Table 1.3 Phases of Interstellar Gas

Phase	$T(\mathrm{K})$	$n_{\mathrm{H}}(\mathrm{cm}^{-3})$	Comments
Coronal gas (HIM) $f_V \approx 0.5?$ $\langle n_{\mathrm{H}}\rangle f_V \approx 0.002\,\mathrm{cm}^{-3}$ ($f_V \equiv$ volume filling factor)	$\gtrsim 10^{5.5}$	~ 0.004	Shock-heated Collisionally ionized Either expanding or in pressure equilibrium Cooling by: ◇ Adiabatic expansion ◇ X ray emission Observed by: • UV and x ray emission • Radio synchrotron emission
H II gas $f_V \approx 0.1$ $\langle n_{\mathrm{H}}\rangle f_V \approx 0.02\,\mathrm{cm}^{-3}$	10^4	$0.2 - 10^4$	Heating by photoelectrons from H, He Photoionized Either expanding or in pressure equilibrium Cooling by: ◇ Optical line emission ◇ Free–free emission ◇ Fine-structure line emission Observed by: • Optical line emission • Thermal radio continuum
Warm H I (WNM) $f_V \approx 0.4$ $n_{\mathrm{H}} f_V \approx 0.2\,\mathrm{cm}^{-3}$	~5000	0.6	Heating by photoelectrons from dust Ionization by starlight, cosmic rays Pressure equilibrium Cooling by: ◇ Optical line emission ◇ Fine structure line emission Observed by: • H I 21 cm emission, absorption • Optical, UV absorption lines
Cool H I (CNM) $f_V \approx 0.01$ $n_{\mathrm{H}} f_V \approx 0.3\,\mathrm{cm}^{-3}$	~ 100	30	Heating by photoelectrons from dust Ionization by starlight, cosmic rays Cooling by: ◇ Fine structure line emission Observed by: • H I 21-cm emission, absorption • Optical, UV absorption lines
Diffuse H_2 $f_V \approx 0.001$ $n_{\mathrm{H}} f_V \approx 0.1\,\mathrm{cm}^{-3}$	$\sim 50\,\mathrm{K}$	~ 100	Heating by photoelectrons from dust Ionization by starlight, cosmic rays Cooling by: ◇ Fine structure line emission Observed by: • H I 21-cm emission, absorption • CO 2.6-mm emission • optical, UV absorption lines
Dense H_2 $f_V \approx 10^{-4}$ $\langle n_{\mathrm{H}}\rangle f_V \approx 0.2\,\mathrm{cm}^{-3}$	$10 - 50$	$10^3 - 10^6$	Heating by photoelectrons from dust Ionization and heating by cosmic rays Self-gravitating: $p > p(\mathrm{ambient\ ISM})$ Cooling by: ◇ CO line emission ◇ C I fine structure line emission Observed by: • CO 2.6-mm emission • dust FIR emission
Cool stellar outflows	$50 - 10^3$	$1 - 10^6$	Observed by: • Optical, UV absorption lines • Dust IR emission • H I, CO, OH radio emission

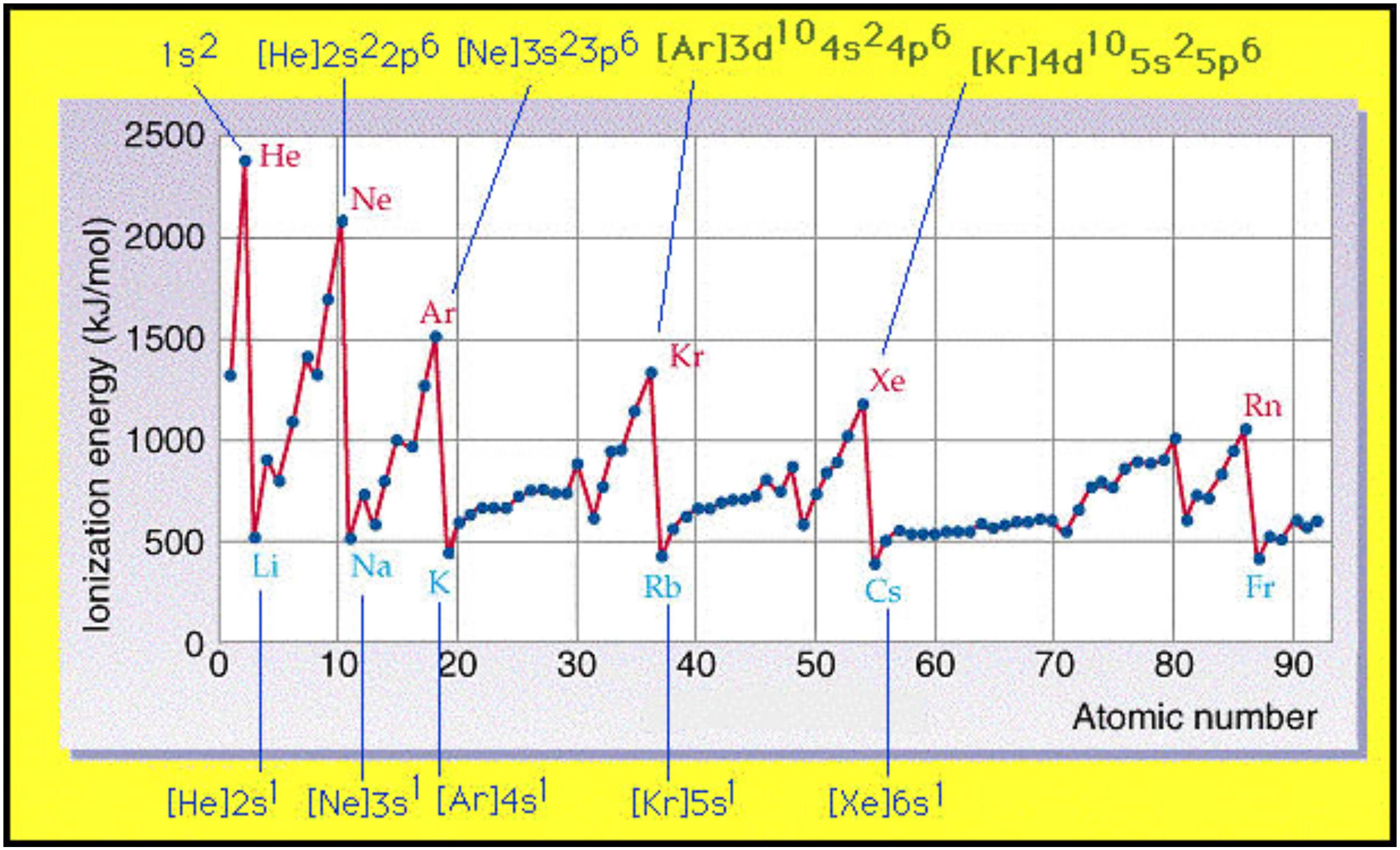
Table 1.4 Protosolar Abundances of the Elements with $Z \leq 32$ (based on Asplund et al. (2009); see text)

Z	X	$\langle m_X \rangle$/amu	$N_X/N_{\rm H}$	$M_X/M_{\rm H}$	Source
1	H	1.0080	1	1	
2	He	4.0026	$9.55 \times 10^{-2\pm0.01}$	3.82×10^{-1}	Photospheric
3	Li	6.941	$2.00 \times 10^{-9\pm0.05}$	1.38×10^{-8}	Meteoritic
4	Be	9.012	$2.19 \times 10^{-11\pm0.03}$	1.97×10^{-10}	Meteoritic
5	B	10.811	$6.76 \times 10^{-10\pm0.04}$	7.31×10^{-9}	Meteoritic
6	C	12.011	$2.95 \times 10^{-4\pm0.05}$	3.54×10^{-3}	Photospheric
7	N	14.007	$7.41 \times 10^{-5\pm0.05}$	1.04×10^{-3}	Photospheric
8	O	15.999	$5.37 \times 10^{-4\pm0.05}$	8.59×10^{-3}	Photospheric
9	F	18.998	$2.88 \times 10^{-8\pm0.06}$	5.48×10^{-7}	Meteoritic
10	Ne	20.180	$9.33 \times 10^{-5\pm0.10}$	1.88×10^{-3}	Photospheric
11	Na	22.990	$2.04 \times 10^{-6\pm0.02}$	4.69×10^{-5}	Meteoritic
12	Mg	24.305	$4.37 \times 10^{-5\pm0.04}$	1.06×10^{-3}	Photospheric
13	Al	26.982	$2.95 \times 10^{-6\pm0.01}$	8.85×10^{-5}	Meteoritic
14	Si	28.086	$3.55 \times 10^{-5\pm0.04}$	9.07×10^{-4}	Photospheric
15	P	30.974	$3.23 \times 10^{-7\pm0.03}$	1.00×10^{-5}	Photospheric
16	S	32.065	$1.45 \times 10^{-5\pm0.03}$	4.63×10^{-4}	Photospheric
17	Cl	35.453	$1.86 \times 10^{-7\pm0.06}$	6.60×10^{-6}	Meteoritic
18	Ar	39.948	$2.75 \times 10^{-6\pm0.13}$	1.10×10^{-4}	Photospheric
19	K	39.098	$1.32 \times 10^{-7\pm0.02}$	5.15×10^{-6}	Meteoritic
20	Ca	40.078	$2.14 \times 10^{-6\pm0.02}$	8.57×10^{-5}	Meteoritic
21	Sc	44.956	$1.23 \times 10^{-9\pm0.02}$	5.53×10^{-8}	Meteoritic
22	Ti	47.867	$8.91 \times 10^{-8\pm0.03}$	4.27×10^{-6}	Meteoritic
23	V	50.942	$1.00 \times 10^{-8\pm0.02}$	5.09×10^{-7}	Meteoritic
24	Cr	51.996	$4.79 \times 10^{-7\pm0.01}$	2.49×10^{-5}	Meteoritic
25	Mn	54.938	$3.31 \times 10^{-7\pm0.01}$	1.82×10^{-5}	Meteoritic
26	Fe	55.845	$3.47 \times 10^{-5\pm0.04}$	1.94×10^{-3}	Photospheric
27	Co	58.933	$8.13 \times 10^{-8\pm0.01}$	4.79×10^{-6}	Meteoritic
28	Ni	58.693	$1.74 \times 10^{-6\pm0.01}$	1.02×10^{-4}	Meteoritic
29	Cu	63.546	$1.95 \times 10^{-8\pm0.04}$	1.24×10^{-6}	Meteoritic
30	Zn	65.38	$4.68 \times 10^{-8\pm0.04}$	3.06×10^{-6}	Meteoritic
31	Ga	69.723	$1.32 \times 10^{-9\pm0.02}$	9.19×10^{-8}	Meteoritic
32	Ge	72.64	$4.17 \times 10^{-9\pm0.04}$	3.03×10^{-7}	Meteoritic

Asplund et al. (2009) have corrected the measured photospheric abundances of He, C, N, O, Ne, Mg, Si, S, Ar, and Fe to allow for diffusion in the Sun.

As recommended by Asplund et al. (2009), the photospheric abundance of Si, and meteoritic abundances (tied to Si), have been increased by a factor $10^{0.04}$ to allow for diffusion in the Sun. Similarly, the measured photospheric abundance of P has been multiplied by $10^{0.04}$ to allow for diffusion in the Sun.

$M(Z > 2)/M_{\rm H} = 0.0199$; $M({\rm total})/M_{\rm H} = 1.402$.



1s2
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[Ne]3s23p6
[Ar]3d104s24p6
[Kr]4d105s25p6
He
Ne
Ar
Kr
Xe
Rn
Li
Na
K
Rb
Cs
Fr
Ionization energy (kJ/mol)
0
500
1000
1500
2000
2500
0
10
20
30
40
50
60
70
80
90
Atomic number
[He]2s1
[Ne]3s1
[Ar]4s1
[Kr]5s1
[Xe]6s1

IONIZATION POTENTIALS[a]

Z	Element	Spectrum																				
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI
1	H	13.598																				
2	He	24.587	54.416																			
3	Li	5.392	75.638	122.451																		
4	Be	9.322	18.211	153.893	217.713																	
5	B	8.298	25.154	37.930	259.368	340.217																
6	C	11.260	24.383	47.887	64.492	392.077	489.981															
7	N	14.534	29.601	47.448	77.472	97.888	552.057	667.029														
8	O	13.618	35.116	54.934	77.412	113.896	138.116	739.315	871.387													
9	F	17.422	34.970	62.707	87.138	114.240	157.161	185.182	953.886	1103.089												
10	Ne	21.564	40.962	63.45	97.11	126.21	157.93	207.27	239.09	1195.797	1362.164											
11	Na	5.139	47.286	71.64	98.91	138.39	172.15	208.47	264.18	299.87	1465.091	1648.659										
12	Mg	7.646	15.035	80.143	109.24	141.26	186.50	224.94	265.90	327.95	367.53	1761.802	1962.613									
13	Al	5.986	18.828	28.447	119.99	153.71	190.47	241.43	284.59	330.21	398.57	442.07	2085.983	2304.080								
14	Si	8.151	16.345	33.492	45.141	166.77	205.05	246.52	303.17	351.10	401.43	476.06	523.50	2437.676	2673.108							
15	P	10.486	19.725	30.18	51.37	65.023	230.43	263.22	309.41	371.73	424.50	479.57	560.41	611.85	2816.943	3069.762						
16	S	10.360	23.33	34.83	47.30	72.68	88.049	280.93	328.23	379.10	447.09	504.78	564.65	651.63	707.14	3223.836	3494.099					
17	Cl	12.967	23.81	39.61	53.46	67.8	98.03	114.193	348.28	400.05	455.62	529.26	591.97	656.69	749.74	809.39	3658.425	3946.193				
18	Ar	15.759	27.629	40.74	59.81	75.02	91.007	124.319	143.456	422.44	478.68	538.95	618.24	686.09	755.73	854.75	918	4120.778	4426.114			
19	K	4.341	31.625	45.72	60.91	82.66	100.0	117.56	154.86	175.814	503.44	564.13	629.09	714.02	787.13	861.77	968	1034	4610.955	4933.931		
20	Ca	6.113	11.871	50.908	67.10	84.41	108.78	127.7	147.24	188.54	211.270	591.25	656.39	726.03	816.61	895.12	974	1087	1157	5129.045	5469.738	
21	Sc	6.54	12.80	24.76	73.47	91.66	111.1	138.0	158.7	180.02	225.32	249.832	685.89	755.47	829.79	926.00						
22	Ti	6.82	13.58	27.491	43.266	99.22	119.36	140.8	168.5	193.2	215.91	265.23	291.497	787.33	861.33	940.36						
23	V	6.74	14.65	29.310	46.707	65.23	128.12	150.17	173.7	205.8	230.5	255.04	308.25	336.267	895.58	974.02						
24	Cr	6.766	16.50	30.96	49.1	69.3	90.56	161.1	184.7	209.3	244.4	270.8	298.0	355	384.30	1010.64						
25	Mn	7.435	15.640	33.667	51.2	72.4	95	119.27	196.46	221.8	248.3	286.0	314.4	343.6	404	435.3	1136.2					
26	Fe	7.870	16.18	30.651	54.8	75.0	99	125	151.06	235.04	262.1	290.4	330.8	361.0	392.2	457	489.5	1266.1				
27	Co	7.86	17.06	33.50	51.3	79.5	102	129	157	186.13	276	305	336	379	411	444	512	546.8	1403.0			
28	Ni	7.635	18.168	35.17	54.9	75.5	108	133	162	193	224.5	321.2	352	384	430	464	499	571	607.2	1547		
29	Cu	7.726	20.292	36.83	55.2	79.9	103	139	166	199	232	266	368.8	401	435	484	520	557	633	671	1698	
30	Zn	9.394	17.964	39.722	59.4	82.6	108	134	174	203	238	274	310.8	419.7	454	490	542	579	619	698	738	1856
31	Ga	5.999	20.51	30.71	64																	
32	Ge	7.899	15.934	34.22	45.71	93.5																
33	As	9.81	18.633	28.351	50.13	62.63	127.6															
34	Se	9.752	21.19	30.820	42.944	68.3	81.70	155.4														
35	Br	11.814	21.8	36	47.3	59.7	88.6	103.0	192.8													
36	Kr	13.999	24.359	36.95	52.5	64.7	78.5	111.0	126	230.39												
37	Rb	4.177	27.28	40	52.6	71.0	84.4	99.2	136	150	277.1											
38	Sr	5.695	11.030	43.6	57	71.6	90.8	106	122.3	162	177	324.1										
39	Y	6.38	12.24	20.52	61.8	77.0	93.0	116	129	146.52	191	206	374.0									
40	Zr	6.84	13.13	22.99	34.34	81.5																
41	Nb	6.88	14.32	25.04	38.3	50.55	102.6	125														
42	Mo	7.099	16.15	27.16	46.4	61.2	68	126.8	153													
43	Te	7.28	15.26	29.54																		
44	Ru	7.37	16.76	28.47																		
45	Rh	7.46	18.08	31.06																		
46	Pd	8.34	19.43	32.93																		
47	Ag	7.576	21.49	34.83																		