Integration - Segregation - Aggression

Models and Mechanisms of Multicultural Societies

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Abstract

A model of human behaviour is derived from intermarriage data of ethnic, religious and national groups in Germany, Switzerland and the US. The resulting model society of sympathetic or antipathetic groups depends on three parameters: group size, sympathy and tolerance. A society will be stable, if the mutual satisfaction of all groups is at a maximum.

The model shows quantitatively, how emotions will influence the degree of integration of minorities. Four states of a regular society are discussed: sympathy between groups leads to co-ordination and order, indifference to integration and disorder, antipathy to segregation and Ghettos, aggression to social conflict. High tolerance will promote integration of an antipathetic society, but will be regarded as unloyal in a sympathetic society. The rate of intermarriage with any minority and the mean rate of divorce are proportional and may be regarded as thermometers of tolerance of a society.

Aggression is equivalent to negative tolerance and leads to instability of a society. The model may be applied to different problems of integration and segregation, like blacks and nonblacks in the US, foreign workers in Germany and Switzerland, European integration, protestant-catholic conflict in Northern Ireland, or Bosnia.

1.0 Introduction

Integration and segregation have been investigated under many different aspects of human science, such as psychology and psychiatry [1-4], social science [5-11], population science [12-14] or economics [15,16].

The present work is carried out under the aspect of natural science. Integration (solubility) and segregation (insolubility) of a mixture of gases, liquids or solids will depend on probability and cohesion and may be explained by the statistical model of regular solutions [17]. In this study we will investigate intermarriage, or mixtures of populations like Catholics and Non Catholics in Germany, or Blacks and Non Blacks in the US. Intermarriage is not only an important indicator of social relations within a multicultural society, but it is based on opportunity and preference [12], it has the same mathematical roots as the model of regular mixtures. For this reason we will not only find similarities between the data for liquids and populations, we will also be able to explain the behavior of liquids and populations by the same model.

For societies the model function may be interpreted as a general happiness or preference of a society. The model will lead to a stable society only, if the general happiness or preference is at a maximum. This demonstrates, that societies will follow a maximum utility principle not only in trade but also in marriage and many other aspects as well.

Depending on the parameters of the model function we may discuss several forms of self organization of a society: sympathy between different groups leads to order, equality to integration, apathy to disorder, antipathy to segregation and hate to separation.

2.0 Statistical data for binary mixtures
(Society diagrams)

Five binary societies will be presented: an ideal mixture of white and red blooming peas, intermarriage of Germans and Non Germans in Germany 1993, intermarriage of Catholics and Non Catholics in Germany and Westfalia 1993, intermarriage of Blacks and Non Blacks in 33 reporting states in USA 1988. These data will be compared to an alloy of gold and platinum.

2.1 Mendel's law

(Red and white blooming peas)

Ideal intermarriage of two completely integrated groups will be random and depend on the percentage of each group. It may be derived from Mendel's law of mixing red and white blooming peas. Be x the percentage of red blooming peas and y the percentage of white blooming peas in an ideally mixed field: The colours of the second generation of peas may be calculated from the binomial law,

$(x + y)^2 = x^2 + 2xy + y^2$.

x^2 is the percentage of red blooming peas, y^2 the percentage of white blooming peas, 2xy is the percentage of white + red = pink blooming peas and corresponds to the probability of intermarriage of ideally mixed society. With $(x + y) = 1$ or $y = (1 - x)$ we find

$$P_{ideal}(x) = 2x(1 - x) \qquad (1).$$

P_{ideal} is the probability of intermarriage for an ideally integrated society of two groups. Table 1 shows the percentage P_{ideal} (x) of pink (=red + white) blooming peas in the second generation as a function of the percentage of red blooming peas in the first generation.

x	P_{ideal} (x)
0.0	0.00
0.1	0.18
0.2	0.32
0.3	0.42
0.4	0.48
0.5	0.50
0.6	0.48
0.7	0.42
0.8	0.32
0.9	0.18
1.0	0.00

Table 1 : Percentage P_{ideal} (x) of pink blooming peas in 2. generation as function of percentage x of red blooming peas in 1. generation (after Mendel).

Probability of intermarriage will be low for small number of people of either group. The maximum rate of intermarriage will be obtained for P_{ideal} = 0.5 for equal number of people of both groups, x = 1/2. $P_{ideal}(x)$ is a parabolic function of x, as indicated in Fig. 1.

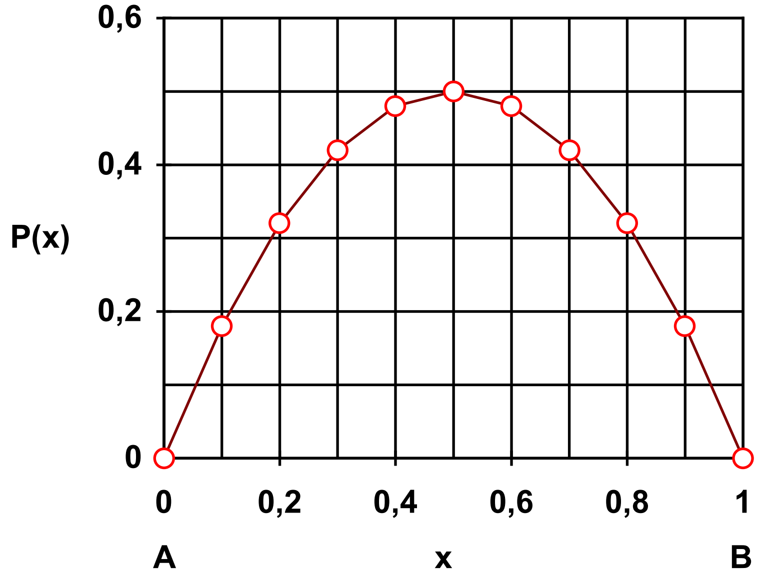


Fig. 1 Probability of intermarriage for an ideally integrated society of two groups A and B, x being the percentage of one group.

The same probability may be expected for ideal intermarriage between two groups A and B in binary societies. This will be investigated for

A = German,	B =	Nongerman in Germany 1993
A = Catholic,	B =	Noncatholic in Germany 1993
A = Black,	B =	Nonblack in USA in 1988
A = Gold	B =	Platinum

2.2 German - Nongerman intermarriage in Germany
In table 2 intermarriage data of German and Nongerman citizen are presented for ten states of Germany [18-20] in 1993. Fig. 2 shows the data to be close to an ideally mixed society.

State	x	P(x)
Baden-Württemberg	11.1	14.1
Bayern	9.2	11.9
Bremen	12.7	14.2
Hamburg	14.4	16.2
Hessen	11.2	15.1
Niedersachsen	4.6	7.1
Nordrhein-Westfalen	7,7	11,1
Rheinland-Pfalz	7.7	12.0
Saarland	7.9	10.3
Schleswig-Holstein	4.1	7.1

Table 2: Intermarriage data of German and Nongerman citizen for ten states of Germany [18-20] in 1993.

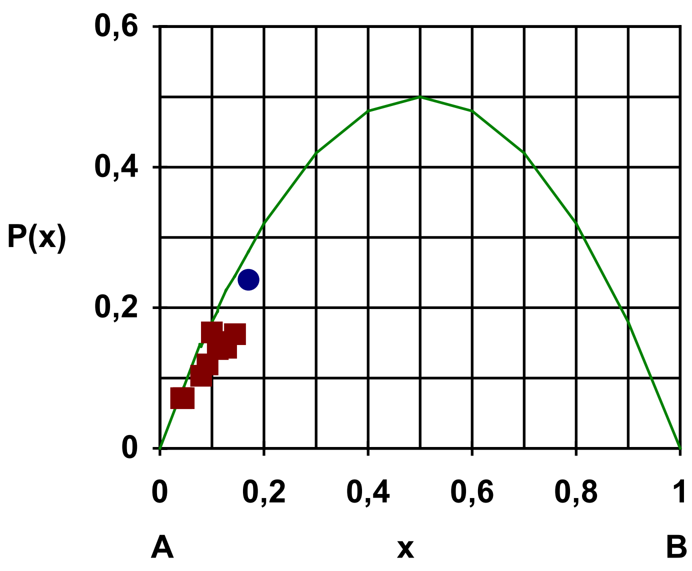


Fig. 2 Percentage of intermarriage P(x) of German and Nongerman citizen as a function of percentage x of foreigners in ten German states 1993. The highest value corresponds to Swiss - Nonswiss intermarriage in CH [18-20]..

2.31 Catholic - Noncatholic intermarriage in Germany

Table 3 shows data for Catholic-Noncatholic intermarriage in ten states of West Germany in 1991-1993. The first column gives the state, the second the percentage of Catholics, the third the percentage P of Catholic-Noncatholic intermarriage in 1991-93 [18-20].

State	**x**	**P(x)**
Baden-Württemberg	43.6	34.6
Bayern	67.2	29.6
Bremen	10	16.5
Hamburg	11.2	14.4
Hessen	29	31.5
Niedersachsen	19,5	19
Nordrhein-Westfalen	49.4	34.8
Rheinland-Pfalz	54.5	33.9
Saarland	67,2	33.1
Schleswig-Holstein	7.7	11.6
Germany (West)	43	29.7

Table 3: Percentage x of Catholics and percentage P of Catholic Noncatholic intermarriage for 6 states of West-Germany in 1991-1993 [18-20]

Fig. 3 a shows the data of table 3. In contrast to Fig. 2 the data do not follow the parabola. The rate of Catholic - Non-Catholic intermarriage is close to 32 % in all states with more than 20 % Catholics, independent of the percentage of Catholics in the state. For states with less than 20 % Catholics, Schleswig-Holstein, Hamburg and Bremen the points are close to the parabola. Only Niedersachsen shows a small deviation.

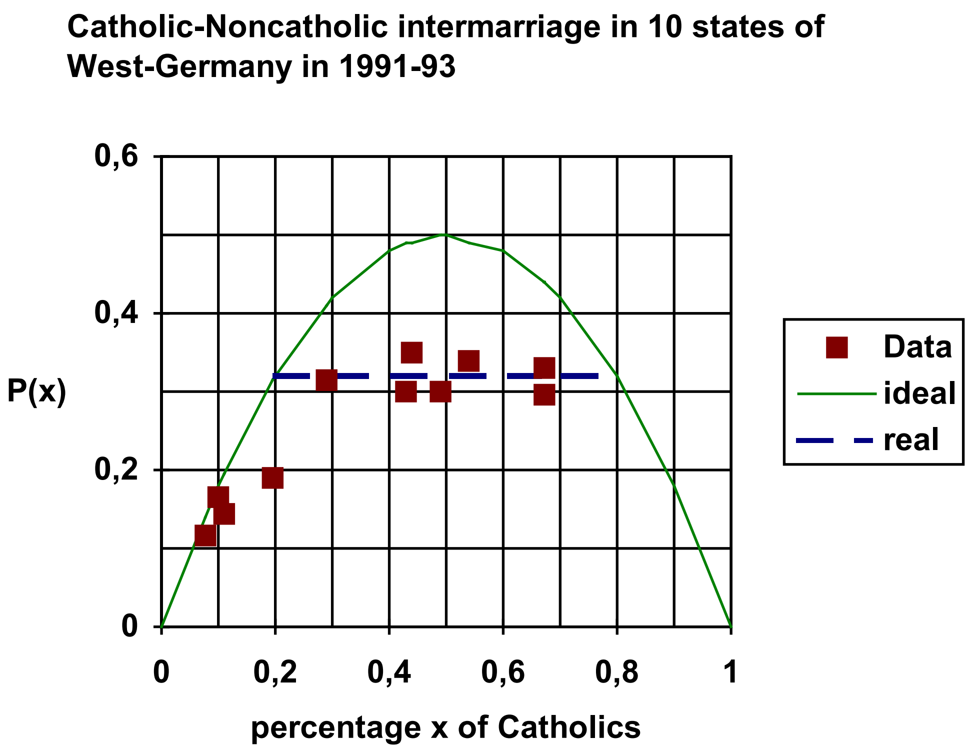


Fig. 3 a: Percentage x of Catholics and percentage P of Catholic Noncatholic intermarriage for 6 states of West-Germany in 1991-1993 [18-20]

This result differs from the rate of intermarriage of Eq.(1) for an ideally integrated society. Indeed, we can explain the rate of P = 32 % in Fig. 3a by two societies, an ideally integrated society with 20 % Catholics, and an ideally integrated society with 80 % Catholics. Accordingly, we have to assume that the German society is segregated, social contact of Catholics are 80 % with other Catholics and only 20 % with Noncatholics, and vice versa.

This result corresponds rather well with the local distribution of Catholics in Germany: parts of the country have catholic minorities and other parts have a catholic majority.

2.32 Catholic - Noncatholic intermarriage in Westfalia

Fig. 3 b shows the ratio of intermarriage and the distribution of Catholics and Protestants in Westfalen with nearly 50 % Catholics and 50 % Noncatholics. The rate of intermarriage is again 32 % and deviates from the ideal rate, which should be P = 50 %. In the map below we see (Black) areas with catholic majority, white areas with Protestant majority and grey areas with nearly equal numbers of Catholics and Protestants, where the local distribution has not been resolved.

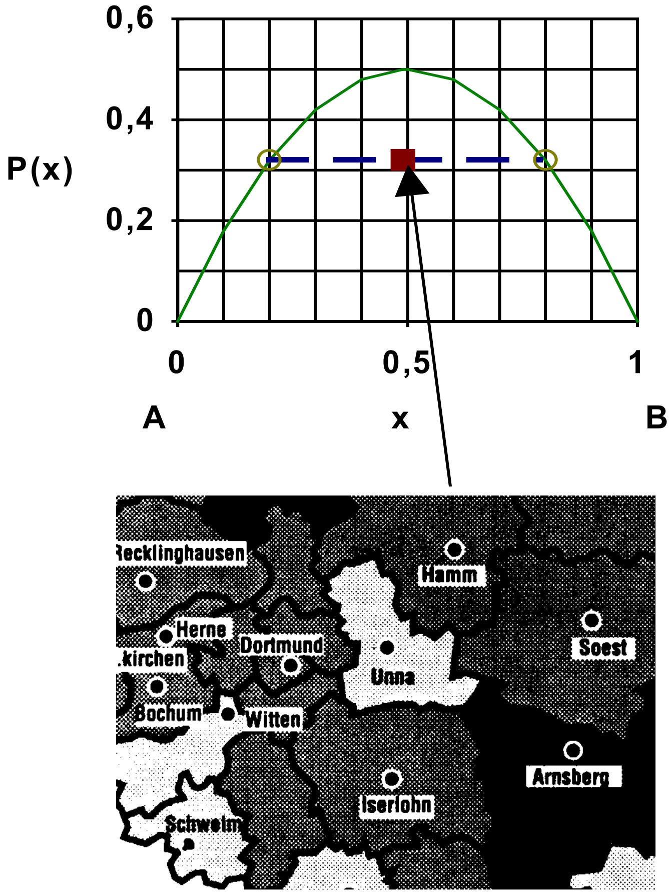


Fig. 3 b : Percentage x of Catholics and percentage P of Catholic Noncatholic intermarriage in the German state of Westfalia in 1991 [19]. The map below shows the segregated areas.

We find: A constant rate of intermarriage like in Fig. 3 b may be explained by segregation of the society. In the next paragraph more data will be presented to support this result.

2.4 Black - Nonblack intermarriage in the US

Table 4 shows the percentage of Black - Nonblack intermarriage for 34 reporting states of the US.

Table 4 : Black - Nonblack intermarriage in the US 1988
National Center for Health Statistics 1988 [21]
Bureau of the Census 1990 [22]

Nr	State	State	$x_B(90)$ %	x_B %	P_{B-NB}%
1.	Alabama	AL	25.3	18.4	1.13
2.	Alaska	AK	4.2	5.3	2.80
3.	Connecticut	CT	8.6	7.4	1.40
4.	Delaware	DE	17.0	14.8	1.60
5.	Florida	FL	13.7	12.5	1.24
6.	Georgia	GA	27.0	19.9	1.37
7.	Hawaii	HI	2.5	2.1	2.20
8.	Idaho	ID	0.4	0.4	0.50
9.	Illinois	IL	15.0	10.6	0.97
10.	Indiana	IN	7.8	6.0	0.96
11.	Kansas	KS	5.8	6.0	1.75
12.	Kentucky	KY	7.2	6.1	1.03
13.	Louisiana	LA	30.9	23.3	0.95
14.	Maine	ME	0.4	0.4	0.49
15.	Minnesota	MI	2.2	2.0	1.30
16.	Mississippi	MS	35.6	26.7	0.60
17.	Missouri	MO	10.7	8.9	1.25
18.	Montana	MT	0.3	0.4	0.34
19.	Nebraska	NE	3.7	3.2	1.16
20.	NHampshire	NH	0.7	1.1	0.96
21.	N. Jersey	NJ	13.8	12.5	1.41
22.	N. Carolina	NC	22.0	17.6	0.96
23.	Oregon	OR	1.7	1.9	2.0
24.	Pennsylvania	PA	9.3	7.4	0.83
25.	Rh. Island	RI	4.3	4.6	0.91
26.	S. Carolina	SC	29.9	22.7	1.46
27.	S. Dakota	SD	0.5	0.8	0.90
28.	Tennessee	TN	16.0	10.7	0.73
29.	Utah	UT	0.7	0.5	0.48
30.	Vermont	VT	0.4	0.3	0.56
31.	Virginia	VA	18.9	17.1	2.07
32.	W. Virginia	WV	3.1	1.6	0.54
33.	Wisconsin	WI	5.0	4.3	1.03
34	Wyoming	WY	0.8	0.8	0.61
	USA 1988	US	12.3	11.1	1.13
	USA 1970		12		0.28

The first three columns give number and state, the 4. column the percentage of Blacks $x_B(90)$ due to the Bureau of the Census 1990 [2] , the 5. column the percentage x_B of Blacks participating in marriage, the last column gives the percentage P_{B-NB} of Black - Nonblack intermarriage.

Fig. 4 shows data points of Table 4 for the rate of intermarriage P of Blacks and Non Blacks for 34 reporting states of the USA [21] as a function of percentage x of Blacks in the particular state.

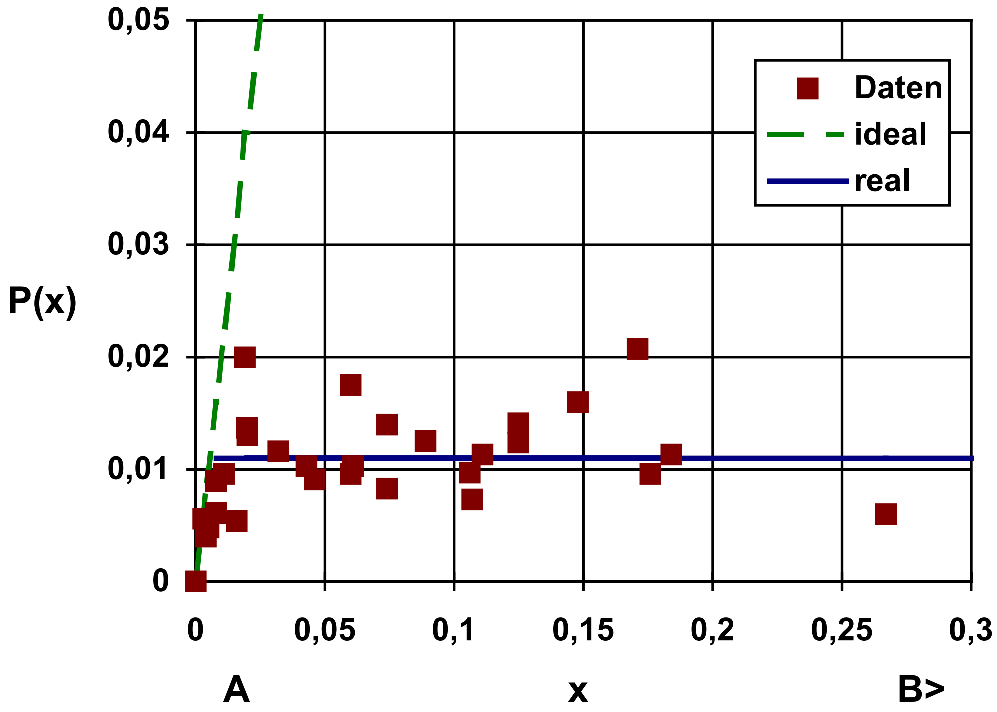


Fig. 4 Percentage of Black - Nonblack intermarriage for 34 reporting states of the US in 1988 [21].

Only for states with a very low percentage of Blacks, like MT, ID, VT, RI or NH the data points follow the dashed line of an ideal integrated society. According to the data a maximum of 0.6 % of Black citizens will be integrated in the US society. For all states with a percentage of Blacks higher than x = 0.6 % the rate of intermarriage does not follow the parabola for an integrated society, but stays nearly constant at P = 1 %. This constant intermarriage rate is obviously independent of the percentage of Blacks: New Hampshire with 1 % Blacks in the state has the same low intermarriage rate as Alabama with about 19 % Blacks. The data for most states are close to the US mean value of P = 1.13 %, the scattering is due to small numbers of intermarrying couples in each state. Intermarriage of Blacks and Nonblacks in the US corresponds to intermarriage of Catholics and Noncatholics in Germany.

2.5 Gold-platinum alloys

In order to understand the data of intermarriage we now turn to physical chemistry of solutions. Let us first look at a cup of tea mixed with a spoon full of sugar. The amount of sugar that will dissolve in a cup of tea depends on temperature. At any constant temperature we may add sugar up to the maximum amount, that is dissolved at this temperature. If we add more sugar at the same temperature, the amount of dissolved sugar will be the same and the additional sugar will drop to the bottom of the cup. The mixture segregates into sweat tea and crystal sugar.

White gold is an alloy that contains gold and platinum. The solid curve in Fig. 5 shows the temperature T that is needed to dissolve a percentage x of platinum in the alloy [23]. At low temperatures only a small percentage of platinum will dissolve, at higher temperatures more platinum may be dissolved. Above T(x) any composition of gold and platinum will form a stable ideally mixed alloy. At a temperature T_1 (dashed line in Fig. 6) a 60 : 40 composition of gold and platinum will not form an ideally mixed alloy. Instead the alloy will segregate into gold with 35 % of platinum and platinum with 15 % of gold.

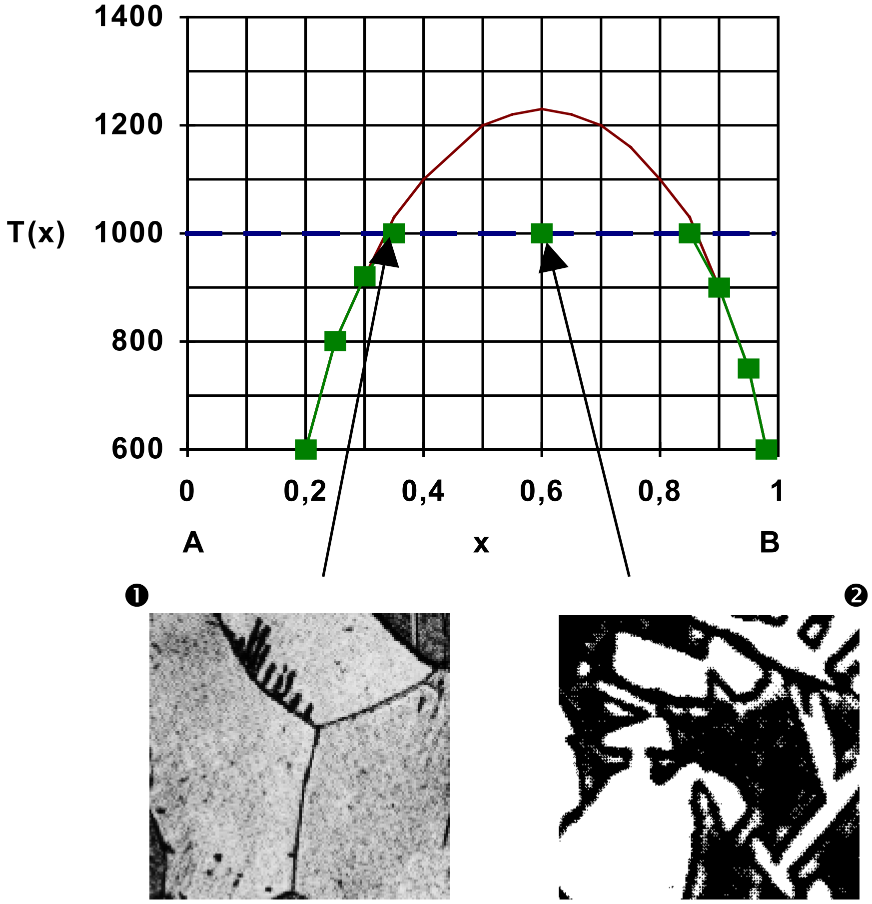


Fig. 5 Phase diagram of gold-platinum alloy with miscibility gap with etched surface below indicating ❶ ideal solution and ❷ segregation into gold- and platinum rich sections [23].

3 The model of regular societies

(Social science and thermodynamics)

The surprising of social and physical data is due to the structure of social and atomic groups. In large societies a person loses the individual character and may be characterised only by group symbols. This effect is often enhanced by uniforms, which will eliminate any personal difference within a group, like for soldiers, policemen, doctors. In a predominantly white society Blacks do not need a uniform, and vice versa.

The phase diagram of gold - platinum alloys in Fig. 5 as well as the solution of sugar in tea correspond to the intermarriage diagrams in Figs. 1-4. All diagrams show an ideal solubility of the minority at a small percentage of the minority. For a larger percentage we find a limited constant solubility, which is independent of the percentage x of the minority.

The analogy of intermarriage data and regular binary solutions is not just coincidence, but due to the same mathematical structure. The model of regular mixtures in natural science is based on probability and cohesion, which corresponds to opportunity and preference in intermarriage. We will now discuss the model of regular mixtures in more detail.

3.1 Opportunity - Probability - Entropy

The model of regular binary solutions is concerned with the mixing of particles or partners of two groups A and B [17]. The model contains two functions: The first is the function S that counts the possibilities to arrange N_A partners of group A with N_B partners of group B. S is called *entropy of mixing* in natural science and may be called *opportunity* in intermarriage:

$$S = \log ((N_A + N_B)! / (N_A! * N_B!)) \quad (2).$$

Due to large numbers we may approximate $\log N_A!$ by the first term in Stirling's formula , $\log N_A! = N_A \log N_A$.

3.2 Preference - Cohesion

The second function of the model E is given by the sum of interactions of A and B partners, E is the *energy of interaction or energy of cohesion* [17] in physical chemistry and may be called *preference* in intermarriage:

$$E = \Sigma \; E_{AB} * (N_A * N_B) / (N_A + N_B) \quad (3).$$

In addition we will introduce the ratio x of group B compared to society:

$$x = N_B / (N_A + N_B) \quad (4).$$

In general we will use x as percentage of the minority of a society, but x will take all values between 0 and 1. We now calculate the model function G(x).

3.3 The model function G(x) of regular societies

The sum of probability and cohesion in Eqs.(2) and (3) leads to the probability function G(x), which corresponds to (negative) *free energy* in natural science. In social science we may regard G(x) as probability function of intermarriage, given by *preference E and opportunity S:*

$$G(x) = E - T S = 2 x (1-x) \varepsilon - T \{ x \ln x + (1-x) \ln(1-x)\} \quad (5).$$

Only the most probable mixture will be realised, the regular solution will be stable only, if the function G(x) is at maximum [17]. The parameter ε reflects the relationship between groups A and B,

$$\varepsilon = (E_{AB} + E_{BA} - E_{AA} - E_{BB}) \quad (6).$$

The value of ε will be positive, if attraction of partners of different groups is stronger than attraction of partners of the same group (sympathy between different groups A and B). ε will be zero, if the attraction is the same for all partners (indifference between the groups A and B), and will be negative, if partners of the same group are more attracted than partners of different groups (antipathy between different groups A and B). The Lagrange factor T in Eq. 5 is called temperature in natural science, the meaning in social science will be discussed, below.

Of course, societies in general will be multicultural, and the model has to be expanded to any number of different groups living in one society. This is easily possible, but for N groups the number of interactions will grow by N^2: for two groups we have four interactions E_{AB}, E_{BA}, E_{AA} and E_{BB}, for ten groups we have 100 interactions! Only for simplicity we will restrict the calculations to binary societies.

3.4 Primary groups

In the literature a small group with personal relations between all group members is called a primary group [25-27]. In this *primary group* a person gathers the primary social experience by personal contact. Primary groups cannot be treated by the model of regular societies.

3.5 Groups in regular societies

Large groups without personal ties are called secondary groups [25-27]. We have discussed several large binary societies that show intermarriage diagrams similar to phase diagrams of regular solutions. Obviously, *large groups of eople in certain situations* may be treated by the model of regular mixtures.

A *society* consists of a large number of different people, which are tied together by a positive bond, like the U. S. society, the residents of a city, the visitors of a stadium. In a large society a personal relationship between all people will be impossible. Instead a person may divide an unfamiliar society into different *groups*. A (secondary) *group* is characterised by a certain familiar *label* like sex, race, language, belief, education, income, caste, lifestyle or any other mark, that a person has chosen, achieved or has been born into. The experience gained from small primary groups may be applied to large societies. By subdivision the unfamiliar society may be sorted into several groups with a familiar label. A group may be regarded as a society again, and be divided into subgroups. In this way an unfamiliar society could be subdivided into many familiar small groups.

The experience gained from the primary group is usually not rational but subconscious, the reaction to a certain label will be emotional. This effect is very pronounced, if the label is given by a uniform. The uniform of a policeman will demonstrate authority, the white coat of a medical doctor will give confidence, the suit of a business manager asks for trust. A person will react by the corresponding emotions to any member of the group, replacing the non existing personal relations by an emotion. This effect is used intentionally by many professions, like priests, soldiers, porters. Blacks and foreigners do not need a uniform. The conformity of groups makes it possible to apply the model of regular solutions of atoms to people, because in large societies they have lost their individuality.

Emotions within groups (E_{AA}, E_{BB}) and between different groups of people (E_{AB}, E_{BA}) are defined by the *group label* and by the *situation* or *circumstances* of the groups, as has been demonstrated by the examples above. Women and men are attracted in a dance and may be separated by sports, Blacks and Whites may be attracted as traders and separated as residents.

In a multicultural society emotions between groups will form different types of relationships like order, integration or segregation, aggression between the same people of a society. A society will be called regular, if the model of regular mixtures applies. In this case all functions of statistics for groups of identical atoms may be translated to groups of similar people.

3.6 Four possible ways of order in regular societies

We now apply model function G (x, ε, T) to large groups of people. The state of the society and the satisfaction G of the people depend on the relative size of the groups x, on sympathy or antipathy ε between different groups and on the factor T. For a stable society of partners (atoms or people!) the function G has to be at its maximum. This leads to four different kinds of society.

4 The ideal society, $\varepsilon = 0$

(Integration and disorder by indifference or apathy)

In binary societies with equal strong relations between equal or different partners we have $\varepsilon = (E_{AB} + E_{BA} - E_{AA} - E_{BB}) = 0$. Accordingly the model function G(x) will be given by Fig. 6 a :

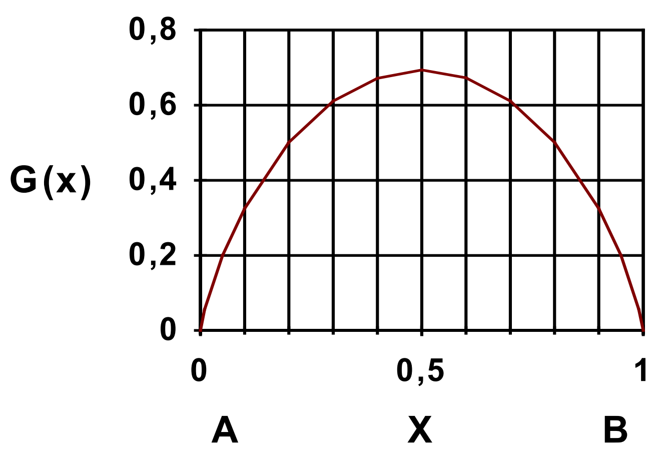


Abb. 6 a : The model function G(x) of an ideally integrated binary society as function of percentage x of one group for $\varepsilon = 0$.

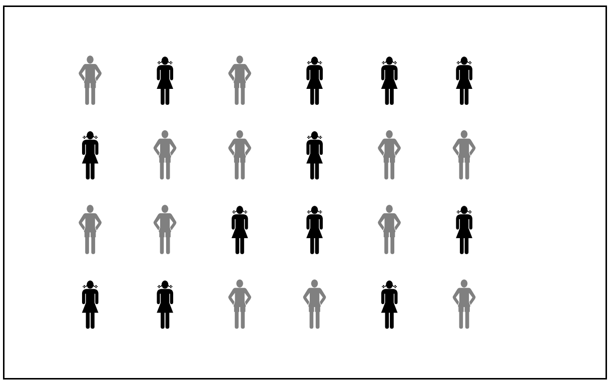


Fig. 6 b : Disorder of an ideally integrated binary society with groups A and B.

We may discuss three examples of integrated binary societies:

Whine as mixture of water and alcohol
Water and alcohol will mix nearly ideally. Fig. 6 a shows the free energy G(x) of the mixture. There is no preferential interaction between equal or different neighbours, $\varepsilon = 0$. The arrangement of water and alcohol molecules will be random at any moment, whine is a completely disordered and homogeneous liquid at any time, as indicated in Fig. 6 b.

Party of boys and girls at refreshments after dancing
After square dancing refreshments are served, and everybody stands in line. Since everyone is very thirsty, the shortest line will be selected and (at the moment) it will make little difference, if a girl or a boy is in front. We now have $\varepsilon = 0$ and a random homogeneous distribution of boys and girls, as shown in Fig. 6 b.

Black and whites shoppers
In a downtown supermarket in Washington, DC we will find a random distribution of Blacks and Whites in the cashier lines. For busy shoppers a short cashiers line will be more important than a Black or white neighbour. The resulting value of ε will be zero and corresponds to indifference. The society of Black and white shoppers according to Fig. 6 b is mixed by chance or integrated.

The meaning of the function ε will depend on the system observed. In natural science ε will be the energy of cohesion, in social science we have two possibilities:

Homogeneous distribution
Equal partners are as attractive as unequal partners, we then have

$$\varepsilon = (E_{AB} + E_{BA} - E_{AA} - E_{BB}) = 0$$

This leads to a homogeneous distribution of different partners.

Apathy
If we find no interaction between partners,

$$\varepsilon = E_{AA} = E_{AB} = E_{BA} = E_{BB} = 0$$

this may be called apathy between partners.

5 The multicultural society, $\varepsilon < 0$

(Segregation by antipathy)

Multicultural means a strong attachment of a group to its own cultural heritage. If the attraction between equal partners is stronger than the attraction between different partners, the value of ε in Eq. (6) will become negative, or $\varepsilon < 0$. The function $G(\varepsilon < 0)$ in Eq. (5) and in Fig. 7 a now has two maxima instead of one. The first maximum is obtained at a small value x_1, the second at a large value x_2.

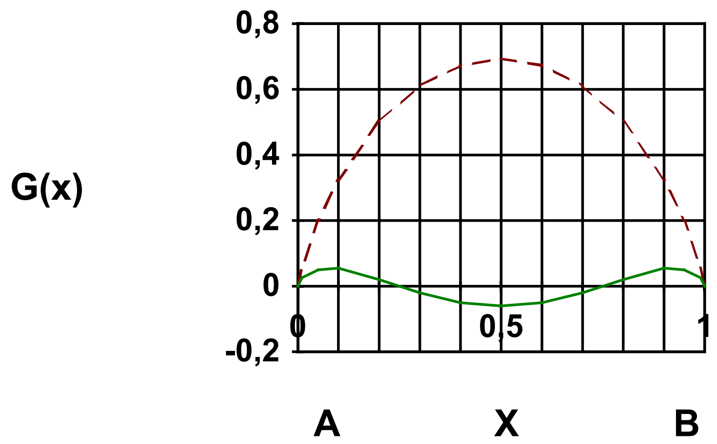


Fig. 7 a Model function G(x) of an A - B society for $\varepsilon < 0$, x is the percentage of group B. G(x) has two maxima, one at a small value x_1, the second at a large value x_2.

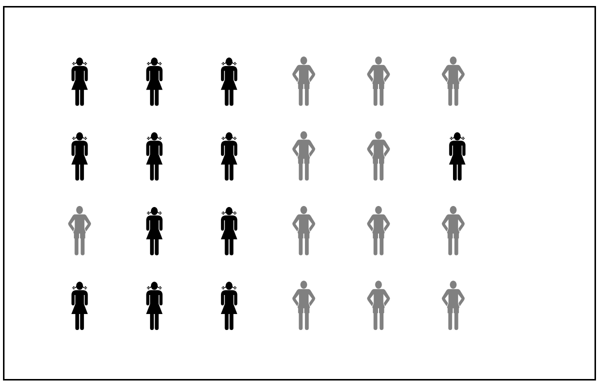


Fig. 7 b Segregation of a binary society

Cup of tea with sugar
Tea and sugar only mix at a limited amount, we have $\varepsilon < 0$. The (negative) free energy in Fig. 7 a has two maxima, one for tea with little sugar, the other with sugar and little crystal water. Fig. 7 b shows a model for the two separated phases, sweet tea and sugar with crystal water at a composition x = 0.5. If the temperature is raised, a larger amount of sugar may be solved.

Alloy of gold and platinum atoms.
In white gold, an alloy of gold (Au) and platinum (Pt) atoms of the same group will be attracted more than different atoms, we have $\varepsilon < 0$. The (negative) free energy in figure 9 a has two maxima, one for Au with few Pt atoms, the other with Pt and few Au atoms. Figure 7 b shows a model for the two separated phases of the alloy at a composition x = 0.5. Fig. 8 a shows the etched surface of a binary alloy a at composition x = 0.5.

The degree of segregation in general will not be 100 % and depends on temperature. Only if the equilibrium temperature is close to zero, we find complete segregation into the two components.

Party of boys and girls talking about football.
After dancing some people start to discuss the latest football results. In general boys are more interested in football than girls, and we find boys being more attracted to other boys talking about football than to girls, who are may prefer not to speak about football, we find $\varepsilon < 0$. Fig. 7 a shows the mutual satisfaction G(x) of the society as a function of the percentage x of girls.

For $\varepsilon < 0$ the function has two maxima, one part of the society with few girls and mainly boys is most satisfied to talk about football and the second part of the society with mainly girls is most satisfied not being forced to listen to sports, perhaps they prefer to talk about fashion. The society segregates according to Fig. 7 b into mainly boys and mainly girls. This way both parts of the society are satisfied.

The degree of segregation in general will not be 100 % and depends on tolerance. Only if the tolerance of girls to listen to sports is close to zero, we find complete segregation into the two groups.

Black and white neighbourhood.
Figure 7 a shows the mutual satisfaction G(x) of a society of Black and white neighbours for $\varepsilon < 0$ as a function of percentage x of Blacks: We have again two maxima, one maximum is obtained, if the percentage of Black neighbours is low and the white people feel at home, the other maximum is obtained at a high percentage of Black neighbours, where Blacks people feel at home.

Figure 7 b shows the corresponding distribution of Black and white neighbours in a town of 50 % Blacks. In order to obtain the maximum of satisfaction the town will segregate into areas with mostly white and few Black residents, and areas with mostly Black and few white residents. This way Blacks and Whites will feel at home. (Of course, in Black-white neighbourhoods

Fig. 8 a: *The segregated alloy:* Etched surface of brass (58 % copper).

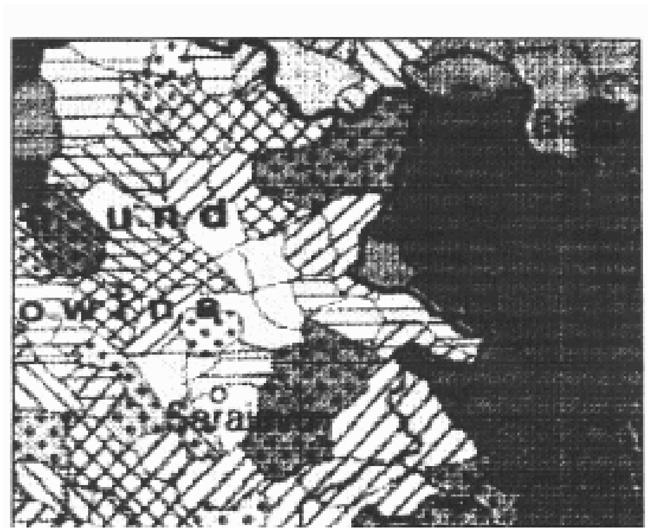


Fig. 8 b: *The segregated society:* Bosnia in 1991
(From Dierke Weltatlas, p.99, Westermann Schulbuchverlag, Braunschweig 1991).

we also have the aspect rich - poor, but in most places segregation will take place between poor white and poor Black residents.)

The degree of segregation in general will not be 100 % and depends on the tolerance of Blacks and Whites to live together. Only if the tolerance is close to zero, we find complete segregation into the two groups.

Serbs and Croats in Bosnia

Bosnia is a society of Serbs and Croats (and Moslems, which we will neglect for a moment). Both groups apparently dislike each other, we have $\varepsilon < 0$. Fig. 7 a shows the mutual satisfaction of Serbs and Croats to live together in Bosnia. G(x) has maxima for two compositions, the first, if there are almost only Serbs, the second, if there are almost only Croats. Fig. 7 b shows the model segregation of Serbs and Croats. In Fig. 8 b the map of Bosnia in 1990 shows the distribution of Serbs and Croats.

The degree of segregation in general will not be 100 % and depends on the tolerance of Bosnic people to live together. Only in times of war, when tolerance is close to zero, we find complete segregation into the two groups.

Fig. 8 b corresponds to the distribution of atoms in binary alloys in Fig. 8 a, indicating the close structural relationship between alloys and societies.

Segregation is due to the negative value of ε, and we may now discuss in more detail the reason for segregation.

The parameter $\varepsilon = (E_{AB} + E_{BA} - E_{AA} - E_{BB})$ contains four different emotions:

E_{AA}, E_{BB}: These are the attractions within the groups. They are always positive and will keep the groups together. Examples for E_{AA}, E_{BB} are common language or dialect, heritage, tradition, religion. These "positive" emotions always enter ε with a negative sign and promote segregation!

E_{AB}, E_{BA}: These are the attractions between the groups. In tolerant societies these are also positive feelings, like curiosity, friendship or interest. However, the interest for the own group is usually larger than for other (unknown) groups and we obtain $E_{AB} + E_{BA} < E_{AA} + E_{BB}$ or $\varepsilon < 0$. In spite of positive emotions between different groups the society will segregate!

5.1 Tolerance in multicultural societies
(Tolerance as temperature of a regular society)

We now have to discuss the meaning of temperature T, which is an important parameter. A cup of tea will not just be hot or cold, but will have a certain temperature T. In a cup of tea with sugar we can determine the temperature of the tea by measuring the amount of sugar dissolved. Cold tea will dissolve little, hot tea a lot of sugar. Accordingly, we may find the "temperature" of a social system by measuring the percentage of a minority that has been integrated. We would call a society with a high rate of integration a "tolerant" society. We may thus define *tolerance* (similar to temperature) by "*the ability to make contact to members of a different group in spite of a certain antipathy*".

Accordingly, the degree of segregation in Black and white (or Croats and Serbs) neighbourhoods in general will not be 100 %, but somewhere in between. Only if the tolerance between different groups is close to zero, we will only find Black "Homelands" and white Ghettos or areas with only Kroats or only Serbs.

We may calculate T from Eq.(4). The probability function G(x), Eq. (4) is always at its maximum, the slope of G(x) will always be zero, $\partial G/\partial x = 0$ or

$$\partial G/\partial x = - T\{\ln x - \ln(1-x)\} + 2\varepsilon(1-2x) = 0 \qquad (7).$$

This equation may be solved for T and leads to phase diagram in Fig. (5):

$$T(x) = 2\varepsilon(1-2x)/\{\ln x - \ln(1-x)\} \qquad (8).$$

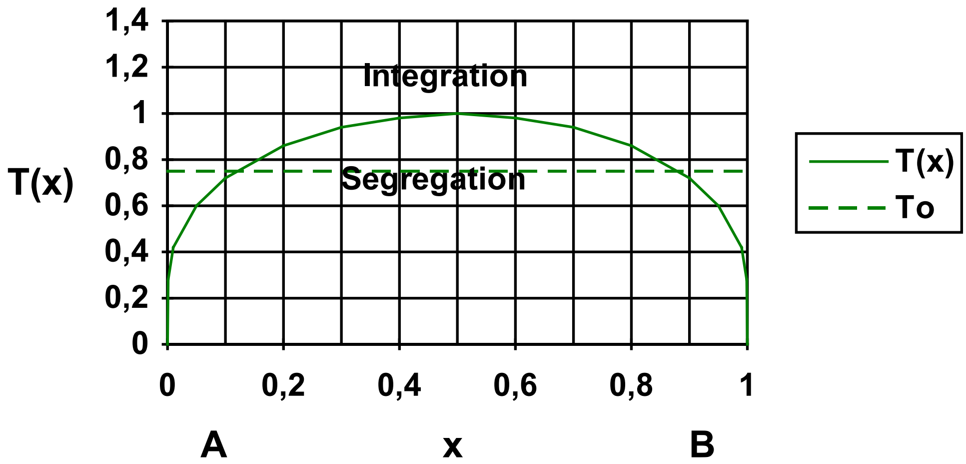


Fig. 9: T(x) of a regular A- B society according to Eq. (5) as function of the percentage x of group B with $|\varepsilon| = 1$.

In Fig. 9 T(x) is given as a function of percentage x of the minority B. Like in Fig. 5 the function T(x) is interpreted as equilibrium temperature needed to solve a given percentage x of platinum in gold. In social science T(x) may be interpreted as mutual tolerance needed to integrate a given percentage x of people of different origin into the society.

Au-Pt: A gold-platinum alloy with $\varepsilon < 0$ segregates into a gold rich and a platinum rich phase. Only for T = 0 the alloy would dissociate into pure gold and pure platinum.

Black-white: A Black and white society segregates into predominantly white and predominantly Black neighborhoods. Only at zero tolerance the society will dissociate into purely white and purely Black "Homelands".

Catholic-Protestant: According to Figs. 3 a and b the German society is segregated into predominantly catholic and predominantly Protestant areas. But also in areas with 50:50 distribution a more detailed map will show segregation again. Due to high tolerance the areas are not purely Protestant or Catholic.

Obviously, the model parameter T may be interpreted as tolerance of a society. Like at high temperature a society will be well mixed at high tolerance. According to the model we may define T as :

Tolerance is the readiness to contact people, which we tend to keep away from, because they are different.

Fig. 9 shows the relation between tolerance T and group size x, and may be regarded as a model of integration:

$T > |\varepsilon|$: At a high level of tolerance higher than antipathy $|\varepsilon|$ between different groups a society will be totally integrated for any size of a minority. The distribution is completely random as in Fig. 6 b.

$T < |\varepsilon|$: If tolerance T is lower than antipathy $|\varepsilon|$ between different groups, a society may only integrate a certain percentage x_1 of a minority, given by $T(x_1)$. The society will segregate, the degree of segregation depends on the ratio of antipathy and tolerance $|\varepsilon| / T$.

T = 0: At zero tolerance a society desegregates completely into the pure groups. Examples are Homelands, concentration camps, Ghettos.

Tolerance T(x) in Fig. 9 and the ideal rate of intermarriage P(x) in Fig. 1 run parallel and are closely related. The rate of intermarriage may be taken as a meter of tolerance of a society.

Fig. 10 shows the rate of intermarriage of Germans and Non Germans between 1950 and 1990 in Germany. Accordingly, tolerance in Germany has risen between 1950 and 1990 by 100 %.

Fig. 10 Rate of intermarriage of Germans and Nongermans in Germany between 1950 and 1990

6 The ordered society, $\varepsilon > 0$

(Attraction between different groups)

If attraction between different groups is stronger than attraction within the groups, e. g. men and women at marriage age, the parameter ε will be $\varepsilon = (E_{AB} + E_{BA} - E_{AA} - E_{BB}) > 0$. Function G(x) in Eq. (2) for $\varepsilon > 0$ is given by Fig. 11 a.

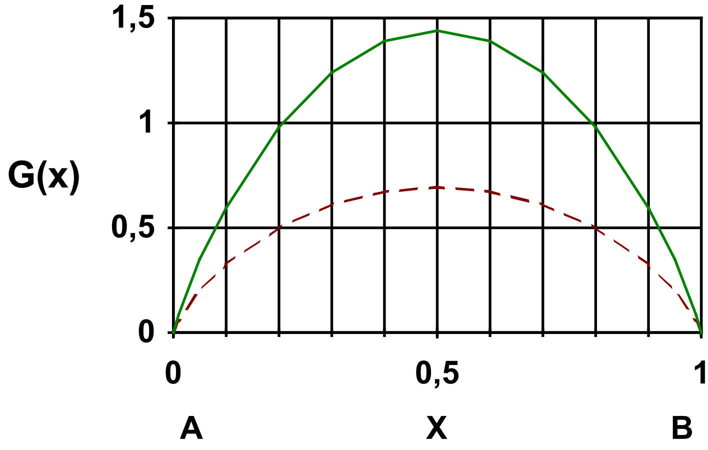


Fig. 11 a: The model function G(x) for $\varepsilon > 0$ is larger than for $\varepsilon = 0$. The maximum is found at x = 0,5 ore equal size of groups A and B.

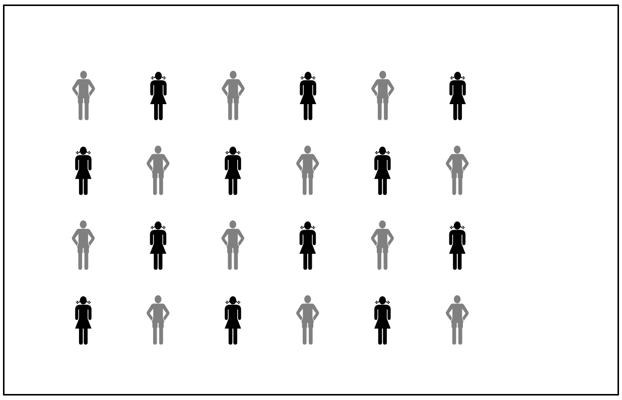


Fig. 11 b : Due to the stronger attraction between A and B we obtain an ordered A-B society.

Sodium and chlorine ions in rock salt NaCl.
In rock salt the attraction of sodium (Na) and chlorine (Cl) ions is much stronger than the attraction between Na-Na or Cl-Cl, and $\varepsilon > 0$ in Eq. (3) applies. In Fig. 11 a the function G(x) is shown for $\varepsilon > 0$. The (negative) free energy G will be low for a small percentage of Na ions or Cl ions. The stable compound is given for the maximum of G(x) at equal numbers of Na and Cl ions at x = 0.5.

Due to the strong Na-Cl attraction rock salt will crystallise into a structure that has a maximum of A-B neighbours. This is the ordered ABABA structure, as shown in Fig. 11 b.

At low temperatures the atoms will stay fixed to their initial position. At high temperatures some atoms will move and trade places by maintaining the ABABA order.

Society of boys and girls at dance.
In dancing the attraction between boys and girls is generally stronger than the attraction between either boys or girls, and $\varepsilon > 0$ in Eq. (3) applies. Fig. 11 a shows the function G(x) for $\varepsilon > 0$. Mutual satisfaction about dancing will be low, if there are only few girls or only few boys. The maximum of mutual satisfaction will be obtained for equal number of boys and girls.

Due to the dominating attraction between boys and girls at the dance boys and girls will arrange in an ABABAB order with a maximum of A-B bonds, as shown in Fig. 11 b.

If a dancing couple is in love, they will usually dance together most of the time. Otherwise, they may trade partners more often during the dance.

Blacks and Whites at market in Africa.
A group of white tourists is visiting a village fair with wonderful masks in Kenya. White buyers are attracted more to Black sellers than white buyers are to white buyers or Black sellers to Black sellers, we have $\varepsilon > 0$. Mutual satisfaction (including economic gain) will be low, if there are few sellers or few buyers. The maximum of mutual happiness in Fig. 11 a will be at equal numbers of white buyers and Black sellers, x = 0.5. Due to the strong Black-White attraction we then find the market society in an ABABA order of white buyers at the tables of the Black sellers, as shown in Fig. 11 b.

If there had been old trade relations before, we would find the same buyers and sellers together. The tourists, however, with no trading bonds will move from one stand to the other.

6.1 Order and tolerance
(Loyalty as intolerance in ordered societies)

A high temperature in ordered NaCl breaks up the bonds between the Na and Cl ions and leads to a change in partners. In ordered structures a high temperature leads to more disorder and mixing of partners.

In ordered societies, like in marriage or trade relations a change in partners will be regarded as unloyalty. An ordered societies prefers loyalty, which corresponds to a low temperature of society and tends to be less tolerant.

In fig. 11 a ($\varepsilon > 0$) we find only one maximum for the model function G(x) at x = 0.5 for any temperature. This is shown in Fig. 12.

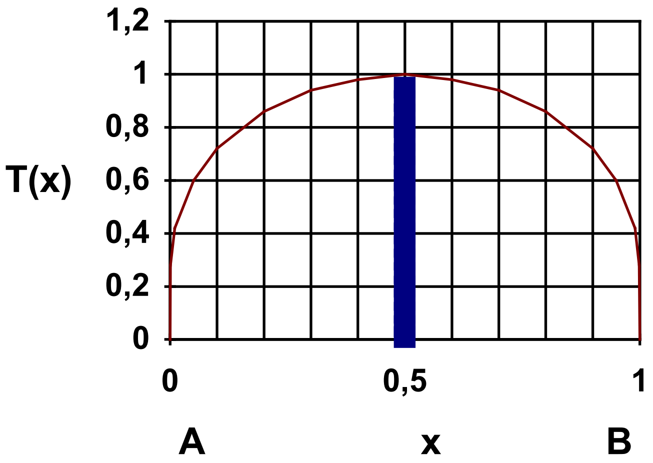


Fig. 12 Phase diagram of an ordered A-B compound (GaAs), or tolerance of an ordered society ($\varepsilon > 0$). Stability is given for x = 0.5, only.

For $\varepsilon > 0$ an order of partners A and B will be possible only, if groups A and B will have equal numbers, x = 0.5. If the groups have unequal numbers, we find ordered pairs and a disordered rest.

NaCl: At low temperatures NaCl pairs are tightly bonded. At higher temperature the bonds will break up, and we will find some vacancies or ions without partners. At very high temperatures all bonds will break up and we find a new disordered phase.

male-female: At low tolerance (high fidelity or high loyalty) partners are tightly bonded. At higher tolerance we will find some partners divorced.
Accordingly, we may expect the rate of divorce to be a meter of tolerance. In Fig. 13 a we find the rate of divorce in Germany between 1950 and 1990.

Rate of intermarriage of Germans and Foreigners in % and rate of divorce per 1000 existing marriages in Germany

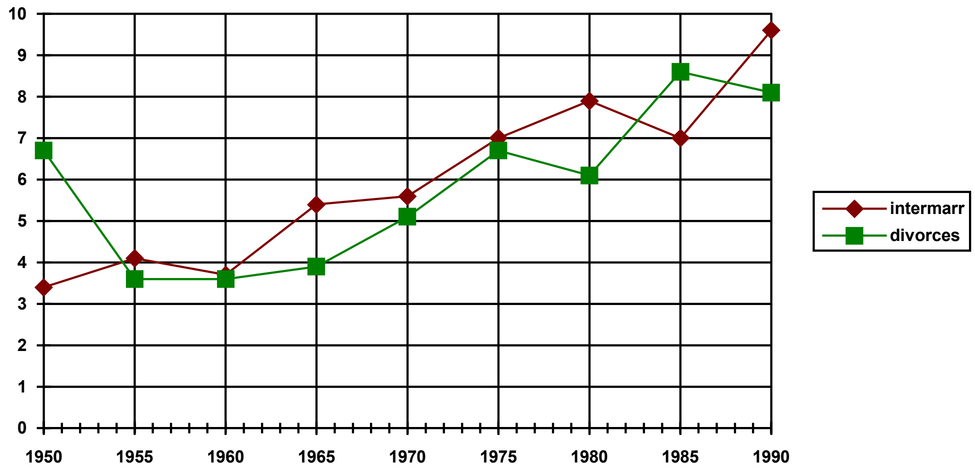


Fig. 13 a Rate of divorce and rate of German-Non German intermarriage in Germany between 1950 and 1990.

Rate of divorce per 10000 inhabitants in USA, Germany, DDR and in Switzerland

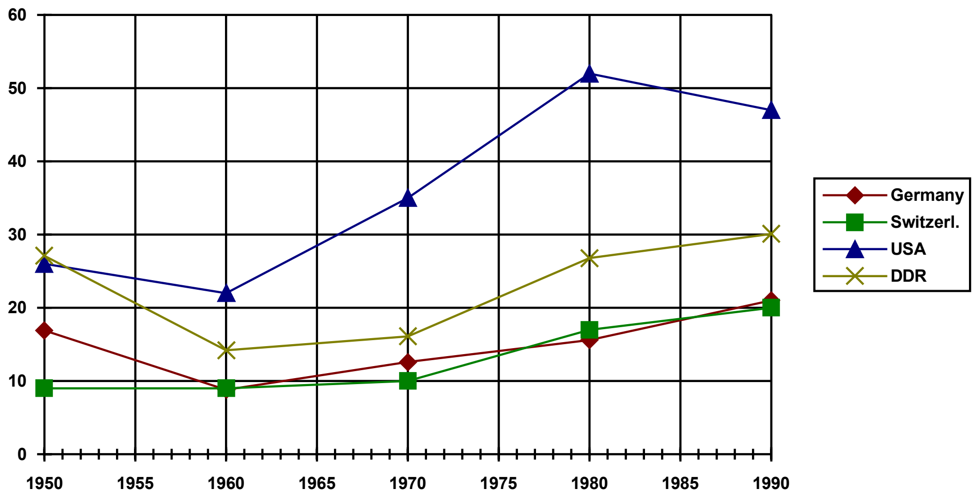


Fig. 13 b Rate of divorce in U.S.A., Germany, GDR and Switzerland between 1950 and 1990.

In Fig. 13 a the rate of divorce is compared with another meter of tolerance, the rate of intermarriage of Germans and Nongermans of Fig. 10. Both rates show nearly the same results, both rates have doubled in Germany within the last 40 years. The good agreement of tolerance meters in Germany indicates that the rate of divorce may be a good meter of tolerance between different societies.

It may be expected, that the male-female bonds will be similar in comparable societies. The rate of divorce will then depend only on the tolerance of a society. Fig 13 b compares the rates of divorce in the US, in West Germany, the GDR and Switzerland between 1950 and 1990. The rates start at a low rate in 1950 to 1960 and have risen mainly between 1960 and 1980. In comparable societies, like the US, Germany and Switzerland, the absolute values of the divorce rate may also indicate the tolerance in each societies. Apparently, Switzerland and Germany show nearly the same tolerance, which is also indicated by the same rate of intermarriage between Catholics and Non Catholics in both countries. Tolerance seems to be higher in the US. The high tolerance in the GDR is due to the different (communist) system, and cannot be compared to other (democratic) systems.

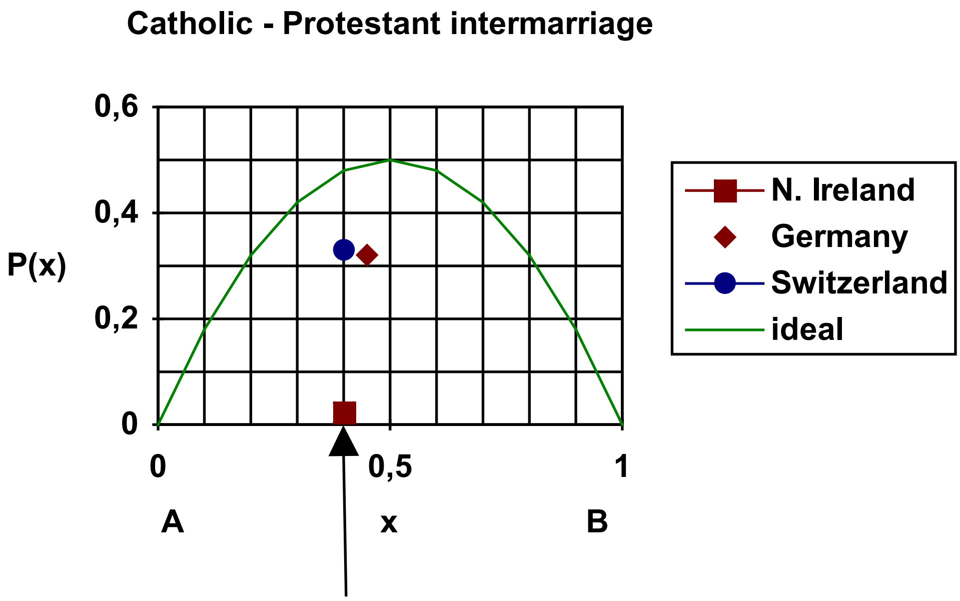
We finally have to discuss, why low tolerance in a society is closely related to aggression. This will be investigated in the next section.

7 The aggressive society, $\varepsilon < 0$ and $T < 0$.

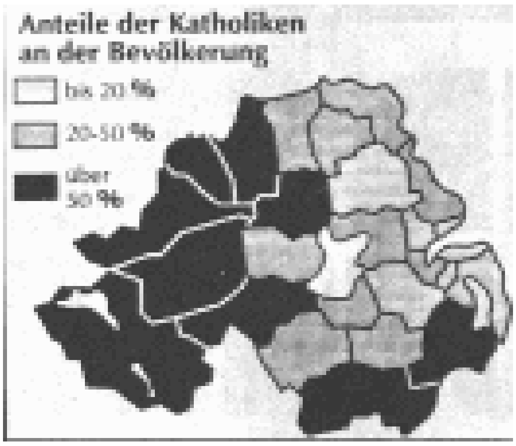
(Aggression as negative tolerance of societies)

A low tolerance in antipathetic societies leads to the formation of Ghettos, and we know from experience, that this situation is always close to violence. A typical example is the relationship of Protestants and Catholics in Switzerland and Germany compared to Northern Ireland.

Catholics and Protestants in Switzerland, Germany and Northern Ireland.
According to Fig. 12 tolerance T will be equivalent to the rate of intermarriage. Fig. 14 a shows the rate of intermarriage of Catholics and Protestants in Switzerland, Germany and Northern Ireland in 1993. In Fig. 14 a the rate of intermarriage of Catholics and Protestants in Germany and Switzerland in 1993 is compared to Northern Ireland. Switzerland, Germany and Northern Ireland have about the same percentage of 40 % Catholics. However, the rates of intermarriage differ drastically. The rate of intermarriage of Catholics and Protestants in Switzerland and Germany in 1993 is P = 32 % compared to Northern Ireland with P = 2,5 %.



14 a



14 b

Fig. 14 a Rate of intermarriage of Catholics and Protestants in Switzerland, Germany (P = 32 %) compared to Northern Ireland (P = 2,5 %) in 1993.

Fig. 14 b Distribution of Catholics and Protestants in Northern Ireland. The map indicates segregation, but only a more detailed map will show the high degree of segregation [24].

The low degree of Catholic - Protestant intermarriage reflects the low tolerance in Northern Ireland. This is related to the danger of aggressive acts, that have been observed in this country for many years. The low rate of integration in Fig. 14 a is due to segregation, this is indicated in Fig. 14 b. The map shows the segregation of Catholics and Protestants in Northern Ireland. However, only a more detailed map will show the high degree of segregation in this country.

The high rate of intermarriage in Germany and Switzerland indicates, why nobody expects Catholics and Protestants to shoot at each other in these countries.

Aggression: This result leads to a definition of tolerance and aggression within the model of regular societies:

Positive feelings between different groups (E_{AB}, $E_{BA} > 0$) in a society lead to tolerance or T > 0.
Negative emotions between different groups (E_{AB}, $E_{BA} < 0$) in a society lead to aggression, T < 0.

This result corresponds to the unstable equilibria like mixed hydrogen and oxygen or laser inversion, which may be regarded as a model for "negative temperature". They are improbable states, that will be changed by a spontaneous reaction.

In societies aggression is equivalent to negative tolerance. This explains, why low tolerance in an antipathetic society ($\varepsilon < 0$) is closely connected to aggression. Low tolerance brings a multicultural society into the state of instability and aggression.

7.1 The model of integration, segregation, aggression

The model of tolerance in Fig. 9 has to be adjusted to aggression. In a multicultural society we observe the states of integration, segregation and aggression in Fig. 16.

High tolerance of an antipathetic society leads to integration and random distribution of A and B partners. The society is stable for any percentage x of a minority.

At lower tolerance a binary antipathetic society will segregate into parts with mainly group A and parts of the society with mainly group B. The stable distribution of A and B depends on tolerance and is given by T(x) in Fig. 15.

Negative tolerance in an antipathetic society leads to aggression, the A-B society is unstable and will be destabilised, spontaneously. We may discuss the model of tolerance in more detail. Six points have been marked:

Model of integration, segregation and aggression in multicutural societies

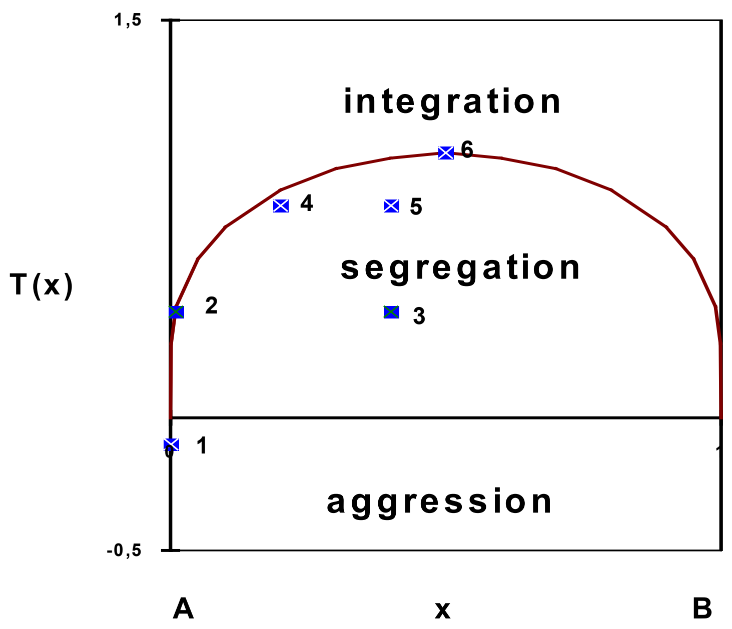


Fig. 15 Model of tolerance T(x) of a binary antipathetic society ($\varepsilon < 0$): High tolerance leads to integration, low tolerance to segregation and negative tolerance to aggression.

❶ (Serbs and Croats in Bosnia in 1995) At negative tolerance the aggressive group A will be ready to attack group B. Point 1 in Fig. 15 corresponds to the state of war.

❷ (Blacks in New Hampshire) A small percentage of a minority will always be integrated, as the tolerance is sufficiently high. The actual tolerance may even be much higher. The small minority will not have much influence on the society and will due to integration be absorbed in a few generations, unless more people of the minority move in.

❸ (Catholics and Protestants in Northern Ireland, or Blacks in Mississippi) The high percentage of a minority will not be integrated at low tolerance. The society is segregated, and due to segregation the minority will survive for many generations. The high percentage of the minority will have a strong effect on the society, and the low tolerance of this state leads to tensions and aggressions.

❹ (Foreigners in Switzerland) At high tolerance a larger percentage of a minority will be integrated. The minority will have some visible effect, but it will be absorbed again after a few generations.

❺ (Catholics and Protestants in Germany or Switzerland) A large percentage of a minority may not anymore be integrated even at rather high tolerance. The society will segregate into areas with changing majorities. Due to high tolerance this leads to a peaceful multicultural society.

❻ (Second or third generation Europeans in the US) When tolerance is above antipathy ($T > |\varepsilon|$), any percentage of a minority will be integrated. The participating groups lose their group identity and form a new society. In alloys this is called a phase transition. Accordingly, most former Europeans in the US have lost their language and customs and have been "melted" into the new US society.

We may find many examples for the model of changing tolerance in regular societies in different social, military, economic and biological systems.
The functions and the corresponding terms have been listed in Table 5.

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