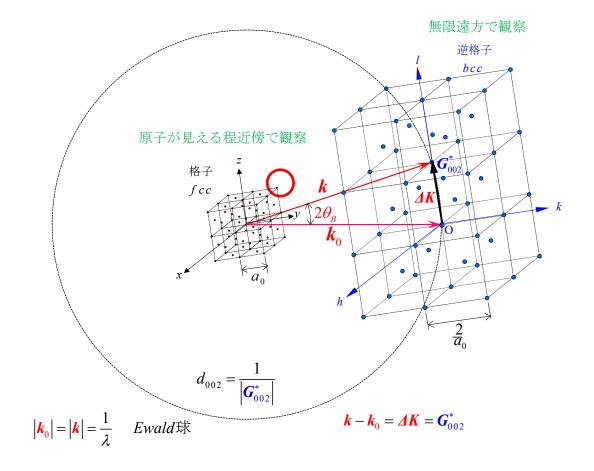
原子散乱因子 : 原子からの散乱波

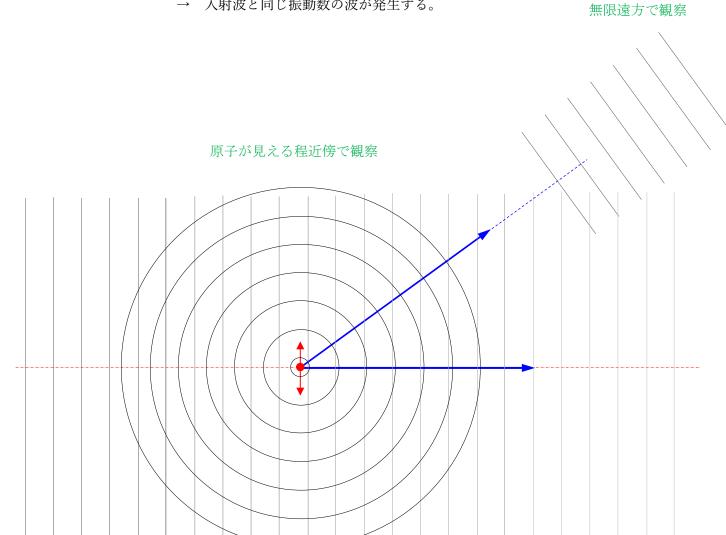
Fraunhofer 回折 :無限遠方で観察する波



電子線回折では入射電子と物質との間にクーロン力による相互作用が生じる 本講義の以下の話では、**X線回折の場合に話を限定する!**

§ Thomson 散乱 1個の電子からの散乱波

- 1個の自由な電子が真空中にある
 - → これに X線が入射する
 - → 電子は X 線の電界により強制振動させられる
 - → 入射波と同じ振動数の波が発生する。



1個の電子から発生した X 線散乱波の強度は

$$I_e(2\theta) = \frac{I_0}{R^2} \left(\frac{e^2}{4\pi \,\varepsilon_0 \, mc^2}\right)^2 \frac{1 + \cos^2 2\theta}{2} \qquad \text{Thomson in the properties of the second second$$

ここで、 2θ 回折角

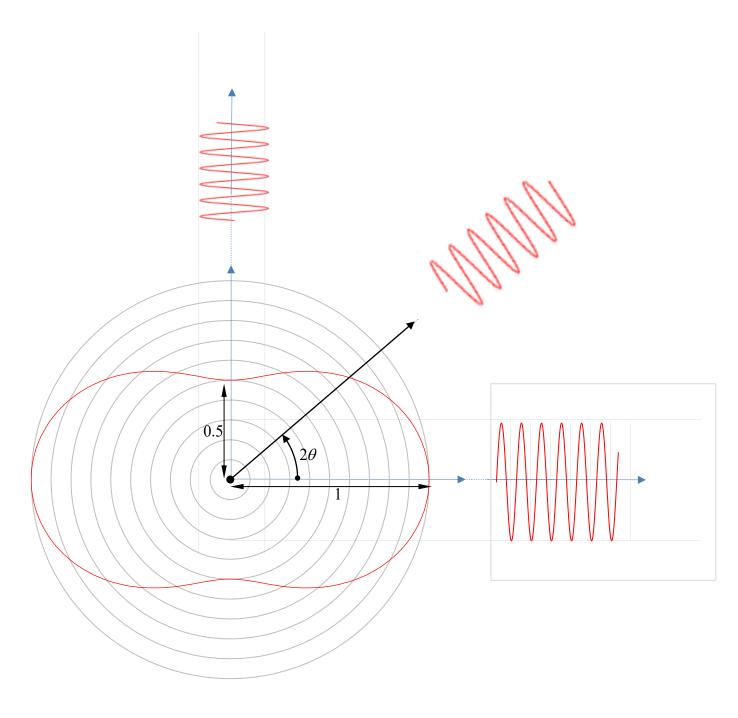
R 電子からの観測点までの距離

e 電子の素電荷

 $arepsilon_0$ 真空の誘電率

m 電子の質量

c 光速度

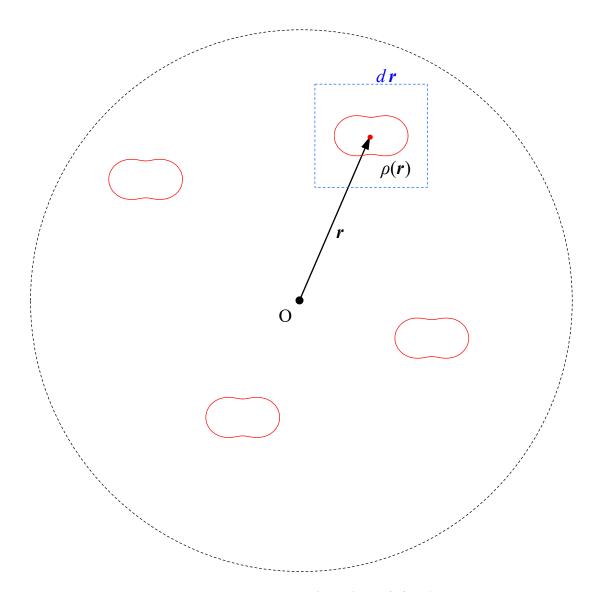


§ 原子散乱因子 1個の原子からの散乱波

電子は数密度 $\rho(r)$ で原子核 O の周りに分布している。 r の原点は原子核

微小空間 dr の電子数 = $\rho(r) dr$ 1 個の電子の散乱強度は式(1)より $I_e(2\theta)$ $\therefore \rho(r) dr$ からの散乱 X 線強度は $I_e(2\theta) \rho(r) dr$ (2)

1 個の原子からの散乱 X 線は、原子内に分布する 原子内の個々の電子からの散乱 X 線を 位相差を考慮して、重ね合わせたものとなる。



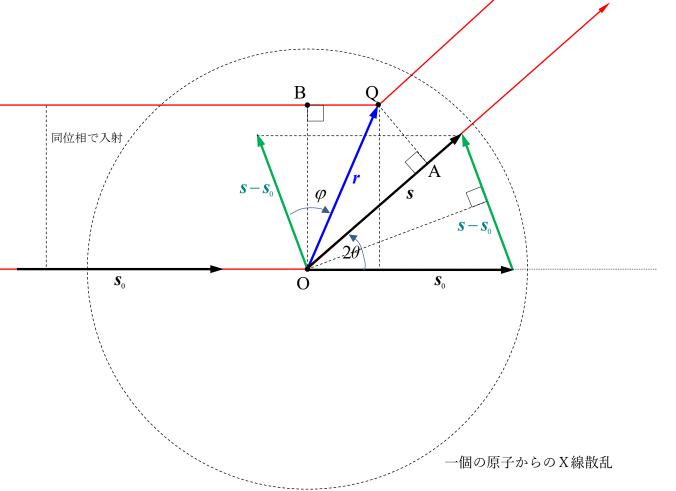
原子一個の電子数密度分布

O に原子核がある。電子の数密度分布関数は $\rho(r)$ である。r にある体積素片 dr中には $\rho(r)dr$ の電子が存在している。

入射波波数ベクトル: $\mathbf{k}_0 = \frac{\mathbf{s}_0}{\lambda}$ ここで λ は波長

位相: $\delta = \frac{2\pi}{\lambda} (s - s_0) \cdot r$ で散乱する

位相: $\delta=0$ で散乱する



Oの電子とQの電子それぞれからの散乱波の $行路差: \Delta$ は

$$\Delta = \overline{OA} - \overline{QB} = r \cdot s - r \cdot s_0$$

$$= (s - s_0) \cdot r$$

$$\downarrow \leftarrow \qquad |s - s_0| = 2|s_0|\sin\theta, \quad \mathbb{E} r \geq s - s_0 \text{ の成す角はφ}$$

$$= 2|s_0|\sin\theta |r|\cos\varphi$$

$$\downarrow \leftarrow \qquad |s_0| = 1, \quad |r| \equiv r$$

$$\Delta = 2r\sin\theta \cos\varphi \tag{3}$$

よって、Oの電子とQの電子それぞれからの散乱波の $\frac{c}{c}$ 相差: δ は

$$\delta = 2\pi \frac{\Delta}{\lambda} = 2\pi \frac{2r\sin\theta\cos\varphi}{\lambda} = \frac{2\pi}{\lambda} 2\sin\theta \times r \times \cos\varphi = \frac{2\pi}{\lambda} (\mathbf{s} - \mathbf{s}_0) \cdot \mathbf{r}$$
 (4)

続いて、原点Oの電子からの散乱波を位相の基準として、rに存在する電子からの散乱波を重ね合わせる。

原子番号:Zの原子は原子核の周りにZ個の電子分布している。この電子に $1,2,\cdots,n,\cdots,Z$ と番号を付ける。n番目の電子の空間電子数密度分布関数を $\rho_n(\mathbf{r})$ とする。 (5)

n番目の電子は1個なので、 $\int_{\mathbb{R}^2} \rho_n(\mathbf{r}) d\mathbf{r} = 1$ である。

n番目の電子による散乱振幅: q_n は次式で与えられる。この電子は $\mathbf O$ に対して $\mathbf r$ の位置に存在している。

$$q_n(\mathbf{K}) = \int_{\mathbb{R}^2} \rho_n(\mathbf{r}) e^{2\pi i \mathbf{K} \cdot \mathbf{r}} d\mathbf{r} \qquad \leftarrow n \, \text{番目の 1 個の電子による散乱振幅}$$
(8)

1原子に電子はZ個含まれるので、1個の原子の電子数密度分布関数は $\rho(\mathbf{r}) = \sum_{n=1}^{Z} \rho_n(\mathbf{r})$ (9)

よって、1個の原子からの散乱波の振幅:散乱振幅 f は

$$f(\mathbf{K}) = \sum_{n=1}^{Z} \left(\int_{\mathbb{R}^{2}} \rho_{n}(\mathbf{r}) e^{2\pi i \, \mathbf{K} \cdot \mathbf{r}} \, d\mathbf{r} \right)$$

$$\downarrow \leftarrow \qquad \qquad \rho_{n}(\mathbf{r}) \equiv \rho_{n}(\mathbf{r}) \quad \leftarrow \quad \text{電子の球対称分布を仮定する}$$

$$f(\mathbf{K}) = \sum_{n=1}^{Z} \left(\int_{\mathbb{R}^{2}} \rho_{n}(\mathbf{r}) e^{2\pi i \, \mathbf{K} \cdot \mathbf{r}} \, d\mathbf{r} \right)$$

$$(11)$$

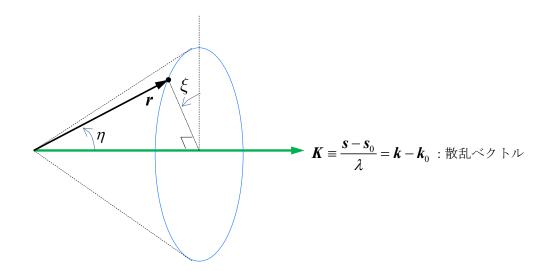
 \leftarrow 球座標 (r, η, ξ) で積分する。変数範囲は $0 \le r \le \infty, 0 \le \eta < \pi, 0 \le \xi \le 2\pi$

$$f\left(\frac{\sin\theta}{\lambda}\right) = \sum_{n=1}^{Z} \left(\int_{0}^{\infty} dr \int_{0}^{\pi} d\eta \int_{0}^{2\pi} d\xi \left(\rho_{n}(r) e^{\frac{4\pi i \sin\theta}{\lambda} r \cos\eta} r^{2} \sin\eta\right)\right)$$

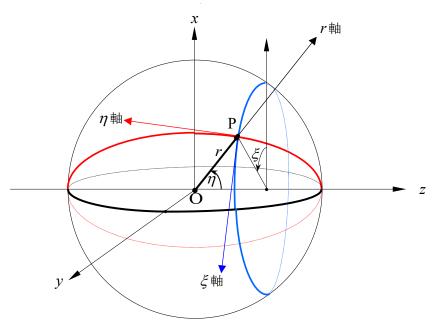
$$(12)$$

$$(12)$$

$$f\left(\frac{\sin\theta}{\lambda}\right) = \sum_{n=1}^{Z} \left(\int_{0}^{\infty} dr \int_{0}^{\pi} d\eta \int_{0}^{2\pi} d\xi \left(\rho_{n}(r) e^{\frac{4\pi i \sin\theta}{\lambda} r \cos\eta} r^{2} \sin\eta \right) \right)$$
 (12)再掲



球座標とその積分



$$\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} r \sin \eta \cos \xi \\ r \sin \eta \sin \xi \\ r \cos \eta \end{pmatrix}$$
 変数範囲は $0 \le \eta \le \pi$ 、 $0 \le \xi < 2\pi$ 、 $r \ge 0$

間 半径
$$R$$
の球の体積 $V_{\rm tk}$ $V_{\rm tk}=\int\limits_{r=0}^{R}\int\limits_{\eta=0}^{\pi}\int\limits_{\xi=0}^{2\pi}r\sin\eta\,d\xi\,\,r\,d\eta\,\,dr$ $ightarrow$ 演習で

ここで、前方散乱($\theta \to 0$ 即ち $4\pi \frac{\sin \theta}{\lambda} = q \to 0$)の極限を考えると、 $\lim_{q \to 0} \frac{\sin(qr)}{qr} = 1$ 長波長極限 よって、 $f(0) = \sum_{n=1}^{Z} \left(\int\limits_{0}^{\infty} 4\pi r^2 \rho_n(r) dr\right) = Z$ 一種の総和則(sum rule)となる (15)

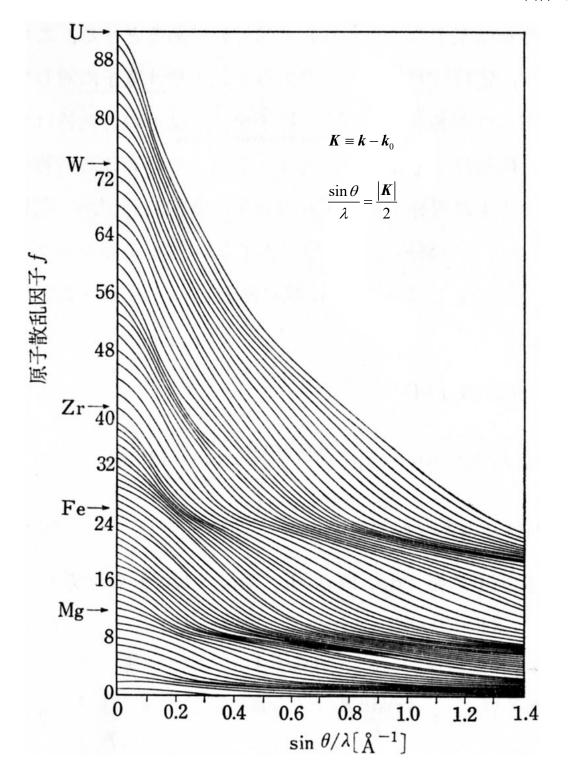


表3 原元素の結晶構造

表4 X線原子散乱因子近似式のパラメータ

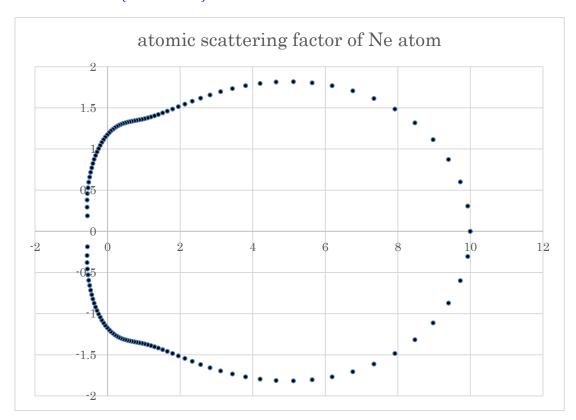
		200 100	格 子 定 数 (Å*)		
元 素	構造	温 度 (°C)	a	ь	c または 軸角
Ac Actinium	FCC, A1	0-	5.311		
Al Aluminum Am Americium, α*	FCC, A1 Hex., La type	25 20	4.0497 3.4681		11.240
Sb Antimony	Rhomb., A7	25	4.5069		$\alpha = 57^{\circ} 6'27''$
As Arsenic	Rhomb., A7	22.5	4.1319		$\alpha = 54^{\circ} 8'$
Ba Barium	BCC, A2	25	5.013		
Be Beryllium, α*	HCP, A3	R.T.	2.286		3.584
Bi Bismuth B Boron*	Rhomb., A7 Tetrag.	25 R.T.	4.736 8.80		$\alpha = 57^{\circ} 14'$ 5.05
Cd Cadmium	HCP, A3	21	2.9789		5.6169
Ca Calcium, α*	FCC, A1	26	5.5886		
Carbon, diamond	Cubic, A4	20	3 5671		0.7000
Carbon, graphite*	Hex., A9	20	2.4613		6.7080
Ce Cerium*	FCC, A1 BCC, A2	23 173°K	5.1603 6.0797		
Cr Chromium	BCC. A2	20	2.8847		
Co Cobalt, α*	HCP, A3	R.T.	2.507		4.070
Cobalt, β	FCC, A1	R.T. 20	3.544 3.6148		
Cu Copper Dy Dysprosium, α*	FCC, A1 HCP, A3	R.T.	3.5148		5.6477
r Erbium, α*	HCP, A3	R.T.	3.5589		5.5876
u Europium	BCC, A2	25	4.5822		£ 3000
Gd Gadolinium, α*	HCP, A3 Orthorh.	20 R.T.	3.6361 4.523	7.661	5.7828 4.524
Se Germanium	Cubic, A4	25	5.6577	7.501	7.024
u Gold	FCC, A1	25	4.0786		
lf Hafnium, α* lo Holmium, α*	HCP, A3	24	3.1947 3.5774		5.0513 5.6160
n Indium	HCP, A3 Tetrag., A6	R.T. R.T.	4.5981		5.6160 4.9469
lodine	Orthorh.	26	4.79	7.25	9.78
r Iridium	FCC, A1	R.T.	3.8390		
e Iron, α* Iron, y	BCC, A2	20 916	2.8665 3.6469		
Iron, δ	FCC, A1 BCC, A2	1394	2.9323		
a Lanthanum, α°	Hex.	R.T.	3.770		12.159
b Lead	FCC, A1	25	4.9504		
Li Lithium*	BCC, A2 HCP, A3	25 R.T.	3.5101 3.5032		5.5511
Mg Magnesium	HCP, A3	25	3.2095		5.2107
Mn Manganese, α*	Cubic, A12	R.T.	8.9142		$\alpha = 70^{\circ} 32'$
Hg Mercury Mo Molybdenum	Rhomb. A10 BCC, A2	227°K 20	3.005 3.1469		$\alpha = 70^{\circ} 32^{\circ}$
Nd Neodynium, α*	Hex., La type	R.T.	3.6580		11.7996
No Neptunium, α*	Orthorh.	20	6.663	4.723	4.887
Ni Nickel	FCC, A1		3.5239		
Nb Niobium Os Osmium	BCC, A2 HCP, A3	25 20	3.3067 2.7354		4.3193
Pd Palladium	FCC, A1	22	3.8908		-
P Phosphorous, black*	Orthorh.	22	3.3137	10.478	4.3765
Pt Platinum	FCC, A1	20	3.9240 6.183	4.822	10.963
Pu Plutonium, α*	Monocl.	21	0.103	4.022	$\beta = 101.79^{\circ}$
Po Polonium, α*	Cubic	~10	3.345		
K Potassium	BCC, A2	78°K	5.247		11 0050
Pr Praseodymium, α* Pa Protactinium	Hex., La type Tetrag.	R.T.	3.6726 3.925		11.8358 3.238
Re Rhenium	HCP, A3	R.T.	2.760		4.458
Rh Rhodium	FCC, A1	20	3.8045		
Rb Rubidium	BCC, A2 HCP, A3	20 25	5.70 2.7059		4.2818
Ru Ruthenium		2.5			$\alpha = 23^{\circ} 13'$
Sm Samarium Sc Scandium, α*	Rhomb. HCP, A3	R.T.	8.996 3.3091		$\alpha = 23^{\circ} 13^{\circ}$ 5.2735
Se Selenium*	Hex., A8	25	4.3658		4.9592
Si Silicon	Cubic, A4	25	5.4309		
Ag Silver Na Sodium	FCC, A1 BCC, A2	25 20	4.0863 4.2908		
Sr Strontium, α*	FCC, A1	25	6.0851		
Sr Strontium, a ² S Sulphur*	Orthorh.	24.8	10.4650	12.8665	24.4869
Ta Tantalum	BCC, A2	R.T.	3.298		,
To Technetium	HCP, A3	R.T. 25	2.735 4.4568		4.388 5.9270
Te Tellurium	Hex., A8				5.6938
Tb Terbium, α* Tl Thallium, α*	HCP, A3 HCP, A3	R.T. 18	3.6011 3.4567		5.5250
Th Thorium, α*	FCC, A1	R.T.	5.0847		
Tm Thulium, α*	HCP, A3	R.T. 25	3.5376 5.8317		5.5548 3.1815
Sn Tin (white), β^* Tin (grey), α	Tetrag., A5 Cubic, A4	20	6.4894		3.1015
Ti Titanium, α*	HCP, A3	25	2.9512		4.6845
Titanium, β	BCC, A2	900	3.3066		
W Tungsten	BCC, A2	25	3.1653	5.8697	4.9550
U Uranium, α* Uranium, β	Orthorh., A20 Tetrag.	25 720	2.8538 10.759	5.609/	4.9550 5.656
Uranium, y	BCC, A2	805	3.524		
V Vanadium	BCC, A2	R.T.	3.0232		
Yb Ytterbium*	FCC, A1	R.T.	5.4864		E 7000
	HCP, A3				5.7308 4.9470
	HCP, A3	25	3.2313		5.1479
y Variation Yb Ytterbium* Y Yttrium* Zn Zinc Zr Zirconium, α* Zirconium, β	FCC, A1 HCP, A3 HCP, A3	R.T. R.T. 25	5.4864 3.6475 2.6650		

FCC=面心立方,Hex=六方,Rhomb=斜方面体,BCC=体心立方,HCP=最密大方, Tetrag=正方,Cubic=立方,Orthorh=斜方,Monocl=半斜,R. T. =室温

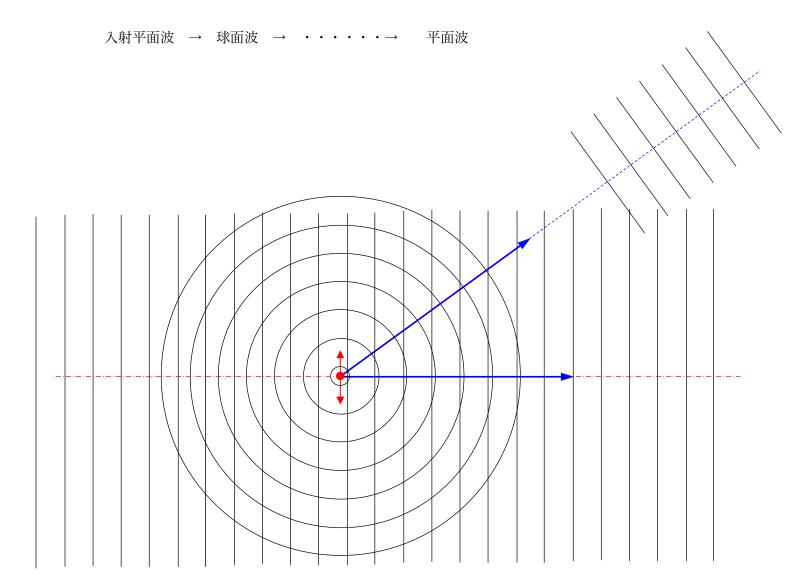
Element	a 1	b 1	a 2	b 2	a 3	ь,	a 4	b 4	с
1 H		10.5109	0.322912	26.1257	0.140191	3.14236	0.04081	57.7997	0.00303
2 He	0.8734	9.1037	0.6309	3.3568	0.3112	22.9276	0.178	0.9821	0.006
Li	1.1282	3.9546	0.7508	1.0524	0.6175	85.3905	0.4653	168.261	0.037
4 Be	1.5919	43.6427	1.1278	1.8623	0.5391	103.483	0.7029	0.542	0.038
5 B	2.0545	23.2185	1.3326	1.021	1.0979	60.3498	0.7068	0.1403	-0.193
s c	2.31	20.8439	1.02	10.2075	1.5886	0.5687	0.865	51.6512	0.215
7 N	12.2126	0.0057	3.1322	9.8933	2.0125	28.9975	11663	0.5826	-11.52
80	3.0485	13.2771	2.2868	5.7011			0.867	32.9089	0.250
					1.5463	0.3239			
9 F	3.5392	10.2825	2.6412	4.2944	1.517	0.2615	1/0243	26.1476	0.277
0 Ne	3.9553	8.4042	3.1125	3.4262	1.4546	0.2306	1 1 2 5 1	21.7184	0.351
1 Na	4.7626	3.285	3.1736	8.8422	1.2674	0.3136	11128	129.424	0.67
2 Mg	5.4204	2.8275	2.1735	79.2611	1.2269	0.3808	2:3073	7.1937	0.858
3 Al	6.4202	3.0387	1.9002	0.7426	1.5936	31.5472	19646	85.0886	1.115
4 Si	6.2915	2.4386	3.0353	32.3337	1.9891	0.6785	1.541	81.6937	1.140
5 P	6.4345	1.9067	4.1791	27.157	1.78	0.526	1.4908	68.1645	1.114
6 S	6.9053	1.4679	5.2034	22.2151	1.4379	0.2536	1.5863	56.172	0.866
7 CI	11.4604	0.0104	7.1964	1.1662	6.2556	18.5194	1 6455	47.7784	-9.557
8 Ar	7.4845	0.9072	6.7723	14.8407	0.6539	43.8983	16442	33.3929	1.444
9 K	8.2186	12.7949	7.4398	0.7748	1.0519	213.187	0.8659	41.6841	1.422
0 Ca	8.6266	10.4421	7.3873	0.6599	1.5899	85.7484	10211	178.437	1.375
1 Sc	9.189	9.0213	7.3679	0.5729	1.6409	136.108	1.468	51.3531	1.332
2 Ti	9.7595	7.8508	7.3558	0.5	1.6991	35.6338	1 9021	116.105	1.280
					2.0703				
3 V	10.2971	6.8657	7.3511	0.4385		26.8938	2 0571	102.478	1.219
4 Cr	10.6406	6.1038	7.3537	0.392	3.324	20.2626	1 4922	98.7399	1.183
5 Mn	11.2819	5.3409	7.3573	0.3432	3.0193	17.8674	2 2 4 4 1	83.7543	1.089
26 Fe	11.7695	4.7611	7.3573	0.3072	3.5222	15.3535	23045	76.8805	1.036
27 Co	12.2841	4.2791	7.3409	0.2784	4.0034	13.5359	23488	71.1692	1.011
28 Ni	12.8376	3.8785	7.292	0.2565	4.4438	12.1763	2.38	66.3421	1.034
29 Cu	13.338	3.5828	7.1676	0.247	5.6158	11.3966	1.6735	64.8126	1.19
30 Zn	14.0743	3.2655	7.0318	0.2333	5.1652	10.3163	2.41	58.7097	1.304
31 Ga	15.2354	3.0669	6.7006	0.2412	4.3591	10.7805	2.9623	61.4135	1.718
32 Ge	16.0816	2.8509	6.3747	0.2516	3.7068	11.4468	3.683	54.7625	2.131
33 As	16.6723	2.6345	6.0701	0.2647	3.4313	12.9479	4.2779	47.7972	2.53
4 Se	17.0006	2.4098	5.8196	0.2726	3.9731	15.2372	4.3543	43.8163	2.840
35 Br	17.1789	2.1723	5.2358	16.5796	5.6377	0.2609	3.9851	41.4328	2.955
36 Kr	17.3555	1.9384	6.7286	16.5623	5.5493	0.2261	3.5375	39.3972	2.82
7 Rb	17.1784	1.7888	9.6435	17.3151	5.1399	0.2748	1.5292	164.934	3.487
88 Sr	17.5663	1.5564	9.8184	14.0988	5.422	0.1664	2.6694	132.376	2.506
			10.2946	12.8006	5.72629	0.1256	3.26588	104.354	1.9121
89 Y	17.776	1.4029							
0 Zr	17.8765	1.27618	10.948	11.916	5.41732	0.11762	3.65721	87.6627	2.0692
1 Nb	17.6142	1.18865	12.0144	11.766	4.04183	0.20479	3.53346	69.7957	3.7559
12 Mo	3.7025	0.2772	17.2356	1.0958	12.8876	11.0048	3.7429	61.6584	4.387
43 Tc	19.1301	0.86413	11.0948	8.14487	4.64901	21.5707	2.71263	86.8472	5.4042
44 Ru	19.2674	0.80852	12.9182	8.43467	4.86337	24.7997	1.56756	94.2928	5.3787
45 Rh	19.2957	0.75154	14.3501	8.21758	4.73425	25.8749	1.28918	98.6062	5.32
46 Pd	19.3319	0.69866	15.5017	7.98929	5.29537	25.2052	0.6#5844	76.8986	5.2659
47 Ag	19.2808	0.6446	16.6885	7.4726	4.8045	24.6605	1.0463	99.8156	5.17
48 Cd	19.2214	0.5946	17.6444	6.9089	4.461	24.7008	1.6020	87.4825	5.069
49 In	19.1624						1.6029		0100
	19,1024	0.5476	18.5596	6.3776	4.2948	25.8499	2.0396	92.8029	
50 Sn	19.1889	0.5476 5.8303	18.5596 19.1005	6.3776 0.5031	4.2948 4.4585				4.939
		5.8303	19.1005	0.5031	4.4585	25.8499	20396 24663	92.8029	4.939 4.782
51 Sb	19.1889	5.8303 5.3034	19.1005 19.0455	0.5031 0.4607	4.4585 5.0371	25.8499 26.8909 27.9074	2.0396 2.4663 2.6827	92.8029 83.9571 75.2825	4.939 4.782 4.59
51 Sb 52 Te	19.1889 19.6418 19.9644	5.8303 5.3034 4.81742	19.1005 19.0455 19.0138	0.5031 0.4607 0.42089	4.4585 5.0371 6.14487	25.8499 26.8909 27.9074 28.5284	2.0396 2.4663 2.6827 2.5239	92.8029 83.9571 75.2825 70.8403	4.93 4.78 4.59 4.3
51 Sb 52 Te 53 I	19.1889 19.6418 19.9644 20.1472	5.8303 5.3034 4.81742 4.347	19.1005 19.0455 19.0138 18.9949	0.5031 0.4607 0.42089 0.3814	4.4585 5.0371 6.14487 7.5138	25.8499 26.8909 27.9074 28.5284 27.766	2.0396 2.4663 2.6827 2.5239 2.2735	92.8029 83.9571 75.2825 70.8403 66.8776	4.939 4.782 4.59 4.3 4.07
51 Sb 52 Te 53 I 54 Xe	19.1889 19.6418 19.9644 20.1472 20.2933	5.8303 5.3034 4.81742 4.347 3.9282	19.1005 19.0455 19.0138 18.9949 19.0298	0.5031 0.4607 0.42089 0.3814 0.344	4.4585 5.0371 6.14487 7.5138 8.9767	25.8499 26.8909 27.9074 28.5284 27.766 26.4659	2.0396 2.4663 2.6827 2.5239 2.2735 1.99	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658	4.939 4.788 4.59 4.3 4.07 3.71
51 Sb 52 Te 53 I 54 Xe 55 Cs	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892	5.8303 5.3034 4.81742 4.347 3.9282 3.569	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062	0.5031 0.4607 0.42089 0.3814 0.344 0.3107	4.4585 5.0371 6.14487 7.5138 8.9767 10.662	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904	4.93 4.78 4.59 4.3 4.07 3.71 3.33
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297	0.5031 0.4607 0.42089 0.3814 0.344 0.3107 0.2756	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202	4.93 4.78 4.59 4.3 4.07 3.71 3.33 2.77
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 La	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361 20.578	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599	0.5031 0.4607 0.42089 0.3814 0.344 0.3107 0.2756 0.24448	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.28719	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124	4.939 4.782 4.59 4.3 4.07 3.71 3.33 2.77 2.146
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 La 58 Ce	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361 20.578 21.1671	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.7695	0.5031 0.4607 0.42089 0.3814 0.344 0.3107 0.2756 0.24448 0.22684	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.28719 3.33049	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113	4.939 4.782 4.59 4.3 4.07 3.71 3.33 2.77 2.146 1.862
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 La 58 Ce 59 Pr	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.7695 19.6697	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22684 0.22209	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 16.7669	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.28719 3.33049 2.82428	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644	4.93 4.78 4.59 4.3 4.07 3.71 3.33 2.77 2.146 1.862 2.05
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 La 58 Ce 59 Pr 50 Nd	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044 22.6845	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.7695 19.6697 19.6847	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22684 0.22209 0.21063	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 16.7669 15.885	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.28719 3.33049 2.82428 2.85137	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903	4.939 4.782 4.59 4.3 4.07 3.71 3.33 2.77 2.146 1.862 2.05 1.984
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 La 58 Ce 59 Pr 50 Nd 51 Pm	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044 22.6845 23.3405	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248 2.5627	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.7695 19.6697 19.6847 19.6095	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22269 0.21063 0.20209	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774 13.1235	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 16.7669 15.885 15.1009	2,0396 2,4663 2,6827 2,5239 2,2735 1,99 1,4953 2,6959 3,28719 3,3049 2,82428 2,85137 2,87516	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721	4.939 4.782 4.59 4.3 4.07 3.71 3.33 2.77 2.146 1.862 2.05 1.984 2.028
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 La 58 Ce 59 Pr 50 Nd 51 Pm 52 Sm	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248 2.5627 2.47274	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.7695 19.6697 19.6847 19.6095 19.4258	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22269 0.21063 0.20209 0.19645	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774 13.1235 13.4396	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 16.7669 15.885 15.1009 14.3996	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.28719 2.82428 2.85137 2.87516 2.89604	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.12 127.113 143.644 137.903 132.721 128.007	4.939 4.782 4.59 4.3 4.07 3.71 3.33 2.77 2.146 1.862 2.05 1.984 2.028 2.209
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 La 58 Ce 59 Pr 50 Nd 51 Pm 52 Sm 53 Eu	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248 2.5627 2.47274 2.3879	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.7695 19.6697 19.6847 19.6095 19.4258	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22269 0.22209 0.21063 0.20209 0.19645 0.1942	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774 13.1235 13.4396 13.7603	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 15.7885 15.1009 14.3996 13.7546	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.28719 3.33049 2.82428 2.85137 2.87516 2.89604	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174	4.939 4.782 4.59 4.3 4.07 3.71 3.33 2.77 2.146 1.862 2.05 1.984 2.028 2.209 2.57
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 La 58 Ce 59 Pr 50 Nd 51 Pm 52 Sm 53 Eu 54 Gd	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248 2.5627 2.47274 2.3879 2.25341	19.1005 19.0455 19.0138 18.9949 19.0292 19.1092 19.599 19.7695 19.6697 19.6847 19.6095 19.4258 19.0886 19.0798	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22209 0.21063 0.20209 0.19645 0.1942 0.18195	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774 13.1235 13.4396 13.7603 13.8518	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 16.7669 15.885 15.109 14.3996 13.7546 12.9331	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.38719 3.33049 2.82428 2.85137 2.87516 2.89604 2.9227 3.54545	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398	4.939 4.782 4.59 4.3 4.07 3.71 3.33 2.77 2.146 1.862 2.05 1.984 2.028 2.209 2.57 2.41
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 La 58 Ce 59 Pr 50 Nd 51 Pm 52 Sm 53 Eu 54 Gd	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 25.8976	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248 2.5627 2.47274 2.3879 2.25341 2.24256	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.6697 19.6847 19.6095 19.4258 19.0896 19.0798	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22209 0.21063 0.20209 0.19645 0.1942 0.18195	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774 13.1235 13.4396 13.7603 13.8518 14.3167	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 16.7669 15.885 15.1009 14.3996 13.7546 12.9331 12.6648	2,0396 2,4663 2,6827 2,5239 2,2735 1,99 1,4953 2,6959 3,38719 3,3049 2,87428 2,85137 2,87516 2,89604 2,9227 3,54545 2,95354	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362	4.939 4.782 4.59 4.3 4.07 3.71 3.33 2.77 2.146 1.862 2.05 1.984 2.028 2.209 2.57 2.41 3.583
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 La 58 Ce 59 Pr 50 Nd 51 Pm 52 Sm 53 Eu 54 Gd	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248 2.5627 2.47274 2.3879 2.25341	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.6697 19.6847 19.6095 19.4258 19.0896 19.0798	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22209 0.21063 0.20209 0.19645 0.1942 0.18195	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774 13.1235 13.4396 13.7603 13.8518 14.3167	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 16.7669 15.885 15.1009 14.3996 13.7546 12.9331 12.6648	2,0396 2,4663 2,6827 2,5239 2,2735 1,99 1,4953 2,6959 3,38719 3,3049 2,87428 2,85137 2,87516 2,89604 2,9227 3,54545 2,95354	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398	4.939 4.782 4.59 4.3 4.07 3.71 3.33 2.77 2.146 1.862 2.098 4.2028 2.209 2.57 2.41 3.583
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 La 58 Ce 59 Pr 60 Nd 61 Pm 62 Sm 63 Eu 64 Gd 65 Tb 66 Dy	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 25.8976 26.507	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248 2.5627 2.47274 2.3879 2.25341 2.24256	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.76697 19.6847 19.6095 19.4258 19.0886 19.0798 18.2185 17.6383	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22209 0.21063 0.20209 0.19645 0.1942 0.18195	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 13.7603 13.7603 13.8518 14.3167 14.5596	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 15.1009 14.3996 13.7546 12.9331 12.6648 12.1899	2,0396 2,4663 2,6827 2,5239 2,2735 1,99 1,4953 2,6959 3,38719 3,3049 2,82428 2,85137 2,87516 2,89604 2,9227 3,54545 2,\$5534 2,\$5537	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362	4.93 4.78 4.59 4.3 4.07 3.71 3.33 2.77 2.146 1.862 2.05 1.984 2.028 2.209 2.57 2.41 3.583 4.297
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 La 58 Ce 59 Pr 50 Nd 51 Pm 52 Sm 53 Eu 54 Gd 55 Tb 56 Dy 57 Ho	19.1889 19.6418 19.9644 20.1472 20.2993 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 25.8976 26.507 26.9049	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248 2.5627 2.47274 2.3879 2.25341 2.24256 2.1802	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.7695 19.6847 19.6984 19.0798 19.258 19.0886 19.0798 18.2185 17.6383 17.294	0.5031 0.4607 0.42089 0.3814 0.344 0.3107 0.2756 0.24448 0.22209 0.21063 0.20209 0.19645 0.18195 0.18195 0.19614 0.20217	4.4585 5.0371 6.1487, 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774 13.1235 13.4396 13.7603 13.8518 14.3167 14.5596 14.5583	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 15.1009 14.3996 13.7546 12.9331 12.6648 12.1899	2,0396 2,4663 2,6827 2,5239 2,2735 1,99 1,4953 3,38719 3,3049 2,82428 2,85137 2,87516 2,89604 2,9227 3,54545 2,95357 3,63837	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.362 111.874	4.939 4.785 4.59 4.3 4.07 3.71 3.33 2.77 2.146 1.862 2.05 1.984 2.028 2.209 2.57 2.41 3.583 4.297 4.567
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 La 58 Ce 59 Pr 50 Nd 51 Pm 52 Sm 53 Eu 54 Gd 55 Tb 56 Dy 57 Ho 58 Er	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 25.8976 26.507 26.9049 27.6563	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248 2.5627 2.3879 2.25341 2.24256 2.1802 2.07051	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.599 19.7695 19.6697 19.695 19.4258 19.0798 18.2185 17.6383 17.294 16.4285	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22684 0.2209 0.19645 0.1942 0.18195 0.19614 0.20217 0.19794	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774 13.1235 13.4396 13.7603 13.8518 14.3167 14.5583 14.9779	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 16.7669 15.885 15.1009 14.3996 13.7546 12.9331 12.6648 12.1894 11.4407 11.3604	2,0396 2,4663 2,6827 2,5239 2,2735 1,99 1,4953 2,6959 3,28719 3,3049 2,87516 2,87516 2,87516 2,9523 3,54545 2,9523	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.874 92.6566 105.703	4.939 4.785 4.59 4.3 4.07 3.71 3.33 2.77 2.146 1.862 2.05 1.984 2.028 2.209 2.57 2.41 3.583 4.297 4.567 5.920
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 La 58 Ce 59 Pr 50 Nd 51 Pm 52 Sm 53 Eu 64 Gd 55 Tb 56 Dy 57 Ho 58 Er 59 Tm	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 25.8976 26.507 26.9049 27.6563	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248 2.5627 2.47274 2.3879 2.25341 2.24256 2.1802 2.07051 2.07356 2.02859	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.5697 19.6697 19.6697 19.6866 19.0798 18.2185 17.6383 17.294 16.4285 15.8851	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22209 0.21063 0.20209 0.19642 0.18195 0.19614 0.20217 0.1973 0.23355 0.23885	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 13.7603 13.7603 13.7603 13.7596 14.5596 14.5583 14.9779 15.1542	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 18.7726 17.6083 16.7669 15.885 15.1009 14.3996 13.7546 12.9331 12.6648 12.1899 11.4407 11.3607 11.3607	2,0396 2,4663 2,6827 2,5239 2,2735 1,99 1,4953 3,3049 2,8719 3,3049 2,8713 2,87516 2,89604 2,9227 3,54545 2,95354 2,96577 3,63837 2,98233 2,98706	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.874 92.6566 105.703 102.961	4.939 4.78: 4.59 4.3 4.07 3.71 3.33 2.77 2.146 2.028 2.209 2.57 2.41 3.583 4.297 4.567 5.920 6.756
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 La 58 Ce 59 Pr 60 Nd 51 Pm 52 Sm 53 Eu 54 Gd 55 Tb 56 Dy 56 Dy 56 Dy 57 Ho 58 Er 59 Tm 70 Yb	19.1889 19.6418 19.9644 20.1472 20.2933 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.8976 26.507 26.9049 27.6563 28.1819 28.6641	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248 2.5627 2.47274 2.3879 2.25341 2.24256 2.1802 2.07051 2.07356 2.022859 1.9889	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.7695 19.6697 19.6886 19.0798 18.2185 17.6383 17.294 16.4285 15.8851 15.84851	0.5031 0.4607 0.42089 0.3814 0.344 0.3107 0.2756 0.242684 0.22209 0.21063 0.19645 0.1942 0.18916 0.19914 0.20217 0.19794 0.20358 0.23885 0.25712	4.4585 5.0371 6.1487, 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774 13.1235 13.4396 13.7603 13.8518 14.3167 14.5596 14.5583 14.9779 15.1542 15.3087	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 18.7726 17.6083 16.7669 15.865 15.1009 14.3996 12.9331 12.6648 12.1899 11.4407 11.3604 10.9975 10.9647	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 3.3049 2.82428 2.87516 2.89604 2.9227 3.34545 2.95354 2.95354 2.96577 3.63837 2.9833 2.98706 2.98963	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 111.874 92.6566 105.703 102.961 100.417	4.939 4.78: 4.59 4.3 4.07 3.71 3.33 2.77 2.146 1.862 2.05 1.984 2.028 2.209 2.57 2.41 3.583 4.297 4.567 5.920 6.7566 7.566
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 La 58 Ce 59 Pr 50 Nd 51 Pm 52 Sm 63 Eu 65 Tb 66 Dy 67 Ho 65 B 66 Tb 67 Ho 67 Ho 68 Ho 69 Tm	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 25.8976 26.507 26.9049 27.6563 28.1819 28.6641 28.9476	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248 2.5627 2.47274 2.3879 2.25341 2.24256 2.1802 2.07051 2.07051 2.07356 2.02859 1.9889 1.90182	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.699 19.7695 19.6697 19.6847 19.6095 19.4258 19.0798 18.2185 17.6383 17.294 16.4285 15.8854 15.4345 15.4345	0.5031 0.4607 0.42089 0.3814 0.3107 0.27548 0.22209 0.21063 0.20209 0.19645 0.1942 0.18195 0.19614 0.20217 0.19794 0.20355 0.2385 0.2385 0.25712 9.98519	4.4585 5.0371 6.1487, 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774 13.1235 13.4396 13.7603 13.8518 14.3167 14.5596 14.5583 14.9779 15.1542 15.3087 15.1	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 15.885 15.1009 14.3964 12.9331 12.6648 12.1899 11.3604 10.9975 11.3604 10.96647 0.26103	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.38719 3.3049 2.82428 2.85137 2.87516 2.9527 3.34545 2.95354 2.9623 2.98233 2.98706 2.98963 3.71601	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.874 92.6566 105.703 102.961 100.417 84.3298	4.939 4.78: 4.59 4.33 4.07 3.71 3.33 2.77 2.146 1.862 2.05 1.984 2.028 2.209 2.57 2.41 3.583 4.297 4.567 5.920 6.7566 7.976
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 La 58 Ce 59 Pr 50 Nd 51 Pm 62 Sm 63 Eu 64 Gd 55 Tb 66 Dy 67 Ho 68 Er 69 Tm 70 Th 71 Lu 72 Hf	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.62749 25.8976 26.507 26.9049 27.6563 28.1819 28.6641 28.9476 29.144	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.7733 2.66248 2.5627 2.47274 2.35341 2.24256 2.1802 2.07051 2.07051 2.07258 1.9882 1.98182 1.83262	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.599 19.7695 19.6697 19.6847 19.6896 19.0798 18.2185 17.6383 17.294 16.4285 15.8851 15.4345 15.2208 15.1726	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22684 0.2209 0.19645 0.19942 0.19614 0.20217 0.19794 0.2355 0.23885 0.25712 9.5999	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 13.7603 13.7603 13.8518 14.3167 14.5596 15.1542 15.3087 15.11 14.7586	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3279 20.2073 18.7726 17.6083 16.7669 15.885 15.1009 14.3996 13.7546 12.9331 12.6648 12.1899 11.3604 10.9975 10.6647 0.26103 0.27512	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 3.4953 2.6959 3.28719 3.3049 2.8748 2.87516 2.87516 2.87534 2.9627 3.54545 2.9637 3.63877 2.98233 2.98706 2.98960 4.9926 4.9927 3.6383 2.98706 4.9926 4	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 127.113 132.721 128.007 123.174 101.398 115.362 111.874 92.6566 105.703 102.961 100.417 84.3298 72.029	4.939 4.782 4.59 4.3 4.07 3.71 3.33 2.77 2.146 1.862 2.05 1.984 2.028 2.209 2.57 2.41 3.583 4.297 5.920 6.7566 7.566 7.566 7.566 8.581
51 Sb 52 Te 53 Xe 55 Cs 56 Ba 57 La 58 Ce 59 Pr 50 Nd 51 Pm 52 Sm 53 Eu 54 Gd 55 Tb 56 Dy 56 Fy 57 Ho 58 Er 59 Tm 70 Yb 71 Lhf 73 Ta	19.1889 19.6418 19.9644 20.1472 20.2933 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 26.9049 27.6553 28.1819 28.6641 28.9476 29.144 29.2024	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.662248 2.56227 2.47274 2.3879 2.25341 2.24256 2.1802 2.07051 2.07356 2.02859 1.9889 1.9889 1.91882 1.83262 1.77333	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.5697 19.6697 19.6896 19.0886 19.0886 17.6383 17.294 16.4285 15.8851 15.4345 15.2208 15.1726 15.2293	0.5031 0.4607 0.42089 0.3814 0.344 0.3107 0.2756 0.24448 0.22209 0.19645 0.1992 0.19614 0.20217 0.19794 0.203885 0.23385 0.23385 0.25712 9.85919 9.37046	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 13.7603 13.7603 13.7603 13.7596 14.5596 14.5583 14.9779 15.1542 15.3087 15.1 14.7586 14.5135	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 18.7726 17.6083 16.7669 15.885 15.1009 14.3996 13.7546 12.1899 11.4407 11.3604 10.9975 10.6647 0.26103 0.27512 0.29598	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 3.3049 2.82428 2.87137 2.87516 2.89604 2.9227 3.54545 2.95354 2.95354 2.96577 3.63833 2.98706 2.98963 3.71601 4.30013 4.30013 4.76492	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.874 92.6566 105.703 102.961 100.417 84.3298 72.029 63.3644	4,939 4,782 4,59 4,3,71 3,71 3,71 2,146 1,862 2,055 4,209 2,577 2,41 3,583 4,297 4,567 7,966 7,566 7,976 6,756 7,976 8,581 9,243
51 Sb 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 La 56 Ba 57 La 59 Pr 50 Nd 51 Pm 52 Sm 53 Eu 54 Gd 55 Tb 56 Cb 57 Pm 57 Ho 58 Er 59 Pm 50 Nd 51 Pm 52 Sm 70 Ho 70 Vb 71 La 72 Vb 73 Fe 74 Vb 75 Vb 77	19.1889 19.6418 19.9644 20.1472 20.2933 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 27.6563 28.1819 28.6641 28.9476 29.144 29.0818	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248 2.5627 2.47274 2.3879 2.25341 2.07356 2.1802 2.07051 2.07256 1.9889 1.90182 1.83262 1.77333 1.72029	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.7695 19.6697 19.6886 19.0798 18.2185 17.6383 17.294 16.4285 15.8851 15.4345 15.2208 15.1726	0.5031 0.4607 0.42089 0.3814 0.344 0.3107 0.2756 0.242684 0.22209 0.21063 0.19645 0.1942 0.1895 0.19914 0.20217 0.19794 0.23885 0.25712 9.8519 9.5996 9.37046 9.2259	4.4585 5.0371 6.1487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774 13.1235 13.4396 13.7603 13.8518 14.3167 14.5596 14.5583 14.9779 15.1542 15.3087 15.1 14.7586 14.5135 14.4327	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6669 15.885 15.1009 14.3996 13.7546 12.9331 12.6648 12.1899 11.4407 11.3604 10.9975 10.6647 0.26103 0.27512 0.29598 0.3217	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.28719 3.3049 2.82428 2.85137 2.87516 2.9227 3.4545 2.95354 2.96577 3.63837 2.98706 2.98963 3.71601 4.30013 4.76492 5.11982	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.874 92.6566 105.703 102.961 100.417 84.3298 72.029 63.3644 57.056	4.939 4.787 4.597 4.3.71 3.71 2.146 4.028 2.277 2.146 4.028 2.028 2.577 2.441 3.583 4.297 4.567 5.920 6.756 6.756 6.8581 9.848 9.888 9.848 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9
51 Sb 52 Te 52 Te 54 St 55 Te 55 Te 56 Ba 57 Te 56 Te 57 Te	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 25.8976 26.507 26.9049 27.6563 28.1819 28.6641 29.9144 29.0214 29.0218 28.7621	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.7733 2.66248 2.5627 2.47274 2.3879 2.25341 2.24256 2.1802 2.07051 2.07051 2.07356 2.02859 1.9889 1.9889 1.98182 1.78202 1.77333 1.72029 1.67191	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.6847 19.6095 19.4258 19.0886 19.0798 18.2185 17.6383 17.294 16.4285 15.8851 15.4345 15.2208 15.1726 15.2293 15.7189	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22209 0.19645 0.19412 0.18195 0.19414 0.20217 0.19794 0.22355 0.23885 0.25712 9.98519 9.5999 9.37046 9.2259 9.09227	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774 13.1235 13.4396 13.7603 13.8518 14.3167 14.5596 14.5583 14.9779 15.1542 15.087 14.7586 14.5135 14.4327 14.5564	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 15.885 15.1009 14.3996 12.9331 12.6648 12.1899 11.3604 10.975 10.6647 0.26103 0.27512 0.29598 0.3217 0.3505	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.38719 3.3049 2.8242 2.85137 2.87516 2.89247 3.63837 2.98233 2.98706 2.8963 3.71601 4.30013 4.76492 5.11982 5.4174	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.870 92.6566 105.703 102.961 100.417 84.3298 72.029 63.3644 57.056 52.0861	4.939 4.787 4.599 4.3.1 4.077 3.717 2.146 1.862 2.050 2.257 2.411 3.583 4.2977 2.414 5.567 5.920 6.7566 7.566 7.566 7.566 7.966 8.581 9.243
51 Sb 52 Te 52 Te 53 I 54 Xe 55 Cs 56 Ca 57 Ca 58 Cc 59 Po Nd 51 Pm 52 Sm 53 Eu 54 Gd 55 Tb 56 Dy 77 Ho 58 8 Er 77 Ho 58 8 Er 77 Tho 78 Se 77 Tho 78 Se 78 Se 77 Tho 78 Se 78 Se	19.1889 19.6418 19.9641 20.1472 20.2933 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.8796 26.507 26.9049 27.6563 28.1819 28.6641 29.144 29.2024 29.0818 28.7621 28.1894	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248 2.5627 2.47274 2.3879 2.25341 2.24256 2.1802 2.07051 2.070516 2.072859 1.9889 1.9889 1.9182 1.7333 1.72029 1.67191 1.662903	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.1599 19.7695 19.6697 19.6997 19.6847 19.6095 19.4258 19.0896 18.2185 17.6383 17.6383 15.4345 15.4345 15.2208 15.1726 15.2293 15.43 15.7189 16.155	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22684 0.2209 0.19645 0.19614 0.20217 0.197614 0.20355 0.23885 0.25712 9.98519 9.5999 9.37046 9.2227 8.97948	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 13.7603 13.7603 13.8518 14.3167 14.5596 14.5536 14.9779 15.1542 15.3087 14.7586 14.5135 14.4327 14.5566 14.5135	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 20.2073 18.7726 17.6083 16.7669 15.885 15.1009 14.3996 12.9331 12.6648 12.1899 11.3604 10.9975 10.6647 0.26103 0.27512 0.29598 0.3217 0.3505 0.38266	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.38719 3.3049 2.8248 2.85137 2.87516 2.89604 2.9227 3.54545 2.95354 2.9637 3.63857 2.98233 2.98706 2.98963 3.71601 4.30013 4.76492 5.1182 5.14174 5.57589	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 127.113 132.721 128.007 123.174 101.398 115.362 111.874 92.6566 105.703 102.961 100.417 84.3298 72.029 63.3644 57.056 48.1647	4,939 4,782 4,59 4,3,71 3,71 3,33 7,77 2,146 1,862 2,028 2,209 2,577 2,41 3,583 4,297 5,920 6,756 5,920 6,756 8,581 9,243 9,888 10,44 11,00
51 Sb 52 Te 52 Te 53 I 54 4 Xe 55 Cs 56 Cs 56 Cs 56 Cs 56 Cs 56 Cs 56 Cs 57 La 58 Cc 59 Pr 50 Nd 51 1 Pm 52 Sm 53 Tb 54 Gd 55 Tb 56 Cp 57 Th 58 Er 59 Pr 70 Yb 58 Er 70 Yb 58 Er 70 Yb 58 Er 70 Yb 70 Yb	19.1889 19.6418 19.9644 20.1472 20.2933 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 25.8976 26.507 26.9049 27.6553 28.1819 28.6641 28.9476 29.144 29.2024 29.0818 28.7621 28.1894 27.3049	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66224 2.3879 2.25341 2.24256 2.1802 2.07051 2.07356 2.02859 1.9889 1.90182 1.87333 1.72029 1.67191 1.62903 1.59279	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.1599 19.7695 19.6697 19.6997 19.6847 19.6095 19.4258 19.0896 18.2185 17.6383 17.6383 15.4345 15.4345 15.2208 15.1726 15.2293 15.43 15.7189 16.155	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22209 0.19645 0.19412 0.18195 0.19414 0.20217 0.19794 0.22355 0.23885 0.25712 9.98519 9.5999 9.37046 9.2259 9.09227	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 13.7603 13.7603 13.8518 14.3167 14.5596 14.5536 14.9779 15.1542 15.3087 14.7586 14.5135 14.4327 14.5566 14.5135	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 15.885 15.1009 14.3996 12.9331 12.6648 12.1899 11.3604 10.975 10.6647 0.26103 0.27512 0.29598 0.3217 0.3505	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.38719 3.3049 2.8248 2.85137 2.87516 2.89604 2.9227 3.54545 2.95354 2.9637 3.63857 2.98233 2.98706 2.98963 3.71601 4.30013 4.76492 5.1182 5.14174 5.57589	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.870 92.6566 105.703 102.961 100.417 84.3298 72.029 63.3644 57.056 52.0861	4.939 4.787 4.597 4.371 3.373 2.777 2.146 1.862 2.058 2.209 2.575 2.41 3.583 4.297 7.566 6.756 7.566 8.581 9.243 9.888 10.41 11.00
51 Sb 52 Te 52 Te 53 I 54 Xe 55 Cs 65 Ba 65 Ba 65 BC 65	19.1889 19.6418 19.9641 20.1472 20.2933 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.8796 26.507 26.9049 27.6563 28.1819 28.6641 29.144 29.2024 29.0818 28.7621 28.1894	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66224 2.3879 2.25341 2.24256 2.1802 2.07051 2.07356 2.02859 1.9889 1.90182 1.87363 1.772029 1.67191 1.62903 1.59279	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.7695 19.6697 19.6896 19.0298 18.2185 17.6383 17.294 16.4285 15.8851 15.4345 15.2208 15.1726 15.2293 15.43 15.71294 16.155 16.7296	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22684 0.2209 0.19645 0.19614 0.20217 0.197614 0.20355 0.23885 0.25712 9.98519 9.5999 9.37046 9.2227 8.97948	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 13.7603 13.7603 13.7603 13.7596 14.5596 14.5583 14.9779 15.1542 15.3087 15.1 14.7586 14.5135 14.4327 14.5564 14.9305 15.6115	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 20.2073 18.7726 17.6083 16.7669 15.885 15.1009 14.3996 12.9331 12.6648 12.1899 11.3604 10.9975 10.6647 0.26103 0.27512 0.29598 0.3217 0.3505 0.38266	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.38719 3.3049 2.8248 2.85137 2.87516 2.89604 2.9227 3.54545 2.95354 2.9637 3.63857 2.98233 2.98706 2.98963 3.71601 4.30013 4.76492 5.1182 5.14174 5.57589	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.874 92.6566 105.703 102.961 100.417 84.3298 72.029 63.3644 57.056 52.0864 48.16647 45.0011	4,939 4,782 4,59 4,3,71 3,71 3,33 4,07 2,77 2,146 1,862 2,058 2,209 2,577 2,41 3,583 4,297 4,567 7,976 6,756 7,976 6,756 8,581 9,243 9,888 10,4 11,00 11,47
51 Sb 52 Te 52 Te 53 I 54 Xe 55 Cs 56 Ba 58 Cc 59 Pr 50 Nd 51 Pm 53 Eu 54 56 Dy 70 Yb 71 Lu 72 Ta 74 W 75 Re 57 77 Ir 76 Re 57 77 Ir 77 Re 58 Te 77 Ta 78 Te 79 Te 70 Te 70 Te 71 Lu 72 Ta 74 W	19.1889 19.6418 19.9644 20.1472 20.2933 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 25.8976 26.507 26.9049 27.6553 28.1819 28.6641 28.9476 29.144 29.2024 29.0818 28.7621 28.1894 27.3049	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248 2.5627 2.47274 2.3879 2.25341 2.07356 2.1802 2.07051 2.07356 2.1882 1.9889 1.90182 1.83262 1.77333 1.72029 1.67191 1.62903 1.59279 1.51293	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.7695 19.6697 19.6896 19.0298 18.2185 17.6383 17.294 16.4285 15.8851 15.4345 15.2208 15.1726 15.2293 15.43 15.71294 16.155 16.7296	0.5031 0.4607 0.42089 0.3814 0.344 0.3107 0.2756 0.242684 0.22209 0.19645 0.19942 0.1995 0.19614 0.20217 0.19794 0.23885 0.25712 9.8919 9.599 9.37046 9.2259 9.09227 8.97948 8.86553 8.81174	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774 13.1235 13.4396 13.7603 13.8518 14.3167 14.5596 14.5583 14.9779 15.11 14.7586 14.5135 14.4327 14.5564 14.9305 15.6115 15.7131	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6669 15.885 15.1009 14.3996 12.9331 12.6648 12.1899 11.4407 11.3604 10.9751 10.6647 0.26103 0.27512 0.29598 0.3217 0.3505 0.38266 0.41792 0.42459	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.38719 3.3049 2.82428 2.85137 2.87516 2.95354 2.96577 3.63837 2.98706 2.98963 3.71601 4.30013 4.76492 5.11982 5.4174 5.57887 5.78377 5.7837	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.874 92.6566 105.703 102.961 100.417 84.3298 72.029 63.3644 57.056 52.0861 48.1647 45.0011 38.6103	4.939 4.787 4.597 3.71 2.146 4.07 2.17 2.146 2.028 2.209 4.567 2.41 4.567 5.920 6.756 6.756 6.756 8.581 9.288 10.41 11.00 11.47 11.68
51 Sb 52 Te 52 Te 53 I 54 Xe 55 Cs 66 Ba 55 Cs 66 Ba 56 SB 67 La 58 Cc 59 Pr 50 Nd 51 Pm 52 Sm 53 Eu 54 Gd 60 Dy 71 Lu 72 Hd 74 W 75 Re 76 GO Ir 77 78 Pt 77 78 Pt	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 25.8976 26.507 26.9049 27.6563 28.1819 28.6641 29.2024 29.0818 28.7621 28.1894 27.3049 27.0059 16.8819	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248 2.5627 2.47274 2.3879 2.25341 2.24256 2.1802 2.07051 2.07051 2.07356 2.02859 1.9882 1.9812 1.72029 1.67191 1.62903 1.51293 0.4611	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.10697 19.599 19.7695 19.6697 19.69847 19.6095 19.4258 19.0896 19.0798 18.2185 17.6383 17.294 16.4285 15.8851 15.4345 15.2293 15.718 16.155 16.7296 17.7639 18.5913	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22209 0.19645 0.21063 0.20209 0.19645 0.19614 0.20217 0.19794 0.22355 0.23885 0.25712 9.98519 9.5999 9.37046 9.2259 9.09227 8.97948 8.86553 8.81174 8.6216	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774 13.1235 13.4396 13.7603 13.8518 14.3167 14.5593 14.9779 15.1542 15.3087 14.5135 14.7586 14.5135 14.9305 15.6115 15.7131 12.5582	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 15.1009 14.3996 13.7546 12.9331 12.6648 12.1897 11.3604 10.9975 10.66470 0.27512 0.29538 0.3217 0.3505 0.38266 0.41792 0.42459 1.4826	2.0396 2.4863 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.:8719 3.:3049 2.8242 2.85137 2.87516 2.89247 3.63837 2.98233 2.98233 2.98706 2.98963 4.30013 4.76492 5.11982 5.41474 5.57589 5.33377 5.7869	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.87 92.6566 105.703 102.961 100.417 57.056 52.0861 48.1647 45.0011 38.6103 36.3956	4,939 4,785 4,597 4,31 4,07 3,71 3,71 3,73 3,73 3,73 2,777 2,146 2,028 2,209 2,21 41 3,583 4,297 7,566 8,581 9,243 9,243 11,00 11,47 11,688 12,066
51 Sb 52 Te 52 Te 53 I 54 4 Xe 55 Cs 65 Cs 6	19.1889 19.6418 19.9641 20.1472 20.2933 20.3892 20.3361 22.0578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.8796 26.507 26.9049 27.6563 28.1819 28.6641 28.9476 29.144 29.0224 29.0818 28.7621 28.1894 27.0059 16.8819 20.6809	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.662248 2.5627 2.47274 2.3879 2.25341 2.24256 2.1802 2.070516 2.07256 2.02859 1.9889 1.9182 1.77333 1.72029 1.67191 1.62903 1.59279 1.51293 0.4611 0.545	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.1069 19.7695 19.6697 19.69847 19.6095 19.4258 19.0886 19.0798 18.2185 17.6383 15.4345 15.4345 15.2293 15.43 15.7189 16.155 16.7296 17.7639 18.5913 19.0417	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22684 0.2209 0.19645 0.19614 0.20217 0.19794 0.20355 0.23885 0.25712 9.98519 9.37046 9.2259 9.09227 8.97948 8.86553 8.81174 8.6216 8.4484	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.868 11.3727 11.8513 12.3856 13.7603 13.7613 13.4396 13.7603 13.8518 14.3167 14.5596 14.5593 14.47599 15.1542 15.3087 15.11 14.7586 14.5135 14.4327 15.518 14.3157 15.518 15.7131 15.5582 21.6575	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3279 20.2073 18.7726 17.6083 16.7669 15.885 15.1009 14.3996 13.7546 12.9331 12.6648 12.1899 11.4409 10.9975 10.6647 0.26103 0.27512 0.29598 0.3217 0.3505 0.38266 0.41792 0.42459 1.4826 1.4826 1.5729	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.38719 3.3049 2.8248 2.85137 2.87516 2.9604 2.9627 3.54545 2.95354 2.9633 2.98706 2.98963 3.71601 4.30013 4.76492 5.11982 5.41474 5.57589 5.83377 5.866 5.9676	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 127.113 143.644 101.398 115.362 111.874 92.6566 105.703 102.961 100.417 84.3298 72.029 63.3644 57.056 48.1647 45.0011 38.6395 38.3246	4.939 4.78 4.59 4.3.3 4.07 3.71 3.33 3.72 2.77 2.146 1.862 2.058 2.209 2.57 4.56 7.566 6.756 7.566 6.756 9.84 11.00 11.47 11.68
51 Sb 52 Te 52 Te 53 I 54 44 Xe 55 Cs 56 Ba 57 T La 58 Ce 59 P N 50 N N 50 N N 50 S S S S S S S S S S S S S S S S S S S	19.1889 19.6418 19.96418 19.9644 20.1472 20.2933 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 25.8976 26.507 26.9049 27.6563 28.1819 28.6641 28.9476 29.144 29.2024 29.0818 28.7621 28.1894 27.3049 27.0059 16.8819 20.68899 27.54466	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66228 2.3579 2.25341 2.24256 2.1802 2.07051 2.07356 2.02859 1.9889 1.90182 1.87363 1.72029 1.67191 1.62903 0.4611 0.545 0.65515	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.7695 19.6697 19.6847 19.6998 18.2185 17.6383 17.294 16.4285 15.8851 15.4345 15.2208 15.4345 15.2208 15.436 15.7266 17.7639 18.5913 16.155 16.7296 17.7639 18.5913 19.0417	0.5031 0.4607 0.42089 0.3814 0.3344 0.3107 0.2756 0.24448 0.22209 0.21063 0.20209 0.19645 0.1995 0.19614 0.20217 0.19794 0.20318 0.23355 0.23885 0.25712 9.98519 9.37046 9.2259 9.99227 8.897948 8.86553 8.81174 8.6216 8.4484 8.70751	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774 13.1235 13.4396 13.7603 13.8518 14.3167 14.5596 14.5583 14.9779 15.1542 15.3087 15.1 14.7586 14.5135 14.4327 15.564 14.5355 15.6115 15.7131 25.5882 21.6575 15.538	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 15.1009 13.7546 12.9331 12.6648 12.1899 11.4407 11.3604 10.9975 10.6647 0.26103 0.27512 0.3250 0.3217 0.3505 0.3226 0.41792 0.42459 1.4826 1.5729 1.96347	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.48719 3.53049 2.82428 2.85137 2.87516 2.89604 2.9227 3.54545 2.9534 2.94504 2.94507 3.63837 2.98706 3.71601 4.30013 4.76492 5.11982 5.4174 5.57583 5.866 5.9676 5.52593	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.874 92.6566 105.703 102.961 100.417 84.3298 72.029 63.3644 57.056 52.0861 48.1647 45.0011 38.6103 36.3956 45.8149	4,939 4,78 4,59 4,3,7 4,07 3,717 3,333 2,77 2,146 1,862 2,058 2,209 2,577 2,41 3,583 4,297 4,567 7,976 6,756 6,756 6,796 6,756 6,797 6,11 1,00 11,47 11,68 12,06 13,17
51 Sb 52 Te 52 Te 53 I 54 4 Xe 55 Cs 66 Ba 68 88 Ce 59 Pr 50 Nd 51 Pm 52 Sm 53 Eu 54 Gd 70 Th 52 Sm 70 Th 54 Gd 77 Th 58 Te 77 Th 58 Te 78 Te 88 St 77 Te 78 Te 88 St 77 Te	19.1889 19.6418 19.9641 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 25.8976 26.507 26.9049 27.6563 28.1819 28.6641 28.9476 29.144 29.0214 29.0214 29.0818 28.7621 28.1894 27.3049 27.0059 16.8819 20.6809 27.5446 31.0617	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.7739 2.25341 2.24256 2.1802 2.07051 2.07356 2.02859 1.9889 1.9889 1.9182 1.72029 1.67191 1.62903 1.51293 0.4611 0.545 0.65515 0.65902	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.7695 19.6697 19.6847 19.6095 19.4258 19.0798 18.2185 17.6383 17.294 16.4285 15.8851 15.4345 15.2208 15.1726 15.2293 15.433 15.7189 16.155 16.7263 17.7639 18.5913 19.0417 19.1584	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22269 0.21063 0.20209 0.19645 0.1942 0.18195 0.19614 0.20217 0.19794 0.22355 0.23885 0.25712 9.98519 9.5999 9.37046 9.2259 9.09227 8.97948 8.86553 8.81174 8.6216 8.4484 8.70751 2.3576	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774 13.1235 13.4396 13.7603 13.8518 14.3167 14.5596 14.5583 14.9779 15.11 14.7586 14.5135 14.4327 14.5564 14.5135 15.6115 15.7131 25.5582 21.6575 15.5387	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6089 15.885 15.1009 14.3964 12.9331 12.6648 12.1899 11.4407 11.3604 10.9751 0.26103 0.27512 0.2953 0.38266 0.41725 0.42459 1.4826 1.5729 1.4826 1.5729 1.4826 1.5729	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.38719 3.3049 2.8242 2.85137 2.87516 2.95354 2.95354 2.95354 2.96353 3.71601 4.30013 4.76492 5.11982 5.14174 5.57589 5.83377 5.866 5.9676 5.52593 5.9696	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.874 92.6566 105.703 102.961 100.417 84.3298 72.029 63.3644 57.056 52.0861 48.1647 45.0011 36.3956 38.3246 45.8149 47.2579	4.939 4.787 4.599 4.3.1 4.077 3.717 2.146 4.862 2.2099 2.577 2.411 3.583 4.297 6.7566 7.976 8.581 9.243 11.00 11.477 11.688 12.06 12.606 12.606 13.171 13.411
51 Sb 52 Te 52 Te 53 I I 54 4 Xe 55 Cs 65 6 Da 65 75 P Lo 55 R Cc 59 P N 65 15 P M 65 15 P M 65 2 Sm 65 2 Sm 65 3 Eu 65 2 To 70 Y Lo 77 P Lo 77 P Au 77 P Au 77 P Au 78 P A	19.1889 19.6418 19.9644 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 25.8976 26.507 26.9049 27.6563 28.1819 28.6641 29.9144 29.0214 29.0818 28.7621 28.1894 27.3049 27.056809 27.5446 31.0617 33.3689	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77334 2.66248 2.5627 2.47274 2.37341 2.24256 2.1802 2.07051 2.07051 2.07259 1.9882 1.7333 1.72029 1.67191 1.62903 1.51293 0.4611 0.545 0.65515 0.6902 0.7004	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.1059 19.7695 19.6697 19.6987 19.6887 19.6886 19.0798 18.2185 17.6383 17.294 16.4285 15.4293 15.1726 15.2293 15.7189 16.155 16.7296 17.76391 18.5913 19.0417 19.1584 13.0637 12.951	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.222684 0.22209 0.19645 0.1916 0.20217 0.19794 0.22355 0.23885 0.25712 9.5999 9.37046 9.2259 8.97948 8.86553 8.81174 8.6216 8.4484 8.70751 2.3576 2.9238	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 13.7603 13.4596 13.7603 13.45793 14.5596 14.5797 15.1542 15.3087 14.5586 14.5135 14.4327 14.5566 15.7131 15.7151 15.7151 15.7151 15.7151 15.7151 15.7151	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 16.7669 15.885 15.1009 14.3996 12.9331 12.6648 12.1899 11.4409 11.3604 10.9975 10.6647 0.26103 0.27512 0.29598 0.3217 0.3505 0.38266 0.41792 0.42459 1.572	2.0396 2.4863 2.6823 2.2735 1.99 3.2735 2.6959 3.28719 3.33049 2.8242 2.85137 2.87516 2.9823 2.98233 2.98203 3.76601 4.30013 4.76492 5.11982 5.14174 5.57589 5.33377 5.865 5.9676 5.52593 5.96966 6.4692	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.874 92.6566 105.703 102.961 100.419 63.3644 57.056 48.1647 45.0011 36.6103 36.3956 38.3246 45.8149 47.2579 48.0093	4.939 4.787 4.597 4.37 4.07 3.717 2.146 1.862 2.029 2.411 3.583 4.297 7.566 8.581 9.243 9.888 10.41 11.00 11.47 11.686 12.60 13.17 13.41
51 Sb 52 Te 52 Te 54 Xe 55 Cs 65 Ba Cc 57 Ba Cc 58 Cc 59 Pr 60 St 51 Pm 65 Sb Cc 58 Cc 59 Pr 60 St 60 Dy 65 Tb 65 Tb 77 Ta 77 Ta 77 Ta 77 Ta 77 Ta 77 Ta 77 Re 77 Pa 77 Pa 78 Pa 79 Au 80 Sb Sb 81 Tl 83 Bi 81 Tl 83 Bi 83 Bi 83 Bi 84 Po 84 Po 85 Ba 86 Po 87 Au 87 Au 88 Ba 87 Au 88 Ba 87 Au 88 Ba 88 Ba 87 Au 88 Ba 88 B	19.1889 19.6418 19.9641 20.1472 20.2933 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 25.8976 26.507 26.9049 27.6563 28.1819 28.6641 28.9764 29.144 29.024 29.0818 28.7621 28.1894 27.0059 16.8819 20.6809 27.5446 31.0617 33.3689 34.6726	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.662248 2.56227 2.47274 2.3879 2.25341 2.24256 2.1802 2.07051 2.07356 2.02859 1.9889 1.9018 1.67202 1.67191 1.62903 1.59279 1.51293 0.4611 0.545 0.65515 0.6902 0.704	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.7695 19.6697 19.6887 19.6886 19.0798 18.2185 17.6383 17.294 16.4285 15.8851 15.4345 15.2293 15.7189 16.155 16.7296 17.7639 18.5913 15.7189 18.1514 13.0637 12.951 15.4733	0.5031 0.4607 0.42089 0.3814 0.3344 0.3107 0.2756 0.24448 0.222684 0.22209 0.19645 0.19614 0.20217 0.19794 0.2355 0.23885 0.23712 9.8519 9.37046 9.2259 9.37046 9.2259 8.81174 8.6216 8.4484 8.70751 2.3578 3.55078	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.868 11.3727 11.8513 12.3856 13.7603 13.7613 13.4396 13.7603 13.8518 14.3167 14.5596 14.5583 14.47586 14.5135 14.4327 14.5564 14.9305 15.6115 15.7131 125.538 18.442 16.5877 13.1138	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 18.7726 17.6083 16.7669 15.885 15.1009 14.3996 13.7546 12.9331 12.6648 12.1899 11.4604 10.9975 10.6647 0.26103 0.27512 0.29598 0.3217 0.3505 0.38266 0.41792 0.42459 1.4826 1.5729 1.96347 8.618 8.7937 9.555642	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.38719 3.33049 2.8248 2.85137 2.87516 2.89604 2.96577 3.54545 2.95354 2.96577 3.63837 2.98706 2.98963 3.71601 4.30013 4.76492 5.11982 5.34174 5.57589 5.33377 5.7867 5.52593 5.9676 5.52593 5.9696 6.4692 7.02588	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.874 92.029 63.3644 57.056 52.0861 48.1647 45.0011 38.6103 36.3956 48.1647 45.8149 47.2579 48.0045	4.939 4.78 4.59 4.3.3 4.07 3.71 3.333 2.77 2.146 1.862 2.058 2.209 2.577 4.567 7.566 7.7566 7.976 1.1.68 1.1.00 1.1.47 1.1.68 1.2.06 1.3.17 1.3.41 1.41 1.57
51 Sb 52 Te 52 Te 54 Xe 55 Cs 65 Ba Cc 57 Ba Cc 58 Cc 59 Pr 60 St 51 Pm 65 Sb Cc 58 Cc 59 Pr 60 St 60 Dy 65 Tb 65 Tb 77 Ta 77 Ta 77 Ta 77 Ta 77 Ta 77 Ta 77 Re 77 Pa 77 Pa 78 Pa 79 Au 80 Sb Sb 81 Tl 83 Bi 81 Tl 83 Bi 83 Bi 83 Bi 84 Po 84 Po 85 Ba 86 Po 87 Au 87 Au 88 Ba 87 Au 88 Ba 87 Au 88 Ba 88 Ba 87 Au 88 Ba 88 B	19.1889 19.6418 19.9641 20.1472 20.2933 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 25.8976 26.507 26.9049 27.6563 28.1819 28.6641 28.9764 29.144 29.024 29.0818 28.7621 28.1894 27.0059 16.8819 20.6809 27.5446 31.0617 33.3689 34.6726	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77334 2.66248 2.5627 2.47274 2.37341 2.24256 2.1802 2.07051 2.07051 2.07259 1.9882 1.7333 1.72029 1.67191 1.62903 1.51293 0.4611 0.545 0.65515 0.6902 0.7004	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.7695 19.6697 19.6887 19.6886 19.0798 18.2185 17.6383 17.294 16.4285 15.8851 15.4345 15.2293 15.7189 16.155 16.7296 17.7639 18.5913 15.7189 18.1514 13.0637 12.951 15.4733	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.222684 0.22209 0.19645 0.1916 0.20217 0.19794 0.22355 0.23885 0.25712 9.5999 9.37046 9.2259 8.97948 8.86553 8.81174 8.6216 8.4484 8.70751 2.3576 2.9238	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.868 11.3727 11.8513 12.3856 13.7603 13.7613 13.4396 13.7603 13.8518 14.3167 14.5596 14.5583 14.47586 14.5135 14.4327 14.5564 14.9305 15.6115 15.7131 125.538 18.442 16.5877 13.1138	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 18.7726 17.6083 16.7669 15.885 15.1009 14.3996 13.7546 12.9331 12.6648 12.1899 11.4604 10.9975 10.6647 0.26103 0.27512 0.29598 0.3217 0.3505 0.38266 0.41792 0.42459 1.4826 1.5729 1.96347 8.618 8.7937 9.555642	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.38719 3.33049 2.8248 2.85137 2.87516 2.89604 2.96577 3.54545 2.95354 2.96577 3.63837 2.98706 2.98963 3.71601 4.30013 4.76492 5.11982 5.34174 5.57589 5.33377 5.7867 5.52593 5.9676 5.52593 5.9696 6.4692 7.02588	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.874 92.6566 105.703 102.961 100.419 63.3644 57.056 48.1647 45.0011 36.6103 36.3956 38.3246 45.8149 47.2579 48.0093	4.939 4.787 4.597 4.37 4.07 3.71 2.146 4.862 2.07 2.146 2.028 2.209 2.57 2.41 3.533 3.533 3.533 4.297 4.567 5.920 6.7566 7.976 8.581 9.243 11.00 11.47 11.68 12.606 12.606 13.17 13.41
51 Sb 52 Te 52 Te 53 I 54 44 Xe 55 Cs 56 Ba 57 T La 58 Ce 59 Pr 50 Nd 51 Pm 52 Sm 53 Eu 54 St 55 Tb 56 Dy 77 La 77 Ta 78 Er 77 Ta 78 Er 77 Ta 78 Er 78 Fr 79 Pr 70 Nd 77 I 78 Er 77 Ta 78 Er 78 Er 77 Ta 78 Er 78 Er 78 Pr 78 Pr	19.1889 19.6418 19.9641 20.1472 20.2933 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 25.8976 26.507 26.9049 27.6563 28.1819 28.6641 28.9764 29.144 29.024 29.0818 28.7621 28.1894 27.0059 16.8819 20.6809 27.5446 31.0617 33.3689 34.6726	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.662248 2.56227 2.47274 2.3879 2.25341 2.24256 2.1802 2.07051 2.07356 2.02859 1.9889 1.9018 1.67202 1.67191 1.62903 1.59279 1.51293 0.4611 0.545 0.65515 0.6902 0.704	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.7695 19.6697 19.6887 19.6886 19.0798 18.2185 17.6383 17.294 16.4285 15.8851 15.4345 15.2293 15.7189 16.155 16.7296 17.7639 18.5913 15.7189 18.1514 13.0637 12.951 15.4733	0.5031 0.4607 0.42089 0.3814 0.3344 0.3107 0.2756 0.24448 0.222684 0.22209 0.19645 0.19614 0.20217 0.19794 0.2355 0.23885 0.23712 9.8519 9.37046 9.2259 9.37046 9.2259 8.81174 8.6216 8.4484 8.70751 2.3578 3.55078	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.868 11.3727 11.8513 12.3856 13.7603 13.7613 13.4396 13.7603 13.8518 14.3167 14.5596 14.5583 14.47586 14.5135 14.4327 14.5564 14.9305 15.6115 15.7131 125.538 18.442 16.5877 13.1138	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.608 15.885 15.1009 14.3996 12.9331 12.6648 12.1899 11.4407 11.3604 10.975 10.6647 0.26103 0.27512 0.29598 0.3217 0.3505 0.38266 0.41792 0.42459 1.4826 1.5729 1.4826 1.5729 1.96347 8.618 8.7937 9.555642	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.48719 3.53049 2.82428 2.85137 2.87516 2.89604 2.9227 3.54545 2.95354 2.96577 3.63837 2.98706 2.98963 3.71601 4.30013 4.76492 5.11982 5.4174 5.57837 5.866 5.9676 5.9696 6.4692 7.02588 7.42518	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.874 92.029 63.3644 57.056 52.0861 48.1647 45.0011 38.6103 36.3956 48.1647 45.8149 47.2579 48.0045	4,939 4,787 4,597 4,33 4,07 3,71 2,146 1,862 2,209 2,57 2,41 4,567 5,920 6,756 6,756 6,756 8,581 11,00 11,47 11,68 12,06 12,60 13,17 13,11 13,17 13,11 13,17 14,17
51 Sb 52 Te 52 Te 53 I 54 A Xe 55 Cs 65 Ba 66 Ba 67 Th 67 Ba 67 Ba 67 Ba 68 Ba	19.1889 19.6418 19.9641 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 25.8976 26.507 26.9049 27.6563 28.1819 28.6641 29.2024 29.0818 28.7621 28.1894 27.3049 27.0559 16.8819 20.6809 27.5446 31.0617 33.3689 34.6726 35.3163	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.7733 2.266248 2.5627 2.47274 2.3879 2.25341 2.24256 2.1802 2.07051 2.07356 2.02859 1.9889 1.90182 1.83262 1.77333 1.72029 0.4611 0.545 0.65515 0.6902 0.704 0.701 0.68587 0.66331	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.599 19.7695 19.6697 19.6847 19.6095 19.4258 19.0896 19.0798 18.2185 17.6383 17.294 16.4285 15.4268 15.1726 15.2293 15.7189 16.155 16.7296 17.7639 18.5913 19.0417 19.1584 13.0637 12.951 15.4733 19.0211 21.2816	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22209 0.19645 0.1942 0.18195 0.19614 0.20217 0.19794 0.22355 0.25712 9.98519 9.5999 9.37046 9.2259 9.09227 8.97948 8.86553 8.81174 8.6216 8.4484 8.70751 2.3576 2.9238 3.55078 3.97458	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 13.7603 13.8518 14.3167 14.5596 14.5135 14.7586 14.5135 14.7586 14.5135 14.4327 14.5564 14.9305 15.6115 15.7131 125.582 16.6757 15.188 18.442 16.5877 13.1138 9.49887 8.0037	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 15.1009 14.3964 12.9331 12.6648 12.1899 11.3604 10.975 10.6647 0.26103 0.27512 0.29529 0.38266 0.41729 1.4826 1.5729 1.4826 1.5729 1.4826 1.5729 1.4826 1.5729 1.96347 8.618 8.7937 9.55642 11.3824 11.3824	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.38719 3.304545 2.85137 2.87516 2.89603 3.71601 4.30013 4.76492 5.41942 5.4174 5.57589 5.8377 5.866 5.9676 5.95293 5.9696 6.4692 7.02588 7.42518 7.4433	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.874 92.6566 105.703 102.961 100.417 84.3298 72.029 63.3644 57.056 52.0861 48.1647 45.0011 36.3956 38.6103 36.3956 38.3246 45.8149 47.2579 48.0093 47.0045 45.4715 44.2473	4,939 4,787 4,597 4,31 4,07 3,71 2,146 1,862 2,209 2,57 2,41 3,583 4,297 5,920 6,756 6,756 8,581 1,00 11,47 11,68 12,06 13,17 13,63 13,71 13,69
51 Sb 52 Te 52 Te 53 I 54 Xe 55 Cs 56 Ba 57 Cs 58 Cc 59 Pr Mod Si 58 Cc 59 Pr Mod Si 59 Pr Mod Si 50 Pr Mod Si Mod Si Mo	19.1889 19.6418 19.9641 20.1472 20.2933 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.8976 26.507 26.9049 27.6563 28.1819 28.6641 29.144 29.2024 29.0818 28.7621 28.1894 27.0369 27.5446 31.0617 33.3689 34.6726 35.3163 35.5631 35.9299	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.65248 2.5627 2.47274 2.3879 2.25341 2.24256 2.1802 2.07051 2.07356 2.02859 1.9889 1.83262 1.77333 1.72029 1.67191 1.62903 1.59279 1.51293 0.4611 0.545 0.65902 0.704 0.701 0.68587 0.70631 0.66465	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.1059 19.69697 19.6997 19.69847 19.6095 19.4258 19.0896 18.2185 17.6383 17.294 16.4285 15.4345 15.4345 15.4293 15.7189 16.155 16.7296 17.7391 19.0417 19.1584 13.0637 19.0211 21.2816 23.0547	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.222684 0.22209 0.19645 0.1919 0.19614 0.20217 0.19794 0.23355 0.23885 0.25712 9.5999 9.37046 9.2259 8.97948 8.86553 8.81174 8.6216 8.4484 8.70751 2.3576 2.9238 3.55078 3.97458 4.0691 4.17619	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 13.7603 13.7613 13.4396 13.7603 13.6518 14.3167 14.5596 14.5538 14.4327 14.7586 14.5135 14.4327 15.5381 15.7131 15.57131 15.5381 15.7131 15.7131 16.5587 17.3138 18.442 16.5877 13.1138 18.49305 18.6115 18.7131	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 16.7669 15.885 15.1009 14.3996 11.35946 12.9331 12.6648 12.1899 11.3604 10.9975 10.6647 0.26103 0.27512 0.29598 0.3217 0.3505 0.38266 0.41792 0.42459 1.4826 1.5729 1.96347 8.618 8.7937 9.55642 11.3824 14.0422 23.1052	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.38719 3.3049 2.82428 2.85137 2.87516 2.9604 2.9827 3.54545 2.95237 2.98233 2.98706 2.9893 3.71601 4.30013 4.76492 5.11982 5.14174 5.57589 5.83377 5.86 5.9676 5.52593 6.9676 5.52593 7.42518 7.42518 7.42518 7.42518 7.42518	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 127.113 143.644 127.113 143.644 127.113 132.721 128.007 123.174 101.398 115.362 111.874 92.6556 105.703 102.961 100.417 84.3298 72.029 63.3644 57.056 148.1647 45.0011 36.3956 38.3246 45.8149 47.2579 48.0093 47.0045 45.4715 44.2473 150.645	4,939 4,782 4,597 4,3,71 3,33,33 4,07 2,777 2,146 1,862 2,028 2,209 2,57 1,984 4,297 2,57 1,566 8,581 1,00 11,47 11,688 11,10 12,60 13,17 13,41 13,17
51 Sb 52 Te 52 Te 53 I I 54 Xe 55 Cs 65 Ba 65 SB 65 Ba	19.1889 19.6418 19.9641 20.1472 20.2933 20.3361 20.578 21.1671 22.044 22.6825 23.3405 24.0042 24.6274 25.9709 25.8976 26.507 26.9049 27.65563 28.1819 28.6641 28.4744 29.0244 29.0818 28.7621 28.1894 27.3049 27.0059 16.8819 20.6809 27.5446 31.0617 33.3689 27.5446 31.0617 33.3689 35.5631 35.5299 35.763	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248 2.56224 2.37526 2.1802 2.07051 2.07356 2.02859 1.9889 1.9018 1.67293 1.67293 1.67293 0.4611 0.545 0.65515 0.6902 0.704 0.701 0.68587 0.6631 0.64645 0.61634	19.1005 19.0455 19.0145 19.0145 19.0145 19.0149 19.0298 19.1062 19.297 19.599 19.7695 19.6697 19.6897 19.6896 19.0798 18.2185 17.6383 17.294 16.4285 15.8851 15.4345 15.2208 15.4345 15.2208 15.436 15.7296 17.7639 18.5913 19.011 19.1584 13.0637 12.915 15.4733 19.0211 21.2816 23.0547 22.9064	0.5031 0.4607 0.42089 0.3814 0.344 0.3107 0.2756 0.24448 0.22009 0.19645 0.19614 0.20217 0.19794 0.20385 0.23885 0.25712 9.8519 9.5999 9.37046 9.2259 9.09227 8.87948 8.86553 8.81174 8.6216 8.4484 8.70751 2.3576 2.9238 3.55078 3.97458 4.0691 4.17619 3.87135	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774 13.1235 13.4396 13.7603 13.7613 14.5596 14.5583 14.4317 15.1542 15.3087 15.1542 15.3087 15.1542 15.3087 15.1542 15.3087 15.1542 15.3087 15.1542 15.3087 15.1542 16.5875 15.538 18.442 16.5877 13.1138 9.49887 8.0037 12.1439 12.4739	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 15.1099 13.7546 12.9331 12.6648 12.1899 11.4407 11.3604 10.9975 10.6647 0.26103 0.27512 0.38266 0.41792 0.42459 1.4826 1.5729 1.96347 8.618 8.7937 9.55642 11.3824 14.0422 23.1052 19.9887	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.38719 3.3049 2.8248 2.85137 2.87516 2.89604 2.96577 3.54545 2.95354 2.96537 3.63837 2.98233 2.98706 2.98963 3.71601 4.30013 4.76492 5.11982 5.34174 5.57589 5.83377 5.7867 5.52593 5.9676 5.52593 5.9696 6.4692 7.02588 7.42518 7.4433 2.11253 3.21097	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 127.113 143.640 137.903 132.721 128.007 123.174 101.398 115.362 111.874 92.029 63.3644 57.056 52.0861 48.1647 45.0011 38.6103 36.3956 48.8149 47.2579 48.0093 47.0045 44.4715 44.473 150.645 142.325	4,939 4.787 4.597 4.371 3.71 2.146 1.862 2.277 2.146 2.028 2.577 2.414 3.583 3.583 3.583 3.583 1.492 4.567 7.976 8.581 11.00 11.47 11.68 12.060 12.606 12.11 13.41 13.57 13.69 13.77 13.69 13.72
51 Sb 52 Te 52 Te 53 I I 54 34 Xe 55 Cs 56 Ba 57 T La 58 Cc 58 56 Ba 58 Cc 59 Pr 50 Nd 51 Pm 53 S Eu 54 54 Xe 55 Cb 56 Ba 57 T La 57 T La 58 Cc 58 S Tb 57 T La 58 T L	19.1889 19.6418 19.96418 19.9644 20.1472 20.2933 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.07096 26.507 26.9049 27.6563 28.18619 28.6641 28.9476 29.144 29.2024 29.0818 28.7621 28.1894 27.3049 27.0059 16.8819 20.6809 27.5446 31.0617 33.3689 34.6726 35.5631 35.9299 35.763 35.6597	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66224 2.3879 2.25341 2.24256 2.1802 2.07051 2.24256 2.1802 2.07051 2.1802 2.07356 2.02859 1.9889 1.90182 1.83262 1.77333 1.72029 1.67191 1.62903 0.4611 0.5455 0.6902 0.704 0.701 0.68587 0.6631 0.64645 0.61634 0.58909	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.297 19.6995 19.6697 19.6847 19.6995 19.4258 19.0886 19.0798 18.2185 17.6383 17.294 16.4285 15.1208 15.4345 15.2208 15.4345 15.2208 15.7189 16.4285 16.4285 16.2293 15.43 15.7189 19.0417 19.1584 13.0637 12.951 15.4733 19.0417 19.1584 13.0637 12.951 15.4733 19.0417 21.2816 23.0547 22.9064 23.1032	0.5031 0.4607 0.42089 0.3814 0.3107 0.2756 0.24448 0.22269 0.21063 0.20209 0.19645 0.1942 0.18195 0.19614 0.20217 0.19794 0.20217 0.19794 0.22355 0.23885 0.25712 9.98519 9.37046 9.22259 9.37046 9.2259 8.81174 8.6216 8.4484 8.70751 2.3576 2.9238 3.55078 3.97458 4.0691 4.17619 3.87135 3.65155	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 12.774 13.1235 13.4396 13.7603 13.8518 14.3167 14.5596 14.5583 14.9779 15.1542 15.3087 15.1 14.75864 14.5355 14.4327 14.5564 14.5355 15.6115 15.7131 25.5582 21.6575 15.131 25.5882 21.6575 15.131 25.5882 21.6575 15.131 25.5882 21.6575 15.131 25.5882 21.6575 15.131 25.5882 21.6575 15.131	25.8499 26.8909 27.9074 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 15.1009 14.3966 15.885 15.1009 14.3966 12.9331 12.6648 12.1899 11.4407 11.3604 10.9751 0.02519 0.38266 0.3217 0.3505 0.38266 0.41792 0.42459 1.4826 1.5729 1.4826	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.28719 3.3049 2.82428 2.85137 2.87516 2.89636 3.71601 4.30013 4.76492 2.8174 5.57889 5.33377 5.866 5.967 6.4692 7.02588 7.42518 7.4433 2.11253 3.21097 4.08655	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.874 92.6566 105.703 102.961 100.417 84.3298 72.029 63.3644 57.056 52.0861 48.1647 45.0013 36.3956 38.3246 45.8149 47.2579 48.0093 47.0045 45.4715 44.2473 150.645 142.325 117.02	4.939 4.787 4.597 4.37 4.077 3.71 2.146 4.862 2.028 2.2099 4.357 2.44 3.583 6.756 6.756 6.756 6.756 6.756 6.71 1.00 1.47 1.13 1.37 1.3.69 1.3.72 1.3.62 1.3.72 1.3.62 1.3.72 1.3.62 1.3.72 1.3.62 1.3.72 1.3.62 1.3.72 1.3.62
50 Sn 51 Sb 51 Sb 51 Sb 52 Te 533 I 54 Xe 55 Cs 55 Cs 56 Ba 57 La 58 Ce 59 Pr 66 Ba 67 Th 66 Ba 67 Th 66 Ba 67 Th 68 Er 69 Tm 67 Th 67 Th 67 Th 67 Th 68 Er 69 Tm 67 Th 67 Th 68 Er 69 Tm 67 Th 67 Th 68 Er 69 Tm 67 Th 68 Er 69 Tm 67 Th 67 Th 68 Er 69 Tm 67 Th 68 Er 68 Er 69 Tm 67 Th 67 Th 68 Er 68 Er 69 Tm 67 Th 67 Th 68 Er 68 Er 69 Tm 67 Th 67 Th 68 Er 68 Er 69 Tm 67 Th 67 Th 68 Er 68 Er 69 Tm 67 Th 67 Th 68 Er 68 Er 69 Tm 67 Th 67 Th 68 Er 69 Tm 67 Th 67 Th 67 Th 68 Er 69 Tm 67 Th	19.1889 19.6418 19.9641 20.1472 20.2933 20.3892 20.3361 20.578 21.1671 22.044 22.6845 23.3405 24.0042 24.6274 25.0709 25.8976 26.507 26.9049 27.6563 28.1819 28.6641 28.9476 29.144 29.0214 29.0818 28.7621 28.1894 27.3049 27.0559 16.8819 20.6809 27.5446 31.0617 33.3689 34.6726 35.3163 35.5631 35.59299 35.763	5.8303 5.3034 4.81742 4.347 3.9282 3.569 3.216 2.94817 2.81219 2.77393 2.66248 2.56224 2.37526 2.1802 2.07051 2.07356 2.02859 1.9889 1.9018 1.67293 1.67293 1.67293 0.4611 0.545 0.65515 0.6902 0.704 0.701 0.68587 0.6631 0.64645 0.61634	19.1005 19.0455 19.0138 18.9949 19.0298 19.1062 19.599 19.7695 19.6697 19.6987 19.6981 19.0898 18.2185 17.6383 17.294 16.4285 15.8851 15.4345 15.1726 15.2293 15.1726 16.155 16.7296 17.7639 19.0417 19.1584 13.0637 12.951 15.4733 19.0417 19.1584 13.0637 12.951 15.4733 19.0417 19.1584 13.0637 12.951 15.4733 19.0417 19.1584 13.0637 12.951 15.4733 19.0417 19.1584 13.0637 12.951 15.4733 19.0417 19.1584 13.0637 12.951 15.4733 19.0417 19.1584 13.0637 12.951 15.4733 19.0417 19.1584 13.0637 12.951 15.4733 19.0417 19.1584 13.0637 12.951 15.4733 19.0417 12.2816 23.0547 22.9064	0.5031 0.4607 0.42089 0.3814 0.344 0.3107 0.2756 0.24448 0.22009 0.19645 0.19614 0.20217 0.19794 0.20385 0.23885 0.25712 9.8519 9.5999 9.37046 9.2259 9.09227 8.87948 8.86553 8.81174 8.6216 8.4484 8.70751 2.3576 2.9238 3.55078 3.97458 4.0691 4.17619 3.87135	4.4585 5.0371 6.14487 7.5138 8.9767 10.662 10.888 11.3727 11.8513 12.3856 13.7631 13.4396 13.7631 13.4596 13.7631 14.5596 14.5135 14.4327 14.5596 14.5135 14.4327 15.16115 15.7131 15.7131 15.7538 18.442 16.5877 13.1138 9.49887 18.0137 12.1439 12.4739 12.4739 12.4739 12.4739	25.8499 26.8909 27.9074 27.9766 28.5284 27.766 26.4659 24.3879 20.2073 18.7726 17.6083 15.1009 14.3996 13.7546 12.9331 12.6648 12.18931 12.6648 12.1897 11.3604 10.9975 10.6647 0.26103 0.27512 0.29538 0.38266 0.41792 1.3826 1.5729 1.4826 1.5729 1.6347 8.618 8.7937 9.55642 11.3824 11.3824 11.3824 11.3824 11.3824 11.3826 1.5729 1.6347 8.618 8.7937 9.55642 11.3824 11.3824 11.3824 11.3824 11.3824 11.3824 11.3824 11.3824	2.0396 2.4663 2.6827 2.5239 2.2735 1.99 1.4953 2.6959 3.28719 3.3049 2.82428 2.85137 2.87516 2.89636 3.71601 4.30013 4.76492 2.8174 5.57889 5.33377 5.866 5.967 6.4692 7.02588 7.42518 7.4433 2.11253 3.21097 4.08655	92.8029 83.9571 75.2825 70.8403 66.8776 64.2658 213.904 167.202 133.124 127.113 143.644 137.903 132.721 128.007 123.174 101.398 115.362 111.87 92.6566 105.703 102.961 100.417 84.3298 72.029 63.3644 57.056 52.0861 48.1647 45.0011 36.3956 38.3103 36.3956 38.3246 45.8149 47.2579 48.0093 47.0045 45.47115 117.02 99.1722	4.935 4.782 4.591 4.301 4.07: 3.71: 3.33: 2.77: 2.146: 1.862: 2.205: 1.984: 2.205: 2.41: 3.583: 4.297: 4.567: 5.920: 6.756: 7.566: 7.566: 7.976: 8.581: 9.243: 9.888 10.4 11.00 11.47: 11.688 12.06: 13.71: 13.61 13.71: 13.62 13.72: 13.62 13.72: 13.62 13.72: 13.62 13.72: 13.63

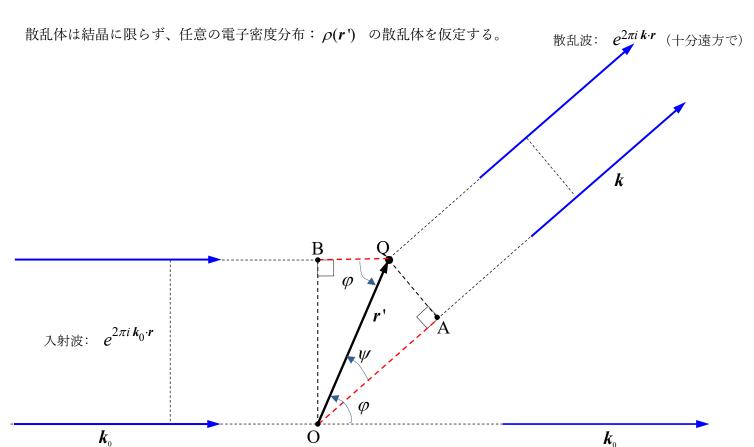
Ne 原子散乱因子

$$f_X\left(\frac{\sin\theta}{\lambda}\right) = \sum_{j=1}^4 \left\{ a_j \ e^{-b_j\left(\frac{\sin\theta}{\lambda}\right)^2} \right\} + c = a_1 e^{-b_1\left(\frac{\sin\theta}{\lambda}\right)^2} + a_2 e^{-b_2\left(\frac{\sin\theta}{\lambda}\right)^2} + a_3 e^{-b_3\left(\frac{\sin\theta}{\lambda}\right)^2} + a_4 e^{-b_4\left(\frac{\sin\theta}{\lambda}\right)^2} + c$$



§§ 散乱波強度の一般式





O点で散乱される波に対し、Q点で散乱される波は

行路差:
$$\Delta = \overline{OA} - \overline{OB} = |r'|(\cos \psi - \cos \varphi)$$
 (16)

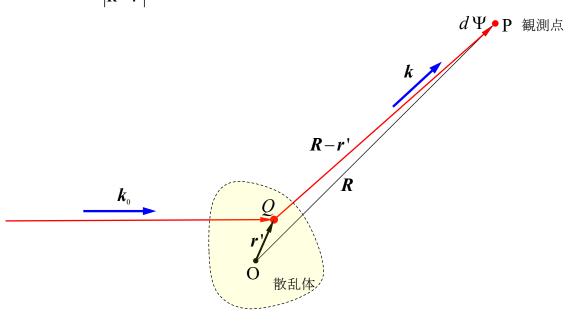
$$\therefore \qquad \text{位相差}: \qquad \delta = \frac{2\pi}{\lambda} \Delta = \frac{2\pi}{\lambda} |\mathbf{r}'| (\cos \psi - \cos \varphi)$$

$$\downarrow \leftarrow \qquad \qquad \boxtimes \ \ \ \, \mathbf{k}_0 \cdot \mathbf{r}' = \frac{1}{\lambda} |\mathbf{r}'| \cos \varphi, \quad \mathbf{k} \cdot \mathbf{r}' = \frac{1}{\lambda} |\mathbf{r}'| \cos \psi$$

よって
$$\delta(\mathbf{r}') = 2\pi(\mathbf{k} - \mathbf{k}_0) \cdot \mathbf{r}'$$
 (17)

Q点における微小体積素片 $d\mathbf{r}'$ で散乱される波 $d\Psi$ は、観測点 \mathbf{P} (座標ベクトル = \mathbf{R}) において

$$d\Psi = \rho(\mathbf{r}')d\mathbf{r}'\frac{e^{2\pi i|\mathbf{k}|\mathbf{R}|+i\delta(\mathbf{r}')}}{|\mathbf{R}-\mathbf{r}'|}$$
 に比例する散乱振幅となる。 (18)



散乱体全体からの散乱波: Ψは(18)の dΨ を積分して

$$\Psi = \int_{\text{散乱体全体}} d\Psi$$

$$= \int_{\text{散乱体全体}} \rho(\mathbf{r}') \frac{e^{2\pi i |\mathbf{k}||\mathbf{R}| + i\delta(\mathbf{r}')}}{|\mathbf{R} - \mathbf{r}'|} d\mathbf{r}'$$

$$\downarrow \leftarrow \delta(\mathbf{r}') = 2\pi (\mathbf{k} - \mathbf{k}_0) \cdot \mathbf{r}' \qquad \leftarrow (17)$$

$$= e^{2\pi i |\mathbf{k}||\mathbf{R}|} \int_{\text{\ti}\text{\tex{$$

散乱体の存在領域 \mathbf{r}' に比べて、観測点までの距離 $|\mathbf{R}|$ が十分遠方の場合は、

 \downarrow ← $\frac{1}{|\mathbf{R} - \mathbf{r}'|} \approx \frac{1}{|\mathbf{R}|}$ として積分の外に出せる。

フラウンホッファー回折 Fraunhofer diffraction

$$\therefore \quad \Psi = \frac{e^{2\pi i |\mathbf{k}||\mathbf{R}|}}{|\mathbf{R}|} \int_{\text{\text{b}} \pm 4\pi} \rho(\mathbf{r}') e^{2\pi i (\mathbf{k} - \mathbf{k}_0) \cdot \mathbf{r}'} d\mathbf{r}'$$
(19)

つまり散乱波は球面波としてP点に到達し、回折角依存性はt散乱体密度 $\rho(r')$ のフーリエ変換で与えられる。

散乱波の強度: 1は

$$I = \left|\Psi\right|^2 = I_0 C \frac{1}{\left|\mathbf{R}\right|^2} \left| \int_{\text{watk} \pm \text{k}} \rho(\mathbf{r}') e^{2\pi i \, (\mathbf{k} - \mathbf{k}_0) \cdot \mathbf{r}'} d\mathbf{r}' \right|^2$$
ここで、 I_0 は入射波強度、 C は散乱断面積に比例する定数

$$\downarrow \leftarrow$$
 $\mathbf{k} - \mathbf{k}_0 = \mathbf{K}$: 散乱ベクトル (21)

$$=I_0C\left.\frac{1}{\left|\boldsymbol{R}\right|^2}\right|_{\text{Walk} \triangleq \text{ch}} \rho(\boldsymbol{r}')e^{2\pi i \boldsymbol{K}\cdot\boldsymbol{r}'}d\boldsymbol{r}'\right|^2$$

$$\downarrow$$
 ←
$$\int_{\text{散乱体全体}} \rho(\mathbf{r}')e^{2\pi i \ \mathbf{K}\cdot\mathbf{r}'}d\mathbf{r}' \equiv G(\mathbf{K}) \leftarrow \rho(\mathbf{r}') \text{ o Fourier 変換}$$
 (22)
$$\text{ ここで、} \rho(\mathbf{r}') \text{ は結晶でも気体でも液体でも可能である。}$$
 特に \mathbf{X} 線の場合は、 $\rho(\mathbf{r}')$ は電子数密度分布関数

$$I(\mathbf{K}) = I_0 C \frac{\left| G(\mathbf{K}) \right|^2}{R^2}$$
 散乱波強度の一般式 (23)