$$\sin^2\varphi/2 \rightarrow \sin^2\varphi/2 + const\ ,$$

with the const chosen so that $\Delta(0) = \Delta_o$, can be used. The minimal value of the first term in the curly brackets of eq. (7) is at $\varphi = \varphi_o/2$, and its value is $2[æ/(2p_o \sin(\varphi_o/4))]^{2n}$. If this is smaller than U/g, then $\Delta(\varphi)$ has a negative value somewhere between the maxima, and hence the gap has two nodes in this region. In case if $\varphi_o = \pi/2$, as it happens in BiSCCO, the nodes have to be located symmetrically around $\pi/4$, and this corresponds to the observations of J.-C. Campuzano et al., which are presented at Fig. 8. If $\varphi_o = \pi$, which is most likely to be the case in YBCO, the negative values of Δ are located around $\pi/2$, i.e. if the positive maxima correspond to the a-direction, the negative values are around the b-direction, which is exactly what is seen in experiments measuring the phase of the order parameter.

The necessary conditions for all that to be true is a sufficiently small value of U:

$$U \ll g æ^2 d / P_{0y}\ . \tag{53}$$

If this condition is fulfilled, Δ_o in the singular region will be defined self-consistently by eq. (49), and hence the critical temperature will be also defined by this equation. As shown in sec. 5, in case, when the characteristic phonon frequency $\omega_o \lesssim \mu_1$ (ω_o is an optical frequency, or acoustical frequency at $k=æ$), the integration in eq.(49) has to be cut off at ω_o, and a regular isotope effect appears. Since this is observed in experiment, we believe that the condition (53) is reasonable. Another concern could be the part of the integral in the equation for $\Delta(\varphi)$ outside the singular region. With respect to the terms, which we have kept, it is either of the order of p_{F1}/p_o, or $[UP_{0y}/(gæ^2 d \times (p_{F1}/P_{0y})$. Both quantities are small.

Since there is no reason for the integral $\int\Delta(\varphi)d\varphi$ to vanish, there should be a Josephson current in the HTSC-Pb junction if the boundary is normal to the c-axis, although it may be smaller than what could be expected from an estimate based on Δ_o. The failure to observe it in a BiSCCO-Pb contact could be due to the weak hopping between the CuO_2 layers. The Fermi surface in this case is an almost straight cylinder, and the c-component of the electron velocity is very small. If the electron crosses the barrier keeping the direction of its velocity, it has to go a very long path. This decreases drastically the tunneling probability and can desroy the Josephson current. This does not happen if the boundary is parallel to the c-axis, because then the velocity normal to the boundary is large, and also in YBCO, where due to the chains the hopping between the CuO_2 layers is stronger, and hence the c-component of the velocity is much larger. In these cases the Josephson effect was really observed [42], [43].