Break-junction experiments on the zero-bias anomaly of non-magnetic and ferromagnetically ordered metals

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One of the many mysteries of point-contact spectroscopy is the so-called zero-bias anomaly (ZBA), an unexplained maximum or minimum of the differential resistance at zero bias. Over a narrow range of contact resistances the size of the ZBA can vary by several orders of magnitude, making the anomalies appear irreproducible. However, we have shown earlier with spear-anvil and shear-type contacts that on a global scale of resistances between $1\,\Omega$ and $10\,\mathrm{k}\Omega$ the ZBA is reproducible[1]. The size δR of the ZBA varies like $\delta R \approx (9\pi/16)R^2/R_K$ where R is the estimated zero-bias resistance without ZBA. This magnitude corresponds to Kondo scattering at a single impurity in the unitary limit or to the on/off switching of a single conductance channel.

Here we report on mechanically controllable break junctions of ferromagnetic Co, Fe, and Ni as well as the non-magnetic normal metals Al, Cd, and Cu in the $1\,\Omega - 10\,\mathrm{k}\Omega$ range. In their spectra ZBAs similar to those of the spear-anvil and shear contacts are present. Co and Fe contacts show the expected $\delta R \sim R^2$ behaviour, while the other metals have a slightly weaker $\delta R \sim R^{3/2}$ dependence. The magnitude of the anomalies of atomic-size Co, Fe, and Ni contacts agrees well with that observed by others[2].

[1]K. Gloos, Low Temp. Phys. **35**, 935 (2009).
[2]Calvo *et al.*, Nature **458**, 1150 (2009).