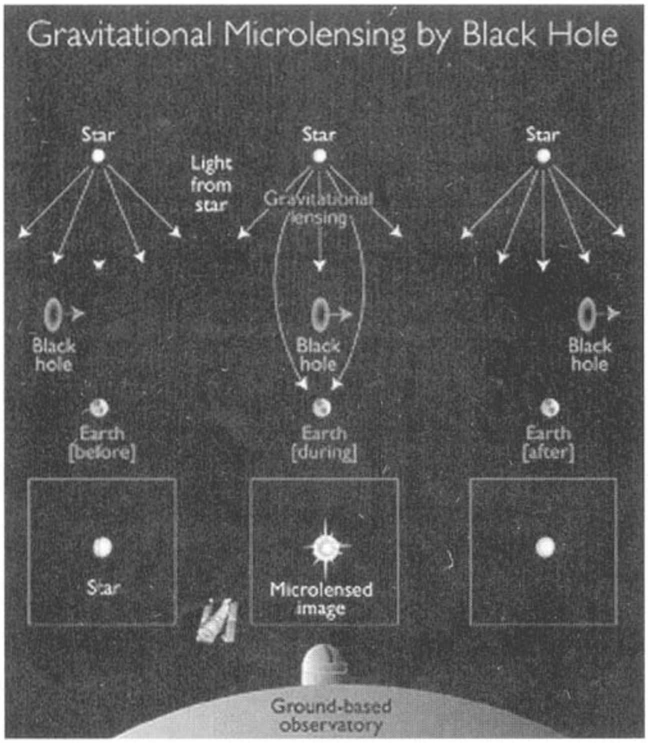
The survey is based upon best practices and covers a number of areas, including information for prospective students, curriculum breadth and flexibility, career guidance and placement services, faculty mentoring, time to degree, department climate, teaching, professionalism, and overall satisfaction.

"Black Holes," continued

also be produced in the collapse of isolated massive stars.

In the case of these two microlensing events, the gravity of the black hole acted like a powerful lens, splitting the light of the background star so that it appeared as two separate images when the black hole slowly drifted in front of it. The bending angle was about 100 times smaller than the angular resolution of Hubble, so the two distorted images of the background star could not be separated, even in high-resolution Hubble images.

Microlensing is at the heart of the Massive Compact Halo Object (MACHO) project at the Mt. Stromlo Observatory in Australia. MACHO astronomers have noted 300 instances of gravitational microlensing near the central regions of the Milky Way Galaxy. The primary aim of the observatory is to search for evidence of extra-solar planets using the gravitional microlensing technique. Due to the universality of gravity, gravitional microlensing is also sensitive to unbound planets ("rogue planets") or brown dwarfs. Amplification can be extensive, but events are extremely rare—to obtain a useful detection rate, it is necessary to monitor photometrically several million stars for a period of years.



The microlensing technique holds promise for detecting other solitary black holes, dark matter, and planets.

"In Memoriam: William E. Scott," continued

during extreme flight conditions.

In 1947 Scott joined the research laboratories of The Franklin Institute in Philadelphia, where he spent the next four years researching the mechanisms of hydrocarbon oxidation. By 1950, as head of the Chemical Kinetics Branch, he was instrumental in the development of the first long path infrared spectrophotometer with a scanning monochrometer. With the increased sensitivity of this instrument, it became possible to perform chemical analyses of gas samples, quantifying trace compounds such as hydrocarbons and oxides of nitrogen in concentrations as low as parts per million. A second prototype of this instrument was transported by Scott to the Los Angeles Basin in southern California where it was used to characterize for the first time the reaction mechanisms and composition of photochemical smog. Scott reported on the findings of the Los Angeles studies in 1957, concluding that a direct correlation had been found between Los Angeles automotive traffic and photochemical smog.

Scott left the Institute in 1958 and founded his own research laboratory—William E. Scott & Associates—near Dublin, PA. His first major research project was a three-year comprehensive study, sponsored by the National Institutes of Health, to investigate the composition of diesel exhaust. In addition to gas phase analyses, this program included reflux extraction and liquid chromatography procedures on particulate matter to separate and then identify known carcinogens by fluorescence spectroscopy.

In 1960, the company became incorporated as Scott Research Laboratories. This laboratory performed most of the automotive exhaust emission studies that led to the Automotive Emission Standards later adopted as law by the state of California and eventually by the nation. National recognition for Scott's pioneering research came in 1967 when he was invited to the White House to witness President Lyndon Johnson's signing of the Clean Air Act.

Between 1958 and 1974, Scott's firm continued to work intensively on air pollution-related research. By 1974, Scott had sold his company and, with Jack Marrin, founded Scott-Marrin, Inc. in Riverside, CA. This company was formed to address the next generation of calibration gas standards, and in a short amount of time, some of the calibration standards it produced were adopted by the National Bureau of Standards.

Scott retired from Scott-Marrin in 1983. His interests in Asian literature and philosophy, many genres of music, and Native American culture helped sustain his leisure time. Other professional society memberships included the American Association for the Advancement of Science and the American Chemical Society.

He is survived by his wife, three children, five grandchildren, and six great-grandchildren.