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Quantiative reliability of the Migdal-Eliashberg theory for strong coupling superconductors JOHANNES BAUER, Max-Planck Institute for Solid State Research, Heisenbergstr.1, 70569 Stuttgart, Germany, JONG HAN, Department of Physics, SUNY at Buffalo, Buffalo, New York 14260, USA, OLLE GUNNARSSON, Max-Planck Institute for Solid State Research, Heisenbergstr.1, 70569 Stuttgart, Germany — The Migdal-Eliashberg (ME) theory for strong electron-phonon coupling and retardation effects of the Morel-Anderson type form the basis for the quantitative understanding of conventional superconductors. The validity of the ME theory for values of the electron-phonon coupling strength $\lambda > 1$ has been questioned by model studies. By distinguishing bare and effective parameters, and by comparing the ME theory with the dynamical mean field theory (DMFT), we clarify the range of applicability of the ME theory. Specifically, we show that ME theory is very accurate as long as the product of effective parameters, $\lambda\omega_{\rm ph}/D$, where $\omega_{\rm ph}$ is an appropriate phonon scale and D an electronic scale, is small enough [1]. The effectiveness of retardation effects is usually considered based on the lowest order diagram in the perturbation theory. We analyze these effects to higher order and find modifications to the usual result for the Coulomb pseudo-potential μ^*. Retardation effects are weakened due to a reduced effective bandwidth. Comparison with the non-perturbative DMFT corroborates our findings [2].

[1] J Bauer, J E Han, and O Gunnarsson, Phys. Rev. B. 84, 184531 (2011).
[2] J Bauer, J E Han, and O Gunnarsson, in preparation (2011).

Johannes Bauer
Max-Planck Institute for Solid State Research,
Heisenbergstr.1, 70569 Stuttgart, Germany

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