

# Tribute to Don Backer (1943–2010)

Cite as: AIP Conference Proceedings **1357**, 3 (2011); <https://doi.org/10.1063/1.3615065>  
Published Online: 02 September 2011

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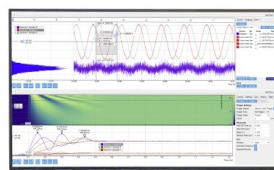
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# Tribute to Don Backer (1943–2010)

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**Abstract.** Don Backer was a true founding father of pulsar astronomy, a dedicated and passionate scientist who, alongside a career of tremendous and varied scientific accomplishment, was friendly, easy-going, dignified, and kind. This tribute summarizes Don's work, highlighting his many contributions to pulsar astronomy and other fields.

**Keywords:** pulsars

**PACS:** 97.60.Gb, 97.60.Jd, 01.60.+q

One challenge scientists face in their careers today is how to balance work and family. On a daily basis, many of us frequently think about how best to spend our time and meet the responsibilities of our personal lives and our work lives. An implicit assumption in this equation is that the two are independent – that our family is distinct from our work and vice versa. Certainly this has been true for me.

But then came the evening this past July 25, when, late at night, I received an email from my friend and colleague at University of California at Berkeley, Jon Arons, telling me the horrible news that Don Backer had passed away suddenly. I do not have words to express the shock and grief I felt.

I was never a student of Don's, nor a postdoc, but I feel like I knew him well and had continued to exchange email with him over the past decade fairly regularly. But even not being an especially close colleague of Don, I felt tremendous pain at his death, as if I had lost a member of my family. I suspect many of you felt the same way.

The reason I think that Don's passing has been such a powerful blow is that in reality, we actually form a family of our own: one determined not by genetics or marriage, but by a shared love of science, astronomy, pulsars – a shared curiosity about the Universe and a determination to understand it and make sense of it all. "Us, a family?" you may wonder, especially given occasional competition and disputes that are common to all areas of research. Yes, I'd argue, a real family (and I challenge any one of you to identify a 'real' family that gets along 100% of the time!) Don's death was a particularly difficult because in this pulsar family, he was a great patriarch: a true founding father of a rich and engaging research field that brought all of us, from around the world, in spite of personal and other professional responsibilities, to attend this conference.

Don was there at the very start of the field of pulsar research. Just two years after Hewish and Bell and colleagues announced the discovery of the first pulsar, Don emerged as an early leader in the field (Fig. 1), publishing no fewer than 4 papers in *Nature* in 1970 [1, 2, 3, 4]. All this was before he was awarded his PhD from Cornell University in 1971, after having obtained his Master's degree from University of Manchester in 1968.

That was just the very beginning of Don's career in pulsar astronomy. In the decade



**FIGURE 1.** Don, circa 1971 (Photo credit: AP).

between 1971 and 1981, during which he held postdoctoral positions at the National Radio Astronomy Observatory in Charlottesville, Virginia and at the Goddard Space Flight Center in Greenbelt, Maryland prior to arriving at the University of California at Berkeley in 1975, Don published many articles on pulsar topics, often pioneering work, ranging from pulse phenomenology including nulling and drifting subpulses [5], to scintillation [6], to the first VLBI observations of pulsar proper motions [7], to early and seminal descriptions of pulsar polarization including orthogonal modes [8], to pulsar beam models [5]. In addition, he began his very significant work on the Galactic Center radio source Sagittarius A\* [9], a source that would also be a lifelong target of interest to Don.

In 1982, Don made a career-defining discovery: the first millisecond pulsar, PSR B1937+21 [10]. Working together with his then-PhD student, a young Shri Kulkarni (I'd always wanted to ask Don what Shri was like as a student!), they found, after a several-year battle to understand a mysterious, compact steep-spectrum radio source 4C21.53, that it was a radio pulsar rotating 20 times faster than any one known before. This discovery was remarkable in many ways, not only for revolutionizing our understanding of binary evolution, but also for applications in time-keeping metrology, astrometry, binary dynamics, interstellar medium physics, and perhaps some time in the future, gravitational wave detection. Here is a recollection of Jill Tarter, Director of the SETI institute, who happened to be at the Arecibo Observatory the day Don and Shri made the discovery, upon encountering Don:

*"I literally ran into a wild man. Don's eyes were the bright twinkly blue we all recall, but they were surrounded by massive amounts of redness because he hadn't seen a bed in a long time. His hair was disheveled, his clothes were worse, and he had totally lost his voice. Don croaked at me "642 Hz!" and I stared back at him blankly. I was clueless. Don noticed. We moved up a few stairs so that Don could take a long drink of water from the drinking fountain on the landing and then, with many hesitations, squeaks, and an extraordinary amount of body-language, he told me about this mystery radio*



**FIGURE 2.** Don with Geoff Bower, collaborator on, among other things, Sgr A\*. Photo taken October 11, 2007 (Photo credit: Colby Gutierrez-Kraybill.)

*source. He told me that against all odds (and certainly against the combined wisdom of the astronomical community) the mystery source had turned out to be a neutron star rotating 642 times a second - the first millisecond pulsar! That day Don shared with me the enormous excitement, joy, and satisfaction of science done well. His jubilation had nothing to do with 'see, I was right!' and everything to do with wonder and amazement."* (I must remark here that I am relieved to know that I was not the only astronomer to take note of Don's amazingly blue eyes!) Years later, Don said about the discovery: "In terms of those few moments of discovery at Arecibo, it was the high point of my career." Today, according to ADS, Backer et al. (1982) has 429 citations and has been cited at a consistent rate for the past two decades.

After 1982, Don's research continued to flourish. In the decade ending in 1992, Don published over 40 papers in refereed journals on a broad range of topics. In pulsar astronomy, Don did important work with a variety of collaborators on young pulsars, including the discovery of a fast pulsar in the supernova remnant CTB 80 [20], a millisecond pulsar in the globular cluster M28 [21], the first negative period derivative in a globular-cluster pulsar [22], work on time variability in pulsar dispersion measures [12], the detection of a planet-mass object in orbit around a millisecond pulsar [11], as well as a variety of spectral studies of millisecond pulsars [19]. Don also did pioneering work on establishing a "timing array" using millisecond pulsars [18], a topic that has been discussed significantly at this conference. Meanwhile, Don continued his work on the Galactic Center, including establishing unprecedented upper limits on the extent of Sgr A\* [13], and subsequently a detection of the intrinsic angular size of Sgr A\* with colleague Geoff Bower [Fig. 2; 16].

Overall Don's contribution to research includes 152 refereed publications, 99 of which are on pulsar topics, 27 on Sgr A\*, and the rest on instrumentation and other radio projects. For the body of his work in radio astronomy, Don was awarded the prestigious Jansky Lectureship by NRAO in 2003. In his last 5 years, Don published 23 refereed



**FIGURE 3.** Don with then-graduate student Paul Demorest, working on pulsar instrumentation in late 2006 (Photo credit: Andrew West).

articles; clearly he had not slowed down one bit prior to his death. On July 25, 2010, astronomy lost a talented, fruitful, energetic scientist.

Don also was a leader in the pulsar community in terms of development and implementation of backend pulsar instrumentation at radio telescopes (Fig. 3). The list of instruments (and acronyms!) built by Don together with his students and colleagues is impressive: the Green Bank/Berkeley Pulsar Processor (GBPP), the Arecibo/Berkeley Pulsar Processor (ABPP), the Navy-Berkeley Pulsar Processor (NBPP), and the Ebersberg/Berkeley Pulsar Processor (EBPP) were several instruments based on the Coherent Dispersion Removal Processor (CDRP) which employed digital hardware coherent dedispersion for pulsar timing and polarimetry [14]. Don was also responsible for the Berkeley/Caltech Pulsar Machine (BCPM), located at Green Bank, which used incoherent processors that evolved from the earlier version. Don continued to work on pulsar backends, collaborating on the Arecibo Signal Processor (ASP), the Green Bank/Arecibo Signal Processor (GASP), and the Berkeley-Orleans-Nançay (BON) instruments for coherent dedispersion and high-precision timing, located at Arecibo, Green Bank, and Nançay, respectively. Those who collaborated on him in this work know of Don's love for and competence in building these remarkable machines. Don's love of electronics found its greatest outlet in his involvement as co-PI in the Center for Astronomy Signal Processing and Electronics Research (CASPER) at Berkeley. He was also appointed Director of Berkeley's Radio Astronomy Laboratory in 2008.

Don's most recent primary research interest was neither with pulsars nor with Sgr A\*, but rather on a completely different topic: the Epoch of Reionization in the early Universe, specifically on the Precision Array to Probe Epoch of Reionization (PAPER)<sup>1</sup>. PAPER consists of broad-band dipoles, active balun, coaxial cable transmission, analog gain/filtering, digitization and correlation, in an array operating in the 100–200 MHz

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<sup>1</sup> <http://astro.berkeley.edu/dbacker/eor/>



**FIGURE 4.** Don at NRAO's 50th anniversary science symposium in June 2007 (Photo credit: Bob Rood).

band. The goal of this project is to detect the power spectrum of fluctuations of 21 cm emission at high redshift (7–11) when the first stars were forming. A prototype had been built in Green Bank, and the first construction on the array proper had just begun in South Africa at the time of Don's death. He had presented a poster on PAPER at the 2010 American Astronomical Society meeting [15]. Simultaneous with his work on PAPER, Don was also actively involved in many aspects of the Allen Telescope Array<sup>2</sup> [17], which was the subject of the last email I received from him, just weeks before his sudden passing.

When I think of Don, I think of a person who was very kind, dignified, thoughtful, modest, and easy-going. He put you at ease with his warm smile, his humility, and his friendliness (Fig. 4). I can think of no one who disliked Don. He was a highly motivated scientist with a clear passion for his work, always eager to jot down an equation or diagram on a napkin to clarify a point. Though he was highly efficient, focussed and extremely competent, he accomplished his work always in a *nice* way. In the words of CASPER co-PI Dan Wertheimer, "Don made pioneering contributions to (several) fields, but he didn't let it go to his head, and he always maintained his characteristic kind and gentle manner." Ethan Schreier, President of Associated Universities Inc. said, "All who know him, and there are many, recall his kindness, his thoughtfulness, his energy, and his integrity, as well as his passion for science. He was highly respected in the astronomy community, and his untimely passing is a true shock to all who hear. Don will be missed."

In conclusion, it is not hard to find inspiration from Don's life and accomplishments, but we must try to focus on the positive even following his untimely passing. For me, it has brought new-found appreciation for the importance of family – our pulsar family – which is held together by a shared life commitment toward understanding Nature in

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<sup>2</sup> <http://ral.berkeley.edu/ata/>

general and the cosmos in particular. I would like to take the opportunity to thank the organizers of this conference, for bringing us all together to the spectacular island of Sardinia. I hope to continue to see all of you at similar events for many years to come, as we work together to build on the foundation and great legacy that Don left behind, all too soon.

Donations can be made in Don's memory to the Donald Backer Memorial Fund, to continue his legacy and to support the new frontiers of astronomy research and education. Checks can be made out to the UC Berkeley Foundation and mailed to Barbara Hoversten, Astronomy Department, MC3411, University of California, Berkeley, CA 94720-7450.

I thank Mallory Roberts and Les Films Kookaburra for providing footage of an interview with Don Backer, presented in this talk, and made for the upcoming documentary *Conversation with the Cosmos*<sup>3</sup>. Thanks also to Ingrid Stairs for comments on an earlier version of this tribute.

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<sup>3</sup> <http://arecibo.lesfilmskookaburra.com/>