Chapter 10

MARTIN D. KAMEN

Montecito, California

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VM = Vivian Moses; MK = Martin D. Kamen

VM: This is a conversation with Martin Kamen on Mat 31st, 1996 in Montecito.

I wonder whether we can start the conversation by your telling me about some of the work that you did with Sam Ruben on photosynthesis before the war, I guess.

MK: He (*Ruben*) came over and he thought we could do something with carbon dioxide, with the route of carbon dioxide in photosynthesis. At first, he wasn't very clear about it but after a while we got started thinking about it. Then, I joined him full-time. I was only there for a while, part-time, at the beginning. As things developed, I became a full-time devotee.

VM: What was your status at the time?

MK: I was the Radiation Lab. chemist.

VM: You were actually an employee? You were a graduate, and did you have your PhD already?

MK: Oh, yes. I was the only paid employee in the Radiation Laboratory.

VM: Oh, really?

MK: I got $1200 a year. (*Laughter*)

VM: Could you live on it?

MK: Oh, yes. That was a lot of money.

VM: What was Sam's position at the time?

MK: He was an assistant professor — no he wasn't, he was an instructor.

VM: In which department was that?

MK: Chemistry.

VM: Your own background is chemistry, is it?

MK: Yes.

VM: How did the two of you dream up this idea of getting involved in a biological matter?

MK: It's a long story.

VM: Please tell it, if you've got time.

VM: Chaikoff (*I. L. Chaikoff, Department of Physiology, University of California, Berkeley*) came over one time with Lawrence (*Ernest O. Lawrence, Director of the Radiation Laboratory*) and said he had thought about using labelled $^{11}CO_2$ in looking at the fate of carbohydrates in rats. Sam said, later on, that it was his idea but Chaikoff had glommed onto it. Anyway, after a while we began thinking what was the reason we were working with rats. Sam said let's forget about that and work on photosynthesis instead. Because, after all, it's a cinch: you and me together can do this in a couple of weeks! That was after three years. I thought about that and maybe several hundred experiments later we still had not figured out where the CO_2 went. We didn't have enough time. Anyway, that's how it started.

VM: Where were you working at that time?

MK: I was a Radiation Lab chemist.

VM: Up on The Hill?

MK: No this was before The Hill. Down in that old shack where the 37-inch cyclotron was located.

VM: That was the building that Calvin's group later occupied?

MK: No. they had a building of their own, I think.

VM: That came much later. In the meantime, they worked in that shack which was called the Old Radiation Lab. So you were actually working in there yourself.

MK: Yes.

VM: This would have been which year, roughly?

MK: 1936-1940, 1941.

VM: What sort of plant material did you use?

MK: We were working with Zev Hassid (*Professor W. Z. Hassid, Department of Biochemistry in Berkeley*) and we used barley and some other plants and then went to algae finally because we figured out that it was easier to work with algae than with plants, for various reasons. First of all, you have millions of algae, and have only one plant. But anyway one or two complications with...(*indecipherable*)...and we weren't getting very reproducible results so we went to algae. We learned a lot about how to handle the algae and that sort of thing. (I'll get my voice under control here in a moment.)

VM: The C^{11} only had a half-life of 20 minutes or so.

MK: Twenty-one minutes.

VM: So, you had to work pretty fast.

MK: Twenty-one minutes is the half-life. You can work seven or eight half-lives.

VM: That's still only a couple of hours.

MK: Well, if you have some definite things to do, you can do them in a few hours. Of course, we couldn't do the important things but we got as far as we could with the short-lived stuff.

VM: How did you make the ^{11}C? Bombarded it in a cyclotron?

MK: We bombarded boron oxide. I had developed a procedure where the CO_2 went out of the gas space. We had a target isolated from the cyclotron, the beam came through an aluminium window and then the CO_2 was collected with an aspirator and taken over to the lab. to work.

VM: So it was actually gaseous CO_2 in the container?

MK: Yes, most of the recoil activity comes off as CO_2 from boron oxide.

VM: How long a bombardment did you have to do to get enough stuff to work with?

MK: Ten minutes.

VM: Oh, as short as that?

MK: Well, the half-life is only 21 minutes, so you are already pretty far up on the saturation scale in ten minutes.

VM: Did you have to take this stuff in a great rush to the lab.?

MK: Well, if I walked to the laboratory it took me 2 minutes; if I ran, one minute and a half! So, I usually ran at the last minute so Sam thought I was really serious about things! But it didn't make much difference with a 21 minute half life.

VM: What was the nature of the experiments? What did you actually do at that time?

MK: We had a desiccator — we had plants in there — and we tried out to find out where the CO_2 went. Of course, after six or seven or more experiments we had no idea where it was. Because we didn't use short enough times. We thought maybe 8 or 10 seconds was enough but it turns out that it's even shorter than that. By the time it had gone 10 seconds already, it was distributed among all the products of photosynthesis. So, we didn't have any definitive notion of where it (*the activity*) went but we finally figured out that was in a compound which was heavily oxygenated and polar and had hydroxyl groups in it. But we couldn't isolate it out of the product itself (*although*) we tried. It takes days and we didn't have that time.

VM: How did you try to isolate it, by traditional chemical means?

MK: I went to the library and looked up all the means there were. It's a long time ago and it's hard to remember. I tried about all the things I could think of that would bring different compounds out. Of course, we (*indecipherable*) everything so we had no idea what it was.

VM: It was before the days of ion exchange or anything like that.

MK: Oh, yes. Before the days of chromatography, that would have helped us a great deal. We had nothing at all except traditional methods which means precipitation, washing, taking hours to get things to the point where they had activity. That was our criteria: that after reprecipitation we still had activity.

VM: Everything had to be timed, presumably, because you had to keep track of the half-life of this isotope.

MK: We had a chart and we kept track...it wasn't difficult at all. We could only work about seven hours so we ran pretty fast.

VM: How many years did this go on?

MK: Three years. We did thousands of experiments, whenever the cyclotron was running, that is. I took care of that part of it. I devised the procedure for making the CO_2. I think Sam started by coming over and putting boron oxide in the target and then scraping it off. Of course, all the carbon came off as CO_2. I designed a target in which all the gas space was labelled, then using an aspirator we were able to get the activity off in a matter of a few seconds.

VM: Luckily, that was easy, otherwise, if you had to spend time on that it would have been hopeless.

MK: I suppose I should be dead by now from all the radiation I took but I seem to be doing all right.

VM: Later on, you found carbon-14.

MK: Yes.

VM: What set you looking for it?

MK: Well, Harold C. Urey was talking about how there wasn't any good tracer for any of the important biological elements: hydrogen, carbon, nitrogen and oxygen. (*Indecipherable*) So, Lawrence called me in and said "Find me something with a long half-life".

VM: Just like that: "Find me something"?

MK: He (*said*) "I know where there is a possibility of one". I went to carbon first and found C^{14} there. Of course, this has got a half-life much longer than it should have, 3,700 years (*Editor: actually 5,700 years*) and it takes an awful lot of carbon-14 before you see it at all so it's hard to find. But anyway, I made a protarget up which had all kinds of complications. The beam is several watts of energy and that's hard to dissipate in a vacuum, even with water cooling, so I made some protargets which stood up to the beam and got a carbon which had enough activity so we could see it. It was hard to make with deuterons; of course, with neutrons it was no trouble at all. While I was knocking myself out trying to make it with deuterons, it was being made in enormous quantities with the ammonium nitrate which was sitting around the (*cyclotron*). We had some ammonium nitrate there and I remembered.

VM: Can I adjust this (*the microphone*) a bit better so that, we can clip it on this side. Off we go.

MK: You live in England? How lucky you are.

VM: Where were we, I've forgotten, can you remember? Perhaps I'll replay it.

You were saying about the ammonium nitrate which was stacked around the cyclotron.

MK: I had that sitting there as a sort of forlorn hope. I didn't expect much from that at all.

VM: You put it there deliberately in the hope that something would happen.

MK: Yes. The neutrons come out in a diffused manner from this large machine and there's no focusing. So, we had a very diffuse beam. It turned out that there's a very high cross-section in this reaction, neutrons on nitrogen, so it came out that we had an awful lot of carbon that we didn't know about. I remember that after we had spent so much time trying to get the carbon-14 from the deuteron bombardment, because

that's the way we did it, then I remember just passing some CO_2-free air through some of these tanks (*of ammonium nitrate*) and getting enough activity to really swamp anything we had before. The reaction with neutrons and nitrogen took over.

VM: What were you bombarding with neutrons?

MK: Ammonium nitrate in solution. We had water tanks also. But mostly I just had ammonium nitrate in solution, and there was, you know, we had to (*indecipherable*) where most neutrons are. These were 10 gallon tanks with acidified ammonium nitrate, which leaked, so after a while I was told to move these tanks. So I took what was left to the Rad. Lab. (*Old Radiation Laboratory*) and ran some air through them. We had enough activity there to keep us going for...we had microcuries. It would have taken us years to get that same kind of activity out of deuterons on carbon.

VM: Did you begin to use the C^{14} for studies on...?

MK: Yes, we had Andy Benson there at that time. He was "undesirable", he was proscribed by the Army (*Editor: he was a conscientious objector*) so he had time free. He was given the job of seeing where the C^{14} went.

VM: Even in those days when you had very little of it?

MK: Yes.

VM: I see. We're going to see Andy Benson next week.

MK: He can tell you about that.

VM: You discovered C^{14} in about 1940, I think, didn't you?

MK: It was in December of 1939 and I wrote up a thing and Sam and I published a note about it in 1940.

VM: I read an article quite recently describing you sitting up one night waiting for the thing to happen. I can't remember, somebody sent me a popular article in a magazine.

MK: That was the time I sat up for three nights and ran the cyclotron, trying to get this thing. It was too long a half-life by far; having it so long in this part of the periodic system. You know, (*indecipherable*) half life which is at least ten orders of magnitude longer than it should be. The whole thing is crazy anyway; nobody has ever understood why all this (*indecipherable*). It turned out that carbon had a much too long (*half life*); sulphur-35 is made exactly the same way, from neutrons on chlorine-35, the same reaction: it has a 87-day half life.

VM: Is that more or less expected?

MK: That's expected but this (*the half-life for carbon-14*) was not expected. I remember all the arm waving and posturing that went on among the theoretical physicists to try

to explain this. But, of course, they couldn't explain it either and nobody could ever really explain it. It's fortuitous. Anyway, there it is.

VM: How long did you go on using the C^{14} that you had?

MK: I never had a chance to use it because the war broke out and we were told to do something else.

VM: I see. At the end of the war...

MK: I wasn't there. I was a security risk, all the time, and I was considered very undesirable. In fact, I was drummed out of Berkeley for that reason. I was really a liability to everybody concerned because I was very liberal in my viewpoint and the Army was very conservative. So if you spoke in a liberal fashion, they thought you were a security risk. I was a security risk all the time. I wouldn't dwell on that; that was 50 years ago.

VM: What did you do, during the war years?

MK: During the war years. I was in charge of making all the radioactivity that the cyclotron could do for various people like Don Yost, (*indecipherable*) and so on. I remember one time we made radioactive chlorine and it was thousands of curies. But I don't remember anyone putting a dosimeter onto that! I remember that there were dosimeters for a while but they were always off scale. We stopped worrying after a while.

VM: Did you have medical checks?

MK: Well, there were supposed to be some but they were really very few/

VM: Really, I suppose people didn't really understand the implications of what the damage could be.

MK: I am a living refutation of everything. I must have been bombarded with; I have more radiation than anybody ever took and never saw any result.

VM: And that's 60 years ago now, so you survived.

MK: Yes, I have children. Of course, the trouble may be in the second generation. If the children (*indecipherable*) marry someone else in the same generation, they may see some trouble but so far that hasn't happened.

VM: I'm glad to hear it! When you left Berkeley, did you come down here to Santa Barbara?

MK: No, after I left Berkeley I went to St. Louis and I ran (*indecipherable*) for a while and then from St. Louis I went on to other things.

VM: You wrote, of course, that book on radioactive methodology.

MK: I did that one summer.

VM: One summer, is that all it took you to write that?

MK: I was pretty full of stuff. I was the only living authority on it.

VM: And that went into more than one edition, as I remember.

MK: It went through three editions. I don't have a copy but I think it was three editions.

VM: I looked it up and the last one, as I remember, was about 1957. It got a bit out of hand, I suppose, after a while.

MK: They wanted me to keep on writing it, and I said "no". It's really a job to keep in touch with all of this stuff.

VM: Did you keep up with the photosynthesis work that was going on?

MK: No.

VM: You just went into other areas?

MK: Right. There was no point in trying to compete with a tribe like Calvin had; he had all the activity, he had all the money so I went on to something else.

VM: Did you have any contact with Calvin's lab. during those years?

MK: No.

VM: Are there other things you can tell us which would be relevant to what we're doing, which is really working around the Calvin story. But, I guess you cut contact with them. You know him, of course?

MK: Yes.

VM: But you were not a frequent visitor...

MK: No. I didn't see him at all because I didn't want to go near the Laboratory. I thought I had been badly treated by them and I wasn't going to go near them. In fact, I was badly treated by them but that's their story.

VM: Can we talk just for a few minutes about what Berkeley was like before the war?

MK: It was all built around Lawrence. He had terrific charisma. I think about it 50 years later it really wasn't there, but we thought it was there. He was a great leader of people. He wasn't much of a physicist. He was more interested in big science, which

he invented. None of us were ever much interested in that: we wanted to do experiments and get some results from this. But always he wanted bigger things, bigger and better. So as soon as he got one cyclotron, he would build another one. That went on until he went on to something else. We never had a chance to do any experiments that had to do with science.

VM: Where did funding for research come from in those days?

MK: Research Corporation and various other sources. Lawrence wasn't around very much — he was out raising money.

VM: Did it come from private sources?

MK: Sometimes. Mostly from the Research Corporation and other places but I have no idea where it came from. He supported the laboratory by going out and raising money.

VM: Were you personally, and the people that you worked with, tight for money?

MK: We were always tight for money. We never had very much.

VM: Did you have other people working with you, graduate students?

MK: No. I wasn't allowed to have graduate students because I wasn't on the faculty in Chemistry. So Sam had them.

VM: It was probably before the days of postdocs., or more or less it was.

MK: I guess so, they called me a postdoc.

VM: But you were actually an employee of the Lab.

MK: But. I was still a postdoc; I had no tenured position.

VM: Berkeley must have been a rather peaceful place at the time, much smaller than it is now.

MK: Oh yes, much smaller. I get lost going around there now. I can't identify the buildings. Most of the ones I knew are gone.

VM: Were there many wide open spaces on the campus?

MK: Oh, yes. It was much more pleasant then than it is now.

VM: Had you yourself been a student at Berkeley?

MK: No. I came from Chicago.

VM: Did you get your PhD in Chicago?

MK: Yes.

VM: OK, I think that's perhaps as much as we can really expect from you after all this time. Unless you have any...

MK: Read the book (*Editor: Kamen's autobiography of the period "Bright Science; Dark Politics*").

VM: "Read the book", indeed; I've read the book. But unless you have any other bits and pieces...

MK: I've written a sequel to it, which may or may not see the light of day, but it's being processed by somebody. I. Robinson in Oregon has the text and he says it will come out soon.

VM: What's is going to be called?

MK: The first book was radiant science and dark politics. Now it's all radiant science and no dark politics.

VM:. Thank you very much.