Observation and modelling of main-sequence star chromospheres – XV. New constraints on the dynamo mechanisms for dM1 stars

Titre	Observation and modelling of main-sequence star chromospheres – XV. New constraints on the dynamo mechanisms for dM1 stars
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Résumé en anglais	With the help of measures of rotation, radius and metallicity for a selected sample of dM1 stars (with Teff= 3460 ± 60 K), we aim to set new constraints on the dynamo mechanisms.We recover 913 high-resolution spectra for 97 different M1 dwarfs from the European Southern Observatory and Observatoire de Haute Provence data bases. We present 660 new measurements of the Ca ii resonance lines and 913 new measurements of the Hα line for dM1 stars. We also compile other measurements available in the literature. In total, we obtain 2216 measures of the Ca ii lines for 113 different dM1 stars. This represents the largest compilation of chromospheric line measurements at a single spectral type. We cross-correlate these magnetic activity indicators with various stellar parameters to set new constraints on the dynamo mechanisms and on the properties of the outer atmosphere. We find a correlation of the Ca ii line mean equivalent width with the absolute magnitude and the metallicity. We correct the Ca ii line measures from the metallicity effect and find that the surface flux in the Ca ii lines grows roughly as the power of 3.6 of the stellar radius. This corrected flux is a direct measure of magnetic activity at the chromospheric level. We find that the total magnetic activity level grows roughly as the power of 5.6 of the stellar radius. This trend is confirmed by the correlation between the Hα line and absolute magnitude and the Hα line luminosity and stellar radius: the Hα luminosity grows roughly as the volume of the star for low activity dM1 stars and as the power of roughly 5/2 of the stellar radius for dM1e stars. The advantage of the Hα line is that its formation in not dependent on metallicity. In contrast to the Ca ii line, we find no correlation between LX and the absolute magnitude. We find that LX roughly correlates with the Ca ii luminosity although the correlation is not very good. This correlation shows that LX grows as the power of 3/2 of the Ca ii luminosity, i.e. the coronal emission grows faster than the chromospheric emission. We find a correlation between the corrected Ca ii line equivalent width and P/sin i, i.e. the Ca ii surface flux grows as the power of −1.5 of the rotation period. We also find a correlation between FX, the X-ray surface flux, and P/sin i: FX∝ (P/sin i)−3.7. In other words, the coronal emission is much more dependent on the rotation period than the chromospheric emission. We find that the level of magnetic activity in dM1 stars is more dependent on the stellar radius than on rotation at the chromospheric level. We discuss the implications of these results on the models of stellar dynamos.
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