Christian Doppler (1803–1853) and the impact of the Doppler effect in astronomy

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Christian Doppler (1803–1853) started his career in Prague in 1835 as teacher in a technical secondary school, then in 1841 he became professor for mathematicsat the polytechnical institute. In 1842 he published a paper with the title ÜBER DAS FARBIGE LICHT DER DOPPELSTERNE UND EINIGER ANDERER GESTIRNE DES HIMMELS suggesting a relation between the colours of the stars and their velocities – this idea was wrong. Nevertheless, his transfer of the idea to acoustics led to important results: you hear a higher pitched sound if a source is approaching, if it is receding you hear a lower pitched sound. The acoustic Doppler effect was first checked with trumpet players on locomotives. Despite of this successful experiment the application of the Doppler effect to optics and astronomy was controversial for a longer time.


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The idea to use the line shifts in the spectra of astronomical objects for getting their velocity originated from A.H.L. Fizeau in 1848 and then from Gustav Kirchhoff in 1860. The first measurement of the resulting line shifts was made by Hermann Carl Vogel (1841–1907) in determining the solar rotation spectroscopically in 1871.

The first visual measurements of the radial velocity of the stars made by some English astronomers were without success. To get reproduceable results, H. C. Vogel, director of the Astrophysical Observatory Potsdam, started to make use of the new technique of photography. This led to the construction of a spectrograph in 1888 which was further developed in interaction with astronomical research. Apart from the idea to use photography as measuring method Vogel tried two further important improvements: the application of gratings instead of prisms and the introduction of iron as comparison spectrum which has the advantage to offer a lot of lines.

Important improvements were made by the Potsdam staff in the further development of spectrographs: Vogel and Johannes Hartmann (1865–1936) built a heating equipment for the three-prism-spectrograph model III (1898) in order to avoid temperature fluctuations during the exposure time. The three-prism-spectrograph model IV (1900) with improved accuracy – made by Vogel and Gustav Eberhard (1867-1940) – still had a small error caused by sagging. The spectrograph may not be flexible during the long exposures. To get a stable but not a heavy instrument, Vogel and Eberhard used for model V (1905) a better cast-iron framework construction and new optics.
Scientists in other countries gave due regard to Vogel's exact measurements of the radial velocities of the stars. Soon Vogel discovered a new class of binaries based on the periodic line shifts in the spectrum.

A further example of the application of the Doppler effect in the 19th century was the determination of the rotation of the large planets, especially Jupiter and Saturn, based on radial velocities. James E. Keeler's (1857–1900) measurements of Saturn's ring in Pittsburgh/Allegheny in 1895 could prove the constitution of the ring consisting of small particles revolving the planet in a circular orbit. Finally one tried to get information about the rotation of the stars from the broadening of their lines.

After Vogel's death the most important application of the Doppler effect concerned the research of nebulae and galaxies. Theirs large red shifts indicated an expansion of the universe in the 1920s.