Comment on "Investigation of the Magnitude and Range of the Ruderman-Kittel Interaction in $SmRh_4B_4$ and $ErRh_4B_4$"

In the subject Letter[1] very delicate calculations are employed using the effect of damage to calibrate the Ruderman-Kittel-Kasuya-Yosida indirect exchange interaction which the authors assume to be responsible for the magnetic transitions in the antiferromagnetic superconductor $SmRh_4B_4$ and the ferromagnetic one $ErRh_4B_4$. Unfortunately, there are equally large spin-spin interactions which this and previous papers on the XRh_4B_4 group have ignored, which are sometimes large enough to account for all the magnetic phenomena alone, namely the magnetic dipole-dipole interaction

$$(\boldsymbol{\mu}_1 \cdot \boldsymbol{\mu}_2 - 3\boldsymbol{\mu}_1 \cdot \mathbf{r} \boldsymbol{\mu}_2 \cdot \mathbf{r})/r^3.$$

It has been pointed out[2,3] that these purely magnetic interactions are of approximately the correct magnitude to explain most of the magnetism in the Chevrel group of antiferromagnetic and/or ferromagnetic superconductors, and similar considerations work in the Rh_4B_4 group. For instance, Er, with a moment of $\sim 9.6\mu_B$, has a ferromagnetic T_c from pure Weiss mean-field theory, according to the Lorentz local field $4\pi M/3$ and, hence, with neglect of the fairly marked departure from cubic symmetry, of

$$T_c^{FM} = \tfrac{4}{9}\pi\mu^2/k \cong 1.0k,$$

essentially the same as the observed magnetic transition temperature. The anisotropic structure will enhance both this and the similar antiferromagnetic T_c's.[4] Thus, any calculations neglecting dipolar interactions are unreliable, to say the least.

In the case of Sm and the other magnetic rhodium borides, either the moments are smaller or the experimental magnetic transition temperatures higher, so that one may presume that there is some contribution from Ruderman-Kittel-Kasuya-Yosida. Nonetheless, without calculating the dipolar contribution to either the scattering or the T_M one can by no means carry out the involved program attempted by Terris, Gray, and Dunlap.

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[1]B. D. Terris, K. E. Gray, and B. D. Dunlap, Phys. Rev. Lett. **54**, 2143 (1985).

[2]M. D. Redi and P. W. Anderson, Proc. Nat. Acad. Sci. U.S.A. **78**, 27–30 (1981).

[3]C. M. Varma, private communication, has also pointed out that the T_c's in the Chevrel group fit $T_c \propto g_J^2 J(J+1) = \mu^2$ better than de Gennes's factor $T_c \propto J(J+1)(g_J-1)^2$.

[4]J. C. Slater, Phys. Rev. **78**, 748 (1950).