EVIDENCE FOR DISKS AROUND CERTAIN LUMINOUS MAGELLANIC CLOUD STARS FROM THE STUDY OF FeII

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ABSTRACT. Study of FeII emission lines in emission and absorption using both emission line self absorption curves and ultraviolet spectral synthetis, shows that line emission is produced in the case of certain luminous Magellanic Cloud stars, in a region not in front of the photosphere. This region is most easily understood as being a disk. Absorption lines of FeII are either produced by a wind, or if the disk inclination is small with respect to the line of sight, in layers associated with the disk. The presence of disks also helps one to explain the form of the continuous energy distribution.

Certain highly luminous stars with a fairly high effective temperature have optical spectra which are very rich in FeII emission lines, while low resolution UV spectra suggest that blends of FeII absorption lines are more often dominant than emission in that spectral region. We have studied stars of this kind in the Magellanic Clouds.

We analyze emission lines using the self absorption curve method, i.e. by plotting graphs of $\log(F_\lambda W_\lambda \lambda^3/gf)$ against $\log(gf\lambda)$. Here F_λ is the continuum flux corrected for interstellar absorption, W_λ the line equivalent width, g the lower level statistical weight, and f the oscillator strength. λ is the wavelength. It can be shown that :

$$\log\left(\frac{F_\lambda W_\lambda \lambda^3}{gf}\right) = \log(2k\pi hc) + 2\log\left(\frac{R_c}{d}\right) + \log(\phi_c V_c) + Q(\tau_c) \quad (1)$$

In this equation k is a constant equal to $0.02654 \mathrm{cm\ s^{-1}}$, h and c have their usual meanings, d is the distance of the star, while R_c, ϕ_c, V_c and τ_c are characteristic values of the radius, the upper level population of a unit column per unit velocity range/statistical weight, velocity and optical thickness of the medium emitting the line. $Q(\tau_c)$ is a function of τ_c, which depends on the nature of the medium. Noting that τ_c is a multiple of k, $gf\lambda$ and of the characteristic value of the lower level population of a unit column per unit

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velocity range/statistical weight, the shape of a self absorption curve for lines of the same multiplet gives the shape of the variation of $Q(\tau_C)$ with log τ_C, as long as the levels of each term have relative populations proportional to their statistical weights. Population ratios of different terms can be found by shifting self absorption curves of different multiplets relative to each other, relative horizontal shifts for multiplets having the same upper term give population ratios for the lower terms, while relative vertical shifts for multiplets having the same lower term give population ratios for the upper terms.

The function $Q(\tau_C)$, giving the shape of the self absorption curve, has been calculated for various simple models, including some of stellar winds. This enabled observations of emission lines to be fitted, and various parameters such as R_C and the column density to be determined.

Spectral synthesis of low resolution IUE spectra has also been performed. The parts of a wind in front of the photosphere produce absorption components, which have been taken into account after calculation of the curve of growth. The form of this for a high velocity wind assuming only Doppler broadening of the lines, was specially calculated.

We conclude that firstly the FeII lines are not photospheric, and that the stars studied appear to have line emission formed in a region not in front of the photosphere, most easily understood as a disk, in addition to the indications found for the presence of a wind in at least some cases. Analysis of the continuum energy distribution also supports the presence of disks, which reprocess radiation from the central star.