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Melting Curves of Deuterium and Hydrogen

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THERE has recently been considerable theoretical interest in the general behavior of the melting curve of simple substances.[1] Earlier experimental work[2] on the melting curves of hydrogen and deuterium had shown that up to one hundred kg/cm² (the highest pressure to which the measurements on deuterium had then been carried) the melting curves of these isotopes were very accurately parallel, i.e., a displacement of the deuterium melting curve in the direction of the positive pressure axis by about 171 kg/cm² would superpose it on that of hydrogen. It appeared, therefore, of importance to establish whether this phenomenon persisted over a wide pressure range.

For this purpose the melting curve of deuterium was determined up to a pressure of about 2800 kg/cm² and that of hydrogen was redetermined (in order to obtain a more accurate comparison) over the same pressure range. The method used was that of the blocked capillary.[3] The pressure was determined by means of Bourdon gauges calibrated before and after the experiments against a free piston gauge and the temperature by means of a platinum resistance thermometer. The limits of experimental error were, for the pressure measurements ±7 kg/cm² and for the temperature ±0.01°K. The results are shown in Fig. 1 while Table I gives the pressure separation of the two curves for various temperatures.

TABLE I. The pressure separation of the melting curves of hydrogen and deuterium.

Temperature °K	Pressure separation kg/cm²
Present experiments	
25.05	176
28.78	178
32.91	179
37.10	170
40.31	169
43.16	176
46.25	171
49.21	166
51.74	161
54.23	160
56.98	168
Mean pressure separation = 170 kg/cm²	
rms deviation = 6 kg/cm²	
Earlier experiments[a]	
19.00	169.7
20.00	171.1
21.00	172.3

[a] See reference 2.

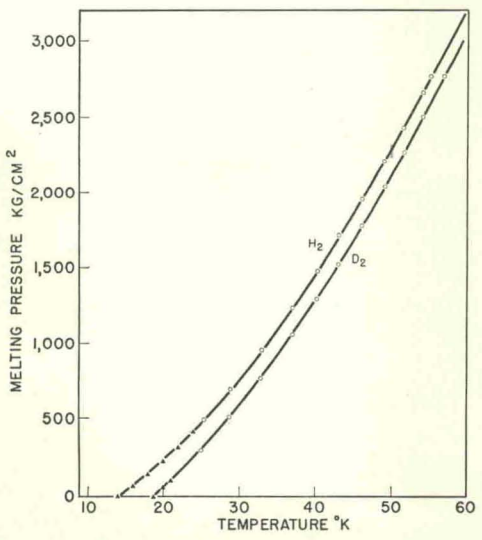

FIG. 1. The melting curves of hydrogen and deuterium. ○ Present measurements. ▲ Previous low-pressure measurements. (See reference 2.)

It is seen that within the experimental error the two curves remain parallel over a pressure range some 27 times greater than that covered in the earlier experiments on deuterium. The striking behavior of the melting curve of these isotopes may be expected to throw light both on the influence of zero-point energy on the melting process and on the nature of this process itself.

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[1] E. g., J. de Boer, Proc. Roy. Soc. (London) **215**, 4 (1952); C. Domb, Phil. Mag. **42**, 131 (1951); L. Salter, Phil. Mag. **45**, 369 (1954); F. E. Simon, *The L. Farkas Memorial Volume* (Research Council of Israel, Jerusalem, 1952), p. 37.

[2] For complete references and data see Woolley, Scott, and Brickwedde, J. Research, Natl. Bur. Standards **41**, 379 (1948).

[3] H. Kamerlingh Onnes and W. van Gulik, Proc. Acad. Sci. Amsterdam **28**, 1184 (1926).

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