



## **William L. Burke, 1941–1996**

**Obituary by Astronomy Professor John  
Faulkner**

**“William L. Burke, Astronomy &  
Astrophysics; Physics: Santa Cruz**

**1941-1996**

William Lionel Burke—Bill to students, friends and colleagues alike—died tragically young at the age of 55 on July 22, 1996, following an automobile accident while on vacation. With his death we lost a uniquely gifted individual of great intellectual breadth and diverse interests, who always marched to the beat of his own drum.

Bill Burke was born in Bennington, Vermont, on July 5, 1941. His New England upbringing made him a person of rugged independence, practical self-sufficiency, and elegantly terse expression. He grew up with a deep love of books, nature, and craftsmanship in all things, and with exceptional talents in physics and mathematics. A National Merit scholar, Bill went to Caltech, obtaining his physics B.S. there in 1963. In 1969 he was awarded his Ph.D. for an influential thesis, “The Coupling of Gravitational Radiation to Nonrelativistic Sources.”

When he was invited to give a talk in early 1969 at the fledgling UCSC campus, his mastery and interdisciplinary breadth were immediately recognized. He served as a lecturer for two years, and then in 1971 was appointed an assistant professor—his position “temporarily” split for financial expediency between two boards of studies. The cobbling together of resources was then the rule at Santa Cruz, though normally just two agencies were involved: a board in one's discipline and a college. In Bill's case however, he was expected to serve three masters from the start (two boards and one college), and what had initially been a creatively produced opportunity became something of a millstone as each entity expected to receive a major

share of his service. Unfortunately, all efforts over the years to resolve the problem of split disciplinary obligations on his behalf were unsuccessful.

A man of his frankness could be guaranteed to speak plain truths in which some would find offense. That and a certain disdain for the usual accouterments of academic success led to undeservedly slow progress up the academic ladder, which probably pained his champions and supporters (externally legion) more than it did him. He was awarded tenure in 1976 and promoted to professor in 1988.

The breadth *and* depth of Bill's knowledge, which invariably impressed themselves upon those who met him, were already evident at Caltech. There, he moved easily among physicists, applied mathematicians, and later, biologists. His intimates, with all of whom he became lifelong friends, included Charles Bures (philosophy and history of science), Bud Cowan (cosmic ray physics), Paco Lagerstrom (applied mathematics, fluid physics) and Max Delbruck (biology). A most important influence was JPL's relativist Frank Estabrook. Caltech had had a great reputation in general relativity, with R. C. Tolman and H. P. Robertson among its staff. After Robertson's own untimely death, and prior to the rising star Kip Thorne's return from Princeton, Estabrook taught graduate relativity and cosmology from 1962 to 1965. Bill was outstanding in that course as a junior in 1962-63; two years later he acted as a graduate teaching assistant in the course. Bill acquired his slant towards differential forms and applied differential geometry from Estabrook, inheriting the latter's indebtedness to J. L. Synge and his own former teacher Tolman. Bill also prized the elegant experimental--mostly optical--techniques he encountered working in Cowan's laboratory, and had a critical influence on parts of the latter's book (*Basic Electromagnetism*) dealing with radiation reaction. He learned the techniques of matched asymptotic expansions, then largely unknown to physicists, from Paco Lagerstrom.

These rare and happy conjunctions of diverse experience clearly laid the groundwork for Bill's thesis with Kip Thorne, a remarkably innovative study of gravitational radiation reaction in general relativity. When Bill began, the whole subject was in a state of confusion. The most widely used simple formula for energy losses then available in the literature (Landau & Lifshitz) was in fact correct as far as it went. Nevertheless, several prominent authors calculating radiation "losses" in detail for explicit systems had obtained results that were all over the place: gravitational waves took energy out of, did nothing to, or fed energy into, the same gravitating system. The difficulty inherent in this work may be gauged from the little known fact that Einstein himself made several separate errors (one of fundamental principle for which he later berated himself) in his papers on the topic. Burke showed that much of the confusion could be traced to failures to appreciate the subtleties of the "matching" required in this complex problem between near and intermediate wave zones, and between intermediate and far zones. (The situation is not unlike stirring the surface of a pond with two sticks. Close in, the disturbances simply follow each stick. Yet at great distances, we know we find outgoing circular waves. The question is: precisely how do the outgoing waves relate to the initial stirring? In the astronomical case, binary stellar motion can provide the stirring--if of spacetime itself! How do distant spacetime waves couple to that motion?)

Bill himself would mainly emphasize these aspects of his graduate work. Yet, at a moving memorial lecture delivered on November 14, 1996, Thorne stated that although Bill was responsible for introducing these fruitful techniques into gravitational physics, his most important contribution was something else. At a time when Thorne feared Bill was "floundering," Bill had a novel idea that completely took Thorne by surprise. Almost by intuition he discovered an extremely small time-varying part of the local gravitational potential (and thus force-field), with a spatial form normally thrown away in the static case, and effectively missed by both Newton and Einstein. This reactive Burke Potential, its consequences traced through its linkage to the distant waves, slowly drains energy and angular momentum from orbiting systems that Newton would have thought eternal. It is ironic that this revolutionary gravitational thinker will be remembered for putting reaction on a sound footing.

I now revert to more personal memories. I knew Bill Burke by sight—he stood out, an image of health, from his Caltech contemporaries—when I was a postdoctoral fellow there in the mid 1960s. I even sat next to him occasionally in a Feynman course. It was therefore a pleasant surprise to arrive at Lick in 1969 and find Bill entering the adjacent office, which he would occupy for the next twenty years. My intellectual interactions with Bill were to prove among the most important and sustained that I had, right up to his departure on the last fateful trip. As Peter Scott has said, “Conversations with Bill were always 'yeasty.’”

Bill Burke was a man of extraordinary physical agility and grace. On an all-day hike in the undeveloped Nisene Marks State Forest with Joe Wampler and myself, he literally danced on redwood logs over swollen streams. At UCSC, he startled colleagues on a walk to lunch one day by giving a half-kick that took him up onto the railing bordering a bridge over one of the campus's many canyons—where he proceeded, fully engaged in the conversation until he jumped down again at the end of the bridge—all of this accomplished nonchalantly without removing his hands from the pockets of his jeans. Avid road cyclist, badminton and squash player, rock-climber, hiker, and cross-country skier, he took up other sports as he, and they, evolved: white-water rafting, windsurfing, mountain-biking; tai chi and other aspects of Asian culture also became a valued part of his life.

Bill was so multi-faceted that it is hard to limit what one recalls. Estabrook wrote, “He was a passionate craftsman in so many fields.” A superb photographer, he hiked into remote areas of Yosemite and the high Sierras with a variety of equipment, creating 360 degree panoramas and large format views that compared favorably with the best professional work. He came close to the world record for stacking playing cards—and a composite photograph showing him casually standing among one of those stacks proved it. His woodworking was astonishing—visitors marveled at a table with seamless joints and exquisite use of orthogonal grains. He helped Lick's wine-making Joe Miller shave and reconstitute a barrel for further use. Skilled coopers expect such barrels to leak for up to 24 hours as the wood re-swells; Bill's stopped leaking before two hours had elapsed.

In the mid-1970s I was privileged to play a minor catalytic role by introducing Bill to an old friend, E.A. (“Turbulent Eddy”) Spiegel at a (Boston) Texas symposium on relativistic astrophysics. The conversation they then had, far into the night, led to Bill making a suggestion to an excellent (but “floundering?”) graduate student (a pattern emerges!) which in turn marked the origins of “The Santa Cruz chaos cabal.” Rob Shaw was to receive a prize from the hands of Rene Thom for the work that flowed from that suggestion and go on to become a MacArthur fellow. When the work began, some thought that it should be tossed out of the department as “not physics.” After it became well-known, others attempted to take credit for first fostering it. But through it all, the brilliant group of students who gathered around Shaw referred to Bill Burke as “the father of the chaos cabal.” Aspects of this fascinating period are described in *Chaos* (Gleick) and *The Eudaemonic Pile* (Bass).

While Burke could handle problems of considerable technical complexity, he also had the happy knack of breaking them down into solvable steps, and of gaining enormous insight from studying extremely simple systems. He passed this philosophy of “limbering up exercises” on to his students. The tethered wheelbarrow on an inclined plane (where the “tether” might be a rod) provided students with a rich example of bifurcation; his “miniature ox-cart” (so named after a problem I invented for the ingenious device he made) traced out geodesics in a local manner whose implications have yet to be fully appreciated by most physicists. Many graduate students found Bill's teaching inspiring; others thought him challenging but ultimately rewarding. Undergraduates, particularly if underprepared, could find themselves in culture shock: “You mean previously certified understanding is for later *use*?!” But Jill Nephew, a recent student, wrote, “As I am sure most of you know, the most ‘difficult’ teachers are often the ones who seem to care the most and give the most. I saw in Bill a tremendous love of nurturing and encouraging the pure pursuit of physics. He tried to recognize a passion, a love, a relentless curiosity, a talent or any combination of these things in a

new student of physics and help the student honor and act on these feelings, maybe when nobody else in the student's life did. He never settled for less in a student. . . ."; or in himself, one might add.

Though a brilliant conversationalist, Bill loved brevity--doubtless he is shaking his head sadly somewhere over this memorial. He was understandably proud of one rare achievement--being asked to *lengthen an Astrophysical Journal Letter*. Not only that, but as he also pointed out, "Even when doubled it still occupied only one page!" Another paper, "The Not-So-Short Beer," corrected an erroneous treatment of refraction in a study of the deliberately misleading American beer glass (a permitted bar practice that simply astonishes Europeans).

He employed aphoristic turns of phrase with wry humor to fix memory and aid understanding. Describing the succession of elementary operations needed to emerge from a constrained parking spot he wrote: "STEER and DRIVE, do not commute; otherwise you could do all your steering at home before driving off on a trip." His last book review, published posthumously, of a work on real-world computing by Acton, an author he much admired, ended thus: "And remember: friends don't let friends subtract."

For much of his career Bill despised the brute force of computers: "A computer is SO INFERIOR to a pencil so much of the time." But once effective visualizable tools became available, he used them with an expertise that astonished the Lick professional computer staff. His spirit lives on in his homepage at <http://www.ucolick.org/~burke/home.html>. One memorable introduction (given here in its entirety) ends with a modification of something said to him as he went off to teach his graduate applied differential geometry course: "Differential forms are taking over the world. I don't use vectors, Fortran, or Roman numerals, all for the same reasons. Here are some resources useful for those trying to form their unformed minds."

The unexamined life is not worth living--and Burke continually examined his life, thoughts, and inputs. Throughout his career, in a series of leather-bound notebooks numbered I-XII (he *could* be inconsistent!), he wrote down his ideas, responses to colloquia, and interactions with colleagues, and generally analyzed his own scientific life and thought processes. Mining this rich vein could provide intriguing insights into the private thinking of a late twentieth-century scientist. He also maintained a separate set of notebooks on his voracious reading. Every book he read, at the rate of more than a hundred a year, is recorded; his notes on them range from one word dismissals to pages of commentary, quotation, and comparison with others. Bill enjoyed geometry and geometrical thinking, whether it involved professional activities, his myriad wooden puzzles, or the games of *Go* he played with all comers in downtown cafes. He would appear at my office door with an anticipatory grin, saying "I've got this geometrical thing I needed to prove. I've done it, but I'm not satisfied with my approach. Now, how would the BS (British schoolboy) handle it?" In his last year, after an internal move had put our offices far apart, he appeared once more one Friday, asking an intriguing question about a novel first-order approach to one of Newton's most celebrated results--the attraction of spherical shells. Stimulated by his query, I was able to sketch the general finite answer to his "infinitesimal question" on Monday morning. His reaction: "It's so geometrically beautiful, it has to be right!" We agreed we would write it up together, although he confessed to a sneaking desire that I would do it alone (as fate has now decreed): "When there are so many fulsome acknowledgments in the literature, I'd just love to be thanked for an infinitesimal contribution!"

In 1980 Bill published his first book, *Spacetime, Geometry, Cosmology* (University Science). His admiring readers found a unique "clock-structure" approach to relativity and elegantly clear and essential line drawings in its pages. A Russian translation, complete with a rare royalty agreement, appeared in 1985; it became a much used text. That same year came *Applied Differential Geometry* (Cambridge University Press), a masterpiece of content, exposition, and style. As the '80s approached, Bill had found the narrow confines of the traditional "one small step" scientific paper too limiting; he concentrated increasingly on extended works, and wrote his last paper per se in 1987. He was to suffer for this preference of style; "The

book” is dismissed and almost despised in science, however widespread its readership. At the time of his death he had almost finished a novel “interactive computer text and graphics book” that he planned to “publish” on the Internet. Ironically, its title is “Div, Grad, Curl are Dead.” He had plans for more in an anticipated retirement.

Bill's early marriage to his wife Pat was dissolved in the early `80s. But on the last Sunday in July, she, many old friends from their fabled pumpkin pie parties, and far more recent intimates and colleagues came together in a remarkable memorial service organized by his surviving domestic partner of the last decade, Violet John. High above the Pacific, on the Stevenson Knoll from where, on clear nights, the Moon can be seen in ten thousand reflections, Bill's friends met to mourn the passing, yet celebrate the life, of one who himself shone with so many facets. Each one of them, reflecting on the person they heard eulogized in such different ways, could themselves think: “William, we hardly knew ye”--yet be thankful for the Bill they'd known.

John Faulkner

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