Kondo Anomaly
of Impurity Spin Resonance Linewidth

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Using the method of Baym and Kadanoff a kinetic equation is derived for the
impurity susceptibility in the s-d model. Summing up the most important diagrams
the impurity self-energy can be expressed in terms of Suhl's T-matrices \( t \) and \( \tau \). The
contribution of the spin non flip amplitude \( t \) to the spin relaxation time is cancelled
by a corresponding vertex correction. Thus the final result can be expressed in terms
of the spin flip amplitude \( \tau \) alone which causes an anomalous temperature dependence
of the relaxation time.

1. Introduction

The purpose of this paper is to present a calculation of the spin
relaxation time \( T_{ds} \) of magnetic ions in metals. The condition under
which \( T_{ds} \) can be observed experimentally are discussed for instance
in \ lowered energy \). In EPR experiments it is usually difficult to observe \( T_{ds} \) because of
the “bottleneck” situation. For our calculation we use the s-d-model
which has been frequently applied to investigate properties of dilute
magnetic alloys. To calculate the properties of the conduction
electrons the dispersion approach of Suhl and the Green's function
decoupling procedure have been applied successfully.

Suhl’s equation can be derived conveniently using a “heavy ion
model” for the impurities, a slight modification of Abrikosov’s
approach. This model allows the application of standard diagrammatic
methods and yields the same quantities as the original s-d model. In
addition it allows the definition of an impurity self-energy which is the
basic quantity in Baym and Kadanoff’s approach to kinetic equations.

3 For a review see also Fischer, K.: Springer tracts of modern physics (to be published).
The dominant contribution to the imaginary part \( \Gamma(\omega) \) of the impurity self-energy at low frequency can be represented by a single three line cut (Fig. 1). In the limit of zero frequency and zero external magnetic field the shaded four point vertex reduces to the electron-impurity scattering matrix \( T = t + \tau s \cdot S \). The \( T \)-matrix can be calculated in Suhl’s approximation by summing the leading divergent diagrams and taking care of the unitarity condition in every order. The final result has been given in \(^9\).

The evaluation of a response function like the susceptibility requires not only self-energy corrections but also vertex corrections. The lowest order self-energy corrections are given in Fig. 2, the lowest order vertex correction in Fig. 3.

Explicit evaluation of the sum of these three diagrams yields terms of the form \( \Gamma_{ds} / \omega \) to the imaginary part of the response function where \( \Gamma_{ds} \) is obtained from \( \Gamma(0) \) by dropping the spin non flip contribution \( \alpha|\tau|^2 \) and reducing the factor in front of the spin flip contribution \( \alpha|\tau|^2 \) from \( S(S+1) \) to 1.

In order to obtain a consistent transport theory one has to iterate the diagrams of Figs. 2 and 3. We find it most convenient to do this by using the method of Kadanoff and Baym \(^8\).

### 2. Kinetic Equations

We introduce the distribution functions \( f_{p\sigma}(r, t) \) and \( n_{k\sigma}(r, t) \) for the conduction electrons and impurities respectively, obeying the kinetic