



William Pendry Bidelman (1918–2011)*

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Received 2016 September 21; accepted 2016 September 30; published 2016 November 29

Abstract

William P. Bidelman—Editor of these *Publications* from 1956 to 1961—passed away on 2011 May 3, at the age of 92. He was one of the last of the masters of visual stellar spectral classification and the identification of peculiar stars. I review his contributions to these subjects, including the discoveries of barium stars, hydrogen-deficient stars, high-galactic-latitude supergiants, stars with anomalous carbon content, and exotic chemical abundances in peculiar A and B stars. Bidelman was legendary for his encyclopedic knowledge of the stellar literature. He had a profound and inspirational influence on many colleagues and students. Some of the bizarre stellar phenomena he discovered remain unexplained to the present day.

Key words: obituaries

Online material: color figure

William Pendry Bidelman—famous among his astronomical colleagues and students for his encyclopedic knowledge of stellar spectra and their peculiarities—passed away at the age of 92 on 2011 May 3, in Murfreesboro, Tennessee. He was Editor of these *Publications* from 1956 to 1961. Bidelman was born in Los Angeles on 1918 September 25, but when the family fell onto hard financial times, his mother moved with him to Grand Forks, North Dakota in 1922. There he was raised by his grandparents.¹ At age 10, he became smitten with classmate Verna P. Shirk, later to become his wife of 69 years. Bidelman developed an interest in astronomy at an early age; he reminisced many decades later that as a child he had written to Alfred H. Joy at the Mount Wilson Observatory to ask how he could become an astronomer, and had received an encouraging reply.

He attended Harvard College, graduating in the Class of 1940 (with classmate John F. Kennedy). The day before graduation, he and Verna were married in the Harvard Chapel (Figure 1). Bidelman then enrolled in graduate school at the Yerkes Observatory, University of Chicago. There he was trained in stellar spectroscopy by giants of the subject, including O. Struve, P. C. Keenan, and his thesis advisor, W. W. Morgan. His Ph.D. dissertation, a spectroscopic study of the Double Cluster in Perseus, appeared in *The Astrophysical Journal* (Bidelman 1943). During the war years, he served as a physicist at the U.S. Army’s Ballistic Research Laboratory at the Aberdeen Proving Ground in Maryland. He returned to Yerkes after World War II as an assistant professor (Figure 2). Later in his career, Bidelman taught and conducted research at the University of California’s Lick Observatory, the University of Michigan, the University of Texas, and lastly at Case Western Reserve University.

One of his first post-war papers (Morgan & Bidelman 1946), which pointed out that the A-type stars in the North Polar Sequence have very small interstellar reddening, attracted little attention then, or in subsequent years. Yet many years later, Morgan (1978) recalled that this had been “the principal paper along the way toward the *UBV* system.” In view of the seminal importance of *UBV* photometry in the ensuing decades, this short paper has a remarkably high ratio of scientific impact to number of citations.

Universally known as “Billy,” Bidelman was one of the last of the great masters of stellar spectral classification and the recognition of spectroscopic anomalies. Younger astronomers of today may be only dimly aware of the situation 60 or 75 years ago, when stellar spectra presented a bewildering array of poorly understood and sometimes outright bizarre phenomena, often with little or no physical explanation. The morphological approach to spectral classification, into which pioneers like A. Maury, A. J. Cannon, C. Payne, H. N. Russell, and Morgan had such insight, was the key to progress. First a network of “normal” stars has to be established. Only then can those unusual objects that depart from this pattern of normality—those that most ruthlessly expose our ignorance of stellar astrophysics—be recognized and studied.

* Material for this article was contributed by several family members, colleagues, and former students, including: Billie Bidelman Little, Joseph Little, James Caplinger, D. Jack MacConnell, Wayne Osborn, George W. Preston, Nancy G. Roman, and Nolan Walborn. Any opinions stated are those of the author.

¹ Bidelman’s maternal grandfather was Joseph Bell DeRemer, a noted architect who designed a number of important buildings in North Dakota, including the state capitol. Although his father had an identical name, Bidelman did not append a “Jr.” to his own name after his college days. His mother was a pianist who traveled with dancer Martha Graham and the Denishawn troupe, described at the time as America’s leading dance company.



Figure 1. William P. Bidelman and Verna S. Bidelman in 1940 June, shortly after their marriage. *Photo courtesy Joseph Little.*

An early example of this approach is Billy’s discovery, along with his colleague Keenan, of the class of “barium” stars (Bidelman & Keenan 1951). These are red giants that do not fit into the sequence of stars with normal spectra. They exhibit a strong absorption line of Ba II 4554 Å, along with stronger features of Sr II, CH, CN, and the C₂ molecule than in spectra of normal red giants. At the time, it was an utter mystery why the chemical element barium would have an apparently enhanced abundance in certain rare stars, and what this might have to do with a high content of strontium and carbon. The developing science of nuclear astrophysics provided a partial explanation later in the 1950s, in terms of the “s-process” of neutron-capture reactions, occurring in the interiors of highly evolved stars, which synthesizes heavy elements like Sr and Ba. But it was already known to Bidelman and Keenan that barium stars are relatively normal giants, not the highly evolved luminous ones that the theorists said were required. It took the eventual discovery that essentially all barium stars are spectroscopic binaries with relatively long orbital periods (e.g., McClure 1984) to provide the modern explanation. A barium star is the companion of a primary component that did become a highly evolved, s-process-enhanced object, whose stellar wind transferred this altered material to the surface of the barium star. The former primary is now an optically invisible white dwarf.

In the same year, Billy published another important paper (Bidelman 1951), pointing out the existence of stars of spectral types A and F at high Galactic latitudes (such as 89 Herculis and HD 161796) whose spectra closely resemble those of massive, high-luminosity supergiants. Luminous supergiants are normally found only in the Galactic plane. This anomaly eventually led to the recognition that high-latitude “supergiants” are actually lower-mass and less luminous stars evolving off of the asymptotic giant branch (post-AGB stars). In the same paper, Bidelman pointed out the remarkable spectrum of HR 885, a red giant displaying very weak features of CH and CN. To my knowledge, a completely convincing explanation of the rare carbon-deficient giants like HR 885 does not yet exist (e.g., Palacios et al. 2016).

As a staff member at Yerkes, Bidelman spent long spectroscopic observing runs at McDonald Observatory in west Texas—a location even more isolated then than it is now. One result of these studies was his recognition (Bidelman 1952, 1953) that there are stars across a wide range of spectral types that are spectacularly deficient in hydrogen. In the spectrum of the O-type star HD 160641, Billy’s low-dispersion spectrograms showed no trace of the Balmer lines, but there were strong features of helium and of doubly ionized carbon and nitrogen. Bidelman’s star is now classified as an “extreme helium star”—one of the hottest ones known,



Figure 2. The staff of Yerkes Observatory in 1946 May, one the most astonishing groups of major astronomers of the mid-20th century ever photographed in one place. Bidelman is fifth from the left in the third row. In the row in front of him can be seen Swings, Herzberg, Morgan, Struve, Greenstein, Kuiper, Chandrasekhar, and Van Biesbroeck, among other titans. The front row includes Underhill, Münch, and Roman. In the back row are Slettebak, Deutsch, Wrubel, Code, Blanco, and others. *University of Chicago Photographic Archive, apf6-00492, Special Collections Research Center, University of Chicago Library.*

according to Wright et al. (2006). Current explanations (e.g., Saio & Jeffery 2002) of such stars involve either a post-AGB star that has lost its entire hydrogen envelope, probably during a late helium core flash; or that they have an origin in mergers of binaries containing a helium white dwarf and a carbon-oxygen white dwarf. (It is worth noting that the preceding sentence would have been almost entirely incomprehensible in 1953—such is the progress of astrophysical theory, building as it does on observational challenges.)

Bidelman’s familiarity with the literature of stellar spectroscopy was legendary. Nancy Roman remembers that “Billy’s fantastic memory played a role in my career.” She had found remarkable variations in the spectrum of the star now known as AG Draconis, and mentioned them to Bidelman. He remembered what the spectrum looked like when he had observed it some years earlier, which made it possible for the changes to be described in some detail (Roman 1953). It was this contribution, she recalls, that brought her to the attention of scientists at the Naval Research Laboratory, who later became the core of the scientific staff at NASA. Subsequently they asked Nancy to set up a program in space astronomy. As has been told elsewhere,² Nancy Roman became a key leader in NASA astrophysics, up to and including the spectacular success of the *Hubble Space Telescope*.

I myself recall, during a discussion of a particular high-velocity star that we had in the department library at Michigan, that he went right to the shelf full of ApJ’s, pulled down a volume, and opened it to the very page that gave the information that we needed on that star—no need to waste time searching for that paper in the five-year index! On another occasion, I had come across an M supergiant with strong [Fe II] emission and other peculiarities while visually scanning an objective-prism plate. After some effort in the library, I was able to identify the object with a known variable star, WY Velorum. I then proudly took the plate to Billy for his reaction to my great discovery, without mentioning that I already knew its identity. His reaction: “This is amazing! Congratulations! I only know of one other star in the sky with a spectrum like this—WY Velorum!”

The story told among the graduate students in those days was that, if you were asked on your preliminary examination how you would go about determining the spectral type of a given star, the correct answer was “write down its HD number, and go ask Bidelman.” His deep knowledge of the literature was on display in two review articles, “On the Carbon and S-Type Stars” (Bidelman 1954a) and “The Carbon Stars—An Astrophysical Enigma” (Bidelman 1956). Some of the enigmas he described six decades ago remain unsolved—for example, the still-unexplained origin of the R-type carbon stars (e.g., Domínguez et al. 2010). Speaking many years later of the first of these articles, Robert Wing (2000) remarked “Papers that have great impact on individuals

² e.g., <https://www.astrosociety.org/wp-content/uploads/2013/07/ab2013-112.pdf>



Figure 3. Bidelman at his home on Mount Hamilton in 1953 April, shortly after his arrival at Lick Observatory, with his daughters. Left to right: Linda, Barbara, Lana, and Billie Jean. *Photo courtesy Billie Bidelman Little.*



Figure 4. A more formal photograph, showing Bidelman examining a spectrogram at Lick. *Photo courtesy Joseph Little.*

are not always the well-known classics. ...I have seldom seen citations to that paper, but its effect on me was profound when I stumbled across it as a graduate student in 1964. ...That paper influenced the direction of my dissertation, and consequently of my entire career.”

For many decades, Bidelman maintained a card catalog of information on individual stars, with the information and literature references entered on 3×5 inch index cards. An early result was his “Catalog and Bibliography of Emission-Line Stars of Types Later than B” (Bidelman 1954b), containing information on nearly 1200 stars and 903 literature references—and published in volume 1 of *The Astrophysical Journal Supplement Series*. Six decades later, this compilation still contains useful information, even in these days of online catalogs. Billy would always respond to requests for data from his card catalog, but it was felt desirable to make this wealth of information more widely available. During the 1970s, the contents of over 60,000 index cards from Bidelman’s collection were converted to machine-readable data by manually keypunching (Parsons et al. 1980). These data are now part of the online data available to all astronomers at the Strasbourg VizieR site.³

³ <http://vizier.u-strasbg.fr/viz-bin/VizieR?source=VI/32>

Bidelman moved to Lick Observatory in 1953, accompanied by Verna and their four daughters (Figures 3 and 4). They were assigned a large rambling house (as described by his daughter Billie Jean) on Mount Hamilton—from which the Bay Bridge could be seen from the living-room windows. The girls had the run of the mountain, where they attended a one-room school, with about a dozen other children of all ages. One spring, when Billie was about six, she ran home with a bouquet of 20 wild yellow-orange California poppies picked from around the 120 inch dome. Her father informed her that she owed the government \$1,000, as the fine for picking the state flower was \$50 apiece. The Bidelmans threw a New Year’s Eve party every year—from which fortunately everyone could walk home when the party finally broke up. Many visiting astronomers were entertained in the Bidelman household, sometimes at the last minute—to the consternation of Verna, since the nearest grocery store was an hour’s drive away.

George Preston recalls that, at the end of his first year of graduate school, he spent the summer in residence at Lick. One night at the 36 inch refractor, Preston accompanied Billy to the darkroom to develop spectrograms, where he “witnessed an extraordinary event that must have affected my career.” On examining a plate fresh out of the hypo, Bidelman remarked that the star was a high-velocity giant. Preston was astonished—how could someone know a star had a high velocity when there wasn’t even a comparison spectrum on the plate? “Of course Billy was making the connection between weak lines and high velocity, of which I was unaware in 1955.” A subsequent higher-dispersion spectrogram of the metal-poor star in question—the now well-known HDE 232078—revealed that it indeed has a very high radial velocity of about -390 km s^{-1} (Preston & Bidelman 1956). Preston says that this experience aroused his interest in the newly recognized halo population of the Milky Way and stimulated a number of his subsequent investigations.⁴

Beginning around 1960, at about the time the coudé spectrograph came into operation at the Lick 120 inch, Bidelman was the leading discoverer of extraordinary abundances of exotic chemical elements in the photospheres of peculiar A and B stars. One of the first was the bizarre spectrum of 3 Centauri A (Bidelman 1960a), exhibiting strong absorption lines of ionized phosphorus. Billy made this finding in the course of a systematic inspection of photographic spectra accumulated over many decades at the Lick Observatory and its Chile Station. The first spectroscopic plate of 3 Cen A had been obtained around 1910; but recognition of its peculiarities had to await an astronomer with a broad enough knowledge of stellar spectra to identify its striking departure from normal. More discoveries of freakish chemical abundances in Ap stars followed quickly. Strong lines of Ga II were found in 3 Cen A and κ Cancri (Bidelman 1960b), the first time gallium had been seen in stellar spectra, although it took precise new laboratory wavelength measurements at the National Bureau of Standards to verify this identification (Bidelman & Corliss 1962). Both stars also show abnormally strong lines of Mn II. Another bizarre magnetic Ap star, HR 465, was found on a Lick spectrogram to exhibit extraordinarily strong features of heavy elements such as molybdenum, niobium, and neodymium (Bidelman 1962). Lawrence Aller told me that, in those days, colleagues would ask each other after every monthly bright-of-the-moon spectroscopic time “What has Bidelman discovered now?”

Many of his discoveries never appeared in the archival literature, but were presented at meetings or communicated privately to colleagues with access to large telescopes with coudé spectrographs. Among the most baffling findings that resulted were the outlandishly high abundances of ^3He , krypton, and xenon in 3 Cen A (e.g., Jugaku et al. 1961; Sargent & Jugaku 1961). A short conference presentation (Bidelman 1966a) gave some results from his line identifications in high-dispersion Lick spectrograms of Ap stars, including anomalously high abundances of selenium, palladium, praseodymium, and perhaps most astonishingly, mercury. The effect is not subtle: the abundance of Hg can be 400,000 times the solar value. More amazingly, the mixture of isotopes of mercury (which can be determined from the isotopic hyperfine splitting of the Hg II 3984 Å line, using very high-dispersion spectrograms of very slowly rotating stars) varies from star to star (e.g., White et al. 1976). In unpublished work cited by Fuhrmann (1989), Bidelman had identified osmium, platinum, gold, and bismuth, among other extremely heavy elements, in the spectrum of HR 465—a magnetic Ap star with a rotation period longer than two decades.

These stunning chemical abundances were, to astronomers of the mid-1960s, a profound astrophysical mystery comparable to the present-day problem of dark energy. The anomalies seemed to expose a woeful ignorance of the origin of a basic stellar phenomenon. The first international conference on peculiar A stars, held at the Goddard Space Flight Center in 1965, attracted the leading stellar astronomers of that era. Billy was invited to give the introductory overview (Bidelman 1967). He led off with remarks that illustrate his sardonic sense of humor (along with his knowledge of classical music) so nicely that I quote them here:

“After all, in some ways, an introduction is a little bit like an overture to an opera. For instance, the overture isn’t expected to be taken very seriously, because people are just supposed to be sliding—mentally or physically—into

⁴ As a young graduate student myself, I and several others accompanied Bidelman—an inveterate punster—to a night of observing at Michigan’s Schmidt telescope. In the darkroom, Billy poured out the developer, and then asked “Where’s Arthur?” We students looked at each other. None of us were named Arthur. Then Billy said, “Ah, here’s our thermometer.”

their seats. Furthermore, all the overture does is to give you bits and snatches of the tunes that are to be played, with ample elaboration, later on during the opera.

“At first I felt that this meant that I really shouldn’t say very much. Then it occurred to me, following the analogy a bit further, that it often happens that the overture is the only part of the opera that survives.”

As Miroslav Plavec (1976) later remarked, Bidelman’s “introduction then was really a masterpiece which can be studied independently and with great profit.”

Theoreticians of the day struggled to explain these “chemically peculiar” stars. A widely cited paper (Fowler et al. 1965) proposed a complex scenario that placed the Ap stars in an advanced evolutionary stage (or else they were contaminated companions of such stars) in which an r -process of nucleosynthesis and surface spallation were invoked. Unfortunately, it was known even then that Ap stars are most likely on or near the main sequence; that they do not have a high incidence of binaries; and that they exhibit no evidence for surface flaring activity. Nucleosynthetic scenarios mostly fell by the wayside when Michaud (1970) argued that diffusive processes are primarily responsible for the peculiar abundances in Ap stars. In a very stable atmosphere, especially if the stability is enhanced by a strong magnetic field—as observed in many Ap stars—a mixture of gravitational settling and radiative levitation can lead to very large under- and overabundances of individual species in the stellar photospheres. This explanation is now widely accepted, and peculiar A stars receive much less attention than they did 50 years ago. However, it remains unclear whether diffusive processes can account for all of their oddities, such as the wide range in isotopic abundances of mercury (see Woolf & Lambert 1999). Billy himself, in his final words on the subject (Bidelman 2002, 2005), had come to believe that the Ap stars had a special origin after all (perhaps merged binaries). He had a strong suspicion of the presence of radioactively unstable elements with very short half-lives in the atmospheres of objects like HD 101065, the infamous Przybylski’s Star (Cowley et al. 2004). If so, these elements must have been created very recently.

Bidelman moved east to join the University of Michigan astronomy faculty in 1962. A 24/36 inch Schmidt telescope, named in honor of Michigan astronomer H. D. Curtis, had been installed at a relatively dark site northwest of Ann Arbor in 1950. The Curtis Schmidt was equipped with a pair of prisms ($4^\circ + 6^\circ$), providing a nearly uniquely high dispersion ($108 \text{ \AA mm}^{-1}$ at $H\gamma$) for objective-prism spectroscopic surveys (Miller 1953). In good seeing, the spectral resolution at $H\delta$ is about $2 \text{ \AA}$, similar to that used for MK classification. However, apart from a study of CN strengths in red giants by Yoss (1961), based on a collection of several hundred objective-prism plates in four declination zones, this powerful capability had remained largely unexploited at the time of Billy’s arrival at Michigan. Using the plate archive, he showed (Bidelman 1966b) that accurate spectral classification was possible using such material, along with the recognition of peculiar A and B stars, and metal-deficient late-type stars. At his direction, several Michigan students used archival and newly obtained Curtis Schmidt plates in their dissertation work (e.g., Bond 1970; Schmitt 1971). But, thinking on a grander scale, Billy began to advocate a new all-sky objective-prism survey that would reclassify all of the stars of the *Henry Draper Catalog* onto the MK system.

To facilitate this goal, Bidelman was instrumental in arranging for the Curtis Schmidt to be relocated in 1967 to Cerro Tololo Inter-American Observatory, and a systematic survey of the entire southern sky with the 10° prism combination was begun. The monumental task of actual visual classification of the spectra was taken up by Nancy Houk. The first catalog of two-dimensional MK spectral types for the HD stars south of -53° appeared in 1975 (Houk & Cowley 1975). The southern-hemisphere survey was eventually completed to $\delta = +5^\circ$ (Houk & Swift 1999), with a total of more than 160,000 MK classifications—the largest number, by far, ever carried out by one person.⁵

As the objective-prism plates arrived in Ann Arbor, they were searched for interesting objects by Bidelman, Jack MacConnell, and several graduate assistants, including myself (see Bidelman & MacConnell 1968; Bidelman et al. 1973). Discoveries of many hundreds of peculiar stars of various types in this “early-result” program were published by Bidelman & MacConnell (1973). Later nearly 150 new luminous O stars and later-type supergiants were discovered in this material by MacConnell & Bidelman (1976), and over 175 additional peculiar stars (Bidelman 1981; Bidelman & MacConnell 1982).

In 1969, Bidelman took a faculty position at the University of Texas, and then in 1970 became the Director of the Warner and Swasey Observatory at Case Western Reserve University, where he spent the rest of his career. Warner and Swasey’s Burrell Schmidt telescope is a twin of the Curtis Schmidt. In 1979, the Burrell Schmidt was relocated to Kitt Peak National Observatory, and the telescope was equipped with a new (single) 10° objective prism for the purpose of extending the southern objective-prism survey to the other half of the sky (Houk & Bidelman 1979). The survey of the northern hemisphere began in 1981, and the observations were completed in 1992. Bidelman began a program of an initial reconnaissance of the plates for early results. He identified over 400

⁵ Many of the Curtis Schmidt southern-hemisphere survey plates are now archived at the Pisgah Astronomical Research Institute (Osborn & Robbins 2009). Appallingly, most of the plates obtained in Michigan before 1967 were discarded (W. Osborn 2016, private communication).

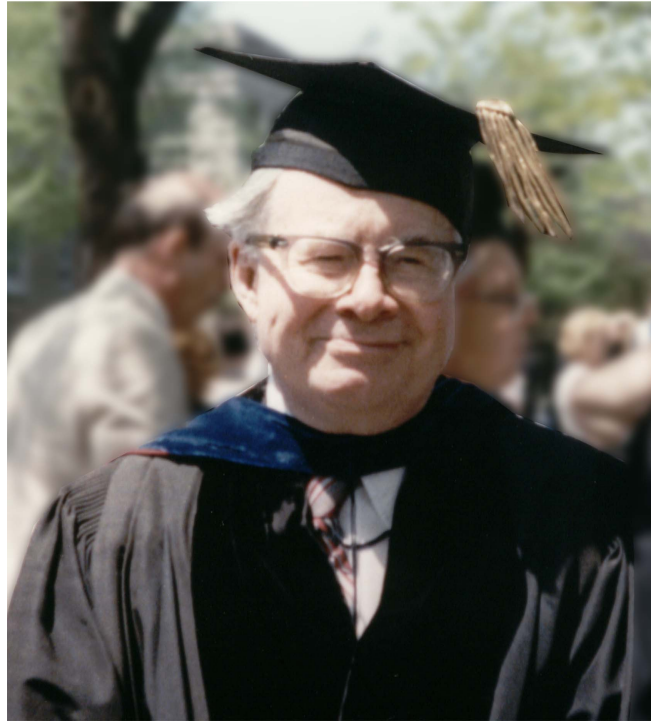


Figure 5. Emeritus Professor Bidelman at a Case Western Reserve graduation ceremony in 1988 May, wearing the quizzical expression that many colleagues and students remember. Photo courtesy James Caplinger.

(A color version of this figure is available in the online journal.)

new peculiar stars (Bidelman 1983, 1985, 1998), but on only a relatively small subset of the plate collection. Unfortunately, to my knowledge, the remainder of the northern plates has not been scanned for peculiar stars—let alone all of the stars given MK classifications. As Billy remarked in his 1998 paper, “...these plates contain high-quality spectral information on a very large number of faint stars ...that should be made available to the astronomical community. It is to be hoped that plans will be forthcoming from some quarter for the further utilization of this magnificent observational material.” The northern-hemisphere plates are now located at Lowell Observatory (B. Skiff 2016, private communication), but I am not aware of a plan to extract their hidden treasures, which must be numerous. As Carl Sagan said, “Somewhere, something incredible is waiting to be known.”

Bidelman formally retired from CWRU in 1985, but continued to come to his office at the department for many years thereafter (Figure 5). He became interested in applying astronomical evidence to Biblical events; this included the “Star of Bethlehem,” which he argued was actually a pair of close conjunctions of Venus and Jupiter (Bidelman 1991). His last publication came in 2009, at the age of 91, and 67 years after his first paper in the *Astrophysical Journal*. With declining health, he moved to Tennessee to be near his daughter Billie, and he passed away there on 2011 May 3. He had been preceded in death by his wife Verna and daughter Lana, and is survived by three daughters, eight grandchildren, and nine great-grandchildren.

Billy had many interests during his long life—philately, music (he played the piano well), square-dancing, baseball, plays, movies—but mostly he was a lover and collector of the stars and their oddities. More than once, after a conference in his office, I was on the way back up to the floor where the grad students lived, but he would call me back to take a look at just one more spectrogram. When I showed him an interesting new object on an objective-prism plate, he would glance at it but then like a connoisseur he would browse through the other spectra, and say “Yes, but what’s this one over here?” He was a master of the morphological approach to science, content to leave detailed astrophysical explanations to others. At a conference, he once said “I don’t particularly like being referred to as an astrophysicist. I hope that I’m an astronomer!”

This style of astronomy now recedes into the past. Spectrograms are obtained with electronic devices and can be made available to everyone in archives, rather than remaining in analog form on photographic plates in private collections. Journal papers can be found instantaneously without leaving one’s chair. Massive amounts of information about the stars are stored in machines, rather than in the brains of astronomers like Bidelman who had mastered the literature. As I write this, the rueful words of Hamlet, musing on the

passing of his revered father, come to mind: “I shall not look upon his like again.”

Billy cherished his friendships and collaborations with astronomers from around the world. He lived in an era of face-to-face conversations and hand-written or typewritten letters, long before the invention of electronic mail or smartphones or online preprints. I want to close by recalling some after-dinner remarks at a conference on the H-R diagram in Washington, DC, in which Bidelman (1977) reminisced about his long career and friendships:

“I recall with great pleasure my early contacts with astronomers—at Harvard ...and the whole motley Yerkes crew: Struve, Morgan, Greenstein, Henyey, Chandrasekhar, Kuiper, and all the rest. When I think about these people ...I marvel at what wonderful people they were—so passionately devoted to science. But more, they were ...passionately devoted to life itself. ...I’ve always felt that astronomers on the whole are the best people on Earth. Let us never forget, nor let our students forget, that of every million people on the face of the Earth, only one is an astronomer.”

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