Mathematical Physics

Binding of Polarons and Atoms at Threshold

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If the polaron coupling constant α is large enough, bipolarons or multi-polarons will form. When passing through the critical α_c from above, does the radius of the system simply get arbitrarily large or does it reach a maximum and then explodes? We prove that it is always the latter. We also prove the analogous statement for the Pekar-Tomasevich (PT) approximation to the energy, in which case there is a solution to the PT equation at α_c. Similarly, we show that the same phenomenon occurs for atoms, e.g., helium, at the critical value of the nuclear charge. Our proofs rely only on energy estimates, not on a detailed analysis of the Schr\"odinger equation, and are very general. They use the fact that the Coulomb repulsion decays like $1/r$, while `uncertainty principle' localization energies decay more rapidly, as $1/r^2$.

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