SPECTROSCOPIC OBSERVATIONS OF LATE-TYPE HALO M DWARFS

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ABSTRACT

In the lower main sequence, the coolest halo population stars do not appear to be particularly subluminous in either the standard HR diagram or the (M_I, R-I) plane. Earlier type M subdwarfs (e.g., Kapteyn's Star) that lie one or more magnitudes below the main sequence exhibit enhanced hydride absorption bands relative to M dwarfs of the same temperature. From visual region (4500-7000 Å) low dispersion image tube spectrograms we find that the cool halo M dwarfs exhibit enhanced absorption in the CaOH 5530 Å band and Na I resonance lines. Easily noticeable changes in the strength of the CaH "B" band relative to that of the TiO bands was found to be more difficult to determine in halo dwarfs later than spectral type M4. Several M dwarfs with old disk type motions have spectral peculiarities similar to those of the halo dwarfs. In both cases, Balmer emission is not present in most stars, in the rest it is very weak. Therefore, the anomalous strength of the CaOH 5530 Å band and Na resonance lines appear to be a more conveniently utilized qualitative criterion in spectroscopically identifying very cool M dwarfs which are subluminous with respect to most main sequence stars of the same temperature class.

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DISCUSSION

KODAIRA: You have told us that it is difficult to distinguish subdwarfs in HR diagrams. One of the reasons is obviously the weakening of TiO bands in the photometric passband V. The metal deficiency can probably shift a point only a little along the (B - V) axis, while the point is shifted at the same time upwards along the V axis. Thus the differences are strongly diminished. On the other hand, if you have an I versus (R - I) diagram, both the passbands I and R are rather insensitive to the variation by line-blocking. Therefore, I think you should plot stars in an I vs. (V-I) diagram, at least, in order to distinguish subdwarfs from the normal M dwarfs.

BOESHAAR: These are good points; however, many of the stars in my sample have no published I-magnitudes. Also, I did not use the absolute strength of the visual region TiO bands as the criterion in determining my temperature scale. I've compared my spectral types with Veeder's effective temperatures and find a good correlation. Note that I'm not calling these M dwarfs with enhanced Na "D" absorption subdwarfs, because we are not certain yet just what constitutes a true subdwarf for the coolest spectral types. I simply prefer to call these stars subluminous with respect to most main sequence stars of the same temperature class.

BIDELMAN: The M dwarfs present a truly serious classification problem. A priori, one might well expect substantial abundance variations in this group. If one uses only the TiO bands as a classification parameter, one is depending on a molecule containing two "heavy" elements, the strength of which may well depend on the M/H ratio. The D lines and CaH depend only on one element that may be deficient in high-velocity stars. These may well be more appropriate temperature classification parameters than the bands of TiO.

BOESHAAR: Mould has analyzed near-infrared coudé spectra of the early M-type subdwarf, Kapteyn's star, and obtained $[Fe/H] \sim -0.5$, $[Ti/H] \sim -0.2$. This is nothing spectacular compared with the abundances obtained for G-type subdwarfs. The metal hydride bands are known to be sensitive to changes in luminosity. In addition, the effect of pressure broadening in these late type stars is to strengthen the Na "D" lines.

BIDELMAN: If Mould's analysis is correct, then Kapteyn's star must be the star with the highest space velocity with that small a metal deficiency.

CAYREL de STROBEL: It's a pity that the sodium-enhanced stars in your sample cannot be given detailed analyses in order to find their sodium abundances. I remember that in the K-star region we have found a sodium-rich sample.

BOESHAAR: The spectra of certain M giants (such as 55 Peg shown on the previous slide) indicate sodium enrichment. However, I don't think that the strengthening of the Na "D" lines in the M dwarfs is solely an abundance effect. Regardless of whether the motion data indicate membership in the young disk, old disk, or halo populations,

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