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A PYTHON PROGRAM TO CALCULATE OSCILLATOR STRENGTHS OF HYPERFINE (HF) MULTIPLETS OF SC II

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Abstract
In this work we theoretically investigated oscillator strengths of hyperfine levels of 131 lines of fine levels in Scandium ion. The Holn-Kronig intensity rule is used to estimate the oscillator strength of hyperfine transitions in the Scandium ion. A Python program is created to determine the weighted oscillator strength, wavenumbers, and relative intensities in a particular hyperfine multiplet of Sc II. Quantum numbers and energy of the levels engaged in transitions, hyperfine constants, as well as the weighted oscillator strength of fine transitions, are the input parameters for the code.

INTRODUCTION

Scandium is a transition metal with the atomic number Z = 21 and an average atomic mass of A = 44.9559 u. This d-block element is in period 4 of the periodic table. It was isolated in 1879 by Lars Fredrik Nilson, who obtained it by separating rare earth elements from euxenite and gadolinite, with its name derived from the European region "Scandinavia" [1]. The ground state electronic configuration and term are [Ar] 3d14s2 2D3/2 [2]. It has a silvery-white appearance. In nature, only one stable isotope of scandium, “45Sc,” exists [1], which has a nuclear spin of I = 7/2 and a corresponding nuclear magnetic moment of μ = 4.756 μm [3]. Supernovas produce this stable form of scandium; however, it is unknown what kind of supernova produced it [4].

The most significant use of scandium is in aerospace engineering, where structural components of aircraft are manufactured using Sc-Al alloys, an alloy of scandium and aluminium [5]. This is mostly because Sc-Al is strong, lightweight, and resistant to corrosion. Additionally, high-performance sporting goods like baseball bats, lacrosse sticks, and bicycle frames are made using scandium-aluminum alloys. High-intensity discharge lamps for outdoor and industrial lighting applications, such as metal halide lamps, use scandium iodide (ScI3) [6]. Because scandium iodide emits strong white light, it can be used for large-scale lighting applications such as stadium illumination and street lighting. One interesting substance for use as an electrolyte in solid oxide fuel cells (SOFCs) is scandium-stabilized zirconia (ScSZ). Scandium doping improves zirconia's ionic conductivity and stability at high temperatures, which boosts SOFC performance and efficiency [7]. These fuel cells may find use in sustainable energy technologies for transportation and power production.

Up to now, the hyperfine constant (HFS) for neutral Scandium (Sc I) and Scandium ion (Sc II) levels has been estimated using experimental, theoretical, and a mixture of both approaches. Below is research of this study.

Childs et al calculated the HFS constants for the ground term 3d4s2 2D3/2,5/2, as referenced in [8]. G. Fricke et al utilized the atomic beam magnetic resonance method (ABMR) [9], while Kopfermann and Rasmussen used radiofrequency (RF) techniques [10] for same purposes.

De Groote et al. recently reported a high-precision measurement of the HFS constants of the 3d4s2 2D3/2,5/2 states [11] using resonance laser ionization spectroscopy and RF spectroscopy, which improves the results of earlier findings by an order of magnitude.

Ertmer and Hofer [12] and Zeiske et al. use the laser-fluorescence ABMR [13] to measure the HFS constants for the metastable state 3d24s4F3/2-9/2.

In the range of 4000 cm^{-1} to 5000 cm^{-1}, Aboussaïd et al. study the hyperfine structure of Sc I for transitions between 3d24s and 3d4s4p. The possibility of obtaining hyperfine constants for the 3d4s4p level through least-square fitting of the line profile is examined; for the 10 levels, HFS constants are assessed in the infrared portion of the spectrum [14].

The findings are consistent with Kopfermann and Rasmussen's values [10]. Xu et al. used Fourier transform spectroscopy to investigate the hyperfine spectrum of the Sc-I and Sc-II systems in the range of 3998 cm^{-1} to 39,979 cm^{-1}. HFS constants were found for "Sc I" systems at 56 energy levels and "Sc II" systems at 12 energy levels. For the first time, HFS constants with 50 levels for Sc I and 9 levels for Sc II were reported [15]. G. and Hala. Nave used Fourier Transform Spectroscopy to examine the hyperfine splitting for Sc I and Sc II systems in the range of 50,000 cm^{-1} to 4000 cm^{-1}. 1431 spectral lines were examined, and HFS constants were assessed.

The laser opto-galvanic method was used by Singh et al. and Başar et al. to obtain the HFS constants of 20 levels of the 3d24s, 3d4s4p, 3d4s5s, and 3d24p configurations [18–19].

Krzykowski and Stefaň used the laser-induced fluorescence method in hollow cathode discharge to obtain the magnetic dipole HFS constants A for 19 levels of Sc I [20].

The HFS constants of the 2D3/2, 5/2 states were calculated using Relativistic Hartree-Fock calculations by Desclaux and Bessis [21].

The HFS "A" constants for the Sc I system configurations 3d24s, 3d4s4p, 3d24p, and 4s24p were found using parametric analysis by Başar et al., Öztürk et al., and Siefart [19, 22-23].

Using the multi-configuration Dirac–Fock model, Bieroń et al. estimated the HFS A constants for specific 3d4s4p and 3d24s levels [24]. The majority of the results are in good agreement with the experimental findings of Aboussaïd et al. [14].

Determining the oscillator strength of various hyperfine transitions for the Scandium ion (Sc II system) is the main goal of this work. Inaccurate conclusions regarding the broadening and asymmetry of the line profile involved in transition, as well as incorrect line position and line strength determination, may arise from the exclusion of hyperfine splitting. The outcomes of the analysis of stellar composition are impacted by these errors. In order to accurately determine the star's Sc abundance, this study can be used to analyze stellar spectra. This analysis provides insight into the nucleosynthesis process governing the stellar evolution and characterizes the star type.

Theory

The oscillator strength "f_{ki}" is related to "transition probability "A_{ki}" by following relationship [25]

$$f_{ki} = \frac{g_i}{g_k}\frac{\varepsilon_0 mc^3}{2\pi e^2 \vartheta^2} A_{ki}$$

Here "ε_0" is permittivity of vacuum, "e" is the elementary charge, "ϑ" is the transition frequency, subscripts "i" and "k" refers to the initial and final states, "g" is the degeneracy with respect to the angular momentum "J" i.e.

$$g = (2J + 1)$$

The energy of a hyperfine level can be obtained by combining the energy of interactions of Electric quadruple interaction and nuclear magnetic moment interaction i.e.

$$E_{hfs} = E_J + \frac{A}{2}C + \frac{3C(C+1) - 4IJ(I+1)(J+1)}{8IJ(2J-1)(2I-1)}B$$

From equation (1) it is evident that energy of a hyperfine level can be estimated by substituting the values of hyperfine constants A and B, quantum numbers F, I and J and the energy E_J of fine structure level.

The wavenumber of transition between two hyperfine levels can be obtained by the energy difference of upper and lower hyperfine levels i.e.

$$\sigma_F = E_{hfs_u} - E_{hfs_l} = \sigma_J + A_u\alpha(F_u, J_u, I) + B_u\beta(F_u, J_u, I) + A_l\alpha(F_l, J_l, I) + B_l\beta(F_l, J_l, I)$$

In the above equation α and β are called Cassimir factors. Mathematical form of these factors can be given as follows

$$\alpha = \frac{C}{2} = [F(F+1) - I(I+1) - J(J+1)]$$

$$\beta = \frac{3C(C+1) - 4IJ(I+1)(J+1)}{8IJ(2J-1)(2I-1)}$$

Here σ_J is known as the center of gravity of hyperfine multiplets which is the energy difference of the fine structure taking part in the transition. Center of gravity of hyperfine multiplets remains unaffected by the magnetic dipole and electric quadruple splitting.

The selection rule to be obeyed in a transition between two hyperfine levels can be given as

$$\Delta F = 0, \pm 1$$

$$\Delta F = 0 \rightarrow 0 \; not \; allowed$$

Consider a hyperfine transition from an upper state specified by quantum numbers F_u, J_u and I to a lower state specified by quantum numbers F_l, J_l and I. The transition probability $A(F_u \rightarrow F_l)$ for this transition can be given by Höln-Kronig intensity rule [26].

$$A(F_u \rightarrow F_l) = (2F_l + 1)(2F_u + 1)\begin{Bmatrix} J_l & I & F_l \\ F_u & 1 & J_u \end{Bmatrix}^2 A(J_u \rightarrow J_l)$$

Methodology:

Computation of oscillator strengths of hyperfine multiplets require various parameters energy difference of upper and lower states (σ_J), Angular momentum of lower (J_l) and upper state (J_u), 1st hyperfine constant or Nuclear magnetic dipole constant for lower (A_l) and upper state (A_u), 2nd hyperfine constant or Nuclear electric quadruple constant for lower (B_l) and upper state (B_u), nuclear angular momentum (I) and weighted oscillator strength of fine transition ($loggf$).

These parameters (excluding $loggf$ & σ_J) for scandium ion (Sc II) for our research available to us from the work of Ruczkowski et al [27].

The "$loggf$" and σ_J for the transitions acquired from NIST line data of Sc II [28].

The data assembled into an xml file. This data file uploaded in python data library "pandas". This library enables us to perform computation on all the data at once.

A computer program in python is developed for the computation of oscillator strengths of hyperfine multiplets of Sc II system.

```
import numpy as np
import pandas as pd
import os
from sympy.physics.quantum.cg import Wigner6j

# --- Original Logic with Unit Correction ---
def c_calc(f, j, i):
    return f*(f + 1) - i*(i + 1) - j*(j + 1)
```

```
def b_factor_calc(f, j, i):
    if i < 1 or j < 1:
        return 0
    c = c_calc(f, j, i)
    num = 0.75 * c * (c + 1) - i * (i + 1) * j * (j + 1)
    den = 2 * i * (2 * i - 1) * 2 * j * (2 * j - 1)
    return num / den

def hfgf_calc(jl, ju, wavenr_j, au, bu, al, bl, loggf):
    iqnr = 3.5  # Scandium (7/2)

    # MHz to cm-1 conversion factor
    mhz_to_cm = 29979.2458

    fu_levels = np.arange(abs(iqnr - ju), iqnr + ju + 1)
    fl_levels = np.arange(abs(iqnr - jl), iqnr + jl + 1)

    results = []
    for fu in fu_levels:
        for fl in fl_levels:
            df = fu - fl
            if abs(df) <= 1 and not (fu == 0 and fl == 0):
                #convert A aur B from MHz to cm-1
                dw_u = (0.5 * (au / mhz_to_cm) * c_calc(fu, ju, iqnr)) + \
                       ((bu / mhz_to_cm) * b_factor_calc(fu, ju, iqnr))

                dw_l = (0.5 * (al / mhz_to_cm) * c_calc(fl, jl, iqnr)) + \
                       ((bl / mhz_to_cm) * b_factor_calc(fl, jl, iqnr))

                wn = wavenr_j + dw_u - dw_l

                s6j = float(Wigner6j(jl, fl, iqnr, fu, ju, 1).doit())
                intensity = (2 * fu + 1) * (2 * fl + 1) * (s6j**2)
                results.append([fu, fl, wn, intensity])

    res_arr = np.array(results)
    total_i = np.sum(res_arr[:, 3])
    relative_i_pct = (res_arr[:, 3] / total_i) * 100
    gf_fine = 10**loggf
    hfgf = (res_arr[:, 3] / total_i) * gf_fine
    loghfgf = np.log10(hfgf)

    return np.column_stack((res_arr[:, 0:3], relative_i_pct, loghfgf))

# --- Excel Read and Write Logic ---

desktop_path = os.path.join(os.path.join(os.environ['USERPROFILE']), 'Desktop')
file_full_name = 'oscillator strength Sc II.xlsx'
```

```
path_to_file = os.path.join(desktop_path, file_full_name)

try:
    # 1, read input from Sheet 2
    df_input = pd.read_excel(path_to_file, sheet_name=1)

    all_results = []

    # 2. calculation for each row
    for index, row in df_input.iterrows():
        data_output = hfgf_calc(
            row['jl'], row['ju'], row['wn'],
            row['au'], row['bu'], row['al'],
            row['bl'], row['loggf']
        )

        # convert Result into DataFrame format
        temp_df = pd.DataFrame(data_output, columns=['Fu', 'Fl', 'Wavenumber', 'Intensity%', 'loghfgf'])
        # Reference ke liye row number add karna
        temp_df.insert(0, 'Input_Row', index + 1)
        all_results.append(temp_df)

    # gather all results
    final_df = pd.concat(all_results, ignore_index=True)

    # 3. save output in Sheet 1 in a new excel file
    desktop_path1 = os.path.join(os.path.join(os.environ['USERPROFILE']), 'Desktop')
    file_full_name1 = 'oscillator strength Sco II.xlsx'
    path_to_file1 = os.path.join(desktop_path1, file_full_name1)
    with pd.ExcelWriter(path_to_file1, engine='openpyxl', mode='a', if_sheet_exists='replace') as writer:
        final_df.to_excel(writer, sheet_name='Sheet1', index=False)

    print("Success")

except FileNotFoundError:
    print(f"Error: File not found")
except Exception as e:
    print(f"Error: {e}")
```

Results:

In this project hyperfine oscillator strengths associated with 131 dipole transitions in scandium ion have been estimated. A total of 1631 hyperfine transitions are analyzed and ("$log\ hfgf$") have been derived using Höln-Kronig intensity rule, together with wavenumber and percentage intensities of the transitions.

A computer program in Python® is developed for analysis, capable of handling all the data at once. The program is verified on published neutral scandium data, and it is in good agreement with that published data. The input parameters of the program are σ_J or the energy difference of states undergoing transition., J_u and J_l or the total electronic angular momentum quantum numbers of the states involved in a transition, Nuclear angular momentum "$I" = 7/2$ for Scandium, HFS constants "A" and "B" for the states involved in a transition, and weighted oscillator strength "$log\ gf$" of fine transition.

The input data is added into the columns of a "csv file". This file serves as the input for our computer program.

The output from the program is obtained in the form of "csv file", with output data in columns (6-10) under the corresponding heading. The total angular momentum quantum number F_u and F_l of states in column 6 & 7 respectively, wavenumbers $\boldsymbol{\sigma_F}$ of hfs multiplets in column 8, percentage relative intensities of hfs multiplets in column 9 and Oscillator strengths of hfs multiplets in column 10 are the results of our analysis shown in Table below

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	$\log gf$	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	$hfs \log gf$
1	4802.87	0	4802.87	-8.79	1.5	2.5	4802.711	10	-9.79
					2.5	2.5	4802.735	9.642857	-9.80579
					2.5	3.5	4802.791	5.357143	-10.0611
					3.5	2.5	4802.769	5.357143	-10.0611
					3.5	3.5	4802.825	12.69841	-9.68625
					3.5	4.5	4802.897	1.944444	-10.5012
					4.5	3.5	4802.868	15.27778	-9.60594
					4.5	4.5	4802.941	9.722222	-9.80223
					5.5	4.5	4802.994	30	-9.31288
2	4802.87	67.72	4735.15	-8.94	1.5	1.5	4735.217	4	-10.3379
					1.5	2.5	4735.174	6	-10.1618
					2.5	1.5	4735.241	6	-10.1618
					2.5	2.5	4735.199	0.071429	-12.0861
					2.5	3.5	4735.139	8.928571	-9.98922
					3.5	2.5	4735.232	8.928571	-9.98922
					3.5	3.5	4735.172	1.904762	-10.6602
					3.5	4.5	4735.095	9.166667	-9.97779
					4.5	3.5	4735.216	9.166667	-9.97779
					4.5	4.5	4735.139	9.469697	-9.96366
					4.5	5.5	4735.044	6.363636	-10.1363
					5.5	4.5	4735.192	6.363636	-10.1363
					5.5	5.5	4735.098	23.63636	-9.56642
3	4802.87	177.76	4625.11	-9.98	1.5	0.5	4625.318	3.571429	-11.4272
					1.5	1.5	4625.285	4.285714	-11.348
					1.5	2.5	4625.231	2.142857	-11.649
					2.5	1.5	4625.309	2.857143	-11.5241
					2.5	2.5	4625.255	6.530612	-11.165
					2.5	3.5	4625.178	5.612245	-11.2309
					3.5	2.5	4625.289	2.040816	-11.6702
					3.5	3.5	4625.212	7.482993	-11.1059

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	$\log gf$	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	$hfs \log gf$
					3.5	4.5	4625.114	10.47619	-10.9598
					4.5	3.5	4625.256	1.190476	-11.9043
					4.5	4.5	4625.157	6.926407	-11.1395
					4.5	5.5	4625.037	16.88312	-10.7525
					5.5	4.5	4625.21	0.454545	-12.3224
					5.5	5.5	4625.09	4.545455	-11.3224
					5.5	6.5	4624.948	25	-10.5821
4	4883.57	67.72	4815.85	-8.68	0.5	1.5	4815.953	3.571429	-10.1272
					1.5	1.5	4815.959	4.285714	-10.048
					1.5	2.5	4815.916	2.857143	-10.2241
					2.5	1.5	4815.968	2.142857	-10.349
					2.5	2.5	4815.925	6.530612	-9.86505
					2.5	3.5	4815.865	2.040816	-10.3702
					3.5	2.5	4815.939	5.612245	-9.93086
					3.5	3.5	4815.879	7.482993	-9.80592
					3.5	4.5	4815.801	1.190476	-10.6043
					4.5	3.5	4815.896	10.47619	-9.6598
					4.5	4.5	4815.819	6.926407	-9.83949
					4.5	5.5	4815.724	0.454545	-11.0224
					5.5	4.5	4815.839	16.88312	-9.45255
					5.5	5.5	4815.745	4.545455	-10.0224
					6.5	5.5	4815.77	25	-9.28206
5	4883.57	177.76	4705.81	-8.93	0.5	0.5	4706.054	0.892857	-10.9792
					0.5	1.5	4706.021	2.678571	-10.5021
					1.5	0.5	4706.059	2.678571	-10.5021
					1.5	2.5	4705.972	4.464286	-10.2802
					2.5	1.5	4706.036	4.464286	-10.2802
					2.5	2.5	4705.981	0.637755	-11.1253
					2.5	3.5	4705.905	5.612245	-10.1809
					3.5	2.5	4705.995	5.612245	-10.1809
					3.5	3.5	4705.918	2.721088	-10.4953

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	$\log gf$	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	$hfs \log gf$
					3.5	4.5	4705.82	5.952381	-10.1553
					4.5	3.5	4705.935	5.952381	-10.1553
					4.5	4.5	4705.837	6.628788	-10.1086
					4.5	5.5	4705.717	5.275974	-10.2077
					5.5	4.5	4705.858	5.275974	-10.2077
					5.5	5.5	4705.738	12.78721	-9.82322
					5.5	6.5	4705.596	3.365385	-10.403
					6.5	5.5	4705.763	3.365385	-10.403
					6.5	6.5	4705.621	21.63462	-9.59485
6	4883.57	4802.87	80.7	-7.65	0.5	1.5	80.73572	3.571429	-9.09716
					1.5	1.5	80.74143	4.285714	-9.01798
					1.5	2.5	80.71725	2.857143	-9.19407
					2.5	1.5	80.75094	2.142857	-9.31901
					2.5	2.5	80.72675	6.530612	-8.83505
					2.5	3.5	80.6929	2.040816	-9.3402
					3.5	2.5	80.74006	5.612245	-8.90086
					3.5	3.5	80.7062	7.482993	-8.77592
					3.5	4.5	80.66267	1.190476	-9.57428
					4.5	3.5	80.72332	10.47619	-8.6298
					4.5	4.5	80.67979	6.926407	-8.80949
					4.5	5.5	80.62658	0.454545	-9.99242
					5.5	4.5	80.7007	16.88312	-8.42255
					5.5	5.5	80.6475	4.545455	-8.99242
					6.5	5.5	80.67221	25	-8.25206
7	4987.79	177.76	4810.03	-8.82	0.5	0.5	4810.303	2.083333	-10.5012
					0.5	1.5	4810.27	0.694444	-10.9784
					1.5	0.5	4810.305	1.488095	-10.6474
					1.5	1.5	4810.272	3.174603	-10.3183
					1.5	2.5	4810.217	0.892857	-10.8692
					2.5	1.5	4810.275	3.27381	-10.3049
					2.5	2.5	4810.22	4.209184	-10.1958

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	$\log gf$	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	$hfs \log gf$
					2.5	3.5	4810.144	0.85034	-10.8904
					3.5	2.5	4810.225	5.612245	-10.0709
					3.5	3.5	4810.148	4.837491	-10.1354
					3.5	4.5	4810.05	0.661376	-10.9996
					4.5	3.5	4810.154	8.597884	-9.88561
					4.5	4.5	4810.056	4.885161	-10.1311
					4.5	5.5	4809.936	0.405844	-11.2116
					5.5	4.5	4810.063	12.31061	-9.72972
					5.5	5.5	4809.943	4.195804	-10.1972
					5.5	6.5	4809.801	0.160256	-11.6152
					6.5	5.5	4809.951	16.82692	-9.594
					6.5	6.5	4809.809	2.617521	-10.4021
					7.5	6.5	4809.818	22.22222	-9.47321
8	4987.79	4883.57	104.22	-7.54	0.5	0.5	104.2492	2.083333	-9.22124
					0.5	1.5	104.2434	0.694444	-9.69836
					1.5	0.5	104.2511	1.488095	-9.36737
					1.5	1.5	104.2454	3.174603	-9.03831
					1.5	2.5	104.2358	0.892857	-9.58922
					2.5	1.5	104.2485	3.27381	-9.02495
					2.5	2.5	104.239	4.209184	-8.9158
					2.5	3.5	104.2257	0.85034	-9.61041
					3.5	2.5	104.2434	5.612245	-8.79086
					3.5	3.5	104.2301	4.837491	-8.85538
					3.5	4.5	104.213	0.661376	-9.71955
					4.5	3.5	104.2358	8.597884	-8.60561
					4.5	4.5	104.2187	4.885161	-8.85112
					4.5	5.5	104.1978	0.405844	-9.93164
					5.5	4.5	104.2257	12.31061	-8.44972
					5.5	5.5	104.2048	4.195804	-8.91718
					5.5	6.5	104.1801	0.160256	-10.3352
					6.5	5.5	104.213	16.82692	-8.314

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	*Percentage* %	*hfs* log gf
					6.5	6.5	104.1883	2.617521	-9.12211
					7.5	6.5	104.1978	22.22222	-8.19321
9	12101.5	0	12101.5	-7.9	2.5	2.5	12101.44	8.928571	-8.94922
					2.5	3.5	12101.5	16.07143	-8.69395
					3.5	2.5	12101.43	16.07143	-8.69395
					3.5	3.5	12101.49	1.058201	-9.87543
					3.5	4.5	12101.56	16.2037	-8.69039
					4.5	3.5	12101.47	16.2037	-8.69039
					4.5	4.5	12101.54	25.46296	-8.49409
10	12101.5	67.72	12033.78	-8.64	2.5	1.5	12033.95	10	-9.64
					2.5	2.5	12033.91	9.642857	-9.65579
					2.5	3.5	12033.85	5.357143	-9.91107
					3.5	2.5	12033.9	5.357143	-9.91107
					3.5	3.5	12033.84	12.69841	-9.53625
					3.5	4.5	12033.76	15.27778	-9.45594
					4.5	3.5	12033.82	1.944444	-10.3512
					4.5	4.5	12033.74	9.722222	-9.65223
					4.5	5.5	12033.65	30	-9.16288
11	12101.5	4802.87	7298.63	-8.82	2.5	1.5	7298.733	10	-9.82
					2.5	2.5	7298.709	9.642857	-9.83579
					2.5	3.5	7298.675	5.357143	-10.0911
					3.5	2.5	7298.696	5.357143	-10.0911
					3.5	3.5	7298.663	12.69841	-9.71625
					3.5	4.5	7298.619	15.27778	-9.63594
					4.5	3.5	7298.647	1.944444	-10.5312
					4.5	4.5	7298.603	9.722222	-9.83223
					4.5	5.5	7298.55	30	-9.34288
12	12101.5	12074.1	27.4	-8.65	2.5	3.5	27.41606	25	-9.25206
					3.5	3.5	27.40357	33.33333	-9.12712
					4.5	3.5	27.38751	41.66667	-9.03021
13	12154.42	0	12154.42	-8.37	1.5	2.5	12154.36	10	-9.37

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	$\log gf$	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	$hfs \log gf$
					2.5	2.5	12154.35	9.642857	-9.38579
					2.5	3.5	12154.41	5.357143	-9.64107
					3.5	2.5	12154.35	5.357143	-9.64107
					3.5	3.5	12154.41	12.69841	-9.26625
					3.5	4.5	12154.48	1.944444	-10.0812
					4.5	3.5	12154.4	15.27778	-9.18594
					4.5	4.5	12154.47	9.722222	-9.38223
					5.5	4.5	12154.47	30	-8.89288
14	12154.42	67.72	12086.7	-7.78	1.5	1.5	12086.86	4	-9.17794
					1.5	2.5	12086.82	6	-9.00185
					2.5	1.5	12086.86	6	-9.00185
					2.5	2.5	12086.82	0.071429	-10.9261
					2.5	3.5	12086.76	8.928571	-8.82922
					3.5	2.5	12086.81	8.928571	-8.82922
					3.5	3.5	12086.75	1.904762	-9.50016
					3.5	4.5	12086.68	9.166667	-8.81779
					4.5	3.5	12086.75	9.166667	-8.81779
					4.5	4.5	12086.67	9.469697	-8.80366
					4.5	5.5	12086.58	6.363636	-8.97629
					5.5	4.5	12086.67	6.363636	-8.97629
					5.5	5.5	12086.57	23.63636	-8.40642
15	12154.42	177.76	11976.66	-7.59	1.5	0.5	11976.96	3.571429	-9.03716
					1.5	1.5	11976.93	4.285714	-8.95798
					1.5	2.5	11976.88	2.142857	-9.25901
					2.5	1.5	11976.93	2.857143	-9.13407
					2.5	2.5	11976.87	6.530612	-8.77505
					2.5	3.5	11976.8	5.612245	-8.84086
					3.5	2.5	11976.87	2.040816	-9.2802
					3.5	3.5	11976.79	7.482993	-8.71592
					3.5	4.5	11976.7	10.47619	-8.5698
					4.5	3.5	11976.79	1.190476	-9.51428

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	$\log gf$	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	$hfs \log gf$
					4.5	4.5	11976.69	6.926407	-8.74949
					4.5	5.5	11976.57	16.88312	-8.36255
					5.5	4.5	11976.69	0.454545	-9.93242
					5.5	5.5	11976.57	4.545455	-8.93242
					5.5	6.5	11976.42	25	-8.19206
16	12154.42	4802.87	7351.55	-9.65	1.5	1.5	7351.645	4	-11.0479
					1.5	2.5	7351.621	6	-10.8718
					2.5	1.5	7351.643	6	-10.8718
					2.5	2.5	7351.619	0.071429	-12.7961
					2.5	3.5	7351.585	8.928571	-10.6992
					3.5	2.5	7351.616	8.928571	-10.6992
					3.5	3.5	7351.582	1.904762	-11.3702
					3.5	4.5	7351.538	9.166667	-10.6878
					4.5	3.5	7351.578	9.166667	-10.6878
					4.5	4.5	7351.534	9.469697	-10.6737
					4.5	5.5	7351.481	6.363636	-10.8463
					5.5	4.5	7351.529	6.363636	-10.8463
					5.5	5.5	7351.476	23.63636	-10.2764
17	12154.42	4883.57	7270.85	-8.81	1.5	0.5	7270.909	3.571429	-10.2572
					1.5	1.5	7270.904	4.285714	-10.178
					1.5	2.5	7270.894	2.142857	-10.479
					2.5	1.5	7270.901	2.857143	-10.3541
					2.5	2.5	7270.892	6.530612	-9.99505
					2.5	3.5	7270.879	5.612245	-10.0609
					3.5	2.5	7270.889	2.040816	-10.5002
					3.5	3.5	7270.876	7.482993	-9.93592
					3.5	4.5	7270.858	10.47619	-9.7898
					4.5	3.5	7270.871	1.190476	-10.7343
					4.5	4.5	7270.854	6.926407	-9.96949
					4.5	5.5	7270.833	16.88312	-9.58255
					5.5	4.5	7270.849	0.454545	-11.1524

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	$\log gf$	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	$hfs \log gf$
					5.5	5.5	7270.828	4.545455	-10.1524
					5.5	6.5	7270.804	25	-9.41206
18	12154.42	12101.5	52.92	-8.27	1.5	2.5	52.91204	10	-9.27
					2.5	2.5	52.90979	9.642857	-9.28579
					2.5	3.5	52.92228	5.357143	-9.54107
					3.5	2.5	52.90664	5.357143	-9.54107
					3.5	3.5	52.91913	12.69841	-9.16625
					3.5	4.5	52.93519	1.944444	-9.9812
					4.5	3.5	52.91508	15.27778	-9.08594
					4.5	4.5	52.93114	9.722222	-9.28223
					5.5	4.5	52.92619	30	-8.79288
19	14261.32	177.76	14083.56	-11.46	0.5	0.5	14083.78	2.083333	-13.1412
					0.5	1.5	14083.74	0.694444	-13.6184
					1.5	0.5	14083.78	1.488095	-13.2874
					1.5	1.5	14083.75	3.174603	-12.9583
					1.5	2.5	14083.7	0.892857	-13.5092
					2.5	1.5	14083.76	3.27381	-12.9449
					2.5	2.5	14083.71	4.209184	-12.8358
					2.5	3.5	14083.63	0.85034	-13.5304
					3.5	2.5	14083.72	5.612245	-12.7109
					3.5	3.5	14083.65	4.837491	-12.7754
					3.5	4.5	14083.55	0.661376	-13.6396
					4.5	3.5	14083.67	8.597884	-12.5256
					4.5	4.5	14083.57	4.885161	-12.7711
					4.5	5.5	14083.45	0.405844	-13.8516
					5.5	4.5	14083.59	12.31061	-12.3697
					5.5	5.5	14083.47	4.195804	-12.8372
					5.5	6.5	14083.33	0.160256	-14.2552
					6.5	5.5	14083.5	16.82692	-12.234
					6.5	6.5	14083.36	2.617521	-13.0421
					7.5	6.5	14083.39	22.22222	-12.1132

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	$\log gf$	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	$hfs \log gf$
20	14261.32	4883.57	9377.75	-10.09	0.5	0.5	9377.722	2.083333	-11.7712
					0.5	1.5	9377.717	0.694444	-12.2484
					1.5	0.5	9377.729	1.488095	-11.9174
					1.5	1.5	9377.723	3.174603	-11.5883
					1.5	2.5	9377.714	0.892857	-12.1392
					2.5	1.5	9377.735	3.27381	-11.5749
					2.5	2.5	9377.725	4.209184	-11.4658
					2.5	3.5	9377.712	0.85034	-12.1604
					3.5	2.5	9377.741	5.612245	-11.3409
					3.5	3.5	9377.728	4.837491	-11.4054
					3.5	4.5	9377.711	0.661376	-12.2696
					4.5	3.5	9377.748	8.597884	-11.1556
					4.5	4.5	9377.731	4.885161	-11.4011
					4.5	5.5	9377.71	0.405844	-12.4816
					5.5	4.5	9377.756	12.31061	-10.9997
					5.5	5.5	9377.735	4.195804	-11.4672
					5.5	6.5	9377.71	0.160256	-12.8852
					6.5	5.5	9377.764	16.82692	-10.864
					6.5	6.5	9377.739	2.617521	-11.6721
					7.5	6.5	9377.773	22.22222	-10.7432
21	14261.32	4987.79	9273.53	-9.87	0.5	0.5	9273.473	1.157407	-11.8065
					0.5	1.5	9273.471	1.62037	-11.6604
					1.5	0.5	9273.48	1.62037	-11.6604
					1.5	1.5	9273.478	1.185185	-11.7962
					1.5	2.5	9273.475	2.75	-11.4307
					2.5	1.5	9273.489	2.75	-11.4307
					2.5	2.5	9273.486	2.011905	-11.5664
					2.5	3.5	9273.482	3.571429	-11.3172
					3.5	2.5	9273.502	3.571429	-11.3172
					3.5	3.5	9273.498	3.527337	-11.3226
					3.5	4.5	9273.492	4.012346	-11.2666

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	$\log gf$	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	$hfs \log gf$
					4.5	3.5	9273.518	4.012346	-11.2666
					4.5	4.5	9273.512	5.89927	-11.0992
					4.5	5.5	9273.505	3.977273	-11.2704
					5.5	4.5	9273.537	3.977273	-11.2704
					5.5	5.5	9273.53	9.324009	-10.9004
					5.5	6.5	9273.522	3.365385	-11.343
					6.5	5.5	9273.559	3.365385	-11.343
					6.5	6.5	9273.551	14.00499	-10.7237
					6.5	7.5	9273.542	2.074074	-11.5532
					7.5	6.5	9273.585	2.074074	-11.5532
					7.5	7.5	9273.575	20.14815	-10.5658
22	26081.34	0	26081.28	-2.01	1.5	2.5	26081.14	10	-3.01
					2.5	2.5	26081.16	9.642857	-3.02579
					2.5	3.5	26081.22	5.357143	-3.28107
					3.5	2.5	26081.19	5.357143	-3.28107
					3.5	3.5	26081.24	12.69841	-2.90625
					3.5	4.5	26081.31	1.944444	-3.7212
					4.5	3.5	26081.27	15.27778	-2.82594
					4.5	4.5	26081.35	9.722222	-3.02223
					5.5	4.5	26081.39	30	-2.53288
23	26081.34	67.72	26013.63	-1.73	1.5	1.5	26013.72	4	-3.12794
					1.5	2.5	26013.68	6	-2.95185
					2.5	1.5	26013.74	6	-2.95185
					2.5	2.5	26013.69	0.071429	-4.87613
					2.5	3.5	26013.63	8.928571	-2.77922
					3.5	2.5	26013.72	8.928571	-2.77922
					3.5	3.5	26013.66	1.904762	-3.45016
					3.5	4.5	26013.58	9.166667	-2.76779
					4.5	3.5	26013.69	9.166667	-2.76779
					4.5	4.5	26013.62	9.469697	-2.75366
					4.5	5.5	26013.52	6.363636	-2.92629

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	*Percentage* %	*hfs* log gf
					5.5	4.5	26013.65	6.363636	-2.92629
					5.5	5.5	26013.56	23.63636	-2.35642
24	26081.34	2540.95	23540.4	0.242	1.5	1.5	23540.37	4	-1.15594
					1.5	2.5	23540.36	6	-0.97985
					2.5	1.5	23540.39	6	-0.97985
					2.5	2.5	23540.38	0.071429	-2.90413
					2.5	3.5	23540.37	8.928571	-0.80722
					3.5	2.5	23540.41	8.928571	-0.80722
					3.5	3.5	23540.39	1.904762	-1.47816
					3.5	4.5	23540.37	9.166667	-0.79579
					4.5	3.5	23540.42	9.166667	-0.79579
					4.5	4.5	23540.4	9.469697	-0.78166
					4.5	5.5	23540.38	6.363636	-0.95429
					5.5	4.5	23540.44	6.363636	-0.95429
					5.5	5.5	23540.42	23.63636	-0.38442
25	26081.34	10944.56	15136.832	-1.31	1.5	1.5	15136.812	4	-2.70794
					1.5	2.5	15136.8	6	-2.5318487
					2.5	1.5	15136.83	6	-2.5318487
					2.5	2.5	15136.818	0.0714286	-4.456128
					2.5	3.5	15136.8	8.9285714	-2.359218
					3.5	2.5	15136.843	8.9285714	-2.359218
					3.5	3.5	15136.825	1.9047619	-3.0301593
					3.5	4.5	15136.803	9.1666667	-2.3477886
					4.5	3.5	15136.858	9.1666667	-2.3477886
					4.5	4.5	15136.835	9.469697	-2.3336639
					4.5	5.5	15136.808	6.3636364	-2.5062946
					5.5	4.5	15136.875	6.3636364	-2.5062946
					5.5	5.5	15136.847	23.636364	-1.9364193
26	27443.71	0	27443.73	0.051	1.5	2.5	27443.547	10	-0.949
					2.5	2.5	27443.578	9.6428571	-0.9647943
					2.5	3.5	27443.634	5.3571429	-1.2200668

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					3.5	2.5	27443.621	5.3571429	-1.2200668
					3.5	3.5	27443.677	12.698413	-0.8452506
					3.5	4.5	27443.749	1.9444444	-1.6602045
					4.5	3.5	27443.732	15.277778	-0.7649398
					4.5	4.5	27443.804	9.7222222	-0.9612345
					5.5	4.5	27443.872	30	-0.4718787
27	27443.71	67.72	27375.97	-0.52	1.5	1.5	27376.014	4	-1.91794
					1.5	2.5	27375.971	6	-1.7418487
					2.5	1.5	27376.045	6	-1.7418487
					2.5	2.5	27376.002	0.0714286	-3.666128
					2.5	3.5	27375.942	8.9285714	-1.569218
					3.5	2.5	27376.045	8.9285714	-1.569218
					3.5	3.5	27375.985	1.9047619	-2.2401593
					3.5	4.5	27375.907	9.1666667	-1.5577886
					4.5	3.5	27376.04	9.1666667	-1.5577886
					4.5	4.5	27375.963	9.469697	-1.5436639
					4.5	5.5	27375.868	6.3636364	-1.7162946
					5.5	4.5	27376.03	6.3636364	-1.7162946
					5.5	5.5	27375.936	23.636364	-1.1464193
28	27443.71	177.76	27265.98	-1.79	1.5	0.5	27266.164	3.5714286	-3.237158
					1.5	1.5	27266.132	4.2857143	-3.1579768
					1.5	2.5	27266.077	2.1428571	-3.4590068
					2.5	1.5	27266.162	2.8571429	-3.334068
					2.5	2.5	27266.108	6.5306122	-2.9750461
					2.5	3.5	27266.031	5.6122449	-3.0408634
					3.5	2.5	27266.151	2.0408163	-3.4801961
					3.5	3.5	27266.074	7.4829932	-2.9159246
					3.5	4.5	27265.976	10.47619	-2.7697966
					4.5	3.5	27266.13	1.1904762	-3.7142793
					4.5	4.5	27266.031	6.9264069	-2.949492
					4.5	5.5	27265.911	16.883117	-2.5625474

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					5.5	4.5	27266.099	0.4545455	-4.1324227
					5.5	5.5	27265.979	4.5454545	-3.1324227
					5.5	6.5	27265.837	25	-2.39206
29	27443.71	2540.95	24902.82	-1.66	1.5	1.5	24902.748	4	-3.05794
					1.5	2.5	24902.737	6	-2.8818487
					2.5	1.5	24902.779	6	-2.8818487
					2.5	2.5	24902.768	0.0714286	-4.806128
					2.5	3.5	24902.753	8.9285714	-2.709218
					3.5	2.5	24902.811	8.9285714	-2.709218
					3.5	3.5	24902.796	1.9047619	-3.3801593
					3.5	4.5	24902.777	9.1666667	-2.6977886
					4.5	3.5	24902.851	9.1666667	-2.6977886
					4.5	4.5	24902.832	9.469697	-2.6836639
					4.5	5.5	24902.809	6.3636364	-2.8562946
					5.5	4.5	24902.9	6.3636364	-2.8562946
					5.5	5.5	24902.876	23.636364	-2.2864193
30	27443.71	4802.87	22640.91	-0.67	1.5	1.5	22640.887	4	-2.06794
					1.5	2.5	22640.862	6	-1.8918487
					2.5	1.5	22640.917	6	-1.8918487
					2.5	2.5	22640.893	0.0714286	-3.816128
					2.5	3.5	22640.859	8.9285714	-1.719218
					3.5	2.5	22640.936	8.9285714	-1.719218
					3.5	3.5	22640.902	1.9047619	-2.3901593
					3.5	4.5	22640.859	9.1666667	-1.7077886
					4.5	3.5	22640.957	9.1666667	-1.7077886
					4.5	4.5	22640.914	9.469697	-1.6936639
					4.5	5.5	22640.861	6.3636364	-1.8662946
					5.5	4.5	22640.981	6.3636364	-1.8662946
					5.5	5.5	22640.928	23.636364	-1.2964193
31	27443.71	4883.57	22560.09	-1.97	1.5	0.5	22560.031	3.5714286	-3.417158
					1.5	1.5	22560.025	4.2857143	-3.3379768

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					1.5	2.5	22560.016	2.1428571	-3.6390068
					2.5	1.5	22560.056	2.8571429	-3.514068
					2.5	2.5	22560.046	6.5306122	-3.1550461
					2.5	3.5	22560.033	5.6122449	-3.2208634
					3.5	2.5	22560.089	2.0408163	-3.6601961
					3.5	3.5	22560.076	7.4829932	-3.0959246
					3.5	4.5	22560.059	10.47619	-2.9497966
					4.5	3.5	22560.131	1.1904762	-3.8942793
					4.5	4.5	22560.114	6.9264069	-3.129492
					4.5	5.5	22560.093	16.883117	-2.7425474
					5.5	4.5	22560.182	0.4545455	-4.3124227
					5.5	5.5	22560.161	4.5454545	-3.3124227
					5.5	6.5	22560.136	25	-2.57206
32	27602.45	67.72	27534.73	0.22	0.5	1.5	27534.792	3.5714286	-1.227158
					1.5	1.5	27534.802	4.2857143	-1.1479768
					1.5	2.5	27534.759	2.8571429	-1.324068
					2.5	1.5	27534.819	2.1428571	-1.4490068
					2.5	2.5	27534.776	6.5306122	-0.9650461
					2.5	3.5	27534.716	2.0408163	-1.4701961
					3.5	2.5	27534.8	5.6122449	-1.0308634
					3.5	3.5	27534.74	7.4829932	-0.9059246
					3.5	4.5	27534.663	1.1904762	-1.7042793
					4.5	3.5	27534.771	10.47619	-0.7597966
					4.5	4.5	27534.694	6.9264069	-0.939492
					4.5	5.5	27534.6	0.4545455	-2.1224227
					5.5	4.5	27534.732	16.883117	-0.5525474
					5.5	5.5	27534.637	4.5454545	-1.1224227
					6.5	5.5	27534.682	25	-0.38206
33	27602.45	177.76	27424.71	-0.418	0.5	0.5	27424.913	0.8928571	-2.467218
					0.5	1.5	27424.88	2.6785714	-1.9900968
					1.5	0.5	27424.923	2.6785714	-1.9900968

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					1.5	2.5	27424.836	4.4642857	-1.768248
					2.5	1.5	27424.907	4.4642857	-1.768248
					2.5	2.5	27424.853	0.6377551	-2.6133461
					2.5	3.5	27424.776	5.6122449	-1.6688634
					3.5	2.5	27424.877	5.6122449	-1.6688634
					3.5	3.5	27424.8	2.7210884	-1.9832573
					3.5	4.5	27424.702	5.952381	-1.6433093
					4.5	3.5	27424.831	5.952381	-1.6433093
					4.5	4.5	27424.733	6.6287879	-1.5965659
					4.5	5.5	27424.612	5.275974	-1.6956974
					5.5	4.5	27424.77	5.275974	-1.6956974
					5.5	5.5	27424.65	12.787213	-1.3112241
					5.5	6.5	27424.508	3.3653846	-1.8909653
					6.5	5.5	27424.694	3.3653846	-1.8909653
					6.5	6.5	27424.552	21.634615	-1.0828508
34	27602.45	2540.95	25061.5	-2.57	0.5	1.5	25061.446	3.5714286	-4.017158
					1.5	1.5	25061.456	4.2857143	-3.9379768
					1.5	2.5	25061.446	2.8571429	-4.114068
					2.5	1.5	25061.473	2.1428571	-4.2390068
					2.5	2.5	25061.463	6.5306122	-3.7550461
					2.5	3.5	25061.448	2.0408163	-4.2601961
					3.5	2.5	25061.487	5.6122449	-3.8208634
					3.5	3.5	25061.472	7.4829932	-3.6959246
					3.5	4.5	25061.453	1.1904762	-4.4942793
					4.5	3.5	25061.503	10.47619	-3.5497966
					4.5	4.5	25061.483	6.9264069	-3.729492
					4.5	5.5	25061.46	0.4545455	-4.9124227
					5.5	4.5	25061.521	16.883117	-3.3425474
					5.5	5.5	25061.497	4.5454545	-3.9124227
					6.5	5.5	25061.542	25	-3.17206
35	27602.45	4802.87	22799.61	-1.6	0.5	1.5	22799.605	3.5714286	-3.047158

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					1.5	1.5	22799.615	4.2857143	-2.9679768
					1.5	2.5	22799.591	2.8571429	-3.144068
					2.5	1.5	22799.632	2.1428571	-3.2690068
					2.5	2.5	22799.608	6.5306122	-2.7850461
					2.5	3.5	22799.574	2.0408163	-3.2901961
					3.5	2.5	22799.632	5.6122449	-2.8508634
					3.5	3.5	22799.598	7.4829932	-2.7259246
					3.5	4.5	22799.554	1.1904762	-3.5242793
					4.5	3.5	22799.629	10.47619	-2.5797966
					4.5	4.5	22799.585	6.9264069	-2.759492
					4.5	5.5	22799.532	0.4545455	-3.9424227
					5.5	4.5	22799.623	16.883117	-2.3725474
					5.5	5.5	22799.57	4.5454545	-2.9424227
					6.5	5.5	22799.614	25	-2.20206
36	27602.45	4883.57	22718.9	-0.54	0.5	0.5	22718.859	0.8928571	-2.589218
					0.5	1.5	22718.853	2.6785714	-2.1120968
					1.5	0.5	22718.869	2.6785714	-2.1120968
					1.5	2.5	22718.854	4.4642857	-1.890248
					2.5	1.5	22718.881	4.4642857	-1.890248
					2.5	2.5	22718.871	0.6377551	-2.7353461
					2.5	3.5	22718.858	5.6122449	-1.7908634
					3.5	2.5	22718.895	5.6122449	-1.7908634
					3.5	3.5	22718.882	2.7210884	-2.1052573
					3.5	4.5	22718.865	5.952381	-1.7653093
					4.5	3.5	22718.913	5.952381	-1.7653093
					4.5	4.5	22718.895	6.6287879	-1.7185659
					4.5	5.5	22718.875	5.275974	-1.8176974
					5.5	4.5	22718.933	5.275974	-1.8176974
					5.5	5.5	22718.912	12.787213	-1.4332241
					5.5	6.5	22718.887	3.3653846	-2.0129653
					6.5	5.5	22718.957	3.3653846	-2.0129653

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					6.5	6.5	22718.932	21.634615	-1.2048508
37	27602.45	4987.79	22614.7	-2.27	0.5	0.5	22614.63	2.0833333	-3.9512412
					0.5	1.5	22614.628	1.4880952	-4.0973693
					1.5	0.5	22614.64	0.6944444	-4.4283625
					1.5	1.5	22614.638	3.1746032	-3.7683106
					1.5	2.5	22614.635	3.2738095	-3.7549466
					2.5	1.5	22614.655	0.8928571	-4.319218
					2.5	2.5	22614.652	4.2091837	-3.6458021
					2.5	3.5	22614.648	5.6122449	-3.5208634
					3.5	2.5	22614.676	0.8503401	-4.3404073
					3.5	3.5	22614.672	4.8374906	-3.5853799
					3.5	4.5	22614.666	8.5978836	-3.3356084
					4.5	3.5	22614.702	0.6613757	-4.4495518
					4.5	4.5	22614.697	4.8851611	-3.5811211
					4.5	5.5	22614.69	12.310606	-3.1797206
					5.5	4.5	22614.734	0.4058442	-4.6616407
					5.5	5.5	22614.727	4.1958042	-3.6471848
					5.5	6.5	22614.719	16.826923	-3.0439953
					6.5	5.5	22614.772	0.1602564	-5.0651846
					6.5	6.5	22614.764	2.6175214	-3.8521098
					6.5	7.5	22614.754	22.222222	-2.9232125
38	27841.35	177.76	27663.58	0.417	0.5	0.5	27663.815	2.0833333	-1.2642412
					0.5	1.5	27663.783	0.6944444	-1.7413625
					1.5	0.5	27663.821	1.4880952	-1.4103693
					1.5	1.5	27663.788	3.1746032	-1.0813106
					1.5	2.5	27663.733	0.8928571	-1.632218
					2.5	1.5	27663.796	3.2738095	-1.0679466
					2.5	2.5	27663.742	4.2091837	-0.9588021
					2.5	3.5	27663.665	0.8503401	-1.6534073
					3.5	2.5	27663.754	5.6122449	-0.8338634
					3.5	3.5	27663.677	4.8374906	-0.8983799

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	*Percentage* %	*hfs* log gf
					3.5	4.5	27663.579	0.6613757	-1.7625518
					4.5	3.5	27663.692	8.5978836	-0.6486084
					4.5	4.5	27663.594	4.8851611	-0.8941211
					4.5	5.5	27663.474	0.4058442	-1.9746407
					5.5	4.5	27663.613	12.310606	-0.4927206
					5.5	5.5	27663.493	4.1958042	-0.9601848
					5.5	6.5	27663.351	0.1602564	-2.3781846
					6.5	5.5	27663.515	16.826923	-0.3569953
					6.5	6.5	27663.373	2.6175214	-1.1651098
					7.5	6.5	27663.398	22.222222	-0.2362125
39	27841.35	4883.57	22957.76	-1.58	0.5	0.5	22957.752	2.0833333	-3.2612412
					0.5	1.5	22957.746	0.6944444	-3.7383625
					1.5	0.5	22957.757	1.4880952	-3.4073693
					1.5	1.5	22957.751	3.1746032	-3.0783106
					1.5	2.5	22957.742	0.8928571	-3.629218
					2.5	1.5	22957.76	3.2738095	-3.0649466
					2.5	2.5	22957.75	4.2091837	-2.9558021
					2.5	3.5	22957.737	0.8503401	-3.6504073
					3.5	2.5	22957.762	5.6122449	-2.8308634
					3.5	3.5	22957.749	4.8374906	-2.8953799
					3.5	4.5	22957.732	0.6613757	-3.7595518
					4.5	3.5	22957.764	8.5978836	-2.6456084
					4.5	4.5	22957.747	4.8851611	-2.8911211
					4.5	5.5	22957.726	0.4058442	-3.9716407
					5.5	4.5	22957.766	12.310606	-2.4897206
					5.5	5.5	22957.745	4.1958042	-2.9571848
					5.5	6.5	22957.72	0.1602564	-4.3751846
					6.5	5.5	22957.767	16.826923	-2.3539953
					6.5	6.5	22957.742	2.6175214	-3.1621098
					7.5	6.5	22957.768	22.222222	-2.2332125
40	27841.35	4987.79	22853.53	-0.42	0.5	0.5	22853.493	1.1574074	-2.3565137

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	*Percentage* %	*hfs* log gf
					0.5	1.5	22853.491	1.6203704	-2.2103857
					1.5	0.5	22853.498	1.6203704	-2.2103857
					1.5	1.5	22853.496	1.1851852	-2.3462138
					1.5	2.5	22853.493	2.75	-1.9806673
					2.5	1.5	22853.504	2.75	-1.9806673
					2.5	2.5	22853.501	2.0119048	-2.1163926
					2.5	3.5	22853.497	3.5714286	-1.867158
					3.5	2.5	22853.513	3.5714286	-1.867158
					3.5	3.5	22853.509	3.5273369	-1.8725531
					3.5	4.5	22853.503	4.0123457	-1.8166017
					4.5	3.5	22853.524	4.0123457	-1.8166017
					4.5	4.5	22853.518	5.8992705	-1.6492017
					4.5	5.5	22853.511	3.9772727	-1.8204146
					5.5	4.5	22853.537	3.9772727	-1.8204146
					5.5	5.5	22853.53	9.3240093	-1.4503973
					5.5	6.5	22853.522	3.3653846	-1.8929653
					6.5	5.5	22853.552	3.3653846	-1.8929653
					6.5	6.5	22853.544	14.004986	-1.2737173
					6.5	7.5	22853.534	2.0740741	-2.1031757
					7.5	6.5	22853.569	2.0740741	-2.1031757
					7.5	7.5	22853.56	20.148148	-1.1157649
41	27917.78	0	27917.75	-0.15	2.5	2.5	27917.631	8.9285714	-1.199218
					2.5	3.5	27917.687	16.071429	-0.9439455
					3.5	2.5	27917.667	16.071429	-0.9439455
					3.5	3.5	27917.723	1.0582011	-2.1254318
					3.5	4.5	27917.796	16.203704	-0.9403857
					4.5	3.5	27917.771	16.203704	-0.9403857
					4.5	4.5	27917.843	25.462963	-0.7440911
42	27917.78	67.72	27850.05	-0.57	2.5	1.5	27850.157	10	-1.57
					2.5	2.5	27850.114	9.6428571	-1.5857943
					2.5	3.5	27850.054	5.3571429	-1.8410668

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					3.5	2.5	27850.151	5.3571429	-1.8410668
					3.5	3.5	27850.091	12.698413	-1.4662506
					3.5	4.5	27850.014	15.277778	-1.3859398
					4.5	3.5	27850.138	1.9444444	-2.2812045
					4.5	4.5	27850.061	9.7222222	-1.5822345
					4.5	5.5	27849.967	30	-1.0928787
43	27917.78	4802.87	23114.9	-0.44	2.5	1.5	23114.94	10	-1.44
					2.5	2.5	23114.916	9.6428571	-1.4557943
					2.5	3.5	23114.882	5.3571429	-1.7110668
					3.5	2.5	23114.952	5.3571429	-1.7110668
					3.5	3.5	23114.919	12.698413	-1.3362506
					3.5	4.5	23114.875	15.277778	-1.2559398
					4.5	3.5	23114.966	1.9444444	-2.1512045
					4.5	4.5	23114.922	9.7222222	-1.4522345
					4.5	5.5	23114.869	30	-0.9628787
44	27917.78	10944.56	16973.13	-2.93	2.5	1.5	16973.128	10	-3.93
					2.5	2.5	16973.115	9.6428571	-3.9457943
					2.5	3.5	16973.098	5.3571429	-4.2010668
					3.5	2.5	16973.152	5.3571429	-4.2010668
					3.5	3.5	16973.134	12.698413	-3.8262506
					3.5	4.5	16973.112	15.277778	-3.7459398
					4.5	3.5	16973.182	1.9444444	-4.6412045
					4.5	4.5	16973.159	9.7222222	-3.9422345
					4.5	5.5	16973.132	30	-3.4528787
45	28021.29	0	28021.25	-0.48	1.5	2.5	28021.14	10	-1.48
					2.5	2.5	28021.151	9.6428571	-1.4957943
					2.5	3.5	28021.207	5.3571429	-1.7510668
					3.5	2.5	28021.165	5.3571429	-1.7510668
					3.5	3.5	28021.221	12.698413	-1.3762506
					3.5	4.5	28021.294	1.9444444	-2.1912045
					4.5	3.5	28021.24	15.277778	-1.2959398

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	*Percentage* %	*hfs* log gf
					4.5	4.5	28021.312	9.7222222	-1.4922345
					5.5	4.5	28021.335	30	-1.0028787
46	28021.29	67.72	27953.57	0.01	1.5	1.5	27953.687	4	-1.38794
					1.5	2.5	27953.644	6	-1.2118487
					2.5	1.5	27953.697	6	-1.2118487
					2.5	2.5	27953.654	0.0714286	-3.136128
					2.5	3.5	27953.594	8.9285714	-1.039218
					3.5	2.5	27953.669	8.9285714	-1.039218
					3.5	3.5	27953.609	1.9047619	-1.7101593
					3.5	4.5	27953.532	9.1666667	-1.0277886
					4.5	3.5	27953.628	9.1666667	-1.0277886
					4.5	4.5	27953.551	9.469697	-1.0136639
					4.5	5.5	27953.456	6.3636364	-1.1862946
					5.5	4.5	27953.573	6.3636364	-1.1862946
					5.5	5.5	27953.479	23.636364	-0.6164193
47	28021.29	177.76	27843.53	-0.55	1.5	0.5	27843.787	3.5714286	-1.997158
					1.5	1.5	27843.755	4.2857143	-1.9179768
					1.5	2.5	27843.7	2.1428571	-2.2190068
					2.5	1.5	27843.765	2.8571429	-2.094068
					2.5	2.5	27843.71	6.5306122	-1.7350461
					2.5	3.5	27843.634	5.6122449	-1.8008634
					3.5	2.5	27843.725	2.0408163	-2.2401961
					3.5	3.5	27843.649	7.4829932	-1.6759246
					3.5	4.5	27843.55	10.47619	-1.5297966
					4.5	3.5	27843.667	1.1904762	-2.4742793
					4.5	4.5	27843.569	6.9264069	-1.709492
					4.5	5.5	27843.449	16.883117	-1.3225474
					5.5	4.5	27843.592	0.4545455	-2.8924227
					5.5	5.5	27843.472	4.5454545	-1.8924227
					5.5	6.5	27843.33	25	-1.15206
48	4802.87	28021.29	23218.44	-1.3	1.5	1.5	23218.49	4	-2.69794

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	*Percentage* %	*hfs* log gf
					1.5	2.5	23218.465	6	-2.5218487
					2.5	1.5	23218.5	6	-2.5218487
					2.5	2.5	23218.476	0.0714286	-4.446128
					2.5	3.5	23218.442	8.9285714	-2.349218
					3.5	2.5	23218.49	8.9285714	-2.349218
					3.5	3.5	23218.457	1.9047619	-3.0201593
					3.5	4.5	23218.413	9.1666667	-2.3377886
					4.5	3.5	23218.475	9.1666667	-2.3377886
					4.5	4.5	23218.432	9.469697	-2.3236639
					4.5	5.5	23218.379	6.3636364	-2.4962946
					5.5	4.5	23218.455	6.3636364	-2.4962946
					5.5	5.5	23218.401	23.636364	-1.9264193
49	28021.29	4883.57	23137.65	-0.25	1.5	0.5	23137.664	3.5714286	-1.697158
					1.5	1.5	23137.658	4.2857143	-1.6179768
					1.5	2.5	23137.649	2.1428571	-1.9190068
					2.5	1.5	23137.669	2.8571429	-1.794068
					2.5	2.5	23137.659	6.5306122	-1.4350461
					2.5	3.5	23137.646	5.6122449	-1.5008634
					3.5	2.5	23137.674	2.0408163	-1.9401961
					3.5	3.5	23137.66	7.4829932	-1.3759246
					3.5	4.5	23137.643	10.47619	-1.2297966
					4.5	3.5	23137.679	1.1904762	-2.1742793
					4.5	4.5	23137.662	6.9264069	-1.409492
					4.5	5.5	23137.641	16.883117	-1.0225474
					5.5	4.5	23137.685	0.4545455	-2.5924227
					5.5	5.5	23137.664	4.5454545	-1.5924227
					5.5	6.5	23137.639	25	-0.85206
50	28161.17	67.72	28093.44	-0.4	0.5	1.5	28093.549	3.5714286	-1.847158
					1.5	1.5	28093.554	4.2857143	-1.7679768
					1.5	2.5	28093.511	2.8571429	-1.944068
					2.5	1.5	28093.562	2.1428571	-2.0690068

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					2.5	2.5	28093.519	6.5306122	-1.5850461
					2.5	3.5	28093.459	2.0408163	-2.0901961
					3.5	2.5	28093.531	5.6122449	-1.6508634
					3.5	3.5	28093.471	7.4829932	-1.5259246
					3.5	4.5	28093.394	1.1904762	-2.3242793
					4.5	3.5	28093.486	10.47619	-1.3797966
					4.5	4.5	28093.409	6.9264069	-1.559492
					4.5	5.5	28093.315	0.4545455	-2.7424227
					5.5	4.5	28093.428	16.883117	-1.1725474
					5.5	5.5	28093.333	4.5454545	-1.7424227
					6.5	5.5	28093.355	25	-1.00206
51	28161.17	177.76	27983.38	0.27	0.5	0.5	27983.629	0.8928571	-1.779218
					0.5	1.5	27983.597	2.6785714	-1.3020968
					1.5	0.5	27983.635	2.6785714	-1.3020968
					1.5	2.5	27983.547	4.4642857	-1.080248
					2.5	1.5	27983.61	4.4642857	-1.080248
					2.5	2.5	27983.556	0.6377551	-1.9253461
					2.5	3.5	27983.479	5.6122449	-0.9808634
					3.5	2.5	27983.567	5.6122449	-0.9808634
					3.5	3.5	27983.491	2.7210884	-1.2952573
					3.5	4.5	27983.393	5.952381	-0.9553093
					4.5	3.5	27983.506	5.952381	-0.9553093
					4.5	4.5	27983.408	6.6287879	-0.9085659
					4.5	5.5	27983.288	5.275974	-1.0076974
					5.5	4.5	27983.426	5.275974	-1.0076974
					5.5	5.5	27983.306	12.787213	-0.6232241
					5.5	6.5	27983.164	3.3653846	-1.2029653
					6.5	5.5	27983.328	3.3653846	-1.2029653
					6.5	6.5	27983.186	21.634615	-0.3948508
52	28161.17	4883.57	23277.62	-1.39	0.5	0.5	23277.626	0.8928571	-3.439218
					0.5	1.5	23277.62	2.6785714	-2.9620968

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					1.5	0.5	23277.631	2.6785714	-2.9620968
					1.5	2.5	23277.616	4.4642857	-2.740248
					2.5	1.5	23277.634	4.4642857	-2.740248
					2.5	2.5	23277.624	0.6377551	-3.5853461
					2.5	3.5	23277.611	5.6122449	-2.6408634
					3.5	2.5	23277.636	5.6122449	-2.6408634
					3.5	3.5	23277.623	2.7210884	-2.9552573
					3.5	4.5	23277.605	5.952381	-2.6153093
					4.5	3.5	23277.638	5.952381	-2.6153093
					4.5	4.5	23277.621	6.6287879	-2.5685659
					4.5	5.5	23277.6	5.275974	-2.6676974
					5.5	4.5	23277.639	5.275974	-2.6676974
					5.5	5.5	23277.618	12.787213	-2.2832241
					5.5	6.5	23277.594	3.3653846	-2.8629653
					6.5	5.5	23277.64	3.3653846	-2.8629653
					6.5	6.5	23277.615	21.634615	-2.0548508
53	28161.17	4987.79	23173.39	-0.1	0.5	0.5	23173.367	2.0833333	-1.7812412
					0.5	1.5	23173.365	1.4880952	-1.9273693
					1.5	0.5	23173.372	0.6944444	-2.2583625
					1.5	1.5	23173.37	3.1746032	-1.5983106
					1.5	2.5	23173.367	3.2738095	-1.5849466
					2.5	1.5	23173.378	0.8928571	-2.149218
					2.5	2.5	23173.375	4.2091837	-1.4758021
					2.5	3.5	23173.371	5.6122449	-1.3508634
					3.5	2.5	23173.387	0.8503401	-2.1704073
					3.5	3.5	23173.382	4.8374906	-1.4153799
					3.5	4.5	23173.377	8.5978836	-1.1656084
					4.5	3.5	23173.398	0.6613757	-2.2795518
					4.5	4.5	23173.392	4.8851611	-1.4111211
					4.5	5.5	23173.385	12.310606	-1.0097206
					5.5	4.5	23173.41	0.4058442	-2.4916407

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					5.5	5.5	23173.403	4.1958042	-1.4771848
					5.5	6.5	23173.395	16.826923	-0.8739953
					6.5	5.5	23173.425	0.1602564	-2.8951846
					6.5	6.5	23173.417	2.6175214	-1.6821098
					6.5	7.5	23173.408	22.222222	-0.7532125
54	29736.27	0	29736.31	-0.703	3.5	2.5	29736.238	25	-1.30506
					3.5	3.5	29736.294	33.333333	-1.1801213
					3.5	4.5	29736.366	41.666667	-1.0832112
55	29736.27	12101.5	17634.73	-1.2	3.5	2.5	17634.73	25	-1.80206
					3.5	3.5	17634.73	33.333333	-1.6771213
					3.5	4.5	17634.73	41.666667	-1.5802112
56	29742.16	0	29742.23	-0.76	2.5	2.5	29742.12	8.9285714	-1.809218
					2.5	3.5	29742.176	16.071429	-1.5539455
					3.5	2.5	29742.149	16.071429	-1.5539455
					3.5	3.5	29742.205	1.0582011	-2.7354318
					3.5	4.5	29742.278	16.203704	-1.5503857
					4.5	3.5	29742.244	16.203704	-1.5503857
					4.5	4.5	29742.316	25.462963	-1.3540911
57	29742.16	67.72	29674.44	-0.373	2.5	1.5	29674.556	10	-1.373
					2.5	2.5	29674.513	9.6428571	-1.3887943
					2.5	3.5	29674.453	5.3571429	-1.6440668
					3.5	2.5	29674.543	5.3571429	-1.6440668
					3.5	3.5	29674.483	12.698413	-1.2692506
					3.5	4.5	29674.406	15.277778	-1.1889398
					4.5	3.5	29674.521	1.9444444	-2.0842045
					4.5	4.5	29674.444	9.7222222	-1.3852345
					4.5	5.5	29674.35	30	-0.8958787
58	29742.16	10944.56	18797.51	-2.01	2.5	1.5	18797.516	10	-3.01
					2.5	2.5	18797.504	9.6428571	-3.0257943
					2.5	3.5	18797.487	5.3571429	-3.2810668
					3.5	2.5	18797.534	5.3571429	-3.2810668

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					3.5	3.5	18797.516	12.698413	-2.9062506
					3.5	4.5	18797.494	15.277778	-2.8259398
					4.5	3.5	18797.555	1.9444444	-3.7212045
					4.5	4.5	18797.532	9.7222222	-3.0222345
					4.5	5.5	18797.505	30	-2.5328787
59	29742.16	12074.1	17668.06	-1.21	2.5	3.5	17668.022	25	-1.81206
					3.5	3.5	17668.051	33.333333	-1.6871213
					4.5	3.5	17668.09	41.666667	-1.5902112
60	29742.16	12101.5	17640.61	-1.31	2.5	2.5	17640.61	8.9285714	-2.359218
					2.5	3.5	17640.58	16.071429	-2.1039455
					3.5	2.5	17640.64	16.071429	-2.1039455
					3.5	3.5	17640.61	1.0582011	-3.2854318
					3.5	4.5	17640.572	16.203704	-2.1003857
					4.5	3.5	17640.648	16.203704	-2.1003857
					4.5	4.5	17640.61	25.462963	-1.9040911
61	29742.16	12154.42	17587.7	-1.07	2.5	1.5	17587.654	10	-2.07
					2.5	2.5	17587.656	9.6428571	-2.0857943
					2.5	3.5	17587.659	5.3571429	-2.3410668
					3.5	2.5	17587.686	5.3571429	-2.3410668
					3.5	3.5	17587.689	12.698413	-1.9662506
					3.5	4.5	17587.693	15.277778	-1.8859398
					4.5	3.5	17587.727	1.9444444	-2.7812045
					4.5	4.5	17587.731	9.7222222	-2.0822345
					4.5	5.5	17587.736	30	-1.5928787
62	29823.93	0	29823.78	-1.87	1.5	2.5	29823.676	10	-2.87
					2.5	2.5	29823.685	9.6428571	-2.8857943
					2.5	3.5	29823.741	5.3571429	-3.1410668
					3.5	2.5	29823.697	5.3571429	-3.1410668
					3.5	3.5	29823.753	12.698413	-2.7662506
					3.5	4.5	29823.825	1.9444444	-3.5812045
					4.5	3.5	29823.769	15.277778	-2.6859398

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					4.5	4.5	29823.841	9.7222222	-2.8822345
					5.5	4.5	29823.861	30	-2.3928787
63	29823.93	67.72	29756.3	-0.738	1.5	1.5	29756.422	4	-2.13594
					1.5	2.5	29756.38	6	-1.9598487
					2.5	1.5	29756.431	6	-1.9598487
					2.5	2.5	29756.388	0.0714286	-3.884128
					2.5	3.5	29756.328	8.9285714	-1.787218
					3.5	2.5	29756.401	8.9285714	-1.787218
					3.5	3.5	29756.341	1.9047619	-2.4581593
					3.5	4.5	29756.264	9.1666667	-1.7757886
					4.5	3.5	29756.357	9.1666667	-1.7757886
					4.5	4.5	29756.28	9.469697	-1.7616639
					4.5	5.5	29756.185	6.3636364	-1.9342946
					5.5	4.5	29756.299	6.3636364	-1.9342946
					5.5	5.5	29756.205	23.636364	-1.3644193
64	29823.93	177.76	29646.16	-0.073	1.5	0.5	29646.423	3.5714286	-1.520158
					1.5	1.5	29646.39	4.2857143	-1.4409768
					1.5	2.5	29646.336	2.1428571	-1.7420068
					2.5	1.5	29646.399	2.8571429	-1.617068
					2.5	2.5	29646.345	6.5306122	-1.2580461
					2.5	3.5	29646.268	5.6122449	-1.3238634
					3.5	2.5	29646.357	2.0408163	-1.7631961
					3.5	3.5	29646.28	7.4829932	-1.1989246
					3.5	4.5	29646.182	10.47619	-1.0527966
					4.5	3.5	29646.296	1.1904762	-1.9972793
					4.5	4.5	29646.198	6.9264069	-1.232492
					4.5	5.5	29646.078	16.883117	-0.8455474
					5.5	4.5	29646.218	0.4545455	-2.4154227
					5.5	5.5	29646.097	4.5454545	-1.4154227
					5.5	6.5	29645.955	25	-0.67506
65	29823.93	12101.5	17722.43	-1.13	1.5	2.5	17722.414	10	-2.13

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					2.5	2.5	17722.423	9.6428571	-2.1457943
					2.5	3.5	17722.411	5.3571429	-2.4010668
					3.5	2.5	17722.435	5.3571429	-2.4010668
					3.5	3.5	17722.423	12.698413	-2.0262506
					3.5	4.5	17722.407	1.9444444	-2.8412045
					4.5	3.5	17722.439	15.277778	-1.9459398
					4.5	4.5	17722.423	9.7222222	-2.1422345
					5.5	4.5	17722.442	30	-1.6528787
66	29823.93	12154.42	17669.48	-0.6	1.5	1.5	17669.44	4	-1.99794
					1.5	2.5	17669.442	6	-1.8218487
					2.5	1.5	17669.449	6	-1.8218487
					2.5	2.5	17669.451	0.0714286	-3.746128
					2.5	3.5	17669.454	8.9285714	-1.649218
					3.5	2.5	17669.464	8.9285714	-1.649218
					3.5	3.5	17669.467	1.9047619	-2.3201593
					3.5	4.5	17669.471	9.1666667	-1.6377886
					4.5	3.5	17669.483	9.1666667	-1.6377886
					4.5	4.5	17669.487	9.469697	-1.6236639
					4.5	5.5	17669.492	6.3636364	-1.7962946
					5.5	4.5	17669.506	6.3636364	-1.7962946
					5.5	5.5	17669.511	23.636364	-1.2264193
67	30815.7	0	30815.71	-1.99	2.5	2.5	30815.613	8.9285714	-3.039218
					2.5	3.5	30815.669	16.071429	-2.7839455
					3.5	2.5	30815.632	16.071429	-2.7839455
					3.5	3.5	30815.688	1.0582011	-3.9654318
					3.5	4.5	30815.761	16.203704	-2.7803857
					4.5	3.5	30815.713	16.203704	-2.7803857
					4.5	4.5	30815.785	25.462963	-2.5840911
68	30815.7	67.72	30747.91	-1.96	2.5	1.5	30748.04	10	-2.96
					2.5	2.5	30747.997	9.6428571	-2.9757943
					2.5	3.5	30747.937	5.3571429	-3.2310668

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					3.5	2.5	30748.016	5.3571429	-3.2310668
					3.5	3.5	30747.956	12.698413	-2.8562506
					3.5	4.5	30747.879	15.277778	-2.7759398
					4.5	3.5	30747.981	1.9444444	-3.6712045
					4.5	4.5	30747.904	9.7222222	-2.9722345
					4.5	5.5	30747.809	30	-2.4828787
69	30815.7	2540.95	28274.76	-0.46	2.5	1.5	28274.774	10	-1.46
					2.5	2.5	28274.763	9.6428571	-1.4757943
					2.5	3.5	28274.748	5.3571429	-1.7310668
					3.5	2.5	28274.782	5.3571429	-1.7310668
					3.5	3.5	28274.767	12.698413	-1.3562506
					3.5	4.5	28274.748	15.277778	-1.2759398
					4.5	3.5	28274.792	1.9444444	-2.1712045
					4.5	4.5	28274.773	9.7222222	-1.4722345
					4.5	5.5	28274.749	30	-0.9828787
70	30815.7	10944.56	19871.18	-0.4	2.5	1.5	19871.2	10	-1.4
					2.5	2.5	19871.188	9.6428571	-1.4157943
					2.5	3.5	19871.17	5.3571429	-1.6710668
					3.5	2.5	19871.207	5.3571429	-1.6710668
					3.5	3.5	19871.189	12.698413	-1.2962506
					3.5	4.5	19871.167	15.277778	-1.2159398
					4.5	3.5	19871.214	1.9444444	-2.1112045
					4.5	4.5	19871.192	9.7222222	-1.4122345
					4.5	5.5	19871.164	30	-0.9228787
71	30815.7	11736.36	19079.35	-0.77	2.5	3.5	19079.325	25	-1.37206
					3.5	3.5	19079.344	33.333333	-1.2471213
					4.5	3.5	19079.369	41.666667	-1.1502112
72	30815.7	12074.1	18741.6	-2.2	2.5	3.5	18741.575	25	-2.80206
					3.5	3.5	18741.594	33.333333	-2.6771213
					4.5	3.5	18741.619	41.666667	-2.5802112
73	30815.7	12154.42	18661.27	-2.11	2.5	1.5	18661.237	10	-3.11

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	*Percentage* %	*hfs* log gf
					2.5	2.5	18661.239	9.6428571	-3.1257943
					2.5	3.5	18661.243	5.3571429	-3.3810668
					3.5	2.5	18661.259	5.3571429	-3.3810668
					3.5	3.5	18661.262	12.698413	-3.0062506
					3.5	4.5	18661.266	15.277778	-2.9259398
					4.5	3.5	18661.287	1.9444444	-3.8212045
					4.5	4.5	18661.291	9.7222222	-3.1222345
					4.5	5.5	18661.296	30	-2.6328787
74	30815.7	25955.2	4860.5	-1.85	2.5	3.5	4860.4752	25	-2.45206
					3.5	3.5	4860.4945	33.333333	-2.3271213
					4.5	3.5	4860.5193	41.666667	-2.2302112
75	32349.98	177.76	32172.22	-2.82	0.5	0.5	32172.429	0.8928571	-4.869218
					0.5	1.5	32172.396	2.6785714	-4.3920968
					1.5	0.5	32172.439	2.6785714	-4.3920968
					1.5	2.5	32172.351	4.4642857	-4.170248
					2.5	1.5	32172.422	4.4642857	-4.170248
					2.5	2.5	32172.367	0.6377551	-5.0153461
					2.5	3.5	32172.291	5.6122449	-4.0708634
					3.5	2.5	32172.389	5.6122449	-4.0708634
					3.5	3.5	32172.313	2.7210884	-4.3852573
					3.5	4.5	32172.215	5.952381	-4.0453093
					4.5	3.5	32172.342	5.952381	-4.0453093
					4.5	4.5	32172.243	6.6287879	-3.9985659
					4.5	5.5	32172.123	5.275974	-4.0976974
					5.5	4.5	32172.278	5.275974	-4.0976974
					5.5	5.5	32172.158	12.787213	-3.7132241
					5.5	6.5	32172.016	3.3653846	-4.2929653
					6.5	5.5	32172.2	3.3653846	-4.2929653
					6.5	6.5	32172.057	21.634615	-3.4848508
76	32349.98	2540.95	29809.03	0.251	0.5	1.5	29808.982	3.5714286	-1.196158
					1.5	1.5	29808.992	4.2857143	-1.1169768

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	*Percentage* %	*hfs* log gf
					1.5	2.5	29808.981	2.8571429	-1.293068
					2.5	1.5	29809.008	2.1428571	-1.4180068
					2.5	2.5	29808.997	6.5306122	-0.9340461
					2.5	3.5	29808.982	2.0408163	-1.4391961
					3.5	2.5	29809.02	5.6122449	-0.9998634
					3.5	3.5	29809.005	7.4829932	-0.8749246
					3.5	4.5	29808.985	1.1904762	-1.6732793
					4.5	3.5	29809.033	10.47619	-0.7287966
					4.5	4.5	29809.014	6.9264069	-0.908492
					4.5	5.5	29808.991	0.4545455	-2.0914227
					5.5	4.5	29809.049	16.883117	-0.5215474
					5.5	5.5	29809.026	4.5454545	-1.0914227
					6.5	5.5	29809.067	25	-0.35106
77	32349.98	10944.56	21405.42	-0.58	0.5	1.5	21405.379	3.5714286	-2.027158
					1.5	1.5	21405.388	4.2857143	-1.9479768
					1.5	2.5	21405.376	2.8571429	-2.124068
					2.5	1.5	21405.404	2.1428571	-2.2490068
					2.5	2.5	21405.392	6.5306122	-1.7650461
					2.5	3.5	21405.374	2.0408163	-2.2701961
					3.5	2.5	21405.414	5.6122449	-1.8308634
					3.5	3.5	21405.397	7.4829932	-1.7059246
					3.5	4.5	21405.374	1.1904762	-2.5042793
					4.5	3.5	21405.425	10.47619	-1.5597966
					4.5	4.5	21405.403	6.9264069	-1.739492
					4.5	5.5	21405.376	0.4545455	-2.9224227
					5.5	4.5	21405.438	16.883117	-1.3525474
					5.5	5.5	21405.411	4.5454545	-1.9224227
					6.5	5.5	21405.452	25	-1.18206
78	32349.98	14261.32	18088.68	0.02	0.5	0.5	18088.673	2.0833333	-1.6612412
					0.5	1.5	18088.666	1.4880952	-1.8073693
					1.5	0.5	18088.682	0.6944444	-2.1383625

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	*Percentage* %	*hfs* log gf
					1.5	1.5	18088.676	3.1746032	-1.4783106
					1.5	2.5	18088.664	3.2738095	-1.4649466
					2.5	1.5	18088.692	0.8928571	-2.029218
					2.5	2.5	18088.68	4.2091837	-1.3558021
					2.5	3.5	18088.665	5.6122449	-1.2308634
					3.5	2.5	18088.703	0.8503401	-2.0504073
					3.5	3.5	18088.687	4.8374906	-1.2953799
					3.5	4.5	18088.667	8.5978836	-1.0456084
					4.5	3.5	18088.716	0.6613757	-2.1595518
					4.5	4.5	18088.695	4.8851611	-1.2911211
					4.5	5.5	18088.67	12.310606	-0.8897206
					5.5	4.5	18088.73	0.4058442	-2.3716407
					5.5	5.5	18088.705	4.1958042	-1.3571848
					5.5	6.5	18088.676	16.826923	-0.7539953
					6.5	5.5	18088.747	0.1602564	-2.7751846
					6.5	6.5	18088.718	2.6175214	-1.5621098
					6.5	7.5	18088.684	22.222222	-0.6332125
79	39002.2	0	39002.16	-0.575	3.5	2.5	39002.088	25	-1.17706
					3.5	3.5	39002.144	33.333333	-1.0521213
					3.5	4.5	39002.216	41.666667	-0.9552112
80	39115.04	0	39115.13	-0.69	2.5	2.5	39114.851	8.9285714	-1.739218
					2.5	3.5	39114.907	16.071429	-1.4839455
					3.5	2.5	39115.012	16.071429	-1.4839455
					3.5	3.5	39115.068	1.0582011	-2.6654318
					3.5	4.5	39115.14	16.203704	-1.4803857
					4.5	3.5	39115.275	16.203704	-1.4803857
					4.5	4.5	39115.347	25.462963	-1.2840911
81	39115.04	67.72	39047.25	-0.227	2.5	1.5	39047.197	10	-1.227
					2.5	2.5	39047.154	9.6428571	-1.2427943
					2.5	3.5	39047.094	5.3571429	-1.4980668
					3.5	2.5	39047.315	5.3571429	-1.4980668

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					3.5	3.5	39047.255	12.698413	-1.1232506
					3.5	4.5	39047.178	15.277778	-1.0429398
					4.5	3.5	39047.462	1.9444444	-1.9382045
					4.5	4.5	39047.385	9.7222222	-1.2392345
					4.5	5.5	39047.291	30	-0.7498787
82	39345.52	0	39345.49	-1.9	1.5	2.5	39345.075	10	-2.9
					2.5	2.5	39345.17	9.6428571	-2.9157943
					2.5	3.5	39345.226	5.3571429	-3.1710668
					3.5	2.5	39345.303	5.3571429	-3.1710668
					3.5	3.5	39345.36	12.698413	-2.7962506
					3.5	4.5	39345.432	1.9444444	-3.6112045
					4.5	3.5	39345.531	15.277778	-2.7159398
					4.5	4.5	39345.603	9.7222222	-2.9122345
					5.5	4.5	39345.813	30	-2.4228787
83	39345.52	67.72	39277.91	-0.711	1.5	1.5	39277.721	4	-2.10894
					1.5	2.5	39277.678	6	-1.9328487
					2.5	1.5	39277.816	6	-1.9328487
					2.5	2.5	39277.773	0.0714286	-3.857128
					2.5	3.5	39277.713	8.9285714	-1.760218
					3.5	2.5	39277.907	8.9285714	-1.760218
					3.5	3.5	39277.847	1.9047619	-2.4311593
					3.5	4.5	39277.77	9.1666667	-1.7487886
					4.5	3.5	39278.019	9.1666667	-1.7487886
					4.5	4.5	39277.942	9.469697	-1.7346639
					4.5	5.5	39277.847	6.3636364	-1.9072946
					5.5	4.5	39278.151	6.3636364	-1.9072946
					5.5	5.5	39278.057	23.636364	-1.3374193
84	39345.52	177.76	39167.83	0.033	1.5	0.5	39167.782	3.5714286	-1.414158
					1.5	1.5	39167.749	4.2857143	-1.3349768
					1.5	2.5	39167.694	2.1428571	-1.6360068
					2.5	1.5	39167.844	2.8571429	-1.511068

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					2.5	2.5	39167.79	6.5306122	-1.1520461
					2.5	3.5	39167.713	5.6122449	-1.2178634
					3.5	2.5	39167.923	2.0408163	-1.6571961
					3.5	3.5	39167.847	7.4829932	-1.0929246
					3.5	4.5	39167.748	10.47619	-0.9467966
					4.5	3.5	39168.018	1.1904762	-1.8912793
					4.5	4.5	39167.92	6.9264069	-1.126492
					4.5	5.5	39167.8	16.883117	-0.7395474
					5.5	4.5	39168.13	0.4545455	-2.3094227
					5.5	5.5	39168.01	4.5454545	-1.3094227
					5.5	6.5	39167.868	25	-0.56906
85	55715.36	2540.95	53174.4	-0.1	2.5	1.5	53174.393	10	-1.1
					2.5	2.5	53174.383	9.6428571	-1.1157943
					2.5	3.5	53174.368	5.3571429	-1.3710668
					3.5	2.5	53174.418	5.3571429	-1.3710668
					3.5	3.5	53174.403	12.698413	-0.9962506
					3.5	4.5	53174.384	15.277778	-0.9159398
					4.5	3.5	53174.448	1.9444444	-1.8112045
					4.5	4.5	53174.429	9.7222222	-1.1122345
					4.5	5.5	53174.405	30	-0.6228787
86	55715.36	10944.56	44770.8	-0.76	2.5	1.5	44770.8	10	-1.76
					2.5	2.5	44770.787	9.6428571	-1.7757943
					2.5	3.5	44770.77	5.3571429	-2.0310668
					3.5	2.5	44770.822	5.3571429	-2.0310668
					3.5	3.5	44770.805	12.698413	-1.6562506
					3.5	4.5	44770.783	15.277778	-1.5759398
					4.5	3.5	44770.85	1.9444444	-2.4712045
					4.5	4.5	44770.828	9.7222222	-1.7722345
					4.5	5.5	44770.8	30	-1.2828787
87	55715.36	11736.36	43979.02	0.25	2.5	3.5	43978.975	25	-0.35206
					3.5	3.5	43979.01	33.333333	-0.2271213

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	*Percentage* %	*hfs* log gf
					4.5	3.5	43979.055	41.666667	-0.1302112
88	55715.36	25955.2	29760.17	-1.4	2.5	3.5	29760.125	25	-2.00206
					3.5	3.5	29760.16	33.333333	-1.8771213
					4.5	3.5	29760.205	41.666667	-1.7802112
89	57551.88	27443.71	30108.19	-0.24	2.5	1.5	30108.273	10	-1.24
					2.5	2.5	30108.243	9.6428571	-1.2557943
					2.5	3.5	30108.2	5.3571429	-1.5110668
					3.5	2.5	30108.264	5.3571429	-1.5110668
					3.5	3.5	30108.221	12.698413	-1.1362506
					3.5	4.5	30108.166	15.277778	-1.0559398
					4.5	3.5	30108.248	1.9444444	-1.9512045
					4.5	4.5	30108.193	9.7222222	-1.2522345
					4.5	5.5	30108.125	30	-0.7628787
90	57551.88	27917.78	29634.09	-0.48	2.5	2.5	29634.11	8.9285714	-1.529218
					2.5	3.5	29634.073	16.071429	-1.2739455
					3.5	2.5	29634.131	16.071429	-1.2739455
					3.5	3.5	29634.094	1.0582011	-2.4554318
					3.5	4.5	29634.047	16.203704	-1.2703857
					4.5	3.5	29634.122	16.203704	-1.2703857
					4.5	4.5	29634.074	25.462963	-1.0740911
91	57614.4	27602.45	30011.99	-0.08	1.5	0.5	30011.984	3.5714286	-1.527158
					1.5	1.5	30011.974	4.2857143	-1.4479768
					1.5	2.5	30011.957	2.1428571	-1.7490068
					2.5	1.5	30012.001	2.8571429	-1.624068
					2.5	2.5	30011.984	6.5306122	-1.2650461
					2.5	3.5	30011.96	5.6122449	-1.3308634
					3.5	2.5	30012.022	2.0408163	-1.7701961
					3.5	3.5	30011.998	7.4829932	-1.2059246
					3.5	4.5	30011.968	10.47619	-1.0597966
					4.5	3.5	30012.047	1.1904762	-2.0042793
					4.5	4.5	30012.017	6.9264069	-1.239492

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	*Percentage* %	*hfs* log gf
					4.5	5.5	30011.979	16.883117	-0.8525474
					5.5	4.5	30012.077	0.4545455	-2.4224227
					5.5	5.5	30012.039	4.5454545	-1.4224227
					5.5	6.5	30011.995	25	-0.68206
92	57614.4	28021.29	29593.07	-0.33	1.5	1.5	29593.009	4	-1.72794
					1.5	2.5	29592.999	6	-1.5518487
					2.5	1.5	29593.037	6	-1.5518487
					2.5	2.5	29593.026	0.0714286	-3.476128
					2.5	3.5	29593.012	8.9285714	-1.379218
					3.5	2.5	29593.064	8.9285714	-1.379218
					3.5	3.5	29593.05	1.9047619	-2.0501593
					3.5	4.5	29593.031	9.1666667	-1.3677886
					4.5	3.5	29593.099	9.1666667	-1.3677886
					4.5	4.5	29593.08	9.469697	-1.3536639
					4.5	5.5	29593.057	6.3636364	-1.5262946
					5.5	4.5	29593.14	6.3636364	-1.5262946
					5.5	5.5	29593.117	23.636364	-0.9564193
93	57614.4	29742.16	27872.24	-0.48	1.5	2.5	27872.18	10	-1.48
					2.5	2.5	27872.207	9.6428571	-1.4957943
					2.5	3.5	27872.178	5.3571429	-1.7510668
					3.5	2.5	27872.246	5.3571429	-1.7510668
					3.5	3.5	27872.216	12.698413	-1.3762506
					3.5	4.5	27872.178	1.9444444	-2.1912045
					4.5	3.5	27872.265	15.277778	-1.2959398
					4.5	4.5	27872.227	9.7222222	-1.4922345
					5.5	4.5	27872.287	30	-1.0028787
94	57743.92	27841.35	29902.57	0.12	0.5	0.5	29902.521	2.0833333	-1.5612412
					0.5	1.5	29902.515	1.4880952	-1.7073693
					1.5	0.5	29902.533	0.6944444	-2.0383625
					1.5	1.5	29902.528	3.1746032	-1.3783106
					1.5	2.5	29902.519	3.2738095	-1.3649466

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					2.5	1.5	29902.548	0.8928571	-1.929218
					2.5	2.5	29902.539	4.2091837	-1.2558021
					2.5	3.5	29902.527	5.6122449	-1.1308634
					3.5	2.5	29902.567	0.8503401	-1.9504073
					3.5	3.5	29902.556	4.8374906	-1.1953799
					3.5	4.5	29902.54	8.5978836	-0.9456084
					4.5	3.5	29902.592	0.6613757	-2.0595518
					4.5	4.5	29902.577	4.8851611	-1.1911211
					4.5	5.5	29902.558	12.310606	-0.7897206
					5.5	4.5	29902.621	0.4058442	-2.2716407
					5.5	5.5	29902.602	4.1958042	-1.2571848
					5.5	6.5	29902.58	16.826923	-0.6539953
					6.5	5.5	29902.655	0.1602564	-2.6751846
					6.5	6.5	29902.633	2.6175214	-1.4621098
					6.5	7.5	29902.607	22.222222	-0.5332125
95	57743.92	28161.17	29582.76	-0.06	0.5	0.5	29582.697	0.8928571	-2.109218
					0.5	1.5	29582.691	2.6785714	-1.6320968
					1.5	0.5	29582.709	2.6785714	-1.6320968
					1.5	2.5	29582.695	4.4642857	-1.410248
					2.5	1.5	29582.724	4.4642857	-1.410248
					2.5	2.5	29582.715	0.6377551	-2.2553461
					2.5	3.5	29582.704	5.6122449	-1.3108634
					3.5	2.5	29582.744	5.6122449	-1.3108634
					3.5	3.5	29582.732	2.7210884	-1.6252573
					3.5	4.5	29582.717	5.952381	-1.2853093
					4.5	3.5	29582.768	5.952381	-1.2853093
					4.5	4.5	29582.753	6.6287879	-1.2385659
					4.5	5.5	29582.734	5.275974	-1.3376974
					5.5	4.5	29582.797	5.275974	-1.3376974
					5.5	5.5	29582.779	12.787213	-0.9532241
					5.5	6.5	29582.757	3.3653846	-1.5329653

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	*Percentage* %	*hfs* log gf
					6.5	5.5	29582.831	3.3653846	-1.5329653
					6.5	6.5	29582.809	21.634615	-0.7248508
96	57743.92	29823.93	27919.88	-0.21	0.5	1.5	27919.803	3.5714286	-1.657158
					1.5	1.5	27919.815	4.2857143	-1.5779768
					1.5	2.5	27919.806	2.8571429	-1.754068
					2.5	1.5	27919.835	2.1428571	-1.8790068
					2.5	2.5	27919.826	6.5306122	-1.3950461
					2.5	3.5	27919.814	2.0408163	-1.9001961
					3.5	2.5	27919.855	5.6122449	-1.4608634
					3.5	3.5	27919.842	7.4829932	-1.3359246
					3.5	4.5	27919.826	1.1904762	-2.1342793
					4.5	3.5	27919.878	10.47619	-1.1897966
					4.5	4.5	27919.863	6.9264069	-1.369492
					4.5	5.5	27919.843	0.4545455	-2.5524227
					5.5	4.5	27919.907	16.883117	-0.9825474
					5.5	5.5	27919.888	4.5454545	-1.5524227
					6.5	5.5	27919.94	25	-0.81206
97	58252.09	26081.34	32170.68	-0.24	1.5	1.5	32170.713	4	-1.63794
					1.5	2.5	32170.695	6	-1.4618487
					2.5	1.5	32170.722	6	-1.4618487
					2.5	2.5	32170.704	0.0714286	-3.386128
					2.5	3.5	32170.679	8.9285714	-1.289218
					3.5	2.5	32170.716	8.9285714	-1.289218
					3.5	3.5	32170.691	1.9047619	-1.9601593
					3.5	4.5	32170.659	9.1666667	-1.2777886
					4.5	3.5	32170.707	9.1666667	-1.2777886
					4.5	4.5	32170.674	9.469697	-1.2636639
					4.5	5.5	32170.635	6.3636364	-1.4362946
					5.5	4.5	32170.694	6.3636364	-1.4362946
					5.5	5.5	32170.654	23.636364	-0.8664193
98	58252.09	30815.7	27436.43	-0.33	1.5	2.5	27436.423	10	-1.33

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					2.5	2.5	27436.432	9.6428571	-1.3457943
					2.5	3.5	27436.413	5.3571429	-1.6010668
					3.5	2.5	27436.444	5.3571429	-1.6010668
					3.5	3.5	27436.425	12.698413	-1.2262506
					3.5	4.5	27436.4	1.9444444	-2.0412045
					4.5	3.5	27436.441	15.277778	-1.1459398
					4.5	4.5	27436.416	9.7222222	-1.3422345
					5.5	4.5	27436.435	30	-0.8528787
99	58252.09	32349.98	25902.13	0.1	1.5	0.5	25902.184	3.5714286	-1.347158
					1.5	1.5	25902.175	4.2857143	-1.2679768
					1.5	2.5	25902.159	2.1428571	-1.5690068
					2.5	1.5	25902.184	2.8571429	-1.444068
					2.5	2.5	25902.168	6.5306122	-1.0850461
					2.5	3.5	25902.145	5.6122449	-1.1508634
					3.5	2.5	25902.18	2.0408163	-1.5901961
					3.5	3.5	25902.158	7.4829932	-1.0259246
					3.5	4.5	25902.129	10.47619	-0.8797966
					4.5	3.5	25902.173	1.1904762	-1.8242793
					4.5	4.5	25902.145	6.9264069	-1.059492
					4.5	5.5	25902.11	16.883117	-0.6725474
					5.5	4.5	25902.164	0.4545455	-2.2424227
					5.5	5.5	25902.129	4.5454545	-1.2424227
					5.5	6.5	25902.088	25	-0.50206
100	59528.42	26081.34	33447.17	0.43	0.5	1.5	33447.181	3.5714286	-1.017158
					1.5	1.5	33447.187	4.2857143	-0.9379768
					1.5	2.5	33447.169	2.8571429	-1.114068
					2.5	1.5	33447.197	2.1428571	-1.2390068
					2.5	2.5	33447.179	6.5306122	-0.7550461
					2.5	3.5	33447.153	2.0408163	-1.2601961
					3.5	2.5	33447.193	5.6122449	-0.8208634
					3.5	3.5	33447.167	7.4829932	-0.6959246

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					3.5	4.5	33447.135	1.1904762	-1.4942793
					4.5	3.5	33447.186	10.47619	-0.5497966
					4.5	4.5	33447.153	6.9264069	-0.729492
					4.5	5.5	33447.114	0.4545455	-1.9124227
					5.5	4.5	33447.175	16.883117	-0.3425474
					5.5	5.5	33447.136	4.5454545	-0.9124227
					6.5	5.5	33447.162	25	-0.17206
101	59528.42	32349.98	27178.5	0.16	0.5	0.5	27178.532	0.8928571	-1.889218
					0.5	1.5	27178.522	2.6785714	-1.4120968
					1.5	0.5	27178.538	2.6785714	-1.4120968
					1.5	2.5	27178.512	4.4642857	-1.190248
					2.5	1.5	27178.538	4.4642857	-1.190248
					2.5	2.5	27178.522	0.6377551	-2.0353461
					2.5	3.5	27178.5	5.6122449	-1.0908634
					3.5	2.5	27178.537	5.6122449	-1.0908634
					3.5	3.5	27178.514	2.7210884	-1.4052573
					3.5	4.5	27178.486	5.952381	-1.0653093
					4.5	3.5	27178.532	5.952381	-1.0653093
					4.5	4.5	27178.504	6.6287879	-1.0185659
					4.5	5.5	27178.469	5.275974	-1.1176974
					5.5	4.5	27178.526	5.275974	-1.1176974
					5.5	5.5	27178.491	12.787213	-0.7332241
					5.5	6.5	27178.449	3.3653846	-1.3129653
					6.5	5.5	27178.517	3.3653846	-1.3129653
					6.5	6.5	27178.475	21.634615	-0.5048508
102	59875.08	27917.78	31957.28	-0.08	2.5	2.5	31957.297	8.9285714	-1.129218
					2.5	3.5	31957.26	16.071429	-0.8739455
					3.5	2.5	31957.321	16.071429	-0.8739455
					3.5	3.5	31957.284	1.0582011	-2.0554318
					3.5	4.5	31957.237	16.203704	-0.8703857
					4.5	3.5	31957.314	16.203704	-0.8703857

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					4.5	4.5	31957.267	25.462963	-0.6740911
103	59875.08	29736.27	30138.84	-0.49	2.5	3.5	30138.81	25	-1.09206
					3.5	3.5	30138.833	33.333333	-0.9671213
					4.5	3.5	30138.863	41.666667	-0.8702112
104	59929.46	28021.29	31908.3	0.11	1.5	1.5	31908.311	4	-1.28794
					1.5	2.5	31908.3	6	-1.1118487
					2.5	1.5	31908.318	6	-1.1118487
					2.5	2.5	31908.308	0.0714286	-3.036128
					2.5	3.5	31908.293	8.9285714	-0.939218
					3.5	2.5	31908.318	8.9285714	-0.939218
					3.5	3.5	31908.304	1.9047619	-1.6101593
					3.5	4.5	31908.285	9.1666667	-0.9277886
					4.5	3.5	31908.317	9.1666667	-0.9277886
					4.5	4.5	31908.298	9.469697	-0.9136639
					4.5	5.5	31908.275	6.3636364	-1.0862946
					5.5	4.5	31908.315	6.3636364	-1.0862946
105	59929.46	29742.16	30187.3	-0.12	1.5	2.5	30187.311	10	-1.12
					2.5	2.5	30187.319	9.6428571	-1.1357943
					2.5	3.5	30187.289	5.3571429	-1.3910668
					3.5	2.5	30187.329	5.3571429	-1.3910668
					3.5	3.5	30187.299	12.698413	-1.0162506
					3.5	4.5	30187.261	1.9444444	-1.8312045
					4.5	3.5	30187.313	15.277778	-0.9359398
					4.5	4.5	30187.275	9.7222222	-1.1322345
					5.5	4.5	30187.291	30	-0.6428787
106	60001.91	28161.17	31840.77	0.33	0.5	0.5	31840.791	0.8928571	-1.719218
					0.5	1.5	31840.786	2.6785714	-1.2420968
					1.5	0.5	31840.793	2.6785714	-1.2420968
					1.5	2.5	31840.78	4.4642857	-1.020248
					2.5	1.5	31840.793	4.4642857	-1.020248
					2.5	2.5	31840.785	0.6377551	-1.8653461

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					2.5	3.5	31840.773	5.6122449	-0.9208634
					3.5	2.5	31840.791	5.6122449	-0.9208634
					3.5	3.5	31840.779	2.7210884	-1.2352573
					3.5	4.5	31840.764	5.952381	-0.8953093
					4.5	3.5	31840.787	5.952381	-0.8953093
					4.5	4.5	31840.772	6.6287879	-0.8485659
					4.5	5.5	31840.754	5.275974	-0.9476974
					5.5	4.5	31840.782	5.275974	-0.9476974
					5.5	5.5	31840.764	12.787213	-0.5632241
					5.5	6.5	31840.742	3.3653846	-1.1429653
					6.5	5.5	31840.776	3.3653846	-1.1429653
					6.5	6.5	31840.754	21.634615	-0.3348508
107	60001.91	29823.93	30178.03	0.15	0.5	1.5	30178.037	3.5714286	-1.297158
					1.5	1.5	30178.04	4.2857143	-1.2179768
					1.5	2.5	30178.031	2.8571429	-1.394068
					2.5	1.5	30178.044	2.1428571	-1.5190068
					2.5	2.5	30178.036	6.5306122	-1.0350461
					2.5	3.5	30178.023	2.0408163	-1.5401961
					3.5	2.5	30178.042	5.6122449	-1.1008634
					3.5	3.5	30178.03	7.4829932	-0.9759246
					3.5	4.5	30178.014	1.1904762	-1.7742793
					4.5	3.5	30178.038	10.47619	-0.8297966
					4.5	4.5	30178.022	6.9264069	-1.009492
					4.5	5.5	30178.002	0.4545455	-2.1924227
					5.5	4.5	30178.032	16.883117	-0.6225474
					5.5	5.5	30178.013	4.5454545	-1.1924227
					6.5	5.5	30178.025	25	-0.45206
108	60267.16	27443.71	32823.36	0.55	0.5	1.5	32823.392	3.5714286	-0.897158
					1.5	1.5	32823.4	4.2857143	-0.8179768
					1.5	2.5	32823.37	2.8571429	-0.994068
					2.5	1.5	32823.415	2.1428571	-1.1190068

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					2.5	2.5	32823.384	6.5306122	-0.6350461
					2.5	3.5	32823.341	2.0408163	-1.1401961
					3.5	2.5	32823.405	5.6122449	-0.7008634
					3.5	3.5	32823.362	7.4829932	-0.5759246
					3.5	4.5	32823.307	1.1904762	-1.3742793
					4.5	3.5	32823.388	10.47619	-0.4297966
					4.5	4.5	32823.333	6.9264069	-0.609492
					4.5	5.5	32823.265	0.4545455	-1.7924227
					5.5	4.5	32823.365	16.883117	-0.2225474
					5.5	5.5	32823.297	4.5454545	-0.7924227
					6.5	5.5	32823.335	25	-0.05206
109	60267.16	27602.45	32664.51	-0.53	0.5	0.5	32664.524	0.8928571	-2.579218
					0.5	1.5	32664.513	2.6785714	-2.1020968
					1.5	0.5	32664.532	2.6785714	-2.1020968
					1.5	2.5	32664.505	4.4642857	-1.880248
					2.5	1.5	32664.537	4.4642857	-1.880248
					2.5	2.5	32664.52	0.6377551	-2.7253461
					2.5	3.5	32664.496	5.6122449	-1.7808634
					3.5	2.5	32664.54	5.6122449	-1.7808634
					3.5	3.5	32664.516	2.7210884	-2.0952573
					3.5	4.5	32664.485	5.952381	-1.7553093
					4.5	3.5	32664.542	5.952381	-1.7553093
					4.5	4.5	32664.512	6.6287879	-1.7085659
					4.5	5.5	32664.474	5.275974	-1.8076974
					5.5	4.5	32664.544	5.275974	-1.8076974
					5.5	5.5	32664.506	12.787213	-1.4232241
					5.5	6.5	32664.462	3.3653846	-2.0029653
					6.5	5.5	32664.544	3.3653846	-2.0029653
					6.5	6.5	32664.499	21.634615	-1.1948508
110	60348.46	27602.45	32745.98	0.69	0.5	0.5	32746.014	2.0833333	-0.9912412
					0.5	1.5	32746.004	0.6944444	-1.4683625

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	*Percentage* %	*hfs* log gf
					1.5	0.5	32746.019	1.4880952	-1.1373693
					1.5	1.5	32746.009	3.1746032	-0.8083106
					1.5	2.5	32745.992	0.8928571	-1.359218
					2.5	1.5	32746.017	3.2738095	-0.7949466
					2.5	2.5	32746	4.2091837	-0.6858021
					2.5	3.5	32745.976	0.8503401	-1.3804073
					3.5	2.5	32746.012	5.6122449	-0.5608634
					3.5	3.5	32745.988	4.8374906	-0.6253799
					3.5	4.5	32745.957	0.6613757	-1.4895518
					4.5	3.5	32746.003	8.5978836	-0.3756084
					4.5	4.5	32745.972	4.8851611	-0.6211211
					4.5	5.5	32745.934	0.4058442	-1.7016407
					5.5	4.5	32745.99	12.310606	-0.2197206
					5.5	5.5	32745.953	4.1958042	-0.6871848
					5.5	6.5	32745.908	0.1602564	-2.1051846
					6.5	5.5	32745.974	16.826923	-0.0839953
					6.5	6.5	32745.93	2.6175214	-0.8921098
					7.5	6.5	32745.955	22.222222	0.0367875
111	60348.46	27841.35	32507.1	-0.5	0.5	0.5	32507.101	1.1574074	-2.4365137
					0.5	1.5	32507.096	1.6203704	-2.2903857
					1.5	0.5	32507.106	1.6203704	-2.2903857
					1.5	1.5	32507.101	1.1851852	-2.4262138
					1.5	2.5	32507.093	2.75	-2.0606673
					2.5	1.5	32507.109	2.75	-2.0606673
					2.5	2.5	32507.101	2.0119048	-2.1963926
					2.5	3.5	32507.089	3.5714286	-1.947158
					3.5	2.5	32507.113	3.5714286	-1.947158
					3.5	3.5	32507.101	3.5273369	-1.9525531
					3.5	4.5	32507.085	4.0123457	-1.8966017
					4.5	3.5	32507.116	4.0123457	-1.8966017
					4.5	4.5	32507.1	5.8992705	-1.7292017

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	*Percentage* %	*hfs* log gf
					4.5	5.5	32507.082	3.9772727	-1.9004146
					5.5	4.5	32507.119	3.9772727	-1.9004146
					5.5	5.5	32507.1	9.3240093	-1.5303973
					5.5	6.5	32507.078	3.3653846	-1.9729653
					6.5	5.5	32507.122	3.3653846	-1.9729653
					6.5	6.5	32507.1	14.004986	-1.3537173
					6.5	7.5	32507.074	2.0740741	-2.1831757
					7.5	6.5	32507.125	2.0740741	-2.1831757
					7.5	7.5	32507.099	20.148148	-1.1957649
112	60400.41	26081.34	34319.09	-0.38	2.5	1.5	34319.141	10	-1.38
					2.5	2.5	34319.123	9.6428571	-1.3957943
					2.5	3.5	34319.098	5.3571429	-1.6510668
					3.5	2.5	34319.134	5.3571429	-1.6510668
					3.5	3.5	34319.109	12.698413	-1.2762506
					3.5	4.5	34319.076	15.277778	-1.1959398
					4.5	3.5	34319.122	1.9444444	-2.0912045
					4.5	4.5	34319.09	9.7222222	-1.3922345
					4.5	5.5	34319.05	30	-0.9028787
113	60400.41	30815.7	29584.65	0.1	2.5	2.5	29584.662	8.9285714	-0.949218
					2.5	3.5	29584.642	16.071429	-0.6939455
					3.5	2.5	29584.672	16.071429	-0.6939455
					3.5	3.5	29584.653	1.0582011	-1.8754318
					3.5	4.5	29584.628	16.203704	-0.6903857
					4.5	3.5	29584.666	16.203704	-0.6903857
					4.5	4.5	29584.641	25.462963	-0.4940911
114	60457.12	27841.35	32615.7	0.79	1.5	0.5	32615.714	2.7777778	-0.7663025
					1.5	1.5	32615.709	1.5555556	-1.0181145
					1.5	2.5	32615.7	0.2121212	-1.8834159
					2.5	1.5	32615.714	4	-0.60794
					2.5	2.5	32615.706	2.4935065	-0.8131895
					2.5	3.5	32615.694	0.3246753	-1.6985507

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					3.5	2.5	32615.713	5.6277056	-0.4596686
					3.5	3.5	32615.702	3.1265031	-0.7149411
					3.5	4.5	32615.686	0.3367003	-1.6827564
					4.5	3.5	32615.711	7.6599327	-0.325775
					4.5	4.5	32615.696	3.4282216	-0.6749311
					4.5	5.5	32615.677	0.2754821	-1.7699066
					5.5	4.5	32615.708	10.123967	-0.2046493
					5.5	5.5	32615.689	3.3375715	-0.6865694
					5.5	6.5	32615.667	0.1748252	-1.967396
					6.5	5.5	32615.703	13.053613	-0.0942693
					6.5	6.5	32615.681	2.7847708	-0.7652105
					6.5	7.5	32615.656	0.0707071	-2.3605372
					7.5	6.5	32615.697	16.484848	0.007085
					7.5	7.5	32615.672	1.6969697	-0.9803259
					8.5	7.5	32615.69	20.454545	0.1007898
115	61071.43	29742.16	31329.24	-0.29	2.5	2.5	31329.29	8.9285714	-1.339218
					2.5	3.5	31329.261	16.071429	-1.0839455
					3.5	2.5	31329.281	16.071429	-1.0839455
					3.5	3.5	31329.251	1.0582011	-2.2654318
					3.5	4.5	31329.213	16.203704	-1.0803857
					4.5	3.5	31329.239	16.203704	-1.0803857
					4.5	4.5	31329.201	25.462963	-0.8840911
116	61071.43	29823.93	31247.5	-0.06	2.5	1.5	31247.544	10	-1.06
					2.5	2.5	31247.535	9.6428571	-1.0757943
					2.5	3.5	31247.523	5.3571429	-1.3310668
					3.5	2.5	31247.526	5.3571429	-1.3310668
					3.5	3.5	31247.513	12.698413	-0.9562506
					3.5	4.5	31247.497	15.277778	-0.8759398
					4.5	3.5	31247.501	1.9444444	-1.7712045
					4.5	4.5	31247.485	9.7222222	-1.0722345
					4.5	5.5	31247.466	30	-0.5828787

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
117	63374.63	27443.71	35930.81	-0.12	1.5	1.5	35930.887	4	-1.51794
					1.5	2.5	35930.856	6	-1.3418487
					2.5	1.5	35930.896	6	-1.3418487
					2.5	2.5	35930.865	0.0714286	-3.266128
					2.5	3.5	35930.822	8.9285714	-1.169218
					3.5	2.5	35930.878	8.9285714	-1.169218
					3.5	3.5	35930.836	1.9047619	-1.8401593
					3.5	4.5	35930.78	9.1666667	-1.1577886
					4.5	3.5	35930.852	9.1666667	-1.1577886
					4.5	4.5	35930.797	9.469697	-1.1436639
					4.5	5.5	35930.73	6.3636364	-1.3162946
					5.5	4.5	35930.818	6.3636364	-1.3162946
					5.5	5.5	35930.75	23.636364	-0.7464193
118	63374.63	27917.78	35456.96	0.14	1.5	2.5	35456.973	10	-0.86
					2.5	2.5	35456.983	9.6428571	-0.8757943
					2.5	3.5	35456.946	5.3571429	-1.1310668
					3.5	2.5	35456.996	5.3571429	-1.1310668
					3.5	3.5	35456.959	12.698413	-0.7562506
					3.5	4.5	35456.912	1.9444444	-1.5712045
					4.5	3.5	35456.976	15.277778	-0.6759398
					4.5	4.5	35456.929	9.7222222	-0.8722345
					5.5	4.5	35456.95	30	-0.3828787
119	63445.16	27602.45	35842.63	0.03	0.5	0.5	35842.665	0.8928571	-2.019218
					0.5	1.5	35842.654	2.6785714	-1.5420968
					1.5	0.5	35842.671	2.6785714	-1.5420968
					1.5	2.5	35842.644	4.4642857	-1.320248
					2.5	1.5	35842.671	4.4642857	-1.320248
					2.5	2.5	35842.654	0.6377551	-2.1653461
					2.5	3.5	35842.63	5.6122449	-1.2208634
					3.5	2.5	35842.669	5.6122449	-1.2208634
					3.5	3.5	35842.645	2.7210884	-1.5352573

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	*Percentage* %	*hfs* log gf
					3.5	4.5	35842.615	5.952381	-1.1953093
					4.5	3.5	35842.665	5.952381	-1.1953093
					4.5	4.5	35842.634	6.6287879	-1.1485659
					4.5	5.5	35842.596	5.275974	-1.2476974
					5.5	4.5	35842.657	5.275974	-1.2476974
					5.5	5.5	35842.62	12.787213	-0.8632241
					5.5	6.5	35842.575	3.3653846	-1.4429653
					6.5	5.5	35842.647	3.3653846	-1.4429653
					6.5	6.5	35842.603	21.634615	-0.6348508
120	63445.16	28021.29	35423.91	0.32	0.5	1.5	35423.89	3.5714286	-1.127158
					1.5	1.5	35423.896	4.2857143	-1.0479768
					1.5	2.5	35423.886	2.8571429	-1.224068
					2.5	1.5	35423.907	2.1428571	-1.3490068
					2.5	2.5	35423.897	6.5306122	-0.8650461
					2.5	3.5	35423.882	2.0408163	-1.3701961
					3.5	2.5	35423.911	5.6122449	-0.9308634
					3.5	3.5	35423.897	7.4829932	-0.8059246
					3.5	4.5	35423.878	1.1904762	-1.6042793
					4.5	3.5	35423.916	10.47619	-0.6597966
					4.5	4.5	35423.897	6.9264069	-0.839492
					4.5	5.5	35423.874	0.4545455	-2.0224227
					5.5	4.5	35423.921	16.883117	-0.4525474
					5.5	5.5	35423.898	4.5454545	-1.0224227
					6.5	5.5	35423.926	25	-0.28206
121	63528.54	27841.35	35687.12	0.14	0.5	0.5	35687.133	1.1574074	-1.7965137
					0.5	1.5	35687.128	1.6203704	-1.6503857
					1.5	0.5	35687.137	1.6203704	-1.6503857
					1.5	1.5	35687.132	1.1851852	-1.7862138
					1.5	2.5	35687.123	2.75	-1.4206673
					2.5	1.5	35687.138	2.75	-1.4206673
					2.5	2.5	35687.13	2.0119048	-1.5563926

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	*Percentage* %	*hfs* log gf
					2.5	3.5	35687.118	3.5714286	-1.307158
					3.5	2.5	35687.139	3.5714286	-1.307158
					3.5	3.5	35687.127	3.5273369	-1.3125531
					3.5	4.5	35687.112	4.0123457	-1.2566017
					4.5	3.5	35687.139	4.0123457	-1.2566017
					4.5	4.5	35687.124	5.8992705	-1.0892017
					4.5	5.5	35687.105	3.9772727	-1.2604146
					5.5	4.5	35687.139	3.9772727	-1.2604146
					5.5	5.5	35687.12	9.3240093	-0.8903973
					5.5	6.5	35687.098	3.3653846	-1.3329653
					6.5	5.5	35687.137	3.3653846	-1.3329653
					6.5	6.5	35687.115	14.004986	-0.7137173
					6.5	7.5	35687.09	2.0740741	-1.5431757
122	63528.54	28161.17	35367.3	0.48	0.5	0.5	35367.299	2.0833333	-1.2012412
					0.5	1.5	35367.294	0.6944444	-1.6783625
					1.5	0.5	35367.303	1.4880952	-1.3473693
					1.5	1.5	35367.298	3.1746032	-1.0183106
					1.5	2.5	35367.289	0.8928571	-1.569218
					2.5	1.5	35367.304	3.2738095	-1.0049466
					2.5	2.5	35367.296	4.2091837	-0.8958021
					2.5	3.5	35367.284	0.8503401	-1.5904073
					3.5	2.5	35367.305	5.6122449	-0.7708634
					3.5	3.5	35367.294	4.8374906	-0.8353799
					3.5	4.5	35367.278	0.6613757	-1.6995518
					4.5	3.5	35367.306	8.5978836	-0.5856084
					4.5	4.5	35367.29	4.8851611	-0.8311211
					4.5	5.5	35367.272	0.4058442	-1.9116407
					5.5	4.5	35367.305	12.310606	-0.4297206
					5.5	5.5	35367.287	4.1958042	-0.8971848
					5.5	6.5	35367.265	0.1602564	-2.3151846
					6.5	5.5	35367.304	16.826923	-0.2939953

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					6.5	6.5	35367.282	2.6175214	-1.1021098
					7.5	6.5	35367.302	22.222222	-0.1732125
123	64366.68	26081.34	38285.22	0.05	1.5	1.5	38285.237	4	-1.34794
					1.5	2.5	38285.219	6	-1.1718487
					2.5	1.5	38285.25	6	-1.1718487
					2.5	2.5	38285.232	0.0714286	-3.096128
					2.5	3.5	38285.207	8.9285714	-0.999218
					3.5	2.5	38285.251	8.9285714	-0.999218
					3.5	3.5	38285.226	1.9047619	-1.6701593
					3.5	4.5	38285.193	9.1666667	-0.9877886
					4.5	3.5	38285.25	9.1666667	-0.9877886
					4.5	4.5	38285.217	9.469697	-0.9736639
					4.5	5.5	38285.178	6.3636364	-1.1462946
					5.5	4.5	38285.247	6.3636364	-1.1462946
					5.5	5.5	38285.207	23.636364	-0.5764193
124	64366.68	30815.7	33550.9	-0.1	1.5	2.5	33550.877	10	-1.1
					2.5	2.5	33550.89	9.6428571	-1.1157943
					2.5	3.5	33550.871	5.3571429	-1.3710668
					3.5	2.5	33550.909	5.3571429	-1.3710668
					3.5	3.5	33550.889	12.698413	-0.9962506
					3.5	4.5	33550.865	1.9444444	-1.8112045
					4.5	3.5	33550.914	15.277778	-0.9159398
					4.5	4.5	33550.889	9.7222222	-1.1122345
					5.5	4.5	33550.918	30	-0.6228787
125	64646.7	29823.93	34822.69	-0.39	2.5	1.5	34822.711	10	-1.39
					2.5	2.5	34822.702	9.6428571	-1.4057943
					2.5	3.5	34822.69	5.3571429	-1.6610668
					3.5	2.5	34822.711	5.3571429	-1.6610668
					3.5	3.5	34822.698	12.698413	-1.2862506
					3.5	4.5	34822.682	15.277778	-1.2059398
					4.5	3.5	34822.709	1.9444444	-2.1012045

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	*Percentage* %	*hfs* log gf
					4.5	4.5	34822.693	9.7222222	-1.4022345
					4.5	5.5	34822.673	30	-0.9128787
126	64705.89	28161.17	36544.66	-0.34	1.5	0.5	36544.666	3.5714286	-1.787158
					1.5	1.5	36544.661	4.2857143	-1.7079768
					1.5	2.5	36544.653	2.1428571	-2.0090068
					2.5	1.5	36544.672	2.8571429	-1.884068
					2.5	2.5	36544.664	6.5306122	-1.5250461
					2.5	3.5	36544.652	5.6122449	-1.5908634
					3.5	2.5	36544.679	2.0408163	-2.0301961
					3.5	3.5	36544.667	7.4829932	-1.4659246
					3.5	4.5	36544.652	10.47619	-1.3197966
					4.5	3.5	36544.687	1.1904762	-2.2642793
					4.5	4.5	36544.672	6.9264069	-1.499492
					4.5	5.5	36544.653	16.883117	-1.1125474
					5.5	4.5	36544.695	0.4545455	-2.6824227
					5.5	5.5	36544.677	4.5454545	-1.6824227
					5.5	6.5	36544.655	25	-0.94206
127	65236.04	32349.98	32886.01	0.64	0.5	0.5	32886.031	2.0833333	-1.0412412
					0.5	1.5	32886.021	0.6944444	-1.5183625
					1.5	0.5	32886.036	1.4880952	-1.1873693
					1.5	1.5	32886.027	3.1746032	-0.8583106
					1.5	2.5	32886.011	0.8928571	-1.409218
					2.5	1.5	32886.036	3.2738095	-0.8449466
					2.5	2.5	32886.02	4.2091837	-0.7358021
					2.5	3.5	32885.998	0.8503401	-1.4304073
					3.5	2.5	32886.033	5.6122449	-0.6108634
					3.5	3.5	32886.011	4.8374906	-0.6753799
					3.5	4.5	32885.982	0.6613757	-1.5395518
					4.5	3.5	32886.028	8.5978836	-0.4256084
					4.5	4.5	32885.999	4.8851611	-0.6711211
					4.5	5.5	32885.964	0.4058442	-1.7516407

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					5.5	4.5	32886.02	12.310606	-0.2697206
					5.5	5.5	32885.985	4.1958042	-0.7371848
					5.5	6.5	32885.943	0.1602564	-2.1551846
					6.5	5.5	32886.009	16.826923	-0.1339953
					6.5	6.5	32885.967	2.6175214	-0.9421098
					7.5	6.5	32885.995	22.222222	-0.0132125
128	67216.56	30815.7	36401.03	-0.36	3.5	2.5	36401.055	25	-0.96206
					3.5	3.5	36401.036	33.333333	-0.8371213
					3.5	4.5	36401.011	41.666667	-0.7402112
129	76360.8	28021.29	48339.5	-0.41	2.5	1.5	48339.54	10	-1.41
					2.5	2.5	48339.53	9.6428571	-1.4257943
					2.5	3.5	48339.515	5.3571429	-1.6810668
					3.5	2.5	48339.528	5.3571429	-1.6810668
					3.5	3.5	48339.513	12.698413	-1.3062506
					3.5	4.5	48339.494	15.277778	-1.2259398
					4.5	3.5	48339.51	1.9444444	-2.1212045
					4.5	4.5	48339.492	9.7222222	-1.4222345
					4.5	5.5	48339.469	30	-0.9328787
130	76589.3	28161.17	48428.15	-0.15	1.5	0.5	48428.16	3.5714286	-1.597158
					1.5	1.5	48428.155	4.2857143	-1.5179768
					1.5	2.5	48428.147	2.1428571	-1.8190068
					2.5	1.5	48428.165	2.8571429	-1.694068
					2.5	2.5	48428.156	6.5306122	-1.3350461
					2.5	3.5	48428.145	5.6122449	-1.4008634
					3.5	2.5	48428.17	2.0408163	-1.8401961
					3.5	3.5	48428.158	7.4829932	-1.2759246
					3.5	4.5	48428.143	10.47619	-1.1297966
					4.5	3.5	48428.176	1.1904762	-2.0742793
					4.5	4.5	48428.161	6.9264069	-1.309492
					4.5	5.5	48428.142	16.883117	-0.9225474
					5.5	4.5	48428.183	0.4545455	-2.4924227

Table. Estimated oscillator strengths (hfs log gf) of hyperfine multiplets for Scandium ion (Sc II).

S.No.	E_u cm^{-1}	E_l cm^{-1}	σ_J cm^{-1}	log gf	F_u	F_l	σ_F cm^{-1}	$Percentage$ %	hfs log gf
					5.5	5.5	48428.164	4.5454545	-1.4924227
					5.5	6.5	48428.142	25	-0.75206
131	76589.3	39115.04	37474.35	-0.1	1.5	2.5	37474.522	10	-1.1
					2.5	2.5	37474.531	9.6428571	-1.1157943
					2.5	3.5	37474.37	5.3571429	-1.3710668
					3.5	2.5	37474.545	5.3571429	-1.3710668
					3.5	3.5	37474.384	12.698413	-0.9962506
					3.5	4.5	37474.177	1.9444444	-1.8112045
					4.5	3.5	37474.402	15.277778	-0.9159398
					4.5	4.5	37474.195	9.7222222	-1.1122345
					5.5	4.5	37474.217	30	-0.6228787

Conclusion

In this work theoretically investigated weighted oscillator strengths of 1631 lines of hyperfine levels in Scandium ions. A Python program created to determine the weighted oscillator strength, wavenumbers, and relative intensities in a particular hyperfine multiplet of Sc II is first verified on previously published weighted oscillator strengths of neutral scandium. This shows that the program gives accurate results.

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