BIOGRAPHICAL MEMOIRS

John Peter Huchra

December 23, 1948–October 8, 2010
Elected to the NAS, 1993

A Biographical Memoir by Robert Kirshner

Stephanie Mitchell/Harvard University.

John Peter Huchra was an outstanding observational astronomer, leader in the astronomical community, and pioneer of large scale redshift surveys to reveal the texture of the universe. His career spanned the era from standing alone in the dome to guide the Mount Wilson 100-inch telescope for his thesis work to decisive use of the Hubble Space Telescope with a large team to establish the cosmic distance scale.

John was born in Jersey City, New Jersey on December 23, 1948. His father, Mieccyslaw Huchra, worked as a railroad conductor, and his mother, Helen Lewicki, took care of John and his sister Christine. John was quietly proud of his humble origins and capable of reverting to "Joisey" dialect for humorous effect in the rarefied settings of academia.

John wasn't interested in sports and had terrible vision, which did not impede his later use of the world's most powerful telescopes. Instead, he read science fiction and works by George Gamow and Fred Hoyle that fired his imagination and convinced him that his calling was math and science. One summer, he went to a stimulating National Science Foundation program in chemistry at the Newark College of Engineering. John reported: "I learned how to program, studied the 'vapor pressure of borate esters,' and baked brownies in the oven in the chemistry lab." John also took Latin and drafting in high school; he wanted to be ready to give things scientific names and to draw up his experiments.[1] After graduating from Ridgefield Park High School in 1966, John was admitted to the Massachusetts Institute of Technology (MIT), where he encountered an inspiring freshman seminar on cosmology taught by the inimitable and magnetic Philip Morrison, known in the wider world for his work at Los Alamos and his literate and stimulating book reviews in *Scientific American*. That experience propelled John toward astronomy and astrophysics. He later paid back that gift with interest by teaching his own very warmly received freshman seminar for undergraduates at Harvard University.

To help pay MIT tuition, John worked summers driving tractor-trailers onto railroad cars. He later joked that he was the only member of the Harvard faculty with a Teamsters Union card. For his undergraduate thesis, John worked with Icko Iben on stellar pulsation codes. That became the basis for his first publication in *The Astrophysical Journal* in 1970. There were 326 more refereed articles in his future.

John's warped corneas led to flunking his draft physical, so he was free to head to the California Institute of Technology (Caltech) as a graduate student in 1970. This was a lively time; he was tossed in the deep end of the pool as a contemporary of John Kormendy, Bill Press, Paul Schechter, Steve Shectman, Gus Oemler, Ed Turner, and me. Richard Gott, Dave Schramm, Martin Rees, and Beatrice Tinsley circulated through as postdocs and visitors. And the faculty, led by Jesse Greenstein, included Maarten Schmidt and Jim Gunn, with Allan Sandage, George Preston, and other luminaries one zip code away at the Mount Wilson and Palomar Observatories on Santa Barbara Street in Pasadena.

John chose to work with Wallace L. W. Sargent to puzzle out the nature of Markarian galaxies—galaxies with exceptional amounts of ultraviolet light that had been cataloged by Benjamin Markarian at Byurakan Astrophysical Observatory in Armenia using an objective prism on a Schmidt telescope. Their underlying nature was undetermined, though there was speculation they might be unusually young. He also worked on the Palomar Supernova Search that had been initiated at Caltech by Fritz Zwicky and which Wal Sargent had inherited.

His observations of Markarian galaxies were carried out at the historic Mount Wilson Observatory, using the 100-inch telescope by standing all night at the perilous Newtonian focus fifty feet above the floor of the dome. John was one of the very last people to use that engineering marvel as it transitioned into a museum piece.

The supernova work at Palomar Mountain used the apex of photographic technology, the 48-inch Schmidt telescope, whose 14-inch square plates had to be bent on a mandrel to match the curved focal plane and handled with exquisite care in the darkroom. Part of the dark art was to determine which side of the plate had the gelatin emulsion by very delicately touching it with your lips. The sticky side went toward the sky. At the end of an observing night, walking back to the dormitory in the still air of a cool morning twilight evoked a quiet pleasure from doing something exceptional exceptionally well.

The arc of John's career carried him from these romantic vestiges of the past into the modern age of telescopes with electronic detectors operated from the warm confines of a control room lit by fluorescent lights and beyond to the fully bureaucratic hands-off rigamarole of using the Hubble Space Telescope. The solitude and beauty of the mountaintops spoke to John's deep engagement with nature, also expressed through hiking New England's peaks and canoeing adventures in the boundary waters of Minnesota. John had the stamina and patience for long nights punctuated by the occasional thrill of discovery (he found Comet 1973h) and rapidly became the observer's observer among his peers, a role he relished.

As a graduate student and later as a postdoc and staff member at the Harvard-Smithsonian Center for Astrophysics, John often observed 100 nights in a year. He claimed it was because his income was limited and the meals on the mountain were free, but John loved what he was doing, and he did more of it than anyone else. He developed excellent cooking skills for midnight lunch in the limited galleys of observatory domes, with a personal flair for enhancing spaghetti with a Budweiser sauce.

John worked well in collaborations, and was a memorably generous mentor to students, but excelled as a lone astronomer enjoying the view from a remote mountain peak. He built up a depth of experience to perceive changes in the weather that could produce blurring effects in the atmosphere that would slow down his data collection. John learned how to get the best results from finite and precious observing time.

Courtesy of James Moran.

John's thesis demonstrated that most of Markarian's galaxies were not a fundamentally new type of galaxy, but a subset of normal galaxies selected by their color. This work was published in two single-author papers in the *Astrophysical Journal* in 1977. "The nature of the Markarian Galaxies" has since been cited 306 times (including twice in 2022).[2] John was offered a postdoc in Australia and had accepted it when fate intervened. Australia's prime minister lost a no confidence vote, Australian research budgets were frozen, and John's job evaporated.

John's thesis advisor, Wal Sargent, had another project underway to tide John over to the next hiring season: getting galaxy redshifts. Hubble's evidence for cosmic expansion in the 1920s was based on galaxy redshifts, but despite growing interest in physical cosmology in the 1970s, stimulated

Margaret Geller and John Huchra with CfA Redshift slices on the monitor. *From Harvard Archives: 1989.*

by Princeton University's P. J. E. Peebles and others, the exposure time required to measure a galaxy redshift was long and the sample was growing slowly. The world's collection of galaxy redshifts amounted to about 1,000 collected over the decades, mostly by heroic work at Mount Wilson and the Lick Observatories.[3]

Without the Australian job, John had time on his hands. It was technologically the right moment: image-intensifiers boosted the efficiency of a telescope by a factor of twenty so that a 1-meter diameter telescope with an image tube could match the speed of the mighty 200-inch with photographic plates.[4] Similarly, radio receivers for the 21-centimeter emission line from hydrogen were improving rapidly so that radio telescopes at Green Bank and Arecibo could be used to collect redshifts and rotation speeds from gas-rich galaxies. John began to measure galaxy redshifts with both optical and radio telescopes.[5]

In the next round of postdoc appointments, John was hoping to get a job at the Kitt Peak National Observatory in Tucson, where I was already a postdoc, but instead he was offered a job at the newly hyphenated Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts. There he met Marc Davis and Margaret Geller, two newly arrived Ph.D. students from Princeton. They were interested in building up statistically significant samples of galaxy redshifts to investigate how galaxies and galaxy clusters formed. John was willing to do the observing and had the distinct advantage of actually having measured redshifts. Though the Smithsonian Astrophysical Observatory had telescopes at Mount Hopkins, south of Tucson, it did not have state-of-the-art instruments. Marc took this on as a challenge.

At the same time, first at Michigan and later at Santa Barbara Street, Steve Shectman was developing a new type of digital detector using a self-scanned silicon diode array behind an image intensifier to count individual photons.[6] A digital detector had important advantages over photographic data recording. The surface brightness of a typical galaxy is not much higher than the night sky: a digital device made subtracting the sky's contribution to a galaxy spectrum reliable and straightforward. Not only that, but the accumulating spectrum could be monitored in real time; instead of guessing the appropriate exposure time, an alert observer would know when to stop with sufficient signal to measure a redshift, denoted by the letter Z. This would help John and his colleagues use precious observing time with maximum efficiency—very important for a big survey.

Shectman generously offered to provide the plans for his device; Marc Davis came to his lab to copy the electronics. John Tonry programmed a 30K minicomputer to take the data. By the summer of 1979, they had a working system they dubbed "the z-machine." The first CfA Redshift Survey was underway. The last spectrum for this survey of 2,400 galaxies was taken in June 1981, which led to significant improvements in estimating the 3D correlation of galaxies in space.[7] This survey hinted that the large-scale distribution of galaxies was not as simple as conventional wisdom held. Instead of a more or less uniform "field" with occasional dense galaxy clusters, like poorly mixed pancake batter, the data hinted at a more frothy structure. But no matter how many projections of the data they devised, the texture of the galaxy distribution was not well-delineated by this shallow survey.

While he was diligently observing in Arizona, John also collaborated with young contemporaries Mark Aaronson and Jeremy Mould on an improved way to measure the intrinsic brightness of spiral galaxies by combining measurements of galaxy rotation speeds with measurements of their infrared emission at 2.2 microns (H-band). If you know the intrinsic brightness and you measure the apparent brightness, you can infer the distance. If you know the distance and measure the redshift, that's the path to measuring the cosmic expansion rate, the Hubble Constant, a topic that John and his colleagues pursued with vigor. Their 1979 paper proposed a value of H_o = 61 +/- 4 km/s/Mpc, and they asserted "… the infrared magnitude/velocity-width relation is now the most powerful tool available for determining redshift-independent distances to the adjacent great clusters."[8] This preliminary value for H_o was close to the values found by Allan Sandage and his Santa Barbara Street colleagues and earned his approbation. But subsequent work by John's team the very next year gave values of 95 +/- 4 km/sec/Mpc, much closer to the values vigorously advocated by Sandage's nemesis, Gérard de Vaucouleurs.[9]

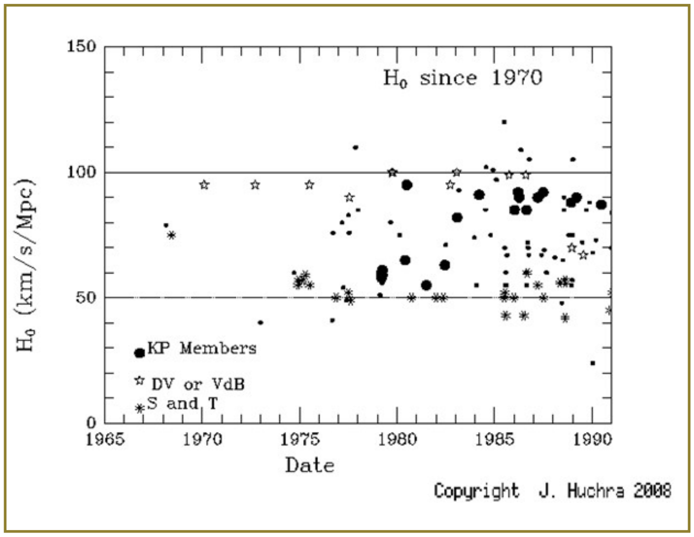
These Hubble Constant measurements put John and his postdoc contemporaries in the middle of the ongoing disagreement between very senior people, offending both sides in this imbroglio. Sandage, along with his longtime collaborator Gustav Tammann, advocated lower values of H_o near 55 km/sec/Mpc with increasing conviction through the 1980s and 1990s.[10] De Vaucouleurs continued to publish papers with much higher values, typically 100 km/sec/Mpc, into the late 1980s.[11]

John appointed himself the record-keeper of this acrimonious discussion, plotting each published value of the Hubble Constant versus time, as shown to the right. Sandage and Tammann's results are plotted with asterisks and those of deVaucouleurs are plotted with stars. Each side stuck with their views, tracing parallel paths across time, with no sign of convergence.

With a touch of melodrama, John declared, "By the late 1970s, this bimodality remained in the estimates of H_o and the middle ground was littered with the bruised and battered remains of young astronomers attempting to resolve the dispute between the two sides."[12] John's perception of the bitterness of this discussion was not misplaced. Much later, when we were no longer young astronomers, Sandage was invited to give a colloquium by the Harvard Department of Astronomy. Sandage replied that his mother had told him not to talk to the village idiot. As long as Huchra and Kirshner were there, he said, he wasn't coming to Harvard Astronomy. He was, however, willing to give a colloquium for the Department of Physics, so we walked over there to see what he had to say. Predictably, it was 55.

John helped resolve this dispute in the 1990s through his participation in the HST Key Project, led by Wendy Freedman. The Key Project used the revolutionary resolving power of the Hubble Space Telescope to observe Cepheid variable stars in a much-improved sample of nearby galaxies to calibrate a clutch of distance-measuring methods, including the relation between infrared magnitudes and rotation speeds that Aaronson, Huchra, and Mould had pioneered in 1979. This program reduced the uncertainty in the Hubble Constant from an embarrassing factor of two to about 10 percent with a final value from the Key Project of Ho = 72 +/- 8 km /sec/Mpc.[13] Modern values have higher precision: the "Hubble Tension" of today is between the value of the local expansion rate of 73 +/- 1 km/sec/Mpc derived from the cosmic distance ladder,[14] as in the Key Project work, and a value of 67.4 +/- 0.5 km/s/Mpc derived from the expansion history in a LCDM Universe implied by the angular fluctuation spectrum of the Cosmic Microwave Background.[15] John's work on the Hubble Constant helped shift this discussion from one based on personalities to a serious topic that may yet hold some clues to unknown properties of the universe.

The first CfA redshift survey of 2,400 galaxies by Marc Davis, John Huchra, Dave Latham, and John Tonry provided interesting statistical measures of the galaxy distribution and



a qualitative description of large-scale structure: "The space distribution of galaxies is frothy, characterized by large filamentary superclusters of up to 60 Mpc in extent, and corresponding large holes devoid of galaxies." In any case, John and his collaborators knew this was an important subject. They concluded, "Our results present a severe challenge to all theories of galaxy and cluster formation."[16]

A related result from a more limited redshift survey also pointed toward a Universe that was inhomogeneous on surprisingly large scales. Although the paper's title ended in a question mark, "A Million Cubic Megaparsec Void in Boötes?,"[17] the void in Boötes was front-page news in *The New York Times*.[18] Was this a statistical fluke with no underlying message for the structure of the Universe or a fortunate, but revealing, sample of something significant? This intriguing question provided some of the motivation for John's next big project: a deeper redshift survey.

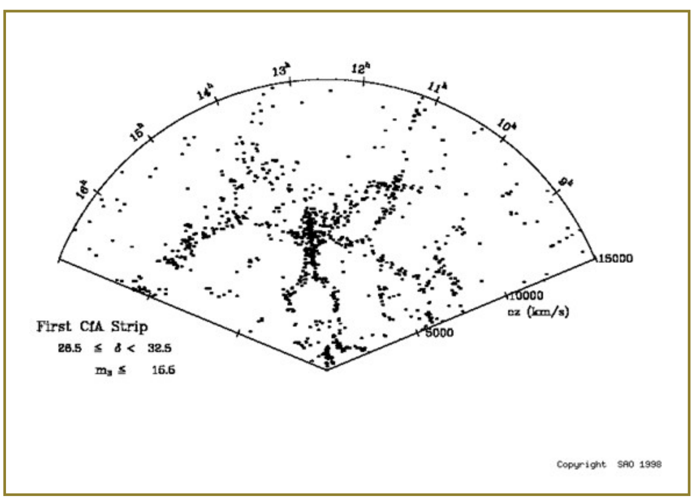
The early 1980s brought significant changes to the cast of characters at the Center for Astrophysics—Marc Davis moved to Berkeley and Margaret Geller came back to Cambridge, Massachusetts after two years at the Institute of Astronomy in Cambridge, England. Together, John and Margaret developed an ambitious plan to get the redshifts for 15,000 galaxies based on Zwicky's catalog. Margaret, with a well-developed visual imagination, advocated taking the data in long stripes across the sky. The redshift survey would take the two-dimension maps of the sky in Zwicky's catalog and transform them into three-dimensional maps by getting the redshift for every one of them in the areas selected. The long stripes would provide a view of features large and small. They likened this to the long traverse of a topographical surveyor on Earth, who might encounter mountains, valleys, deserts, and oceans. And, from John's practical point of view, since the sky swings by as the Earth turns, he could keep the telescope pointed in more or less the same direction as he measured redshifts for the passing targets, maximizing the efficiency of harvesting redshifts.

Together, John, Margaret, and their colleagues showed clearly in the 1980s that the 3D structure of the Universe has a frothy, bubble-like texture, with long walls of galaxies bounding extensive voids that are almost empty. The Boötes Void was not a fluke; it was a sample. While we now understand these structures as the result of gravitation acting over time in a Universe of dark matter, then they were a surprise and a mystery, revealed by insightful planning, new detector technology, creative analysis techniques, and an ample dose of hard work at the telescope, much of which was supplied by John.

The first slice of the CfA Survey by Valerie de Lapparent, Margaret Geller, and John Huchra shown below was a vivid illustration of just how well the tactic of sampling long strips evoked a more complex distribution than just "field" and "cluster."[19] The paper's abstract says this "looks like a slice through the suds in the kitchen sink." Margaret's idea of a bubble-like Universe caught on as an evocative way to summarize the empirical evidence.

The CfA Survey carried out between 1985 and 1995 by John and Margaret and their students eventually comprised 18,000 redshifts. This work was boosted in 1994 by an efficient spectrograph for the 1.5m Tillinghas Telescope at Mount Hopkins created by Dan Fabricant and his collaborators.[20, 21]

Between 1978 and 2001, Margaret and John wrote sixty-seven papers together. Their 1989 review article in *Science Magazine* summarized the chief findings from this work: "Maps of the galaxy distribution in the nearby universe reveal large coherent structures. The extent of the largest features is limited only by the size of the survey. Voids with a density typically 20 percent of the mean and with diameters of 5000 km s-1 are present in every survey large enough to contain them. Many galaxies lie in thin sheet-like structures." This article won the 1990 AAAS Newcomb Cleveland Prize for the outstanding paper published in *Science* that year.[22]



John's exceptional facility in carrying out these surveys relied on a vast deck of index cards, each of which had a Polaroid picture of the target galaxy along with handwritten information on its position and brightness. He dealt cards from that analog database, as he once dealt cards for his favorite card game, pinochle, to get the most from limited telescope time. Optimal rates of data gathering were not the only criterion for selecting targets. At the Multiple Mirror Telescope (MMT) at Mount Hopkins, the whole building rotates as the telescope points in different directions, so John could determine the azimuth of the building by selecting the right targets. During the 1983 broadcast of the science fiction television series *V*, which echoed his early interest in the genre, John selected targets to get the best reception of Tucson TV stations as the show depicted the invasion of Earth by reptilian humanoids disguised as human beings. This parable was useful to John in his later work in academic administration.

John's service to the astronomical community is literally too extensive to recount here. He was often charged with providing the summary of a conference, which he did with wit, generosity, comprehensive knowledge and a sense of purpose. This wit is demonstrated in his summary of a conference on stars and galaxies from 1996: "I am extremely pleased to have been given the difficult but interesting task of summarizing and concluding this conference. This, I figure, is due to my early work in this field, my status as a generalist, and to the fact that I haven't published a paper on galaxy populations and evolution in ten years, so have no axes to grind."[23] His breadth of experience in optical, infrared, and radio astronomy made him a frequent choice for the committees and boards that help the astronomical profession function. John was widely known as fair, trustworthy, and diligent, as completing a manuscript for a conference proceeding exemplified. For those sins, he served as associate director of the Harvard-Smithsonian Center for Astrophysics from 1994 to 1998, as president of the American Astronomical Society from 2008 to 2010, and helped lead the National Research Council's 2010 Decadal Survey of Astronomy and Astrophysics. In an exceptional gesture of respect, the report was dedicated to his memory.[24] John's 326 refereed articles include many that have stood the test of time and are still cited today (54,868 times according to ADS), but a professor's real legacy is his students. John's own eight Ph.D. students graduated over the years from 1980 to 2010: Walter L. Rice in 1980, Irene Cruz-Gonzales in 1984, Ronald Marzke in 1994, Pauline Barmby in 2002, Lucas Macri in 2002, Jenny Greene in 2007, and Julie Nantais in 2010. He demonstrated a deft touch as an advisor.

As Jenny Greene, professor of astrophysical sciences at Princeton, wrote: "John was extremely generous to me … without ever asking to be on my papers. His generosity left me free to pursue the thesis I wanted and I'm forever grateful to him for this."

Lucas Macri, project director of the U.S. Extremely Large Telescope Program, recognized John's varied scientific interests through an apt cooking metaphor: "John was like a highly skilled chef who always had a lot of pots in the fire and would warmly welcome you into his kitchen to work on yet another dish. John did that with … warmth, compassion, and team spirit."

Distinguished University Professor Pauline Barmby, of the University of Western Ontario, wrote for this memoir: "My strongest memories of John as a thesis advisor are his incredible curiosity, his unassuming kindness, and his near-illegible green-pen scribbles on my paper drafts. As an advisor, he simultaneously let me find my own way and made sure I never got too lost. I can't think of a better way to begin a scientific career."

But his impact on the graduate program at Harvard was broader and more pervasive than just his own students—he worked with Margaret Geller's students, and he served as director of Graduate Studies from 1997 until his death, providing kind and thoughtful guidance to all our students. He was not just gently steering their careers; he was a warm and generous person who understood the anxieties anyone feels when embarking on the unknown outcome of a Ph.D. thesis in a field where progress in gathering essential data depends on things as intractable as telescope time allocations and the weather on your assigned nights. John made a practice of inviting students, especially those who had no other place to go, to his home for Thanksgiving, where he relished cooking for them. And his house in Lexington had a much better kitchen than the MMT's galley at Mount Hopkins.

John served as a senior advisor to the Provost for Research Policy at Harvard in 2005. Provost Steve Hyman has described how John leapt into complex tasks with energy, common sense, and penetrating intelligence. In a linguistic tour de force, Hyman noted that John had a rare combination of joie de vivre and *stizfleich* (endurance) that allowed him to deal with teams of lawyers on tough problems of scientific administration with cheerful energy.

John, ever busy with his observing tasks, eventually found time to get married in an alliance engineered by mutual acquaintances at the Center for Astrophysics. His joy with Rebecca Henderson (now McArthur University Professor at the Harvard Business School) and his pride in his son, Harry, made him a more complete person. Nobody worked harder at his craft, gave more of himself to his students and colleagues, or was less puffed up by his achievements than John.

John Huchra and Rebecca Henderson. *Courtesy of James Moran.*

John died of a heart attack at home in Lexington, Massachusetts on October 8, 2010.

He was happiest in the observatory with the telescope controls in his hands. On cloudy nights, he was unbeatable at eight-ball pool and untouchable at pinochle, having misspent hours of his life perfecting those skills. Counting cards, John said, is like counting galaxies. We miss him terribly.

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1 John wrote a very interesting autobiographical sketch in Alan Stern's edited volume, *Our Universe: The Thrill of Extragalactic Exploration as Told by Leading Experts* (Cambridge, U.K.: Cambridge University Press, 2001). Other obituaries of interest are the one by James Moran Jr. on p. 66 of the October 2011 *Physics Today,* by Dennis Overbye in the *New York Times* on October 13, 2010, a Memorial Minute written by Jonathan Grindlay, James Moran Jr., and Robert Kirshner adopted by Harvard's Faculty of Arts and Sciences on April 1, 2014, and one by Robert Kirshner in *Nature* 468, p. 174, published on November 11, 2010. I have borrowed from all of these. John's colleague at the Smithsonian Astrophysical Observatory, Dan Fabricant, has preserved John's informative CfA website that is the source of both figures used here: https://lweb.cfa.harvard.edu/~dfabricant/huchra/

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