Pressure induced superconductor quantum critical point in multi-band systems

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In multi-band superconductors where quasi-particles arising from different orbitals coexist at a common Fermi surface, external parameters which affect the mismatch of the Fermi wave vectors associated with these distinct quasi-particles can destroy superconductivity even at zero temperature. This problem has a wide interest in physics ranging from cold atom systems to color superconductivity in neutron stars. In condensed matter this is relevant for inter-metallic systems and heavy fermions where external pressure can reduce the critical temperature and eventually drive these systems to the normal state. In many cases this transition is continuous and is associated with a superconductor quantum critical point (**SQCP**). In this work we study a two-band superconductor in the presence of hybridization $\boldsymbol{V}$. This one-body mixing term is due to the overlap of the different wave-functions and directly determines the mismatch of the bands. Since it can be tuned by external pressure, it turns out as an important control parameter to study the phase diagram and the nature of the phase transitions. We use a BCS approximation and include both inter and intra-band attractive interactions. For negligible inter-band interactions, as hybridization (pressure) increases we find a **SQCP** separating a superconductor from a normal state at a critical value of the hybridization $\boldsymbol{V_c}$. We show that in the case inter-bands interactions are dominant the transition to the normal state is discontinuous. We obtain the behavior of the electronic specific heat close to the **SQCP** and the shape of the critical line as $\boldsymbol{V}$ approaches $\boldsymbol{V_c}$.