

Phonons and thermodynamics



calorimetry (heat capacity)



ice and glass



Peter Debye



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When heat capacity becomes important



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Experimental technique

calorimetry (heat capacity)

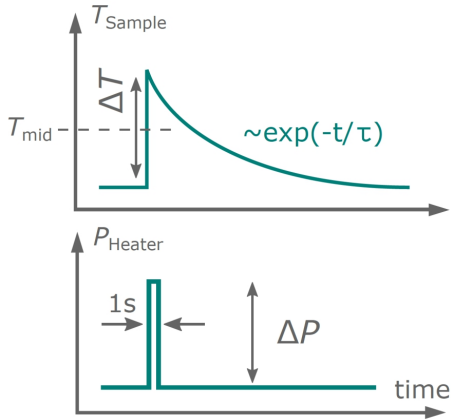


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Quantum Design

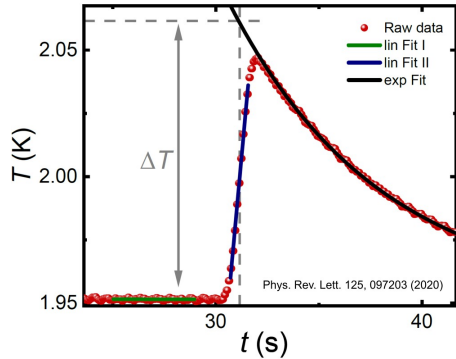
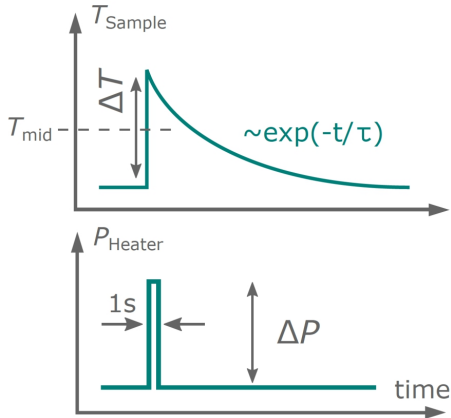


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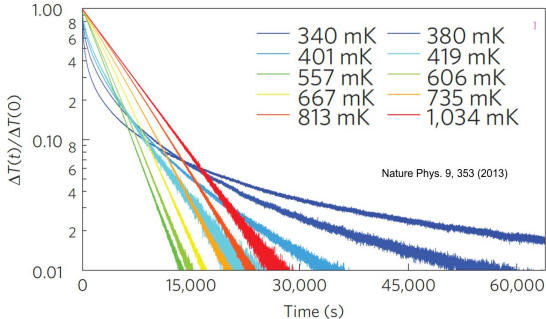
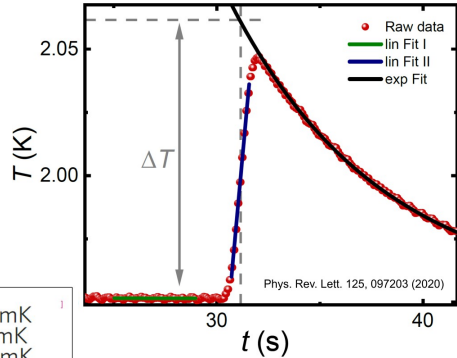
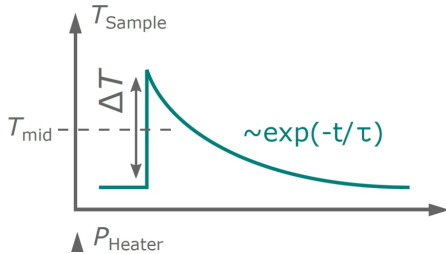


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Person

Peter Debye



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1884–1966

- 1901–1906: studied electrical engineering in Aachen (RWTH)
- 1908: PhD on radiation pressure (Munich, Sommerfeld)



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- 1912: theory of **relaxation in dielectrics**
- 1912: theory of **lattice heat capacity**
- 1914: lattice dynamics vs. crystal structure (**Debye-Waller factor**)

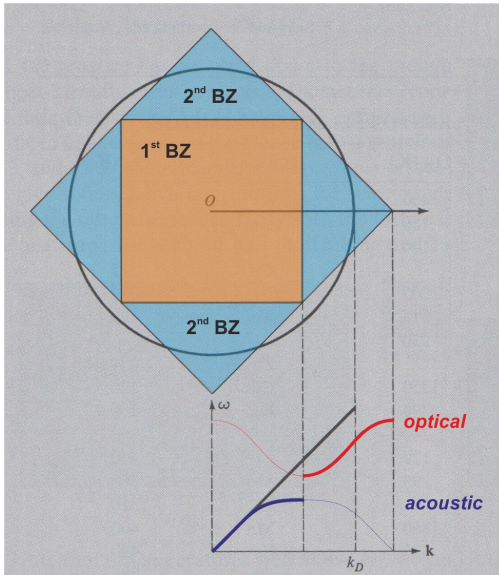


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- 1923: **Debye-Hückel theory** of electrolytes
- 1936: Nobel prize in chemistry “for his study of molecular structure”



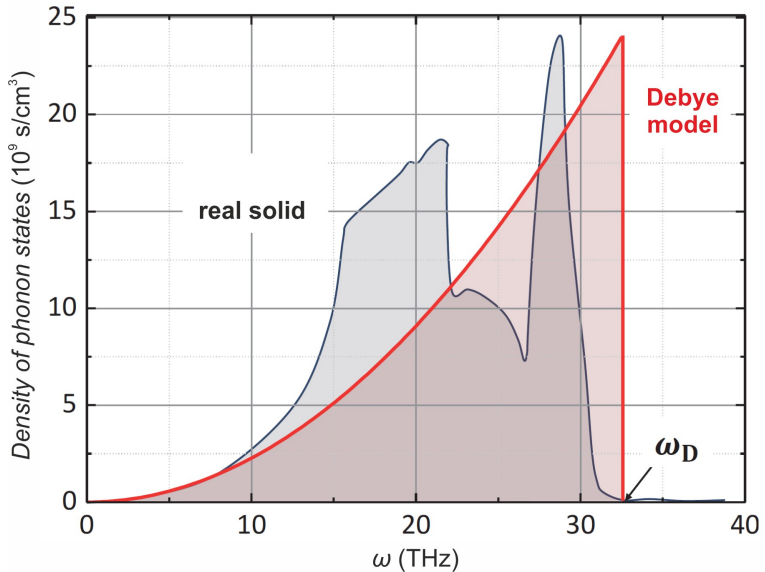
Debye monument in Maastricht

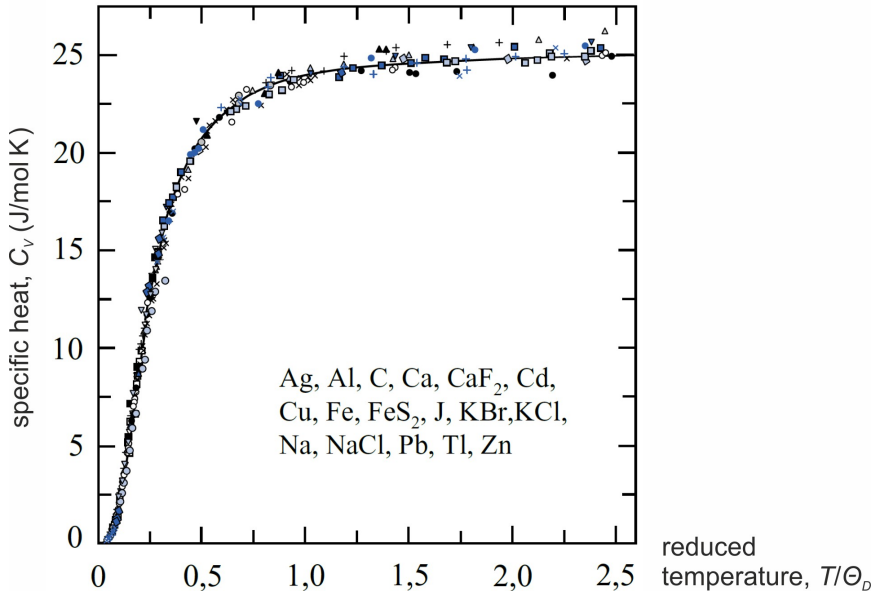


$$\omega = c q$$

approximates both
acoustic and optical modes

(Debye interpolation)





Measure of lattice stiffness

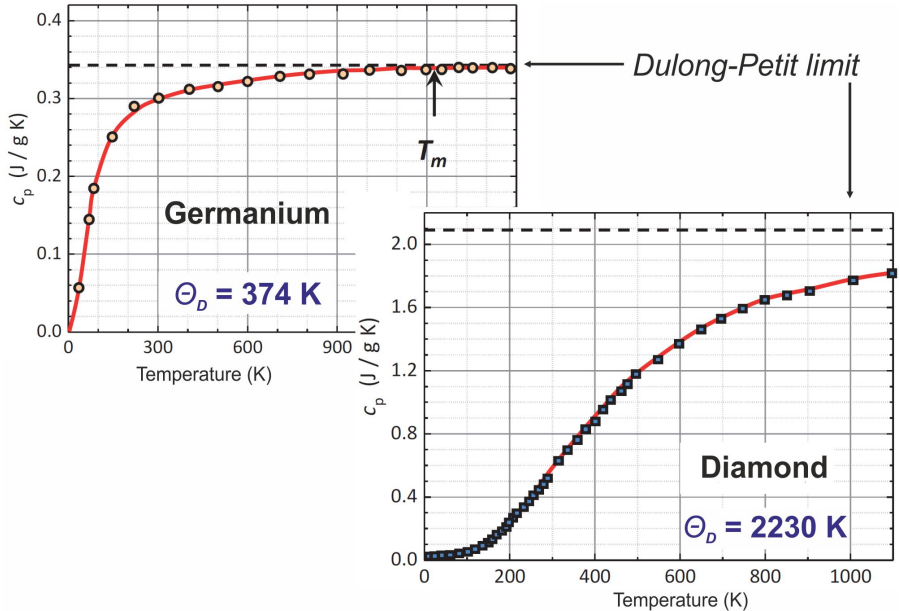


Image credit: Gross and Marx, Festkörperphysik

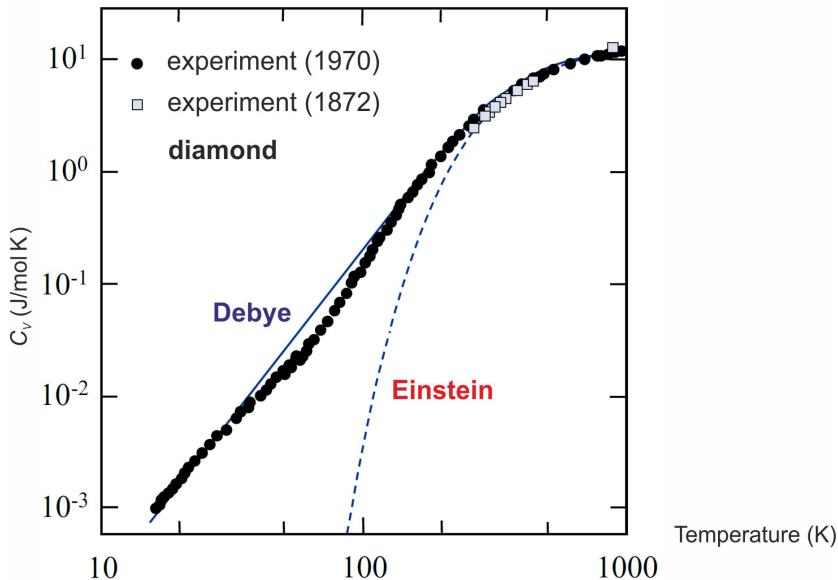
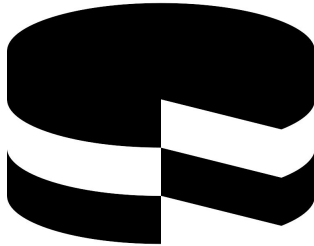


Image credit: S. Hunklinger, Festkörperphysik



Material

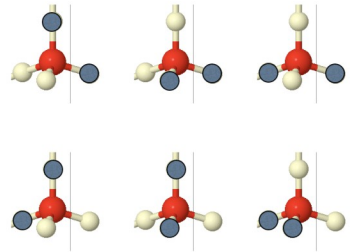
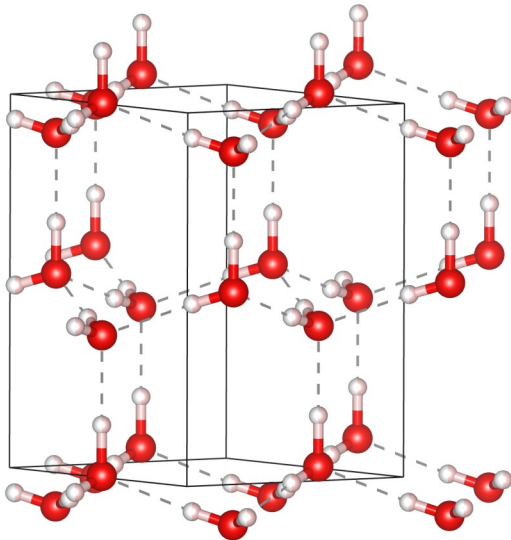
ice and glass



Residual entropy

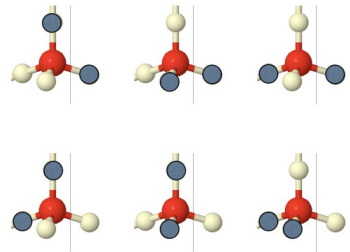
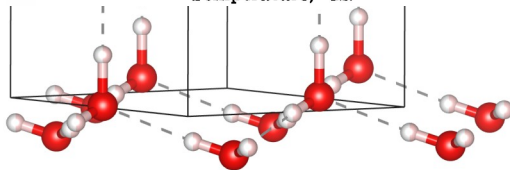
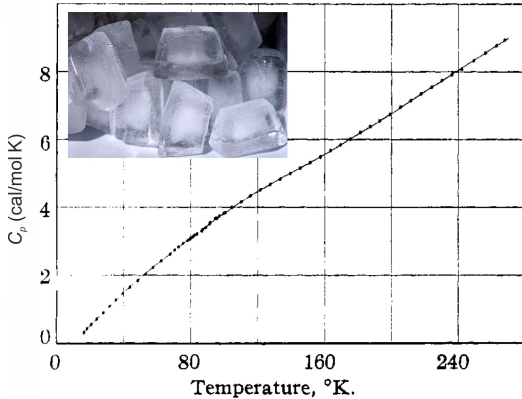
amorphous solids

crystals
with disorder



2-in-2-out (**ice rule**)

Conventional ice (I_h)
 features residual entropy
 of $R \ln \frac{3}{2}$ due to random
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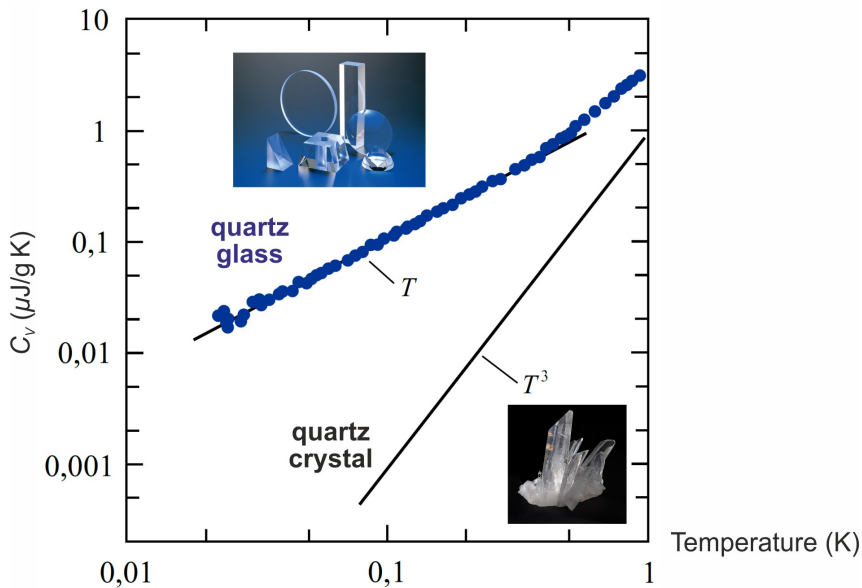


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