Frustrated two-level impurities in two-dimensional antiferromagnets

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Dynamical properties of the impurity spin-$\frac{1}{2}$ in 2D and quasi-2D Heisenberg antiferromagnets (AFs) at $T \geq 0$ are discussed. The specific case of an impurity coupled *symmetrically* to two neighboring host spins is considered. The specific feature of this problem is that the defect is degenerate (frustrated) being located in zero molecular field. It is shown that this problem can be described by spin-boson model without tunneling term and with a more complex interaction. We demonstrate that the effect of the host system on the defect is completely described by the spectral function. It is found within the spin-wave approximation that for not too small ω the spectral function is proportional to ω^2/J^3, where J is the exchange constant between the host spins. The defect dynamical susceptibility is derived using Abrikosov's pseudofermion technique and diagrammatic expansion. The calculations are performed within the fourth order of the dimensionless coupling parameter f. It is found that transverse impurity susceptibility $\chi_\perp(\omega)$ has a Lorenz peak with the width proportional to $f^4 J(T/J)^3$ which disappears at $T = 0$, and a non-resonant term. The later term diverges logarithmically as $\omega, T \to 0$. The static susceptibility $\chi(0)$ has the free-spin-like contribution $1/(4T)$, and a logarithmic correction proportional to $f^2 \ln(J/T)$. The influence of finite concentration of the defects n on the low-temperature properties of AF is also investigated. A logarithmic correction to spin-wave velocity of the form $nf^4 \ln|J/\omega|$ and an anomalous damping of spin waves proportional to $nf^4|\omega|$ are obtained. The results of the present paper can be applied to other systems with a frustrated impurity in which the spectral function is proportional to ω^2.