The line spectrum of delta cephei

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SUMMARY

A number of spectra of delta Cephei have been photometrically measured and reduced. The plates had been taken by Professor Pannekoek with the three-prism spectrograph of the Dominion Astrophysical Observatory at Victoria.

The method is an extension of earlier methods developed at Amsterdam, and its aim was to measure the separate spectral lines as well as possible. The intensity curves, obtained after registration, have been reduced to a logarithmic scale. Then the spectral lines were fitted as well as possible into the intensity curves, making use of their theoretically computed profiles and their known wavelengths.

The equivalent widths thus obtained, together with relative Nf values derived from the solar spectrum, furnished curves of growth for different elements and for every plate. The Doppler width appeared to be rather large and was the same for all elements, so that it is interpreted as a turbulence in the atmosphere of the star. No important variation of this quantity with the phase of light variation could be established.

Making use of a mean curve of growth, the dependence on phase of the Nf value was derived for various atoms and ions. From the relation between excitation potential and Nf value for the iron lines, which are the most numerous, the excitation temperature relative to the sun could be derived. The theory of thermal ionization and excitation, combined with the assumption that negatively charged hydrogen atoms are responsible for the continuous absorption enabled us to find the ionization temperature and electron pressure, likewise with respect to the sun. It appeared that the temperature depends solely on the atomic lines, whereas the electron pressure is determined chiefly by the ion lines. The agreement of the results for different elements is satisfactory.

The wings of the hydrogen lines furnished another excitation temperature.

The variation with phase of the temperatures thus obtained from spectral line intensities agrees qualitatively with that for the color temperature according to other observers. The excitation temperatures show a smaller amplitude than the ionization temperature.

The variation of electron pressure with phase is similar to that of radial velocity. The observed maxima of temperature and electron pressure coincide with the maximum of brightness and with the minimum of radial velocity.

The theory of model stellar atmospheres of B. Strömgren has been used to compute the effective gravity from our observed values of temperature and pressure, use being made of Strömgren's results for the sun. For this the value of A, i.e. the ratio between the numbers of hydrogen atoms and metal atoms was of importance. Strömgren's value $\log A = 3.8$ has been used, but the effective gravity was also computed for the extreme cases where the number of electrons is determined only by the hydrogen atoms or only by the metal atoms.

Generally the gravity found in this way is 35 times smaller than the static value computed from mass and radius. Moreover the variation with phase did not agree with the model of standing pulsation proposed by Eddington. Reasonable agreement was obtained with the running wave model, used by M. Schwarzschild.

The low value of effective gravity suggests the possibility of an outward stream of gas, and, as Pannekoek remarked, it is probable that this outward flow has the form of periodically expelled shells, dissipating into space, as a consequence of the outward running wave.

More and better observations, however, are necessary to establish this effect with certainty.