Chapter 5 University Physics: The Middle Years at WRU

Barrows,	**Smith,**	**Freeman,**	**Whitman,**	**Mountcastle**
1866-1870	1870-1881	1881-1886	1886-1919	1907-1945

As described in the last chapter, Dayton Miller took the Case physics department almost halfway through the twentieth century, so we must now backtrack seventy years and pick up the story of the successors of the solar astronomer Charles Young at the college in Hudson. Young left Reserve in 1866 and the trustees quickly chose a replacement. **Allen Campbell Barrows** had graduated from Western Reserve in 1861. He spent three years in the army and two teaching at Phillips Andover. He would be the first Western Reserve alumnus on the WRU physics faculty. He was appointed the second Perkins Professor of Natural Philosophy and Astronomy. Today, the tenth holder of this endowed chair is my colleague Philip Taylor. While the more recent holders have retained the title until retirement, Professor Barrows did so for only five years, at which time he was appointed professor of Latin and English literature.

There would, in fact, be three more Perkins professors appointed over the following 16 years. **Charles Josiah Smith** was appointed in 1870, just a few days before he received his BA from WRC. Three years later he completed a master's degree. His principal interests did not lie in physics or astronomy and he switched to the department of mathematics in 1881, heading that department for two decades. (**Fig. 5-1**) Smith (according to his obituary) teamed up with Edward Morley in putting together the "first" classroom demonstration of the telephone. In his book, *"Western Reserve University – The Hudson Era"* (WRU Press 1943), Frederick Waite noted that following the departure of Young in 1866, all research in and teaching of astronomy at WRC essentially came to an end, and "has never been extensively revived".

Fig. 5-1. Charles J. Smith.

The Perkins went in 1881 to **Spencer H. Freeman** (MA Johns Hopkins 1878). There were great expectations for this talented young professor, but he died at age 31 after only 5 years on the faculty. Young Freeman must have been considerably occupied with the move of the college from Hudson to Cleveland.

In 1886 the Perkins chair was given to **Frank Perkins Whitman**, who would four years later be awarded a D.Sc. from Johns Hopkins. Whitman would lead the Western Reserve University physics department for more than thirty years His picture is shown in **Fig. 5-2.**

Teaching and research at WRU

The general picture of the WRU physics department, from its inception in 1830 until 1907, was that of a single professor assisted by one or two instructors who would remain with him for only two or three years. (The same was true for the neighboring Case department under Michelson and Reid, and under Miller until 1905.) The bulk of the physics teaching at WRU was in the two-semester introductory physics course with laboratory (about 50 students), and advanced classes for perhaps two or three students who were enrolled in the advanced physics courses.

Fig. 5-2. Frank Perkins Whitman.

The CWRU Archives have a complete collection of both WRU and CSAS annual catalogues and bulletins which expanded from a brochure of a dozen pages in the 1830's to thick soft-cover books of several hundred pages by 1920. They include names of trustees, officers, faculty, various functionaries, and even the names and addresses of all the students and alumni, descriptions of all the departments and courses, facilities, clubs, and prizes. Information on research is a bit more difficult to come by, although some clues can be found in the annual departmental reports.

In many instances, text books are mentioned in the course descriptions, and as an indication of what physics was being taught, I list here those titles which appeared in the catalogues most often: 1860 Lardner's *Natural Philosophy*, Jackson's *Mechanics*, Snell's Olmsted's *Natural Philosophy (*a translation by Mr. Snell of Mr. Olmsted's book*)*; 1870 Tyndall's *Heat and Sound*, Loomis' texts on astronomy and meteorology; 1880 Atkinson's Ganot's *Frictional and Dynamic Electricity*; 1890 Deschanel's *Physics*, Glassbrooks' *Physical Optics*; 1900 Hastings and Beach *General Physics*. Chairman Whitman in fact wrote a detailed and thoughtful review of the Hastings and Beach text for the Physical Review. **(***Phys. Rev. Series I* **9** 313 1899*).*

Buildings and facilities

From the very beginning, *natural philosophy*, later *physics*, was provided with state-of-the-art accommodations. Loomis' Observatory in Hudson was built in 1838 and the Athenaeum completed in 1843. (From the 1938 article by Dr. Waite: "In the Athenaeum on the first floor was provided a room for physics and one for chemistry, the first definite laboratory rooms to be provided. The greater part of the third floor of this building was devoted to a museum for scientific specimens of various types and some curios, chiefly contributions of alumni who had become foreign missionaries.") After the move in 1881 from Hudson to Cleveland, the department occupied space in Adelbert Main, the new building which housed administration, classrooms, labs and even dormitories on the top floor. Today it accommodates the CWRU administrative offices. The new Western Reserve undergraduate college for men was given the name "Adelbert" to honor the memory of Adelbert Stone, the son of the college's major benefactor, Amasa Stone. The young fellow, a student at Yale, had drowned while trying to swim across the Connecticut River.

Meanwhile, on the other side of the fence, the Case physicists occupied rooms in the new Case Main Building until it was gutted by fire in 1886. For the next few years, Case borrowed space in the basement of Western Reserve's Adelbert Main and in its large dormitory building (later called Pierce Hall). No doubt the friendship between Michelson and Morley facilitated this arrangement. It was in the basement of this dormitory building that the 1887 MM experiment took place. By 1890, the Case physics department had moved back to the restored Case Main building.

In 1894, Western Reserve celebrated the dedication of a splendid three-story Physical Laboratory on Adelbert Road just south of Adelbert Main. This fully equipped teaching and research facility, funded by a gift from Mr. Samuel Mather, was built under the direction of Chairman Whitman. The architect was Charles F. Schweinfurth.

Reserve's physics building was completed a full decade before the construction, only a hundred yards away, of Case's Rockefeller Building which was described in the previous chapter. Miller was no doubt determined to match and surpass the first-class facility at the neighboring institution. It is interesting that each of these large and well equipped buildings was built for a department with one professor! Of course, there were various instructors and assistants. No doubt the growing numbers of engineering students at Case and pre-med students at Reserve required extensive classroom and lab space.

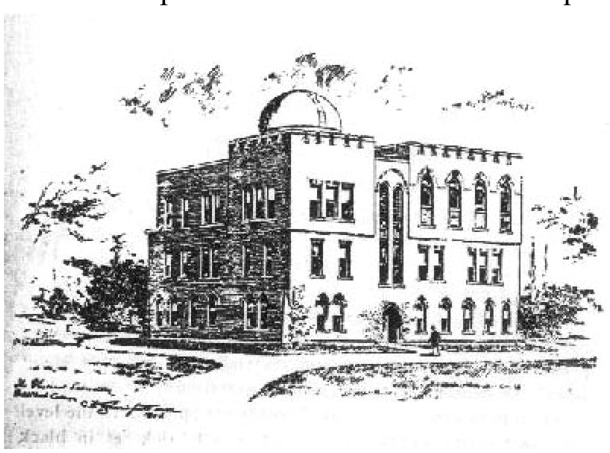

Fig. 5-3. The Western Reserve physics building on Adelbert Road.

A drawing of Whitman's building is shown in **Fig. 5-3.** It featured a large lecture hall and generous teaching and laboratory space. Floorplans of the building were included in the 1894-5 university catalogue along with a full description of the modern facility. A domed astronomical observatory was constructed on the roof. Later an equatorial telescope (10.5 inch aperture, 15 foot focal length), a gift from the Warner and Swasey Company, was installed under the rotating dome.

A stone-slab platform outside the southwest corner of the third floor was included as a mounting place for a heliostat. This device is a spring-driven mirror which is designed to follow the sun through the day so as to provide a steady beam of sunlight for the "optics and photography" laboratory. Because sensitive magnetic measurements were to be made in this building, no iron, not even nails, was used in its construction.

The building was demolished in 1969. In 2005, the last two weather-worn red sandstone remnants of this building sit hidden in the shrubbery along the south wall of Adelbert Main: the first is inscribed PHYSICS MDCCCXCIV, the other appears to have a curious mix of Aleph and Omega. ℵ Ω

Whitman and Springsteen-Mountcastle 1886 to 1935

Whitman was interested in photometry and the measurement of the reflectivity of colored surfaces. In a paper titled "On the Photometry of Differently Colored Lights and the "Flicker" Photometer" (*Phys. Rev. Series I* **3** 241 1896), he describes a clever technique for comparing two surfaces. A photometer consists of a track (like an optical bench) with light sources placed at each end. Placed on a movable carriage on the photometer track is a spinning disk with its plane at a 45-degree angle with the track. The disk is shaped like two half-circles as in the right-hand half of **Fig. 5-4**. The left-hand side of that figure shows a view looking down upon the track DE and the spinning disk AB and a cardboard "standard" surface C. When an observer looks through tube F, he sees the surface C alternating with the surface of the spinning disk. The visible surface of the disk is illuminated by the light at D and that of the standard is illuminated by the light at E. With one light and the spinning disk held at fixed positions, the second light is moved along the track until the observer no longer sees a flicker through the tube. In this way, the relative reflectivities of various colored surfaces may be determined. This type of "applied research" would be of interest for example to printers and manufacturers of paints and dyes.

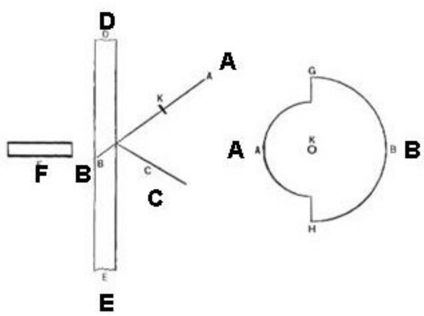

Fig. 5-4. Sketch of Flicker Photometer.

In his 1902 report to the Western Reserve trustees, chairman Whitman mentions research being done by **Harry William Springsteen** on the thermal conductivity of glass. Mr. Springsteen held a BS from Case and an MS from Western Reserve (1901), another example of WRU-CSAS cross-fertilization. The young Springsteen appears again in the 1907 catalog as Assistant Professor of Physics, with a 1904 PhD from Johns Hopkins. He would be a member of the Western Reserve faculty until his retirement in 1945. He became Perkins Professor in 1914 and took over the chairmanship from Whitman in 1918, the same year he changed his name to **Harry W. Mountcastle**. *(The CWRU Archivist found the official announcement: Harry William Springsteen having used the name of his step-father for twenty-two years announces that after July fifth nineteen hundred and eighteen he will resume the name of his father and will be known as Harry William Mountcastle*.) Mountcastle's photo is shown in **Fig. 5-5.**

Fig. 5-5. Harry Mountcastle.

We mentioned above Springsteen's interest in the thermal conductivity of glass. A year after I wrote that paragraph, I came across a copy of a doctoral thesis among Dayton Miller's documents. The 1898 thesis was from the University of Göttingen and written in German. The topic was the thermal conductivity of glass, which had little to do with Miller's interests. However, on the last page, the new young doctor, Theodore Moses Focke, writes that he was born in Massilon, Ohio, and that he received his BS degree at the Case School of Applied Science in 1892. It would seem that there was some connection, presumably in the person of a Case professor, between Focke and Springsteen. Focke was possibly the first CSAS physics BS to earn a doctorate.

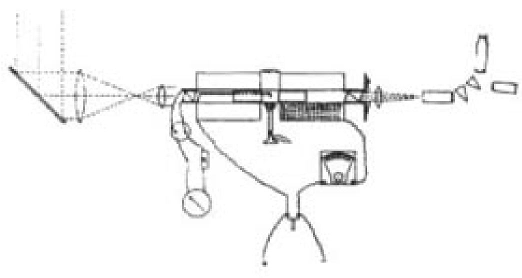

Fig. 5-6. Schematic of polarization spectrometer.

Springsteen published a paper titled "The Magnetic Rotation of Sodium Vapor" (*Phys. Rev. Series I* **21** 41 1905), coauthored with R. W. Wood of Johns Hopkins. Three years earlier, Pieter Zeeman in Amsterdam had reported on the behavior of light passing through a sodium vapor in a magnetic field. He had found that the plane of polarized light would be rotated as it passed through the vapor, in one direction at wavelengths just below the sodium D lines and in the opposite direction just above these lines. (The sodium D lines at 5889 and 5895 Ångstroms are produced when the sodium atom returns from its first two excited states to the ground state.)

Springsteen and Wood improved upon the Zeeman experiment by using a much denser sodium vapor. They used white sunlight from the heliostat mentioned above, and looked at the absorption lines. They used nicol prisms to polarize and analyze the light and selected the desired wavelengths by using diffraction gratings and a prism spectrometer. The applied magnetic field was about 2800 Gauss. Their sketch of the apparatus is shown, along with their results. **Figs. 5-6 and 5-7**. The "rotation in degrees" is plotted against the wavelength, and the plot is symmetric about the D lines – i.e. with no change in sign. (The vertical scale is essentially arbitrary; being based on the high density vapor measurements. The very large rotations, e.g. above 100 degrees, were determined by extrapolating upward from measurements made with low density vapor.) Their result was clearly in contradiction to that of Prof. Zeeman.

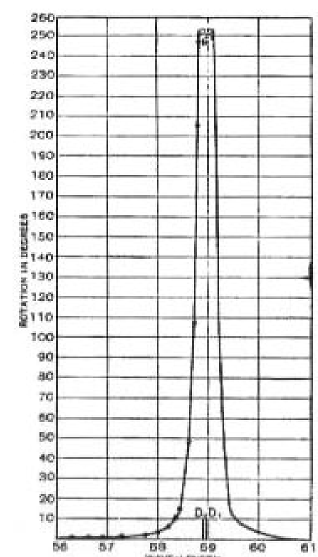

Fig. 5-7. Rotation (in degrees) of plane of polarization vs. wavelength in sodium vapor.

This 1905 experiment is a benchmark of sorts in that Springsteen's work was less "applied" than the work which Miller (x-rays and acoustics) and Whitman (photometry) had been doing It was closer to the hot-topics of the day: electromagnetism and the beginnings of atomic physics.

Graduate research

From 1920 to 1935, Mountcastle was Reserve's only professor of physics. He directed the research of eight students working on their MA degrees. The earliest, Lawrence Henry Ott, studied the production of single crystals of iron. The author thanks the scientists at the General Electric lab at Nela Park for their help. (A decade later, physicists at Case would develop strong ties to Nela Park. See Chapter 7.)

Another MA student was Abe Offner whose 1931 thesis was titled "A Critical Survey of Ether Drift Experiments". This was two years before Miller, over at Case, published his "definitive" paper on his own ether drift measurements (See Chapter 4.) The Offner thesis includes detailed descriptions of experiments ranging from the 19th century work of Arago, Fizeau, Maxwell, Michelson-Morley, and Rayleigh, as well as a dozen or more optical and electrical attempts up through the 1920's. Every one of these experiments resulted in ether drifts compatible with zero. Young Mr. Offner then turns to the data published by the chairman of the neighboring department. He thanks Professor Miller "for the prints which appear in this paper." He concludes diplomatically: "Miller's individual results are not impressive and his curves show that the errors of observation were almost as large as the result sought for. However the consistency of the results found at different times of the year and at different places shows that an effect has been observed which cannot be ascribed to errors of measurement." In his summary, Offner says "…only one experimenter, Miller, has attempted to detect the motion of the earth through the ether by means of a sufficiently extended series of observations." He no doubt had heard Miller's argument that the great extent of his data-set somehow justified his claim of a small effect. Finally, and this is 1931, Offner concludes, "…it is not necessary to abandon the hypothesis of an ether in order to explain the results of ether drag experiments, as was done by Einstein…"

The challenges of the new physics (relativity and the quantum) were further explored in an MA thesis by Herbert E. White in 1934. "The Laws of Radiation: a Critical Survey". This paper, too, included a detailed history of the subject: Kirchhoff, Maxwell, Boltzmann, Planck. The final sentence of the summary might very well have been written 70 years later by the typical perplexed student in the sophomore "modern physics" course. White concludes: "Thus the experimental evidence seems to indicate that both theories are true simultaneously. In spite of the vast amount of data bearing on the subject we are apparently still unable to answer the question: Is radiation undulatory or corpuscular? Any hope of compromise between the two theories appears to involve concessions fatal to either. Thus we are left confronted with the riddle of modern physics."

Later thesis topics give some clues to Mountcastle's very wide interests. These included the measurement of dielectric constants, the properties of dental amalgams, crystallography, and infra-red spectrometry. A 1932 thesis on fluoride gases has ***two*** authors: a curious departure from the usual arrangement. I wonder how their "defense" was handled. Appendix B lists all master's and doctoral thesis titles.

Between 1936 and around 1941, Mountcastle was joined in directing the master's level research program by a young colleague, **Cassius W. Curtis**. Curtis had just received his doctorate from Princeton where he did atomic spectroscopy. His dissertation was on the spectrum of manganese. His single-author paper on this subject, published after his arrival at WRU, included the classification of over 700 spectral lines. "The First Spark Spectrum of Manganese" *Phys. Rev*. **53** 474 1938 His first MA student, Paul Spremulli, wrote his thesis on an extended analysis of these same data.

Fig. 5-8.
Cassius Curtis.

Curtis directed the master's level research of four other students, on a variety of topics: dielectric constants of alcohols, striations in Kundt's tubes, ultrasonic emulsifiers, and supersonic oscillators. The photo in **Fig. 5-8**, from the CWRU Archives, identifies Curtis as the WRU tennis coach. He moved on to Hamilton College, and subsequently to Lehigh University where he was on the faculty for over thirty years. Curtis died in 2004 at age 98.

Chairman Harry Mountcastle was elected fellow of the AAAS. He retired in 1946 after almost 40 years on the faculty. Soon after, Richard Beth took over the department as described in Chapter 10. Mountcastle died in 1955.