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# Anomalous magnetic field dependence of the nuclear spin–lattice relaxation in liquid lithium–silicium alloys

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Received 10 November 1994, in final form 31 August 1995

**Abstract.** Accurate measurements of the nuclear spin–lattice relaxation rate ( $1/T_1$ ) of  $^8\text{Li}$  nuclei in liquid  $\text{Li}_x\text{Si}_{1-x}$  have been performed as a function of temperature ( $T$ ) and magnetic field ( $B$ ) for various compositions using the  $\beta$ -NMR method. The results show clearly that the magnetic field dependence of  $T_1$  follows a  $\sqrt{B}$  law around the  $x = 0.5$  composition. We interpret this as an indication for anomalous diffusion of electrons due to strong disorder. From the coefficient of the  $\sqrt{B}$  contribution to  $1/T_1$  we derive that the partial Li s density of states at the Fermi level is about 1/10 of the total density of states at the Fermi level. This is the first observation of such a magnetic field dependence of  $1/T_1$ .

## 1. Introduction

In this paper we present measurements of the magnetic field ( $B$ ) dependence of the nuclear spin–lattice relaxation (NSLR) of Li in liquid Li–Si alloys using the  $\beta$ -NMR method. Measurements of the NSLR of Li–Si for up to 43% Si in liquid Li–Si alloys have already been presented in [9, 18]. No magnetic field dependence was found in that concentration range. In the present paper additional measurements are presented of the NSLR at higher Si concentrations. A consistent interpretation of these data on liquid Li–Si and related alloy systems is attempted.

Before we present and discuss our experimental results we briefly describe physical properties of Li–Si and related systems, of importance for an understanding of the results reported below on the Li–Si system. These liquid Li–Si alloys belong to the interesting group of liquid lithium–group-14 ( $M = \text{Si, Ge, Sn, Pb}$ ) alloys. These alloys have been studied extensively [14, 15, 25, 13] in the last decade. In particular liquid Li–Pb alloys received much attention in the 1970s and 1980s; however, recently the focus has shifted to liquid Li–Si alloys.

These systems show anomalous properties around the octet (=20%  $M$ ) composition. These anomalous properties are qualitatively explained by assuming electron transfer from the lithium to the group-14 atoms: from 0 to 20%  $M$  the outer valence shell of the group-14 atoms is nearly fully occupied. For the octet composition the outer valence shell of  $M$  is just fully occupied, while this outer valence shell is only partially filled for larger fractions of  $M$ . This charge transfer causes an ionic-like order of the liquid alloy, Li preferentially coordinated by Si/Ge/Sn or Pb, and Si etc by Li, called heterocoordination.

This charge transfer explains, for instance, the sharp drop of the Li Knight shift,  $K_L$ , (see experimental Knight shifts: Li–Pb and Li–Sn [16], Li–Ge [17] and Li–Si [23]), and

NSLR rate,  $1/T_1$  (experimental NSLR rates: Li–Pb [8] and [10], Li–Sn [18] and Li–Ge [20]) on adding group 14 to Li. The Knight shift is proportional to the local density of states (DOS) at the Fermi level at the probe (Li) nucleus  $N_F(0)$ , and the NSLR rate is proportional to the average of the square of this quantity  $\langle N_F(0)^2 \rangle$ . This local DOS decreases due to transfer of charge away from the Li. A free-electron model for the Li band combined with a rather narrow fully occupied valence M band, positioned below the Fermi level, explains the observed decrease in  $K_{Li}$  well up to about 15% M. At 20% M the local Li DOS is about 30% of that of pure Li for all Li–group-14 alloys.

However, this simple charge transfer picture cannot explain some of the remaining anomalies observed in liquid Li–Ge and Li–Si alloys around the equiatomic composition. In these systems one finds—next to the above-mentioned deviations—strong deviations *also* from ideal behaviour near the *equiatomic* composition (50 at.% Si/Ge) or in alloys that are somewhat richer in Li.

The liquid Li–Si system behaves rather differently from the Li–Ge system: the resistivity of liquid Li–Si is nearly constant from about 20% to 50% Si and is in the strong-scattering regime. The  $^7\text{Li}$  Knight shift and NSLR rate show in the same composition range a small and continuous decrease. From the Knight shift we find that around 50% Si, the local DOS  $N_F(0) \approx 20\%$  of that of pure Li, and about 10% of the free-electron DOS calculated for LiSi. The temperature dependence does not show as pronounced peaks as are observed for Li–Ge alloys. Alloys with a higher Si concentration are at present inaccessible experimentally because of their high melting temperature.

From an analysis of structural and thermodynamic data on the solid and liquid state ([5], [4] and [6]) one concludes that the anomalous properties around the equiatomic composition are due to the formation of relatively stable Si networks or clusters. A three-dimensional network has been observed in the solid-state structure of LiGe and LiSi [2], while at more Li-rich compositions different clusters of Si are found at different compositions in such a way that the Fermi level is in a minimum of the DOS, thereby minimizing the total energy of the system. This point of view has recently been corroborated by *ab initio* electronic and atomic structure calculations on liquid Li–Si within the Car–Parrinello scheme by de Wijs *et al* [29]. They find very extended Si clusters, and a very low DOS at the Fermi level.

The formation of this local order in the Si sublattice is due to the same mechanism as the dimerization of a linear chain with a half-filled band; in other words it is a three-dimensional liquid-state analogue of the Peierls transition which is usually applied to one-dimensional crystalline systems. So in liquid alloy systems, like Li–Si, the Fermi level can be kept in a minimum of the DOS by adjusting the type of cluster(s). This is the liquid alloy analogue of the Zintl–Klemm–Bussmann [24] valence rule for solid-state compounds.

## 2. Experiment

The NSLR measurements were performed at the High Flux Reactor in Grenoble, using the in-beam  $\beta$ -NMR spectrometer S6. Polarized  $\beta$ -active  $^8\text{Li}$  ( $T_{1/2} = 0.8$  s) nuclei were produced in the Li–Si samples by capture of polarized thermal neutrons. The  $^8\text{Li}$  polarization was monitored via the asymmetry of the  $\beta$ -radiation with respect to the external magnetic field  $B$ . The NSLR time  $T_1$  of  $^8\text{Li}$  was measured by recording the transient asymmetry after neutron-activation pulses. For details on the  $\beta$ -NMR method we refer the reader to [1].

The samples were prepared in a high-purity helium-filled glove box (oxygen,  $\text{H}_2\text{O}$  and  $\text{N}_2$  content  $< 1$  ppm), using isotopically pure  $^7\text{Li}$  (99% from Oak Ridge) and Si (chemical purity 99.99%, bought from Koch & Light Inc.). Pure tantalum proved to be insoluble in liquid Li–Si alloys containing up to 50% Si at 800 °C, and was used as a container material

for these alloys. The alloys were made by melting the components together in a tungsten crucible at a temperature of approximately 800 °C and quenching the liquid on a copper plate. The polycrystalline solid obtained proved to be hard and brittle and could easily be crushed by pestle and mortar. A flat tantalum sample holder was filled with the powder obtained and placed in a stainless steel container. This container was closed vacuum tight by compressing a niobium foil (25  $\mu\text{m}$ ) between polished surfaces. More details of the sample preparation are given by van der Marel *et al* [21].

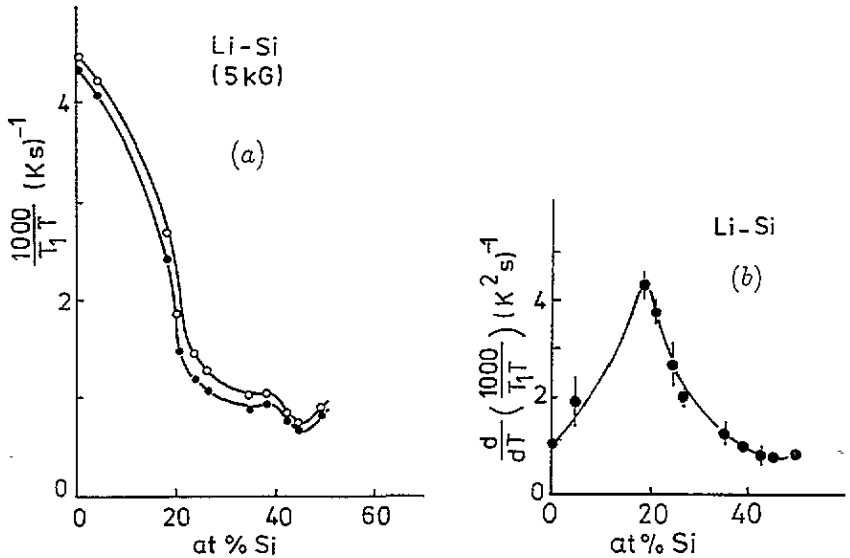


Figure 1. (a) The  $^8\text{Li}$  NSLR rate divided by the temperature,  $1000/T_1T$ , in liquid Li-Si alloys as a function of composition: Li-Si,  $\circ$ , 1100 K;  $\bullet$ , 1000 K at 0.5 kG; earlier reports are in [9] and [18]. (b) The temperature dependence of  $1/T_1T$  in liquid Li-Si alloys as a function of composition. Li-Si present results: at 0.5 kG. The lines are drawn to guide the eye.

We performed NSLR rate measurements as a function of the magnetic field ( $B$ ) from 0.5 to 6 kG for various compositions and temperatures. The NSLR rate of Li in a 0.5 kG field is presented in figure 1. It behaves qualitatively similarly to the Li Knight shift.

We found that in alloys with between 40 and 50% Si,  $T_1$  increases with increasing magnetic field. We fitted the magnetic field dependence of the NSLR rate of the Li-Si alloys with a linear law and a square-root law. The latter gives the best fit: for high magnetic fields especially there is a systematic deviation from linearity in the direction of a square-root law. Furthermore, the error in the square-root fit is always smaller than that of the linear fit by a factor of 50% to 100%. The results of these fits are shown in figure 2, where we plotted  $1000/T_1T$  versus  $\sqrt{B}$  for various compositions. The coefficient  $\gamma$  of the  $\sqrt{B}$  term ( $1000/TT_1 = 1000/TT_1|_0 + \gamma\sqrt{B}$ ) is plotted versus composition in figure 3. The coefficient  $\gamma$  peaks near the 47% Si composition and vanishes within experimental accuracy for compositions with 38% Si or less.

### 3. Theoretical discussion

In this section we try to give a consistent picture of the experimental data on liquid Li-Si alloys, and also in relation to the other liquid lithium-group-14 alloys and concentrate on the magnetic field dependence of the NSLR rate.

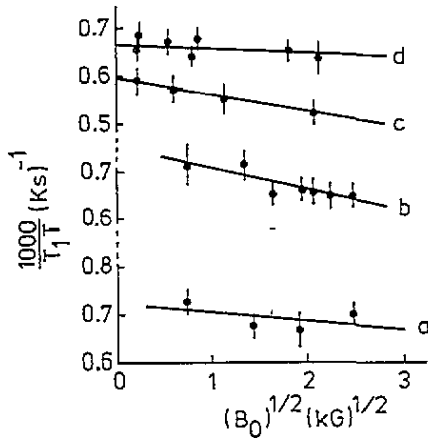


Figure 2. Some typical examples of the magnetic field ( $B$ ) dependence of the NSLR rate in liquid Li-Si alloys for (a) 42.5%Si (1013 K), (b) 44.9%Si (1076 K), (c) 47.5%Si (1004 K), and (d) 50.2%Si (1066 K) % Si. The solid lines are a fit to the data with  $1000/TT_1 = 1000/TT_1|_0 + \gamma\sqrt{B}$ . One finds  $\gamma = -0.020, -0.056, -0.035, -0.010$ .

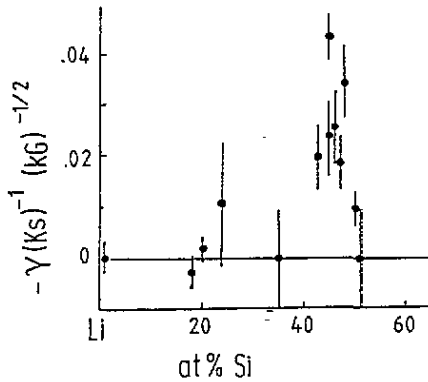


Figure 3. A plot of the coefficient  $\gamma$  of the magnetic field term  $\sqrt{B}$  (see figure 2) as a function of the composition of the NSLR rate of liquid Li-Si alloys.

A magnetic field dependence of the NSLR rate has been observed earlier in Ge:As by Tunstall and Deshmukh [27] and in Si:P by Kobayashi *et al* [11]. This magnetic field dependence has usually been interpreted in terms of exchange-coupled localized magnetic moments centred at the impurity (see, for example, [3]). Recently Shastry and Abrahams [26] have discussed the NSLR enhancement in dirty metals due the combined effect of ferromagnetic Stoner enhancement and disorder. According to these models the NSLR rate is inversely proportional to the magnetic field. So local moment formation on for example dissolved paramagnetic impurities cannot be the explanation for the observed behaviour in liquid Li-Si alloys.

A square-root dependence of the NSLR rate on the magnetic field is an indication for anomalous long-time behaviour of the electron diffusion. Dynamically the magnetic field dependence plays the same role as the frequency dependence. To our knowledge this is the first time that such a magnetic field dependence has been observed experimentally. Such a square-root magnetic field dependence has been predicted [7] and [12] for electrons in the strong-scattering regime. We adopt this model for the interpretation of our results.

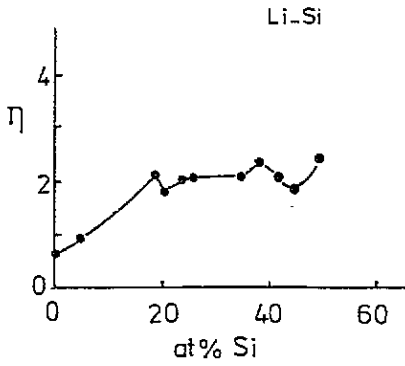


Figure 4. The Korringa enhancement factor,  $\eta$ , of liquid Li-group-14 alloys. Li-Si,  $\bullet$ , 1000 K at 0.5 kG; Knight shifts are taken from [23].

If the Knight shift and the NSLR rate are known, one can combine these two and calculate what is called the Korringa enhancement factor:

$$\eta = \frac{\langle K^2 \rangle}{K^2} = \frac{S_0}{K^2 T_1 T} \quad (1)$$

where  $T$  denotes the absolute temperature and  $S_0 = (\gamma_e/\gamma_n)^2(\hbar/4\pi k_B)$ , where  $\gamma_e$  and  $\gamma_n$  are the gyromagnetic ratios of the electron and the NSLR probe nucleus, respectively (for  ${}^8\text{Li}$ :  $S_0 = 1.2 \times 10^{-5}$  K s).  $T_1$  is proportional to the correlation time of the field fluctuations. For free electrons  $\eta = 1$ . This factor is presented in figure 4 for liquid Li-Si alloys. Data on the related systems liquid Li-Sn and Li-Ge alloys are in [18] and [20] respectively. This factor is nearly constant for compositions between 20% and 50% Si, unlike for the liquid alloy systems Li-Pb and Li-Sn, which only show a maximum at the 80% Pb/Sn composition, and for Li-Ge which shows two maxima.

The Korringa enhancement factor is a measure of the residence time of a Fermi electron at or around the probe nucleus, i.e. it is a measure of electron localization. In the electron hopping regime Warren [22] derived a linear relation between the resistivity and this enhancement factor:  $\eta = \sigma_0 \rho$ , where  $\sigma_0 = e^2 d^2 n_e / 3\hbar \approx 1500 - 3000 \Omega^{-1} \text{cm}^{-1}$ ;  $d$  is the electron hop distance and  $n_e$  is the electron density. Using the experimental value for  $\sigma$  of liquid Li-Si in the plateau region (between 50 and 80% Li) we find  $\eta = 2.4$  (experiment:  $\eta = 2.2$ )—so this seems consistent. Experimentally one does not find this linear relationship between the enhancement factor and the resistivity when one uses the temperature as an internal variable, but

$$\eta \propto \rho^n \quad (1 \leq n \leq 2) \quad (2)$$

(see [28], [10], [18]).

It is important to note that the Knight shift and NSLR rate are determined by the Fermi electron density at the probe nucleus, while the resistivity is determined by some weighted average of the scattering strength of the various potentials for Fermi electrons. For the latter property the details of the electronic structure of the core are irrelevant, while for the first two they are relevant. Later we will come back to this point, as it is an essential ingredient of our interpretation of the data. The consistency found above between the experimental conductivity and enhancement factor seems accidental. This is clear from the fact that very often one finds that this relation is not satisfied when  $\sigma$  and  $\eta$  are plotted with some internal variable like composition or temperature. Because  $\eta > 1$  and  $\rho > 300 \mu\Omega \text{cm}$  for liquid Li-Si alloys between 80% and 50% Li, we conclude that these alloys are in the strong-scattering regime.

It has already been known for a long time that one finds anomalous diffusion in strongly disordered systems. Götze and Ketterle [7] and Ketterle [12] derived an expression for the magnetic field dependence of the Korringa enhancement using the Mori-Zwanzig formalism. For small magnetic fields and in the strong-scattering limit, they find for the enhancement factor of a single-band system

$$\eta = \frac{\chi_s}{D_s} \frac{q^+}{\pi^3 N_F^2} \left[ 1 - \left( \frac{\pi^2 \mu_B}{4D_s (q^+)^2} B \right)^{1/2} \right] \quad (3)$$

where  $\mu_B$  is the Bohr magneton,  $D_s$  is the electron spin diffusivity,  $\chi_s$  is the electron spin susceptibility and  $q^+$  is an upper integration limit given by the cut-off of the static electron density correlations which is approximately  $2k_F$ . For noninteracting electrons one can use the following relations:  $\kappa = 4\chi_s$  is the electron compressibility and  $D = D_s$  is the electron diffusivity. Furthermore we use Einstein's relation  $\sigma = De^2\kappa$ . The free-electron DOS is  $N_{0F} = mk_F/2\pi^2\hbar^2$ . The electron compressibility  $\kappa$  is in the case of a noninteracting electron gas equal to the DOS at the Fermi level ( $\kappa = N_F$ ).

The Warren constant becomes in this model, using the noninteracting electron limit for the various quantities,  $\sigma_0 = e^2 k_F / (2\pi^3 \hbar)$ . This expression differs slightly from the equation derived in the electron hop model used by Warren [28]. We define  $\alpha$  as the coefficient of  $\sqrt{B}$  in expression (3) for the Korringa enhancement factor  $\eta$ :  $\eta = \eta_0 - \alpha\sqrt{B}$ . This coefficient is linearly related to the coefficient in figure 3:  $\alpha = -(S_0/1000K^2)\gamma$ . Note that this coefficient is independent of the cut-off  $q^+$ . This coefficient becomes large when the DOS at the Fermi level and/or the conductivity becomes small. One can derive, in a straightforward way, from this coefficient the total DOS at the Fermi level:

$$N_F = 64\pi^4 \left( \frac{\hbar\sigma}{e^2} \right)^3 \left( \frac{\alpha^2}{\mu_B} \right). \quad (4)$$

So when the conductivity and the coefficient  $\alpha$  are known one can calculate the DOS at the Fermi level.

In the diffusive motion regime, the conductivity is given by  $\sigma = e^2 g_M^2 / (3d\hbar)$ , where  $g_M = N_F/N_{0F}$  is the Mott factor;  $d$  is the average electron hop distance. Substituting this expression for the conductivity in (4) we find the following relation

$$g_M = \left[ \frac{27d^3 \mu_B N_{0F}}{64\pi^4 \alpha^2} \right]^{1/5}. \quad (5)$$

So in this regime the coefficient  $\alpha$  is directly related to the DOS at the Fermi level. The coefficient  $\alpha$  becomes large in the case of a small DOS on the probe nucleus w.r.t. the total DOS.

From experimental data (figure 3) on the magnetic field dependence of the NSLR rate we derive, using the relation  $\alpha = -(S_0/1000K^2)\gamma$ , that  $\alpha \approx 0.1 \text{ kG}^{-1/2}$  near the equiatomic composition. When we use the experimental conductivity of LiSi we find from (4) for the DOS at the Fermi level  $N_F \approx 0.016 \times 10^5 \text{ eV}^{-1} \text{ \AA}^{-3}$ . This is a factor  $10^5$  larger than the free-electron DOS expected assuming five conduction electrons per LiSi unit. This is a rather unphysical result.

In the case where we use the other formulation, equation (5), valid in the diffusive motion regime, and substitution of the appropriate values for  $\alpha = 0.1 \text{ kG}^{-1/2}$ ,  $N_{0F} = 0.013 \text{ eV}^{-1} \text{ \AA}^{-3}$  and  $d = 3 \text{ \AA}$ , we obtain  $g_M \approx 0.061$ .

From the resistivity of liquid Li-Si at the equiatomic composition we find a Mott factor  $g_M = 0.7$ . From the magnetic field dependence obtained using (5) we find near 50% Si a DOS which is about 1/10 of the total DOS at the Fermi level. We interpret this result now

as follows. The DOS calculated in equation (5) is the local DOS on the Li. The value we find for the Li DOS is a reasonable value near the Fermi level, and agrees with the results of the electronic structure calculation of de Wijs *et al* [29] on liquid  $\text{Li}_{12}\text{Si}_7$ .

One should take the local conductivity or diffusivity in equations (3) to (5). The nuclear Li spin relaxes on the electron spins near the Fermi level. The hyperfine interaction is a local interaction between the nucleus—in this case Li—and the electron density on this nucleus. The diffusion of the spins/electrons away from this nucleus is determined by the square of the *local* DOS averaged over all configurations, just as expressed in (1) in the numerator. One has to take the local DOS because this quantity is just the projection of the total DOS on the relaxing site.

On adding more Li to Li-Si, the Fermi level decreases and so comes nearer to the Li states. Then we expect that the Li DOS increases. Interpreting (5) as the expression for the local Li DOS it follows that in this case the value of the coefficient  $\alpha$  will decrease, i.e. the magnetic field dependence of  $1/T_1$  decreases when the corresponding local DOS increases. This is actually what is observed. Equation (4) is not in agreement with the experimental data, unless we interpret the conductivity in this expression as the local conductivity of the Li only.

#### 4. Discussion

We conclude that the observed magnetic field dependence of the NSLR rate gives strong indications for anomalous diffusion of electrons in liquid Li-Si alloys around the equiatomic composition. We derive this from the magnetic field dependence ( $\sqrt{B}$ ) of the NSLR rate ( $1/T_1$ ). The observed magnetic field dependence is largest in the composition range where we have clear indications for relative strong scattering, and a small local Li DOS relative to the total DOS. We derive from the coefficient of the  $\sqrt{B}$  term in the expression for the relaxation rate a local Li DOS of about 0.1 of the total DOS around the equiatomic composition of liquid Li-Si alloys. In the composition range 0 to 30% Si, the local Li DOS at the Fermi level is probably too large to give a significant coefficient of the  $\sqrt{B}$  term in the NSLR rate. This is the first time that such a magnetic field dependence has been observed in liquid alloys. Such a law for the magnetic field dependence of the enhancement factor has been predicted by Götze and Ketterle [7] to hold generally in the strong-scattering regime of disordered systems.

Let us compare the Knight shift, NSLR rate, conductivity and enhancement factor of the Li-Si alloy system. We note that the Li Knight shift and NSLR rate have approximately the same composition dependence: a fast decrease of these quantities when Si is added to pure Li, and for compositions larger than 20% Si a slow decrease. The conductivity and enhancement factor behave in nearly the same way; only for compositions larger than the octet composition do these quantities remain nearly constant. The temperature dependences of these quantities all show similar behaviour: a peak near the octet as well as at the equiatomic composition.

We can explain this as follows. Near the octet composition the liquid alloy has an ionic-like order. The valence band consists of Li *s* states, while the conduction band is mainly of Si character. These bands are partially overlapping, and the Fermi level is in a pseudogap. Changes in the ionic order as a function of temperature will change the depth of the pseudogap. The local Li DOS changes by approximately the same factor as the total DOS.

For equiatomic compositions the Si forms some type of threefold-coordinated disordered sublattice. Such order will for this composition also give rise to a minimum in the DOS



at the Fermi level. This is not due to ionic order but due to covalent chemical bonding. With increasing temperature this Si sublattice breaks down, thereby increasing the Si DOS at the Fermi level. The local Li DOS also changes with temperature but more slowly in the equiatomic case than in the octet case, probably because its value in the limit of complete disorder is much smaller than in the case of the octet composition.

In the octet case, complete disorder would cause a complete overlap of Li and Si bands, the relative energy of the Li and Si bands is very sensitive to this ionic order. There is not such a sensitivity of the Li DOS in the case of breakdown of the Si sublattice order. The total DOS is obviously very sensitive to this sublattice order around the equiatomic composition (total DOS predominantly Si) and to ionic order around the octet composition (total DOS Li + Si). So, in the case of Si sublattice order, properties which depend on the total DOS like the conductivity will have a pronounced peak in the temperature coefficient for both compositions, while properties which depend on the local Li DOS will have a strong peak in the temperature coefficient for the octet composition and a weaker peak near the equiatomic composition.

When such sublattice order extends over a broad composition range one will observe a broad maximum. When such sublattice order does not occur in a liquid Li-M alloy system one does not expect anomalous behaviour in the temperature coefficient. This is observed in the liquid Li-Sn and Li-Pb systems. For the latter systems the conductivity only has a maximum at the octet composition (resistivity data: Li-Pb [22], Li-Sn [16], Li-Ge [30] and Li-Si [23]). For this composition the Mott  $g_M$  factor is about  $g_M = 0.7$ , well in the diffusive motion regime. The observed small peak in the temperature coefficient of the Knight shift of Li-Ge near the equiatomic composition indicates that Ge forms some type of sublattice order: chains and/or clusters, but the covalent bonding between the Ge is not strong enough to give rise to such order over a broad composition regime like in the liquid Li-Si alloys.

The difference in behaviour of the magnetic field dependence of the NSLR rate and conductivity in the Li-Si system around 50% and at 20% Si is due to the fact that the Korringa enhancement is a local property while the conductivity is a property of the total DOS. While the average total DOS is approximately the same for both compositions, the local Li DOS is not. We get a consistent interpretation of the data by using the local quantities in the expression for the Knight shift, the NSLR rate and for the magnetic field dependence of the enhancement factor. With a similar approach [19] we were able to explain the conductivity and Knight shift of liquid Li-Au alloys: the conductivity is determined by the total DOS, while the experimental Knight shift could be explained by the partial Li DOS.

It follows from (5) that one might expect a large magnetic field dependence for systems with a small local DOS at the Fermi level on the probe atom relative to the total DOS, and a conductivity in the strong-scattering regime. We predict that the magnetic field dependence of the NSLR rate will be found to be small around the equiatomic composition of Li-Ge, Sn, Pb alloys, because around this composition the resistivity is too low.

There are no indications for extended networks in Li-Sn and Li-Pb alloys like those found in Li-Si. An attempt to determine the magnetic field dependence of the NSLR in liquid Li-Ge alloys, for which there are indications of a small degree of network formation, failed to show any dependence outside the experimental accuracy (typically 3%).

Systems which might satisfy these conditions are for instance the liquid heavier alkali-metalloid alloys. Because the method for measuring the NSLR is restricted to  $\beta$ -emitters, one could use Li as a probe nucleus to get information about the Fermi level states. It would also be of interest to measure the relaxation rate and Knight shift on the metalloid

nuclei in order to check whether these satisfy the Warren relation, and show any magnetic field dependence of the NSLR. For the latter one has to find a suitable isotope.

Because the present measurements are not accurate enough to determine the coefficient  $\gamma$  around the octet composition, and so to determine their local Li DOS, it would be of interest to perform more accurate magnetic-field-dependent measurements of the NSLR rate for these compositions.

## 5. Conclusions

We conclude that we have observed for the first time a magnetic field dependence of the NSLR rate in a disordered system: the liquid Li-Si alloy system. The NSLR rate has a square-root dependence on the magnetic field. Such a dependence has been predicted theoretically by Götze and Ketterle [7] for disordered systems in the strong-scattering regime. From this magnetic field dependence we calculate the local Li DOS around the equiatomic composition. This value of the local Li DOS agrees well with the Knight shift.

## Acknowledgments

This work was sponsored by the Bundesministerium für Forschung und Technology, and the second author gratefully acknowledges the hospitality of the Institut Laue-Langevin, Grenoble. The first author acknowledges the hospitality of the Liquid Matter Group of the University of Groningen. We thank Professor W Götze for his valuable suggestions for the interpretation of the magnetic field dependence.

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