I think that the superconductivity is due to the probability current

$$J = \frac{\hbar}{2im}\left(\Psi^*\nabla\Psi - \Psi\nabla\Psi^*\right)$$

where Ψ is the wave function of a quantum charge system of fermions.
The wave function is a solution of the Schrödinger equation:

$$i\hbar\frac{\partial}{\partial t}\Psi(\vec{x},t) = \left(-\frac{\hbar^2}{2m}\sum_i \Delta_i + U\right)\Psi(\vec{x},t)$$

an infinitesimal perturbation can be applied to the system:

$$i\hbar\frac{\partial}{\partial t}\Psi(\vec{x},t) = \left[-\frac{\hbar^2}{2m}\sum_i \Delta_i + U + e\epsilon x\right]\Psi(\vec{x},t)$$

if the probability current of the perturbed system is great, then there are quantum current and there is superconductivity ($e\epsilon L << \sqrt{< U^2 >}$ where L is the order of magnitude of the superconductor length):

the quantum system is a superconductor when there is a great quantum current, compared to a small field of perturbation

The ground state of the system, obtained using the variational method, is the state where there is no a probability current: the probability current carries kinetic energy, and it generates magnetic energy, so that the ground state must have

the complete ejection of magnetic field lines from the interior of the superconductor

so that the probability current is null in each point of the superconductor.
I hypothesize that a probability current is null in each point of the superconductor, only if the wave function is a real function:

$$\Psi(\vec{x},t)^* = \Psi(\vec{x},t) \ for \ each \ many \ charge \ system$$

so that there is probability currents when there is a complex part in the power series of the perturbation ϵ:

$$u_k = \sum_n \epsilon^n u_k^{(n)}$$

so that, if there is a non-degenerate system to the absolute zero, then the perturbation give a series with real parameters, because of the parameters $a_{ks}^{(n)}$:

$$u^{(n)} = \sum_r a_{ks}^{(n)} u^{(0)}$$

are all reals, for example:

$$a_{ks}^{(1)} = \frac{< u_s^{(0)}|e\epsilon x|u_k^{(0)} >}{E_k^{(0)} - E_s^{(0)}} \in \Re$$

and so on for subsequent orders, so that

a non-degenerate system with a little perturbation field is a perfect insulator

there are not probability currents because of the perturbed wave function are reals.

If there is a quantum system with a degeneration of the energy levels, then the perturbation can change the parameters with a complex part:

$$\begin{vmatrix} < 1|e\epsilon x|1 > -E_n^{(1)} & < 1|e\epsilon x|2 > & \cdots \\ < 2|e\epsilon x|1 > & < 2|e\epsilon x|2 > -E_n^{(1)} & \cdots \\ \cdot & \cdot & \cdot \end{vmatrix} = 0$$

these determinants can have a complex solution (if there are not complex solution, then the material is a perfect insulator), and these solution allow to obtain perturbed wave function with complex part (and probability current).

So that the high temperature superconductor could be a completely transparent material for the phonon frequencies, or a system that is completely reflective to the phonon frequencies of the inner material.

A completely transparent material don't absorbs the radiation of the environmet, and there are some band structure that permit to obtain a partial transparency (for example the Kronig-Penney model).

A completely reflective material could be a layered material, with an overlap of layers with different dispersion relation for the phonons, and different dispersion curves (band gap); for particular values of the the layers thickness and material structure the reflectivity could be greatly increased, so that the material could work like a high-reflective coating, limiting the phononic oscillations to the outer layer.

If it is all true, then it could be possible to measure the infrared reflection of the materials, and it could be possible to optimizing the high temperature reflectivity (the atomic collision and the infrared photons seem to carry the same energy).