Report on:

Bogoliubov Quasiparticles in Superconducting Qubits

by L. I. Glazman and G. Catelani

Based on lectures given within the Les Houches summer school series, the authors review the effects of quasiparticle excitations in superconducting qubits, including their interaction with the qubit and their contribution to qubit relaxation and dephasing.

I find the review clear and well-written, giving a good starting point for both students and scientists interested in understanding the role of quasiparticle dynamics in superconducting qubits and its effect on qubit decoherence and relaxation. I have a few comments and suggestions:

1. In the paragraph above Eq. (29) the authors argue that at an average gate offset charge $\bar{n}_g = 1/4, 3/4$, the transmon energy levels are insensitive to e-jumps. I believe that a quantitative discussion of the transmon energy levels and their dependence on n_g may be beneficial for the average reader.

2. A few typos/grammatic:

*) Three lines below Eq. (2) - "As the result,..." should be "As a result,...". This appears also in the last paragraph before Section 2, in the 8th line below Eq. (30), and in the line below Eq. (79).
*) Seven lines below Eq. (2) - To be consistent with Eq. (2), $(\lambda/\nu_0)\psi_k(\mathbf{r})\psi_l(\mathbf{r})\psi^*_m(\mathbf{r})\psi^*_n(\mathbf{r})$ should be $(\lambda/\nu_0)\psi^*_k(\mathbf{r})\psi^*_l(\mathbf{r})\psi_m(\mathbf{r})\psi_n(\mathbf{r})$.
*) Three lines below Eq. (7) - $\omega_{\rm D}/\delta\epsilon$ should be $\hbar\omega_{\rm D}/\delta\epsilon$.
*) I think the minus sign on the right hand side of Eq. (13) is redundant, because Eqs. (6) and (8) are defined without a minus sign. So either Eqs. (6) and (8) should be written with a minus sign (as conventionally done in BCS theory) or Eq. (13) be written with a plus sign.
*) The equation for T^* at the beginning of page 7 is not numbered.
*) Third line below Eq. (46), "...comes from first term..." should be "...comes from the first term..."
*) Last line on page 19 - junction should be junctions.
*) First line below Eq. (94) - "This in..." should be "This is in...".

3. Below Eq. (40) the phase φ is defined as $2(\phi_L - \phi_R)$, whereas below Eq. (45) it is defined as $2(\phi_R - \phi_L)$, which differs by a minus sign. In Section 2.4 it seems that the central phase φ is again defined as $2(\phi_L - \phi_R)$. I suggest to keep the definitions consistent or at least explaining the origin for differences.

4. If the unitary transformation discussed above Eq. (34) is of the form $|\tilde{\psi}(t)\rangle = U(t)\,|\psi(t)\rangle$, then it seems to me that the correct form of Eq. (34) should be $\tilde{\mathcal{H}} = U\mathcal{H}U^\dagger + i\hbar\frac{dU}{dt}U^\dagger$.

5. The paragraph above Eq. (39): "One may worry that we applied a formalism developed for isolated islands..." is a bit unclear, and I suggest explaining this point in more detail, or referring the reader to suitable reference where this formal derivation can be found.

6. I suggest that authors define the quasiparticle current spectral density $S_{\rm qp}(\omega)$ right after Eq. (65) and relate it to Eq. (64). Then it is easier to understand how Eq. (66) is derived.

7. Could the authors shortly derive the replacement (83) in the presence of cavity photons? I believe the reader could benefit from further details about the coupling of the photon electric field to the superconducting phase.