OBSERVED TRANSITIONS BETWEEN THE LEVELS OF THE GROUND CONFIGURATION IN Si

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ABSTRACT
Accurate wavelengths of three transitions in the Si ground configuration are obtained, and the intensities are discussed in view of the theoretical transition probabilities. The level values are revised. The solar-line identifications are strengthened.

Subject headings: atomic processes — line identifications — transition probabilities

I. INTRODUCTION
The forbidden transition \(^{3}P_{2}{\rightarrow}^{1}D_{2}\) in Si \(^{3}S_{1}\) as identified by Swensson (1968, 1969) in the solar spectrum had the wavelength 10821.20 ± 0.02 Å whereas the value calculated from the levels was 0.06 Å lower (Eriksson 1973). The main purpose of the present investigation was to supply a laboratory wavelength for this transition, but a check was done also for the transitions \(^{1}D_{2}{\rightarrow}^{3}S_{0}\) and \(^{3}P_{2}{\rightarrow}^{3}S_{0}\) previously measured by McConkey et al. (1968) and Eriksson (1973).

II. THE EXPERIMENTS
The light source was a quartz tube 35 cm long and 4 cm wide containing neon and some sulfur, excited by means of a dc discharge between hollow nickel electrodes in side tubes. It was run in the pressure range from 1.0 to 1.3 kilopascal (kPa) with currents between 0.3 and 0.5 A at voltages between 0.5 and 0.3 kV. The measurements were made by means of a 5.5 m Czerny-Turner spectrograph, described by Eriksson and Wenâker (1970). Reference lines were obtained from an iron-neon hollow-cathode lamp (Crosswhite 1975). The measured wavelengths are given in the third column of Table 1 together with their uncertainties. Their previous energy values, in column (3) of Table 2, were given due weight in the revision given here. The level 4s\(^{2}\)S\(_{1}\) is also included in Table 2 to show the general agreement with the previous level values used by Kaufman and Edlén (1974) in the calculation of vacuum-ultraviolet reference wavelengths. The revision given here implies only slight changes in their standards.

III. RESULTS AND DISCUSSION
The measured wavelengths are given in the third column of Table 1 together with their uncertainties. The relative line intensities, in the second column of Table 1, are visual estimates on a linear scale, derived by using the spectral sensitivity graphs of Kodak spectroscopic plates. A corresponding set of intensities, predicted from Czyzak and Krueger’s (1963) vacuum-ultraviolet measurements (Kaufman 1971) and the system of well-connected high levels (Jakobs-son 1967), the latter with the correction +0.947 cm\(^{-1}\). It was recalculated by means of the theoretical transition probabilities with the supposition that the population of the levels \(^{3}D_{2}\) and \(^{3}S_{0}\) is proportional to the statistical weight and inversely proportional to the probability of spontaneous-emission de-excitation, agrees surprisingly well, being 100, 30, and 10. It should be noted that for the transitions from \(^{3}S_{0}\) to \(^{1}D_{2}\) and \(^{3}P_{1}\) the ratio of the probabilities as measured by McConkey et al. (1968) coincides with the theoretical ratio, 5.1, according to Czyzak and Krueger (1963).

Table 2 gives revised level values, \(E\), relative to the ground level. For the levels \(^{3}P_{2}\) to \(^{1}D_{2}\) and \(^{3}S_{0}\) the uncertainty is ±0.005 cm\(^{-1}\). Their previous energy values, in column (3) of Table 2, with the proposed uncertainty ±0.02 cm\(^{-1}\) were given due weight in the derivation. The level \(^{3}P_{0}\) has the uncertainty ±0.03 cm\(^{-1}\). It was recalculated by means of the theoretical transition probabilities (Kaufman and Edlén 1967), with the correction +0.947 cm\(^{-1}\). The high level 4s\(^{2}\)S\(_{1}\) is also included in Table 2 to show the general agreement with the previous level values used by Kaufman and Edlén (1974) in the calculation of vacuum-ultraviolet reference wavelengths. The revision given here implies only slight changes in their standards.

IV. THE SOLAR SPECTRUM DATA
For the Si transition \(^{3}P_{2}{\rightarrow}^{1}D_{2}\), the new laboratory wavelength in Table 1 confirms the solar
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Spectrum wavelength 10821.20 Å in the list by Swensson et al. (1970) within their limits of error. Furthermore, a possible correction to their value reducing the deviation can be suggested: since the solar spectrum wavelength 10818.30 Å listed for an adjacent Fe I line is 0.02 Å larger than the laboratory wavelength, as remeasured by Litzén and Vergès (1976), this same difference should probably be subtracted from Swensson et al.'s value of 10821.20 Å.

Swings, Lambert, and Grevesse (1969) also report solar spectrum scans of the two forbidden S I lines, at 10821.23 Å and 7725.023 Å. On their tracings are given the Si I wavelengths 10827.14 Å and 7725.184 Å, which in comparison with the values calculated from the Si I levels, tabulated by Radziemski et al. (1967), are 0.05 Å larger and 0.008 Å smaller, respectively. These corrections similarly might be applied to the S I lines close by, just bringing them into proper position.

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REFERENCES

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