

## Excerpts from an Interview with Cecilia Payne-Gaposchkin<sup>1</sup>

by Owen Gingerich, March 5, 1968 at the Hale Observatories, Santa Barbara State

### Section I: Undergraduate Life

**Gingerich:** In London. And it was there that you heard Eddington?

**Gaposchkin:** No. I heard him in my first year in Cambridge. He gave a lecture on relativity right after he had returned from the expedition in Brazil at which the Einstein shift of light at the eclipse had been recorded for the first time... He had gone to Brazil, had taken the plates, then had measured them.

...

**Gingerich:** Well, your undergraduate education then was in London?

**Gaposchkin:** In Cambridge. I went to Cambridge as an undergraduate.

**Gingerich:** All right. It's because when I say "school," you take that to mean secondary school.

**Gaposchkin:** Yes.

**Gingerich:** And then you went to Cambridge. And there were special colleges for women there?

**Gaposchkin:** Yes, We attended the same lectures as the men, but we lived in, well, colleges are not the same thing as they are here. A college is more like a hall of residence here. There are twenty—odd men's colleges in Cambridge.

**Gingerich:** But there is a tutorial scheme associated with the colleges themselves?

**Gaposchkin:** Well, there should have been, unfortunately didn't have a tutor because there weren't any women who were qualified to tutor in physics. The men had tutors, and occasionally got some help from a man from a man's college, but it was rather casual. I suffered from that, rather.

**Gingerich:** You were the only woman working in physics at that time? Or were there others suffering with you?

**Gaposchkin:** There was one other, but I think she dropped out was the only woman who sat through the second part of the studies, ought to explain that at Cambridge one took what is called a Part One of the Tripos in natural sciences in which one had to study three sciences. The ones I studied were physics, chemistry and botany. And then after two years you specialize in one science (that is called Part Two of the Tripos)—in physics.

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<sup>1</sup> To access the interview transcript in its entirety, see <http://www.aip.org/history-programs/niels-bohr-library/oral-histories/4909>.

**Gingerich:** And so you continued alone as far as the women were concerned?

**Gaposchkin:** Yes.

**Gingerich:** And there had been women there in physics before you?

**Gaposchkin:** Yes. Not too many. There had been some.

**Gingerich:** You were probably the only woman at the lectures.

**Gaposchkin:** I was, indeed.

**Gingerich:** You were regarded as something of a curiosity, or you were ignored?

**Gaposchkin:** Well, was I think rather resented, know was resented by [Ernest] Rutherford because there was a rule that the women were not allowed to occupy the same rows of seats as the men, so I had to sit in the front row all by myself. And Rutherford always used to start his lectures very pointedly: "Ladies...and gentlemen."

**Gingerich:** I take it that he resented your taking up the entire row of seats that might have been occupied by men, or?

**Gaposchkin:** No. I don't think he thought much of women in research.

**Gingerich:** Or did this cramp his lecturing style?

**Gaposchkin:** I don't believe so. He was rather forthright. I became quite a close friend of his daughter, and she reported to me that he had said to her indignantly, "She isn't interested in you, my dear; she's just interested in me," which made me so mad that I decided that I would not continue in physics but that I would turn to astronomy as soon as I could.

....

**Gingerich:** Now just let me double check to make sure I've got something. So let me have some details of the occasion when you heard Eddington. This was a lecture in Cambridge. Was it a special lecture or...

**Gaposchkin:** It was a perfect lecture that was given at Trinity College, which was his college, when he had completed his results.

**Gingerich:** And I recall your telling me that you were so impressed with that lecture that you wrote it out.

**Gaposchkin:** That's right. And it was the day after the lecture that I went to my director of studies and said I was going to change my studies from botany to physics.

## **Section II: Degrees and Titles**

**Gingerich:** Well, when you had your exam in physics, did you feel that you were asked a substantial amount about what would be called the new physics, or was the emphasis on classical things?

**Gaposchkin:** It was both, and one didn't have to answer all the questions. There were, I suppose, twenty questions. I think it was left to you how many you answered. I imagine six or eight would be adequate. Or perhaps six or eight thorough answers and sketches for the rest. The examinations are very lengthy; they take all day for several days. Quite a test of physical endurance.

**Gingerich:** And this is then followed by the oral exam, after they have looked at your papers, or...?

**Gaposchkin:** No. The oral exam and the practical exam are part of it. The practical exam, as I recall, occupies a whole day, during which you eat a segregated lunch where you can't talk to anybody else.

**Gingerich:** I've seen that happen here [at Harvard], too. So anything you heard from the astronomers during that time was just sort of extra for you and didn't have any direct bearing on your exams.

**Gaposchkin:** Well, I remember making a good deal of use of it in answering a question on the determination of temperature, talking about the energy curves of stars, and [Edward] Milne was beginning at that time to do spectrophotometry, and remember dilating a good deal on the spectrophotometry that he had taught me.

**Gingerich:** I see. Very good. Now, do I understand that you took this exam at the end of the two years or is this your one that came at...

**Gaposchkin:** At the end of four years.

**Gingerich:** And then this qualified you for a B.A. at Cambridge.

**Gaposchkin:** That's right. It was only the title of a B.A. at that time. Women were not entitled to the privileges of the university. That came later.

**Gingerich:** What does that mean?

**Gaposchkin:** It meant that you were granted a certificate saying that you had fulfilled the requirements that would, if you had been a man, entitled you to a B.A., that you had passed the examinations and had attained a certain level in them, and if you had been a man, therefore you would have got a B.A.

...

**Gingerich:** I see. You couldn't write B.A. after your name because you hadn't really got it?

**Gaposchkin:** You could say "tit. B.A.," I think. But I know that a good many people who taught me, women who had taught me in secondary school, who had been to Cambridge, had a degree from T.C.D., that is, Trinity College, Dublin. And it was considered of value to have that. You didn't have to do anything at Dublin except pay.

### **Section III: Working with Eddington**

**Gingerich:** Then let's backtrack just a little bit because you have told me in times past more things about speaking with and hearing [Arthur] Eddington, so I gather that though you were never formally a student of his because of the program you were in, you were hearing him or talking with him...

**Gaposchkin:** When I became disenchanted with Rutherford, I went to Eddington and asked him if he would give me some research to do. And first he handed over to me some plates which had been taken of a galactic cluster, Messier 36, and said that I could use the observatory's measuring machines to determine the proper motions. And I sat down and did this in all my spare time, probably neglecting the physics on this account. And I asked advice of Smart as to what to do next when I'd made the measures, and he said, "Well, you reduce them by least squares." I didn't know anything about reducing things by least squares, and so I went to the British Museum and asked for the works of Gauss and sat down and thrashed through all that Gauss had written about least squares, and...

**Gingerich:** In Latin, of course?

**Gaposchkin:** No, they were in German, in enormous, fat volumes, probably the original edition. Probably I am the only surviving student that went all the way back to Gauss to learn how to do least squares. Then I brought back the results to Eddington and handed them to him. He said, "Very nice. We'll publish this." And he sent it to the Royal Astronomical Society. And that was the first paper I ever published when I was still an undergraduate.

**Gingerich:** This I saw in a paper on your bibliography list.

**Gaposchkin:** Then I was looking for more worlds to conquer and Eddington said he would give me some stellar interiors to compute and he gave me a problem of integrating a stellar structure. It would be polytrope, starting at the center with an adopted temperature and density and working out to the outside by successive zones--I forget now what steps were taken, but they were small steps, but a very lengthy calculation, all done by hand.

**Gingerich:** Had he done an example before or was this the first time?

**Gaposchkin:** No, I think he had done some of them. This was the time when he was getting interested in stellar structure, but of course before he had published the "Internal Constitution of the Stars." He pointed out that the temperature and density should arrive at zero in the same zone; then you knew that you had finished the star. If they didn't, then you knew that you had made the wrong assumption in the middle and you had to make another assumption and start again, so it took forever. And it was rather laborious doing it by hand with a table of logarithms. I happened to meet a neighbor, a Mrs. Western, whose husband was the secretary of the London Mathematical Society. He had an arithmometer--I think that is what it was--an enormous calculating machine that really took very heavy work to make all the dials rotate. You set up what you wanted and then you turned a handle with main force and everything went grinding around and the result came out. So he allowed me to come in during the vacations and use his machine and I won't say I completed the stellar model, because I didn't, but I

went on working on the stellar model with it. However, I had a bright idea in the course of the calculations, I decided this was a rather uninteresting spherical star and that what I would do would be to put in a term for rotation which I did and of course it made things pretty difficult. It made  $g$  vary. I forget now how the equations ran but I know the star was distorted of course. It was no longer spherical. I struggled with this for a long time and finally I took it back to Eddington who by this time was no longer interested in the problem. think I had worked on it for something like a year and he laughed and said, I have been trying for years to figure out what effect rotation would have on the distribution of radiation and, in particular, temperature over a vast surface, So he was not surprised that I bogged down as a consequence of putting in this refinement.

**Gingerich:** When you mentioned arithmometer...

**Gaposchkin:** I think that is what it was, it had about nine dials in front and a handle at the side that you turned with great force, Perhaps I am using the wrong name was it a comptometer?

**Gingerich:** No, a comptometer was a keyboard instrument and the kind that has dials that you set would have been an arithmometer, but I am not sure about the handle at the end.

**Gaposchkin:** I know it was very hard physical work to operate it. I remember that.

**Gingerich:** It was not a direct multiply machine, you had to keep turning the handle for each cycle, guess you are right, that would be an arithmometer.

**Gaposchkin:** It looked pretty ancient.

**Gingerich:** Well, it was a machine invented around 1820.

...

**Gingerich:** Well, the search is for those of course are really made possible by the calculating machines. When you said you came back to Eddington after about a year on this research, this means that he had more or less sent you off with this project. You didn't really...

**Gaposchkin:** He was rather unapproachable. He was very shy, very silent, not an easy man to talk to and I regarded him with considerable reverence. The professor appeared at his lectures when he gave them and then disappeared. He didn't have an office or anything where you could go and see him, so you had to go to one of his lectures and ask whether you might see him and he would say, "yes, come up to the Observatory and I'll see you tomorrow" or something. It was rather a business. I was, and still am, very shy. It could have been easier I suppose if I had gone around and asked him more often. He had done this as a sort of a kindness. I wasn't a student of his.

**Gingerich:** I gather that you didn't feel that he had antipathy toward women researchers the way Rutherford did.

**Gaposchkin:** Oh, no, there were several women working at the Observatory. There was one who came from Denmark I think. I have never seen her again. And then there was Dr. Douglas who is at Queens College in Ontario, or was; I think she has retired now. She had also been disenchanted with Rutherford, or vice versa, I am not quite sure which and so had then gone to the Observatory.

**Gingerich:** Yes, I was just looking at her biography of Eddington and saw illustrated a dinner menu card for the British Association Meeting in Canada in 1925 and I saw you were one of the signers.

**Gaposchkin:** Oh, yes, I was there. That's right.

**Gingerich:** Eddington must have been over for something. Thus you must have met him on a fair number of other occasions.

**Gaposchkin:** I saw him there, but only briefly. Again I was too shy to do much except say, "Thank you for coming to listen to my paper," which he did, which was very nice of him.

**Section IV: Life at Harvard** (audio available at <https://www.aip.org/history-programs/niels-bohr-library/oral-histories/audio/4620>)

**Gingerich:** Did you feel when you came to Harvard that the exclusion of women was as severe?

**Gaposchkin:** No, coming to Harvard was intoxicating. It was partly the climate. I had never been in a climate like that before. The New England climate in the fall, well, I found it physically intoxicating. I had never felt like that before. Cambridge has an awful climate. When you go to Cambridge, you — at least I — used to resign myself to feeling like a vegetable and aching from head to foot all the time I was there because it is so damp and so cold.

**Gingerich:** And places are not centrally heated.

**Gaposchkin:** Well, not then but maybe now. I was always in a wretchedly rheumatic and creaky condition. And feeling really rather stupid and somehow the climate of New England and the intellectual climate of the Observatory, I suppose, with [Harlow] Shapley and [Willem Jacob] Luyten who had just come and who was great fun to talk to, though of course he wasn't interested in astrophysics; he was interested in statistics. The whole thing was pretty intoxicating. Also being free, for the first time, to do astronomy just as much as I wanted when I never had been before was intoxicating because even though I had done these little bits of research at Cambridge and there had always been lectures to go to and things to study and one had to keep up with one's studies, and lights had to go out at 11 in the college; no lights on after that, you were permitted a candle, but who can work by a candle? For a bit, I almost worked night and day without stopping, it was marvelous. And the Radcliffe building where I lived didn't even mind if I was out all night working. They didn't seem to care. I probably explained where I was and what I was doing, and that was that.

## **Section V: The First Book**

**Gingerich:** So I saw in your book, in looking at it. Well, this is a very remarkable book considering that you were working it out without any direct feedback with Milne or Fowler. Did you correspond with them at all?

**Gaposchkin:** I don't think so. Certainly not with Fowler. I might have corresponded with Milne, but I don't believe I even did that.

**Gingerich:** And then when you had the book ready to be presented it occurred to somebody that maybe this was a thesis?

**Gaposchkin:** Well, Shapley said, "Why don't you get a doctor's degree?" I said, "I don't want a doctor's degree. I have a degree from Cambridge. That is the highest degree in the world. I don't want any other." He-- well, I don't know, perhaps he stuck his neck out in getting me admitted as a student and wanted me to get a degree anyway. He persuaded me and I did.

**Gingerich:** I see. So this came more or less about the time the book was formulated?

**Gaposchkin:** Yes, yes.

**Gingerich:** I wish you would tell me something of the reaction the people had to your book.

**Gaposchkin:** I think they were pleased with it.

**Gingerich:** Yes, but I mean specific people who were working in that field. When Milne made his review, was he critical?

**Gaposchkin:** I forget what he said now. I think he was probably critical of some things, but in general it was accepted. Eddington's review was one that amused me. What was it he said? "The basic idea is not so wild as might at first appear." And then he explained why it wasn't.

**Gingerich:** You once indicated to me that he had put that in an appendix or at the end of one of his books.

**Gaposchkin:** Oh, yes. It's probably in the "Internal Constitution of the Stars." Yes, it's not a review at all, is it? That's right, it is a book that he refers to as giving material bearing on certain things. At least he referred to it. I think he was pleased with it. He didn't tell me so, but I think he told Shapley so. Pleased that I was able to go back to England after two years with a book published.

**Gingerich:** But that was just for a trip back, or...

**Gaposchkin:** Just for a trip. By that time Shapley had offered me a job, which I had accepted.

**Gingerich:** I was looking at the book and I came to one passage which I would put down as the "clouded crystal ball department" and that was of course the statements about the hydrogen and helium abundance. Can you recall anything about the discussions of that in that period?

**Gaposchkin:** The only thing I remember is saying to Eddington that I was surprised to find how large a proportion of the material of the universe is hydrogen and he smiled and said, “Well, that is on the stars, but you don’t know that it is in the stars.”

**Gingerich:** I suppose that the reason that people were astonished was that terrestrial abundances were not like that.

**Gaposchkin:** Yes, that is true. But that is the way it came out. It qualitatively was not so far from what we are forced to suppose today.

**Gingerich:** You have given a list in which silicon is at the top and down at the end of the list is hydrogen and helium in parentheses with the comment that while it appears that hydrogen and helium are very abundant, this must be a mistake of some kind.

**Gaposchkin:** Oh, did I say that? Well, pretty soon I convinced myself that it wasn’t. I would have said that I always thought that it was so. But it certainly didn’t take me very long to be convinced that it was.

**Gingerich:** I gather that lots of people were in fact becoming convinced around the same time, between 1925 and 1930 about the role of hydrogen. I have seen it sometimes attributed to D. H. Menzel and sometimes to Russell.

**Gaposchkin:** More likely Russell, I should think.

**Gingerich:** Did you meet Russell sometime along there when you were...

**Gaposchkin:** He used to come to Harvard for a whirl-wind visit every so often, but he mostly talked, he didn’t listen; he wasn’t a good listener. So what one had to do was pick up as much as possible from what he said.

**Gingerich:** Because his interests would surely have been closer to yours than anyone?

**Gaposchkin:** Yes.

**Gingerich:** Did you get any reaction from Russell about the book?

**Gaposchkin:** I think he was enthusiastic about it. I forget exactly what he said but I know I received the impression that he thought after that book my career as an astronomer would be established.

#### **Section VI: The Second Book**

**Gingerich:** Then you put out the second installment of your monograph, that is to say “The Stars of High Luminosity” which was in some respects the first book revisited but quite different in structure. Did you think of that as another sort of landmark or was that just amongst the papers which...

**Gaposchkin:** No, it was a book which Shapley suggested I write and it went against the grain from the first. I never enjoyed writing it. I have never thought it was a very good book, though Morgan, who I think is a valued critic, seems to attach some value to it. The only good part about it I think is the chapter on variable stars, which really first put variable stars on the map for me.

**Gingerich:** I sensed that when looked at it.

**Gaposchkin:** Suddenly they seemed to make sense. Before then they had been a scattered subject, simply observed without anyone tying them together.

**Gingerich:** At the same time that you did that you were working very hard with Shapley on "The Star Clusters" book. Is this...

**Gaposchkin:** Well, I didn't work with him. He just asked me to work as an assistant helping get it together, and draw the diagrams, get together the tables and stuff like that. It was in no sense a collaboration. He wanted the book written, was ready to work at it.

**Gingerich:** It is a nice book in a way for historical purposes and a nice year for it to have come out in 1930 because it is a pre-general absorption book and if it had been written a year or two later that particular stage in the development wouldn't really have been recorded so definitely.

**Gaposchkin:** I think he was mistaken about a lot of things but it wasn't my business to do any thinking in connection with the subject, only to get it together.

**For further reading:**

**Biographies:**

- Byers, Nina, and Gary Williams. *Out of the Shadows: Contributions of Twentieth-Century Women to Physics*. Cambridge University Press, 2006.
- Kass-Simon, Gabriele. *Women of science: Righting the record*. Vol. 813. Indiana University Press, 1993.
- McMurray, Emily J., Jane Kelly Kosek, and Roger M. Valade, eds. *Notable Twentieth-century Scientists: AE*. Vol. 1. Gale Research International, Limited, 1995.
- Payne-Gaposchkin, Cecilia, and Katherine Haramundanis. *Cecilia Payne-Gaposchkin: an autobiography and other recollections*. Cambridge University Press, 1996.
- Soter, Steven, and Neil deGrasse Tyson. *Cosmic Horizons: Astronomy at the Cutting Edge*. New Press, 2001.

**Important publications:**

- Gaposchkin, Cecilia Helena Payne. "Introduction to astronomy." *New York, Prentice-Hall, 1954*. 1 (1954). (textbook by Gaposchkin)
- Payne-Gaposchkin, Cecilia Payne. "The stars of high luminosity." *Harvard Observatory Monographs* 3 (1930): 1.
- Payne-Gaposchkin, Cecilia. *Stellar Atmospheres*. Observatory, 1925. (Ph.D. thesis submitted to Radcliffe College)