attachment process at the highest solute concentration. The rate of neutralization is determined by the drift velocity of the electrons and is given by \[ \frac{[e_0]}{t} \text{ with } [e_0] \text{ the initial concentration and } t \text{ the drift time} \]

In the liquefied rare gases electron drift times per centimeter are always greater than 10^{-5} s. Since our measurements were carried out mainly with cells of 1-mm plate separation, the neutralization rate is estimated to be 10^{-14} M s^{-1}. At low solute concentration and higher field strength, the neutralization rate becomes comparable to the attachment rate and corrections are necessary. The decay of the electron current is then given by

\[ i(t) = i_0 e^{-k[S]t} \left( 1 - \frac{t}{t_d} \right) \]  
\[ \text{(2)} \]

Plotting the data \( \ln \left( \frac{i(t)}{i_0} \right) \) as a function of \( t \) yields

\[ \ln \left( \frac{i(t)}{i_0} \right) = -k[S]t + \ln \left( 1 - \frac{t}{t_d} \right) \]  
\[ \text{(3)} \]

which for \( t \ll t_d \) yields a straight line with slope \(-k[S]\).

For the determination of \( k[S] \) we used the data of \( i(t)/i_0 = 1 \) to \( i(t)/i_0 = 0.5 \). The influence of the drift was taken into account by approximating eq 3 by

\[ \ln \left( \frac{i(t)}{i_0} \right) = -t \left( k[S] + \frac{2}{t_d} \right) \]  
\[ \text{(3a)} \]

III. Results

The rate constants for electron attachment to \( \text{SF}_6 \), \( \text{N}_2\text{O} \), and \( \text{O}_2 \) in liquid argon at 87 K and in liquid xenon at 165 K are shown in Figures 1 and 2, respectively. The rate constant for attachment to \( \text{SF}_6 \) is extremely high. At 10 V cm^{-1} it is well above 10^{14} M^{-1} s^{-1} and it decreases with increasing field strength by almost an order of magnitude. The rate constant for electron attachment to \( \text{O}_2 \) is a factor of 10^8 smaller and also decreases with increasing field strength. The rate constant \( k(e + \text{N}_2\text{O}) \) is comparable to \( k(e + \text{O}_2) \); however, it increases with increasing field strength by more than one order of magnitude.

IV. Discussion

Measurements of the electron drift velocity as a function of the electric field strength in liquid argon and xenon have demonstrated that at higher field strengths the electrons are no longer in thermal equilibrium with the atoms of the liquid but gain energy from the electric field. The electron mobility decreases with increasing field strength and above 10^4 V cm^{-1} in argon and 2 x 10^5 V cm^{-1} in xenon the electron drift velocity remains constant. Several models have been proposed for the explanation of this field dependent electron mobility.\[10-12\] A theory specifically taking into account properties of the liquid argon was developed by Lekner.\[11\] The motion of the electrons through the liquid is treated by assuming that single scattering events on argon atoms limit the magnitude of the mobility. The gas phase scattering potential is modified by the local structure of the liquid around the scattering center.

The steady state momentum distribution function \( f(p) \) in the equations of Legendre polynomials \( P_n \)

\[ f(p) = f_0(x)P_0 + f_1(x)P_1(\cos \theta) + \ldots \]  
\[ \text{(4)} \]

with \( \theta \) the angle between momentum \( p \) and electric field \( F \). The functions \( f_0(x) \) and \( f_1(x) \) \( f_n(x) \), \( n \geq 2 \) can be neglected.

\[ \text{Figure 1. Rate constant for the attachment of electrons in liquid argon} \]  
\[ \text{at } T = 87 \text{K} \]  
\[ \text{to several solutes: (A) } \text{SF}_6, \text{ (B) } \text{N}_2\text{O}, \text{ (C) } \text{O}_2. \text{ The solid line through the } \text{SF}_6 \text{ data corresponds to the cross section of Figure 4. The} \]  
\[ \text{solid line through the } \text{SF}_6 \text{ data corresponds to a } \sigma = \nu^{-2} \text{ dependence.} \]

\[ \text{Figure 2. Rate constant for the attachment of electrons in liquid xenon} \]  
\[ \text{at } T = 165 \text{K} \]  
\[ \text{to several solutes: (A) } \text{SF}_6, \text{ (B) } \text{N}_2\text{O}, \text{ (C) } \text{O}_2. \text{ The solid line through the } \text{SF}_6 \text{ data corresponds to the cross section of Figure 4. The} \]  
\[ \text{solid line through the } \text{SF}_6 \text{ data corresponds to a } \sigma = \nu^{-2} \text{ dependence.} \]

\[ \text{follow from the solution of the Boltzmann equation and are given by two linear differential equations} \]

\[ [x + b(x)] \frac{d}{dx} f_0(x) + x f_0(x) = 0 \]  
\[ \text{(5)} \]

and

\[ \frac{eF\Lambda(x)}{k_BT} \frac{d}{dx} f_0(x) = -f_1(x) \]  
\[ \text{(6)} \]

The variable \( x \) is \( x = e/k_BT \), \( e \) is the electronic charge, \( \Lambda \) the mean free path for momentum transfer, and \( \epsilon \) is the electron energy. The function \( b(x) \) is given by

\[ b(x) = \frac{1}{3} \frac{eF\Lambda_0(x)}{eF\Lambda_1(x)} \left[ \frac{2m}{M} \left(k_BT\right)^2 \right]^{-1} \]  
\[ \text{(7)} \]

where \( F \) is the electric field strength, \( m \) the electron mass, \( M \) the mass of an argon atom, \( \Lambda_0 \) the mean free path for energy...