

## Laser cooling of solids

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### Abstract

The optimum conditions for laser cooling of solids are studied. By way of example, a system of impurity molecules in a molecular crystal is considered which efficiently interact with photons and phonons, resulting in direct and indirect energy transitions. A generalized system of equations is constructed for the number of phonons and the nonequilibrium difference of populations. The expressions are obtained for the number of pseudo-localized phonons upon laser excitation. It is found that under certain conditions the number of phonons decreases upon excitation of molecules at the Stokes transition with absorption of phonons. If the excitation is performed at the direct transition without a change in the number of phonons, the laser cooling proves to be only possible if the intensity of the anti-Stokes transitions (in emission) is substantially higher than that of the Stokes transitions. For both cases, equations are obtained which determine the final temperature of a sample achieved upon cooling of the entire crystal. Analysis of these equations shows that the cooling process at a high temperature of a sample is more efficient than at a lower temperature.

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