

ON THE BINDING IN $A^n B_M^3$ PHASES

K. Schubert

Max-Planck-Institut für Metallforschung, Institut für Werkstoffwissenschaften
Seestraße 75, 7000 Stuttgart 1, FRGermanySummary

The systematic assignment of bonding types (bindings) to two-component alloy phases given previously for AB_M^4 phases is continued for Al, Ga, In, Tl as a second component. The values of T temperature and mole fraction dependent valence electron contribution (\underline{b} contribution) of the A^n components as found in earlier analyses have been confirmed. The rule of decrease of number $N_{P^n}^{P'}$ (N_2) of peripheral core electron correlation places (\underline{c} correlation places P^n) per \underline{b} correlation place (P'), with increasing mole fraction N_2 holds in the present alloy class. In $A^{10..11} B_M^3$ mixtures the $N_{P^n}^{P'}$ (N_2) function displays a distinct plateau for the two-factorial isotypic bindings XX2. This plateau is characteristic for the brass-like mixtures. It appears that within the plateau the closer packed binding is stable at the greater valence electron concentration N_D^A . The $A^{12..13} B_M^3$ mixtures cannot permit XX2 as this binding is limited to the valence electron concentration $N_D^A \approx 1.5$ (generalized rule of Hume-Rothery). The rule of Raynor that A^n Atoms may absorb \underline{b} electrons in Al rich alloys has been confirmed. This absorption causes suppression of paramagnetic susceptibility and decrease of distance $\underline{d}(A, Al)$ (rule of W.H.Taylor). For several phases as Fe_3Al or $NiAl$ the assumption must be made that the 3sp electrons are in correlation with the 3d electrons (great count) while in neighbouring phases this is not the case (little count); it appears that the transition temperature of this change is in some alloys nearly equal to the Curie temperature. Also the great count may cause a smaller mean atomic volume than the little count. Further energetic arguments emerge for lacuna homeotypism (L), filling homeotypism (F), deformation homeotypism (D), displacing homeotypism (I), shear homeotypism (S), and chain shear homeotypism (C). An interpretation of new transformations found recently in $FeAl_M$ alloys is proposed. The model also suggests possible high pressure structural transformations. The binding analysis of the more complicated structures has been postponed in order to finish a first approach for the whole $A^n B_M^3$ alloy class. There is a good probability that future improvement of the analysis method will permit extension of interpretations to the more complicated structures.

Concordance of symbols used in binding analysis

Homologous classes (columns of the periodic system of elements): A^1 (alkali metals), A^2 (Be,...), A^3 (Sc,...), A^4 , A^5 , ..., A^{10} , B^1 (Cu,...), B^2 (Zn,...), B^3 (B,...), ..., B^8 (nob.g.).

This notation is especially appropriate to describe subsets of mixtures or phases. Phase designation by chemical formula with element symbols in the sequence of the above homologous classes; within a homologous class the lighter element first.

Affixes separated by a point: p= high pressure phase, h= high temperature-, r= room temperature- (mostly omitted), l= low temperature; i= impurity stabilized, m= metastable phase. The stoichiometric index M (undetermined mole number) serves to designate a whole mixture. Sometimes the mole fraction designates composition. Structural type is noted by formula of prototype i.e. of the first found representative. The prototype itself is described (not exhaustively) by a letter for the Bravais group (Amer.Soc.Test.Mater.Standard E157-77), the number of atoms of the first component in the primitive cell, point, number of atoms of sec.comp. Bravais groups: C,B,F = cubic primitive, body centered, face centered

T,U= tetragonal primitive, body centered

H,R= hexagonal primitive, rhombohedrally centered

O,P,Q,S= orthorhombic primitive, body centered, one face centered, all faces c.

M,N,Z= monoclinic primitive, face centered; triclinic.

Homeotypisms: R= replacement of atoms, L= formation of vacancies (lacunae), F= filling of interstices, D= homogeneous deformation, I= inhomogeneous deformation, S= shear of layers, C= shear of chains. The symbols may be placed with the affix htp (homeotypical) before a prototype formula.

Densities: $D_{XX'}$ = density matrix, χ = configuration (spin and spatial coordinates)

$D_{XX'}$ = diagonal of $D_{XX'}$, D_{X_1, X_2}^{SC} = spatial correlation, D^{av} = averaged spatial correl.,

D_{ed} = electron density, \underline{x} = spatial coordinate.

Cells and commensurabilities: \underline{a} = cell (matrix) of crystal, \underline{a}_1 = edge vector of \underline{a} ,

\underline{b} = cell of valence electron correlation, \underline{c} = cell of peripheral core el. corr.

$\underline{a}^{-1}\underline{a} = \underline{K}$ = homeotypic commensurability, similarly $\underline{b}^{-1}\underline{a} = \underline{K}'$, $\underline{c}^{-1}\underline{a} = \underline{K}''$, $\underline{c}^{-1}\underline{b} = \underline{K}'''$.

\underline{d}_b , \underline{d}_c = distances of essential maxima in the D^{av} function, $\underline{a} = \underline{b}\underline{K}' = \underline{c}\underline{K}''$ is the binding.

Isometric lattices (containing three linearly independent shortest vectors)

are written omitting the 1 for one atom in the cell, as C,B,F,R,U,H. A lattice aspect different from the conventional aspect may be indicated by the (pseudo) symmetry of the aspect and noted behind the Bravais group. Sometimes the lattices are deformed (for instance by spin correlation) this is indicated by ~. Sometimes at certain places Hund insertion of spin down electrons into a spin up lattice occurs, this is indicated by a prime behind the isometric lattice symbol.

Particle numbers: N_A^a = number of atoms per cell,

N_b^a , N_c^a , N_p^a , N_p^a = number of \underline{b} , \underline{c} electrons, atom places, \underline{b} -places, per \underline{a} cell,

N_A^a = number per atom, N_p^b = number of \underline{c} places per \underline{b} place

Matrix notation: $\underline{a}_i p = (\underline{a}_{11}, \underline{a}_{12}, \underline{a}_{13}; \underline{a}_{21}, \dots)$, i (mostly omitted) refers to an

orthonormal spatial coordinate system, P numbers the edge vectors and incidentally designates the phase. An H before a numerical matrix or behind the last index of a symbolic matrix indicates that i refers to a hexanormal i coordinate system, analogously MB³ for a monoclinic normal system. Following abbreviations are convenient: $(\underline{a}_{11}, 0, 0; \dots) = (\underline{a}_{11}; \dots)$, $(\underline{a}_{11}; \underline{a}_{11}; \underline{a}_{33}) = (\underline{a}_{11}; \underline{a}_{33})$, $(\underline{a}_{11}; \underline{a}_{11}) = (\underline{a}_{11})$.

Furthermore $(2, 1, 0; -1, 2, 0; 1) = (\sqrt{5}; 1)R$, where $5 = \det(2, 1; -1, 2)$ and R=rotation matrix which is generally not noted.

Alphabetical index of symbols used in binding analysis

A=class of homologous elements left to the Cu class in the periodic system; atom
 \underline{a} =elementary cell of crystal, \underline{a}_1 =edge vector of el. cell; \underline{a}_{ip} =matrix element
B=class of homologous elements right to the Ni class; body cent.cub.Bravais group
 \underline{b} =elementary cell of valence electron correlation; \underline{b} -electrons=valence electrons
C=cubic primitive Bravais group; chain shear homeotypism
 \underline{c} =cell of peripheral core electrons; \underline{c} -electrons=peripheral core electrons
 \underline{D} = density, \underline{D}_{XX} =density matrix; \underline{D} =deformation homeotypism
 \underline{D}^{SC} = spatial correlation; \underline{D}^{AV} = averaged spatial correlation; \underline{D}^{ed} = electron density
 \underline{d}_b = distance of essential maxima in $\underline{D}^{AV}, \underline{D}$; \underline{d}_c = the same for $\underline{D}^{AV,C}$
 \underline{E} = electrical dipol vector, \underline{E}_3 = its third component
F= cubic face centered Bravais group; filling homeotypism
H= hexagonal Bravais group; hexagonal aspect
h= high temperature phase
I= inhomogeneous deformation homeotypism
i= impurity stabilized phase; matrix index referring to orthonormal coord.system
 \underline{K} = commensurability matrix, $\underline{K}=\underline{a}^{-1}\underline{a}'$, $\underline{K}'=\underline{b}^{-1}\underline{a}$, $\underline{K}''=\underline{c}^{-1}\underline{a}$, $\underline{K}'''=\underline{c}^{-1}\underline{b}$
k= running index for components
L= vacancy formation (lacuna) homeotypism
l= low temperature phase
M= monoclinic primitive Bravais group; undetermined mole number
m= metastable phase
N= monoclinic face centered Bravais group; number; N_2 = mole fraction of the second component
n= exponent indicating the homologous class; number index of electron
O= orthorhombic primitive Bravais group; orthorhombic aspect
P= atom place, $P'=\underline{b}$ -correlation place; $P''=\underline{c}$ -correlation place; index counting edge v.
P= orthorhombic body centered Bravais group
p= high pressure phase
Q= orthorhombic one face centered Bravais group
R= rhombohedral Bravais group; replacement homeotypism
r= room temperature phase
S= orthorhombic all faces centered Bravais group; layer shear homeotypism
T= tetragonal primitive Bravais group; tetragonal aspect
U= tetragonal body centered Bravais group
W= wolfram type
 \underline{X} = spin spatial configuration
 \underline{x} = local coordinate of an electron
Z= triclinic Bravais group

Introduction

In the title tacitly the liberty has been taken to equate $B^n = A^{10+n}$, where A and B are homologous classes of chemical elements defined by the well known IUPAC convention [1] and n may be taken as column number of the periodic system of elements. The phases considered here may therefore be delimited by $A^{n \leq 13} B_M^3$ ($M =$ undetermined mole number). These phases have been reviewed thoroughly [2a..f]. They shall be analysed here with respect to their bonding type (binding) by means of the two-correlations model [3a...i]; the procedure of the analysis and the format of the results is the same as in the previous investigation of the binding in AB_M^4 phases [3c], and for concepts like the different homeotypisms this reference should be consulted. It will be understood that the Structure Reports A(SR) reference used in the tables is very appropriate because of its brevity, but that the information given there cannot be assumed to be completely free of mistakes, these may be avoided by regression to the original publications cited there. It is an old desideratum of systematic crystallography and of systematic chemostatics to develop a coherent valence classification of the AB_M^3 phases. The two-correlations model is the first to enter this problem. Starting points are electron counts. As the electron count is not quite certain in many of these compounds the rule of smoothness of the $N_{p''}^{P'}/N_2$ function [3c] is very helpful ($N_{p''}^{P'}$ =number of c places per b place, N_2 =mole fraction of the second component). The unexpected result of earlier analyses, that the majority of the phases display whole numbered commensurability between b correlation and c correlation only in two directions is confirmed in the present alloy class. It is apparently a fundamental phenomenon.

In advance it should be mentioned that a complete analysis in the first attempt may not be attained, as the assignment of a binding becomes uncertain in phases with large elementary cells. Therefore it is appropriate at first to try an analysis of the simpler structures of the present alloy class. When the results of this attempt appear promising, the discussion of the more complicated structures may be added. Of course a completeness of the table of the phases stabilized must be aspired in order to indicate where the analysis is to be continued.

Sometimes it happens that isotypic phases are not assumed isodesmic. This may be real when the phases are not homologous, but it may also be erroneous. Since it is sometimes difficult to decide where the error may lie, both proposals are noted to have a first approach at least.

A^{1,3}_M phases

The type BaAl₄ (U1.4 drawing [3a] p.313, see[4]) of NaGa₄ (electron count Na^{1,8}Ga_M^{3,10}) is a F-homeotype of Cu₃Au with the commensurability $\underline{a}=\underline{a}_{\text{Cu}_3\text{Au}}(1;2)$, in a (001) plane together with Ba are packed Al₂ dumbbells with [001] direction. Assuming $\underline{a}=\underline{c}_B(\sqrt{8};7.5)$ leads to a HTB/2 binding. The misfit of the number \underline{N}_b^C of \underline{b} electrons per cell to the number \underline{N}_p^C of \underline{b} places per cell could be reduced by assuming that the Na¹ electrons form a correlation of their own.

Another simple phase is NaIn(NaTl,F2.2, drawing [3a] p.127) a R-homeotype of W which obeys Zintl's rule. A FB2 binding does not give enough \underline{c} places, therefore a FF2 binding may be assumed with $\underline{N}_p^C=256 \underline{c}$ places per cell. The elements K,Rb,Cs do not form this type as their partial structure of the Si type would require too great a volume.

Other simple structures have been reported for Cs₅In₃ and CsIn₄, but their analysis must be deferred until the atomic positions are known. The more complicated structures shall be postponed. It must be admitted that the A^{1,3}_M and A^{2,3}_M phases do not have the most convincing binding proposals as the great size of the A^{1...2} atoms causes a great number of \underline{c} places per atom and thus makes the approximation of the two correlations less good.

A^{2,3}_M phases

With the electron count Mg^{2,8}Al_M^{3,8} comes for Mg₁₇Al₁₂ (Mn.r,B29, drawing [3a] p.155) a HTC2 or C'C2 binding and for MgAl₂.m (HfGa₂,drawing [3a] p.92), a RD-homeotype of Cu, a BHT2 binding. This binding has more \underline{c} places per \underline{b} place, $\underline{N}_p^{P'}/\underline{N}_p^{P''}=5.6$ than the FB2 binding of In with $\underline{N}_p^{P'}/\underline{N}_p^{P''}=4$. This leads to conjecture that the binding of Al is $\underline{a}=4.05A=\underline{b}_{\text{FU}}(\sqrt{4.5};2.7/2)=\underline{c}_B(3)$ which is a fore-runner of the FB2 binding; the number of \underline{c} places per atom, $\underline{N}_p^A=13.5$, is greater than in Ga and In, in agreement with the place number rule [3b]. Also the frequent BaAl₄ structure which occurred already in NaGa₄ has for CaAl₄ a fully occupied \underline{b}_F correlation as part of a FU2 binding and may be easily understood in comparison with Al by decrease of \underline{b} electron concentration. See also Mg₃Al₅ (SR 38.7).

SrAl(C32.32,drawing SR42.11) is an I-homeotype of NaCl with $\underline{a}=\underline{a}_{\text{NaCl}}(2)$, the FUHT2 binding opens a possibility to understand the I-homeotypism. SrAl₂ (KHg₂,drawing [3a] p.218) is an I-homeotype of B₂Al with $\underline{a}=\underline{a}_{\text{B}_2\text{Al}}(0;1;0,1,1;2,0,0)$ the UHUH/3 binding is given in the table for the hexagonal subcell.

Ba₄Al₅ (H8.10,drawing SR41,4) and Ba₇Al₁₃(H7.13) are homeotypic to MgZn₂ (H4.8,drawing [3a]p.161) which is composed of layers with $\sqrt{4}$ and $\sqrt{3}$ commensurability.

TABLE 1: A1B3M

NaA1M (nic,phdH⁻)
 KA1M (nic,phdHA)
 RbA1M (nic,phdHA)
 Na5Ga8 phdHA cmp,Na22Ga39(ActCryst.B38.1101),Na7Ga13(Z Natf 37b.119,127)
 NaGa4(BaA14,SR34.140)4.223;11.19A=bHT(2;6/2)=cB(γ/8;7.5)N=26,96
 K5Ga8 phdM,KGa3(U3.9,CRParis294.1982.1083)6.278;14.799A
 K3Ga13(Q12.52,SR46.81)6.441;16.143;28.404A
 Rb5Ga8 phdM,RbGa3(,Z anal1g Chem 480.1981.181)
 RbGa4
 RbGa7(N2.14 ,ACB37.1981.2060)M111.85⁰11.432;6.603;10.259A
 Cs5Ga8 phdM
 CsGa4
 Na2In phdM
 NaIn(NaT1,SR3.19)7.31A=bF(2)=cF(4) N=32,144
 Na5In8 cmp
 K5In8 phdM cmp
 KIn4(BaA14,SR34.140)4.835;12.71A=idmNaGa4
 Rb5In8 phdM
 RbIn4(BaA14,SR34.140)4.914;12.82A=idmNaGa4
 Cs5In8(08.12,JLCM83.1982.143)6.805;6.965;16.40A phdM
 CsIn4(T2.8,JLCM83.1982.143)7.089;6.693A
 Na6T1(F88.14,SR38.146)24.154A=bU(6;7.3)=cB(18) phdHA N=520,3376
 Na2T1(Q16.8,SR32.124)13.935;8.880;11.693A=bFU(5;2/1;4)=cB(10;6;8) N=80,416
 NaT1(F2.2,SR3.19)7.487A=idmNaIn cmp
 NaT12
 KT1 phdM
 K4T15 cmp
 K5T18
 Rb4T15 phdM cmp
 RbT12
 RbT13
 Cs5T17 phdM cmp
 Cs4T17
 CsT13

TABLE 2: A2B3M

Mg17A112(Mn.r,SR3.358, Nawi57.1970.128)10.481A=bHT(5;5.7/2)=cC(10) N=140,464
 Mg44A156.m(Mn.rD,SR44.105)10.501;10.185A=idmMg17A112 phdHA
 Mg23A130(R23.30,SR33.8)H12.825;21.748A=bUH(6;11.5)=H(12;20) N=408,1272
 Mg2A13(F116.176,SR30.5)28.239A=bU(11;13)=cB(22) N=3040,9312
 MgA12.m(HfGa2,SR44.105)4.132;26.602A=bB(√3.25;10)=cHT(γ/13;23) N=64,192
 CaA12(MgCu2,SR8.6)8.038A=bU(3;3.7)=cB(6) N=64,192 phdHA cmp
 CaA14(BaA14,SR8.6)4.362;11.09A=bF(√2;3.5)=cU(γ/8;9) N=28,80
 SrA17(C32.28,SR42.11)12.753A=bFU(5;7)=cHT(10;11/2) N=160,512(FornasiniMerlo1983)
 SrA12(KHg2,SR41.119)4.793;7.922;7.937A=bUH(√4.3;4/2)=cUH(γ/3;7/2) N=32,96phdM
 SrA14(BaA14,SR 7.203)4.46;11.07A=idmBaA14 cmp
 Ba4A15(H8.10,SR41.3)H6.C92;17.782A=bFH(√5.3;9/3)=cH(√21;13) N=46,144 phdM
 Ba7A113(H7.13,SR41.3)H6.099;17.269A=bFH(√5.3;8/3)=cH(√21;13) N=53,160
 BaA14(U1.4,SR21.3)4.566;11.250A=bF(√2;3.5)=cU(γ/8;9) N=28,80 cmp
 Mg5Ga2(P10.4,SR28.23)13.708;7.017;6.020A=bFU(6;3;3.6/2)=cFUK'(2) N=64,240
 Mg2Ga(H12.6,SR35.62)H7.794;6.893A=bUH(√12;3.5/2)=cH(2γ/12;6) N=42,156
 MgGa(U8.8,SR28.23)10.53;5.53A=bU(4;5/2)=cB(8;4) N=80,288
 MgGa2(O8.16,SR34.84)6.802;16.346;4.111A=bB(2γ/2;5γ/2;1.7)=cHT(4γ/2;10γ/2;4/2)
 MgGa2.m(CaIn2,SR46.129)H4.343;6.982A=bFH(2;4/3)=cBH(2;16/3)N=16,56 N=64,224
 Mg2Ga5(U4.10,SR34.84)8.63;7.11A=bB(√13;3)=cCK'(2) N=76,264

Ca3Ga phdM
Ca5Ga2
Ca5Ga3(Cr5B3,SR44.108)7.954;15.084A=bB($\sqrt{7.3;5}$)=cB($\sqrt{2.9;10}$) N=76,280
CaGa(Tl1,71Ec)4.382;11.535;4.196A=bc(2;5.3)=cU($\sqrt{8;9}$) N=20,72
Ca2Ga3
CaGa2(B2A1,SR9.37)H4.323;4.323A=bH(2;2)=cUH($\sqrt{12;4/2}$) cmp N=8,28
CaGa4(htpBaA14,JLCM63.105)4.34;25.90A=hdmBaA14
Sr8Ga7(Sr8A17,FornasiniMer101983)12.484A=idmSr8A17 phdM
SrGa2(B2A1,SR19.61)H4.344;4.732A=idmCaGa2 cmp
SrGa4(BaA14,SR30.140)4.437;10.70A=idmBaA14
Ba10Ga(VA11,SR45.31)20.52A
Ba8Ga7(Sr8A17,FornasiniMer101983)12.990=idmSr8A17
BaGa
BaGa2(B2A1,SR19.61)H4.432;5.064A=idmCaGa2
BaGa4(BaA14,SR30.116)4.560;10.81A=idmBaA14 cmp
Mg3In(R12.4,SR28.23)H6.323;31.060A=bUH($\sqrt{7;15/2}$)=cH($\sqrt{28;26}$) N=108,408 phdM
Mg2.9In1.1(Cu3Au,SR11.130)4.49A=bHT(2;2.3/2)=cC(4) N=9.1,34
Mg5In2(Mg5Ga2,SR28.23)14.23;7.36;6.19A=bFU(6;3;3.6/2)=cHT(12;6;6/2) N=64,240
Mg2In(H6.3,SR28.23)H8.27;3.42A=bFH($\sqrt{12;1.75}$)=cH($\sqrt{48;2.8}$) N=21,78
MgIn(CuAu,SR6.180)3.25;4.39A+4.60;439A=bF($\sqrt{2;1.35}$)=cC(4;3.8) N=10,36
MgIn2.5(Cu3Au,SR6.180)4.61A=bF($\sqrt{2;1.4}$)=cU($\sqrt{8;3.5}$)
MgIn5(Cu,ZM54.1963.422)4.66A=bF($\sqrt{2;1.4}$)=cB($\sqrt{8;2.8}$)
Ca3In(Fe3Si,SR29.108)7.860A=bF(2)=cF(4) N=36,136 phdS cmp
CaIn(CsCl,SR29.107)3.856A=bFU($\sqrt{2.25;2.1/2}$)=cC(3) N=5,18 cmp
CaIn2(H2.4,SR29.107)H4.895;7.750A=bFH(2;4/3)=cUH($\sqrt{12;6.5}$) N=16,56 cmp
Sr3In(Fe3Si,71Ec)8.360A=idmCa3In FF2 phdM cmp
Sr5In3(Cr5B3,SR44.117)8.738;16.442A=idmCa5Ga3 BB2
SrIn(0,71Ec)4.09;5.18;11.10A
Sr2In3
SrIn2(CaIn2,SR29.121)H5.000;8.021A=idmCaIn2 cmp
Sr2In5
SrIn3(Ni3Sn,JLCM11.1966.249)H6.769;5.481A=bUH($\sqrt{8.3;2.7/2}$)=cH(5;4) N=22,76
SrIn5(H,JLCM11.1966.249)H5.937;4.827A
Ba13In phdM
Ba3In
Ba2In
BaIn,BaIn2(CeCu2,RendAccadNazLi48.1970.235)5.225;8.439;8.439A
BaIn2(0,JLCM11.1966.249)5.94;5.94;5.225A cmp
BaIn4(BaA14,JLCM11.1966.249)4.963;11.905A=idmBaA14 cmp
Mg5Tl2(Mg5Ga2,SR35.63)14.285;7.328;6.197A=idmMg5Ga2 phdH
Mg2TL(Fe2P,SR35.62)H8.083;3.680A=bUH($\sqrt{12;1.8/2}$)=cH(2 $\sqrt{12;2.8}$)
MgTl(CsCl,SR3.271)3.635A=idmCaIn
Ca3Tl(Fe3Si,71Ec)7.85A=idmCa3In,Ca5Tl2(,AnnChim Roma56.1966.1306)
CaTl(CsCl,SR3.271)3.855A=idmCaIn phdH cmp
Ca3Tl4
CaTl3(Cu3Au,SR3.639)4.803A=idmMgIn2.5 N=11,38
Sr3Tl(0,71Ec)23.72;8.07;5.77A
Sr5Tl3(Cr5B3,SR44.122)8.635;16.389A=idmCa5Ga3
SrTl(CsCl,SR3.272)4.032A=idmCaIn,Sr2Tl3(,AnnChim Roma56.1966.1306)
SrTl2(CaIn2,SR29.133)H5.074;8.217A=idmCaIn2
SrTl3(Tl.3,71Ec)4.882;4.843A
BaTl,Ba13Tl,Ba2Tl (seeSr2Tl3)
BaTl2(CaIn2,SR29.105)H5.220;8.437A=idmCaIn2
BaTl3
BaTl4

surability to the basal mesh, while in $MgZn_2$ the stacking sequence is $\sqrt{3}, \sqrt{4}, -\sqrt{3}, \sqrt{4}$, in Ba_4Al_5 it is $\sqrt{3}, \sqrt{4}, \sqrt{3}, \sqrt{3}, \sqrt{4}, \sqrt{3}$, and in Ba_7Al_{13} $\sqrt{3}, \sqrt{4}, \sqrt{3}, \sqrt{4}, \sqrt{3}, \sqrt{4}, \sqrt{3}$; the binding might be FHH2 in a $\sqrt{21}$ commensurability which is greater than the $\sqrt{4}$ commensurability of many NiAs type phases.

Mg_5Ga_2 (P10.4, drawing [5]) obeys the Lewis rule and the Zintl rule, and in the Cu type partial structure of Ga one Mg per Ga is in an octahedral interstice and 1.5Mg per Ga are in tetrahedral interstices, a FF2 binding appears possible. Mg_2Ga (H12.6, drawing SR35.63) a RDI-homeotype of W is also homeotypic to Fe_2P with $\underline{a}=\underline{a}_{Fe_2P}(1;2)$ and permits a UHH2 or FHUH2 binding.

$MgGa$ (U8.8, drawing [5]) is a DIC-homeotype of NaCl with $\underline{a}=\underline{a}_{NaCl}(2;1)$, the electrical dipole vectors generated by the UB2 binding are probably the cause of the row shears as compared to NaCl. $MgGa_2$ (O8.16, drawing SR34.85) is an I-homeotype of B_2Al , one of four Ga is shifted into the Mg layer ($\underline{a}_1 \& \underline{a}_2$) by the BHT2 binding. $MgGa_{2.m}$ ($CaIn_2$) another I-homeotype of B_2Al with $\underline{a}=\underline{a}_{B_2Al}(1;2)$ permits a FB2 binding. Mg_2Ga_5 (U4.10, drawing SR34.87) permits a BC2 binding.

Ca_5Ga_3 (Cr_5B_3 , drawing [3a] p.254) is a RDI-homeotype of W, in the quasi homologous Ca_5Si_3 (Cr_5B_3) the binding was $\underline{a}=\underline{b}_C(\sqrt{13};6.9)=\underline{c}_B(\sqrt{26};10)$, it is seen that the \underline{c} correlation is closely homeotypic. Also $CaGa$ (TII) is isotypic to $CaSi.r$ but heterodesmic.

Mg_3In (R12.4) is a S-homeotype of $Ni_3Sn.r$ or Cu_3Au and a RS-homeotype of Mg with $\underline{a}=\underline{a}_{Mg}(2;6)$. The distance value $d_b(Mg_3In)=2.4A$ leads to $\underline{a}=\underline{b}_{UH}(\sqrt{7};15/2)$ and this could be supplemented by $\underline{a}=\underline{c}_H(\sqrt{28};26)$. The value $K_{33}^u=26$ might be idealized to $K_{33}^u=25.5$ and this would lead by the method [3a] used for the explanation of the shear law in Cu_3AuZn_m (m =small mole number) to an explanation of the shears distinguishing Mg_3In from the $Ni_3Sn.r$ (H6.2) type. The number of \underline{c} places per \underline{b} place is $N_{p,n}^{P'}=7.0$ for UHH2 binding, therefore it is gratifying that for $Mg_{2.9}In_{1.1}(Cu_3Au)$ a HTC2 binding fits which has also $N_{p,n}^{P'}=7.0$. Extrapolating the $N_{p,n}^{P'}$ values towards Mg leads for this element to the surprising binding $\underline{a}=\underline{H}3.21;5.21A=\underline{b}_H(\sqrt{1.75};2.3)=\underline{c}_{UH}(\sqrt{7};5)$, the absence of a CC2 or homeotypic binding apparently has to do with the great atomic volume of Mg. The simple structures $Ca_3In(Fe_3Si)$, $CaIn(CsCl)$ and $CaIn_2$ (H2.4) are all homeotypes of W and permit FF2, FUC2 and FHUH/3; Ca_3In gives indication of \underline{b} electron descent. Plotting the number of \underline{c} places per atom it is found $N_{p,n}^A=16,13.5,13.0,12$; this strong decrease is caused by the great atomic volume of Ca, and this volume influence accounts for the change of binding when the \underline{b} electron concentration does not change as in $CaZn_M$ e.g.. This could not be understood before.

The FU2 binding of $CaTl_3(Cu_3Au)$ is confirmed by the tetragonality of $SrTl_3$.

A³B_M³ phases

The phase ScAl(CsCl) is apparently not isodesmic to CaIn(CsCl), its BFU2 binding yields $N_p^C = 5.7$ b places per cell so that the b contribution of Sc is nearly 3; for this reason YAl.h(CsCl) is not stable at lower temperatures as the b electron contribution diminishes with decreasing temperature. Curiously a FUC2 binding fits in ScAl₂(MgCu₂), however, using the hexagonal cell probably opens other possibilities. ScAl₃(Cu₃Au) is homeotypic and homeodesmic to In and this confirms a b electron contribution below 3.

The ditypism of Y₂Al is caused by the temperature dependent b contribution of Y; as Y₂Al(Ni₂Si) is compatible with a FF2 binding it must be assumed that Y contributes here no b electrons. Y₃Al₂(Zr₃Al₂) is homeotypic to U₃Si₂(T6.4) with $a = a_{U_3Si_2}(1;2)$ and permits CU $\sqrt{2}$. YAl₃.h has a BaPb₃(R3.9,SR29.30) structure a stacking homeotype of Cu₃Au like Mg₃In, while YAl₃.r(Ni₃Sn) has a simple two layer structure. The binding of h has a smaller $N_p^{P'}$ value (4.9) than the binding of r (6.0).

While La₃Al(Ni₃Sn) belongs to the Cu family, in LaAl(CeAl) there are only ribbons of CsCl cells. The binding has not yet been found. Just as LaAl₂(MgCu₂) may be described as a structure in which La replaces two Al atoms [3a], also LaAl₄.h(BaAl₄) may be described similarly. La₃Al₁₁(P3.11,drawing SR32.7) is L-homeotypic to BaAl₄ with the commensurability $a = a_{BaAl_4}(1;3;1)$.

The high melting point of LaGa₂(B₂Al) is due to the good commensurability of the b correlation to the small crystal cell.

A⁴B_M³ phases

In the mixture TiAl_M two different phases of the same structure have been reported, Ti₃Al(Ni₃Sn.r) and Ti₂Al(Ni₃Sn.r). Although two different bindings are available, additional confirmation of the empirical facts appears desirable. Also in TiAl(CuAu) the electron count Ti^{1,3}Al^{3,8} is probable and leads to a UFU2 binding but in TiAl₂(HfGa₂,drawing [3a] p.92) this count appears less acceptable, the Ekman rule (see [3a]) becomes valid. TiAl₂ opens a series of S-homeotypes of Cu₃Au which displays a remarkable increase of the axial ratio of the Cu type subcell with increasing b concentration: TiAl₂|a₃|6|a₁| = 1.021, Ti₅Al₁₁ 1.055, Ti₉Al₂₃ 1.089, TiAl₃ 1.116. This D-homeotypism follows easily from the binding. Curiously the binding appears to be the same in all four phases and the electro-dipole vectors generated by the c correlation favour

TABLE 3: A3B3M

Sc2Al(Ni2In, SR41.112)H4.888;6.166 phdM
 ScA1(CsCl, SR30.108)3.450A=bB($\sqrt{2}$;1.4)=cF(2) cmp
 ScA12(MgCu2, SR29.100)7.580A=bFU($\sqrt{13}$;5/2)=cC($\sqrt{52}$;7) N=64,200 cmp
 ScA13(Cu3Au, SR29.100)4.10A=bF($\sqrt{2}$;1.4)=cU($\sqrt{8}$;3.5)
 Y3A1(Cu3Au, SR32.16)4.818A=bC(2)=cC(4) N=6,38
 Y2A1.h(Er2Al, SR30.110)7.62;9.22;11.14A phdE
 Y2A1.r(Ni2Si, SR32.16)6.642;5.084;3.469A=bF(2;1.5;2/2)=cFK'(2) N=20,112
 Y3A12(Zr3Al2, SR28.43)8.239;7.648A=bC($\sqrt{13}$;3.3)=cU($\sqrt{26}$;6) N=36,184 cmp
 YA1.h(CsCl, SR32.16)3.75A=idmScA1
 YA1.r(TlI, SR31.16)3.884;11.522;4.385A=bC(1.75;5;2)=cB(1.7 $\sqrt{2}$;7;2 $\sqrt{2}$) N=12,76
 YA12(MgCu2, SR28.43, 24.35)7.860A=idmScA12 N=56,208 cmp
 YA13.h(BaPb3, SR32.15)H6.204;21.184A=bH(3;10)=cBH(3;50) N=90,306
 YA13.r(Ni3Sn.r, SR32.15)H6.276;4.582A=bH(3;2.2)=cUH($\sqrt{27}$;4.4/2) N=20,68
 YA14(BaAl4, SR26.238)
 La3A1(Ni3Sn.r, SR30.106)H7.195;5.503A=bH(3;2.3)=cUH(6;5/2) N12,82 phdM
 LaA1(CeAl, SR30.106, 30.105)5.809;7.734;9.531A N=24,152
 LaA12(MgCu2, SR23.214, 30.105)8.153A=idmScA12 cmp
 La3A17.h(B2Al, SR30.105)H4.478;4.347A=bH(2;2)=cH($\sqrt{12}$;3.5)
 LaA13(Ni3Sn.r, 30.105, 41.9)H6.662;4.609A=idmYA13.r
 La3A111.r(0, SR32.65)4.431;13.142;10.132A
 LaA14.h(BaAl4, SR9.10, SR30.105)4.48;10.42A=bF($\sqrt{2}$;3.3)=cU($\sqrt{8}$;4) cmp
 Sc5Ga3(Mn5Si3, SR29.53)H8.074;5.951A=bUH($\sqrt{13}$;3/2)=cUHK'(2) N=38,138 phdM cmp
 Sc5Ga4
 ScGa(TlI, SR45.121)4.022;10.205;3.895A=idmYA1.r
 ScGa2 cmp
 ScGa3(Cu3Au, SR45.122)4.095A=bHT(2;2.3/2)=cB($\sqrt{8}$;2.8) N=9,41
 Y5Ga3(Mn5Si3, SR29.53)H8.576;6.479A=idmSc5Ga3 phdM
 YGa(TlI, SR45.122)4.296;10.876;4.074A=idmYA1.r cmp
 YGa2(B2Al, SR26.146)H4.198;4.095A=idmLa3A17.h cmp
 La3Ga(Cu3Au, SR45.121)5.66A=bC($\sqrt{5}$;2.2)=cFU($\sqrt{20}$;6/2) phdM
 La5Ga3(Cr5B3, 71Ec)8.066;14.733A=bC($\sqrt{10}$;6)=cCK'(2) N=56,320
 LaGa(TlI, SR45.121)4.523;11.588;4.256A=idmYA1.r
 LaGa2(B2Al, SR26.146)H4.320;4.416A=idmLaA12.3.h cmp
 LaGa6.h
 LaGa6.r
 Sc3In(Ni3Sn, SR27.245)H6.421;5.183A=idmLa3A1 Sc2In(Ni2In, SR39.116)
 YIn(CsCl, 71Ec)3.806A=idmScA1
 YIn3(Cu3Au, SR29.121)4.597A=ScA13
 La3In(Cu3Au, 71Ec)5.075A=idmY3A1
 LaIn(CsCl, 71Ec)3.985=idmScA1
 LaIn3(Cu3Au, 71Ec)4.732A=idmScA13
 ScT1M
 YT1(CsCl, 71Ec)3.751A=idmScA1
 YT13(Cu3Au, 71Ec)4.680A=idmScA13
 La3T1(Cu3Au, 71Ec)5.13A=idmLa3A1 phdM
 La2T1
 La5T13(W5Si3, JLCM18.93)
 LaT1(CsCl, SR8.51)3.922A=idmScA1 cmp
 LaT13(Cu3Au, 71Ec)4.806A=idmScA13 cmp

TABLE 4: A4B3M

Ti3A1(Ni3Sn,SR26.28)H2⁵.806;4.655A=bUH($\sqrt{5.3;2.1}$)=cH($\sqrt{21;3.6}$) N=12,34 phdM
 Ti2A1(Ni3Sn,SR27.30)H5.789;4.639A=bFH($\sqrt{5.3;2.1}$)=cH($\sqrt{21;3.6}$)
 TiA1(CuAu,SR16.15)4.011;4.069A=bU($\sqrt{2;1.75}$)=cFU($\sqrt{8;4/2}$) N=8,20
 TiA12(HfGa2,U4.8,SR27.35)3.976;24.360A=bB($\sqrt{2.5;10}$)=cC($\sqrt{10;20}$) N=56,152
 Ti5A11(ZrA13,SR30.109)3.917;16.524A=bB($\sqrt{2.5;6.5/2}$)=c($\sqrt{10;13}$) N=33,108
 Ti9A123(tetr.,SR30.109)3.84;33.46A=
 TiA13(U1.3,SR7.13)3.85;8.59A=bB($\sqrt{2.5;3.5}$)=cC($\sqrt{10;7.05}$) N=18,56
 Zr3A1(Cu3Au,SR19.45,27.37)4.37A=bU($\sqrt{2;1.75}$)=cU($\sqrt{8;3.5/1}$) N=6,14 phdHA
 Zr2A1.h?(CuA12,SR26.1,27.36)6.854;5.501A=bHT($\sqrt{8;2.6/2}$)=cC($\sqrt{3;2;4.5}$) N=24,112
 Zr2A1(Ni2In,SR26.31,27.37)H4.882;5.918A=bH($\sqrt{4.3;2.5}$)=cUH($\sqrt{13;5/2}$) N=10,28
 Zr5A13.h(W5Si3,SR24.21)11.049;5.396A=bB($\sqrt{17;2}$)=cFU($\sqrt{68;5.6/2}$) N=56,156
 Zr3A12(Ti2.8,SR24.39)7.630;6.998A=bB($\sqrt{8.5;2.6}$)=cFU($\sqrt{34;7.5/2}$) N=36,100
 Zr4A13(H4.3,SR24.39)H5.433;5.390A=bCH($\sqrt{3;4.3/3}$)=cCH($\sqrt{3;7.2/3}$) N=13,68
 Zr5A14.h(Ti5Ga4,H10.8,SR27.37)H8.447;5.810A=bCH($\sqrt{7;4.5/3}$)=cCH($\sqrt{21;7.8/3}$) N=34,110
 ZrA1(Ti1,SR27.37)3.353;10.866;4.266A=bFU($\sqrt{2.3/2;2.5}$)=cU($\sqrt{27;8;5/50}$) N=14,80
 Zr2A13(S4.6,SR26.31,27.37)5.572;9.599;13.879A=bH($\sqrt{7;6.5}$)=cBH($\sqrt{7;32}$) N=72,256
 ZrA12(MgZn2,H4.8;SR23.20)H5.282;8.748A=bH($\sqrt{7;4.3}$)=cBH($\sqrt{7;21/3}$) N=28,112 cmp
 ZrA13(U2.6,SR7.14)4.01;17.32A=bB($\sqrt{2.5;6.8}$)=cC($\sqrt{10;13.6}$) N=36,112
 Hf3A12(Zr3A12,SR24.20)7.535;6.906A=idmZr3A12
 Hf4A13(Zr4A13,SR27.16)H5.343;5.422A=idmZr4A13
 HfA1(Ti1,SR26.9)3.253;10.831;4.282A=idmZrA1
 Hf2A13(Zr2A13,SR24.20)9.523;13.763;5.522A=idmZr2A13
 HfA12(MgZn2,SR24.20)H5.288;8.739A=idmZrA12
 HfA13.h(TiA13,SR27.16)3.893;8.925A=idmTiA13
 HfA13.1.r.(ZrA13,SR24.20)4.010;17.310A=idmZrA13
 Ti3Ga(Ni3Sn,SR22.122)H5.752;4.645A=idmTi3A1 phdS
 Ti2Ga(Ni2In,SR22.122)H4.51;5.50A=idmZr2A1 UHH³ cmp
 Ti5Ga3(W5Si3,SR27.204)10.22;5.054A=idmZr5A13.h
 Ti5Ga4(H10.8,SR27.204)H7.861;5.452A=idmZr5A14.h
 TiGa(CuAu,SR27.204)3.970;3.970A=bU($\sqrt{2.5;2}$)=cFU($\sqrt{10;4.5/2}$) N=10,40
 Ti2Ga3(T4.6,SR27.204)6.284;4.010A=bU($\sqrt{6.25;2}$)=cFU($\sqrt{5;4.5/2}$) N=22,72
 TiGa2(HfGa2,U4.8,SR27.204)3.929;24.37A=bB($\sqrt{2.5;10}$)=cC($\sqrt{10;20}$) N=48,112
 TiGa3(TiA13,SR9.83,27.204)3.789;8.734A=idmTiA13 BC2
 Zr2Ga(CuA12,SR27.205)6.712;5.443A=bHT($\sqrt{8;2.7/2}$)=cC($\sqrt{32;4.5}$) N=20,64 phdS
 Zr5Ga3(Mn5Si3,SR22.124)H8.04;5.71A=bH($\sqrt{12;2.5}$)=cUH($\sqrt{6;5/2}$) N=28,90 cmp
 Zr3Ga2(U3Si2,SR27.205)7.349;3.692A=bB($\sqrt{8;1.4}$)=cFU($\sqrt{32;4/2}$) N=18,58
 Zr5Ga4.h(Ti5Ga4,SR27.205)H8.350;5.757A=idmZr5A14
 ZrGa.h
 ZrGa.r(MoB,U4.4,SR27.205)3.865;20.56A=bU($\sqrt{2;9.5}$)=cFU($\sqrt{8;21/2}$)
 Zr2Ga3(Zr2A13,SR27.205)5.497;9.444;13.755A=idmZr2A13
 Zr3Ga5(orth,SR27.205)7.111;8.848;9.084A
 Zr2Ga2(Q2.4,SR27.205)12.89;3.994;4.123A=bB($\sqrt{2.5;5}$)=cC($\sqrt{10;10}$) N=24,128
 ZrGa3(ZrA13,SR27.205)3.960;17.44A=bB($\sqrt{2.5;7}$)=cC($\sqrt{10;14}$)
 Hf2Ga(CuA12,SR27.207)6.686;5.295A=idmZr2Ga phdM
 Hf5Ga3(Mn5Si3,SR27.207)H7.970;5.686A=idmZr5Ga3
 Hf5Ga4
 HfGa
 Hf2Ga3(Zr2A13,SR27.207)5.472;9.402;13.63A=idmZr2A13
 HfGa2(U4.8,SR27.207)4.046;25.446A=bB($\sqrt{2.5;10}$)=cC($\sqrt{10;20}$) N=48,192
 HfGa3(TiA13,SR27.207)3.881;9.032A=bB($\sqrt{2.5;3.7}$)=cC($\sqrt{10;7.4}$)
 TiIn0.9(Ni3Sn,SR22.123)H5.89;4.76A=idmTi3A1 UHH2 phdE
 Ti3In2(CuAu,SR30.149)4.203;4.238A=bU($\sqrt{2;1.75}$)=cB($\sqrt{8;2.8}$) N=8 ,25
 TiIn.h(CuAu,
)
 Ti3In4(T6.8,SR30.14)9.98;2.98A=bHT($\sqrt{17;1.43/2}$)=cB($\sqrt{34;1.75}$) N=24,104
 Zr3In(Cu3Au,SR27.379)4.46A=bU($\sqrt{2;1.75}$)=cB($\sqrt{8;2.8}$) N=6,19
 Zr2In(CuAu,SR30.149)4.419;4.460A=bU($\sqrt{2;1.75}$)=cB($\sqrt{8;2.8}$) N=6,23
 ZrIn.h(Cu ,SR30.149)4.418A
 ZrIn3.h(TiA13,SR30.149)4.238;9.786A=bB($\sqrt{2.5;3.65}$)=cC($\sqrt{10;7.3}$)
 ZrIn3.r.(ZrA13,SR30.149)4.303;18.94A=bB($\sqrt{2.5;7}$)=cC($\sqrt{10;14}$)
 Hf3In4(Ti3In4,SR30.14)10.23;3.053A=idmTi3In4
 HfIn2(CuAu,SR30.144)4.36;4.51A
 Ti3.2Ti10.8(Cr3Si,71Ec)5.256A=bC(2)=cC(4)
 ZrTiM
 HfTiM

the observed stacking sequences following the method of [3a]. To be sure the average dipole vectors probably disappear, but the \underline{c} correlation is a function in the six-dimensional space [3] and the three-dimensional sections certainly generate "momentaneous" electrical dipoles. It might be questioned whether the $\sqrt{10}$ commensurability element might be replaced by a simpler, say whole number commensurability element like 3 e.g., however, a little inspection reveals that the $\sqrt{10}$ element is better adapted to the atomic sites than the element 3.

While in Ti_3Al only UHH2 (with $N_{p''}^{P'} = 7$) was found, the phase $Zr_2Al(Cu_3Au)$ permits a UU2 binding (with $N_{p''}^{P'} = 3$); this evidently is caused by the greater atomic volume of Zr which favours greater $N_{p''}^{P'}$ values. $Zr_2Al(Ni_2In)$, a RC-homeotype of W falls into the HUH/3 binding ($N_{p''}^{P'} = 6$) and $Zr_5Al_3h(W_5Si_3)$ a homeotype of NaCl permits the BFU2 ($N_{p''}^{P'} = 5.6$) binding which reappears with different commensurability in $Zr_3Al_2(Tl_2.8, drawing SR24.41)$ an I-homeotype of $U_2Si_2(Tl_6.4, drawing [3a] p.252)$ with $a = a_{U_3Si_2}(1;2)$. $Zr_3Al_4(H_4.3, drawing SR24.40)$ represents the coalescence of a $\sqrt{3}$ and a $\sqrt{4}$ packing in a small cell, it is a RF-homeotype of $CaZn_5(H_1.5, drawing [3a] p.165)$ and belongs therefore to the Laves phase family. $Zr_5Al_4(Ti_5Ga_4)$ a F-homeotype of $Mn_5Si_3(H_{10.6}, drawing [3a] p.306)$ reveals the CHCH/3 binding but $ZrAl(TlI)$ is stabilized by a FU2 binding which has a slightly different commensurability from that in $CaSi(TlI)$. The quasi hexagonal $Zr_2Al_3(S_8.12, drawing SR27.38)$ permits FHUH/3 while $ZrAl_2(MgZn_2)$ is compatible with HBH1. It is surprising that $ZrAl_3(U_2.6)$ a S-homeotype of Cu_3Au is not isotypic with $TiAl_3$ but it suggests a BC2 binding, which affords dipole vectors favouring the stacking sequence.

A fortunate event is the occurrence of $HfAl_3.h(TiAl_3)$ and $HfAl_{3.1}.r(ZrAl_3)$ in one mixture; the great \underline{d}_b value of $HfAl_3.h$ is compatible with the stability of that phase only at high temperatures.

In $TiGa_M$ the highest melting point of an intermediary phase occurs for $Ti_2Ga(Ni_2In)$ which is stabilized by the favourable HUH/3 binding containing simple commensurability in three directions. The rooted commensurability of $TiGa(CuAu)$ is confirmed by $Ti_2Ga_3(T_4.6)$ which reveals the rotation connected with the root [3] by the superstructure. The electron count is here $Ti_2^{1.5, 2.5} Ga_3^{3, 10}$ and in the next phase $Ti^{0, 4} Ga_2^{3, 10}$; surprisingly this difference appears to cause a distinct irregularity in the $\underline{d}_b(N_2)$ function (\underline{d}_b = distance in the \underline{b} correlation, N_2 = mole fraction of the second component). It is not clear at the moment why the change in electron count is so abrupt, but it appears to be real.

For $ZrGa_M$ and $HfGa_M$ similar irregularities have been found.

In A^4In_M and A^4Tl_M only few compounds are stable, perhaps the d electron distance of In and Tl is too great for the natural d electron distance of the A^4 . The remarkable phase Ti_3In_4 (T6.8) a LI-homeotype of CsCl with $\underline{a}=\underline{a}_{CsCl}$ ($\sqrt{8};1$), or R-homeotype of Mn_2Hg_5 (T4.10, drawing [3a] p.289) may be understood by the rooted commensurability which favours the I-homeotypism. Appreciating the homeotypism of U1 and Cl and of Cl and H1 it is found that the $\sqrt{17}$ commensurability is a successor of the $\sqrt{16}$ commensurability of Ti_3In_2 e.g. The gratifying coalescence of $ZrIn_3$, h, r($TiAl_3, ZrAl_3$) clearly shows that the $TiAl_3$ type offers more \underline{b} and \underline{c} places than the $ZrAl_3$ type, therefore the homeotypism $TiAl_3-ZrAl_3$ follows the place number rule [3].

A^5B_3M phases

Starting with the electron count $V^{1.5, 11.5}A_1^{3,8}M$ permits for $V_3Al(Cr_3Si)$, drawing [3c] p.150) a BB2 binding. Reminding that $\overline{Cr_3Si}$ (C6.2) is a RC-homeotype of NaCl, a homeotype of W appears probable for $V_5Al_8(Cu_5Zn_8)$, however, this phase should not be considered isodesmic with Cu_5Zn_8 as the alloys are very different. With respect to the rhombohedral symmetry of Cr_5Al_8 a hexagonal cell with the content $V_{30}Al_{48}$ may be considered, it permits a FHFH/3 binding or something similar, for coordination polyhedra and drawings see [5]. $VA_3(TiAl_3)$ has the binding of $TiAl_3$ so that the old problem is solved why both phases with such a different electron count are isotypic: the difference of electron number refers to the \underline{c} correlation where it has less influence. A \underline{c}_{HT} correlation could be assumed also in order to have a smoother $N_{p''}^{P'}(N_2)$ curve.

Another old problem emerges here: why are so many and complicated Al-rich phases formed? The binding analysis confirms an earlier suggestion of Raynor [6] that A atoms in these phases absorb \underline{b} electrons of Al; this has been corroborated by magnetic measurements (see [3a] p.290), and also the abnormally small d_{AB} distances [7] fit into this assumption. Because of this good confirmation we speak of the Raynor rule. In these phases frequently $\overline{icosA_{14}}$ icosahedrally surrounded by 12 (preferredly) B atoms similar as Au in Cu_3Au ; if A atoms are in the icosahedral shell of another A atom then A contacts occur and this has been described as icosahedra-fusion ([3a] p.293). V_4Al_{23} (H8.46, drawing [3a] p.294) is remotely homeotypic to a H1 structure with the commensurability $\underline{a}=\underline{a}_{H1}$ (3;6) and this confirms the homeotypism to Co_2Al_5, Mn_3Al_{10} [3a], it permits FHFH/3. Postponing V_7Al_{45} (N7.45) the phase VA_{10} (F4.40, drawing [3a] p.292) may be considered; a part of a F1 structure may be seen [3a] similarly as in WA_{12} and

TABLE 5: A5B3M

V3A1(Cr3Si,SR28.43)4.926A=bB(2)=cB(4) N=12,94 phdHA,S
V5A18(Cu5Zn8,SR19.40,43.9)9.234A+H13.02;7.97A=bFH(6;4.5/3)=cFH($\sqrt{108}$;8/3)N=96,356
VA13(TiA13,SR19.40)3.778;8.324A=bB($\sqrt{2.5}$;3.5)=cC($\sqrt{10}$;7) N=18,58
V4A123(H8.46,SR21.25)H7.693;17.040A=bFH($\sqrt{13}$;10/3)=cH($\sqrt{39}$;14)
V7A145(N7.45,SR23.15)M128,9^o25.604;7.621;11.081A
VA110(F4.40,SR21.23)14.49A=bB(6)=cC(12) N=480,1360
Nb3A1(Cr3Si,SR22.24)5.19A=idmV3A1 phdS
Nb2A1(U.h1,SR23.13)9.90;5.19A=bHT($\sqrt{20}$;2.7/2)=cC($\sqrt{80}$;4.7) N=50,320
NbA13(TiA13,SR7.100)3.844;8.605A=idmVA13
Ta3A1 phdM
Ta2A1(U.h1,SR26.25)9.825;5.232A=idmNb2A1
Ta17A112.h(Mn.r,SR30.109)9.88A=hdmNb2A1
Ta17A112.r(,SR30.109)19.315A
Ta2A13(H92.138,SR38.157)H12.776;27.04A no atomic pos.
TaA13(TiA13,SR7.100,30.109)3.842;8.553A=idmVA13
V3Ga.h phdM
V3Ga.r(Cr3Si,SR30.206)4.82A=idmV3A1
V5Ga3.i(Mn5Si3,71Ec)H7.28;4.69A
V6Ga5(Ti6Sn5.h,SR29.117)H8.496;5.176A=bH(4;2.5)=cH($\sqrt{48}$;4) N=42,244
V6Ga7.h(Cu5Zn8?,SR29.117)9.197A
V2Ga5(Mn2Hg5,T4.10,SR30.140)8.954;2.689A=bB($\sqrt{13}$;1.1)=cHT($\sqrt{52}$;25/2) N=30,120
V8Ga41(R8.41,SR41.68)H13.938;14.892A=bBH(4;21/3)=cCH(8;21/3) N=369,1350
Nb3Ga(Cr3Si,SR44.115,22.24)5.171A=idmV3A1 phdM
Nb5Ga3(W5Si3,SR30.139)10.28;5.06A=bB($\sqrt{17}$;2)=cFU($\sqrt{68}$;5.7/2)
Nb3Ga2(U3Si2,SR29.116)6.922;3.500A=bFU($\sqrt{10}$;2.2/2)=cC($\sqrt{40}$;3.2) N=22, cmp
Nb5Ga4(Ti5Ga4,SR30.139)H7.96;5.45A=bCH($\sqrt{7}$;4.5/3)=cCH($\sqrt{21}$;7.7/3)
Nb4Ga5(T, JLCM58.1978.111)8.381;17.081A
Nb5Ga13(Q5.13,SR30.49)3.778;3.778;40.335A=bB($\sqrt{2.5}$;17)=cC($\sqrt{10}$;34)
NbGa3(TiA13,SR27.379)3.789;8.715A=idmVA13
NbGa4.h
Ta5Ga3.h(W5Si3,SR28.46)10.208;5.116A=idmNb5Ga3
Ta5Ga3(Cr5B3,SR29.117)6.588;11.92A
Ta3Ga2(U3Si2,SR28.46)6.817;3.471A=idmNb3Ga2
TaGa2(T, JLCM52.1977.77)
TaGa3(T, 71Ec)
V3In(Cr3Si,71Ec)5.28A=idmV3A1
Nb5In.h(W,SR29.121;Z.Meta11k.73,1982,169)3.326A phd Z.Meta11k.73,169
Nb3In(Cr3Si,SR29.121,71Ec)5.303A=idmV3A1
TaInM(nic,Z.Meta11k.93,169)
V3Ti(Cr3Si,71Ec)5.21A=idmV3A1
NbTiM(nic,Z.Meta11k.73,169)
TaTiM(nic,ibid)

a BC2 binding fits well.

$Nb_2Al(U.h_1, T30, drawing [3a] p.152)$ is homeotypic to (r_3Si) and displays rotated tetrahedral stars; this corresponds as a rule to a rooted commensurability.

While $V_3Ga.r(Cr_3Si)$ is a RC-homeotype of $NaCl, V_6Ga_5(Ti_6Sn_5.h, H12.10)$ is a RF-homeotype of NiAs with the commensurability $\underline{a} = \underline{a}_{NiAs}(2;1)$ and therefore RL-homeotypic to W and so are $V_6Ga_7.h(Cu_5Zn_8)$ and $V_2Ga_5(Mn_2Hg_5, drawing [3a] p.289)$. If for V_2Ga_5 , which may be described as a junction of VGa_{10} polyhedra a BHT2 binding is assumed, then for $V_8Ga_{41}(R8.41)$ a BC2 binding is possible which requires 1.4 \underline{b} electrons absorbed by a V atom. The astonishing fact that $NbGa_M$ and $TaGa_M$ do not display such phases must be interpreted by a smaller absorbing ability of these A atoms. The cell of Nb_5Ga_{13} is homeotypic to $TiAl_3$ with $\underline{a} = \underline{a}_{TiAl_3}(1;4.5)$. It would be of interest to examine the shear sequence in relation to the binding proposed.

The phases $V_3In(Cr_3Si)$, $Nb_3In(Cr_3Si)$ and $V_3Ti(Cr_3Si)$ have been observed, but no one richer in B.

$A_6B_M^3$ phases

The phase $Cr_2Al(MoSi_2)$ is RD-homeotypic to W and yields a CC'2 binding (for the electron count $Cr_2^{0.5, 13.5}Al^{3, 8}$) where the prime on C indicates Hund insertion, and this binding has a different commensurability to the crystal than the BB2 binding of CuZn. But the Bradley mechanism of vacancy formation (see [3d]) may apply here too and leads to phases homeotypic to Cu_5Zn_8 . $Cr_5Al_8.r(\gamma_2)$ has a well confirmed structure but the other $CrAl_M$ phases homeotypic to Cu_5Zn_8 need further study. With $CrAl_4$ the set of phases with Raynor absorption by Cr begins. Well established is $CrAl_7(N7.45)$ but the interpretation must be postponed until the interpretation of simpler structures provides a firm basis for the more complicated problems.

In $MoAl_M$ the structures of $MoAl.h$ and $Mo_3Al_5.h$ are not yet known. The structure of $Mo_3Al_8(N3.8, drawing [3a] p.104)$ is S-homeotypic to $TiAl_3$ and may be generated by one non normal shear system [3a] from $TiAl_3$. The calculation of the $TiAl_3$ subcell of Mo_3Al_8 (tab.6) reveals a strong orthorhombic split of \underline{a}_1 and \underline{a}_2 . The electron count for " $MoAl_3(TiAl_3)$ " gives $\frac{N}{b,c} = 18,60$ and this value might be too great for the BC2 binding to that BHT2 might be aspired. If the axis of this binding points into an $\underline{a}_1(TiAl_3)$ direction than

an orthorhombic split and also a shear might result. But as Tab.6 shows even the BC2 could cause a shear as the ratio of commensurability elements

$$K_{11}''/K_{22}'' \neq 1.$$

MoAl₅.h(WAl₅, drawing [3a]p.118) is R-homeotypic to Nd with $\underline{a} = a_{Nd}(\sqrt{3};1)$. The FHH/3 binding yields Raynor descent, and the electro-dipole vectors generated by the \underline{c} correlation at the minority component favour the observed stacking sequence.

MoAl₁₂(WAl₁₂, B1.12, drawing [3a]p.291) may be described as a LI-homeotype of Cu₃Au with the commensurability $\underline{a} = a_{Cu3Au}(2)$. The lacuna-forming W atoms have in fact the smaller \underline{b} electron contribution as compared with Al like the Ni in Bradley's prototype example NiAl. The W atoms are not inserted into the Cu type substructure, they are substituted, but they are inserted into the \underline{b} correlation and therefore a L-homeotypism becomes possible. A \underline{c}_C correlation would fit excellently to the structure but \underline{c}_{HT} is chosen for its $N_p^{P'}$ value 3.8. The \underline{b} correlation does not give place for all valence electrons so that Raynor descent must be assumed.

The phase Cr₃Ga(Cr₃Si) is stabilized by a BB2 binding in which a Cr^{1.7,12.3} count is valid. The structure of Cr₃Ga₄(Fe₃Ga₄) will be discussed later. CrGa₄(NiHg₄) is a L-homeotype of CsCl, the Ga partial structure may be derived from In(U1) by a change of support number [3a] of (001) layers. It is therefore satisfactory that a $\underline{c}_B(4)$ correlation is found as in In but the BB2 binding of NiHg₄ [8] would give too great a Raynor descent, therefore a twinned CB/2 binding is probable which gives a smaller Raynor descent.

In the phases Mo₆Ga₃₁, Mo₈Ga₄₁ the characteristic close coordination of Ga to Mo is observed just as it was found in the earlier phases with Raynor descent, but here the coordination number is 10 [9], similar as in V₂Ga₅ and several structures to be discussed below. The binding proposal shall be postponed.

A₇B_M³ phases

Several structures of the mixture MnAl_M are not yet solved so that the interpretation must remain tentative or also lacking when the crystal cells are too great. Mn₃Al₂.h(Mg) is compatible with a HH2 binding and Mn_{1.1}Al_{0.9}.h(CuAu) a magnetic phase (SR 22.20,28.7) permits a CU/2 binding. Mn₄Al₁₁(Z4.11, drawing [3a] p.296) is homeotypic to MnAl₆. A simple structure has been found for Mn₃Al₁₀.m-(H6.20, drawing [3a]p.294) the metastability of which has been reported [10] on

TABLE 6: A6B3M

Cr2A1(MoSi2,SR5.35)3.00;8.64A=bC($\sqrt{2}$;4)=cCK'(2) N=8,70 phdHA,S
 Cr5A18.h(see phdS)
 Cr5A18.r(R10.16,SR5.5,43.8)H12.73;7.95A=bH($\sqrt{39}$;4)=cUH($\sqrt{117}$;8) N=144,564
 Cr4A19.h
 Cr4A19.r
 Cr3A17(CuZn8,SR8.7)9.123A needs confirmation
 CrA14
 Cr2A111
 Cr7A145(V7A145,SR24.9)M128.72^O25.196;7.574;10.949A
 Mo3A1(Cr3Si,SR22.24)4.950A=bB(2)=cB(4) N=16,88
 MoA1.h
 Mo3A15.h
 Mo3A18(N3.8,SR27.23,27.377)M100.78^O9.21;3.64;10.07A N=48,164
 TiA13 subcell 3.64;3.95;8.35A=bB(1.5;1.63;3.5)=cC(3;3.26;7)
 MoA14.h(WA14,SR29.7)M100.88^O5.255;17.768;5.225A
 MoA15.h(Wa15,H210,SR23.12)H4.89;8.80A=bFH($\sqrt{5.3}$;5/3)=cH(4;7.2) N=30,92
 MoA16(M4.24,SR24.26)M95^O5.12;13.0;13.5A sites desired N=72,216
 MoA112(WA112,SR18.30)7.582A=bU(3;3.7)=cHT(6;7/2) N=72,204
 WA12.h phdHA
 W3A17.h, WA13.h
 WA14(N3.12,SR22.28)M100.2^O5.272;17.77;5.218A
 WA15(H2.10,SR19.42)H4.902;8.857A=idmMoA15
 WA112(B1.12,SR18.30)7.580A=idmMoA112
 Cr3Ga(Cr3Si,SR22.24)4.645A=idmMo3A1 N=16,94 phdM
 CrGa.h(Cr5A18,SR30.125)R89.2^O9.01A=idmCr5A18
 Cr3Ga4(Fe3Ga4,N9.12,SR41.45)M105.58^O10.135;7.845;7.986A
 CrGa4(NiHg4,B1.4,SR30.125)5.64A=bC($\sqrt{8}$;2.8)=cB(4) N=24,92
 Mo3Ga(Cr3Si,SR22.24)4.943A phdM
 MoGa*1(,ACB31.117)
 MoGa*2(,ACB31.117)
 Mo6Ga31(M24.124,SR40.69)M95.09^O9.517;16.067;16.995A
 Mo8Ga41(V8Ga41,ACB31.1975.117)H14.04;15.05A
 WGaM(nic,phdHA)
 CrIn3(Cu,SR29.111)4.69A=bC(2)=cB($\sqrt{8}$;2.8)
 MoInM(nic,phdS)
 WInM
 CrT1M
 MoT1M
 WT1M

the basis of thermal analysis and metallography; Mn_9Al_{31} and $MnAl_{3.9}$ too are perhaps metastable. The structure of Mn_3Al_{10} , which is probably stable in Mn_3Al_9Si (SR16.11) is RLIC-homeotypic to W and permits a HH/3 binding with Raynor descent. To be sure the descent should be confirmed by magnetic analysis.

While $MnAl_{3.9}(H)$ and $MnAl_4(H)$ are not yet known sufficiently, the phase $MnAl_6$ (Q2.12, drawing [3a] p.294) has a small cell and a structure characteristic for Raynor descent. All Mn are 10-coordinated by Al and many Al belong to two Mn. The Al polyhedra around a Mn may be derived from an icosahedron by replacing 4 Al by two Al. The b_{FH} correlation in Q-aspect requires full Raynor descent and may be supplemented to a FHH/3 binding. The full descent results in an abnormally great d_b value, we return to this problem once more below.

The phase $Tc_2Al(MoSi_2)$ is doubtless homeodesmic to $CrAl(MoSi_2)$ but the commensurability element $K'_{33}=45$ is necessary for the c correlation to give sufficient c places in the CC'2 binding. In $Tc_2Al_3(Ni_2Al_3)$ there is a smaller b contribution of Tc, and the electron count must be chosen $Tc^{0.5,6.5}$ instead of $Tc^{0.5,14.5}$. $TcAl_4(M)$ has the same basal mesh as $TcAl_6$ and is homeotypic to it.

When for $Re_3Al_2(Mn.r)$, drawing [3a] p.155) a FF2 binding is assumed then the same commensurability comes as for the BB2 binding of $Mn.r$ [14].

The equilibrium of Mn_8Ga_5 and Mn_7Ga_6 hints to the existence of twinned bindings. Two different bindings for two different phases with CuAu structure are available. $Mn_2Ga_5(Mn_2Hg_5)$ is assumed to be not isodesmic to $V_2Ga_5(Mn_2Hg_5)$, further development must show which binding proposal is to be preferred.

$A^8B^3_M$ phases

If for $Fe_3Al.r(Fe_3Si)$, drawing [3a] p.127), a R-homeotype of W, a FF2 binding is chosen just as in Fe_3Si then for $FeAl(CsCl)$, drawing [3a] p.127) a HTU/2 binding appears appropriate which does not require Raynor descent. Besides these well-known phases new phases have been proposed by Köster and Gödecke [12] on the basis of thermoanalytic and dilatometric effects. They assume for instance a $Fe_3Al.h$ and a $FeAl.h$; the ordering structures of these phases are not yet fully established, but it appears tempting to see a relation between the temperature dependent b electron contribution of Fe assumed in the present analysis and the effects found by these authors. When the b electron contribution of Fe is increased in $FeAl(HTU/2)$ then the possibility arises that the bind-

TABLE 7: A7B3M

Mn3A12.h(Mg,SR24.25)H2.68;4.34A=bH($\sqrt{7/2}$;2)=cHK'(2) phdM
Mn1.1A10.9.h(CuAu,SR28.7)2.77;3.54A=bC($\sqrt{2}$;1.8)=cU(2;2.5)
MnA1.h
Mn5A18.r(Cr5A18,SR24.120)H12.739;15.871A=idmCr5A18 HUH/3
Mn4A111(Z8.22,SR22.20)Z85.32⁰100.4⁰105.33⁰5.092;8.862;5.047A
MnA13.h
Mn3A110.m(H6.20,SR23.9)H7.543;7.898A=bH($\sqrt{13}$;3.8)=cH($\sqrt{39}$;6.5) N=60,20
Mn9A131(O36.124,SR26.16)14.79;12.42;12.95A
MnA13.9(H,SR24.25)H19.95;24.52A
MnA14(H,SR24.25)H28.41;12.38A
MnA16(Q2.12,SR17.25)6.498;7.552;8.870A=bFHQ(3;2;5/3)=cHQ(3;6;7) N=72,220
MnA112.m(WA112,71E)7.47A=bU(3;3.7)=cHT(6;7/2)
Tc2A1(MoSi2,SR30.109)2.977;9.476A=bC($\sqrt{2}$;4.5)=cC($\sqrt{8}$;9) N=10,72
Tc2A13(Ni2A13,SR28.43)H4.16;5.13A=bH(2;2.5)=cUH($\sqrt{12}$;5/2) N=9,54
TcA14(M,SR28.42)M100⁰5.1;17.0;5.1A
TcA16(MnA16,SR27.30)6.58;7.63;9.00A=idmMnA16
TcA112(WA112,SR29.9)7.526A=idmMnA112.m
Re3A12(Mn.r,SR27.29)9.58A=bF(3)=cF(6) N=104,708 phdE
ReA1(CsCl,SR24.29)2.88A=bC($\sqrt{2}$;1.4)=cU(2;2.5) N=3,15
ReA12(htpMo3A18,phdE)atomic positions desired
Re4A111(Mn4A111,SR28.42)Z85⁰100⁰106⁰4.97;8.80;4.90A
ReA14(Z,htpMoA14,SR28.42)Z99.5⁰94⁰103.5⁰9.13;13.8;5.16A
ReA16(MnA16,SR27.30)6.59;7.61;9.02A=idmMnA16
ReA112(WA112,SR29.9)7.527A=idmMnA112.m
Mn2Ga.h(Mg,SR30.139)2.68;4.34A=idmMn3A12.h phd Z.Metk.56,527
Mn2Ga.r(CuAu,SR30.139)3.89;3.61A=bHT(2;2.1)=cC(4;3.7)
Mn8Ga5(htpCu5Zn8,SR30.139)9.00A
Mn7Ga6.h(Cr5A18,SR30.138)H12.59;8.04A=idmCr5A18
Mn3Ga2.r(CuAu,SR30.138)3.88;3.69A=bC(2;1.9)=cU($\sqrt{8}$;3.3)
MnGa1.1
Mn5Ga7
Mn3Ga5
Mn2Ga5(Mn2Hg5,SR27.379)8.80;2.69A=bHT($\sqrt{20}$;1.5/2)=cB($\sqrt{40}$;2)
MnGa4(NiHg4,SR30.138)5.59A=idmCrGa4
MnGa6(Q,SR30.138)8.95;8.81;9.94A
TcGaM
ReGa^M
Mn3In(htpCu5Zn8,SR.120,45.81)9.420A=hdmCr5A18
TcInM
ReInM
MnT1M(nic,phdHA)
TcT1M
ReT1M

ing goes over to the related FU2 type. Since the \underline{b} electron contribution by Fe is "soft" it is conceivable that the transition happens in a small temperature interval.

With FeAl_2 (Z6.12) the phases with Raynor descent begin. Fe_2Al_5 has an especially simple substructure which is homeotypic to MnAl_6 (SR17.23); a UHH/3 binding fits well. Using a similar binding for FeAl_6 (MnAl_6) would give too great a Raynor descent. However, since the $(\underline{a}_1, \underline{a}_2)$ mesh of FeAl_6 is very nearly hexagonal ($\underline{a}_H = \underline{a}_{\text{FeAl}_6}(-0.5, 0.5, 0; 0.5, 0.5, 0; 0, 0, 1)$) and \underline{a}_H contains a $\sqrt{12}$ commensurability with $\underline{b}_{\text{FH}}$ as is easily verified, this commensurability needs only to be changed into a $\sqrt{13}$ commensurability to get a better \underline{d}_B distance value and an admissible Raynor descent.

While $\text{RuAl}(\text{CsCl})$ is isodesmic to FeAl , $\text{Ru}_2\text{Al}_3(\text{Os}_2\text{Al}_3)$ is homeodesmic in an interesting manner. In $\underline{a} = \underline{a}_{\text{CsCl}}(1;5)$ it is conspicuous that $|\underline{a}_1| > \underline{a}_{1\text{RuAl}}$ and this suggests a changed commensurability of the HTU/2 binding to the cell. This binding conservation is continued in $\text{OsAl}_2(\text{MoSi}_2)$ which gives with $K_{33}^* = 7.2/2$ an additional energy gain by the electron dipole method [3a]. It is seen that the binding of Ru_2Al_3 is quite hidden, it could not be found without analysis of the binding in the neighbouring phases.

Similar as in FeAl_M , in FeGa_M a new phase $\text{Fe}_{2.9}\text{Ga}_{1.1} \cdot h_2$ has been found by Köster and Gödecke [13] which is said to have at the stability temperature a CsCl powder diffraction diagram, but is not identical with $\text{Fe}_3\text{Ga}_2 \cdot h(\text{CsCl})$. Since some disordering of the $\text{Fe}_3\text{Si}(\text{F3.1})$ type of structure may produce a CsCl diagram the phase $\text{Fe}_{2.9}\text{Ga}_{1.1} \cdot h_2$ ("B2'") is subsumed to $\text{Fe}_3\text{Ga} \cdot h(\text{Fe}_3\text{Si type})$ in TAB.8 For $\text{Fe}_3\text{Ga} \cdot h$ the electron count $\text{Fe}_3^{1.7, 14.3}\text{Ga}^{3, 10}$ may be used. it permits the FF2 binding. Similarly for $\text{Fe}_{2.9}\text{Ga}_{1.1} \cdot r(\text{Cu}_3\text{Au})$ a BB2 binding may be assumed, but for $\text{Fe}_{2.9}\text{Ga}_{1.1} \cdot h(\text{Ni}_3\text{Sn})$ a HUH/3 has been assumed which implies that in Fe the 3sp electrons fall out of correlation. As the loss of ferromagnetism is very near to the temperatures at which the 3sp electrons fall out of correlation, there may be a causal connection between both phenomena so that the Curie temperature does not only imply a disordering of the magnetic polarisation but also a falling of 3sp electrons out of the 3d electron correlation.

The phase $\text{FeGa}_3(\text{CoGa}_3, \text{T4.12}, \text{drawing [3a]p.301})$ shows the typical high coordination of Fe by 8Ga+1Fe of a structure with Raynor descent and permits a HTB/2 binding. The \underline{c}_B correlation of Ga.p and In is conserved and fits very well to the atom positions, the \underline{b}_F correlation of Ga.p and In has been strained to a $\underline{b}_{\text{HT}}$ correlation which requests Raynor descent and this is corroborated by the fact that no $\text{A}^{10}\text{B}_3(\text{CoGa}_3)$ phase has been found so far.

TABLE 8: A8B3M

Fe13A13(C13.3,SR22.14)5.794A=bHT($\sqrt{8}$;3.3/2)=cFU($\sqrt{32}$;8/2)
 Fe3A1.r(Fe3Si,SR2.680,22.14)5.793A=bF(2)=cF(4) N=24,212
 FeA1(CsCl,SR2.680,22.14)2.909A=bHT($\sqrt{2}$;1.65/2)=cU(2;2.5) N=4,15
 Fe2A13.h
 FeA12(Z6.12,SR39.5)Z91.75⁰73.27⁰96.89⁰4.878;6.461;8.800A
 Fe2A15(substr.Q2.5,SR17.23)7.67;6.40;4.20A=bUH₆(2;3;2.3/3)=cHQ(6;3;3.3) N=30,112
 Fe4A113(N12.39,SR19.22)M107.72⁰15.498;8.083;12.476A
 Fe2A17(Edshammar)
 FeA16(MnA16,SR30.4)6.464;7.440;8.779A=hdmMnA16
 RuA1(CsCl,SR24.29)2.95A=idmFeA1 HTUy/2 N=4,15 phdS
 Ru2A13.h(0s2A13,71Ec)3.079;14.33A=bHT($\sqrt{2.25}$;8/2)=cU($\sqrt{4.5}$;12) N=18,80
 RuA12(TiSi2,SR31.16)8.012;4.717;8.735A
 Ru2A15
 Ru4A113(Fe4A113,SR30.12)M107.77⁰15.862;8.188;12.736A
 RuA14
 RuA16(MnA16,SR33.16)7.488;6.556;8.961A=idmFeA16
 RuA112
 OsA1(CsCl,SR21.12)3.005A=idmFeA1
 Os2A13(U2.3,SR30.10)3.106;14.184A=idmRu2A13.h
 OsA12(MoSi2,SR30.10)3.162;8.302A=bHT($\sqrt{2.5}$;4.8/2)=cU($\sqrt{5}$;7.2/2) N=12,48
 Os4A113(N4.13,SR29.10)M115.15⁰17.64;4.228;7.773A
 Os2A15
 Fe3Ga.h(Fe3Si,71Ec)5.81A=idmFe3A1.r FF2 N=24,220 phdM
 Fe2.9Ga1.1.h(Ni3Sn,SR24.120)5.234;4.213A=bH($\sqrt{7}$;2)=cUH($\sqrt{21}$;4) N=12,62
 Fe2.9Ga1.1.r(Cu3Au,SR24.120)3.701A=bB($\sqrt{2.5}$;1.6)=cBK'(2) N=6,55
 Fe3Ga2.h(CsCl,71Ec)2.91A=idmFeA1 HTUy/2
 Fe3Ga2.m(Cr5A18?,Z.Metk.68.1977.661)
 Fe6Ga5.h(Cr5A18,SR24.120)H12.463;15.577A
 Fe6Ga5.r(N12.10,SR40.67)M109.33⁰10.058;7.946;7.747A
 Fe3Ga4(N9.12,SR41.45)M106.67⁰10.091;7.666;7.866A
 FeGa3(CoGa3,T4.12,SR23.119)6.25;6.56A=bHT(3;3.6/2)=cB($\sqrt{18}$;4.5) N=36,152
 RuGa(CsCl,SR28.46)3.010A
 RuGa2(TiSi2,SR28.46)8.184;4.749;8.686A
 RuGa3(CoGa3,SR23.119)6.47;6.73A=idmFeGa3
 OsGa3(CoGa3,SR23.119)6.488;6.748A=idmFeGa3
 FeInM(nic,phdM)
 Ru3In(Ni3Sn,SR29.121)H5.942;4.58⁰A=idmFe2.9Ga1.1.h
 RuIn3(CoGa3,SR29.121)6.998;7.240=idmFeGa3
 OsInM
 FeTlM(nic,phdHA)
 RuTlM
 OsTlM

A₉B₃M phases

A melting temperature of CoAl(CsCl) which is greater than that of Co indicates a great stability of CoAl at high temperatures. Remembering the temperature dependence of the \underline{b} electron contribution of Co suggests a binding $\underline{a}=\underline{b}_F(1)=c_U(2;2.5)$ which implies a positive \underline{b} contribution of Co and is energetically favourable. At lower temperatures the \underline{b} contribution of Co must decrease and a binding $\underline{a}=\underline{b}_{HT}(\sqrt{2};1.65/2)=c_U(2;2.5)$ becomes probable. This transition should lead to effects which are similar to the effects found by Köster and Gödecke in FeAl_M [12] and FeGa_M [13]. In the phase Co₂Al₅(H8.20,drawing[3a] p.294) the Raynor descent begins. For CoAl_M, the structure is remotely homeotypic to Ni₂In or W and contains one more atom in the cell than suggested by the homeotypism to W, a BHBH/3 binding appears probable.

Also Co₂Al₉(M4.18, drawing [3a]p.302) displays a coordination of 9Al to Co as to be expected in phases with Raynor descent. The \underline{a}_2 & \underline{a}_3 mesh is quasi tetragonal and the pure Al layers have a $\sqrt{5}$ commensurability to it, so that a $\sqrt{20}$ commensurability of \underline{c} to \underline{a} may be conjectured. In fact the electron distances suggest a HTB/2 binding in $\sqrt{20}$ commensurability and this is reminiscent of the $\sqrt{18}$ commensurability of the HTB/2 binding in FeGa₃ in agreement with the place number rule [3b]. The monoclinic deformation of the Co₂Al₉ cell probably has to do with the value of the commensurability element $k_{33}^1=5/2$, it should be mentioned here that FeCu₂Al₇(T4.8.28,drawing [3a]p.302) is tetragonal and homeotypic to Co₂Al₉. [The structure of CoGa₃(T4.12,drawing [3a]p.301) is RDI-homeotypic to W with $\underline{a}=\underline{a}_W(2)$ and yields a HTB/2 binding like FeGa₃(CoGa₃). This binding occurs also in the phase Co₂Al₉, and the $N_{Pn}^{B/A}$ value (B=Al or Ga) for Co₂Al₉ is 13.3, but 13.5 for CoGa₃, so that Ga with 1.25 times more peripheral core electrons has only 1.02 times more core places. This is one more example for the place number rule [3b] which destabilizes the CoGa₃ type for Al alloys. The phase Rh₁₀Ga₁₇(T40.68) is homeotypic to TiSi₂(S2.4,drawing [3a]p.313) which is stacked in hexagonal close packed layers with the support number 2. The isometric U1 lattice also has this property and therefore TiSi₂ is pseudo tetragonal. This fact and the thermodynamic equilibrium of Rh₁₀Ga₁₇ with RhGa (CsCl) suggests to consider the remote homeotypism with W: $\underline{a}=\underline{a}_W(2;16)$. This homeotypism makes the isodesmism as described in TAB.9 quite plausible. The TiSi₂(S2.4) homeotypes obey the Ekman rule [3a] and therefore the \underline{b} correlation is built up exclusively of the B atom valence electrons and this causes an adaptation of the atom sites to the electron correlation [14].

The phase CoIn₂(Mg₂Cu,S8.4,drawing [3a]p.288) displays the coordination

TABLE 9: A9B3M

Co3Al_m(Cu3Au,71Ec)3.658A=bU($\sqrt{2}$;1.75)=cUK'(2) N=6,56 phdM
 CoAl(CsCl,SR7.196)2.86A=bHT($\sqrt{2}$;1.65/2)=cU(2;2.5) N=3,17 cmp
 Co2Al5(H8.20,SR6.175)H7.672;7.672;7.609A=bBH($\sqrt{5.3}$;11/3)=cB(4;19/3) N=60,232
 CoAl3
 Co4Al13(Fe4Al13,SR27.8)15.183,0,-3.793;8.122;11.743A
 Co2Al9(M4.18,SR11.8)8.527;6.290;-0.710,0,6.213A=bHT($\sqrt{10}$;5/2)=cB($\sqrt{20}$;6) N=54,180
 RhAl(CsCl,SR21.12)2.99A=idmCoAl
 Rh2Al5(Co2Al5,SR32.12)H7.893;7.854A=idmCo2Al5
 RhAl3
 Rh2Al9(Co2Al9,SR33.15)M94.81^Q6.352;6.428;8.721A=idmCo2Al9
 IrAl(CsCl,SR21.11)2.983A=idmCoAl
 IrAl3(Na3As,71Ec)H4.246;7.756A=bFH(2;4.5/3)=cFH($\sqrt{12}$;7.8/3) N=18,57
 Ir2Al9(Co2Al9,SR33.15)M94.77^Q6.378;6.430;8.732A=idmCo2Al9
 CoGa(CsCl,SR23.119)2.87A=idmCoAl phdM
 CoGa3(T4.12,SR23.119)6.26;6.48A=bHT(3;3.6/2)=cB($\sqrt{18}$;4.5) N=36,156
 RhGa(CsCl,SR23.118)3.01A=idmCoAl HTU/2 or HTC2
 Rh10Ga17(T40.68,SR32.68)5.813;47.46A=bHT($\sqrt{8}$;2 6/2)=cU(4;40)
 RhGa3(CoGa3,SR23.119)6.488;6.553A=idmCoGa3 HTB/ $\sqrt{2}$
 Rh2Ga9(Co2Al9,)
 RhGa6
 IrGa(CsCl,SR23.118)2.98A=idmCoAl
 Ir3Ga5(T12.20,SR32.69)5.823;14.20A=bHT($\sqrt{8}$;8)=cU(4;12)
 IrGa3.h(CoGa3,SR23.119)6.41;6.61A=idmCoGa3
 Ir2Ga9(Co2Al9,) idmCo2Al9
 IrGa6
 CoIn(Mg2Cu,SR41.52)9.402;17.846;5.282A=bH($\sqrt{5.3}$;8/2)=cUH(4;16/2) N=96,464
 CoIn3(CoGa3,SR43.49)6.830;7.094A=idmCoGa3
 RhIn(CsCl,SR23.118)=idmCoAl
 RhIn3(CoGa3,SR23.119)7.01;7.15A
 Ir2In3
 IrIn2(Mg2Cu,JLCM79.1981.P1)**9.809;18.060;5.349 A**
 IrIn3(CoGa3,SR23.119)6.99;7.20A=idmCoGa3
 CoTIM(nic,phdHA)
 RhTIM
 IrTIM

(2Co+8In)-Co so that Raynor descent is possible. The HUH/3 binding requests in fact a descent of 11 electrons.

$A_{10}^{10}B_{10}^3$ phases. These phases have been analysed with respect to binding several years ago [3d]. The present TABLE 10 eliminates shortcomings and mistakes of this analysis and uses a more appropriate binding notation. It is found in the present alloys that the stability of several Al rich phases with neighbouring compositions is no more observed, as Raynor descent is no longer possible. For Ni_3Al the binding of Cu has been proposed [3d] but the $N_{p,n}^{p,n}(N_2)$ function suggests a smaller d_b value to attain a BU2 binding which is homeotypic to the UU2 binding in Ni_3Ge [3c]. The phases Ni_2Al and Ni_3Al_2 need further confirmation. $NiAl$ must have a very favourable binding as its melting temperature is comparable to that of Fe and Ti. Probably lower electrons take part in the binding, i.e. the electron count is $Ni^{1,17}Al^{3,8}$. The structure is ordered up to the melting temperature [15]. The FF2 binding is valid only for high temperatures, the good internal commensurability of the binding causes the Bradley vacancy formation to extend the binding to more Al rich compositions [see 3a]. At lower temperatures the binding might be as in $FeAl$ and this change should cause weak thermal effects like as in $FeAl_M$. The HUH/3 binding of Ni_2Al_3 (42,6) was found earlier [3c]. The b place number $N_{p,C}^C=9.6$ explains the fact that isotopes solve B^4 but not B^2 [3g,h].

The UFU2 binding of $NiAl_3$ is an improvement of the earlier [3d] UC2 binding which violates the place number rule. The d_c values of Ni_2Al_3 and $NiAl_3$ are strikingly great, probably as the soft $c(Ni)$ correlation is no more supported by the 3sp electrons and comes under the pressure of the $b(Al)$ correlation.

$Pd_2Al(Ni_2Si)$, drawing [3a]p.322, a RDI-homeotype of Cu, permits a UU2 binding for the great count $Pd_{12}^{1,17}Al^{3,8}$ where the c correlation is fully occupied, a rare event. For the homeotype $Pd_5Al_3(Rh_5Ge_3)$, drawing [3a]p.324 a similar binding is acceptable. The non whole number commensurability elements should generate shears, but these have not yet been found. The transformation $PdAl.h-r$ is caused by the temperature dependent b electron contribution. The FF2 binding of $PdAl.h(CsCl)$ requires 1 b electron per Pd while the HH2 binding of the I-homeotype $PdAl.r(R13.13)$ needs only 0.6. The decrease of b concentration favours the transition to b_H and the tendency to attain a whole number element $(\frac{b-1}{a})_{33}=K'_{33}$ leads to the root $\sqrt{57}$ which causes the I-homeotypism $PdAl.h-r$. The phase $PdAl_{1,1}(FeSi)$, drawing [3a]p.308 should be considered in the hexagonal aspect ([3a]p.331) which reveals the LDI-homeotypism to W. Astonishingly the HH2 binding appears to be stable once more. $Pd_2Al_3(Ni_2Al_3)$ belongs to the

TABLE 10: A10B3M

Ni3Al(Cu3Au, SR2.684)3.568A=bB($\sqrt{2}$;1.4)=cU($\sqrt{8}$;3.5) N=6,59g phdHA
 Ni2Al(H4.2, JapplCryst9.1976.263)H4.02;4.93A=bCH($\sqrt{1.75}$;4/3)=cCHK'(2) N=10,52
 Ni3Al₂h(CuAu, SR15.11)3.78;3.24A=bFU($\sqrt{3}$.25;2.5/2)=cFU($\sqrt{13}$;5/2) N=72,54g
 NiAl(CsCl, SR5.127)2.873A=bF(1)=cF(2) N=3,26g
 Ni2Al3(H2.3, SR5.67)H4.036;4.901A=bH(2;2.4)=cUH($\sqrt{12}$;4.8/2) N=9,441
 NiAl3(Fe3C, SR5.60)6.612;7.366;4.812A=bU(3.3/1;3;2)=cFU(7.6/2;6;4) N=36,136
 Pd2Al(Ni2Si, SR21.15)7.77;5.41;4.05A=bU(2.9;2;1.8)=cUK'(2) N=20,168g phdS
 Pd5Al3(Rh5Ge3, SR23.121)10.41;5.35;4.03A=bU(3.9;2;1.8/1)=cUK'(2) N=28,218g
 PdAl.h(CsCl, SR13.23)3.037A=idmNiAl FF2 cmp
 PdAl.r(R13.13, SR43.12)H15.659;5.251A=bH($\sqrt{57}$;2.5)=cHK'(2) N=117,1014
 PdAl1.1(FeSi, SR29.12)4.859AorH6.86;8.41A=bH($\sqrt{10}$.7;4)=cH($\sqrt{43}$;8) N=36,312g
 Pd2Al3(Ni2Al3, SR13.23)H4.22;5.16A=idmNi2Al3
 PdAl2.7(, SR17.31)
 PdAl3.8(PtAl4, JapplCryst14.981.212)H13.085;9.633A FHUH/3 phdS
 Pt3Al.r(Pt3Ga.r, JLCM41.1975.19)5.459;7.806A=bFU($\sqrt{5}$;4.5/2)=cB($\sqrt{20}$;6.5) N=24,236g
 Pt2.9Al1.1(Cu3Au, SR22.25)3.876A=idmNi3Al BU2 N=6,58 cmp
 Pt2Al.h(Ni2Si, SR41.8)5.401;4.055;7.899A=idmPd2Al
 Pt2Al.r(O16.8, SR42.10)16.297;3.921;5.439A=bU(6;1.8;2)=cUK'(2) N=40,336
 Pt5Al3(Rh5Ge3, SR22.25)5.41;10.70;3.95A=idmPd5Al3
 Pt1.1Al0.9.h(CsCl, SR44.105)3.123A=idmNiAl
 PtAl(FeSi, SR21.12)4.865AorH6.87;8.42A=idmPdAl1.1 cmp
 Pt2Al3(Ni2Al3, JLCM41.1975.19)H4.209;5.175A=idmNi2Al3 cmp
 PtAl12(CaF2, SR5.54)5.922A=bHT($\sqrt{8}$;3.3/2)=cB(4) N=24,104
 Pt8Al21(U16.42, SR31.10)12.97;10.65A=bU(5;5)=cB(10;8) N=252,1248g
 PtAl4(H18.72,)13.068;9.619A=bFH($\sqrt{39}$;5.5/3)=cUH($\sqrt{117}$;9/2) N=16,756
 Ni3Ga(Cu3Au, SR21.118)3.582A=idmNi3Al phdM
 Ni5Ga3(Pt5Ga3, SR34.140)7.53;6.72;3.77A=bU(3;2.66;1.8/1)=cUK'(2) N=28,230g
 Ni3Ga2.h(NiAs, SR11.122)H4.000;4.983A=bCH($\sqrt{1.75}$;4/3)=cCHK'(2) N=9,501
 Ni13Ga9(Ni3.9, SR34.137)13.822;0.6.869;7.894;4.968A=bCH($\sqrt{21}$;7;4.1)=cCHK'(2) N=54,4401
 NiGa(CsCl, SR11.123)2.895A=idmNiAl FF2 N=4,27g
 Ni3Ga4(B24.32, SR34.137)11.411A=bC($\sqrt{32}$;5.7)=cU(8;10) N=192,11201
 Ni2Ga3(Ni2Al3, SR11.123)H4.060;4.897A=idmNi2Al3 HUH/3
 NiGa4(httpRu3Sn7, SR13.111)8.42A=bHT($\sqrt{17}$;4.8)=cB($\sqrt{34}$;6) N=84,340
 Pd13Ga5 phdE
 Pd5Ga2(O20.8, SR40.71)18.396;5.485;4.083A=bU(6.7;2;1.8)=cUK'(2) N=44,340m
 Pd7Ga3
 Pd2Ga(Ni2Si, SR23.120)5.493;4.064;7.814A=idmPd2Al N=20,144m cmp
 Pd5Ga3(Rh5Ge3, SR23.121)10.51;5.42;4.03A=idmPd5Al3
 Pd5Ga4.h(CsCl, SR40.108)3.04A=idmNiAl
 PdGa(FeSi, SR11.123)4.89AorH6.92;8.47A=bBH(2;12/3)=cFH(6;9/3) N=16,108g
 Pd3Ga7(Ru3Sn7, SR11.123)8.77A=bHT($\sqrt{18}$;5/2)=cB(6) N=84,400
 PdGa5(U2.10, SR23.119)6.448;10.003A=bHT($\sqrt{10}$;6/2)=cB(20;7) N=60,240
 Pt3Ga(Tl2.4, SR41.8)5.472;7.886A=idmPt3Al.r N=24,244g phdM
 Pt2.8Ga1.2(Cu3Au, SR24.115)3.892A=idmNi3Al BU2
 Pt.69Ga.31.h(CuAu, SR34.140)3.93;3.79A=bB($\sqrt{2}$;1.37)=cU($\sqrt{8}$;3.3) N=6.5,60g
 Pt.68Ga.32.h(httpCuAu, Metal128.1974.1160)3.90;3.92;3.79A
 Pt2Ga.r(Pt2Al.r, SR42.83)16.440;3.922;5.488A=idmPt2Al.r
 Pt1.95Ga.h(Rh5Ge3, SR42.83)10.860;5.484;3.950A=idmPd5Al3
 Pt5Ga3(Q5.3, SR24.115)8.031;7.440;3.948A=idmNi5Ga3
 PtGa(FeSi, SR11.123)4.91AorH6.94;8.50A=idmPdGa
 Pt2Ga3(Ni2Al3, SR11.123)H4.23;5.18A=idmNi2Al3
 PtGa2(CaF2, SR5.54)5.923A=bHT($\sqrt{8}$;3)=cB(4) N=24,120
 Pt3Ga7(Ru3Sn7, SR23.156)8.799A=idmPd3Ga7 HTB/12
 PtGa5
 PtGa6(, SR24.116)15.946;12.034;8.866A

Ni3In(Ni3Sn.r,SR13.121)H5.331;4.251A=bH($\sqrt{5.3}$;1.8)=cFH($\sqrt{21}$;4.5/3) N=12,122g
Ni2In.r phdHA
Ni3In2.h(FhtpNiAs,SR9.91)H4.185;5.135A=idmNi3Ga2.h
Ni12.8In9.2(Ni13Ga9,SR34.137)14.65,0,7.324;8.33;5.195A=idmNi13Ga9
NiIn.h(CsCl,SR11.132)3.099A=idmNiAl
NiIn.r(CoSn,SR11.132)H5.210;4.343Aor5.2;4.3;9.0A=bH(2.4;2;4.8)=cHK'(2)N=9,601
Ni2In3(Ni2Al3,SR11.132)H4.396;5.302A=idmNi2Al3
Ni3In7(Ru3Sn7,SR30.61)9.18A=idmPd3Ga7
Pd3In.h(TiAl3,JLCM17.1969.73)4.15;2x3.74A=bU($\sqrt{2}$;3)=cC(4;7.2) N=12,122g
Pd3In.r(ZrAl3,JLCM17.1969.73)4.07;4x3.80A=bB($\sqrt{2}$;5)=cC(4;15)
Pd2In(Ni2Si,SR21.15)8.24;5.61;4.22A=idmPd2Al
Pd5In3(Rh5Ge3,SR23.121)11.02;5.60;4.24A=idmPd5Al3
PdIn(CsCl,SR11.133)3.26A=idmNiAl
Pd2In3(Ni2Al3,SR11.133)H4.53;5.50A=idmNi2Al3
Pd3In7(Ru3Sn7,SR11.133)9.44A=idmPd3Ga7 HTB $\sqrt{2}$
Pt3In(Cu3Au,SR34.140)3.992A=idmNi3Al BU2
Pt2In(Pt5Ga3,SR34.140)8.18;7.81;4.08A=bU($2\sqrt{2}$;3.3; $\sqrt{2}$)=cUK'(2) N=23,160
Pt3In2.h(FhtpNiAs,SR34.140)H4.35;5.55A=idmNi3Ga2.h
Pt3In2.r(Pt3Ti2,SR34.140)H5.56;13.65A=bCH($\sqrt{3}$;10/3)=cCHK'(2) N=30,1941
Pt13In9(Ni13Ga9,SR44.72)15.338,0,7.626;8.802;5.563A=idmNi13Ga9
Pt1.1In(CuAl.r,SR44.72)11.007;4.430;7.939,0,7.580A=bCH(8/3; $\sqrt{1.75}$) N=30,200
PtIn.h(CsCl,ZMetk69.1978.333)3.28A=idmNiAl FF2
Pt2In3(Ni2Al3,SR11.133)H4.52;5.50A=idmNi2Al3 HUH $\sqrt{3}$
PtIn2.h(CaF2,SR5.54)6.366A=idmPtAl2 HTU $\sqrt{2}$
Pt3In7(Ru3Sn7,SR13.112)9.435A=idmPd3Ga7 HTB $\sqrt{2}$
NiTiM(nic,phdHA)
Pd3Ti.h(TiAl3,JLCM16.1968.415)4.146;7.497A=idmPd3In.h phdM
Pd3Ti.r(ZrAl3,SR34.141)4.10;15.32A=idmPdIn.r
Pd2Ti.h(FhtpNiAs,SR18.158)H4.53;5.66A=idmNi3Ga2.h
Pd2Ti.r(Ni2Si,SR34.141)8.30;5.72;4.21A=idmPd2Al
Pd13Ti9(H13.9,SR34.137)H8.958;5.623A=bCH($\sqrt{7}$;4/3)=cCHK'(2) N=27,220
PdTi2(CuAl2,SR34.141)6.71;5.74A=bHT($\sqrt{8}$;3/2)=cU(4;4) N=24,120
Pt3Ti2(H12.8,SR33.125)H5.645;13.851A=bUH($\sqrt{5.2}$;6.5)=cUHK'(2) N=30,200
PtTi(CoSn,SR3.618)H5.616;4.648A=bH($\sqrt{5.2}$;2)=cH($\sqrt{21}$;4) N=9,60
PtTi2(CuAl2,SR34.141)6.82;5.56A=idmPdTi2

small electron count $\text{Pd}_2^{0,10}\text{Al}_3^{3,8}$ and is isodesmic to Ni_2Al_3 . It is gratifying that the mean atomic volume in the mixture PdAl_M [16] clearly shows the difference between great and little count. The great count forces the volume down as the electron distance of the 4sp shell is smaller than that of the 4d shell [11]. The choice between great and small electron count is another parameter influencing the valence picture of the AB_M^3 alloys.

The BU2 binding of $\text{Pt}_{2,9}\text{Al}_{1,1}(\text{Cu}_3\text{Au})$ appears to have an over-occupied c_u correlation. At lower temperatures and smaller Al content the b electron concentration decreases and the c electron concentration increases. This causes a change to a FUB2 binding with a new commensurability in $\text{Pt}_3\text{Al.r}$ - ($\text{Pt}_3\text{Ga.r.T12.4}$), a I-homeotype of Cu_3Au with $\underline{a}=\underline{a}_{\text{Cu}_3\text{Au}}(\sqrt{2};2)$. The phases $\text{Pt}_2\text{Al.h}(\text{Ni}_2\text{Si})$ up to $\text{PtAl}(\text{FeSi})$ have XX2 bindings ($X=U,F,H$) which are especially frequent in brass-like alloys [8]. While $\text{Pt}_2\text{Al}_3(\text{Ni}_2\text{Al}_3)$ obeys the small count, the phase $\text{Pt}_8\text{Al}_{21}$ (U16.42, drawing SR31.12) probably returns to the great count. This results in a curious behaviour of the $V_{\text{At}}(N_2')$ curve [17] which even appears to be oscillatory [16b].

Starting from the binding $\text{Ni}(\text{Cu}, \text{SR1.68})3.52\bar{A}=b_c(\sqrt{2};1.4)=c_B(\sqrt{8};2.8)$ affords for $\text{Ni}_3\text{Ga}(\text{Cu}_3\text{Au})$ a BU2 binding which leads over to the set of phases with XX2 binding. The main phase is $\text{NiGa}(\text{CsCl})$ with FF2 binding under great count, but also $\text{Ni}_3\text{Ga}_2.h(\text{NiAs})$ belongs to the set and yields a CC2 binding under little count. The quasi hexagonal $\text{Ni}_{13}\text{Ga}_9$ (N13.9, drawing [18]) is a RF-homeotype of NiAs with the commensurability $\underline{a}=\underline{a}_{\text{NiAs}}(-2,2,-1;2,2,1;0,0,1)$ and with anomalous substitution. It also yields CC2 under little count and the anomalous substitution serves to fill the b correlation while the lacunae on Ni places serve to not overfill the c correlation under little count and the monoclinicity gives a better commensurability. It may be that the little count is only apparent and that c_c is partly filled to c_B . $\text{Ni}_5\text{Ga}_3(\text{Pt}_5\text{Ga}_3, \text{Q5.3, drawing [3a] p.105})$ is a RDI-homeotype of CuAu.r and permits a UU2 binding the c correlation of which is fully occupied in great count. $\text{NiGa}(\text{CsCl})$ curiously returns to the great count while Ni_3Ga_4 (B24.32, drawing JLCM19.1969.245) is L-homeotypic to CsCl , its $\text{CuH}/2$ binding (little count) having been correctly found earlier [3d]. $\text{Ni}_2\text{Ga}_3(\text{Ni}_2\text{Al}_3)$ confirms the little count and was also correctly found in [3d]. $\text{NiGa}_4(\text{htpRu}_3\text{Sn}_7)$ is not yet completely known but its remarkable HTB $\sqrt{2}$ binding appears fairly certain. In summary it is found that the $N_{\text{pu}}^{\text{P}}(N_2')$ function implied in the data of TAB.10 is smooth and monotonous but has a plateau for the XX2 bindings, which confirms the energetic favourable property of the XX2 bindings.

The XX2 plateau gives an interpretation for the puzzling phenomenon that in the mixture PdGa_M five phases not yet all solved are crowded around Pd_2Ga .

The solved phases are RDI-homeotypes of Cu like Pd₂Al and yield therefore a UU2 binding. In Pd₅Ga₂(020.8) the great electron count did not work, therefore a medium count (m) was used which assumes that 4 electrons of the 4sp shell are in Hund insertion and therefore need not be counted. The phases Pd₂Ga and Pd₅Ga₃ have different commensurability of UU2 to the cell a and therefore are separate phases. The UU2 binding is followed by a FF2 binding in Pd₅Ga₄.h(CsCl). Following the place number rule [3b] PdGa(FeSi) has less P" places than NiAl or PdAl so that other structures are stable. It is curious that in PdGa₅ a HTB/2 binding is stable where \checkmark indicates a little deformation.

As in Pt_{2.8}Ga_{1.2}(Cu₃Au) Hund insertion is to be assumed (see Ni₃Al) the small deformation in Pt_{.69}Ga_{.31} and Pt_{.68}Ga_{.32} may be caused by this influence. A new structure appears in PtGa₂(CaF₂), the small compression of b_{HT} is compatible with an increase of $N_{P''}^C$ as compared with Pt₃Ga₇. The knowledge of the structures of PtGa₅ and PtGa₆ would be of interest.

It is an old question why Ni₃In(Ni₃Sn.r) and Ni₃Al(Cu₃Au) are not isotypic. Now $N_{P''}^C=56$ for Ni₃Al and $N_{P''}^C=2x47$ for Ni₃In so that the great In atom increases d_C and causes another commensurability and another structure. For a greater mole fraction of In the XX2 bindings come and stabilize homeotypes of W. A structure which is not so frequent has NiIn.r(CoSn); it is a FC-homeotype of NiAs [3c] and may have a HH2 binding as the b contribution of Ni decreases.

The phase Pd₃In.h(TiAl₃) and also Pd₃In.r(ZrAl₃) is homeotypic to Cu as $N_{P''}^C=58$ because of the UC/8 binding. The b_U and b_B correlations just stabilize the structures found following the energy assessment [3a p.99] by correlation-induced electro-dipoles.

The phase Pt₂In(Pt₅Ga₃) is quasi tetragonal with a₂ as axis. The BU2 binding of Pt₃In(Cu₃Au) goes over here into a UU2 binding, but it is surprising that after this phase homeotypes of W become stable which display a CC2 binding, as it is a rule that XX2 bindings increase their density with increasing b concentration. Pt₃In₂.h(NiAs), Pt₃In₂.r(Pt₃Tl₂) and Pt₁₃In₉(Ni₁₃Ga₉) show a CC2 binding, it is therefore surprising that Pt_{1.1}In(CuAl.r,N5.5), a homeotype of NiAs, also is compatible with this binding. Following Bradley's rule [3a] the phase Pt₁₃In₉ has 0.5 vacancies per NiAs substructure cell while Pt₁₁In has 1.0; this number is conserved in Pt₂In₃ as the binding is here no more of the XX2 type, Pt₃In₇ has 1.6 vacancies per three W substructure cells.

The phase PdTl₂(CuAl₂,HTU/2) is in competition with Pd₃In₇(Ru₃Sn₇,HTB/2) and

PtIn₂.h(CaF₂,HTU/2), the emergence of the CuAl₂ type conforms to the place number rule [3b] as it requires the smallest number of places.

B¹B_M³ phases. These phases have been discussed previously [3e] but shall be included as the better appreciation of the $N_{p''}^{P'}(N_2')$ rule allows some improvements. The twinned FUB2 binding of Cu and Cu_{3.4}Al_{0.9} has been discussed earlier [3f], the b correlation is compressed tetragonally when the b electron concentration is increased as this is the easiest way. When ideally the compression is continued then the correlation goes over eventually into the BB2 type and this is compatible here by experience with a structure homeotypic to W. The phases NiAl and Cu₃Al.h are not isodesmic as the b electron concentration of NiAl is really $N_b^A = 2$ because of the temperature dependent b contribution of Ni, while of Cu₃Al.h it is $N_b^A = 1.5$. Just as the NiAl type, the Cu₃Al.h type permits the L-homeotypism of Bradley, i.e. vacancy formation when N_b^A increases; different order of the vacancies causes different structure types. The plateau of $N_{p''}^{P'}(N_2')$ belonging to BB2 phases ends with Cu₃₂Al₁₉, and for greater N_{Al}^A follow homeotypes of NiAs, one of these with HUH/3 binding. Finally the FU2 binding is found in CuAl₂, the compression of b_F is mitigated by a slight shift of stability range to Al richer compositions.

In AgAl_M three phases correspond to different possibilities of XX2 binding, and the greatest N_b^A value corresponds to the closest packing of the correlations.

In AuAl_M the BB2 and UU2 binding is shifted to smaller Al mole fractions as Au has a b electron contribution $N_b^{Au} = 1.15$ [3a p.80], however, the FF2 binding belongs to a MoSi₂ type of structure, while in AgAl_M it belonged to a Mg type. The number of b places per atom is $N_{p'}^A = 1.5$ in Ag₂Al and $N_{p'}^A = 1.75$ in Au₂Al because of the greater b electron contribution of Au. At lower temperatures DI-homeotypes of MoSi₂ become stable in order to adapt the atom sites to the electrical dipoles induced by the bindings at the atoms. AuAl(M4.4) is another RDI-homeotype of W. A FF2 binding is, following the $N_{p''}^{P'}$ rule, not possible but the FUC2 bindings fits well. The tetragonal binding of AuAl₂ responds to the problem of pleochroism of this phase [19,16].

CuGa_M is isotypic to CuAl_M with the exception of CuGa₂(T1.2) which is heterotypic to CuAl₂, the HTU/2 binding is preferred to FUU/2 as Ga has a greater c contribution than Al. Ag₃Ga.r(Ag₂Zn.r, drawing [3a]p.127) is a RD-homeotype of W, it has also a FF2 binding but the commensurability is improved. Au₇Ga(TiNi₃) has a HFH₂ binding which favours the stacking sequence of the structure. Au₇Ga₂.h(H21.6, drawing JLCM23.1971.83) is a RI-homeotype of Fe₂P with $\underline{a} = a_{Fe_2P}$

TABLE 11: B1B3M

Cu3.1A10.9(ShtpCu3Au,ZMetk60.1969.488,TransJIM18.1977.807)3.668;8x3.677A=hdmCu
 Cu3A1.h(W,SR13.5)2.94AorH7.20;5.09A=bBH(2;7/3)=cBHK'(2) phdHA
 Cu3A1.m1(Fe35i,SR13.5)5.83A=idmCu3A1.h
 Cu3A1.m2(Cu3Sb.h1,SR8.9)4.52;5.21;4.23
 Cu7A13.h
 Cu2A1.h1=htpCu9A14
 Cu2A1.h2=htpCu9A14
 Cu9A14(C36.16,SR33.72)8.702A=idmCu3A1.h
 Cu32A119(M64.38,Natur168.1951.661)
 Cu3A12.h2
 Cu3A12.h1(H(3.2).(2.2),JLCM29.1972.133)H4.146;5.063A=bFH($\sqrt{3.2}$;2.7/3)=cUH($\sqrt{13.5/2}$)
 Cu30A120(JInstMet63.1938.149) N=10,50
 Cu4A13.h
 Cu4A13.r(M12.9,JInstMet63.1938.149)M90.63⁰7.08;4.09;10.04A
 CuA1.h(orth.PhilMag12.1931.980)
 CuA1.r(N5.5,SR38.4)9.889;4.105;6.914,0,6.913AorH4.1;5.0A=bH(2;2.5)=cUH($\sqrt{12.5/2}$)
 Cu2A13.m?(Ni2A13,SR40.100)H4.106;5.094A=probablyCu3A12.h1 N=40,180
 CuA12(U2.4,SR3.589)6.066;4.874A=bF(2;3.5/2)=cU(4;4) N=28,104
 Ag3A1.h(W,SR4.233)3.302A+H8.1;5.7A=idmCu3A1.h BB2 phdHA
 Ag3A1.r(Mn.h,SR21.22)6.945A=bU($\sqrt{5}$;2.8)=cUK'(2) N=29,190
 Ag2A1(Mg,SR1.558)H2.88;4.60A-H4.99;4.60A=bFH(2;2.25)=cFHK'(2)
 Au4A1.h(W,SR15.5)3.24A=idmCu3A1.h BB2
 Au4A1.r(Mn.h,SR8.13)6.921A=idmAg3A1.r UU2 phdHA
 Au8A13.r(H96.36?,)H7.718;41.99A N=204,1248
 Au2A1.h(MoS2,SR40.100)3.349;8.893A=bF(1;5.3)=cFK'(2) N=10,56
 Au2A1.r(O8.4,SR40.3)6.715;3.219;8.815A=bF(2.1;1;2.75)=cFK'(2)
 Au1.97A11.03.r(O20.10,SR40.3)16.772;3.219;8.801A=bF(5.25;1;2.75)=cFK'(2)
 AuA1(M4.4,SR35.7)M93.04⁰⁶.415;3.331;6.339=bFU($\sqrt{8}$;2.1/2; $\sqrt{8}$)=cC($\sqrt{32}$;3; $\sqrt{32}$)N=16,72
 AuA12(CaF2,SR3.20)6.01A=bHT($\sqrt{8}$;3.5/2)=cB(4) N=28,104
 Cu3Ga.h2(W,SR3.600)2.967A=idmCu3A1.h phdHA
 Cu3Ga.h1(Mg,SR4.237)H2.598;4.236A=idmAg2A1
 Cu3Ga.r(htpMg,)=hdmCu3Ga.h1
 Cu9Ga4.h(Cu9A14,SR40.54)8.749A=idmCu9A14
 Cu2Ga (htpCu5Zn8)
 Cu1.8Ga(htpCu5Zn8)
 Cu3Ga2(htpCu5Zn8)
 CuGa2(Tl.2,SR38.79)2.830;5.839A=bHT($\sqrt{2}$;3.5/2)=cU(2;5) N=7,30
 Ag3Ga.h(Mg,SR26.248)H2.887;4.675A=idmAg2A1 FF2 phdHA,E
 Ag3Ga.r(Ag2Zn.r,SR29.53)H7.768;2.877A=bFH($\sqrt{9.75}$;1.5/3)=cFHK'(2) N=13.5,90
 Au7Ga(TiNi3,71Ec)H2.874;9.426AorH4.96;9.43A=bBH($\sqrt{1.3}$;11/3)=cFH(4;9/3) N=15,120
 Au7Ga2.h(H21.6,SR37.87)H7.724;8.751A=bFH(3;4.2/3)=cFHK'(2) N=39,270
 Au7Ga2.r()7.649;8.766;9.014A
 Au2Ga(Pd2As.r,SR40.66)18.023;3.199;6.999A=bF(5;1;2)=cF(10;1.8;4) N=39,240
 AuGa(MnP,SR13.28)6.267;3.421;6.397A=bF(2;11;2)=cU(4;2.7) N=16,80
 AuGa2(CaF2,SR5.54)6.075A=idmAuA12 HTB/2 N=28,120
 Cu4In.h(W,SR3.573)3.00A=idmCu3A1.h phdHA
 Cu7In3.h(Cu5Zn8,SR16.82)9.250A=idmCu3A1.h BB2
 Cu7In3.r(Z28.12,SR46.63)Z90.91.706.81⁰10.071;9.126;6.724A
 Cu2In.h(NiAs,SR9.65)H4.289;5.263A+H7.43;5.26A=bUH(2;2.8/2)=cH(4;5)
 Cu2In.r(htpNiAs,ZMetk63.1972.456)
 Cu7In4.h(htpNiAs,ZMetk63.456)21.38;7.41;5.22A=bB(6;2,0;6,2,0;0,0,2) N=95,550
 Cu7In4.r(htpNiAs,ZMetk63.456)
 Cu11In9(CuA1.r,ZMetk72.1981.275)M54.49⁰12.814;4.354;7.353AorH4.3;5.2A=idmCuA1
 Ag3In.h2(W,SR26.172)3.368A=idmCu3A1.h phdHA N=38,200
 Ag3In.h1(Mg,SR26.248)H2.95;4.79A+H5.11;4.79A=idmAg2A1

Ag3In.r(Ni3Sn,SR15.82)H2.95;4.80A=idmh
 Ag9In4.h(Cu9A14,SR43.66)9.922A=idmCu3A1.h
 Ag9In4.r
 AgIn2(CuA12,SR15.82)6.883;5.615A=bFU(3;3.5/2)=cU($\sqrt{18}$;4) N=28,120
 Au7In(Nd,SR22.69)H2.901;9.528A($\sqrt{3.1}$)=bBH($\sqrt{1.33}$;1 1/3)=cFH(4;9/3) N=15,120 phdS
 Au6In(Mg,SR22.69)H2.91;4.79A HH2 N=2.57,20
 Au10In3.h(Cu4.5Sb,ZM51.1960.327)H2.914;4.775A
 Au10In3.r(Cu10Sb3.h,SR24.119)H10.524;4.759A=bH($\sqrt{19}$;2)=cHK'(2) N=38,260
 Au3In(Cu3Sb.h,SR22.69)5.850;5.140;4.733A=bU(2;1.5;2/1)=cUK'(2) N=12,80
 Au7In3(H42.18,SR41.74)H12.215;8.509A=bBH(3;10.3/3)=cBHK'(2) N=96,600
 Au9In4.h(Cu9A14,SR41.73)9.843A=idmCu9A14 BB2
 Au3In2.h(Ni2A13,SR23.151)H4.537;5.658Aor a($\sqrt{3}$;1)=bBH(2;7/3)=cFH(6;5/3)
 AuIn,htp:Au5In4Sn1(T11,ZMetk50.1959.146)4.28;10.50;3.60A=bB($\sqrt{2.5}$;4;0.84 $\sqrt{2.5}$)=
 AuIn2(CaF2,SR6.164)6.515A=idmAuA12 HTB/2 cFU($\sqrt{10}$;11/2;0.84 $\sqrt{10}$)N=17,80
 CuT1M(nic,phdHA)
 AgT1M(nic,phdHA)
 AuT12(CuA12,SR38.5)7.26;5.60A=bHT(9;3/2)=cU($\sqrt{18}$;4) N=28,120 phdHA

TABLE 12: B2B3M

Zn3A12(Cu,see Elliott)4.045A=bC($\sqrt{4.5}$;2.1)=cB(3) phdE
 ZnA12.m(R1,SR31.17)H2.852;6.785A
 CdA1M(nic,phdHA,M)
 HgA1M(nic,phdHA)
 ZnGaM(nic,phdHA)
 CdGaM(nic,phdE)
 HgGaM(nic,phdE)
 ZnInM(nic,phdHA)
 Cd3In.h(Cu,SR23.74)4.513A=bHT(2;2.3/2)=cB($\sqrt{8}$;2.8) phdE
 Cd0.4In3.6.h(Cu,SR6.179)4.5A=bF($\sqrt{2}$;1.4)=cB($\sqrt{8}$;2.8)
 Hg6In(T3?,JLCM5.1963.41)3.89;5.21A? phdS
 Hg4In(Pu.h2,S2,SR45.82)10.872;4.847;3.522A=bUH(5.2;2;1.7)? N=17.6,80
 HgIn.l(PtCu,R1.1,SR38.105)H3.572;13.168A=bUH($\sqrt{2.3}$;6.5/2)=cH($\sqrt{7}$;10/2) N=15,60
 HgIn2.l(,JLCM11.1966.186)
 HgIn8(Cu,SR18.173)4.69A=idmCdIn9 FB2
 ZnT1M(nic,phdHA)
 CdT1M(nic,phdE)
 Hg3T1(Cu,SR4.136)4.68A=idmCd3In.h HTB/2
 HgT15(W,SR3.645)3.82A=bB(1.5)=cC(3)

TABLE 13: B3B3M

AlGaM(nic,phdE)
 AlInM(nic,phdHA)
 GaInM(nic,phdHA)
 AlT1M(nic,phdHA)
 GaT1M(nic,phdE)
 In2T1(Cu,SR13.122)4.76A=bF(1.5;1.5)=cB(3) phdS

(1;3) and permits FF2. $Au_2Ga(Pd_2As.r, drawing SR40.67)$ is also homeotypic with Fe_2P and displays alternating 8- and 9-coordination, the FF2 binding is a degeneration of the FF2 binding.

$CuIn_M$ has a XX2 plateau extending from $Cu_4In.h(W)$ to $Cu_7In_3.h(Cu_5Zn_8)$. $Cu_7In_3.r(Z28.12)$ must have a slightly different binding as judged from $N_{p1}^{B1}(N_2)$. An investigation of the RF-homeotypes of NiAs would be of interest for the analysis of binding. The homeodesmism of $AgIn_2$ to $CuAl_2$ should be noted. $AuIn_M$ has like $AuGa_M$ pre-XX2 compounds. While for $Au_7In(Nd)$ a S-homeotype of Mg , before a FF2 binding appeared probable [20], the consideration of the $N_{p1}^{B1}(N_2)$ function lead to the interesting modified binding BHFH/12 which changed the $d_b(N_2)$ fraction slightly and had therefore influence on neighbored proposals. The HH2 binding of $Au_{10}In_3(H20.6, drawing [3a]p.114)$, a R-homeotype of Mg with $a=a_{Mg}(\sqrt{13};1)$, is to be preferred to the earlier FF2 binding because of its whole number commensurability element $K_{33}^2=2$. Also for $Au_6In(Mg)$ a HH2 binding must be assumed which displays a small rotation against the $\sqrt{19}/\sqrt{13}$ commensurability of $Au_{10}In_3.r$.

For $Au_3In(Cu_3Sb.h_1, formerly named TiCu_3, drawing [3a]p.114)$ a deformed $\bar{U}U2$ binding might be possible which was not found earlier but which has some advantages for the atom sites, it might explain them by the method used for the S-homeotypes of $Cu_3Au[3a]$. Perhaps this $\bar{U}U2$ binding describes only a twinned HH2 binding but this problem should be postponed here with respect to the good fit of the remaining bindings.

$B^2..3B_M^3$ phases. In the mixture $ZnAl_M$ the existence of $Zn_3Al_2(Cu)$ was assumed. The binding of Al may be described by $a=b_{HT}(\sqrt{4.5;2.7/2})=c_B(3)$, so that the b correlation is somewhat compressed. Substitution of Zn mitigates the deformation and even permits a $CB\sqrt{2}$ binding. Since this yields $N_{p1}^C=9.5$ places per cell the occupation rule requests the composition Zn_3Al_2 , which in fact is observed. Many $B^2..3B_M^3$ mixtures do not form intermediary phases as the energy of formation is too small since no expansion of B^3 electrons into the B^2 atoms is possible the b electron density of B^2 being too great. In $CdIn_M$ two phases are formed, the binding of which confirms neatly the binding of In .

The translation group of Hg_6In needs confirmation and the binding problem of Hg_4In is not yet solved. $HgIn(PtCu)$ is homeotypic to $Hg(R1)$ with commensurability $a=a_{Hg}(1;2)$ and permits a $UHH\sqrt{3}$ binding. The phase $HgIn_8(Cu, FB2)$ is a confirmation of the binding of In , and also $In_2Tl(Cu)$ permits a simple FB2 binding, and the possibility of the change of commensurability of the binding to the crystal answers the old question why In_2Tl is cubic and In_3Sn not.

Concluding remarks

With respect to the utility of valence models in chemistry of salt-like compounds for learning and memorizing empirical facts, there can be no doubt that a valence model is desirable also for alloy phases. The strange fact that the two-correlations model is somewhat different from the known valence models of inorganic chemistry may be connected with the other strange fact that the inorganic valence models could not be extended so far to the interpretation of metallic phases. A gain afforded by the new model lies in the emergence of crystal chemical rules which give better insight into what is happening energetically during compound formation.

For instance it was early realized that the isotypes NiAl(CsCl) and CuZn(CsCl) have seemingly the same valence electron concentration N_b^A , but since they are melting at 1630°C and 900°C respectively, there must be a distinct difference in binding between them. In fact the present analysis assumes that NiAl has a FF2 binding with much better commensurability to the crystal than the BB2 binding of CuZn or Cu₃Al. It has, and therefore causes as a rule a higher melting temperature. Many new questions arise in connection with the new understanding. For instance when the \bar{b} electron contribution of Ni is dependent on temperature, to what value does it decrease at temperature 20°C in NiAl? May it be confirmed by susceptibility measurements that $N_b^{Ni}=1$ at 1500°C as is assumed here? Is there some change of \bar{b} correlation at medium temperatures? Has this change a more gradual or a more sudden character? Another example for new questions is the optical anisotropy of AuAl₂: at which temperature above 20°C does it go lost? Is it feasible to anneal crystals below that temperature long enough as to get a tetragonally deformed translation group? Is the process of loss of anisotropy more gradual or more sudden? Are there domains of anisotropy in a single crystal?

Another new crystal chemical rule is the monotonous decrease of the $N_{p_n}^{P'}(N_2^V)$ function (see summary) with increasing valence electron concentration N_b^A . The validity of this rule is a confirmation for the assumption that the \bar{b} -electron gas may be considered in a first approximation as uniformly distributed in the crystal. Another confirmation is the rule of full occupation of the \bar{b} gas, for if the distribution were not uniform, there were no reason for full occupation. A phenomenon not to be expected immediately is the distinct plateau (at $N_{p_n}^{P'}=8$) for the XX2 binding. This plateau is an expression for the energetic advantage of the XX2 binding. An analogous plateau is to be expected for the FB2 binding, but it cannot be found in the present alloys as the marginal elements lie just at the beginning of the FB2 binding as

$\frac{N_b}{A}$ increases. When several $N_{P_n}^{P'}(N_2)$ curves are drawn using the data contained in the tables it becomes apparent that frequently a positive value of the second derivative of $N_{P_n}^{P'}(N_2)$ is found, while the first derivative is never positive. Since the c distance may be considered as constant in the first approximation it may be said that an increase of the mole fraction N_2 of the second component causes a compression of the b gas against the c gas. In the XX2 plateau the compression is interrupted because of the energetic advantage of the XX2 binding, but at the end of the plateau a stronger compression begins which decreases soon so that a positive second derivative is formed.

A rule of great and little electron count was found for the A elements for which the electron distance $d(nsp) \cdot d(nd)$, where n = main quantum number of atomic orbitals and s, p, d are their different representations. This rule needs further confirmation so that its discussion should be postponed here.

Besides the emergence of new crystal chemical rules many old questions for the incident alloys are answered by the two-correlations model. Only few examples will be given:

Why are in $AgAl_M$ just three different phases stable near Ag_3Al ? All three phases have the wellknown valence electron concentration $\frac{N_b}{A}=1.5$, they obey the extended Hume-Rothery rule. But it was not understood why three different structures belong to one and the same $\frac{N_b}{A}$. It is easily seen that any two-factorial isotypic binding leads for brass-like phases just to $\frac{N_b}{A}=1.5$: there are 10 peripheral core electrons per atom, this number suggests $10/0.83=12$ c places per atom (0.83= average occupation in c correlation), and since to 8 c -places there belongs 1 b -place in a XX2 binding, to 12 c -places belong 1.5 valence electrons. This suggests that all three phases of $AgAl_M$ belong to a XX2 binding and the consequence that different bindings must exist confirms once more the assumption that in the two-correlations model different isometric [3b] correlations are to be expected. The question which of the XX2 bindings belongs to a given phase is a problem for the analysis. For instance the BB2 binding of Ag_3Al was found during a solution of the structure of $AuCd_r$ [3b] which makes apparent the commensurability of the binding by little shifts of the atoms. A similar lucky chance applies to Ag_2Al which is closely homeotypic to Au_5Sn_r , revealing the commensurability by the sites of the minority component.

Why are $CuGa_2(T1.2)$ and $AuGa_2(CaF_2)$ not isotypic [2f]? In fact, ^{the} structures are closely homeotypic and homeodesmic and the homeotypism obeys the rule of place numbers [3b]: $N_{P_n}^C(CuGa_2)=40 > N_{P_n}^C(AuGa_2)/4=32$. Why are $CuAl_2$ and $CuGa_2$ not isotypic [2f]? Also these phases are homeodesmic, but $CuGa_2$ offers more

peripheral core electrons than CuAl_2 , therefore $N_{p''}^C(\text{CuAl}_2)/4 = 32 < N_{p''}^C(\text{CuGa}_2) = 40$. Why are CuGa_2 and $\text{AgIn}_2(\text{CuAl}_2)$ not isotypic? Once more $N_{p''}^C(\text{CuGa}_2) = 40 > N_{p''}^C(\text{AgIn}_2)/4 = 36$ i.e. the place number rule is fulfilled. These remarks suggest an experiment: CuGa_2 should under pressure transform to the AgIn_2 type.

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