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aggregate is merely a reflection of the state of the majority of its constituents. Recognition of this fact some forty years ago, in the early stages of the investigation that led to the results now being reported, was a major step in the clarification of physical fundamentals that ultimately opened the door to the formulation of a general physical theory.

The liquid state has long been an enigma to conventional physics. As expressed by V. F. Weisskopf, "A liquid is a highly complex phenomenon in which the molecules stay together yet move along each other. It is by non means obvious why such a strange object should exist."[11] Weisskopf goes on to speculate as to what the outcome would be if physicists knew the fundamental principles on which atomic structure is based, as present-day theory sees them, but "had never had occasion to see structures in nature." He doubts if these theorists would ever be able to predict the existence of liquids.

In the Reciprocal System of theory, on the other hand, the liquid state is a necessity, an intermediate condition that must necessarily exist between the solid and gaseous states. When the thermal motion of a molecule reaches equality with the inward progression of the natural reference system in one dimension of the region outside unit distance, the cohesive force in that dimension is eliminated. The molecule is then free to move in that dimension, while it is held in a fixed position, or a fixed average position, in the other dimensions by the cohesive forces that are still operative. The temperature at which the freedom in one dimension is reached is the melting point of the aggregate, because any additional thermal energy supplied to the aggregate is absorbed in changing the state of additional molecules until the remaining content of solid molecules reaches the percentage that can be accommodated within the liquid aggregate.

These remaining solid molecules are gradually converted to the liquid state in a temperature range above the melting point. Thus the liquid aggregate in this range contains a percentage of solid molecules, while the solid aggregate in a similar temperature range below the melting point contains a percentage of liquid molecules. The presence of these "foreign" molecules has a significant effect on the physical properties of matter in both of these temperature ranges, an effect which, as we will see in the subsequent discussion of the liquid state, can be evaluated accurately by using probability relations to determine the exact proportions in which molecules of the two states exist at each temperature.

While the end point of the solid state is the temperature at which the intermolecular reach an equilibrium at the unit level, arrival at this end point does not mean automatic entry into the liquid state. It merely means that the cohesive forces of the solid are no longer operative in all three dimensions, and therefore do not *prevent* the free movement in one dimension of space that is the distinguishing characteristic of the liquid state. The significant point here is that a liquid *molecule* is limited to certain specific temperatures. A liquid *aggregate* can take any temperature within the liquid range, but only because the aggregate temperature is an average of a large number of the restricted individual values.

This same restriction to one of a limited set of values also applies to the temperature of the solid molecule, but in the vicinity of the melting point the solid is

at a high time region temperature level, where the proportionate change from one possible value, n units, to the next, n + 1 units, is small. The motion of the liquid state, on the other hand, is in the region outside unit space, and is equivalent to gas motion in the one dimension in which the thermal energy exceeds the solid state limit. As we saw in Chapter 5, temperatures in the vicinity of the melting point are very low on the scale applicable to this outside region, and the proportionate change from n to n + 1 is large. The intervals between the possible temperatures of liquid molecules are therefore large enough to be significant.

Because of the limitation of the liquid temperatures to specific values, the temperature at which a molecule qualifies as a liquid is not the end point temperature of the solid state, but a higher value that includes the increment necessary to bring the end point temperature up to the next available liquid level. This makes it impossible to calculate melting points from solid state theory alone. Such calculations will have to wait until the relevant liquid theory is developed in a subsequent volume in this series, or elsewhere. But the temperature increment beyond the solid end point is small compared to the end point temperature itself, and the end point is not much below the melting point. A few comparisons of end point and melting point temperatures will therefore serve to confirm, in a general way, the theoretical deductions as to the relation between these two magnitudes.

There is a considerable degree of uncertainty in the experimental results at the high temperatures reached by the melting points of many of the elements, and there are also some theoretical aspects of the thermal situation in the vicinity of the melting point that have not yet been fully explored. The examples for discussion in this initial approach to the subject have been selected from among those in which these uncertain elements are at a minimum. First, let us look at element number 19, potassium. This element has a specific heat curve of the type identified by the notation n = 3 in Fig.4. Its thermal factors are 2-1-1, and it maintains the same factors throughout the entire solid range. As indicated in Chapter 5, the end point temperature of this type of curve is 9.32 times the temperature of the first transition point. This leads to an end point temperature of 336° K. The measured melting point is 337° K. In this case, then, the solid end point and the melting point happen to coincide within the limits of accuracy of the investigation.

Chlorine, an element only two steps lower in the atomic series than potassium, but a member of the next lower group, has the lower type of specific heat curve, with n = 2. The end point temperature of this curve is 4.56 on the relative scale where the first transition point is unity. The thermal factors that determine the transition point, and are applicable to the first segment of the curve, are 4-2-1, but if these factors are applied to the end point they lead to an impossibly high temperature. It is thus apparent that the factors applicable to the second segment of the curve are lower than those applicable to the first segment, in line with the previously noted tendency toward a decrease in the thermal factors with increasing temperature. The indicated factors applicable to the end point in this case are the same 2-1-1 combination that we found in potassium. They correspond to an end point temperature of 164° K, just below the melting point at 170° K, as the theory requires.

Next we look at two curves of the n = 4 type, the end point of which is at a relative temperature of 17.87. On the basis of thermal factors 4-6-1, the absolute temperature of the end point is 1765° K, which is consistent with the melting points of both cobalt (1768) and iron (1808). Here, too, the indicated factors at the end point are lower than those applicable to the first segment of the specific heat curve, but in this case there is independent evidence of the decrease. Cobalt, which has the factors 4-8-2 in the first segment is already down to 4-6-1 at the second transition point, while iron, the initial factors of which are also 4-8-2, has reached 4-6-2 at this point, with two more segments of the curve in which to make the additional reduction.

Compounds of elements about group 1B, or having a significant content of such elements, follow one or another of the Type 1 patterns that have been illustrated by examples from the elements. The hydrocarbons and other compounds of the lower group elements have specific heat curves of type 2 (Fig.3) in which the end point is at a relative temperature of 1.80. As an example of this class we can take ethylene. the thermal factors of these lower group compounds are limited to 1-1-1, 2-1-1, and the combination value $1^1/2$-1-1. As we found in Volume I, however, the two groups of atoms of which ethylene and similar compounds are composed are inside one time region unit of distance. They therefore act jointly in thermal interchange rather than acting independently in the manner of two inorganic radicals, such as those in NH_4NO_3. Each group contributes to the thermal factors of the molecule, and the value applicable to the molecule as a whole is the sum of the two components. Ethylene uses the 1-1-1 and $1^1/2$-1-1 combinations. A difference of this kind between the two halves of an organic molecule is quite common, and no doubt reflects the lack of symmetry between the positive and negative components that was the subject of comment in the discussion of organic structure. The combined factors amount to a total of $6^1/2$ units. This corresponds to a transition point at 58° K, which agrees with the empirical curve, and an end point at 104° K, coincident with the observed melting point.

The joint action of the two ends of an organic molecule that combines their thermal factors in the temperature determination is maintained when additional structural units are introduced between the end groups. As brought out in Chapter 6, such an extension of the organic type of structure into chains or rings also results in the activation of additional thermal motions of an independent nature within the molecules. The general nature of this internal motion was explained in the previous discussion. The same considerations apply to the transition point temperature, except that the internal motion is independent of the molecular motion in vectorial direction as well as in scalar direction. It is therefore distributed three–dimensionally, and the fraction in the direction of the molecular motion is 1/8 rather than 1/2. Each unit of internal motion thus adds 1/8 of 8.98 degrees, or 1.12 degrees K to the transition point temperature. With the benefit of this information we are now able to compute the temperatures corresponding to the specific heats of the paraffin hydrocarbons of Table 21. These values are shown in Table 23

composition was as foreign to them as the concept of a rotating unit of space is to most individuals today. But the discovery that kinetic energy is only one form of energy in general opened the door to a major advance in physical understanding. Similarly, the finding that the "space" of our ordinary experience, extension space, as we are calling it in this work, is merely one manifestation of space in general opens the door to an understanding of many aspects of the physical universe, including the phenomena connected with the movement of electrons in matter.

In the universe of motion, the universe whose details we are developing in this work, and whose identity with the observed physical universe we are demonstrating as we go along, space enters into physical phenomena only as a component of motion, and the specific nature of that space is, for most purposes, irrelevant, just as the particular kind of energy that enters into a physical process usually has no relevance to the outcome of the process. The status of the electron as a rotating unit of space therefore gives it a very special role in the physical activity of the universe. It should be noted at this time that the electron that we are now discussing carries no charge. It is a combination of two motions, a basic vibration and a rotation of the vibrating unit. As we will see later, an electric charge is an additional motion that *may* be superimposed on this two-component combination. The behavior of charged electrons will be considered after some further groundwork has been laid. For the present we are concerned only with the uncharged electrons.

As a unit of space, the uncharged electron cannot move through extension space, since the relation of space to space does not constitute motion. But under appropriate conditions it can move through ordinary matter, inasmuch as this matter is a combination of motions with a net positive, or time, displacement, and the relation of space to time does constitute motion. The present-day view of the motion of electrons in solid matter is that they move through the spaces between the atoms. The resistance to the electron flow is then considered to be analogous to friction. Our finding is that the electrons (units of space) exist *in* the matter, and move *through* that matter in the same manner as the movement of matter through extension space.

The motion of the electrons is negative with respect to the net motion of material objects. This is illustrated in the following diagram:

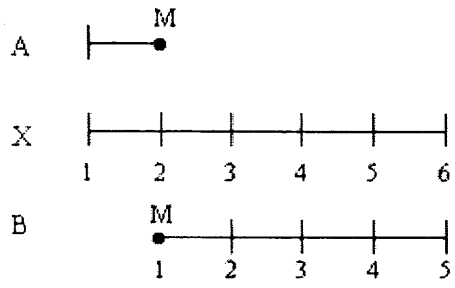

Table 35: *Atomic Mass Equilibrium Values*

Z	m_v	m	Obs	Diff.	Z	m_v	m	Obs.	Diff.
1	.01	2	1	-1	47	14.12	108	108	0
2	.03	4	4	0	48	14.73	111	112.5	+1,5
3	.06	6	7	+1	49	15.35	113	115	+2
4	.10	8	9	+1	50	15.98	116	119	+3
5	.16	10	11	+1	51	16.63	119	122	+3
6	.23	12	12	0	52	17.28	121	128	+7
7	.31	14	14	0	53	17.96	124	127	+3
8	.41	16	16	0	54	18.64	127	131	+4
9	.52	19	19	0	55	19.34	129	133	+4
10	.64	21	20	-1	56	20.05	132	137	+5
11	.77	23	23	0	57	20.77	135	139	+4
12	.92	25	24	-1	58	21.50	138	140	+2
13	1.08	27	27	0	59	22.25	140	141	+1
14	1.25	29	28	-1	60	23.01	143	144	+1
15	1.44	31	31	0	61	23.78	146	145	-1
16	1.64	34	32	-2	62	24.57	149	150	+1
17	1.85	36	35.5	-0.5	63	25.37	151	152	+1
18	2.07	38	40	+2	64	26.18	154	157	+3
19	2.31	40	39	-1	65	27.01	157	159	+2
20	2.56	43	40	-3	66	27.84	160	162.5	+2.5
21	2.82	45	45	0	67	28.69	163	165	+2
22	3.09	47	48	+1	68	29.56	166	167	+1
23	3.38	49	51	+2	69	30.43	168	169	+1
24	3.68	52	52	0	70	31.32	171	173	+2
25	4.00	54	55	+1	71	32.22	174	175	+1
26	4.32	56	56	0	72	33.14	177	178.5	+1.5
27	4.66	59	59	0	73	34.06	180	181	+1
28	5.01	61	59	-2	74	35.00	183	184	+1
29	5.38	63	63.5	+0.5	75	35.96	186	186	0
30	5.75	66	65	-1	76	36.92	189	190	+1
31	6,14	68	70	+2	77	37.90	192	192	0
32	6.55	71	73	+2	78	38.89	195	195	0
33	6.96	73	75	+2	79	39.89	198	197	-1
34	7,39	75	79	+4	80	40.91	201	200.5	-0.5
35	7.83	78	80	+2	81	41.94	204	204	0
36	8.28	80	84	+4	82	42.98	207	207	0
37	8.75	83	85.5	+2.5	83	44.03	210	209	-1
38	9.23	85	88	+3	84	45.10	213	209	-4
39	9.72	88	89	+1	85	46.18	216	210	-6
40	10.23	90	91	+1	86	47.28	219	222	+3
41	10.74	93	93	0	87	48.38	222	223	+1
42	11.28	95	95.5	+0.5	88	49.50	226	226	0
43	11.82	98	98	0	89	50.63	229	227	-2
44	12.37	100	101	+1	90	51.78	232	232	0
45	12.94	103	103	0	91	52.93	235	231	-4
46	13.53	106	106.5	+0.5	92	54.10	238	238	0