GLOBAL AND PHOTOSPHERIC PHYSICAL PARAMETERS OF ACTIVE DWARF STARS

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Abstract
Physical parameters (temperature, luminosity, radius, mass and chemical abundance) of the photospheres of red dwarf flare stars and spotted stars are determined for quiescent conditions. The interrelations between these quantities are compared to the results of theoretical investigations for low mass stars. The evolutionary state of flare stars is discussed. Observational results from spectroscopic and photometric methods to determine the rotation of active dwarfs are reviewed. The possibilities of global oscillations in dwarf stars are considered and preliminary results of a photometric search for oscillation in red dwarf luminosities are presented.

1. INTRODUCTION

Flares and spots have been observed in a variety of stars. Extremes are young T Tauri stars and old subdwarfs; luminous giants and faint main sequence dwarfs; very rapid rotators (100 km/s) of the FK Com type and slow rotators (1 km/s) on the main sequence; single stars and multiples of different kinds. In this paper I will concentrate on the lower main sequence, where stars of the UV Cet and BY Dra types are located.

2. PHYSICAL PARAMETERS OF FLARE STARS

Broad band photometry and a variety of spectroscopic information on flare stars and spotted stars have been obtained to study the photospheres of these stars in their quiescence.

2.1. Effective temperature

Photometric data can be transformed into energy distributions of stars over the observed wavelength interval, and put on a flux scale calibrated in absolute units. By comparing this distribution with that of a theoretical model taking into account the effect of blanketing, one obtains an approximation to the effective temperature of the star. The
theoretical distribution in this comparison may be the flux distribution of a model atmosphere (Mould 1976a). Unfortunately, no set of models exists for the entire range of temperatures covered by the red dwarf stars. In default of this, black body curves have been used (Veerder 1974, Pettersen 1980). A complicating element with Planck curves is that blanketing effects cannot be dealt with directly. Veeder (1974) used the method of Greenstein et al. (1970) which compensates for blanketing in a subjective manner, while Pettersen (1980) handled the problem by fitting the Planck function to data longwards of 1 μm and simultaneously required that the integral under both distributions be equal. Figure 1 shows the empirical colour-temperature relations obtained by different authors. Also included is the one used by Johnson (1965) which was established from giants with measured diameters. The differences in certain areas of the diagram approach about 250 K. To preserve consistency in the following discussion of flare stars I shall use the results of Planck function comparisons with Pettersen's (1980) method.

![Figure 1](image)

**Fig. 1.** Left: Empirical colour-temperature relations from different authors. Right: The linear colour-temperature relation of Pettersen (1980) based on analysis of 34 stars.

We find the empirical relations between effective temperature and various colour indices to be linear, as demonstrated in Fig. 1. Results obtained from least square analyses are given in Table 1.

<table>
<thead>
<tr>
<th>Colour index</th>
<th>Number of data</th>
<th>Correlation coefficient</th>
<th>Linear fit</th>
<th>Typical scatter</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-V</td>
<td>35</td>
<td>-0.88</td>
<td>$T_{\text{eff}}=-1510(B-V)+5738$</td>
<td>±156 K</td>
</tr>
<tr>
<td>V-R</td>
<td>29</td>
<td>-0.90</td>
<td>$T_{\text{eff}}=-645(V-R)+4469$</td>
<td>±112 K</td>
</tr>
<tr>
<td>R-I</td>
<td>29</td>
<td>-0.95</td>
<td>$T_{\text{eff}}=-648(R-I)+4311$</td>
<td>± 79 K</td>
</tr>
<tr>
<td>V-K</td>
<td>35</td>
<td>-0.93</td>
<td>$T_{\text{eff}}=-264(V-K)+4624$</td>
<td>±120 K</td>
</tr>
</tbody>
</table>

Several molecules manifest themselves in the photospheric spectra of red dwarfs, with feature strengths in accordance with the temperature of the