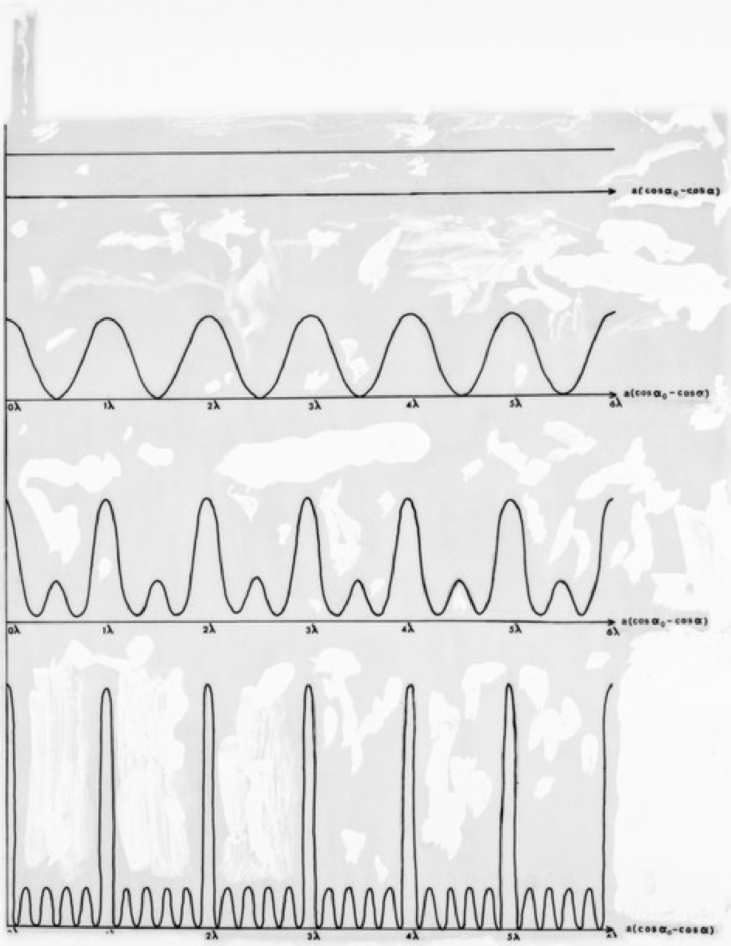
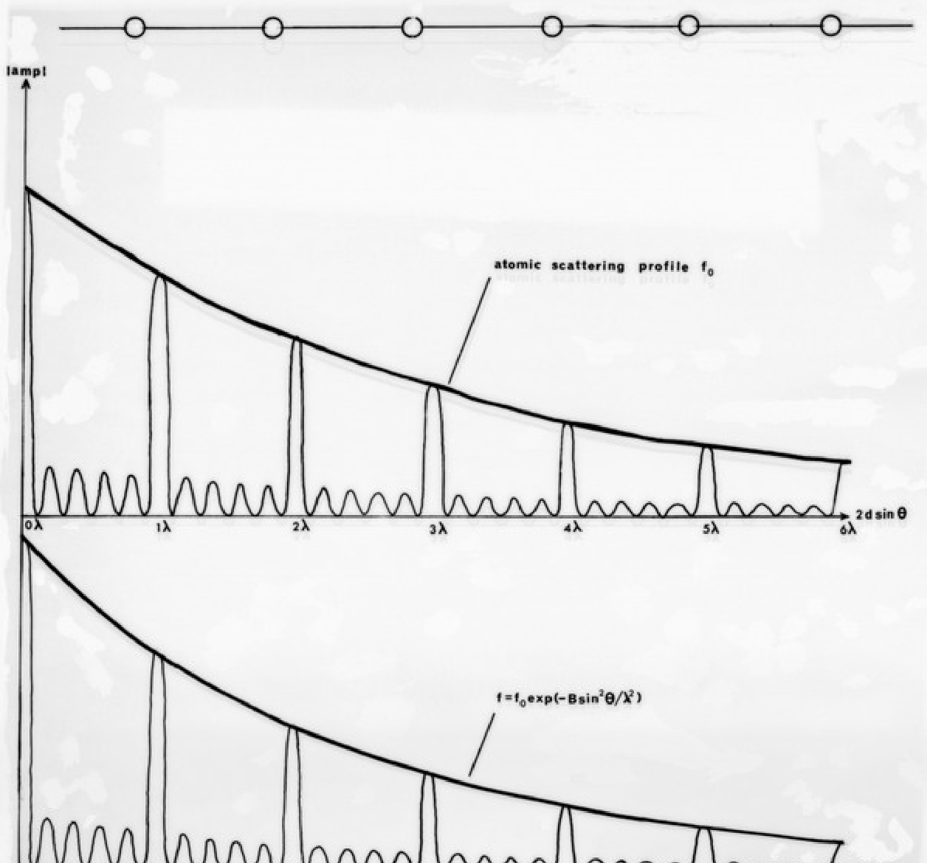
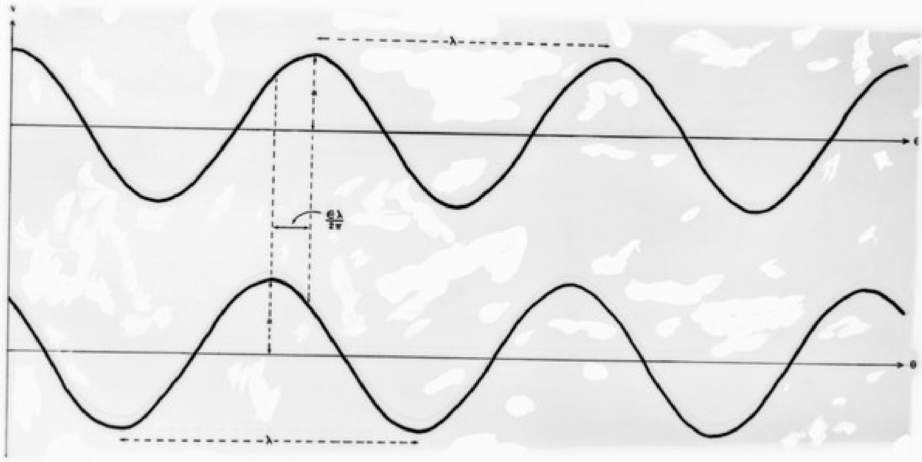
$$
A = \begin{bmatrix} -\cos\phi & -\sin\phi & 0 \\ \sin\phi\cos\tau & -\cos\phi\sin\tau & \sin\tau \\ -\sin\phi\cos\tau & \cos\phi\sin\tau & \cos\tau \end{bmatrix} \qquad L = \begin{bmatrix} L \\ 0 \\ 0 \end{bmatrix}
$$

$$
X_{n+1} = A X_n + L
$$

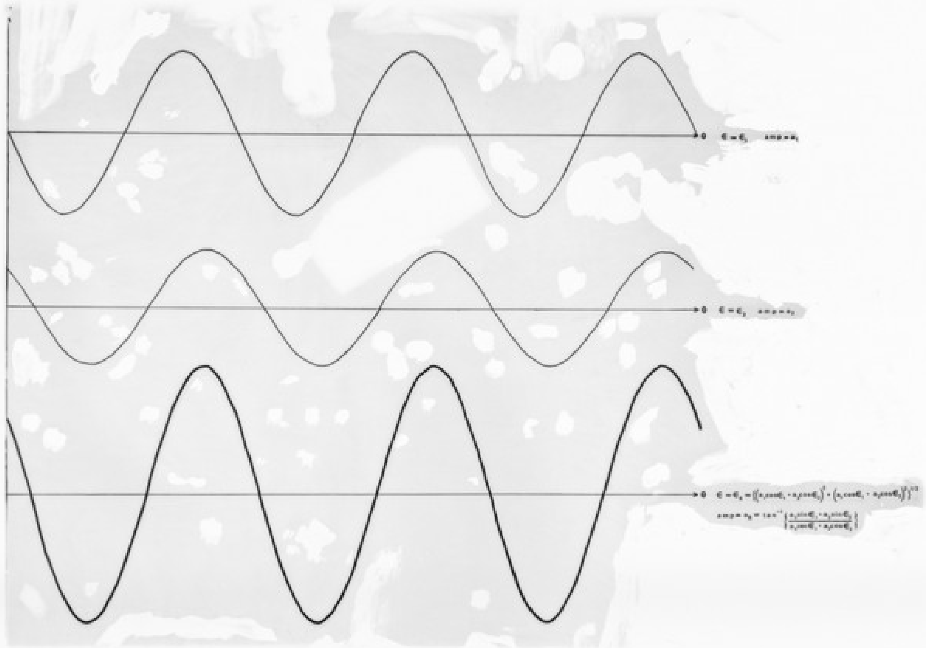
$$
R = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\theta_1 & -\sin\theta_1 \\ 0 & \sin\theta_1 & \cos\theta_1 \end{bmatrix} \begin{bmatrix} \cos\theta_2 & 0 & -\sin\theta_2 \\ 0 & 1 & 0 \\ \sin\theta_2 & 0 & \cos\theta_2 \end{bmatrix} \begin{bmatrix} \cos\theta_3 & -\sin\theta_3 & 0 \\ \sin\theta_3 & \cos\theta_3 & 0 \\ 0 & 0 & 1 \end{bmatrix}
$$

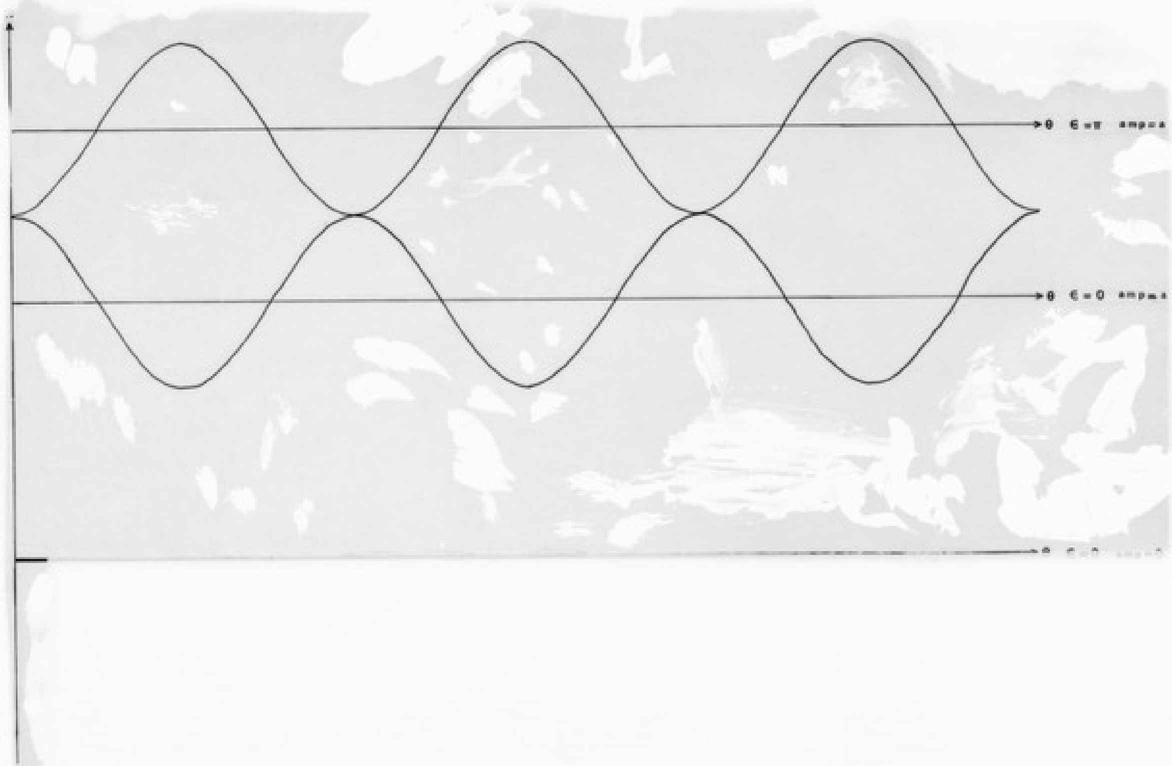

a(cos α0 - cos α)
0λ 1λ 2λ 3λ 4λ 5λ 6λ
a(cos α0 - cos α)
0λ 1λ 2λ 3λ 4λ 5λ 6λ
a(cos α0 - cos α)
2λ 3λ 4λ 5λ
a(cos α0 - cos α)

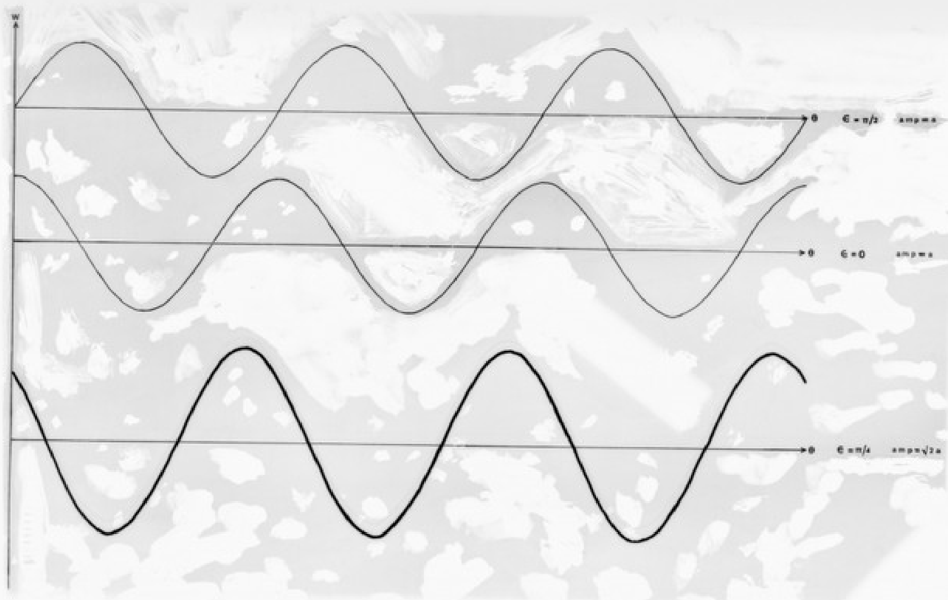

|ampl
atomic scattering profile f_0
0λ
1λ
2λ
3λ
4λ
5λ
6λ
2d sin θ
$f = f_0 \exp(-B\sin^2\theta/\lambda^2)$
0λ
1λ
2λ
3λ
4λ
5λ
6λ
2d sin θ

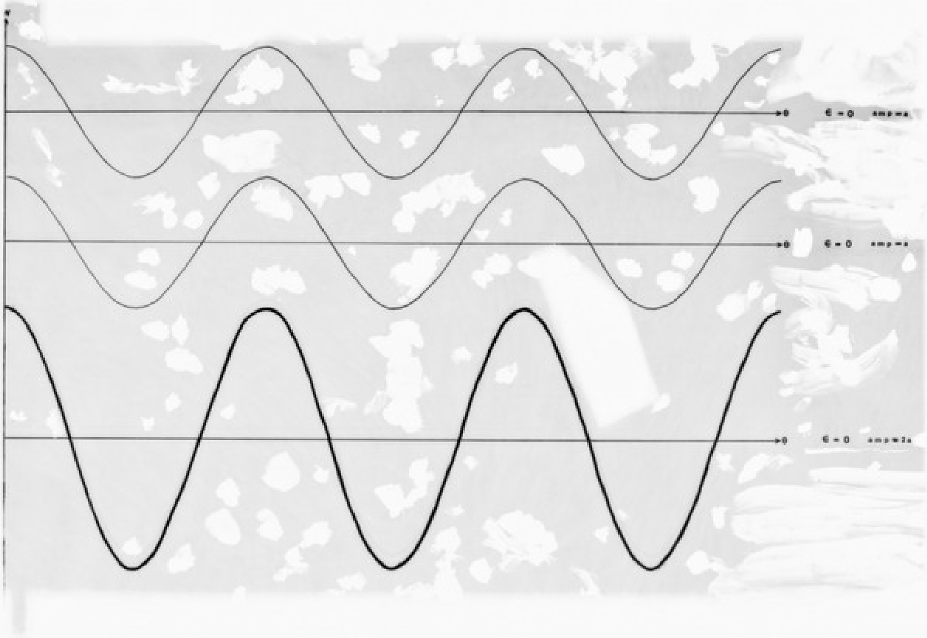


λ
λ




θ ε=π
θ ε=0


w
θ
ϵ = π/2
amp = a
θ
ϵ = 0
amp = a
θ
ϵ = π/4
amp = √2a

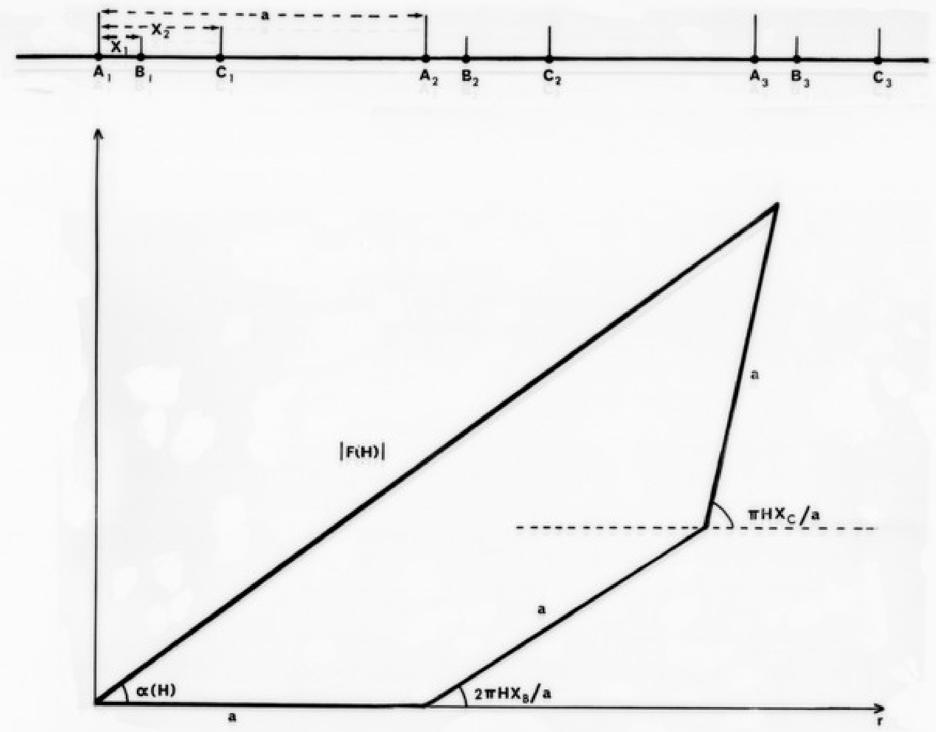


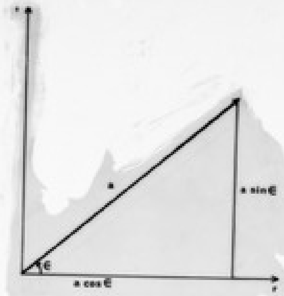
θ
ε = 0 amp = a
θ
ε = 0 amp = a
θ
ε = 0 amp = 2a

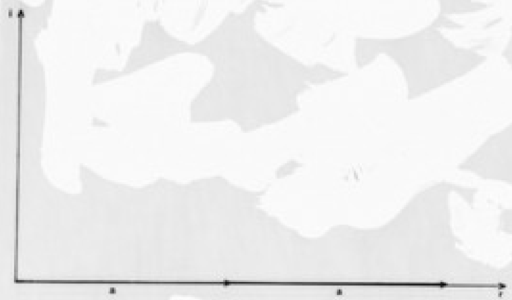
$$F(l, \psi, \xi) = \sum_n \sum_j f_j J_n(2\pi R_j \xi) \exp i\left\{ n\left(\psi - \phi_j + \frac{\pi}{2}\right) + \frac{2\pi l z_j}{c} \right\}$$

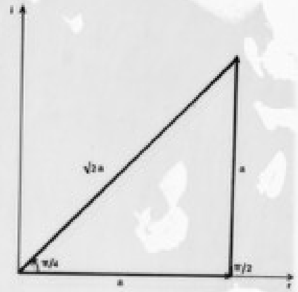
$$J_{n+1}(x) = \frac{2n}{x} J_n(x) - J_{n-1}(x)$$

$$2J_n'(x) = J_{n-1}(x) - J_{n+1}(x)$$

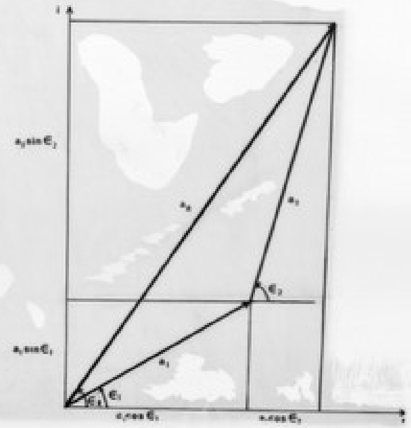

a
X_2
X_1
A_1
B_1
C_1
A_2
B_2
C_2
A_3
B_3
C_3
a
|F(H)|
$\pi HX_C/a$
a
$\alpha(H)$
$2\pi HX_B/a$
a
r

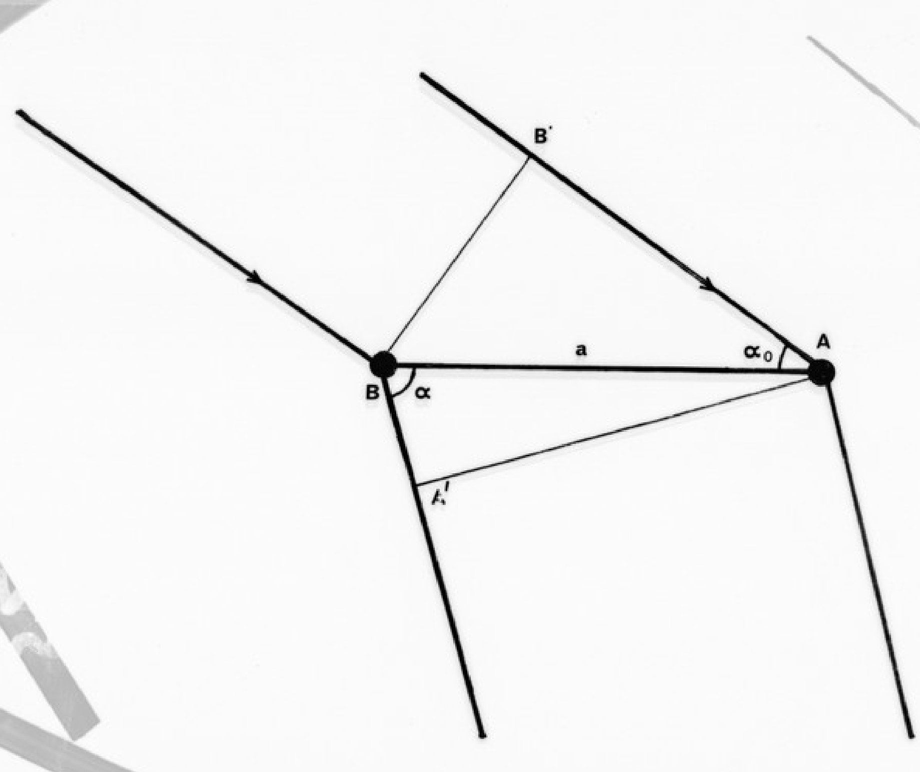

a
a sin ε
ε
a cos ε

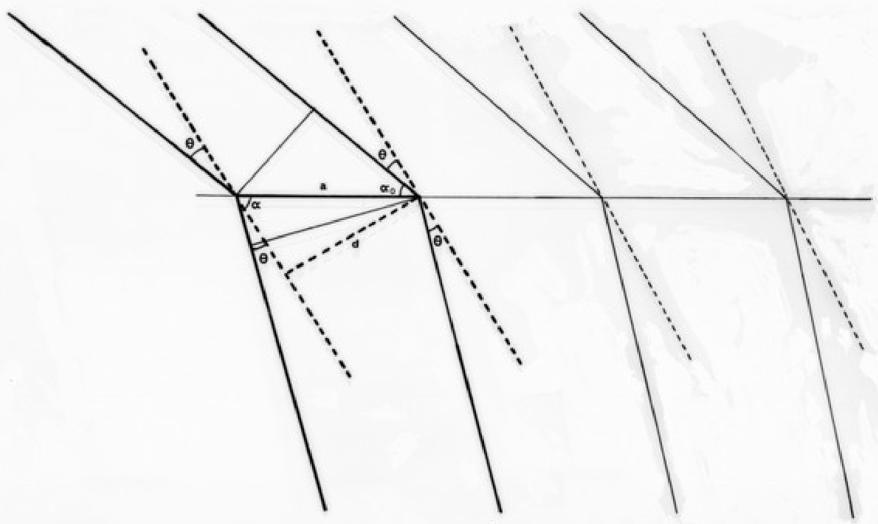

a
a

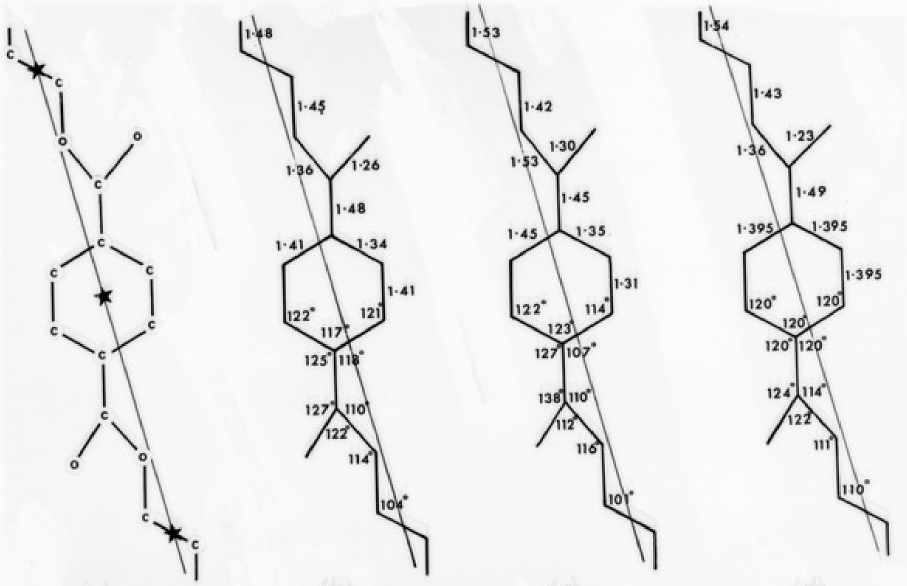

√2 a
a
π/4
π/2
a


π
a


$a_2 \sin \epsilon_2$
$a_1 \sin \epsilon_1$
a_2
a_1
ϵ_2
ϵ_1
$a_1 \cos \epsilon_1$
$a_2 \cos \epsilon_2$


B'
a
α0
A
B
α
A'


θ
θ
α
a
α_0
θ
d
θ

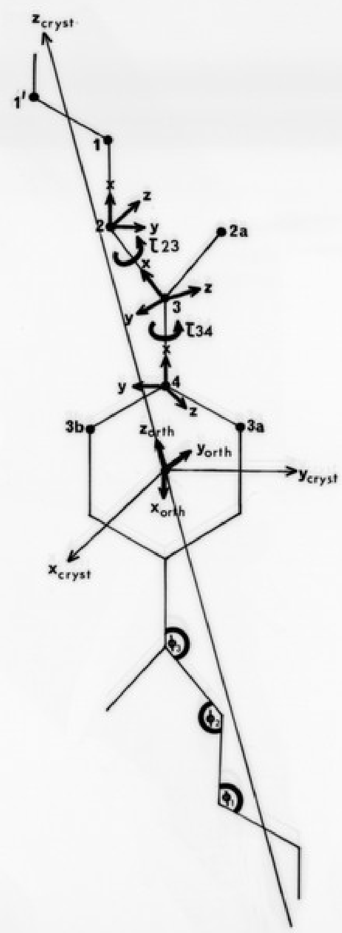


1·48
1·45
1·36
1·26
1·48
1·41
1·34
1·41
122°
121°
117°
125°
118°
127°
110°
122°
114°
104°
1·53
1·42
1·30
1·53
1·45
1·45
1·35
1·31
122°
114°
123°
127°
107°
138°
110°
112°
116°
101°
1·54
1·43
1·23
1·36
1·49
1·395
1·395
1·395
120°
120°
120°
120°
120°
124°
114°
122°
111°
110°

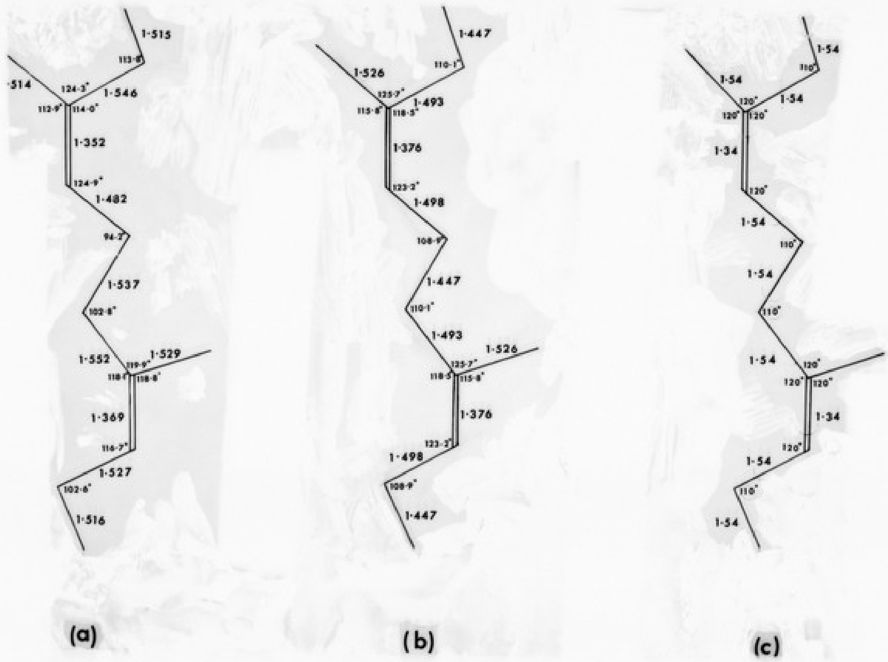
(a) (b) (c) (d)

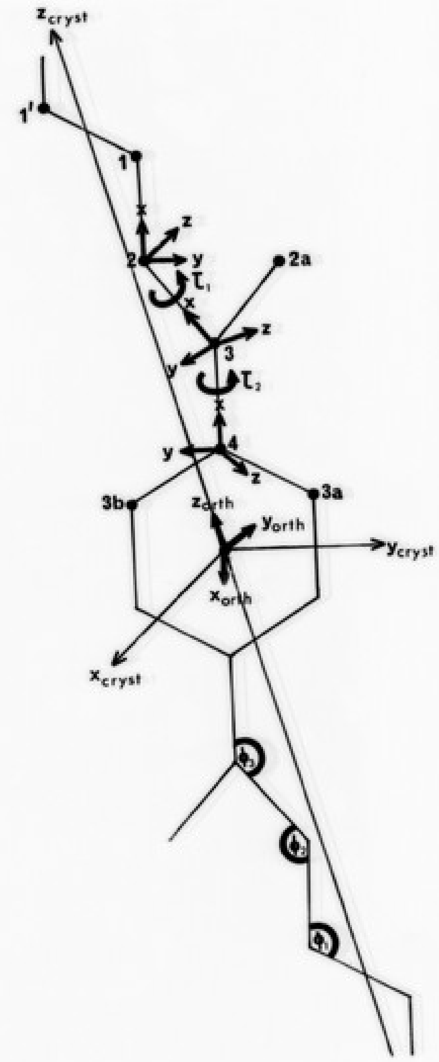
1

1·54

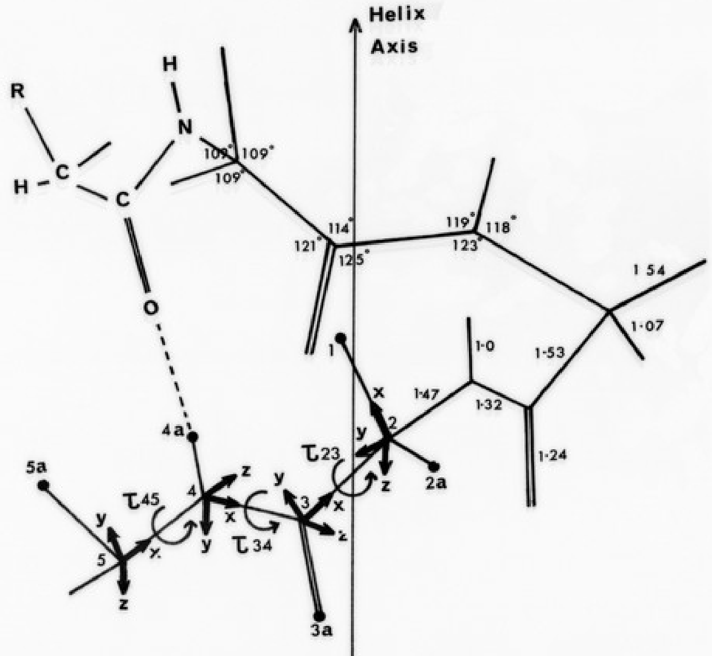


z cryst
1'
1
x
z
2
y
τ23
2a
x
3
z
y
τ34
x
y
4
z
3b
z orth
3a
y orth
y cryst
x orth
x cryst

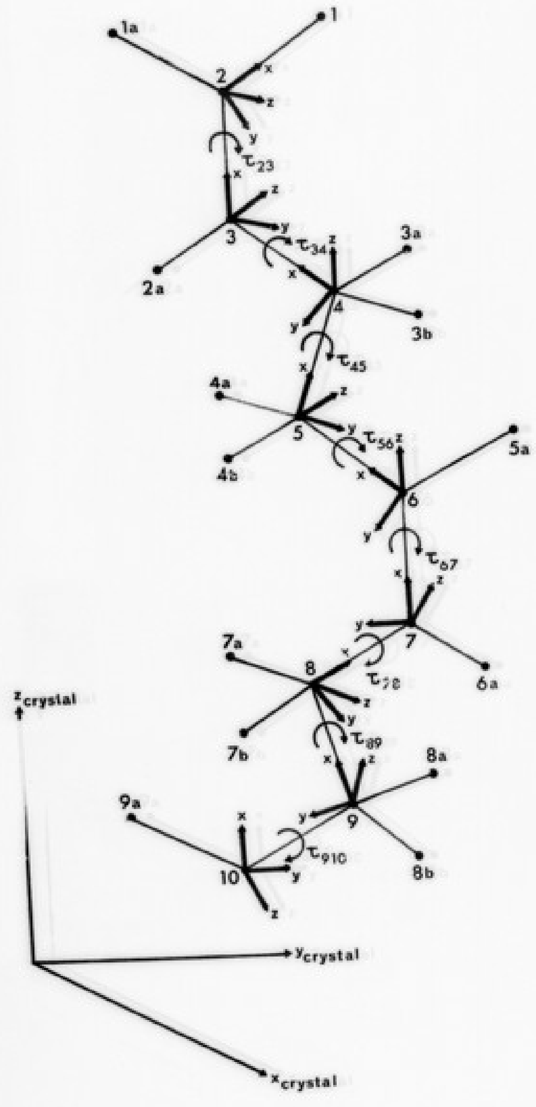

1·515
·514
1·546
1·352
1·482
1·537
1·552
1·529
1·369
1·527
1·516
1·447
1·526
1·493
1·376
1·498
1·447
1·493
1·526
1·376
1·498
1·447
1·54
1·54
1·54
1·34
1·54
1·54
1·54
1·34
1·54
1·54
(a)
(b)
(c)

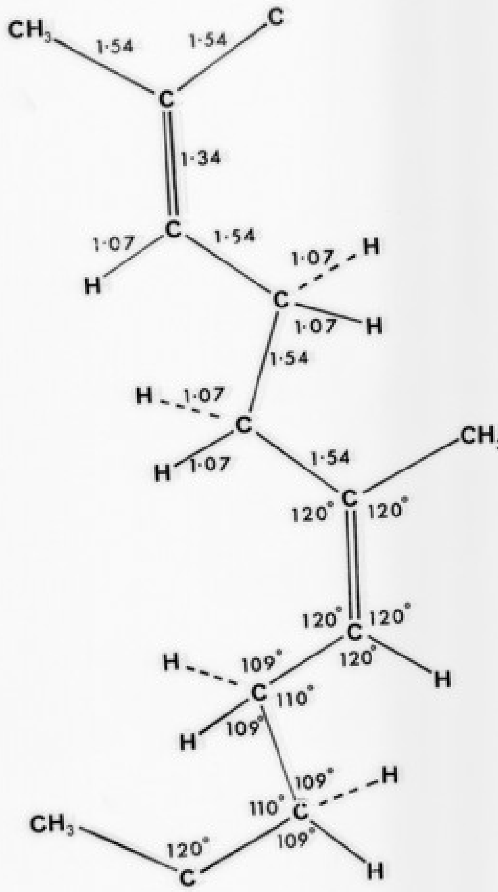


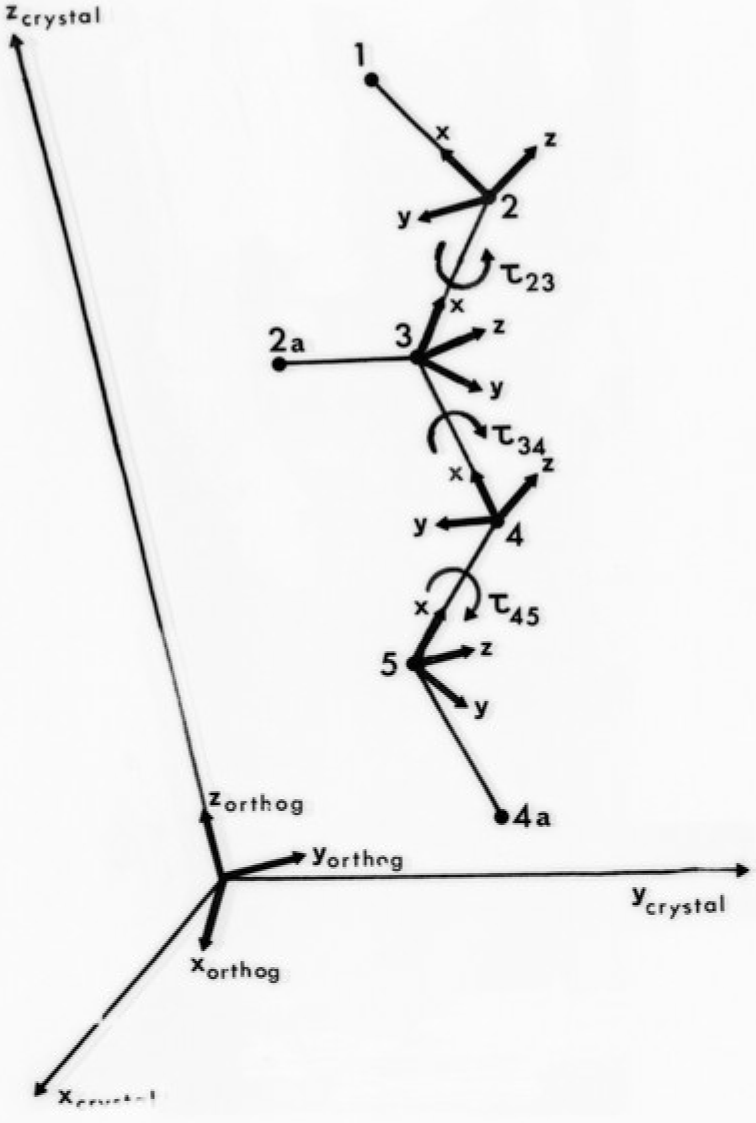
z_cryst
1'
1
2
2a
3
4
3a
3b
z_orth
y_orth
x_orth
y_cryst
x_cryst

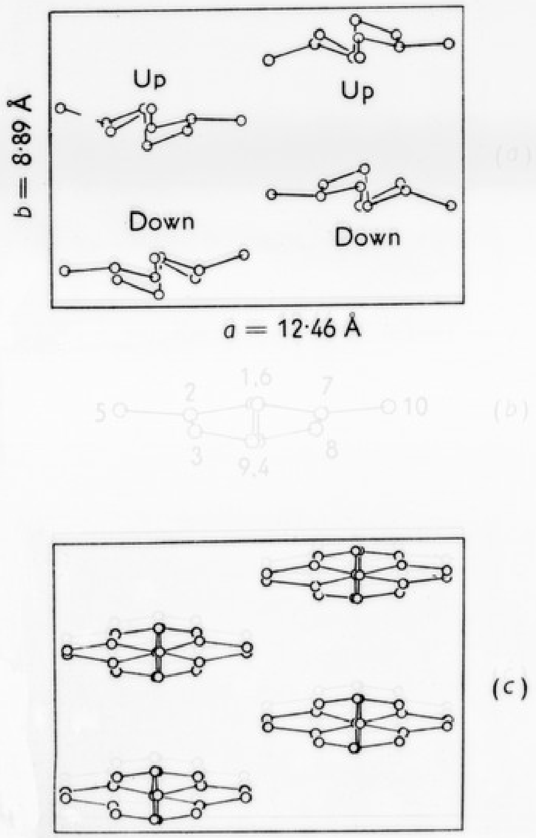


Helix Axis
R
H
N
H
C
C
O
109°
109°
109°
114°
121°
125°
119°
118°
123°
1 54
1·07
1·53
1·0
1·47
1·32
1·24
1
2
2a
3
3a
4
4a
5
5a
τ23
τ34
τ45
x
y
z


1a
1
2
3
3a
2a
4
3b
4a
5
5a
4b
6
7
7a
8
6a
7b
8a
9
9a
10
8b
τ23
τ34
τ45
τ56
τ67
τ78
τ89
τ910
z crystal
y crystal
x crystal


CH3
C
1·54
1·54
1·34
1·07
1·54
H
1·07
H
1·07
H
1·54
H
1·07
H
1·07
1·54
CH3
120°
120°
120°
120°
120°
H
H
109°
110°
109°
H
109°
H
110°
109°
H
CH3
120°
C


z crystal
1
x
z
y
2
τ 23
x
z
2a
3
y
τ 34
x
z
y
4
x
τ 45
z
5
y
4a
z orthog
y orthog
y crystal
x orthog

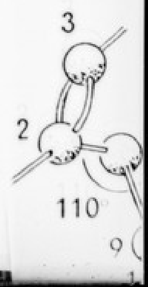


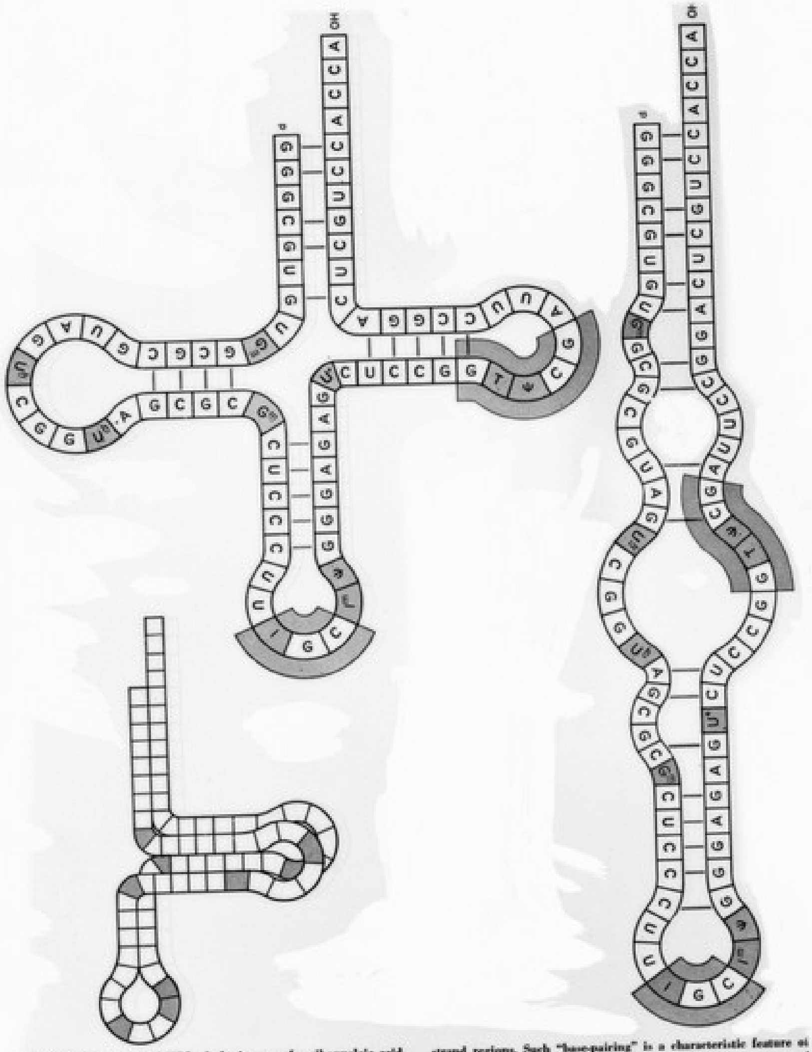
Projections along z axis of (a) structure due to Bunn, (b) proposed isolated molecule, (c) proposed structure.

...y indexe
projectio
al bond
re predic
Bunn, or
reflexion
nfirmato
Further
eatly im
(§ 5).

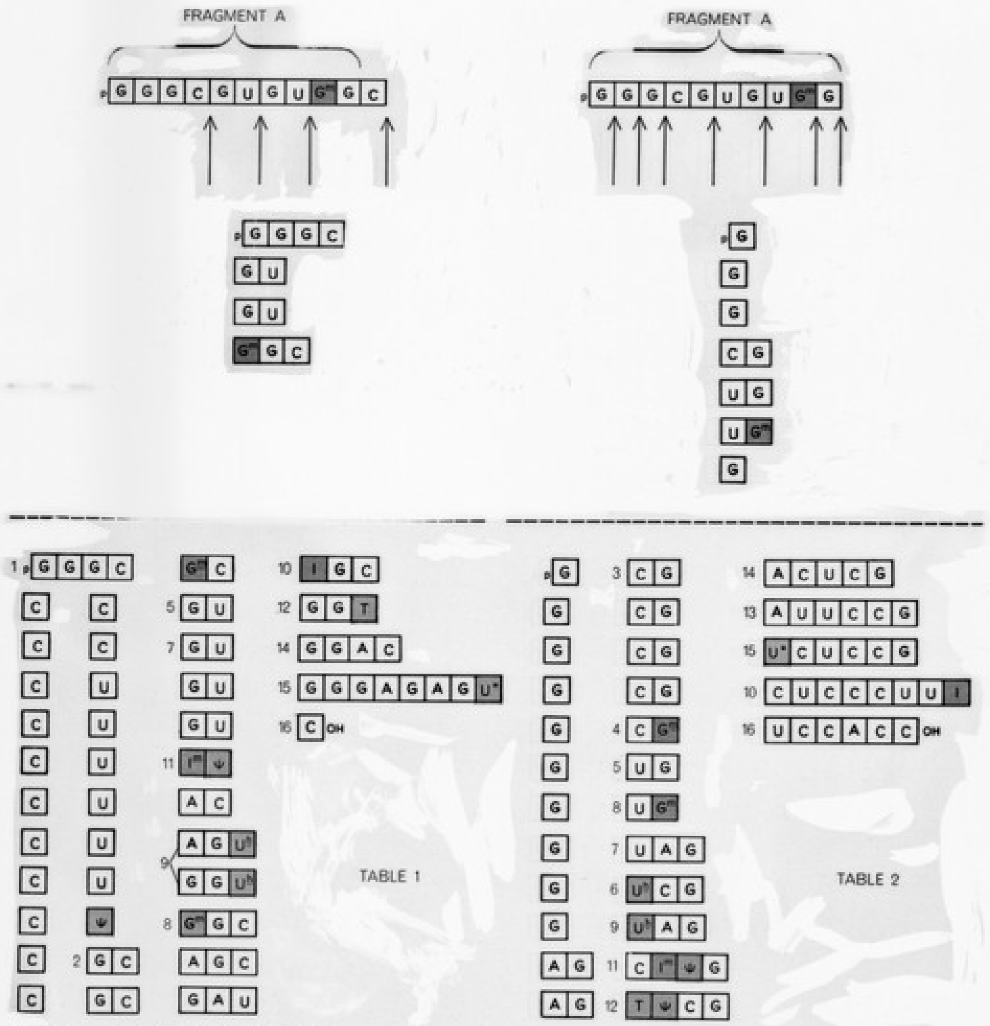
cription

structu
was suf
The frac
ed mol
given in
idenced
eing $\frac{1}{4}$
nolecule
bond leng

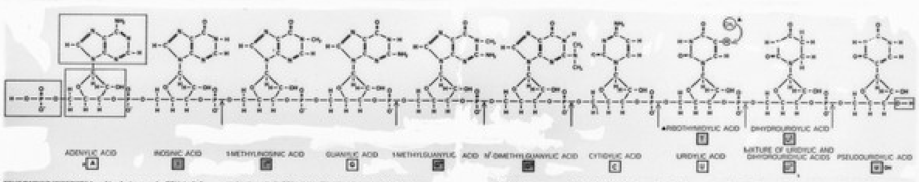




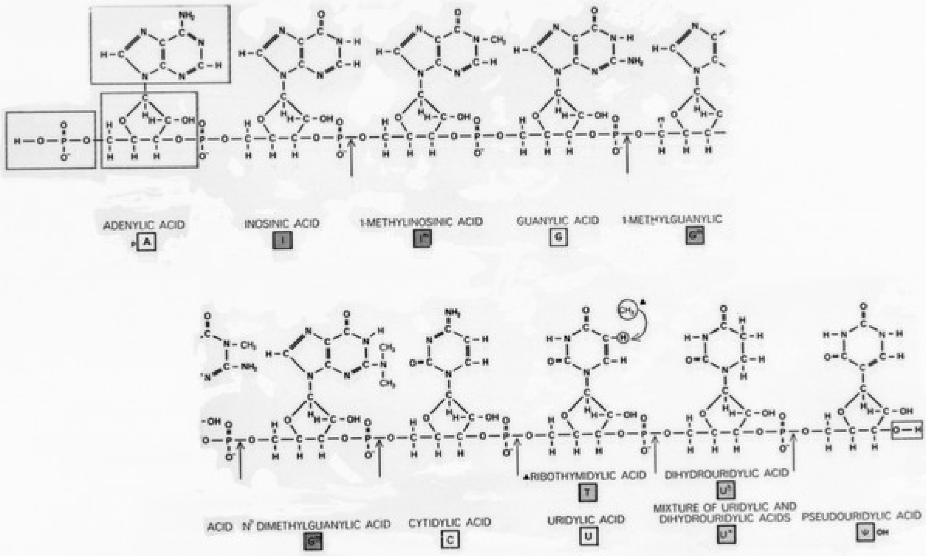
HYPOTHETICAL MODELS of alanine transfer ribonucleic acid (RNA) show three of the many ways in which the molecule's linear chain might be folded. The various letters represent nucleotide subunits; their chemical structure is given at the top of the next two pages. In these models it is assumed that certain nucleotides, such as C—G and A—U, will pair off and tend to form short double-strand regions. Such "base-pairing" is a characteristic feature of nucleic acids. The arrangement at the lower left shows how two of the large "leaves" of the "clover leaf" model may be folded together. The triplet I—G—C is the presumed anticodon shown in the illustration on the opposite page. The region containing the sequence G—T—ψ—C—G may be common to all tran[...] RNA[...]



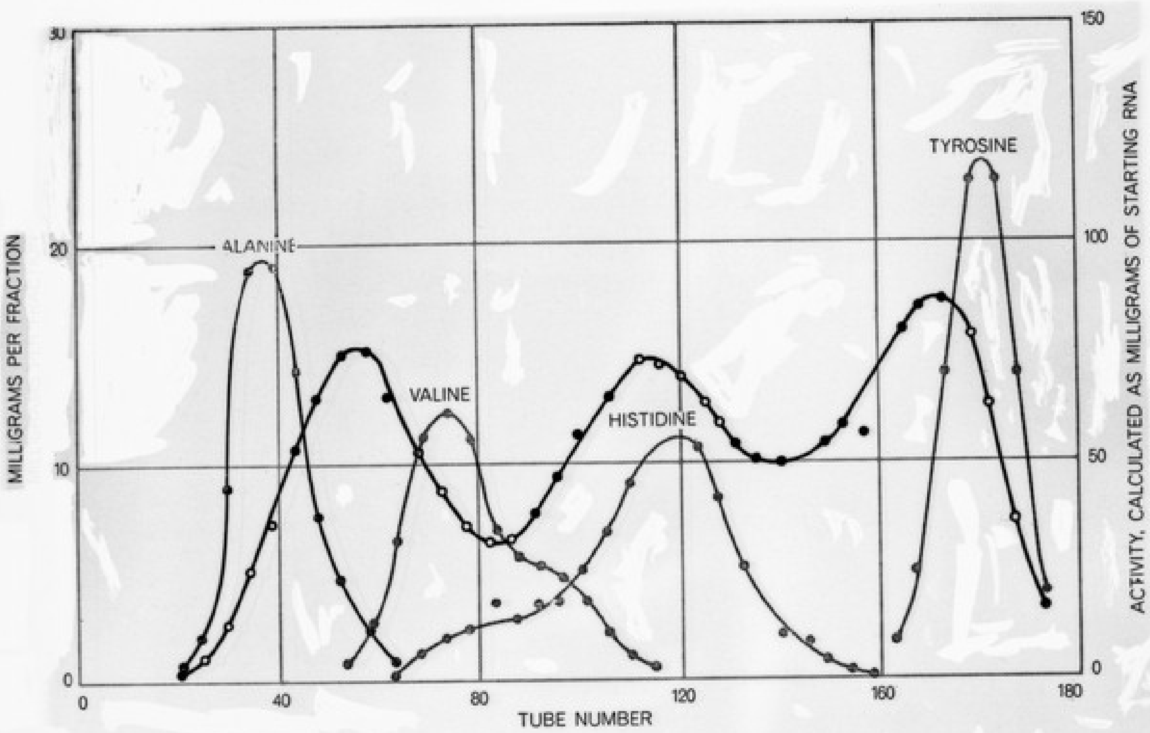
ACTION OF TWO DIFFERENT ENZYMES is reflected in these two tables. Table 1 shows the fragments produced when alanine transfer RNA is completely digested by pancreatic ribonuclease, which cleaves the molecule to the right of nucleotides containing bases with pyrimidine structures (*C, U, U^h, ψ and T*). The diagram at top left shows how pancreatic ribonuclease would cleave the first 11 nucleotides of alanine transfer RNA. The diagram at top right shows how the same region would be digested by takadiastase ribonuclease T1. Table 2 contains the fragments produced by this enzyme; they all end in nucleotides whose bases contain purine structures (*G, G^m, G^m and I*). The numbers indicate which ones appear in the consolidated list in Table 3 on the opposite page.



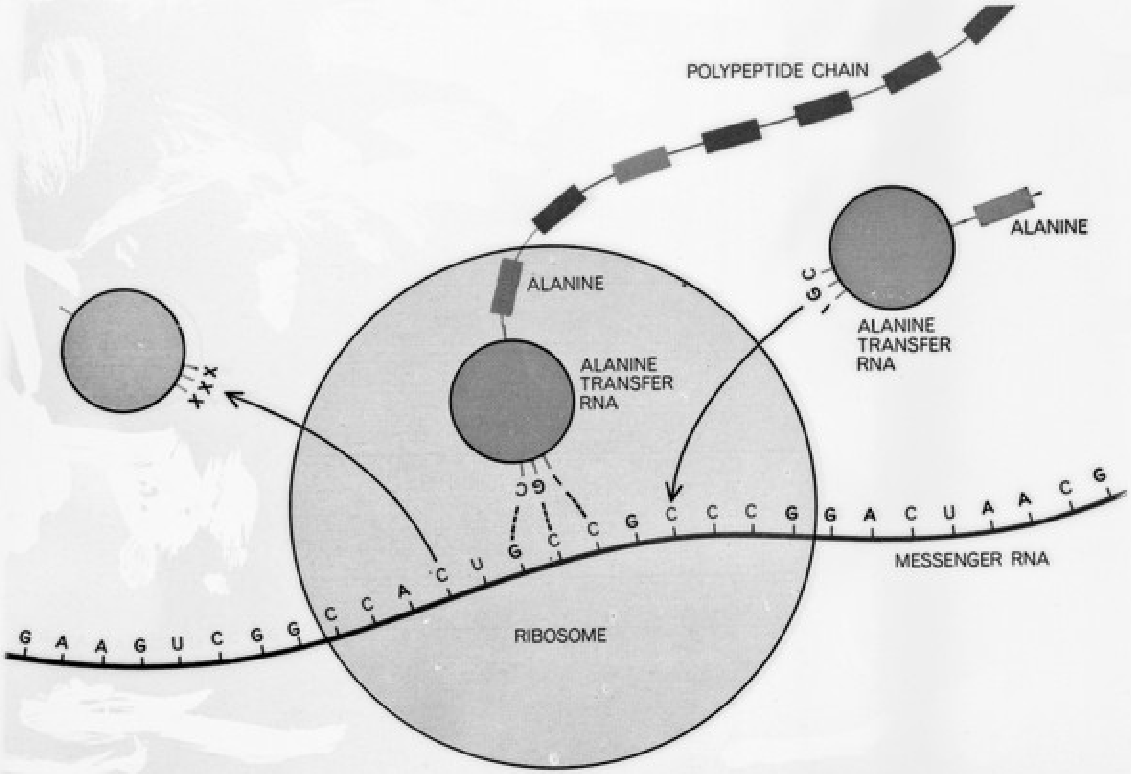
NUCLEOTIDE SUBUNITS found in alanine transfer RNA include the four commonly present in RNA (A, G, C, U), plus seven others that are variations of the standard structures. Ten of these 11 differ- [illegible] together in a single RNA chain. The chain begins at the left with a phosphate group (outlined by a small rectangle) and is followed by a ribose sugar group (large rectangle); the two groups alternate to form the backbone of the chain. [illegible] a hydroxyl (OH) group. Each nucleotide subunit consists of a phosphate group, a ribose sugar group and a base. The base portion in the nucleotide at the far left, adenylic acid, is outlined by a large rectangle. [illegible] in color. The base structures without color are those commonly found in RNA. Black arrows show where RNA chains can be cleaved by the enzyme takadiastase ribonuclease T1. Colored arrows show where RNA chains can be cleaved by pancreatic ribonuclease



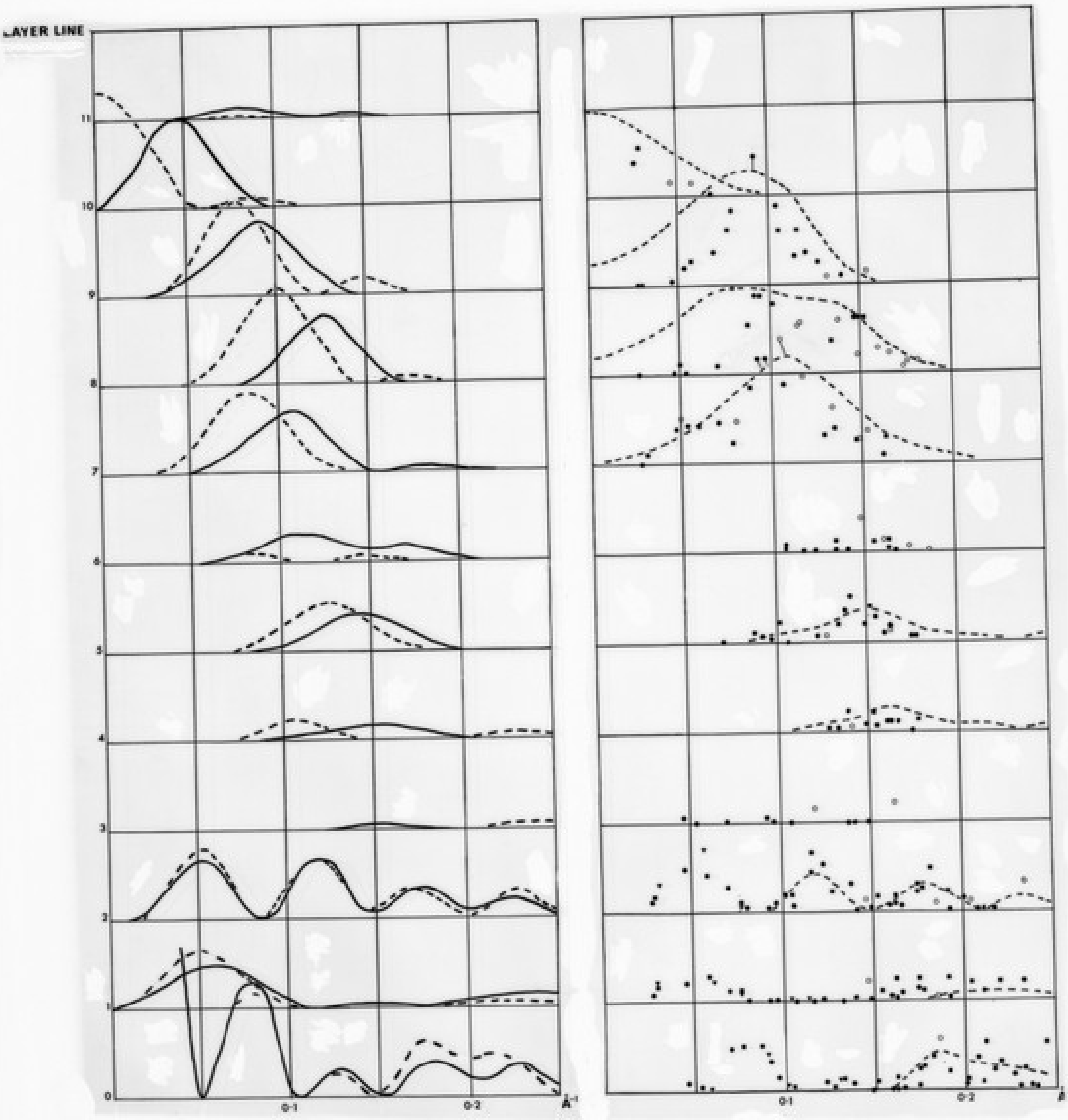
NUCLEOTIDE SUBUNITS found in alanine transfer RNA include the four commonly present in RNA (A, G, C, U), plus seven others that are variations of the standard structures. Ten of these 11 different nucleotide subunits are assembled above as if they were linked together in a single RNA chain. The chain begins at the left with a phosphate group (*outlined by a small rectangle*) and is followed by a ribose sugar group (*large rectangle*); the two groups alternate to form the backbone of the chain. The chain ends at the right with a hydroxyl (OH) group. Each nucleotide subunit consists of a phosphate group, a ribose sugar group and a base. The base portion in the nucleotide at the far left, adenylic acid, is outlined by a large rectangle. In the succeeding bases the atomic variations are shown in color. The base structures without color are those commonly found in RNA. Black arrows show where RNA chains can be cleaved by the enzyme takadiastase ribonuclease T1. Colored arrows show where RNA chains can be cleaved by pancreatic ribonuclease.

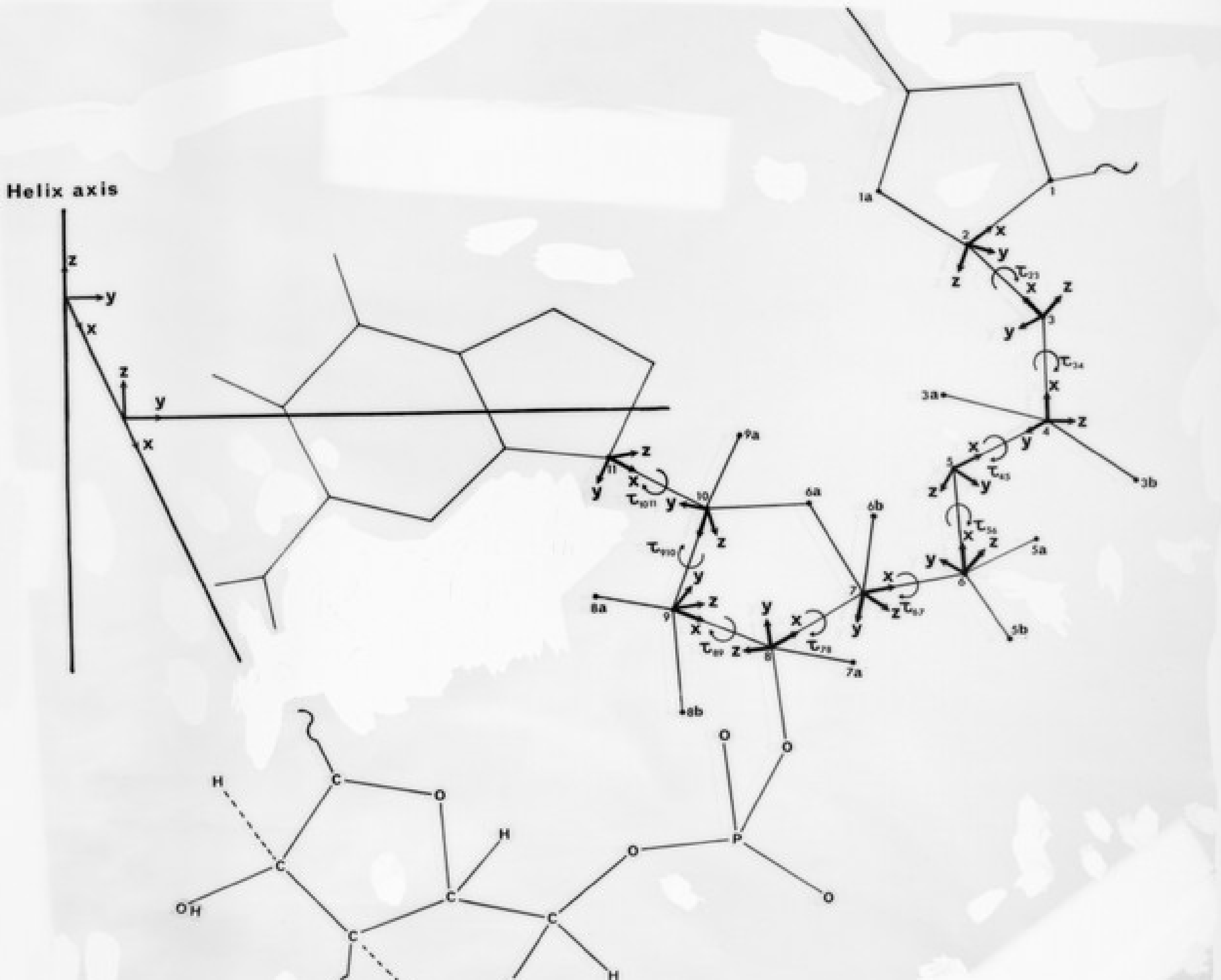


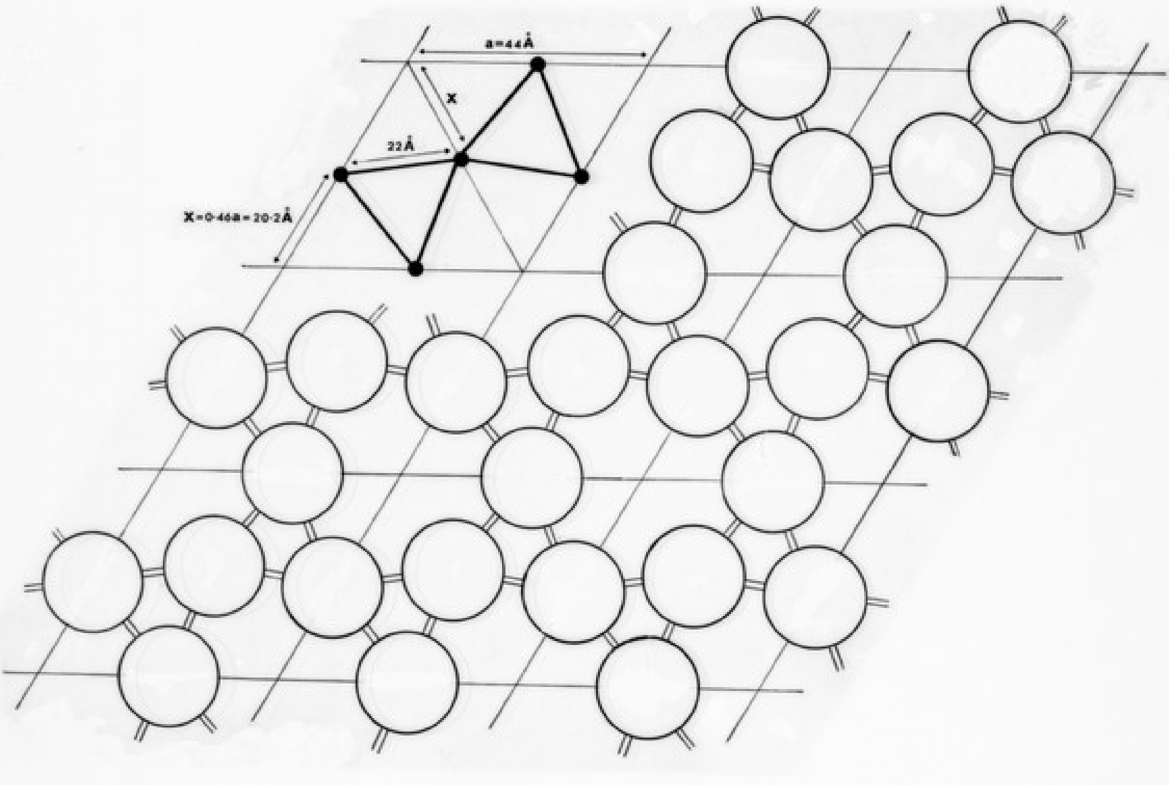
COUNTERCURRENT DISTRIBUTION PATTERN shows two steps in the separation of alanine transfer RNA, as carried out in the author's laboratory. After the first step the RNA content in various collection tubes, measured by ultraviolet absorption, follows the black curve. Biological activity, indicated by the amount of a given amino acid incorporated into polypeptide chains, follows the colored curves. Pure transfer RNA's of four types can be obtained by reprocessing the tubes designated by open circles.

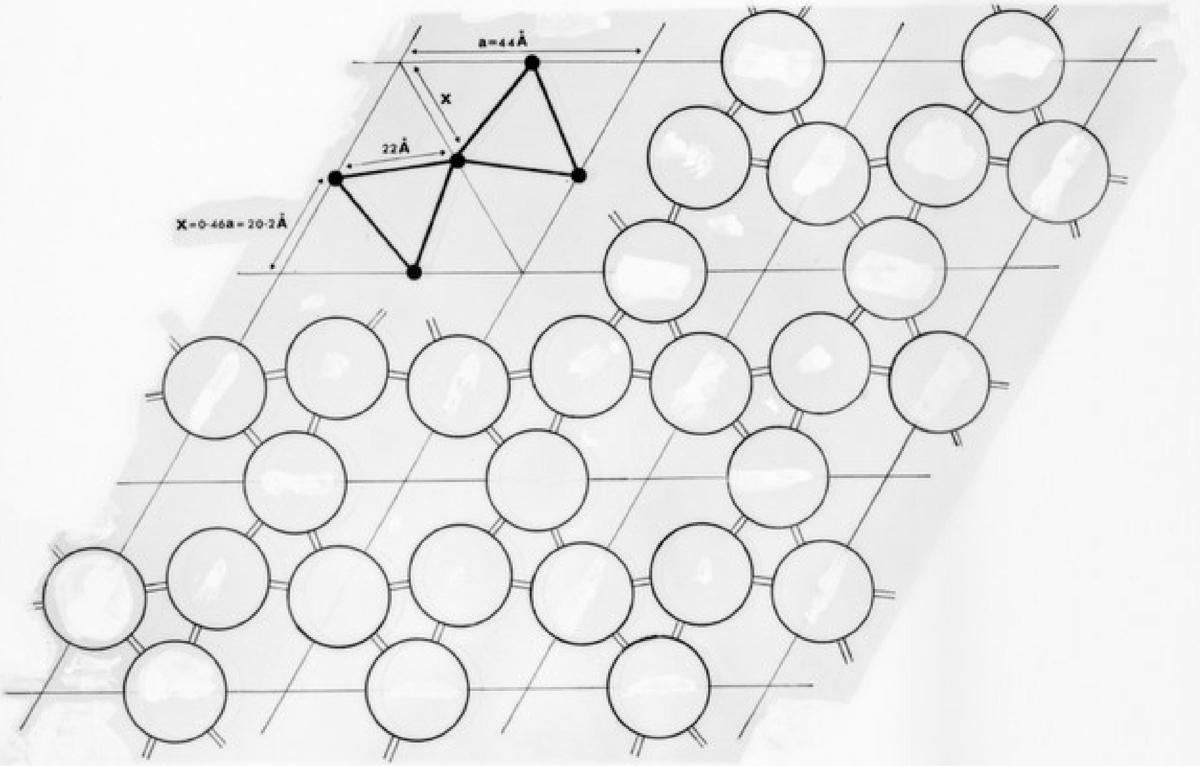


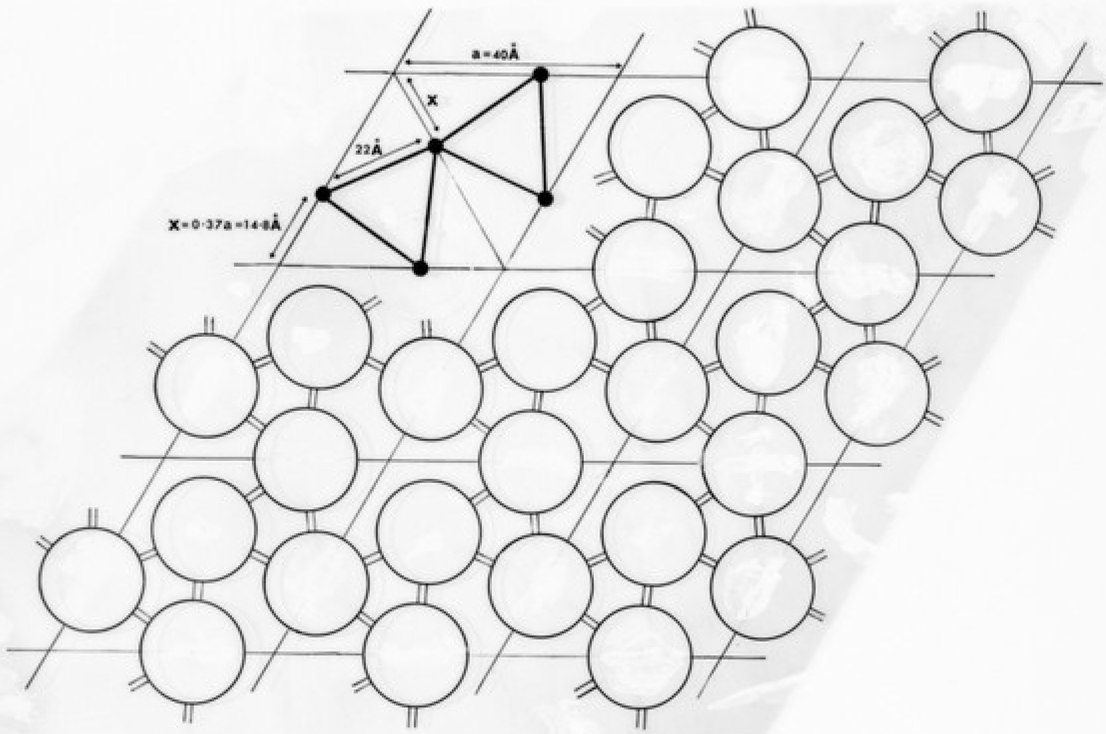
ROLE OF TRANSFER RNA is to deliver a specific amino acid to the site where "messenger" RNA and a ribosome (which also contains RNA) collaborate in the synthesis of a protein. As it is being synthesized a protein chain is usually described as a polypeptide. Each amino acid in the polypeptide chain is specified by a triplet code, or codon, in the molecular chain of messenger RNA. The diagram shows how an "anticodon" (presumably I—G—C) in alanine transfer RNA may form a temporary bond with the codon for alanine (G—C—C) in the messenger RNA. While so bonded the transfer RNA also holds the polypeptide chain. Each transfer RNA is succeeded by another one, carrying its own amino acid, until the complete message in the messenger RNA has been "read."

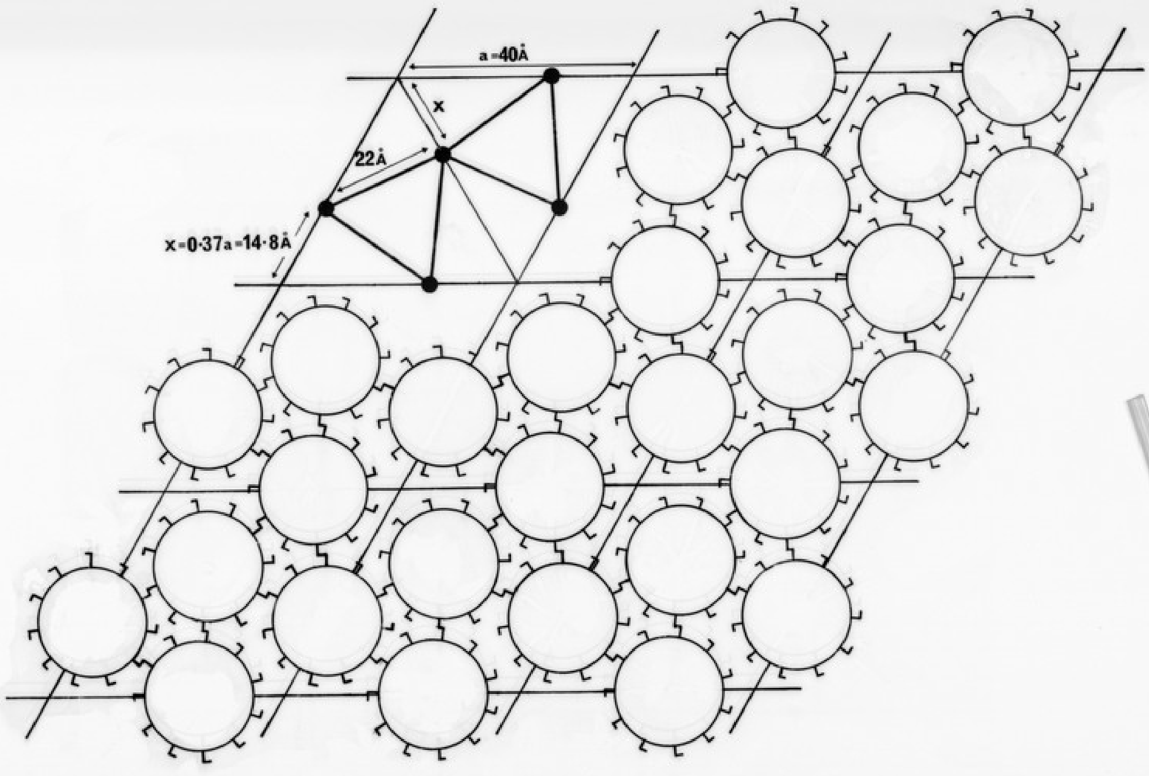

LAYER LINE
11
10
9
8
7
6
5
4
3
2
1
0
0·1
0·2
Å⁻¹
0·1
0·2
Å


Helix axis
1a
1
2
3
3a
3b
4
5
5a
5b
6
6a
6b
7
7a
8
8a
8b
9
9a
10
11
P
O
OH
H
C

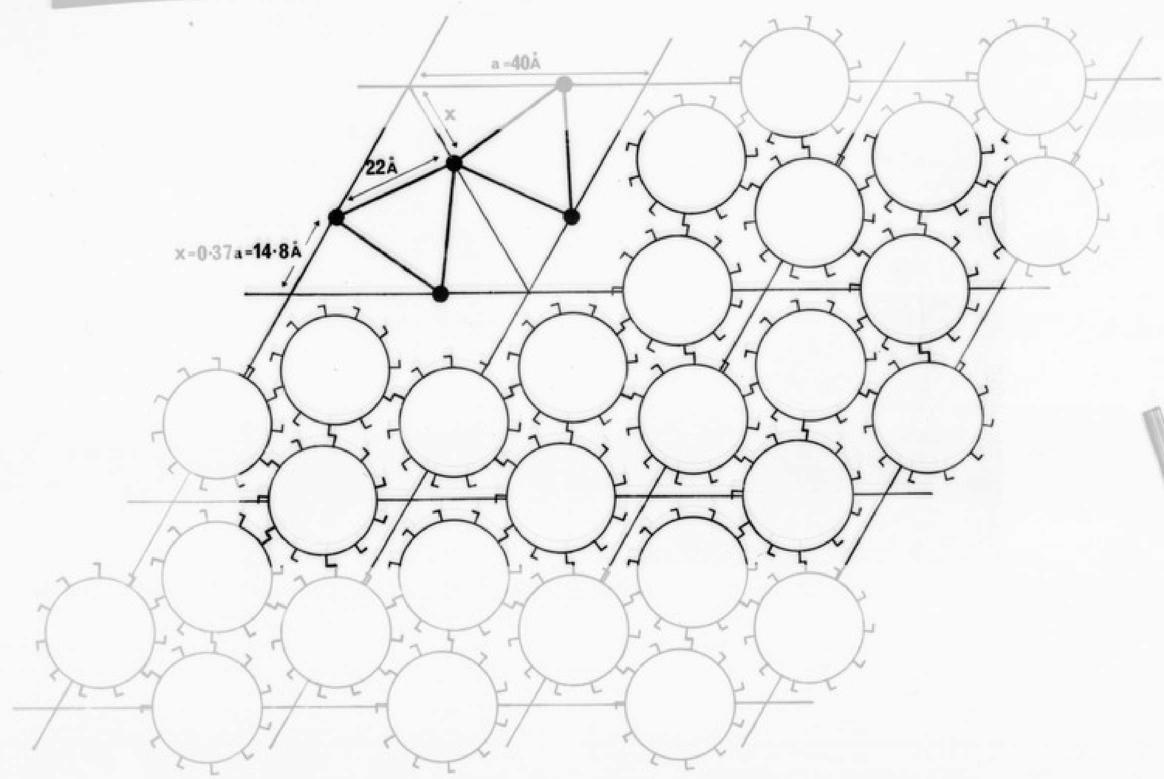

a=44Å
X
22Å
X=0·46a=20·2Å


a=44Å
x
22Å
x=0·46a=20·2Å

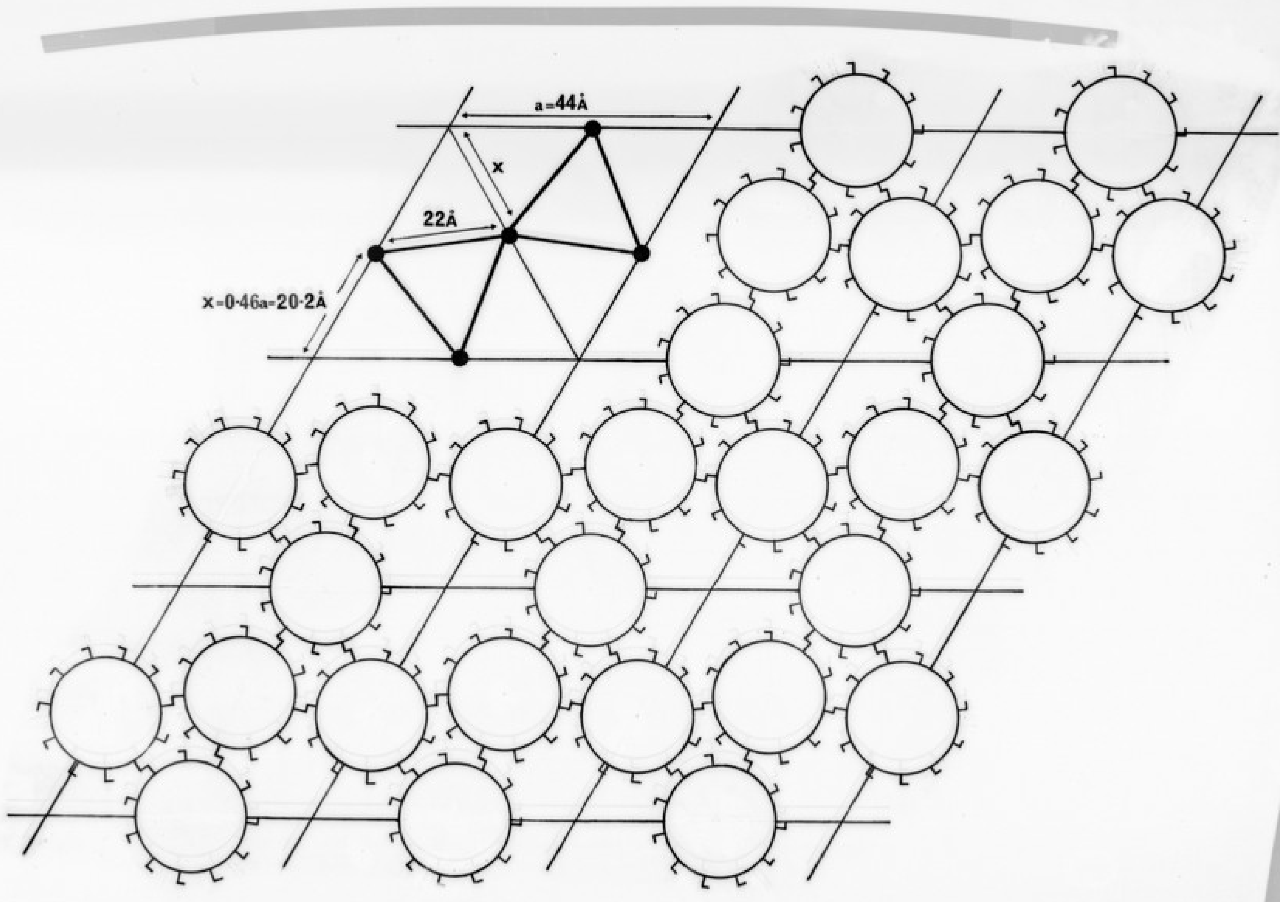

a = 40Å
x
22Å
x = 0·37a = 14·8Å



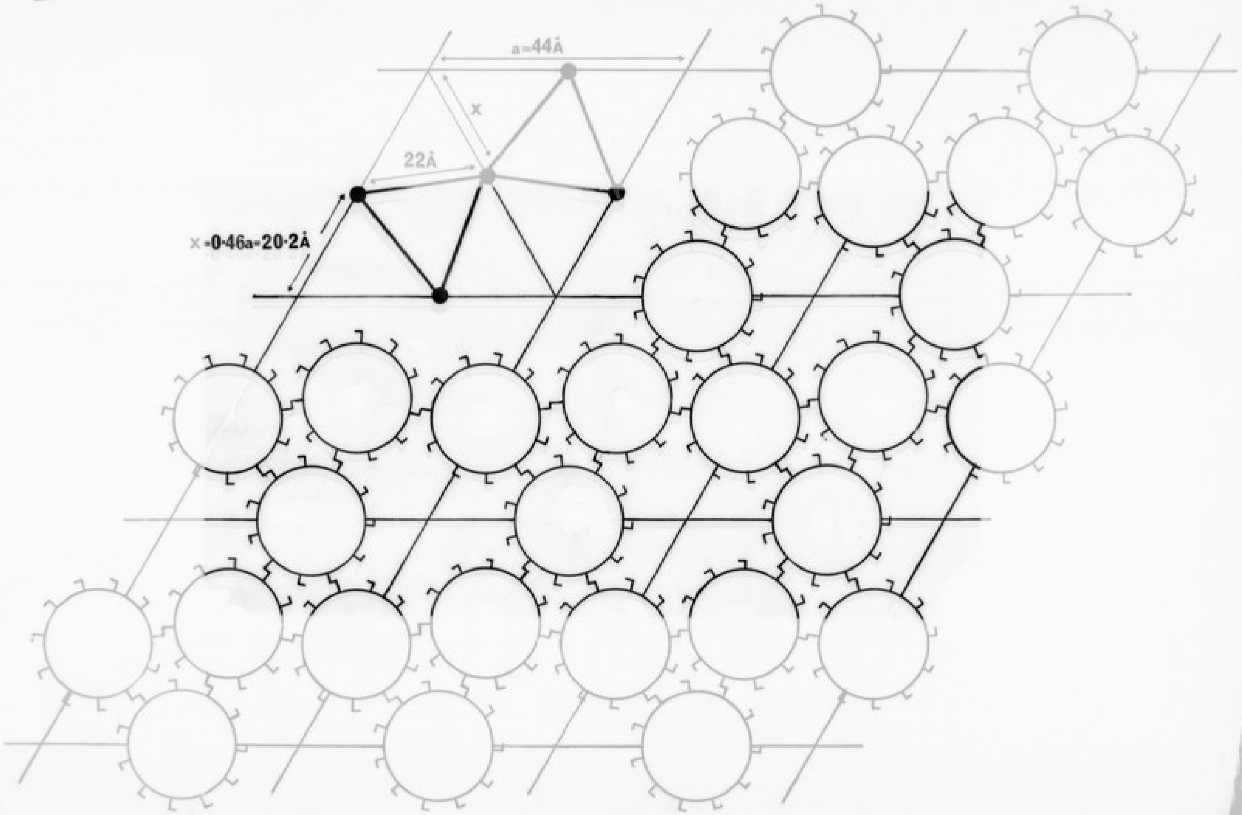
a =40Å
x
22Å
x=0·37a=14·8Å

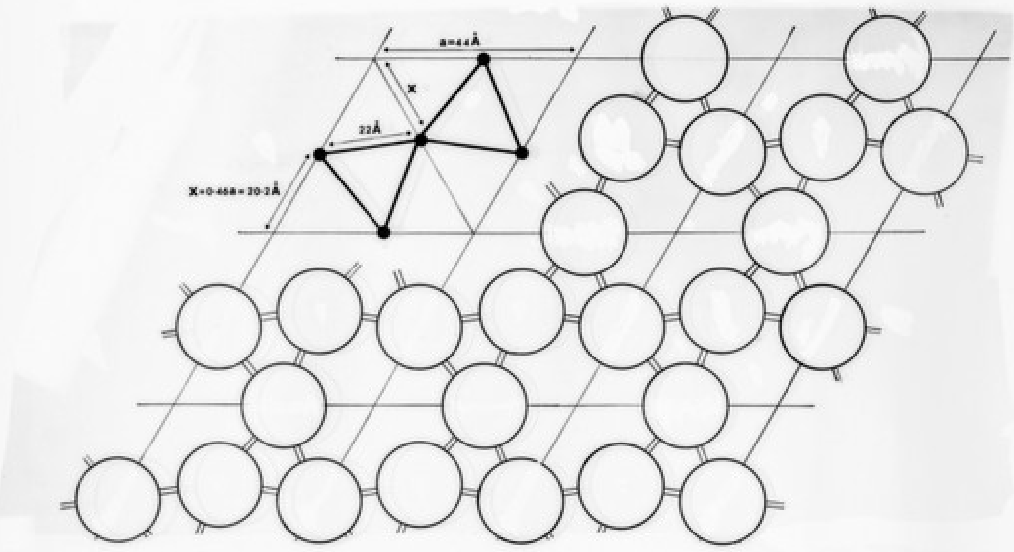


a =40Å
x
22Å
x=0·37a=14·8Å

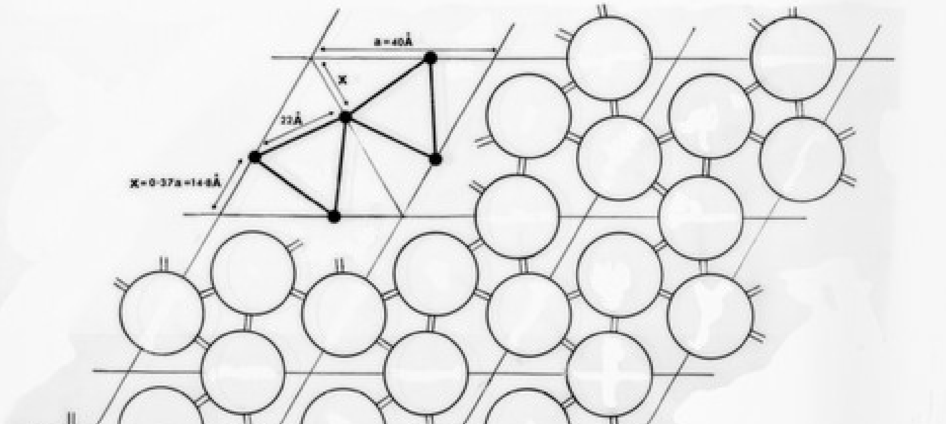


a=44Å
x
22Å
x=0·46a=20·2Å

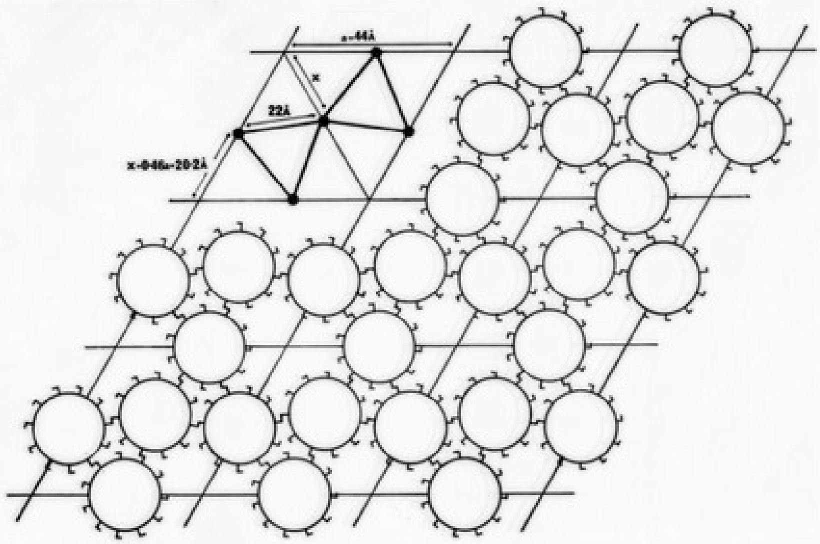

a=44Å
x
22Å
x =0·46a=20·2Å



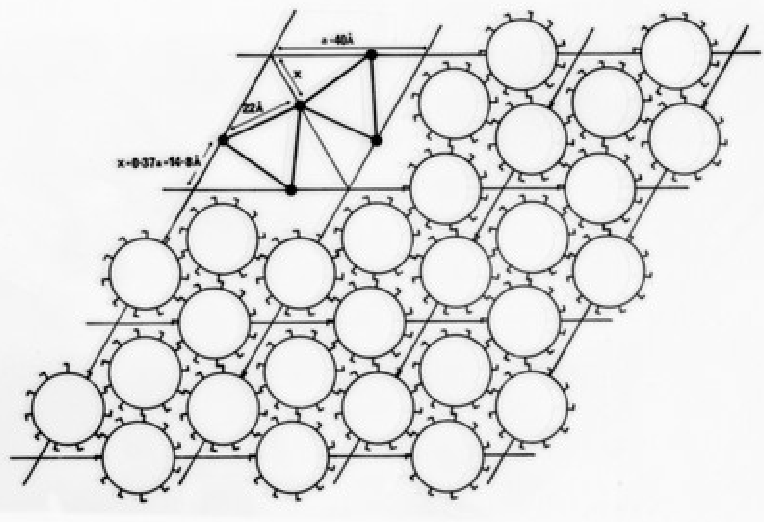
a=44Å
x
22Å
x=0·46a=20·2Å



a=40Å
x
22Å
x=0·37a=14·8Å



a = 44Å
x
22Å
x = 0·46a = 20·2Å



a = 40Å
x
22Å
x = 0·37a = 14·8Å