Manfred and Denise Caldwell

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Manfred

Can you tell me about your time at the SRC?

We came to the SRC relatively early, when I say we I meant Tom Carlson and myself. We worked together. I was in charge of the atomic part of our work and he was in charge of the molecular part of our work, and all of our work was done in the gas phase. It was a new thing for synchrotron radiation I couldn’t claim at this moment whether we were the first or among the first do that gas phase work with synchrotron radiation.

Jim Taylor, of the chemistry department, one of his students did build an apparatus and we were consulting and observing when they did some of their first experiments. Then I build an apparatus suitable for gas phase work to go to the synchrotron radiation source, here in Oak Ridge National Laboratory. I already came up in January or February of 1981.

So we did our first work at the Tantalus 3 Meter TGM (Torroidal Grating Monochrometer) I did some measurements on the Xenon atom and Tom Carson did some measurements on the simple molecule but I don’t remember what. Here again, unfortunately he has passed away in the meantime.

We continued work, let me talk of my work. I did some work on metal vapors, in other words we vaporize the metal and looked at these so called metal atoms in the gas phase. Some of the first experiments work was on manganese and silver and I think lead (Pb). Most of it was at relatively low energy, well at Tantalus, one could hardly go above 100 eV and most of our work was done there at the TGM and the SEYA monochrometer, which was very low energy.

After a few years, when finally, Aladdin opened up for business, we moved over there and we continued our experiments with an emphasis on metal vapors. I would look at anything that would vaporize up to 1100 degrees centigrade-Celsius; we looked a whole array of gases from helium to Cleon.

What were the intentions of your studies?

We called it from the beginning that we were examining and investigating the structure and the dynamics of the electronic structure of these atoms. By way of the photo electric effect and later on by the way of the O’Shea effect, which told us the cross sections and the angle distributions of the electrons and in return, told us about the wave functions of these more lightly bound electron shells. First of all, the outer most shells go further inside the penultimate shells as far as we could go with the available energies. Of course the further you go inside the atom the more energy you need inside these atoms.

What were the differences when you switched from Tantalus to Aladdin?

Ultimately, the idea was to have a much wider energy range, several hundred eV of the photons. Also, we had a much greater intensity and we had much better resolution. In other words we could detect the final details of the electronic structure. And by that, we got more information of various interactions of the electron in the various shells.

Of course, what became very important, was later, and not just the switch from Tantalus to Aladdin, but also that Aladdin the so called undulators were introduced. That was very important in the switch, from the ordinary bending magnets to the undulators which meant an additional factor of usually a magnitude of intensity gain of the photon beam as well, and better focusing down to a smaller spot. In addition with the associated monochrometers, they had much better resolution.

So we were, in regard to the metal vapor work, I think we had first at Tantalus, but more at Aladdin, we were among the leading researchers in that field. Later on, I was joined by a number of various students and colleagues and usually from abroad.

In 1986, Denise Caldwell of the University of Florida joined in the work so we worked together. We continued the work with the metal vapors and also then, it added another dimension to the research and I think no one else had done that at the synchrotron radiation source. We looked at what were called the open shell atoms. You have to remember the array of gas also known as the noble gasses, have a closed shell structure, while most other atoms in the periodic table have actually open shell structures, which means that some electrons are missing in the outermost shell. That usually doesn’t matter to much when you speak of the solid state systems, because there is this interaction of these electrons when forming bands etc… But not that much of the molecules, but that has other aspects of it, but let’s talk about the atoms, because that’s important with me (laugh). What that means when they have the open shell structures…some of the work was already down with the metal vapor, they had open shell structures, we measured usually those first that had closed shell structures for two reasons:

It was of course simple, to treat theoretically feel, for other people the theoreticians to work on it, and it was simpler for us experimentally, because they usually had a lower vapor pressure, and we could heat them up and make vapors out of these atoms. So many of them vaporized nicely anywhere from a few hundred to degrees to 1250 degrees which was the limit of our oven in our setup.

However, then we went to what you may call the real open shell atoms which are the chlorine, oxygen, and their realties, and we investigated those, who was most responsible for that were some of my co-workers. One was a student from Amsterdam, who was writing his thesis with me. Then of course, Denise Caldwell also worked with me. So we investigated these atoms to find out what special interactions were at work in these open shell atoms. These electrons have quite complex configurations among possible electrons that may be caused by electrostatic interactions expressed in the russel-sound coupling and it may be affected by the magnetic type like spin interactions, which had to be treated relativistically, in simple terms.

That was our work for a long time, you probably know from the applications and records at SRC about the various people work with me and Denise from University of Central Florida. Some of these guys continue to work in synchrotron radiation, some abroad and elsewhere. One of them, Whitfield continued at SRC, he got a professorship at Eau Claire. He took my spectrometer with him, and at that time it was already 20 years old, which is an awfully long time for a scientific instrument still work and be good enough to get good results, in some ways it’s kind of unique. There are some very good cars that last for 20 years, but scientific instruments are usually out of date in 5 years. This spectrometer, with some improvements of course, did continue to give good results after 20 years. Scott Whitfield did some experiments last year. He probably still used that instrument. So I think, that is essentially my global story on my research at the SRC.

Can you describe the atmosphere and community at Tantalus and SRC?

When it comes to the atmosphere, it was just excellent, this has been a big strength of the SRC, that it was always very collegial and positive, when you worked there. That was especially true because at Tantalus it was so much smaller. Everybody knew the other one and management and staff were always very responsive and I think that accounted for the fact that Tantalus was so productive and the number of good research, you could almost say pioneering research came out of Tantalus.

Now going to Aladdin, in the sense, it became larger, and that always means a little bit more bureaucracy, well a more structured approach. The staff and the management were still responsive and outstanding all the time I had been there, from the beginning to my official retirement in 1995, but I did do experiments up to 2000. So the last time I did experiments at Aladdin was in 2000. Things were always wonderful, they knew me and I knew them which was undoubtedly very helpful but it went beyond that. The interaction between the various researchers which had multiplied at that time it was still always collegial and amicable, it has always been a great place to work and do experiments.

Of course in later years, with some other sources coming along, synchrotron radiation sources, especially t he Advanced Light Source (ALS) in Berkley, which would be the most comparable to Aladdin. It was of course a bigger source, a new generation and we eventually did at some point did an experiment there. Some people in solid state like Franz Himpsel did research there. It was a different atmosphere in a sense, there was more pressure at this institution like you generally find at bigger institutions at these so called bigger machines, whether they are proton accelerators or synchrotron sources or neutron sources whatever. They are usually quite high pressure sources for the people and researchers. Aladdin was always great, we got the time and most usually when we wanted it. To get as a rule, a fair amount of time, more than you usually could get elsewhere and by that, a lot of good work could be done at Aladdin and I think we proved that ourselves and if you listen to the other people they probably could tell you the same thing.

Denise Caldwell

The first time I was at the SRC was in 1986, I was on the faculty of the Uni of Central Florida, I started a collaboration with Manfred, at this time Aladdin was up and running so I never worked on Tantalus. The firs t thing we did that winter was that we moved the spectrometer, the electrons spectrometer, from the old Tantalus building to Aladdin and we setup the SEYA. We did an experiment on gallium. Then very shortly after that, I had someone who was working with Manfred as a post doc from Mexico, Jose Jineneas. I think we did one of the first experiments on the 4M NIM (Normal incidence Monochrometer.) Then from that time, for certainly the next ten years, we worked together with Manfred and I had several students and post docs who came up and we pretty well did a lot of experiments, pretty much all the way around the ring, on quite a number of different instruments. Depending on the different experiments we wanted to do and the beam time we could get. I did that until 1996 I think. I left the university and actually moved to the National Science Foundation and I took a position there. That essentially closed down my experimental effort and I didn’t go back anymore. So that’s kind of it, we have a fairly long record of publications and it was a good experiments.

What was your role at the NSF?

I’m still at the NSF, I was originally a program director for the Atomic Molecular and Optical and Plasma Physics program, I am now the deputy director in the Physics division.

Do you have any insight you could share about the NSF’s relationship to the SRC?

It’s an entirely different division from the one I work in. The SRC was always funded by the Division of Materials Research. I know some of the people who were responsible for the SRC and I think many of them left the NSF, they retired. I really honestly couldn’t tell you who has responsibility now, the person I knew best was Loretta Engelhardt, later Loretta Hopkins when she married, but she’s been gone for several years, so I don’t know a lot of detail about the support with the SRC and who handles it not, since it’s not in my division.

Can you tell me about the different experiments with Aladdin?

Manfred has already told you much of things we did. We worked on metal vapors, noble gasses, and we worked with the Halogen atoms, which was the last group of things we did. It was as I would say just like everything Manfred described to you. We did a lot of work with our theoretical colleagues. A number of the measurements we made on the halogen molecules went into the NIST set of data, the fluorine measurements, the spectroscopic energies of fluorine which went into the NIST data tables, so I would call it spectroscopy.

What is the difference between vapor and solid metals?

You’re looking at different physics. If you’re looking at a solid metal, all of your band structures are very different, so your energy levels are going to reflect the band structure; it’s going to reflect the way the energy levels are distributed in the metal. Unless you go really really deep, then you can see inside an atom that’s embedded in a metal, then you can see evidence of atomic lights features, but you’ll never see them really cleanly because of all the metal that the photons have to go through. If you’re studying the metal, you study the metal, if you study the gas phase; you’re studying the individual atom. You’re getting slightly different physics.

Can you describe the atmosphere of Aladdin?

Oh it was wonderful… I really enjoyed working there. I would say the best thing about it, it was just myself I was an individual investigator, I didn’t have a lot of people. At any one time there was, well Manfred and I collaborated, he and I would do experiments. Sometime there would be just a student or a post doc; it was a very small group. Aladdin is wonderful for a small group, it’s just fantastic because you’re not running 24 hours a day and with a small group, 2 or three people you can’t run 24 hours a day. Plus the fact that we needed sort of down time to, particularly with the metal vapors we’d run out of stuff and we’d have to take stuff apart and add more vapor. The gasses, if it starts off as a gas it are a little bit easier. What was nice was that the Aladdin facility was really supportive, particularly for small l groups like mine was.

If you have three weeks to do an experiment, that’s it, you have three weeks, you don’t fool around, and within those three weeks you have to get it down. So if something goes wrong you have to fix it, you just fix it, you don’t talk about it, you just fix it. The situation was the staff really knew this, if you needed something, they were right there. They worked you in, they helped you get what you needed right away, because they really understood the pressure you had to finish.

The one case that comes to mind was when we did the measurements for the fluorine atom, we were in the third week and still the thing hadn’t worked. We finally got down on Monday, to try one last thing to see if it will work, and sure enough it worked. Just about the time it started working, my microwave generator had a problem and they helped us fix it. They knew the company that had the part and they got it essentially overnight and we were running the next day. And I would say that was typical, that kind of support that we all got.

From that perspective it was really a great place to work and particularly for small university based groups.

Have you since then retired?

Oh no! The only reason you got me today was that I work for the federal government so they gave us the 4th off.

Anything else you’d like to add?

No, I just think the general comment I already made. It was really 10 wonderful years of being there and working with the people and getting to know them and doing the experiments it was 10 wonderful years.