ATMOSPHERIC PARAMETERS AND ACCELERATIONS IN THE OUTER PARTS OF LUMINOUS HOT STARS

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1. OUTLINE

In the atmospheres of the most extreme luminous stars, close to the Humphreys-Davidson limit, the inward gravitational acceleration is for a great part compensated by outward accelerations due to radiation pressure, turbulent pressure and dynamic pressure of the stellar winds. As a result the effective acceleration is very small, resulting in blown-up atmospheres that can no longer be considered plane-parallel or in hydrostatic equilibrium.

In order to estimate the physical conditions in the outer parts of the atmospheres of extreme stars an iteration procedure was developed based on the equations

$$g_{eff} - \frac{k_R}{\tau_R} P = 0 \tag{1}$$

$$k_R = k_R(P,T) \tag{2}$$

$$-g_{eff} = -g_{grav} + g_{grav}\Gamma_{Edd} + \frac{1}{2}\frac{d(v^2)}{dr} - \frac{\psi}{2\rho}\frac{d}{dr}(\rho s^2) \tag{3}$$

$$T(\tau_R) = f(T_{eff})$$

Here τ_R is the Rosseland mean optical depth of the level considered, k_R the Rosseland mean absorption coefficient at that level.

The functions (2) and (4) are read from Kurucz's tables and models, while the function ψ is an empirical ratio between the squared microturbulent velocity component $\langle\xi_\tau^2\rangle$ and the squared velocity of sound, s^2. The three last terms at the right-hand side of eq.(3) are respectively the radiative acceleration, and the accelerations resulting from dynamic wind pressure and turbulence.

The system of equations is solved iteratively with $g_{eff} = 0.5\ g_{grav}$ as a starting value. The calculations presented here refer to the level $\tau_R = 0.1$.

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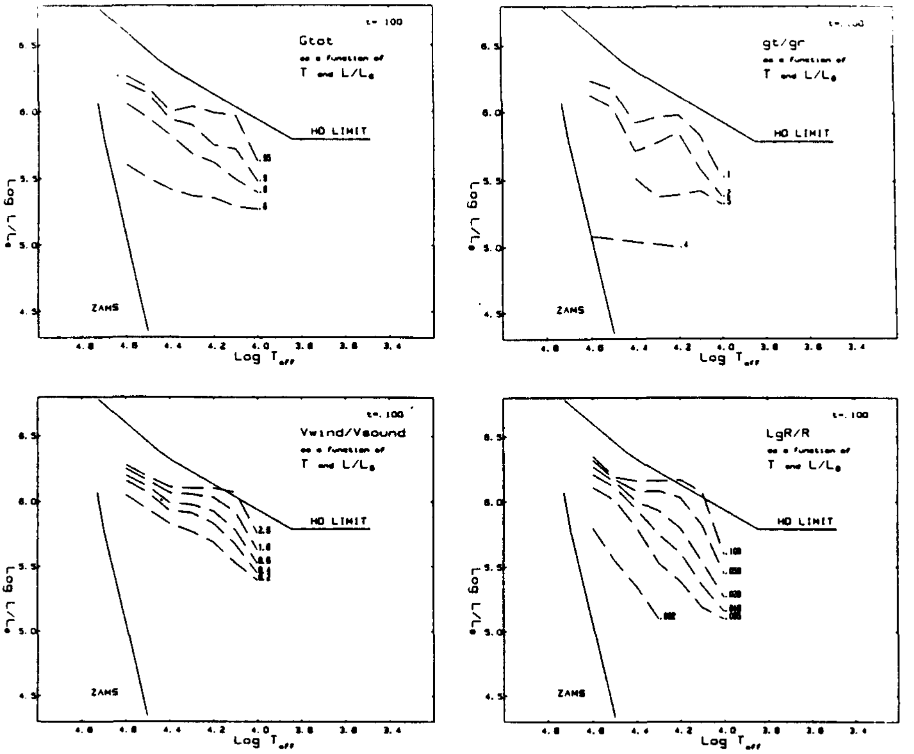

2. RESULTS

The figures give, for the upper part of the Hertzsprung-Russell diagram respectively: $-g_{out}/g_{grav}$ (G_{tot}); g_{turb}/g_{rad} (gt/gr); v_w/s and log $R/R_\star$ (LgR/R), where v_w is the wind velocity and $R-R_\star$ is the geometric distance between the levels τ_R=0.1 and τ_R=2/3, the latter assumed to refer to the star's radius.

The diagrams show that at the HD limit $g_{out} \approx -g_{grav}$, and that the stars' atmospheres become quite extended there.

Crucial for the understanding of the LBV phenomena seems that the upper boundary of the LBV area in the Hertzsprung-Russell diagram coincides with the line $v_w \approx s$ and where the ratio g_{turb}/g_{rad} drops rapidly to a small value. Inside the LBV-area the ratio g_{turb}/g_{rad} reaches large values, close to 0.5 and even higher. This shows that dynamic effects may be predominant for explaining the LBV phenomenon.

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