OSCILLATOR STRENGTH FROM ARC SPECTRUM OF DILUTED COPPER ALLOYS IN THE REGION (4000 - 6000) A°

THESIS
Submitted By

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SUMMARY

Summary

The present work is concerned with the determination of oscillator strengths from arc spectrum of diluted copper alloys in the spectral region λλ4000 - 6000 A°. The oscillator strengths or f-values are determined for the spectral lines of FeI, CoI, NiI, MnI, CrI, SbI, AgI, BiI, SnI, SiI, Pb and GaI.

F-values are determined from theoretical or experimental methods. Theoretical means give reliable f-values only for simple atoms with an electron outside closed shells. For complex atoms such as iron - group elements emperical means do not give reliable f-values for such elements. Most of experimental oscillator strengths have been determined from absorption or emission spectra.

At present one can find great discrepancies between the values published previously for some elements. These discrepancies are due to certain in accuracy in the values of the different parameters involved in the experiments. However, the f-values of certain elements may be regarded as well determined. Also the previous measurements for some Iron-group elements especially for higher level lines of Astrophysical interest are stell few and insufficient.

For such reasons , the aim of the present work is to measure experimental f-values for spectral lines of FeI, MnI, NiI, CoI, CrI, SiI, AgI, BiI, SnI, SbI, PbI and GaI in

the spectral region λλ 4000 - 6000 A° . Besides improving the accuracy of the previous experimental f-values and measuring f-values for lines which are not measured previously in the studied wave length range. The method used in the present work is similar to that applied by A.S. Asaad (51)

The elements under investigation have been added to cupper with very small but known concentration to give lines free from self-absorption. The arc temperature is estimated by comparing our intensity measurements with the published f-values for lines in common .

A mean temperature has been adopted. By using the temperature obtained and the intensities of spectral lines of each element under investigation, corrected for the colour variation, we have determined relative f-values. By comparing our relative f-values with published absolute values given by other investigators all the relative f-values are converted to an absolute scale. A comparison between the absolute log gf-values determined through this work with previously published values shows a good agreement.

This indicates that the method applied through this work gives reliable f-values as those measured from other techniques. So the results obtained in the present work confirmed the reliability of the arcs between poles of diluted alloys for the determination of line intensities free from self-absorption.

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INTRODUCTION

Introduction

Studies of quantitative chemical abundances of elments in chemical compounds or celestial objects require accurate knowledge of the number of excited atoms which radiate at certain wave length in a spectral line. This can only be obtained from the fundamental emission or absorption per atom of the spectral lines. These factors are usually expressed in terms of oscillator strengths or f-values and their determination is the prime purpose of the present thesis.

The oscillator strength is an atomic factor, given as the number of disperision electrons associated with a spectral line. In other words when, an assembly of N atoms is absorbing radiation in a particular spectral line, absorption is the same as would be produced by Nf classical electron oscillators, so that each atom is equivalent to f oscillators (3).

The f-values can be calculated for atoms of simple structure through quantum mechanics. But for complex atoms, such as the Iron group elements where the deviations from Ls coupling are pronounced, the f-values cannot be calculated by theoretical means and recourse must be had to laboraory experiments.

The present thesis is concerned with the experimental determination of oscillator stengths for spectral lines in the range (4000 - 6000) A° of 12 elements mixed with cupper with minute traces but of known concentration. In our experiment where the radiation is obtained by using an electric arc burning in air with the alloys as elecrodes. The intensities measured in emission are more precise than in absorption. The arc spectra, however suffers from self absorption and self reversal. Workers in the past were obliged to use arcs with different currents to correct for these defects. In this case, they could not assign a temperature to their arcs and thus were unable to measure oscillator strengths from arcs. This difficulty was overcome by using alloys having minute amounts of the elements for which f-values are required and the spectra is therefore free from self absorption. The excitation temperature of the arc is determined from the measured intensities of the lines of an element for which f-values were known and the excitation potentials. The temperature was used to convert the measured intensities into relative f-values after correcting for concentration and colour variation. In the last stage by comparing previously published absolute values for some lines and the relative values were converted to absolute values.

For this purpose one needs previously determined f-values to obtain temperature of the arc and to determine the absolute values. It is therfore , appropriate to give a brief survey of previous work in this field.

Historical Survey

Most of the previous f-values had been measured for lines produced either from absorption or emission speectra. Also other techniques such as anomalous dispersion, shock tube and life time methods had been applied for measuring the f-values. In what follows a brief historical survey of each previously used method will be given.

I. Determinations of oscillator strengths from absorption spectra :

The absorption spectra can be produced by either total absorption method or atomic beam method.

a- Total absorption method :

The theory of this method depends upon the measurement of the absorption intensity of a spectral line produced when passing through an absorbing medium. A beam of continuous spectrum is passed through the metal's vapour contained in an electric furnace kept at an accurately known temperature. The continuous spectra formed by the source is crossed by dark lines arising from absorption by the metal vapour. If N is the number of atoms/cm^3 in the furnace, then the oscillator strength of aspectral line of wave length λ is determined from the relation (2)

$$W_{\lambda} = h N \lambda^{2} \frac{\pi e^{2}}{m c^{2}} f$$

Where w_λ is the equivalent width which would remove the same amount of energy, from the spectrum and is determined from w-Nf relationship which is called the curve of growth. N is determined from the relation between the vapour pressure and temperature, unless this relation is accurately known only relative f-values can be obtained.

This method was applied early by A.S King and R.B.King (5) in 1935. They measured relative f-values for seventy-five lines in nine multiplets of FeI in the region λ 3650 to λ 4400 A°. Owing to the difficulty of maintenance of a constant tempterature in the furnace in addition to errors of photographic photometry these values were not so accurate. In 1938 the same investigators modified the furnace to keep a constant temperature during the experiment (6) they measured ralative f-falues for 115 lines in 19 multiplets of FeI between λ 2912 and 5455 A°. This method is suitable only for strong absorption lines of low excitation potential levels. In 1924 R.B. King (7) measured the absolute f-values in two multiplets of neutral Iron and used these values to convert their relative f-values measured before to an absolute scale.

The same procedure was applied by R.B. King (8) to measure relative f-values for 134 lines of NiI in the region 3012 to 3912 A°. In 1951 A.J. Hill and R.B. King (9) measured relative f-values of CrI in the region 3912 to 7462 A°.