Bureau
International des
Poids et
Mesures

The Provisional Low Temperature Scale from 0.9 mK to 1 K, PLTS-2000

1 édition 2019

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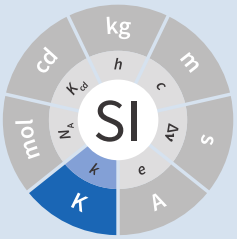

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1. The scale

The scale is defined by the following equation relating the melting pressure p of ^{3}He to temperature T_{2000}:

$$p/\,\mathrm{MPa} = \sum_{i=-3}^{+9} a_I (T_{2000}/\,\mathrm{K})^i$$

$$a_{-3} = -1.3855442 \cdot 10^{-12}$$

$$a_{-2} = 4.5557026 \cdot 10^{-9}$$

$$a_{-1} = -6.4430869 \cdot 10^{-6}$$

$$a_0 = 3.4467434 \cdot 10^{0}$$

$$a_1 = -4.4176438 \cdot 10^{0}$$

$$a_2 = 1.5417437 \cdot 10^{1}$$

$$a_3 = -3.5789853 \cdot 10^{1}$$

$$a_4 = 7.1499125 \cdot 10^{1}$$

$$a_5 = -1.0414379 \cdot 10^{2}$$

$$a_6 = 1.0518538 \cdot 10^{2}$$

$$a_7 = -6.9443767 \cdot 10^{1}$$

$$a_8 = 2.6833087 \cdot 10^{1}$$

$$a_9 = -4.5875709 \cdot 10^{0}$$

2. Background to the PLTS-2000

The melting pressure of ^{3}He was chosen as the property on which the extension of the ITS-90 should be based because of the sensitivity and reliability with which it may be measured over a wide range (covering more than three decades of temperature) apart from a narrow region around the pressure minimum at 315.24 mK (see Figure 1, see p. 5). The pressure minimum itself has the compensating advantage of providing a convenient pressure fixed point for calibrating the pressure transducer (the pressure must be measured using a transducer *in situ* because for temperatures below the minimum a sensing line will be blocked with solid ^{3}He and the cell is therefore isolated).

The pressure minimum is one of four natural features which may be located and used as fixed points of pressure and temperature, the others being the transition to the superfluid 'A' phase, the 'A to B' transition in the superfluid and the Néel transition in the solid. The pressure and temperature values of these four points on the PLTS-2000 are:

Point	p/ MPa	T_{2000}/ mK
minimum	2.931 13	315.24
A	3.434 07	2.444
A-B	3.436 09	1.896
Néel	3.439 34	0.902

The standard uncertainty of the scale in thermodynamic terms is estimated to be 0.5 mK down to 500 mK, decreasing linearly to 0.2 mK at 100 mK. It decreases further with falling temperature, but in percentage terms it increases to about 0.3% of T at 25 mK and 2% of T at 0.9 mK. The standard uncertainties in the absolute pressures are estimated to be about 60 Pa (in about 3 MPa).

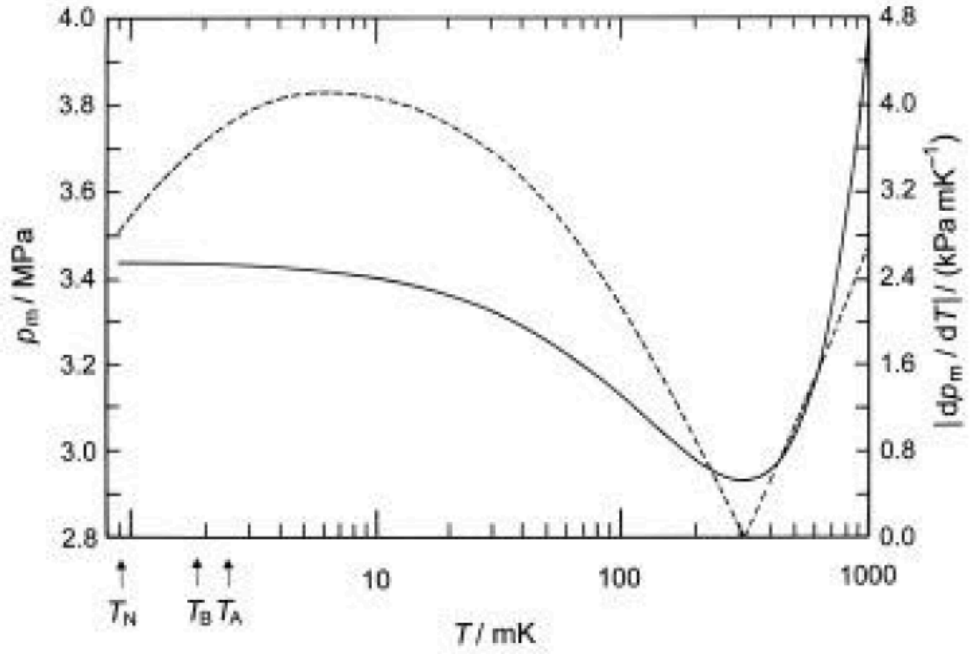

Figure 1 — The ^{3}He melting pressure p (full line) and the absolute value of the derivative $\mathrm{d}p/\mathrm{d}T$ (dashed line) *vs.* temperature. T_N, T_B and T_A indicate the temperatures of three phase transitions in solid or liquid ^{3}He.