The electronic structure of the Abrikosov vortex core and the pinning on a cylindrical defect

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The model of the Abrikosov vortex pinning on a cylindrical defect is proposed. The pinning of the vortex core is modelled as the bound state of the couple of elementary excitations within the potential well formed by both the defect and the magnetic field which penetrates into the vortex core. It is shown that in the limit $\kappa \gg 1$ the potential for the vortex core excitations can be treated within the zero-range potential method. The corresponding pinning energy is represented as following:

$$E = E_0 + \alpha E_1 + o(\alpha)\,,$$

where $\alpha = \{\frac{\Phi}{\Phi_0}\}$ is the fractional part of the magnetic flux Φ through the vortex core and Φ_0 is the magnetic flux quantum. Here E_0 is the pinning energy contribution due to the defect and E_1 is the additional magnetic energy, which in general depends on E_0. Basing on the representation for the energy of pinning we use the variational method to estimate the characteristics of pinning: the energy, the force and the density of critical current. The comparison with the data for YBaCuO is made. The results obtained are in a good agreement with the known theoretical results.