Schuster, Arthur

Born **Frankurt, Germany, 12 September 1852**
Died **Berkshire, England, 14 October 1934**

German-English theoretical astronomer Arthur Schuster is commemorated in the Schuster–Schwarzschild (or reversing layer) approximation for analyzing the spectra of stars to learn their chemical composition. The idea is that you can treat the situation as if there were a hot layer, the photosphere, emitting a blackbody continuum, and a cooler layer above which imposes the absorption lines. The opposite approximation, that the continuum source and absorbing atoms are uniformly mixed, is called the Milne–Eddington approximation, and real stars come somewhere in between. **Karl Schwarzschild**, **Edward Milne**, and **Arthur Eddington** appear elsewhere in this book.

Schuster was the son of a Frankfurt textile merchant and banker. In the wake of the 1866 "seven weeks war" when Frankfurt was annexed by Prussia, the family moved to Manchester, England. Schuster was educated privately and at the Frankfurt Gymnasium. He attended the Geneva Academy from 1868 until he joined his parents at Manchester in 1870. Schuster studied physics at the Owens College, Manchester, and the University of Heidelberg, where he obtained his doctorate in 1873.

After a few years at the Cavendish Laboratory in Cambridge (1875–1881), Schuster returned to Manchester to become professor of applied mathematics (1881–1888) and later professor of physics (1889–1907). After an early retirement at the age of 56, he spent his time with his own research and on the formation of the International Research Council. With his retirement, Schuster made way for **Ernest Rutherford**.

Schuster worked in following different areas, many of them related to astronomy:

Spectroscopy. In 1881, Schuster refuted the speculation of **George Stoney** that spectral lines could be regarded as harmonics of a fundamental vibration. He did this using a statistical analysis of spectral lines of five elements. Schuster concluded: "Most probably some law hitherto undiscovered exists which in special cases resolves itself into the law of harmonic ratios." In 1888, **Johann Balmer** took a fairly large step forward when he delivered a lecture to the Naturforschende Gesellschaft in Basel. He represented the wavelengths L of the spectral lines as $L = h \cdot m^2/ (m^2 - n^2)$, where m and n are integers. For the hydrogen atom, where n = 2, it would lead to wavelengths $h \cdot 9/5$, $h \cdot 16/12$,$h \cdot 25/21$ …, the Balmer Series which forms visible light. While Schuster had not yet seen this, his statistical analysis had refuted the speculation of a law $L = h\dot{c}m$, which Stoney had speculated. The Balmer law $1/L = R \cdot (1/m^2 - 1/n^2)$ would later be derived by quantum mechanics.

Schuster's most notable paper, on the analysis of stellar absorption features, was not published until 1905.

Electricity in gases. Schuster was the first to show that an electric current is conducted by ions. He also showed that the current could be maintained by a small potential once ions were present. He was the first to indicate a path toward determining the charge–mass ratio e/m for cathode rays by using a magnetic field. This method would ultimately lead to the discovery of the electron.

Terrestrial magnetism. Schuster's study on terrestrial magnetism showed that there are two kinds of daily variations in the magnetic field of the Earth—atmospheric variations caused by electric currents in the upper atmosphere as well as internal variations due to induction currents in the Earth. The Schuster–Smith magnetometer is the standard instrument for measuring the Earth's magnetic field. Schuster's numerous articles examined and rejected many proposed theories of geomagnetism, usually because of shortcomings in their mathematics or physics.

X-rays. In 1896, Wilhelm Röntgen had sent copies of his manuscript to a small group of fellow scientists—Schuster in Manchester, Friedrich Kohlrauch in Göttingen, Lord Kelvin (**William Thomson**) in Glasgow, **Jules Poincare** in Paris, and Franz Exner in Wien. In the same year, Schuster proposed that the new x-rays of Röngten were, in fact, transverse vibration of the ether of very small wavelength, that is, a short-wavelength extension of the radiation (light) implied by Maxwell's equations.

Antimatter. Schuster published two letters on antimatter in *Nature* in 1898. In them, he surmised "if there is negative electricity, why not negative gold, as yellow as our own?" For 30 years, Schuster's conjecture gathered dust. Only in 1927, an equation by Paul Dirac predicted a new duality and underlined what Schuster had suggested in 1898.

Expeditions. Schuster, having been invited by **Norman Lockyer** to join an expedition to Siam in 1875, to observe a total eclipse, was then asked by **George Stokes** to take charge of the whole expedition on behalf of the Royal Society. In the 19th century, some, if not all, of the world's astronomers believed in a planet inside the orbit of Mercury. This speculative intra-Mercury planet was called Vulcan. Only a total solar eclipse would make possible seeing it.

The planet Vulcan had been a theoretical construct to solve a problem in planetary dynamics—the mystery of Mercury's orbit. This problem was only resolved in 1915 with **Albert Einstein**'s general theory of relativity, in which the orbital deviations could be explained due to relativistic effects of the Sun's huge mass bending space-time. Vulcan does not exist, and never did; the hunt for it was finally abandoned after the total solar eclipse of 1929.

No eclipse yielded an intra-Mercury planet. But Schuster photographed a comet during the total solar eclipse of 1882.

Laboratory. Schuster raised funds to construct a new laboratory in 1897 and created new departments, including a department of meteorology in 1905.

Schuster was the first secretary of the International Research Council, established under the Treaty of Versailles (which abolished all pre-World-War-I international scientific collaborations) from 1919 to 1928, and was knighted in 1920.

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