Journal of Astronomical History and Heritage, 13(2), 88-89 (2010).

THE FIRST CENTURY OF ASTRONOMICAL SPECTROSCOPY

Joseph S. Tenn
Department of Physics and Astronomy, Sonoma State University, Rohnert Park, CA 94928, USA.
E-mail: joe.tenn@sonoma.edu

Abstract: This is an introduction to the following seven papers, which are expanded versions of talks presented to the Historical Astronomy Division of the American Astronomical Society at its January 2010 meeting in Washington, D.C.

Keywords: astronomical spectroscopy

Spectroscopy speakers and session organizer in Washington. Front (left to right): Barbara Becker, Matthew Stanley, John Hearnshaw, Jay M. Pasachoff; Rear: Richard A. Jarrell, Barbara Welther, Joseph S. Tenn, Vera C. Rubin and David H. DeVorkin.

1 INTRODUCTION

For the meeting of the Historical Astronomy Division (HAD) of the American Astronomical Society in January 2010 I organized a special session of invited papers on the first century of astronomical spectroscopy. This was defined as starting with the breakthroughs of Gustav Kirchhoff and Robert Bunsen in 1859-1860 and commemorated the sesquicentennial of those discoveries.

All but one of the speakers in that session, plus the authors of a relevant contributed paper, have provided expanded versions of their papers for this issue.

In the first paper, John Hearnshaw (2010) gives us an overview of the history of stellar spectroscopy, with emphasis on what it took to learn stellar compositions in detail, thus proving Auguste Comte wrong in his famous use of stellar composition as the perfect example of unattainable knowledge.

Matthew Stanley (2010) provides a look at the reaction of leading astronomers and physicists to this new method of learning about stars.

In the late nineteenth century spectroscopy was dominated by amateurs, while the professional astronomers at national observatories and universities continued to measure and compute stellar positions and motions. Barbara Becker (2010) shows how one of the most successful amateurs, William Huggins (1824–1910), made the transition to insider and winner of medals within just a few years of starting work in spectroscopy.

An interesting sidelight is the development of nomenclature. Joseph Fraunhofer (1787–1826) had labeled the lines in alphabetical order some 45 years before Kirchhoff and Bunsen, but he did not get as far as the letter K. Jay Pasachoff and Terry-Ann Suer (2010) have tracked down the origin of the notation for the two lines of ionized calcium which dominate the spectrum of Sun-like stars.

One of the major goals of stellar spectroscopy in the early twentieth century was the determination of radial velocities, to obtain full three-dimensional motions and eventually the structure of the system of stars in which we live. This required international cooperation, and Richard Jarrell (2010) tells us how that grew with the 1910 solar conference in Pasadena and at Mt. Wilson Observatory.

Another major goal was the determination of stellar compositions. Breakthroughs in atomic physics and the application of statistical mechanics to stellar atmospheres by Meghnad Saha (1894–1956), Ralph H. Fowler (1889–1944), and E. Arthur Milne (1896–1950) made it possible for young Cecilia Payne to make the first quantitative determination of the composition of the solar atmosphere in her 1925 doctoral dissertation. The reception she received for this work from leading astrophysical theorist Henry Norris Russell (1877–1957) is the topic of David DeVorkin's (2010) fascinating paper.

Those who measured wavelengths of lines in stellar spectra required laboratory measurements in order to know which gases formed those lines in stellar atmospheres and, for radial velocities, their rest wavelengths. Later they needed multiplet tables to work out compositions. Much of the laboratory work was done to order, particularly at the United States National Bureau of Standards (now the National Institute of Standards and Technology), and gathered, organized, and published by Charlotte E. Moore Sitterly. We are fortunate to have a senior astronomer of today, Vera Rubin (2010), recount for us not only some of Sitterly's history, but her own interaction with Sitterly over half a century, starting when Rubin was a young graduate student.

We were unable, however, to cover all of the interesting developments in the first century of astronomical spectroscopy.

There is nothing in these papers on the spectroscopy of the objects now known as galaxies. The work of V.M. Slipher (1875–1969) in measuring the redshifts and blueshifts of what were then called spiral nebulae (Slipher, 1913; 1915), greatly expanded by Milton Humason (1891–1972) (1931) and a host of others, especially Allan Sandage (b. 1926) (see, for example, Humason, Mayall, and Sandage, 1956), was a major part of the first century of astronomical spectroscopy, as was the discovery of galaxy rotation by Slipher (1914; see also Brémond, 2009) and the 1939 measurement of the rotation curve of M31 by Horace W. Babcock (1912–2003).

Nor is there anything here about the spectroscopy of planets, where again Slipher was a major contributor (see Slipher, 1933), but we could also have included discussions of the work of James E. Keeler (1857–1900), who measured the rotation of Saturn's rings (1895); Walter S. Adams (1876–1956) and Theodore Dunham, Jr. (1897–1984), who found carbon dioxide on Venus (1932; also Dunham, 1933); and Gerard P. Kuiper (1905–1973), who discovered carbon dioxide and methane in the atmospheres of Mars (1952) and Titan (1944), respectively.

Also, a full discussion of the first century of astronomical spectroscopy would have to include not only more about the early rocket flights that extended solar and then stellar spectroscopy into the ultraviolet and infrared, but also what might be the single most important spectral line: the 21-cm radiation of atomic hydrogen, predicted by H.C. van de Hulst (1918–2000) in 1944 and detected in 1951 by Harold Ewen (b. 1922) and Edward Purcell (1912–1997).

2 REFERENCES

Adams, W.S., and Dunham, T., Jr., 1932. Absorption bands in the infra-red spectrum of Venus. *Publications of the Astronomical Society of the Pacific*, 44, 243-245.

Babcock, H.W., 1939. The rotation of the Andromeda Nebula. *Lick Observatory Bulletin*, 498, 41-51.

Becker, 2010. From dilettante to serious amateur: William Huggins's move into the inner circle. *Journal of Astronomical History and Heritage,* 13, 112-120.

Brémond, A.G., 2009. V.M. Slipher's discovery of the rotation of spiral nebulae and the controversy with Bertil Lindblad. *Journal of Astronomical History and Heritage*, 12, 72-80.

DeVorkin, D., 2010. Extraordinary claims require extraordinary evidence: C.H. Payne, H.N. Russell and standards of evidence in early quantitative stellar spectroscopy. *Journal of Astronomical History and Heritage*, 13, 140-145.

Dunham, T., Jr., 1933. The spectra of Venus, Mars, Jupiter, and Saturn under high dispersion. *Publications of the Astronomical Society of the Pacific*, 45, 202-204.

Ewen, H.I., and Purcell, E.M., 1951. Radiation from galactic hydrogen at 1,420 MHz. *Nature*, 18, 356-358.

Hearnshaw, J., 2010. Auguste Comte's blunder: an account of the first century of stellar spectroscopy and how it took one hundred years to prove that Comte was wrong! *Journal of Astronomical History and Heritage*, 13, 90-104.

Humason, M., 1931. Apparent velocity-shifts in the spectra of faint nebulae. *Astrophysical Journal*, 74, 35-42.

Humason, M.L., Mayall, N.U., and Sandage, A.R., 1956. Redshifts and magnitudes of extragalactic nebulae. *Astronomical Journal***,** 61, 97-162.

Jarrell, R.A., 2010. The 1910 Solar Conference and cooperation in stellar spectroscopy. *Journal of Astronomical History and Heritage*, 13, 128-139.

Keeler, J.E., 1895. A spectroscopic proof of the meteoric constitution of Saturn's rings. *Astrophysical Journal*, 1, 416-427.

Kuiper, G.P., 1944. Titan: a satellite with an atmosphere. *Astrophysical Journal*, 100, 378-383.

Kuiper, G.P., 1952. *The Atmospheres of the Earth and Planets*, Second Edition. Chicago, University of Chicago Press.

Pasachoff, J.M., and Suer, T.-A., 2010. The origin and diffusion of the H and K notation. *Journal of Astronomical History and Heritage*, 13, 121-127.

Rubin, V.C., 2010. Charlotte Moore Sitterly. *Journal of Astronomical History and Heritage,* 13, 146-149.

Slipher, V.M., 1913. The radial velocity of the Andromeda Nebula. *Lowell Observatory Bulletin*, 2, 56-57.

Slipher, V.M., 1914. The detection of nebular rotation. *Lowell Observatory Bulletin*, 2, 66.

Slipher, V.M., 1915. Spectrographic observations of nebulae. *Popular Astronomy*, 23, 21-24.

Slipher, V.M., 1933. Spectrographic studies of the planets (George Darwin lecture). *Monthly Notices of the Royal Astronomical Society*, 93, 657-658.

Stanley, M., 2010. Spectroscopy—so what? *Journal of Astronomical History and Heritage*, 13, 105-111.

van de Hulst, H.C., 1945. Radiogolven uit het wereldruim. II. Herkomst der radiogolven. *Nederlands Tijdschrift voor Natuurkunde*, 11, 210-221.

Joseph S. Tenn taught physics and astronomy at Sonoma State University from 1970 to 2009. He now serves as Secretary-Treasurer of the HAD and as an Associate Editor of this journal, and he maintains the Bruce Medalists website at http://phys-astro.sonoma.edu/brucemedalists/. He acted as Guest Editor for the papers in this section of the journal.