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This Week's Citation Classic

Sar-EI H Z. Cylindrical capacitor as an analyzer. I. Nonrelativistic part. *Rev. Sci. Instr.* **38**:1210-16, 1967. [Soreq Nuclear Research Center, Yavne, Israel]

Calculations of dynamic and optical properties of the cylindrical capacitor as an analyzer for a certain arrangement of source and image are presented followed by a description of their experimental verification. A second order focusing feature was revealed for the first time for electrostatic analyzers. It was accompanied by a relatively high transmission. [The *SCI*® indicates that this paper has been cited over 105 times since 1967.]

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"As a part of my graduate studies I was asked to design and build a simple, cheap electron spectrometer for the low energy level. Impressed by the work of Harrower,[1] I chose the parallel plate capacitor analyzer over others. The problem that most disturbed me then was the high degradation in transmission expected in the low energy level. A naive idea for improving the transmission was to increase the length of both the entrance and exit slits of the analyzer. It soon became clear that a considerable reduction in resolution would result. To overcome this I thought that the entrance slit could be replaced by a small hole, more expedient for 'point source' accommodation, and the shape of the exit slit could be changed to a circular arc with the entrance hole as its center. I became highly disappointed when after a short consultation with the mechanical engineer, this idea was rejected as impractical. During this consultation the well-known feature of the parallel plate capacitor as a limiting case of the cylindrical capacitor flashed upon me. I then stopped the design and began to work on the cylindrical capacitor.

"While doing the theoretical work, I revealed the unexpected existence of a second order focusing property. Since it was the first time that this property was found in electrostatic analyzers, the question of its validity arose. Therefore, I applied the same principles to the spherical capacitor.[2] Instead of obtaining clarification, I obtained many more unexpected results. I was thus advised by one of my supervisors, Israel Pelah, to discuss the theoretical predictions with three referees, physicists at the Weiz-mann Institute of Science, Rehovot. It was a two-meeting discussion at the end of which I heard their comments. The first referee greatly appreciated the results and expected their full realization. The second absolutely rejected the theory and claimed that he didn't believe that it would work at all. The third could not make up his mind. The response at Soreq was to build a prototype.

"In the summer of 1965, Aron Kupperman of the California Institute of Technology visited the Weizmann Institute and was invited by Michael Anbar to visit my laboratory. Although I showed him the prototype and described to him the principles, he too did not believe in it. Soon after my work was published, Hafner, Simpson, and Kuyatt[3] gave the analyzer its name, the cylindrical mirror analyzer (CMA). Although a Russian team[4] published the theoretical part of the work before me, I received many letters from people all over the world asking for advice in building such an analyzer. They were all impressed by the completeness of my work, in which the experimental results fully verified the theoretical predictions.

"Besides the scientific benefits of the analyzer, it was manufactured commercially by well-known companies such as Varian, Vacuum Generators, Physical Electronics Industries (purchased recently by Perkin Elmer), and Balzers. I believe the paper has been so highly cited because it presents an almost complete theoretical and experimental investigation. Yves Ballu recently published a review in this field."[5]

1. **Harrower G S.** Measurements of electron energies by deflection in a uniform field. *Rev. Sci. Instr.* **26**:850-4, 1955.
2. **Sar-EI H Z**. More on the spherical condenser as an analyzer. *Nucl. Instrum. Methods* **42**:71-6, 1966.
3. **Hafner H, Simpson J A & Kuyatt C E.** Comparison of the spherical deflector and the cylindrical mirror analyzers. *Rev. Sci. Instr.* **39**:33-5, 1968.
4. **Zashkvara V V, Korsunskii M I & Kosmachev O S.** Focussing properties of an electrostatic mirror with a cylindrical field. *Sov. Phys.-Tech. Phys.* **11**:96-9, 1966.
5. **Ballu Y.** High resolution electron spectroscopy. (Septier A, ed.) *Advances in electronics and electron physics.* New York: Academic Press. 1980. Suppl. 13B. p. 291-6.