COMPARISON OF EFFECTIVE DEPTHS OF FRAUNHOFER LINE FORMATION CALCULATED BY VARIOUS METHODS

(Research Note)

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Abstract. The effective depths of formation of some typical Fraunhofer lines, calculated by the methods suggested by Gurtovenko et al. (1974), Beckers and Milkey (1975), and Makita (1977) are compared.

Gurtovenko et al. (1974) discussed the question of the effective depths of formation of absorption lines and the determination of effective depth by the use of the Unsöld-Pecker contribution function \( F_d^* = g \eta e^{-\tau_i} \) has been suggested. Since that time other publications concerning this problem (Beckers and Milkey, 1975; Makita, 1977; Caccin et al., 1977; Lyubimkov, 1977) have appeared. In particular, in the papers by Beckers and Milkey, and by Makita the advantages of other proposed methods are considered.

Without entering again in a discussion of the relative values of the various methods, we give the next table in which the effective depths of formation of typical Fraunhofer lines are calculated by using our \( F_d^* \)-function, Beckers and Milkey's RF-function, and Makita's method.

The data in Table I also give information for a comparison of the methods mentioned above.

<table>
<thead>
<tr>
<th>( \lambda ) (Å)</th>
<th>Element</th>
<th>Central intens.</th>
<th>Excitation poten. (eV)</th>
<th>( \tau_{5,F_d^*} )</th>
<th>( \tau_{5,RF} )</th>
<th>( \tau_{5,M} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>6213.438</td>
<td>Fe I</td>
<td>0.298</td>
<td>2.22</td>
<td>0.021</td>
<td>0.042</td>
<td>0.010</td>
</tr>
<tr>
<td>7771.954</td>
<td>O I</td>
<td>0.658</td>
<td>9.14</td>
<td>0.20</td>
<td>0.28</td>
<td>0.20</td>
</tr>
<tr>
<td>6097.101</td>
<td>Fe I</td>
<td>0.971</td>
<td>2.22</td>
<td>0.14</td>
<td>0.18</td>
<td>0.20</td>
</tr>
<tr>
<td>6052.682</td>
<td>S I</td>
<td>0.940</td>
<td>7.87</td>
<td>0.93</td>
<td>1.21</td>
<td>1.70</td>
</tr>
<tr>
<td>6158.171</td>
<td>O I</td>
<td>0.975</td>
<td>10.74</td>
<td>1.55</td>
<td>2.13</td>
<td>2.30</td>
</tr>
</tbody>
</table>

The table gives the effective depth of formation of some typical Fraunhofer lines, calculated by using the \( F_d^* \)-function (Gurtovenko et al., 1974): \( \tau_{5,F_d^*} \), by the
RF-function (Beckers and Milkey, 1975): $\tilde{\tau}_{5,RF}$; and by Makita’s method (Makita, 1977): $\tau_{5,M}$.

The lines $\lambda\lambda$ 6213, 6097 have equal excitation potentials but different intensities. The lines $\lambda\lambda$ 6097, 6052, 6158 represent a group of weak lines with different excitation potentials. The line $\lambda$ 7771 is moderately strong with a high excitation potential.

The calculations are made for the line centers with the photospheric velocity fields as proposed by Gurtovenko (1975) and using the Van der Waals damping constant. To reduce possible non-LTE effects on the moderately-strong line $\lambda$ 6213 all calculations were made with a combined photospheric model: HSRA at large depths, and Holweger’s model at depths $\log \tau_5 \leq -3.5$.

References