Table II. Suggested values (eV) of L_I-level energies for elements with atomic number from $Z = 8$ to $Z = 23$. Interpolated energies, given to the nearest electron volt, should be regarded as tentative. For some elements the level energy may differ by several electron volts for different source forms.

Element	E_B	Element	E_B
${}_{8}\mathrm{O}$	23.7	${}_{16}\mathrm{S}$	225
${}_{9}\mathrm{F}$	34	${}_{17}\mathrm{Cl}$	269
${}_{10}\mathrm{Ne}$	45	${}_{18}\mathrm{A}$	316
${}_{11}\mathrm{Na}$	65	${}_{19}\mathrm{K}$	367
${}_{12}\mathrm{Mg}$	89.2	${}_{20}\mathrm{Ca}$	423
${}_{13}\mathrm{Al}$	117.4	${}_{21}\mathrm{Sc}$	482
${}_{14}\mathrm{Si}$	149	${}_{22}\mathrm{Ti}$	544
${}_{15}\mathrm{P}$	185	${}_{23}\mathrm{V}$	611

revised by as much as 30 and 26 eV, respectively, which on a relative scale corresponds to about 40 percent. The tentative identification made by Townsend for the Mg L_I level is in fair agreement with our results, whereas the oxygen L_I level is only within about 50% of the measured value. These revisions imply that tabulated L_I energies of the whole series of elements with atomic number smaller than $Z = 24$ (chromium) have to be revised since they are obtained by an interpolation, based on aluminum and magnesium.

Suggested values for the L_I energies of the elements oxygen ($Z = 8$) up to and including vanadium ($Z = 23$) are given in Table II. The quadratic interpolation that has been made has a discontinuity at the closed $2p$ shell of neon. All these energies will be subject to direct electron spectroscopic measurements, and possible chemical shifts of the levels will be studied in more detail. There is good reason to believe that these measurements can be extended to even lower Z values as well as to more peripheral shells, in particular to the band structure of the outermost levels.

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ABSENCE OF SUPERFLUIDITY IN LOW-PRESSURE LIQUID He^3 ABOVE 0.0035°K†

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A recent paper by Peshkov[1] reported the observation of superfluidity[2-4] in low-pressure liquid He^3 with a transition temperature at about 5.5 mdeg (1 mdeg $= 10^{-3}$ °K). Peshkov measured the heat capacity of a mixture of powdered cerium magnesium nitrate [$CeMg(NO_3)_6$] and liquid He^3 and found a bump on the heat capacity curve at about the above temperature. The word "superfluidity" in the present context is meant to describe a state of the He^3 in which its properties are radically different from those of the Fermi liquid.

Working independently of Peshkov, we also measured the heat capacity of a mixture of $CeMg(NO_3)_6$ and He^3 using an apparatus similar in essentials to one described some time ago.[5] We found no anomalous results down to about 4 mdeg on the magnetic temperature scale. The principal differences in the apparatus, comparing our work with that of Peshkov, were that the ratio of He^3 to $CeMg(NO_3)_6$ was about six times greater, that the grain size was 10-50 times greater, and that the heater was located entirely internally. However, in view of the difficulties in proving thermal equilibrium and in relating the magnetic and Kelvin temperatures, we felt that the heat-capacity results were not conclusive.

According to theory[6,7] the transition to the superfluid phase should be accompanied not only by a discontinuity in the specific heat, but also by a decrease of the nuclear susceptibility in the case of even orbital-momentum pairing of quasiparticles. Recent work of Balian and Werthamer[8] indicates that for $l=1$ pairing there is also a drop in susceptibility, so it may be that the susceptibility would deviate from constancy for all types of pairing. The transition should also be accompanied by an abrupt decrease in the transport coefficients.[9]

To rule out uncertainties in thermal equilibrium and thermometry, it would be highly desirable to measure one property of He^3 against another. The simplest pair are the nuclear susceptibility, χ, and the self-diffusion coefficient for the magnetization, D, which are readily measured using the spin-echo method. The only experimental change required to shift from measurements of one to the other is to switch on an external magnetic-field gradient to measure D and to switch it off to measure χ. Experimental measurements[10] of D and χ in low-pressure He^3 have been carried out previously down to 22 mdeg, and the results, in agreement with the predictions[11] of the Fermi liquid theory, show that at low enough temperatures the susceptibility is independent of T and the diffusion coefficient obeys the law $D=AT^{-2}$, where A is a function of pressure only. Hence one might expect to use $D^{-1/2}$ as a quantity linearly proportional to the Kelvin temperature at lower temperatures. Since D may be reduced from its value as extrapolated from higher temperatures due to some scattering mechanism unimportant at higher temperatures, the true temperature might be lower than the value deduced from $D^{-1/2}$. One might object to the procedure of measuring χ against D as a test for superfluidity on the basis that χ might be unaffected or only weakly affected by the transition. However, measurements of D only as a function of time may be meaningful in this connection, for one would expect D to increase with time if the initial temperature after demagnetization were below the transition temperature. In the present experiments D has always decreased with time following final demagnetization.

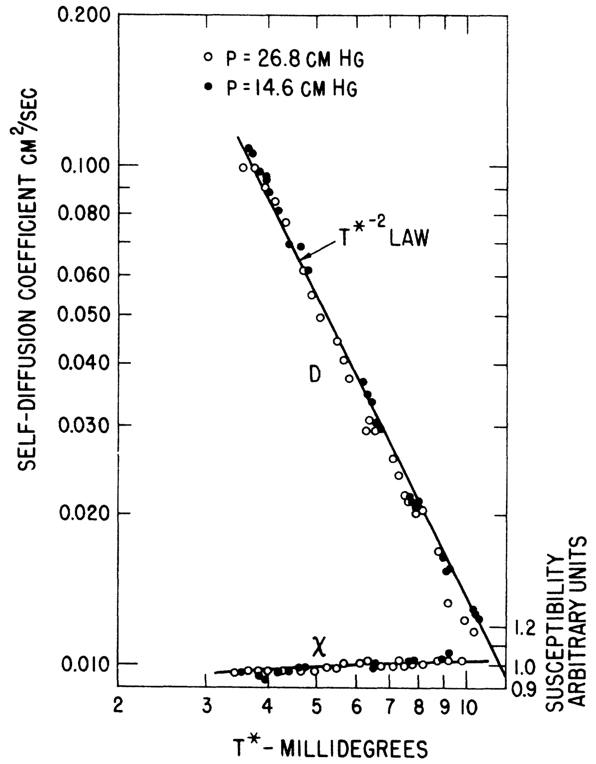

FIG. 1. Nuclear susceptibility χ and self-diffusion coefficient for magnetization D as functions of magnetic temperature T^*.

Results of the measurements for temperatures less than 10 mdeg are shown in Fig. 1. Details of the experiments, methods of refrigeration, and more complete results over a wider temperature range will be published elsewhere. The input He^3 gas had a He^4 impurity of (2 ± 1) parts per million, and runs were made at pressures of 14.6 cm Hg and 26.8 cm Hg. The D and χ measurements were correlated by means of the magnetic temperature T^* of the $CeMg(NO_3)_6$ powder used for final cooling of the He^3. The lowest temperature on the $D^{-1/2}$ scale was about 3.5 mdeg, corresponding to a magnetic temperature of about 3.6 mdeg. The χ values show a rather smooth decrease of several percent as the temperature drops. This change can be accounted for on the basis of a shift of the static magnetic field due to the induced dipolar field of the $CeMg(NO_3)_6$, and hence does not represent a real decrease in the nuclear susceptibility of the He^3. We therefore conclude that there is no transition to a superfluid state in He^3 above 3.5 mdeg. With a low-temperature limit of about 4 mdeg, this conclusion is supported by measurements of heat capacity and spin-lattice relaxation time which will be reported elsewhere.

The above results lead us to believe that the heat-capacity anomaly reported by Peshkov is not a property of bulk He^3. A further discussion will be given in a paper to be submitted shortly for publication.

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UNSTABLE ELECTROSTATIC PLASMA WAVES PROPAGATING PERPENDICULAR TO A MAGNETIC FIELD*

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In the past few years significant progress has been made toward the stabilization of plasmas against hydromagnetic disturbances by using suitable magnetic configurations.[1,2] This progress has made more urgent the conquest of a second broad class of instabilities which limit densities and containment times in fusion experiments; viz., microinstabilities.

It has been known for some time that in an infinite homogeneous plasma in a uniform magnetic field electrostatic waves may be unstable if the velocity distribution function is sufficiently anisotropic.[3] The criteria for this instability have been examined in considerable detail.[4-6] Recently, Rosenbluth and Post[7] have shown that distribution functions of the form $f(v_\perp, v_\parallel)$ which vanish for $v_\perp = 0$ can be unstable ($v_\perp$ and $v_\parallel$ are the components of velocity perpendicular and parallel to the magnetic field). Because distributions of this form are a natural consequence of mirror confinement and of loss mechanisms such as charge-exchange reactions, these instabilities may be quite serious in fusion experiments. However, in the approximate dispersion relation of Rosenbluth and Post, only those waves for which $k_\parallel \neq 0$ are unstable ($k_\parallel$ is the component of the wave-propagation vector parallel to the magnetic field). There is reason to believe that these waves will be strongly damped in the region of the mirrors where the plasma density falls to zero. Thus the pessimistic predictions made for an infinite homogeneous plasma may not prove correct for laboratory plasmas of finite size.

It is the purpose of this note to point out that if some of the approximations made by Rosenbluth and Post are not made, then unstable waves with $k_\parallel = 0$ can exist. Such waves do not propagate toward the mirrors and therefore are not damped either by the effect of the density gradient noted above or by Landau damping from cold electrons moving along the magnetic field. The limit imposed by finite machine length, as described by Hall, Heckrotte, and Kammash,[6] may not be applicable in this case. We also show that if the distribution of perpendicular