Electronics – Free electron gas

1. Perspectives

Thermal conductivity

Thermoelectricity

Coupling between electronic charge and crystal lattice

2. Free electron gas

Electron dispersion

Fermi energy E_F

Electronic DOS

Fermi-Dirac distribution

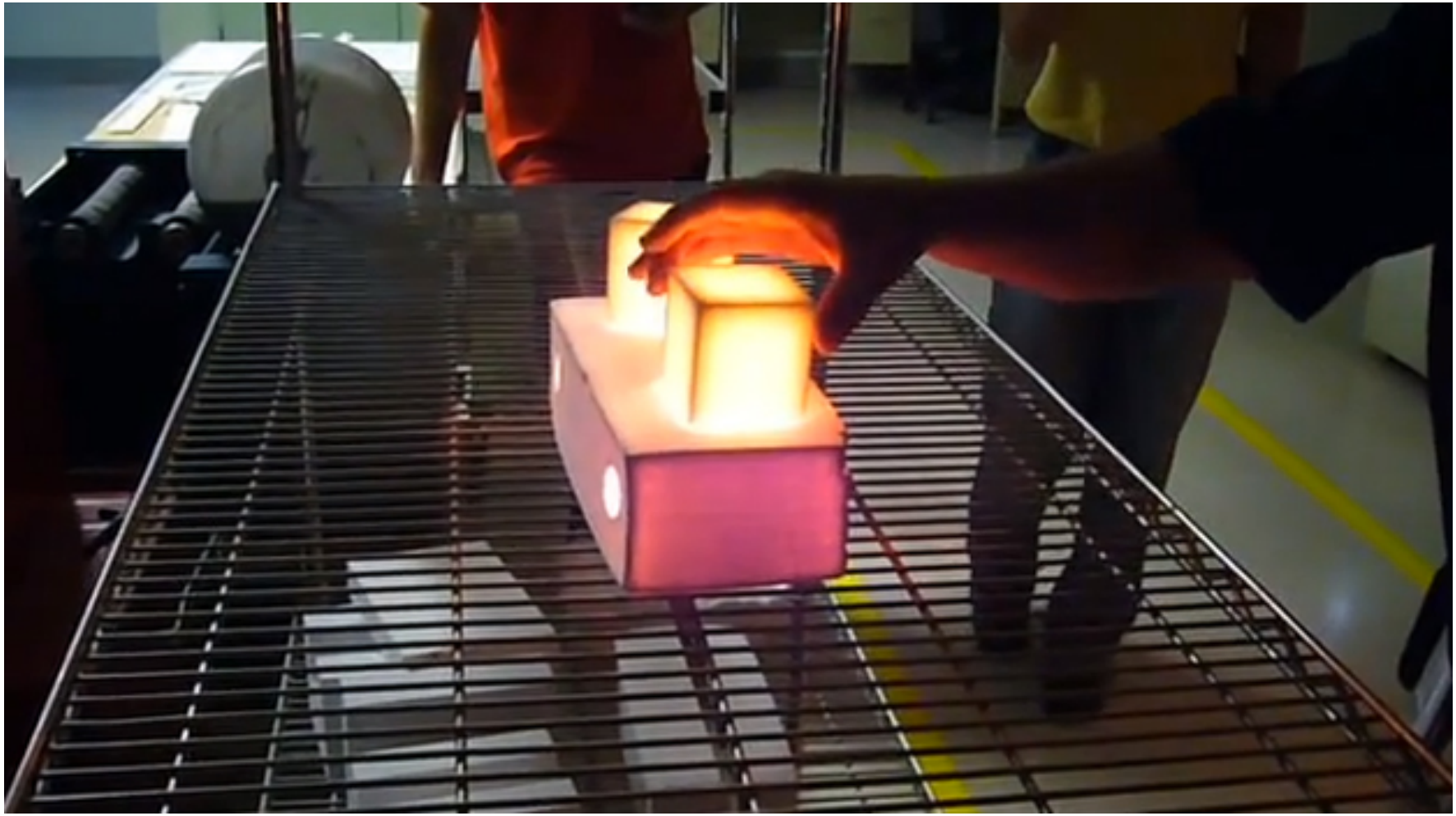
3. Electronic specific heat

Temperature dependence

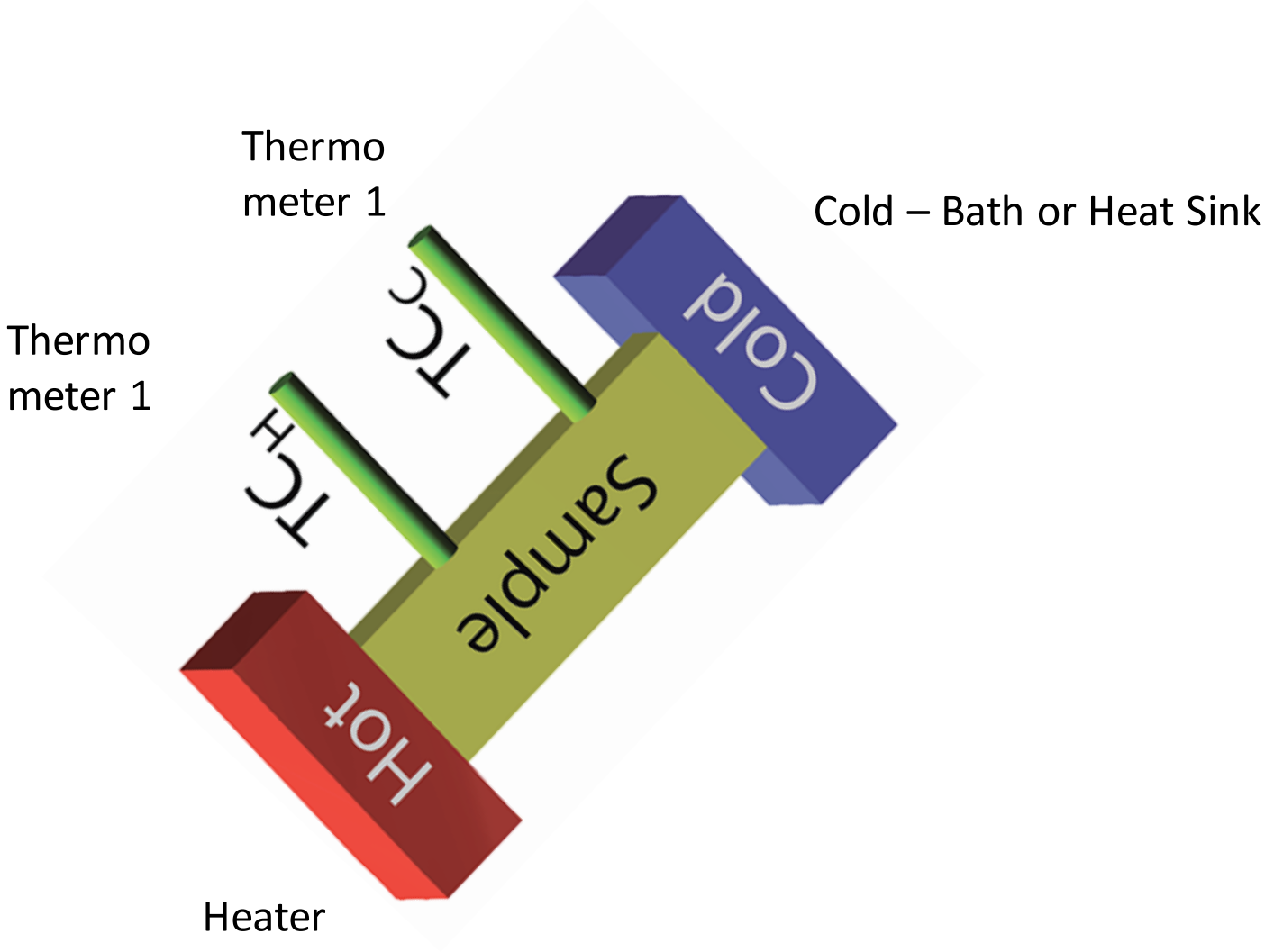
Quantitative expression

Comparison to experiments

Thermal Conductivity



Thermal Conductivity - Setup



Thermal Conductivity: NaF

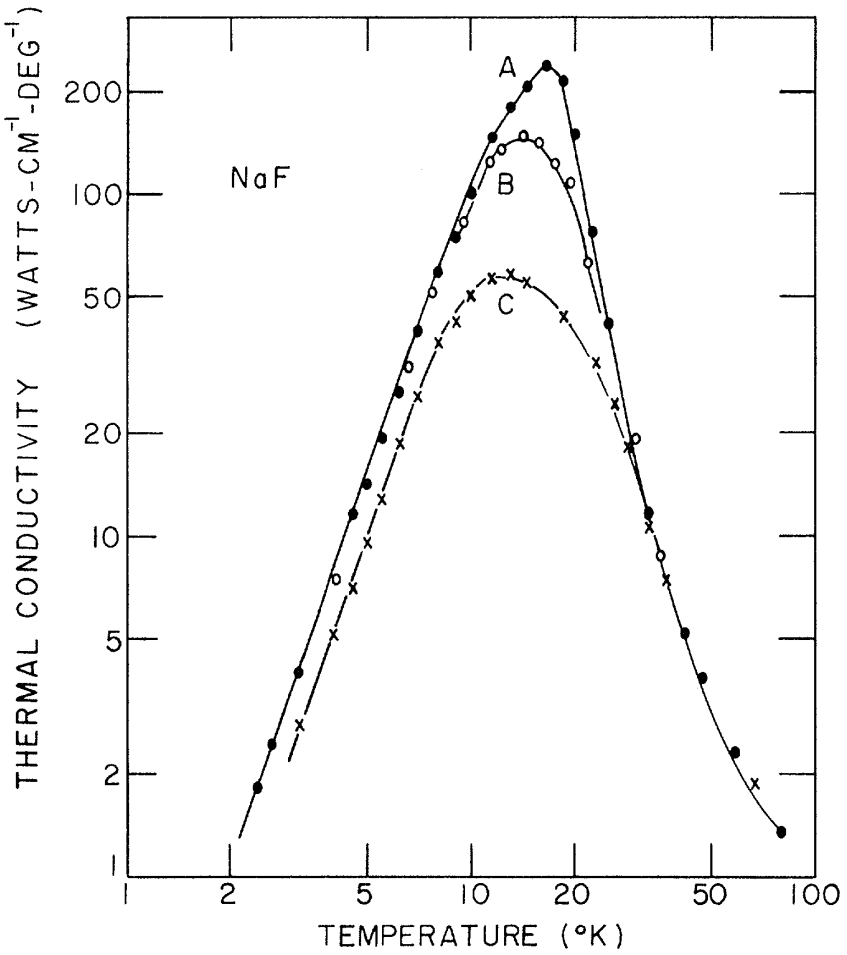
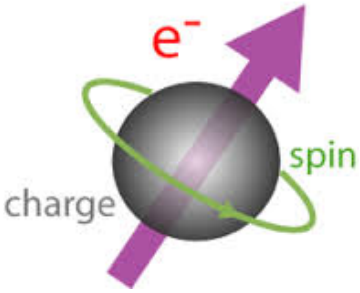
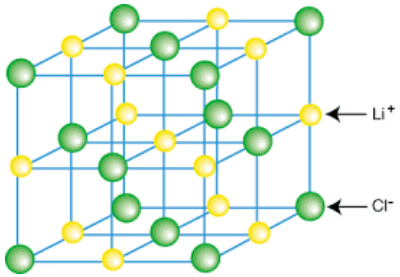


FIG. 1. Thermal conductivity versus temperature for pure NaF crystals. Curve *A*, NaF sample, this paper; curve *B*, NaF sample, Ref. 1; curve *C*, typical singly grown NaF (smaller cross section).

Important Material Parameters



SPIN	ORBITAL
CHARGE	LATTICE



Waste heat

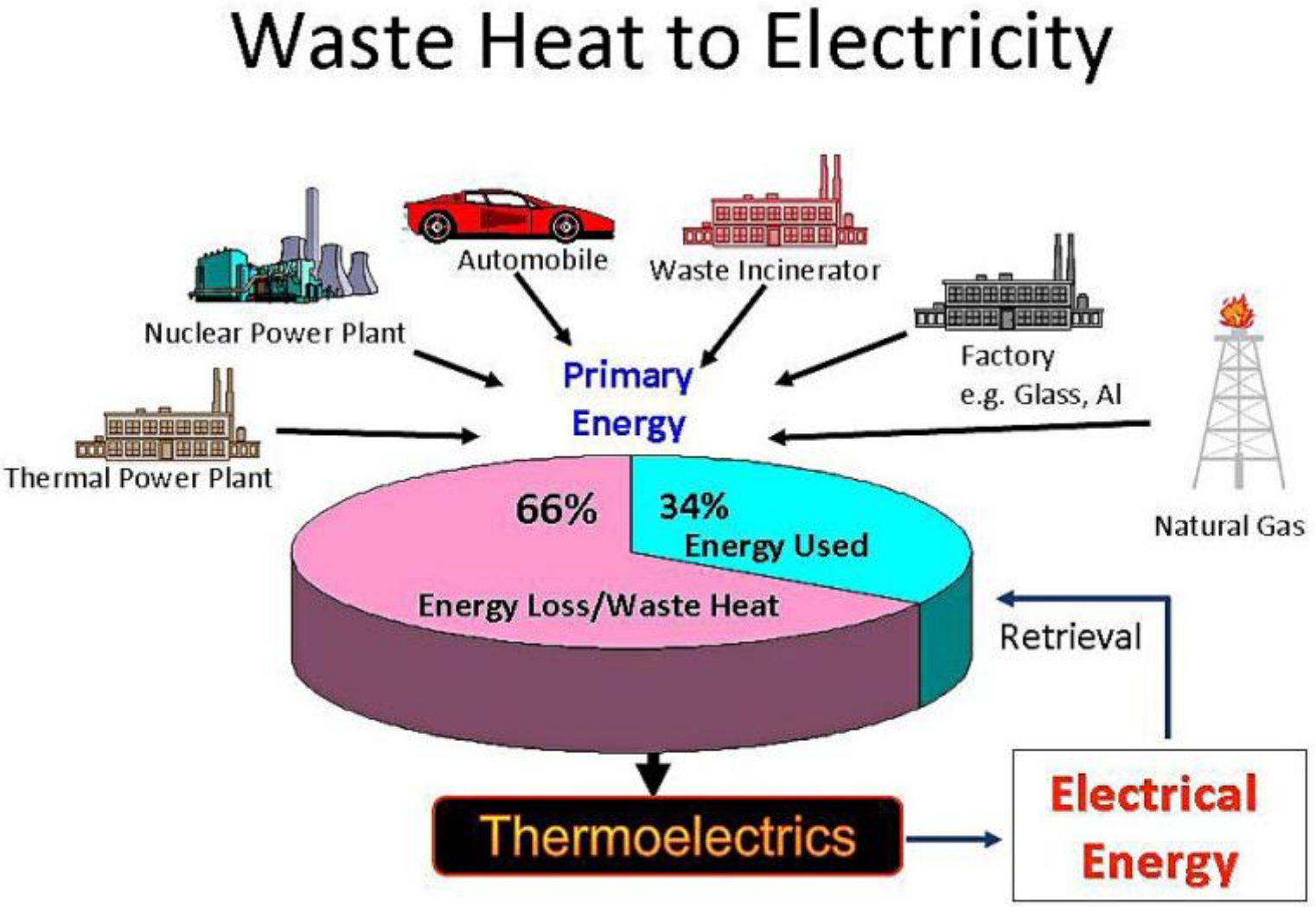

Waste Heat to Electricity
Automobile
Waste Incinerator
Nuclear Power Plant
Factory
e.g. Glass, Al
Primary
Energy
Thermal Power Plant
Natural Gas
66%
34%
Energy Used
Energy Loss/Waste Heat
Retrieval
Thermoelectrics
Electrical
Energy

Figure of Merit - Thermoelectricity

$$zT = \frac{S^2}{\rho\kappa} T.$$

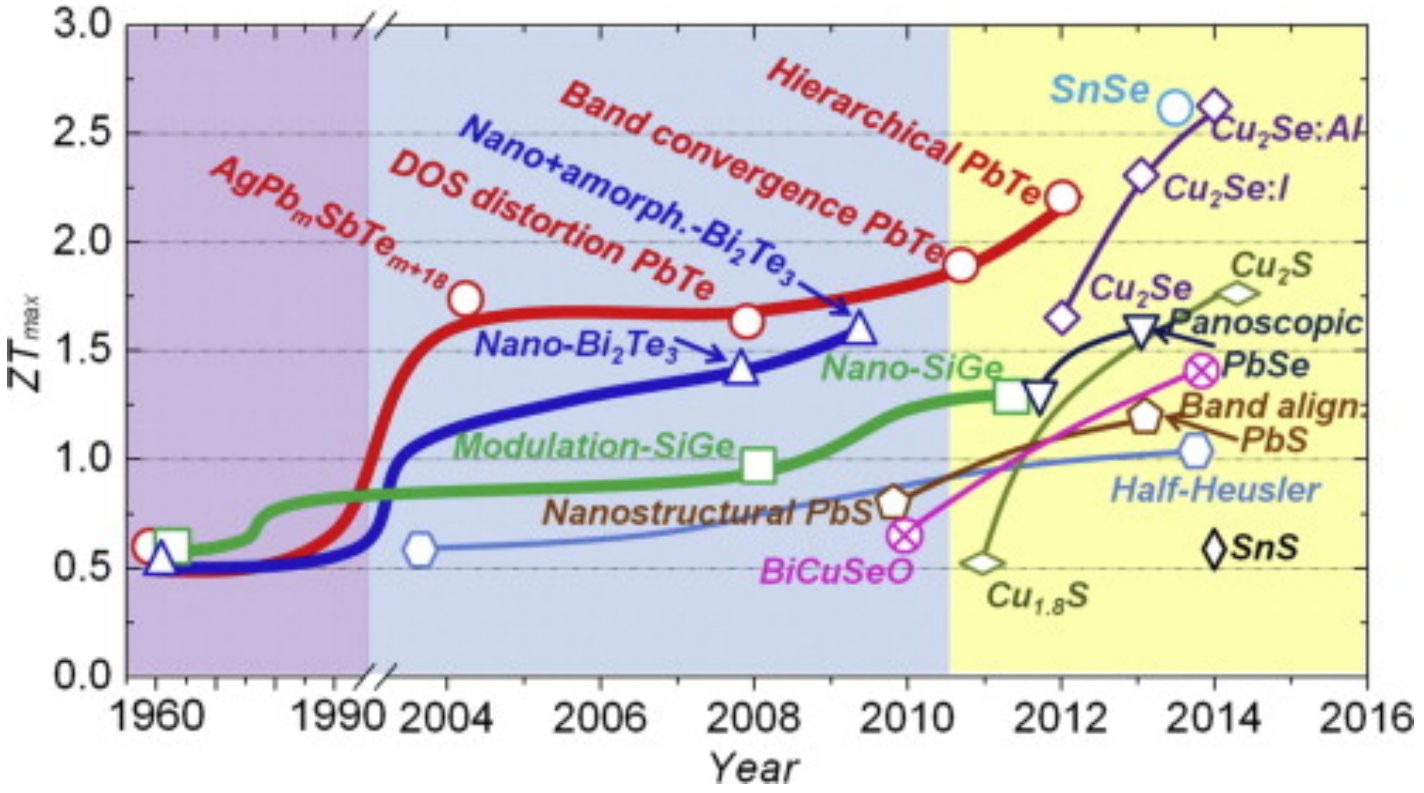
S = Seebeck coefficient

T = Temperature

ρ = Resistivity (ohm)

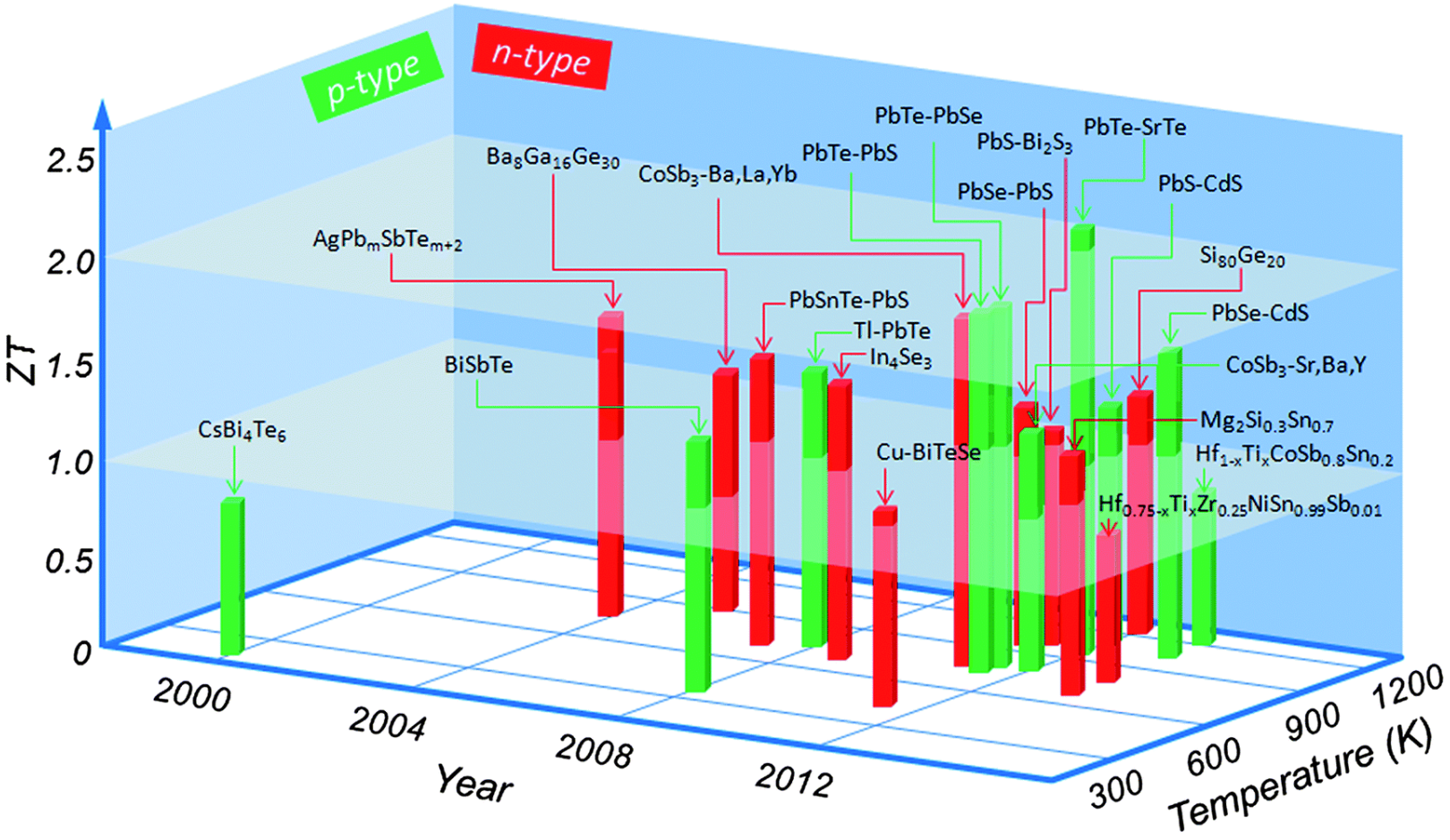
κ = Thermal conductivity

Figure of Merit – versus time



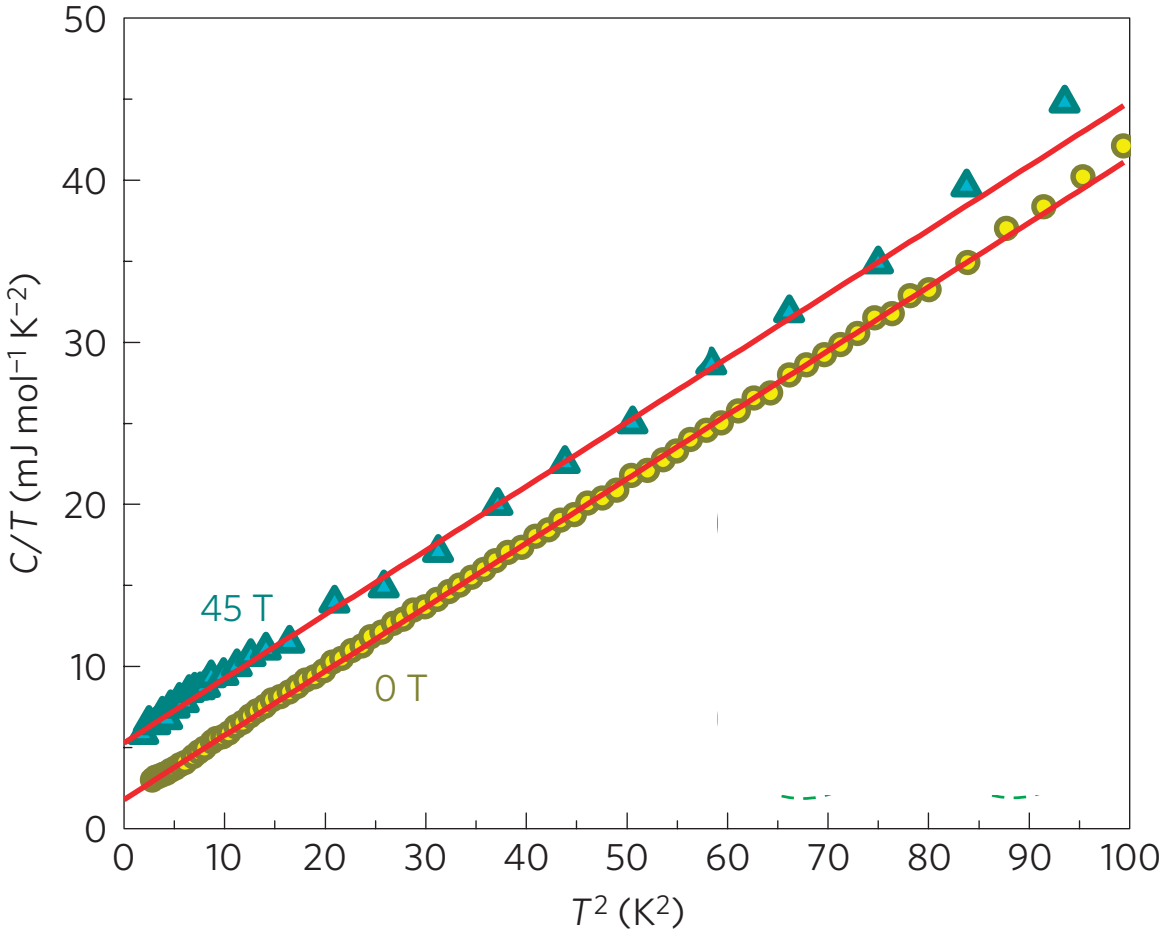
http://www.sciencedirect.com/science/article/pii/S2352847815000258

Figure of Merit – versus time & T



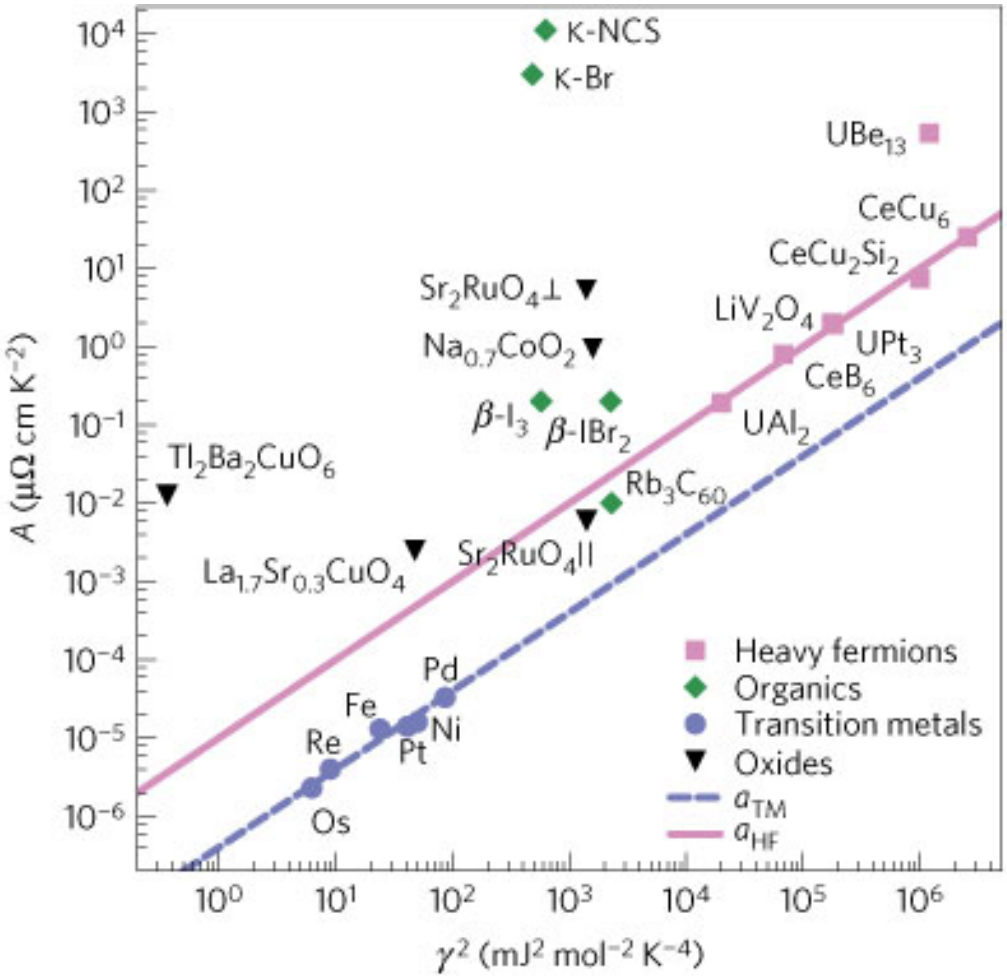
http://pubs.rsc.org/en/content/articlelanding/2014/ee/c3ee43099e/unauth#!divAbstract

Heat Capacity – $YBa_2Cu_3O_{6.5}$



http://www.nature.com/nphys/journal/v7/n4/pdf/nphys1921.pdf (2011)

Heavi Fermions



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