3-rd Annual Meeting COST Action P10 **Physics of Risk**

The Nature of Socio - Economic Interactions

Chemistry of Social Bonds

Jürgen Mimkes, Physics Department, Paderborn University, Germany

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Chemistry of Social Bonds

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Crystal growth / Opinion dynamics (G. Weisbuch, S. Galam,..)

Binary alloys / Competition of faith, ethnicity, language (D. Stauffer, Kulakowsky..)

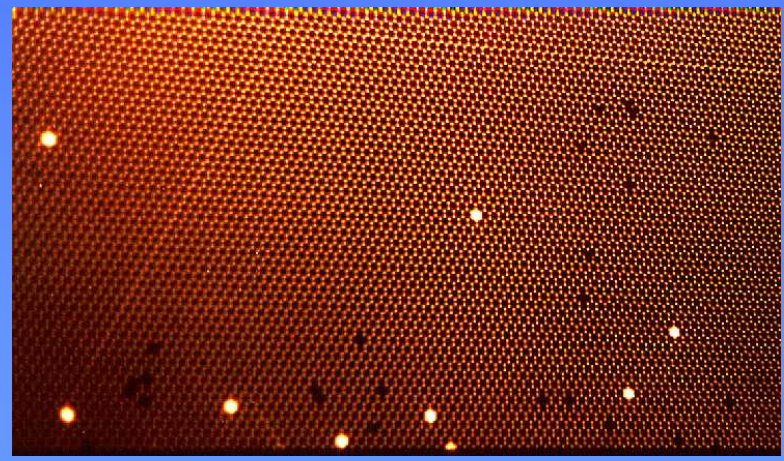
Free energy /socio-economic systems (M. Patriarca, S. Thurner, I. Simonsen...)

Boltzmann distribution / Distribution of wealth (V. Yakovenko, P. Richmond,..)

Crystal structure / Networks (J. Holyst , J. Kertesz..)

Chemistry of Social Bonds

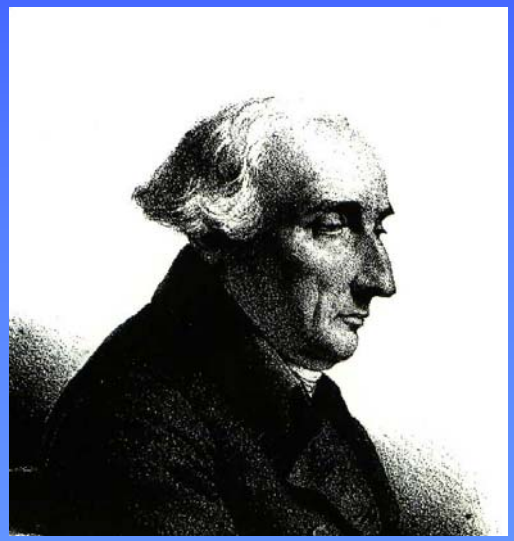
Three many particle systems



Chemistry of Social Bonds

Stochastic systems with constraints (Lagrange LeChatelier principle)

$$\mathbf{L = T \ln P - p V + E \rightarrow maximum!}$$



Joseph de Lagrange

(1736 – 1813)

L : Lagrange function, free energy, utility

P : probability,
ln P: entropy, individual disorder

E : constraint, bonds, interaction law, order

T : Lagrange parameter, temperature
mean energy, mean capital, tolerance

p : pressure

V : individual freedom

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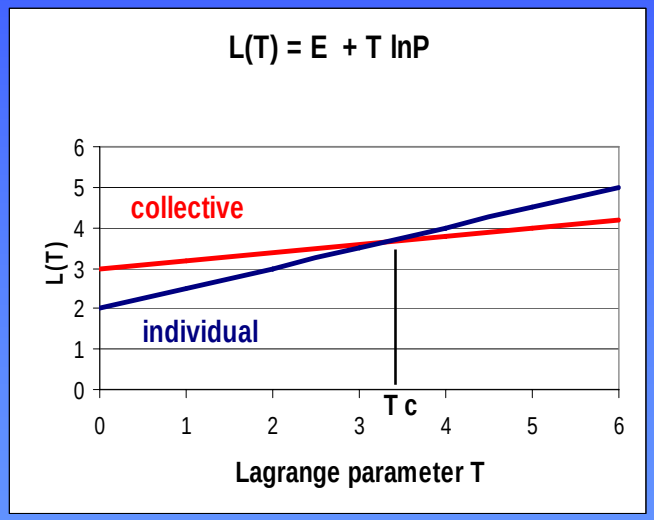

Phases in stochastic many particle systems

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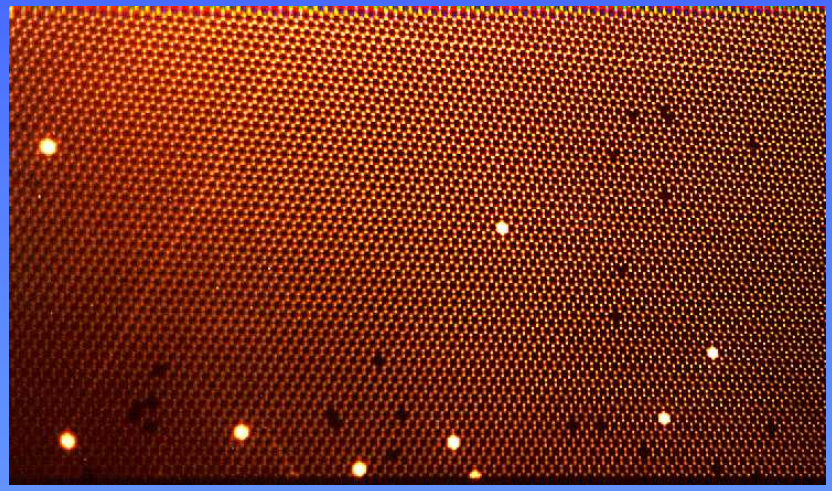

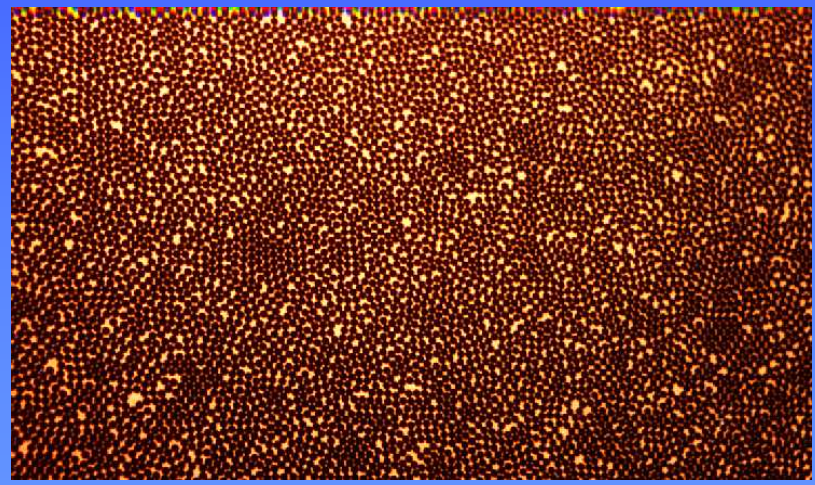

T small, p high : collective order

T large, p low: individual

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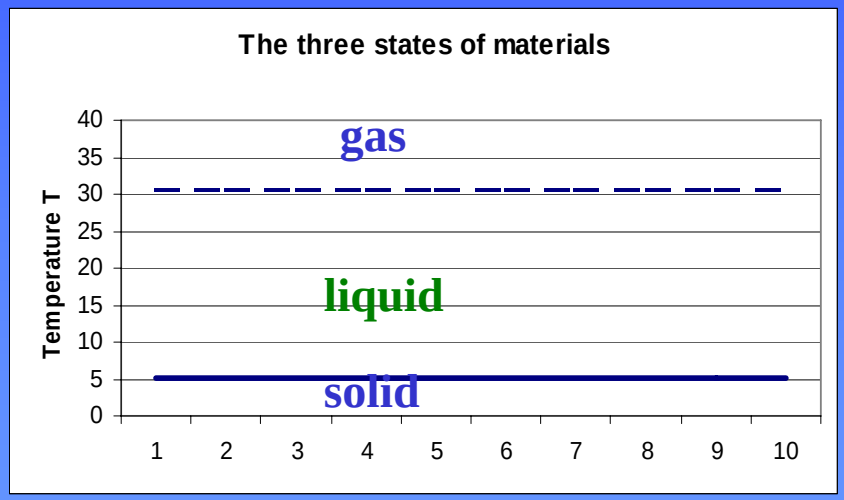
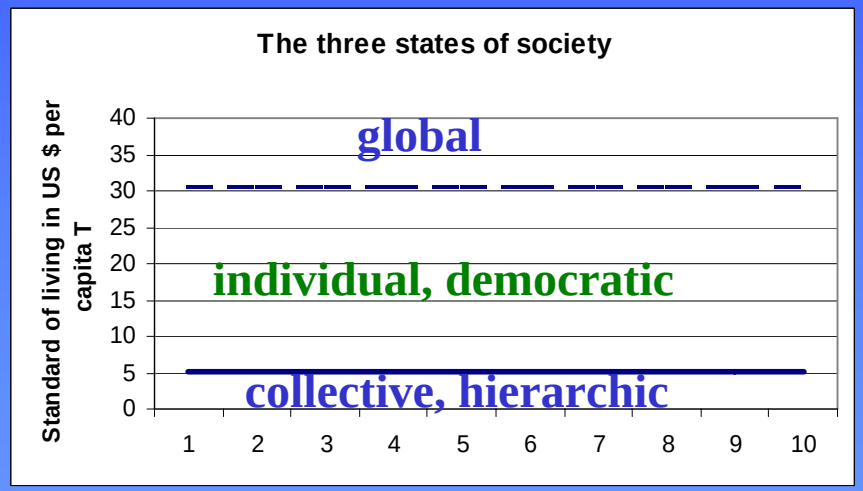




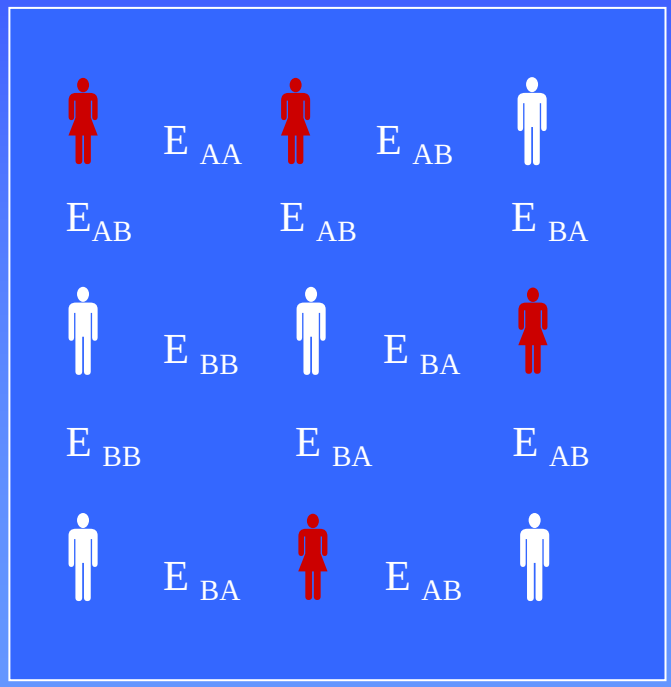
Atomic phases

Social states

Chemistry of Social Bonds

Bond model: Regular solutions (Bragg Williams)

$$L = E_0 + \varepsilon\, x\,(1-x) - p\,V + T\,*\{x \ln x + (1-x) \ln (1-x)\} \rightarrow \text{maximum!}$$



$$x = N_B / N$$

$$\varepsilon = E_{AB} + E_{BA} - E_{AA} - E_{BB}$$

$\varepsilon > 0$ partnership, cooperation

$\varepsilon = 0$ integration, independence

$\varepsilon < 0$ segregation, competition

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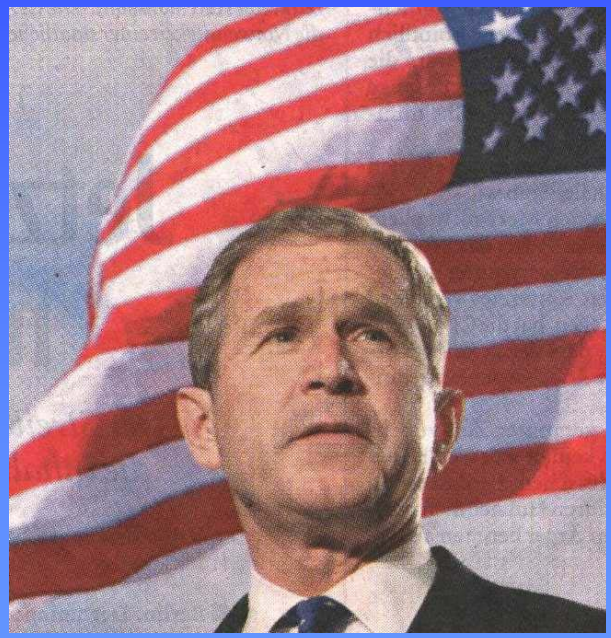
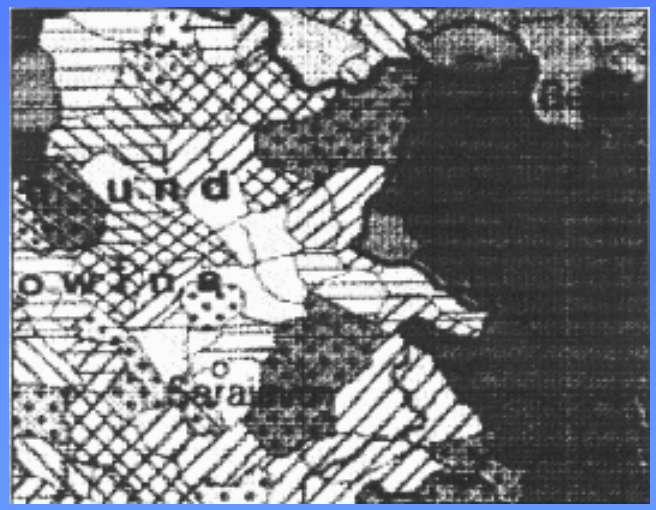
Application to collective state: crystal growth or opinion formation

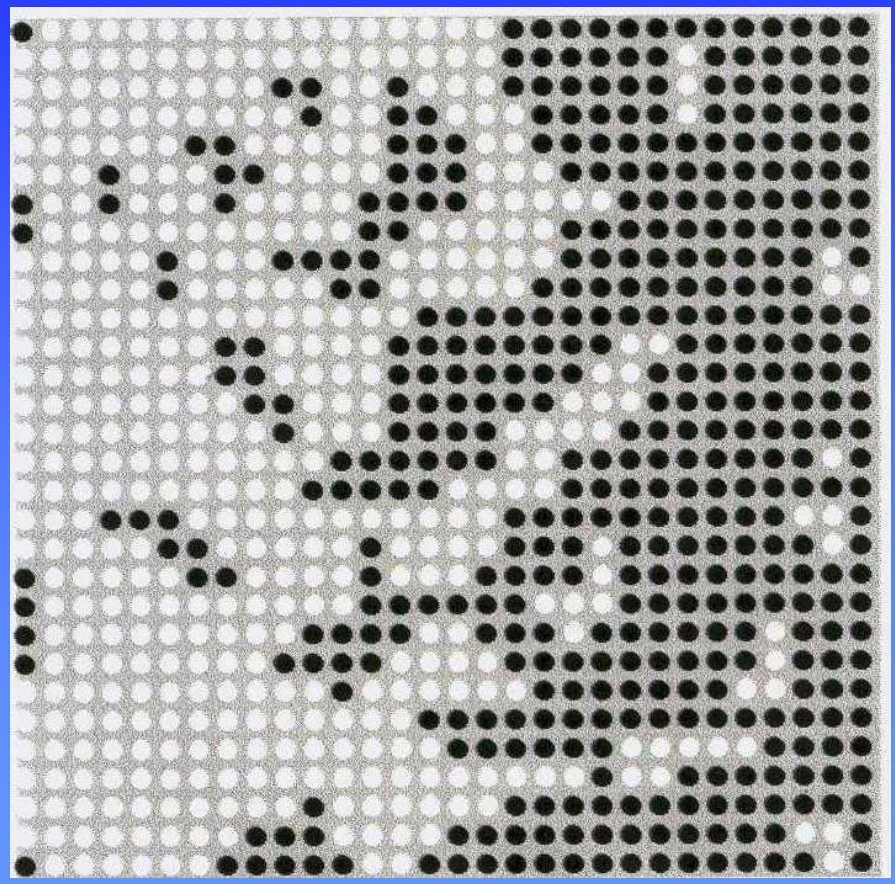
$$L = T \ln P - p V + E \rightarrow \textbf{maximum!}$$



One nucleus determines the direction of the whole system

Chemistry of Social Bonds

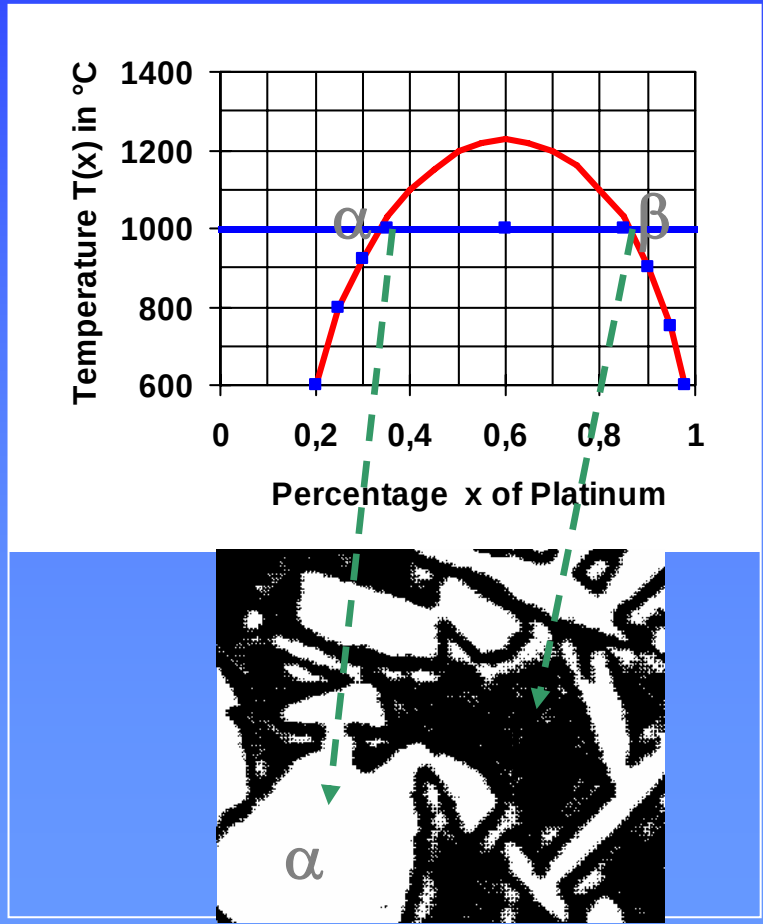




Simulation of segregation

Application: Phase diagram for binary alloys (Au Pt)

$$\frac{T(x)}{\varepsilon} = \frac{(1-2x)}{\ln x - \ln(1-x)}$$



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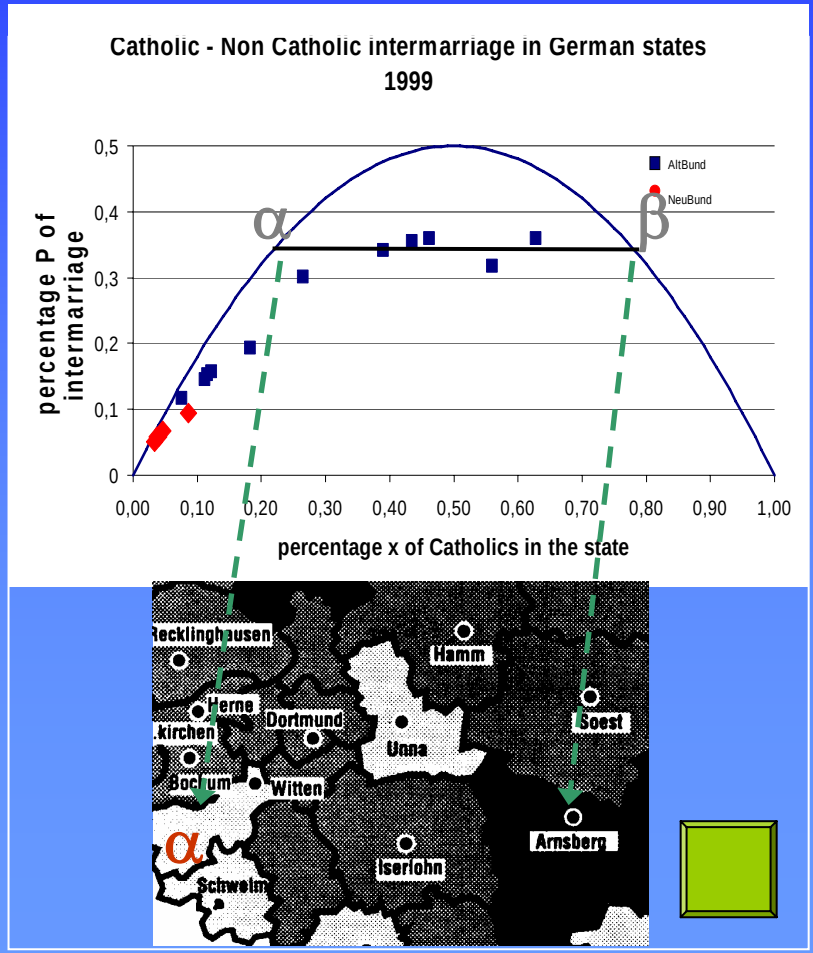
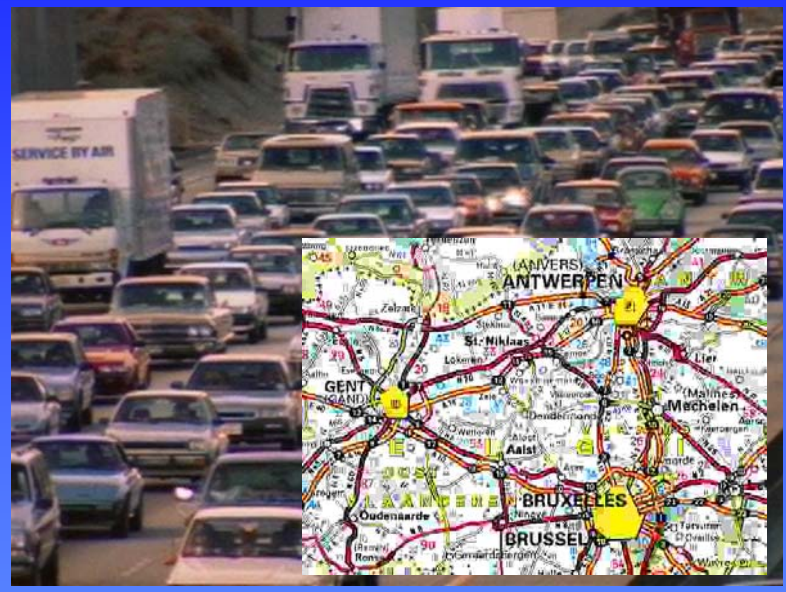
Application: Intermarriage diagram Catholic Non-Catholic in Germany

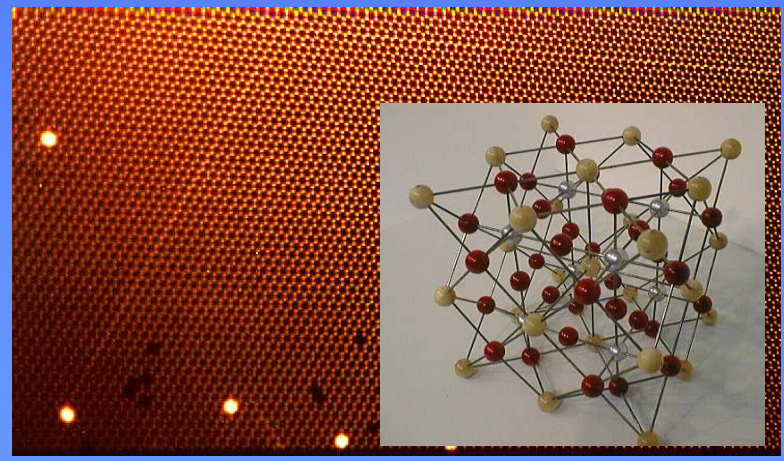
$$P = 2 x (1 - x)$$



Chemistry of Social Bonds

Network structure of bonds





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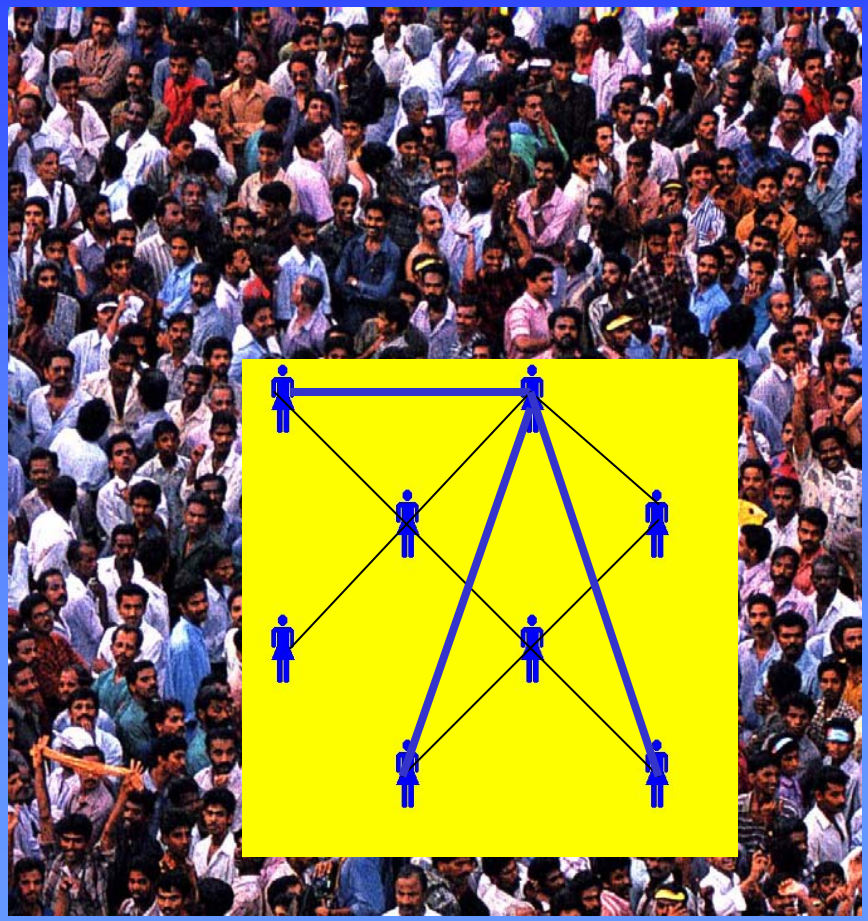
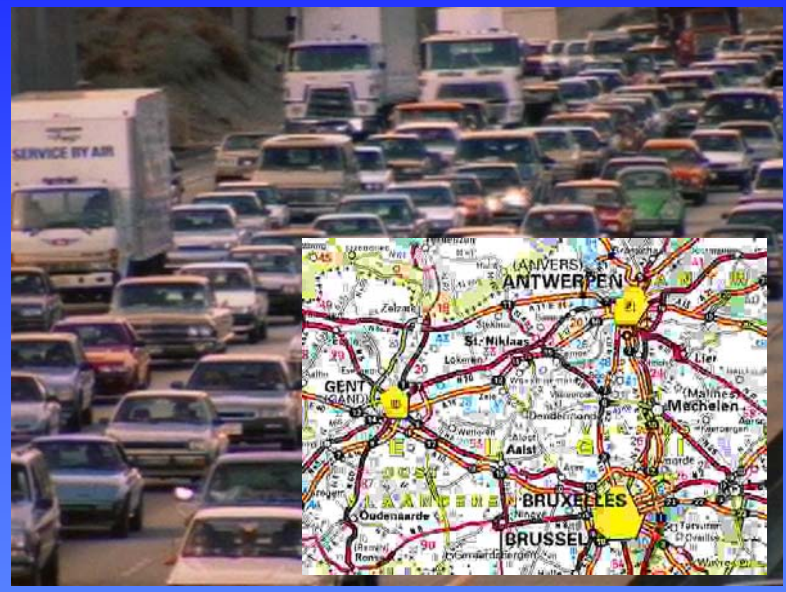
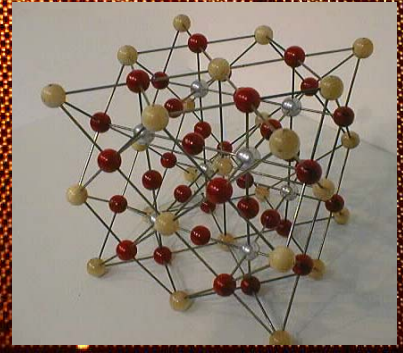




Coulomb law:

$E = C_{AB} / d$

d : distance



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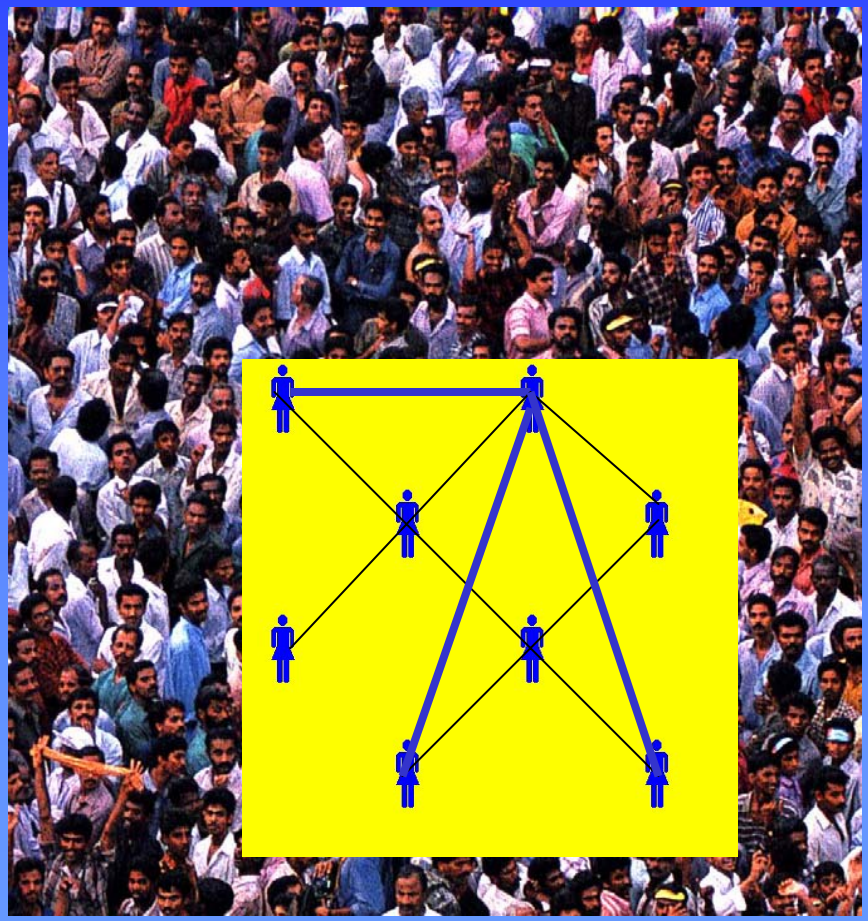

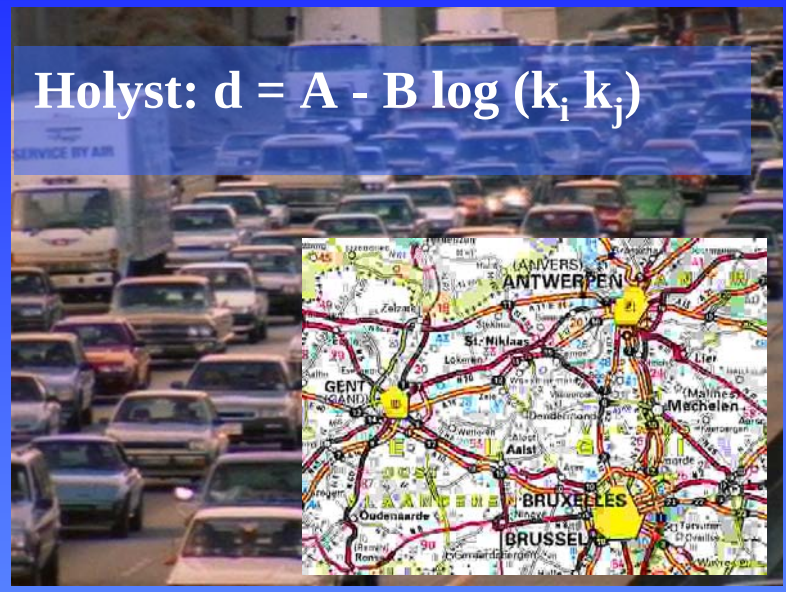

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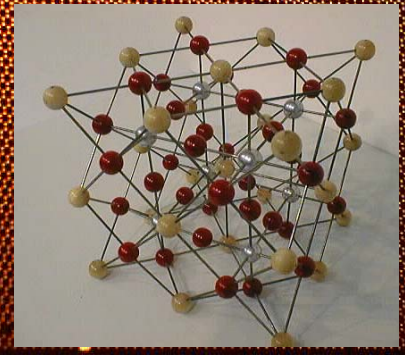


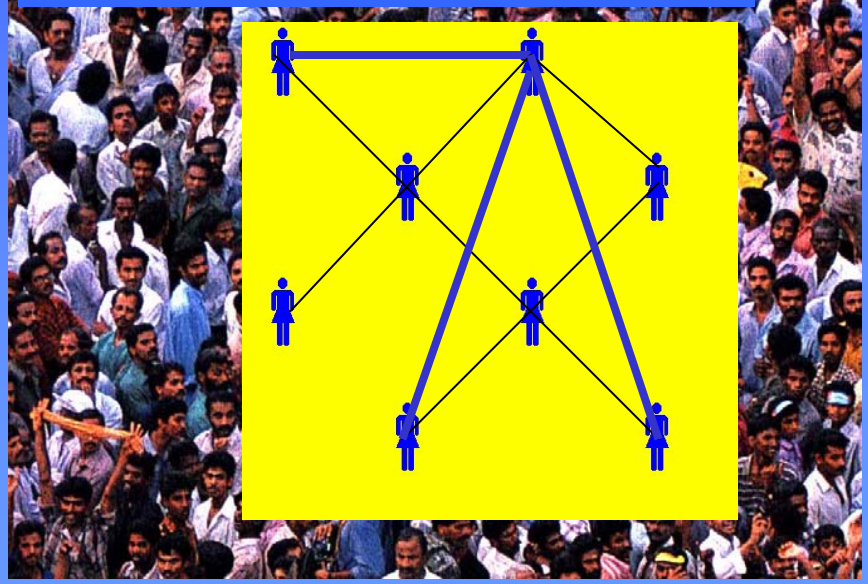
Chemistry of Social Bonds

Network structure of bonds

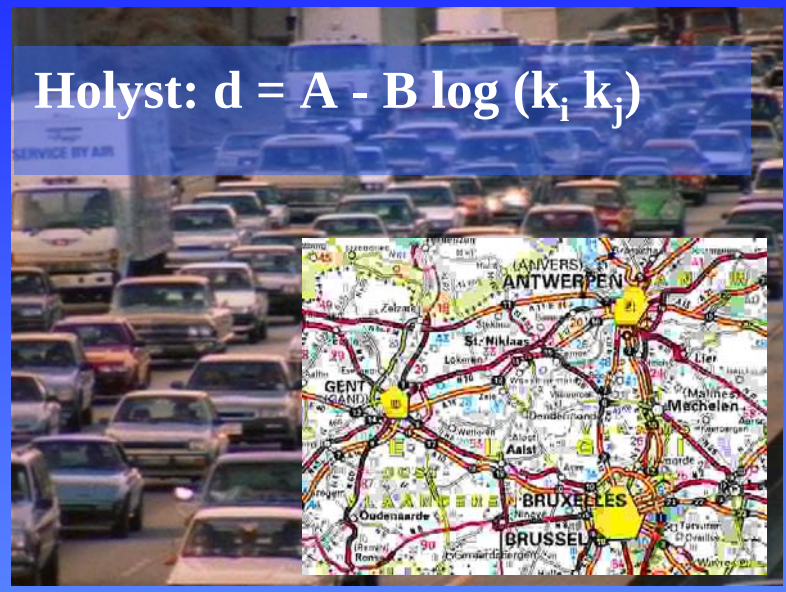
Coulomb law of social bonds:

$E = C_{AB} / d$

d : social distance



Holyst: $d = A - B \log (k_i k_j)$



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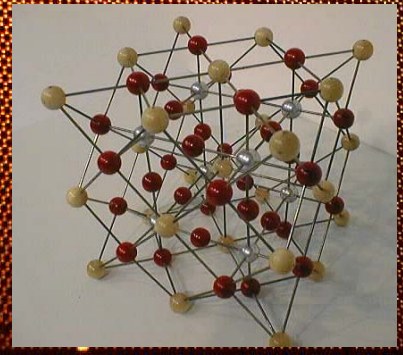

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Society with telephone bonds

Vapor with atomic bonds

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