On magnetic inhibition of photospheric macro turbulence generated in the iron-bump opacity zone of O-stars

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Massive, hot OB-stars show clear evidence of strong macroscopic broadening (in addition to rotation) in their photospheric spectral lines. This paper examines the occurrence of such ``macro-turbulence'' in slowly rotating O-stars with strong, organised surface magnetic fields. Focusing on the CIV 5811A line, we find evidence for significant macro-turbulent broadening in all stars except NGC1624-2, which also has (by far) the strongest magnetic field. Instead, the very sharp CIV lines in NGC1624-2 are dominated by magnetic Zeeman broadening, from which we estimate a dipolar field 20 kG. By contrast, magnetic broadening is negligible in the other stars (due to their weaker field strengths, on the order of 1 kG), and their CIV profiles are typically very broad and similar to corresponding lines observed in non-magnetic O-stars. Quantifying this by an isotropic, Gaussian macro-turbulence, we derive vmac 2.2 (+- 0.9/2.2) km/s for NGC-1624, and vmac = 20-65 km/s for the rest of the magnetic sample. We use these observational results to test the hypothesis that the field can stabilise the atmosphere and suppress the generation of macro-turbulence down to stellar layers where the magnetic pressure PB and the gas pressure Pg are comparable. Using a simple grey atmosphere to estimate the temperature T0 at which PB = Pg, we find that T0 > Teff for all investigated magnetic stars, but that T0 reaches the layers associated with the iron opacity-bump in hot stars only for NGC1624-2. This is consistent with the view that the responsible physical mechanism for photospheric O-star macro-turbulence may be stellar gravity-mode oscillations excited by sub-surface convection zones, and suggests that a sufficiently strong magnetic field can suppress such iron-bump generated convection and associated pulsational excitation.

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