J. Plasma Physics (2000), *vol.* 64, *part* 4, *pp.* 315–318. Printed in the United Kingdom
© 2000 Cambridge University Press

John P. Dougherty: Some recollections

DONALD T. FARLEY
School of Electrical and Computer Engineering
Cornell University, Ithaca, NY, USA

(Received 27 September 2000)

Abstract. What follows are some personal recollections of John that I thought might be of interest to some readers of this special issue of the *Journal of Plasma Physics*.

Cambridge

I first met John in the fall of 1959. I had just finished my PhD at Cornell with Henry Booker, and I had a postdoctoral fellowship for a year at the Cavendish Laboratory, which Booker held in high regard. I arrived (by ship! – my only trip to this day on a large ocean liner) with my wife Jennie and infant daughter and most of our worldly possessions in September. Finding housing was more of a challenge than we had anticipated, but we finally rented a small 1890s era semidetached house, with no refrigerator and heated only by a coal fireplace, on French's Road.

I found my way to the Cavendish in due course, and was assigned to my office, which I shared with John. I remember it as a pretty large, bare room, with a couple of tables and no doubt a bookshelf or two. John was in the last year or so of his PhD work, and so we were about the same age. We got along well right from the start, in spite of my American accent. He commented only occasionally on my Americanisms, and he quickly introduced me to an assortment of pubs and other points of interest in Cambridge.

These were prime years, as I later came to realize, for the ionosphere and radio astronomy groups at the Cavendish. Martin Ryle and Tony Hewish (future Nobel Laureate) were there in radio astronomy, and the ionosphere group was headed by J. A. Ratcliffe – known as 'jar' to us junior people, but always addressed as 'Mr Ratcliffe'. There were those who called him 'Jack', but that group most definitely did not include us! In radio physics and propagation, there were Kenneth Budden and Phillip Clemmow. Closer to the age of John and me was Henry Rishbeth, who later coauthored a definitive text on ionospheric physics. Mr Ratcliffe ran a tight ship in those days. I remember particularly the Saturday morning meetings at which we discussed journal articles. Attendance at these meetings was *not* optional, and whoever was assigned to present the article of the week came well prepared. Saturday morning meetings were unheard of at Cornell even then, and I suppose the same is true now at the Cavendish. There was also the almost obligatory (not that is it was a chore) daily afternoon tea, at a specific time, something that no doubt still takes place and which I found a very pleasant way to get to know people and to exchange ideas. Too bad this civilized custom never crossed the Atlantic.

It happened that my year at the Cavendish was Mr Ratcliffe's last year; he was

https://doi.org/10.1017/S0022377800008734 Published online by Cambridge University Press

about to become the director of the Slough Observatory. In planning for the move, he wanted to broaden his ionospheric background, and so John and I were directed to come up with a one-hour presentation for him every week on some interesting topic of our choice. It kept us busy, and Ratcliffe was a demanding listener. If we didn't explain something clearly enough for him, he let us know.

One of our discussion topics was incoherent scatter. In looking for something to work on during my postdoc year, I had begun talking with John about the very new subject of incoherent scatter of radar signals from the ionosphere. This scatter is exceedingly weak, since it is from the random thermal fluctuations in electron density, but it can provide a lot of information about the ionospheric plasma. The idea of incoherent scatter was first proposed by Professor W. E. (Bill) Gordon (Gordon 1958) in a small seminar at Cornell that I attended in the spring of 1958. A few months later, Ken Bowles, a recent PhD from Cornell, made the first measurements of the scatter using a large 41 MHz radar in Illinois (Bowles 1958). Gordon's first paper predicted that the Doppler spectrum of the scatter would be wide and Gaussian-shaped, consistent with the random thermal velocities of the free electrons that do the scattering, but Bowles's measurements showed that the spectrum was considerably narrower, more consistent with ion velocities. How could this be, since it is certainly the electrons that do the scattering, and we know what their thermal velocity distribution is? Clearly, collective plasma effects were involved, and John and I thought it would be interesting to try to figure out what was going on.

The only trouble was that neither of us knew much about plasma physics, a subject that was then just in its infancy. Spitzer's famous book on the *Physics of Ionized Gases* had been published just a few years earlier. Undaunted, we started to think about the problem. We made a pretty good pair; I tend to try to think from a physical point of view, whereas John is a mathematician at heart. So we kept each other on track pretty well. It happened also that Oscar Buneman was at the Cavendish then and taught an eight-week course on plasma physics, which we both attended. Another piece of good luck was that Bill Thompson spent a few days at Cambridge during the fall, and he mentioned to John the idea of using a generalized version of the Nyquist noise theorem (now usually called the fluctuation–dissipation theorem) (Callen and Welton 1951) to calculate the plasma density fluctuations. This appealed to my electrical engineering background, and it had a certain elegance of approach that appealed to John.

So we learned how to do plasma kinetic theory to find a complex plasma impedance, which we then inserted into the Nyquist theorem to derive an expression for the power and spectrum of the scattered radar signal in terms of the plasma temperature, density, and composition. The final expression involved what would later be called the plasma dispersion function, which had to be found numerically. We enlisted the aid of David Barron, who knew how to program the EDSAC, a very state-of-the-art (at the time), one-of-a-kind computer. We wound up with results that turned out to be exactly correct, one of the few cases in plasma physics where you can show that linear kinetic theory and experiment agree to at least three significant figures! We published our results in two papers in the *Proceedings of the Royal Society* (Dougherty and Farley 1960; Farley et al. 1961), a journal that I had never seen, much less published in, as a graduate student in the United States, but which I soon realized was held in very high esteem in Britain. These papers got our careers off to a good start. I should mention that several other authors,

https://doi.org/10.1017/S0022377800008734 Published online by Cambridge University Press

using a surprisingly diverse assortment of approaches, independently derived the incoherent scatter theory at about the same time that we did. We all got exactly the same results, except for one author (who shall remain nameless here) who did not believe in Landau damping!

Peru

After my year in Cambridge, I spent another postdoctoral year in Sweden and then went to Peru, where the Jicamarca Radio Observatory was being built by Ken Bowles (with funding from the United States) to do incoherent scatter measurements in the ionosphere. I thought it would be interesting to actually see these signals that we had theorized about. Once settled in Peru, I corresponded with John and suggested that he come for a visit – which he eventually did. In fact, he came twice.

Those who know John know that he is a serious classical musician and an excellent piano player. He also has perfect pitch. During his first visit in 1963, the Observatory organized an international meeting on equatorial ionospheric physics, held in a small rustic hotel in a little town called Huaychulo up on the Andean plateau at about 11 000 feet. (We took oxygen tanks to the conference, and at least one participant was heard to say, 'It's fine to have a conference on the ionosphere, but did we really have to get so close to it?') John was of course invited to go, and to give a talk I think, but he said he would go only if there was a piano at the hotel. There was, and so John went. During a free afternoon, when most participants (including me) went exploring, John stayed at the hotel to tune the piano, which badly needed it. One of my colleagues (B. B. Balsley) reported:

> I stayed with him to watch. He spent the better part of the afternoon tuning the piano. Late in the afternoon he ran through a few scales and asked me what I thought of the tuning. I guess I replied positively; what did I know? His [John's] reply was, 'Right, it's pretty good, but the whole keyboard is about a half step flat!' And this using only his ear.

That same evening after dinner, we all collected in the hotel lounge to hear John give a recital. Balsley continues:

> After a few preliminary selections, he began in earnest to play a series of pieces that were clearly variations on a theme. What, or by whom, I didn't, and still don't, know. People wandered in and out during this time, except one tweedy gentleman, who sat in an overstuffed chair in the corner smoking his pipe and listening intently to John's efforts. At the end of the series, which took the better part of thirty minutes, there was appropriate applause, and everyone began to leave. At that point, tweedy gentleman arose and approached John, who was closing up the piano. The ensuing conversation went something like:
>
> Tweedy gentleman: 'Very good, John ... well done ... but I notice you didn't play #32.'
>
> John: 'Right ... I never did like #32.'
>
> And that was the end of that. I never did find out the composer [maybe Scarlatti, a favorite of John's as I remember?] or the theme. A very British exchange, to my mind.

https://doi.org/10.1017/S0022377800008734 Published online by Cambridge University Press

John stills plays the piano, and his wife Margaret is an excellent singer. It is a pleasure to hear them together.

John's ear for music does not seem to extend to foreign languages. His pronunciation of Spanish, even of the name of the Observatory, leaves something to be desired, shall we say. Nevertheless, during his second visit to Jicamarca, John made a deal with one of the guards (who came from a small village in the Andes, had little formal education, spoke no English, and was named Primitivo): John would teach Maxwell's equations to Primitivo in return for some lessons in Quechua, which Primitivo spoke much better than Spanish. How he and John communicated remains a mystery. I still remember seeing Primitivo, by himself, drawing beautiful sets of Maxwell's equations on a blackboard. I'm afraid that John's command of Quechua never reached a comparable level, but he would spout a couple of Quechua (at least he thought they were Quechua; Primitivo might not have agreed) words to the rest of us gringos now and then with great gusto.

Later years

John returned to the academic life of Cambridge, became the founding editor of the *Journal of Plasma Physics*, and involved himself primarily with fundamental aspects of plasma physics. I left Peru for a faculty position at Cornell and a mixture of theoretical and experimental ionospheric research, mostly involving radar probing. We gradually drifted apart professionally, but have maintained contact with each other. In fact, my wife and I recently visited John and Margaret in Cambridge. I had trouble recognizing some of our old haunts. Forty years is a long time. Both of our lives were shaped by that one year we spent together so long ago – although we didn't realize it at the time, of course.

References

Bowles, K. L. 1958 Observation of vertical-incidence scatter from the ionosphere at 41 Mc/sec. *Phys. Rev. Lett.* **1**, 454–455.

Callen, H. B. and Welton, T. A. 1951 Irreversibility and generalized noise. *Phys. Rev.* **83**, 34–40.

Dougherty, J. P. and Farley, D. T. 1960 A theory of incoherent scattering of radio waves by a plasma. *Proc. R. Soc. Lond.* **A259**, 79–99.

Farley, D. T., Dougherty, J. P. and Barron, D. W. 1961 A theory of incoherent scattering of radio waves by a plasma, II. Scattering in a magnetic field. *Proc. R. Soc. Lond.* **A263**, 238–258.

Gordon, W. E. 1958 Incoherent scattering of radio waves by free electrons with applications to space exploration by radar. *Proc. IRE* **46**, 1824–1829.

https://doi.org/10.1017/S0022377800008734 Published online by Cambridge University Press