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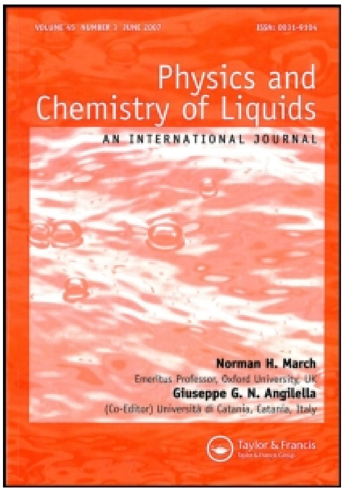

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A comment on "liquid metal transport properties"

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A Comment on "Liquid Metal Transport Properties"

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In a recent paper, Pasternak has proposed a useful correlation of the self-diffusion coefficients of liquid metals.[1] The comment we make here neither questions nor compromises the validity of this correlation. The basis for this correlation is the principle of corresponding states which was first employed for liquid metals by Chapman[2,3] and later by Pasternak.[4] Reduced values of the transport coefficients can be defined in terms of ϵ and σ, the energy and distance parameters, where the intermolecular potential is of the form[5]

$$u = \epsilon u^* (\gamma/\sigma) \tag{1}$$

Values of ϵ and σ are usually obtained from second virial or transport coefficient measurements in the dilute gas phase.[6] Such a source is not feasible for the liquid metals, and an alternative scheme was proposed by Chapman[2] and used by him[3] and Pasternak.[1,4]

When plotted against the log of reciprocal temperature, the reduced transport coefficients of liquid metals were shown to form families of approximately parallel curves.[1,2] By choosing appropriate values of ϵ for the liquid metals, all data can be reduced to a single curve of the reduced transport coefficient as a function of reduced temperature, $T^* = kT/\epsilon$. All values of ϵ/k were reported relative to a value of ϵ/k for sodium obtained from the analysis of X-ray diffraction data by Ling.[7] Subsequently a linear relationship between the melting point and the ϵ/k value of the liquid metals was proposed:[1,2]

$$\epsilon/k = 5{\cdot}2\ T_m \tag{2}$$

More recent neutron diffraction data for sodium and potassium[8] differ considerably from the results of Ling.[7] A careful analysis in terms of both the Born-Green and Percus-Yevick theories of these recent data and other scattering data[9] suggest that these offer a better basis for a relative estimate of ϵ/k for liquid metals. The various estimates of ϵ/k for the liquid metals are compared in Table 1. The most obvious observation that can be made is that the well depths estimated by Chapman[2] and Pasternak[1] relative to the values of ϵ/k found by Ling[7] for sodium and potassium are a factor of 2-5 larger than those obtained by Johnson *et al.*[9] In general, reasonable agreement with the well depths from the Born-Green and Percus-Yevick analysis is observed, with cesium and mercury showing the largest differences.[9] The Percus-Yevick well depth is lower in all cases than the corresponding Born-Green result, and the values of the well depth estimated for liquid argon as a check on the analyses[9] bracket the accepted value for the Lennard-Jones parameter.[6]

In Figure 1, a plot of ϵ/k against the melting point is made for the metals listed in Table 1. Values of ϵ/k for the noble liquids from Reference 6 are also plotted. It can be seen that a linear correlation of well depth and melting point is only moderately succesful. We have used a relation

$$\epsilon/k = 1{\cdot}32\ T_m$$

to obtain an estimate of the well depth for several metals to interpret shock data,[10,11] and like Chapman[2] and Pasternak,[1] have found such a relationship adequate in the absence of a better estimate of ϵ/k.

TABLE 1

Potential well depths for liquid metals ϵ/k °K

Metal	Johnson *et al*[9]		Chapman[2]	Pasternak[1]
	BG	PY		
Na	582	442	1970	1970
K	578	360	1760	
Li	454	450	2350	2380
Rb	424	361	1600	
Cs	694	230	1550	
Hg	649[a]	192	1250	1200
Al	879	735	4250	
Pb	1180	879	2800	2750
Ar	150	109		

[a] Compare with a value of ϵ/k = 851° K from low density vapor visosity data[6].

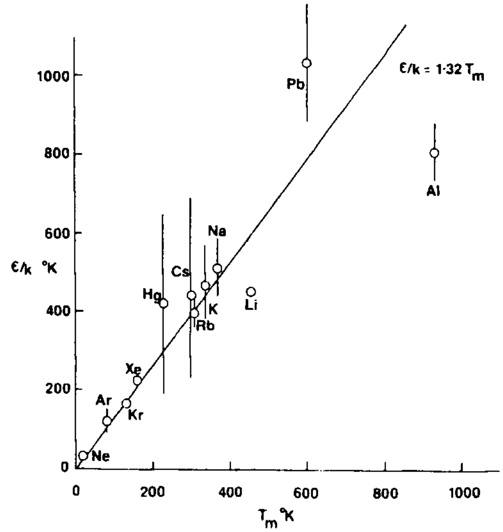

FIGURE 1 The correlation of potential well depths and melting points for several liquid metals and the noble liquids.

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