Spring, 1968: Observed that the "defective"

skip to 3a

2 3

1

Correlated random walks (isotope effect)

Infinite symmetric graphs (enumerate them)

Voronoi cells (Physicists call them 'Wigner-Seitz' cells)

Search for method of matching no. of faces of "Voronoi-like" polyhedron with degree of the corresponding infinite symmetric graph

Konrad Wachsmann (chairman, USC Dept. of Architecture)
(designed A. Einstein's summer house, Berlin, ~ 1930)

Peter Pearce / Charles Eames
"saddle polyhedra"

Developed empirical "algorithm" for deriving the "DUAL" of an infinite symmetric graph (inspired by a study of interstitial sites in close-packed [and other] crystal structures)

April 1966: "discovered" Schwarz's P and D surfaces the day after meeting Peter Pearce

April 1966: phoned Hans Nitsche (Showed Coxeter Schwarz's P and D

July 1967: moved from L.A. to NASA/Cambridge

Began 'systematic' study of infinite symmetric graphs, Voronoi cells, expandable space-frames, TRIPLY PERIODIC MINIMAL SURFACES LABYRINTHS, SKELETAL GRAPHS, "INSIDE/OUT" transformation of skeletal graph into its dual, through CMC intermediates.

Spring, 1968: Observed that the "defective" infinite symmetric graph of degree 6 on the vertices of the B.C.C. lattice (which is normally represented by a graph of degree 8) defined a counter-example to the so-called dual graph algorithm of 1966.

Constructed the DUAL regular skew polyhedron {6, 4 | 4}, having already constructed {4, 6 | 6} (vacuum-formed plastic faces)

Observed that this DUAL has regular helical polygon edge-chains.

Decided that circular helices would smooth the structure.

Had $2500 "gyroid"-tool — with 6 helical 1/4-pitch edges — fabricated by automatic screw machine company.

Filled in the interior of the hexagon face with epoxy (shrink-film stretched across the "shillelagh")

Made first gyroid model.

3

(skip to 3a)

1968 — Late spring — Phoned Fred Almgren, Bob Osserman. Sent model to Bob.

1969 Blaine Lawson tried to figure it out. Finally gave up (busy finishing his PhD thesis).

Aug. 69 Went to Tbilisi with 19 boxes of models. Returned with 14 boxes. (Vekua's students apparently needed some of the models)

Sept. 69 visited Stefan Hildebrand at Mainz. Had good time (but Stefan had a terrible cold. He took some good pictures, anyway.)

(MOMA) ★ Received \$25 K grant from NASA Headquarters to build 11-foot-diameter gyroid model, using 5-axes computer ~~Omni~~ OMNI-MILL vacuum forming die. Jeanie Freyburghaus helped write the Fortran program (8000 points; Weierstrass, for a $\{\tilde{6}\}$ face).

3a

1968 – Summer – Obsewed that this new "gyroid" model looked very much like a TPMS

Described and exhibited it at AMS summer meeting at Madison (shocked Hans Nitsche)

Two days after Madison meeting, realized gyroid is associate to Schwarz's P and D.

New Years Eve — Eve: Dec. 30, 1969

Richard Nixon decided he didn't want Ted Kennedy to replace him in the White House. (He told Lee DuBridge, his science adviser.)

Director of NASA came to Cambridge to tell us all we were fired. (We had moved into a $40 M new building one week before.)

Tried to complete the 11 ft G-model, but lost the remaining funds ('by accident') in March 1970.

May, 1970: finished writing NASA TN D 5541 on TPMS.

Correlated random walks

Bardeen-Hering (1949)

$$D = \frac{1}{6} a^2 \Gamma \cdot f$$

$$\boxed{\left(f = \frac{1 + \langle \cos\theta \rangle_{AV}}{1 - \langle \cos\theta \rangle_{AV}} \right)}$$

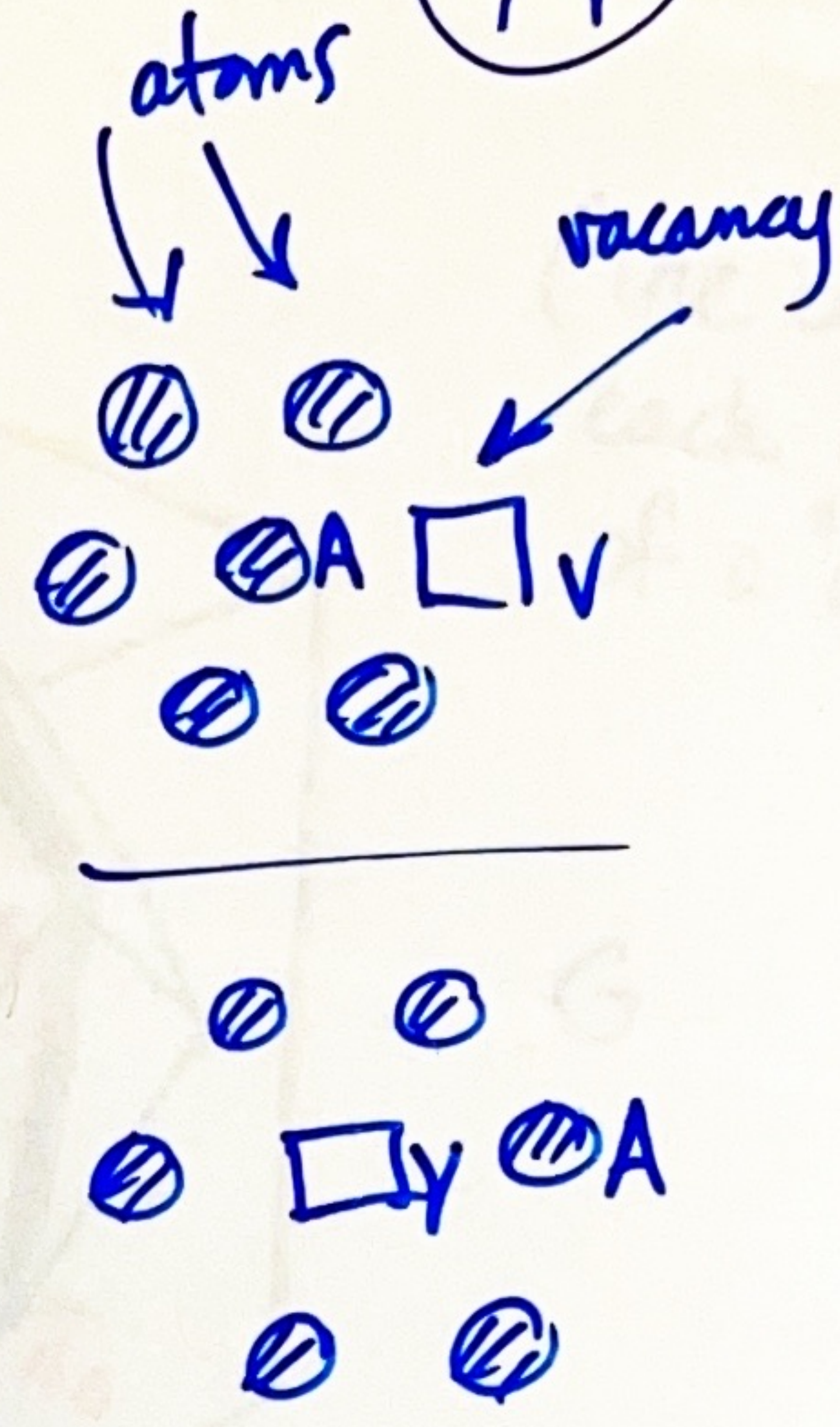
Schoen (1958)

Showed that f can be measured by studying atomic diffusion with TWO isotopic tracers of different mass.

This is best done in cases where the graph of jump sites is an INFINITE SYMMETRIC GRAPH, in CUBIC crystals.

(Ergo, search for such graph examples.)

A



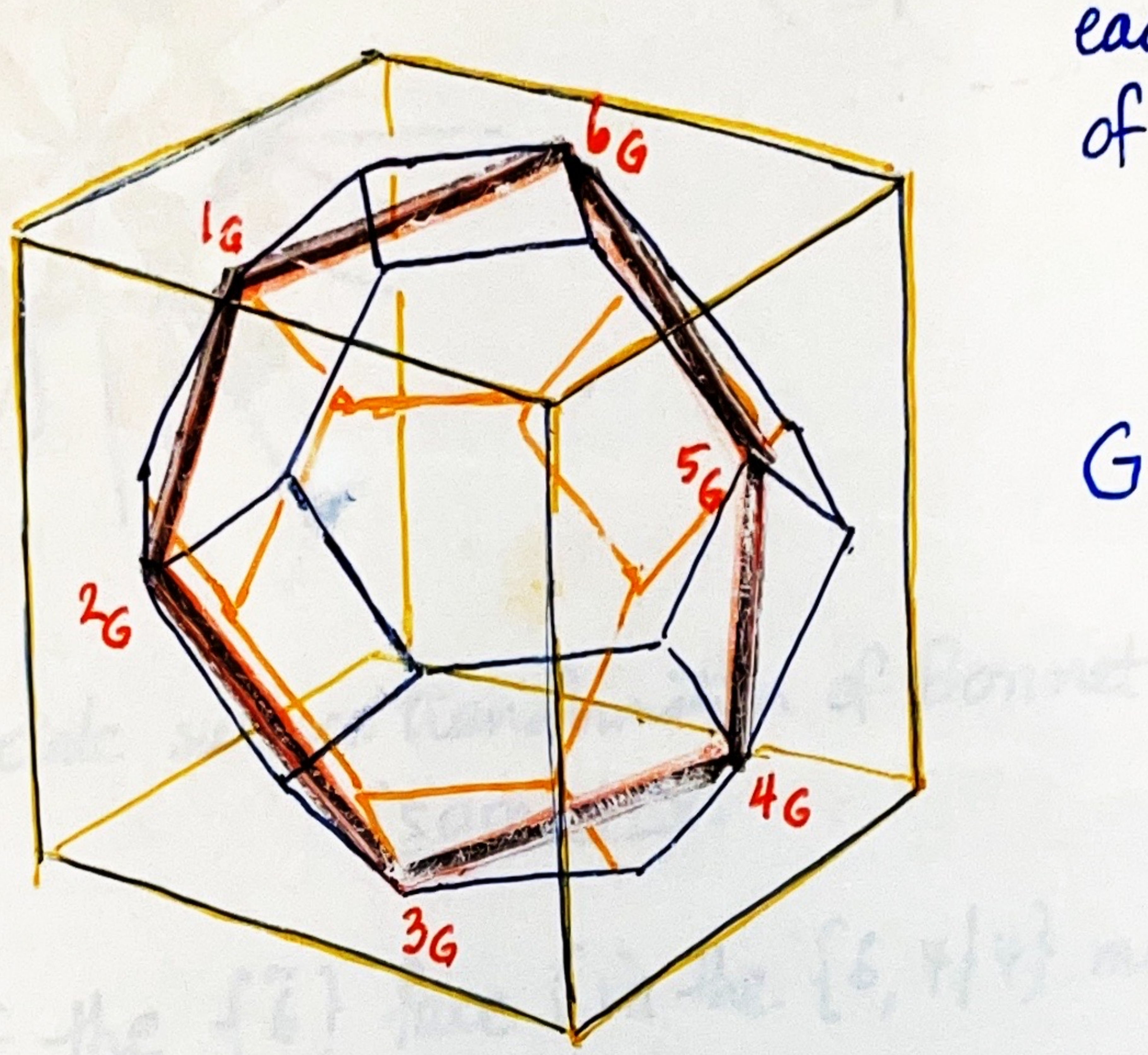
Atom A has exchanged sites with the vacancy V.

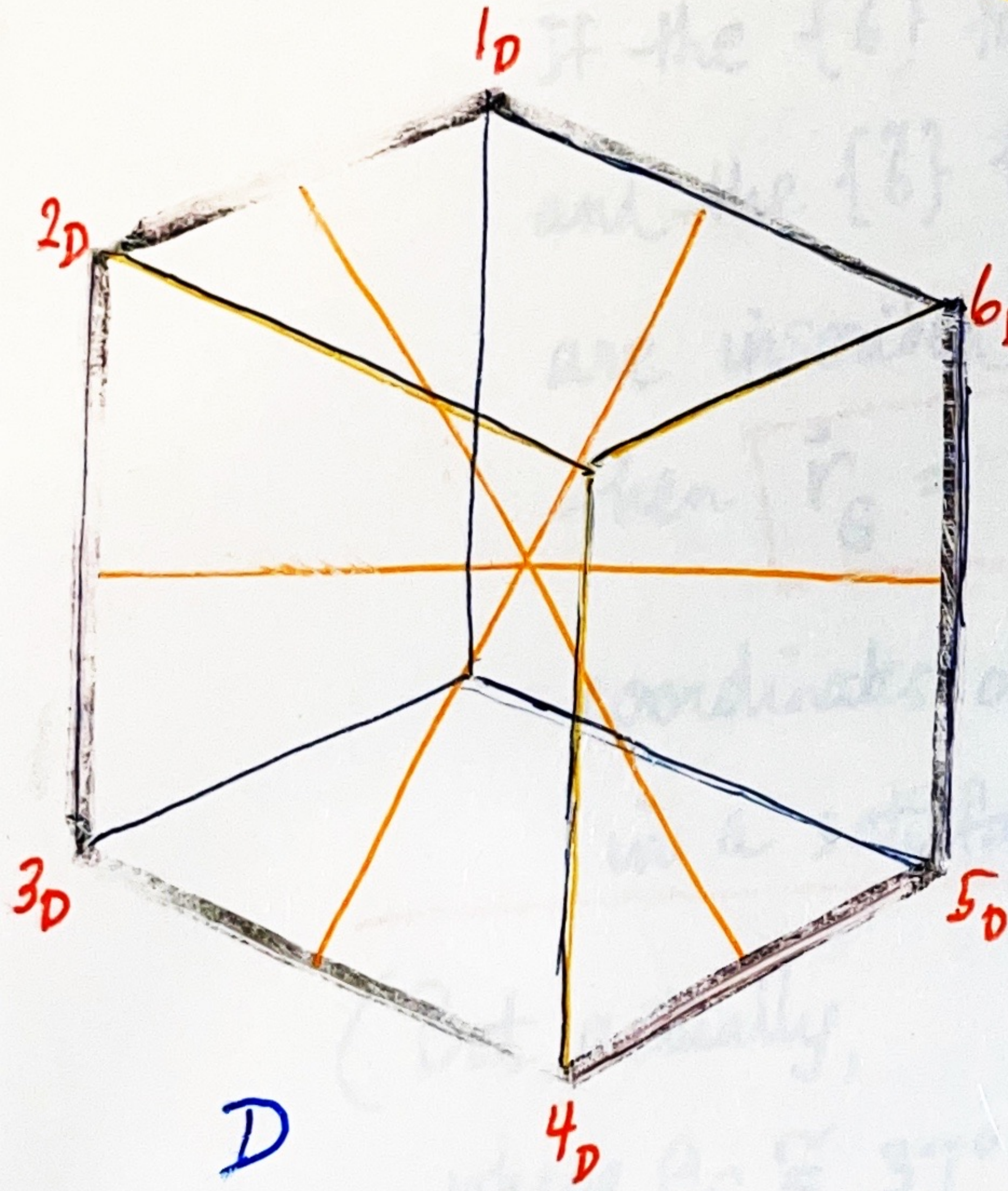
The next jump of atom A is not "isotropically distributed" (because — like Mt. Everest — the vacancy "IS THERE"!).

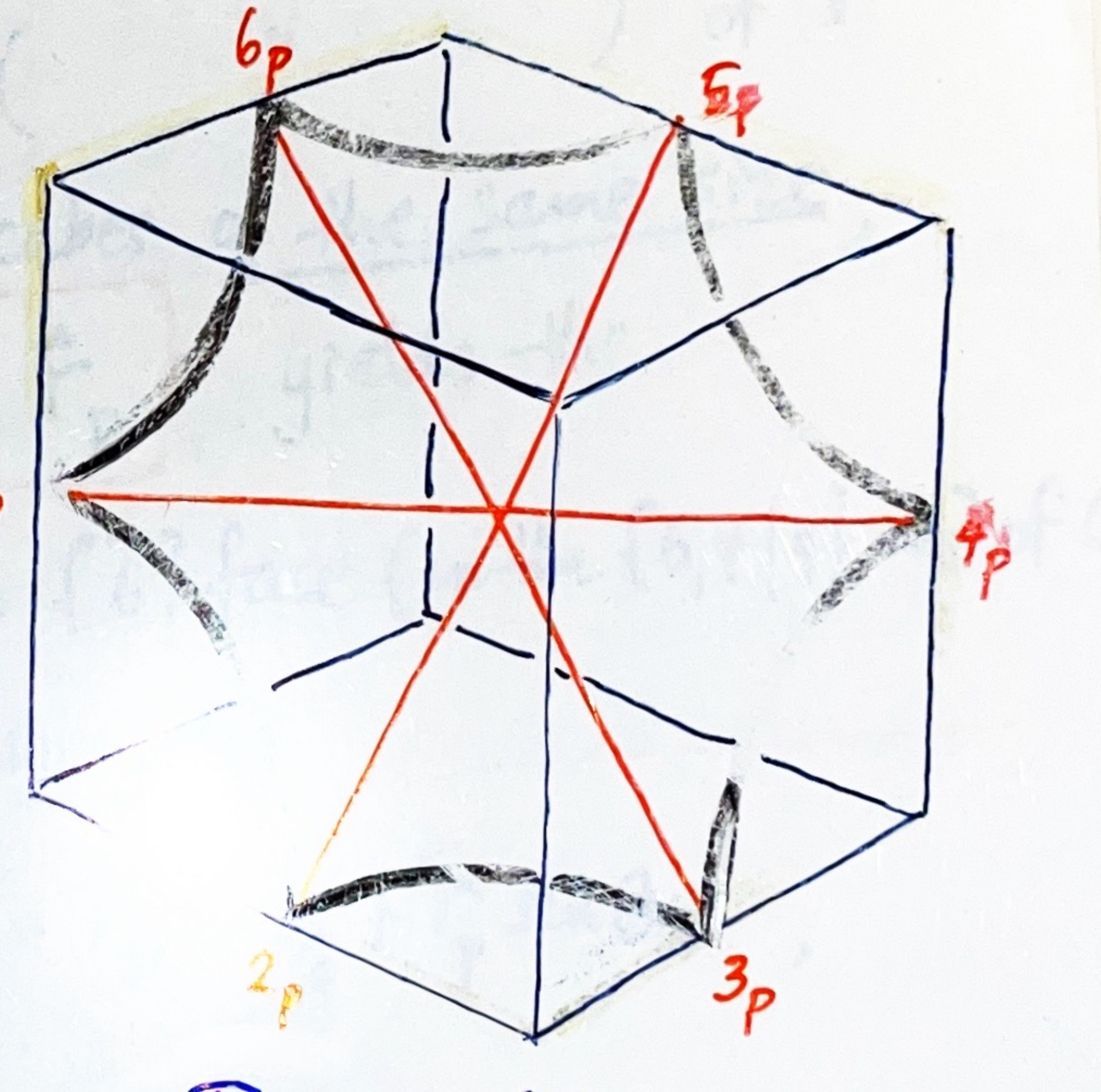
B

B

(The edges here are each a quarter-pitch of a "quasi-helix".)







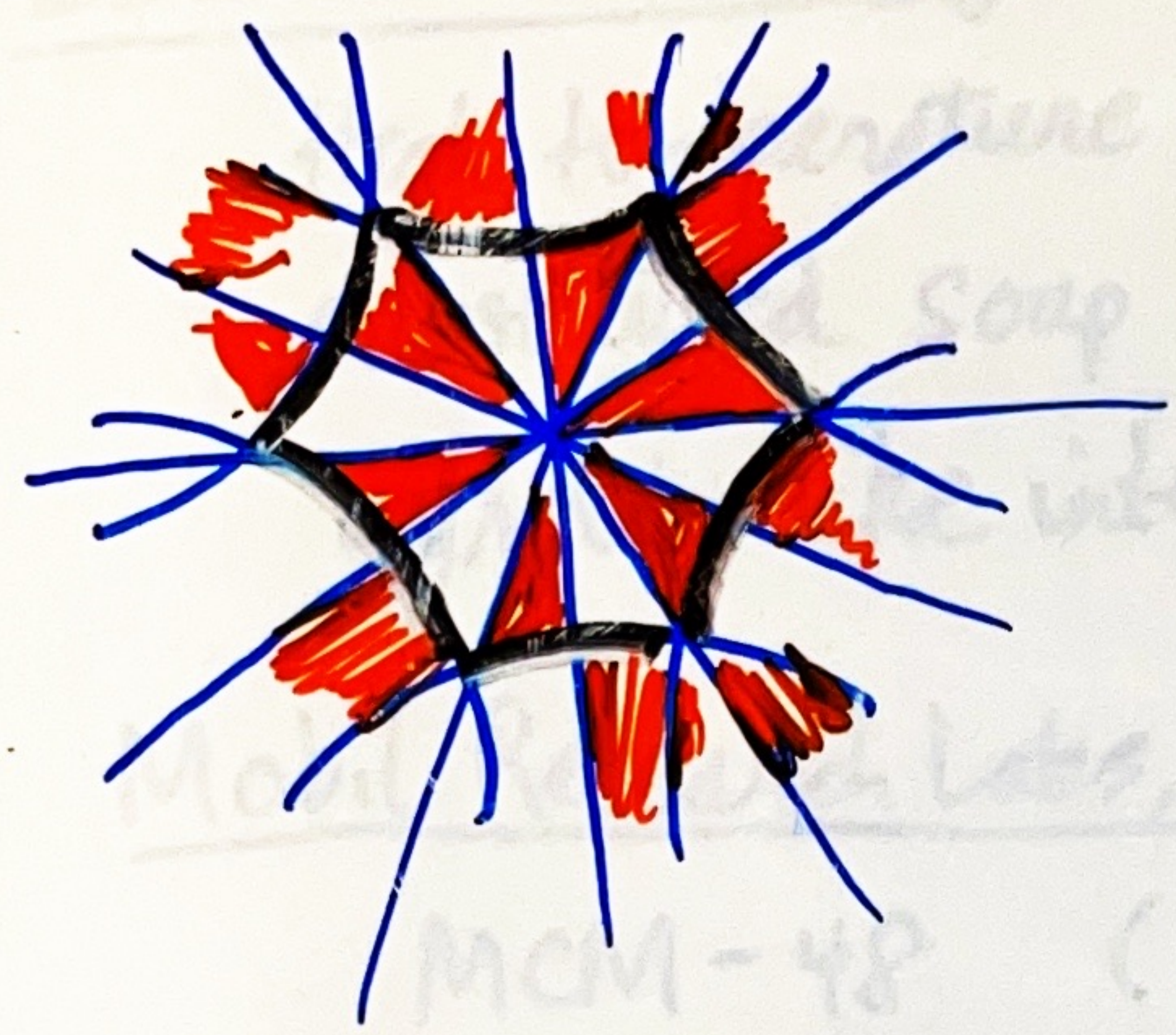
(The edges here are each approximately circular arcs.)

$\{\tilde{6}\}$ faces of P, D, G in the $\{6, 4|4\}$ map

(associate transformation of O. Bonnet)

C

$\{6,4\}$ Poincaré map
(hyperbolic tessellations)



The associate surface transformation of Bonnet is an isometry.

If the $\{\tilde{6}\}$ face (in the $\{6,4|4\}$ map) of D
and the $\{\tilde{6}\}$ face (") of P
are inscribed in cubes of the same size,
then $\boxed{\vec{r}_G = \vec{r}_D + \vec{r}_P}$ yields the
coordinates of the face (in the $\{6,4|4\}$ map) of G
in a satisfactory way.

(But actually, $\vec{r}_G = \vec{r}_D \cos\theta_G + \vec{r}_P \sin\theta_G$,
where $\theta_G \cong 37°$.)

F

Luzzati and Spegt 1967

High temperature phase of divalent cation-(Ba^{++}, Ca^{++})
substituted soap single crystals — Lipid layer
gyroid-like interface

Mobil Research Labs, N.J. ~1993

MCM-48 (glass: 4 to 5 Si atom diameters thick)
Mesoporous silicate — silica gel + surfactant

Liu (Battelle Northwest) - 1997

Coated MCM-48 with sulfur.
Traps "100%" of heavy metals (Ag, Hg, etc.)
from simulated industrial waste water.
Patented in fall 1998 (cf. Sept. '98 Business Week)

Stucky et al [Nature, Sept. 1998]

Synthesized zeolite in which a crystalline
(not amorphous) gyroid-like interfacial
structure is present.

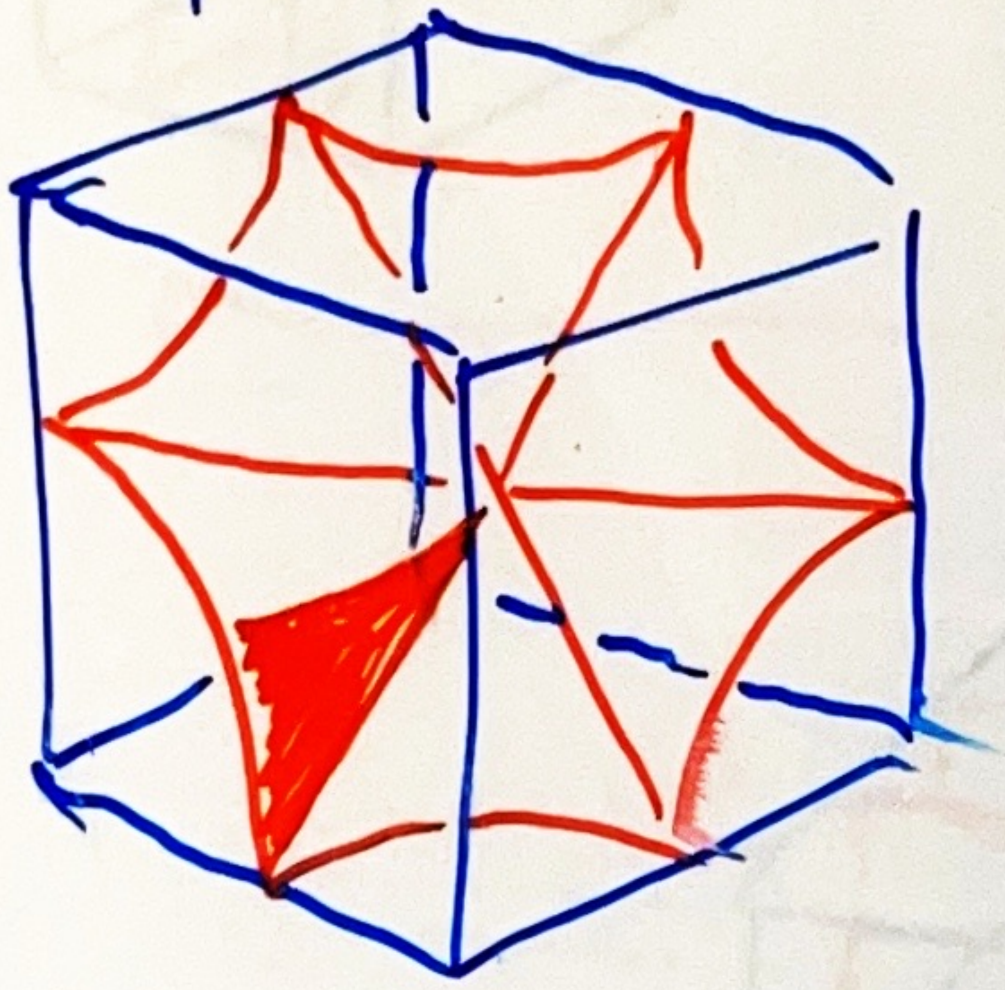
Ned Thomas (MIT) [~1993 to present]

Diblock copolymers.
Gyroid interface seems often to be
preferred to Schwarz's D.

Others (many): liquid crystals, lipid-water systems,
etc.

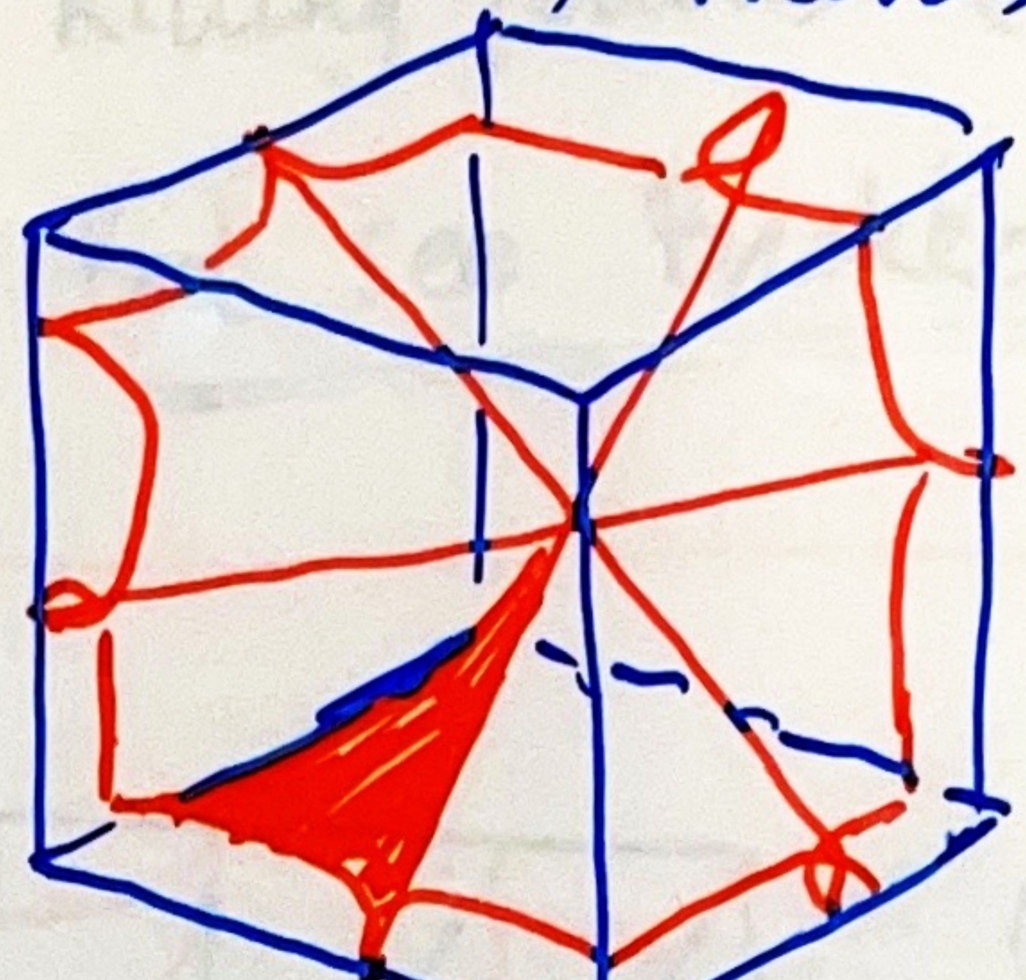
G

P



p = 3

C(P) Neovius



p = 9

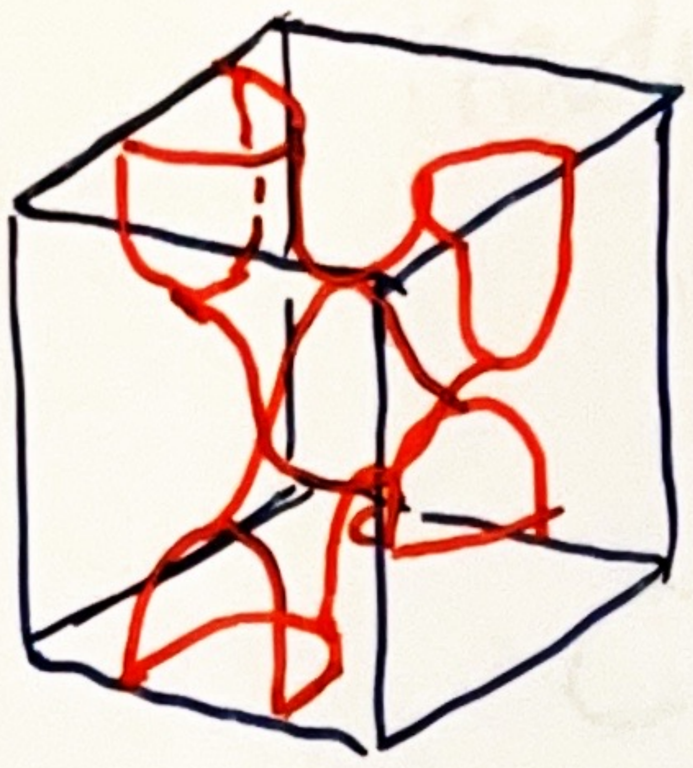
Schoen (unpublished, 1969)

p = 15, 21, 27, ... examples
(Brakke 1998)
(Polthier, 1998)

C(D) (p = 19) is described in Schoen [1970]
~~Nats~~ NASA Tech. Note
TN D-5541 (?)

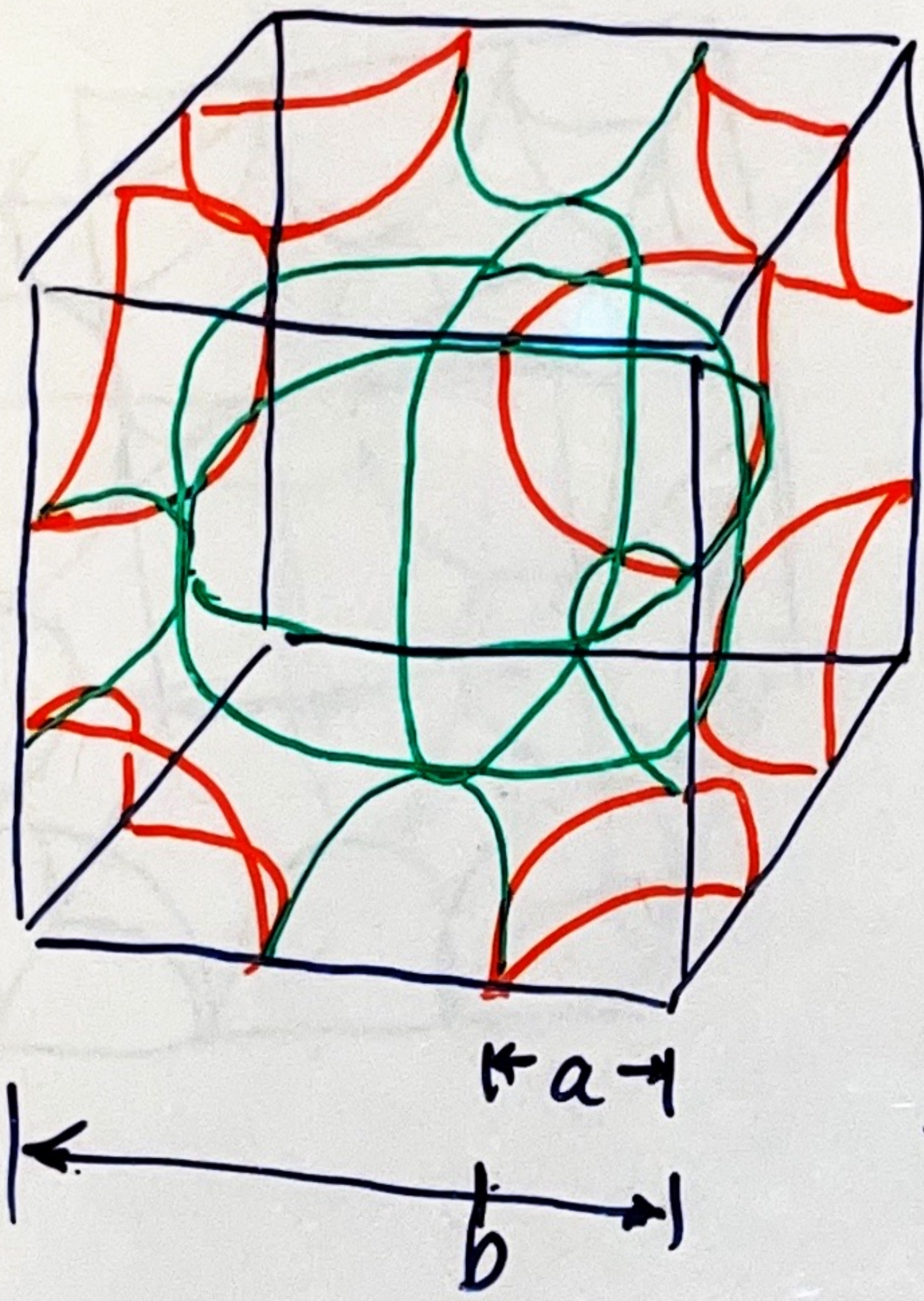
It is probably not possible to d[illegible] the Weierstrass polynomial for C(D) even in IMPLICIT FUNCTION form. There are ~~too~~ many points in a unit cell that have * the same Gauss sphere image but are not equivalent, considering the relatively low symmetry of a lattice fundamental region (TETRAHEDRAL).
But FOGDEN [1993] succeeded with F-RD (and easily rederived Neovius's C(P)) in IMPLICIT form.

M



Laser/goniometer method for killing periods (laborious !)

But see Brakke's web site



(. . . . . ?)

Cjovovic

~ 1994

(Weierstrass parametrization reduces to Gauss hypergeometric function)

$\frac{b}{a} = 3$ (exactly)

Lidinoid (Sven Lidin — Lund — 1992)

An analog of the gy[illegible]

Associate to Schwarz's H and H*

H is embedded

H* (its adjoint) is self-intersecting.

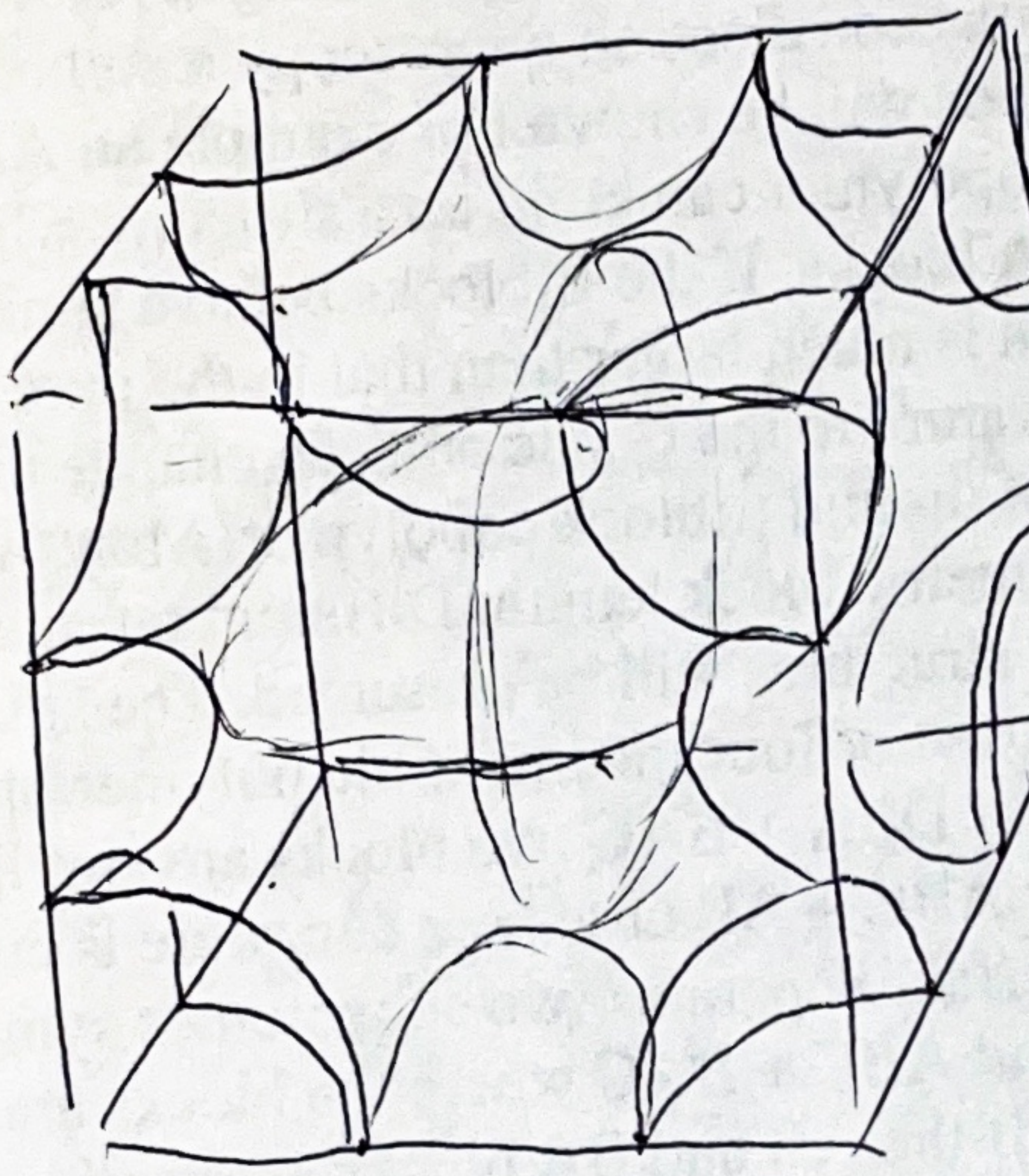
Lalvani Phys Rev St. mech. gyroid

Heidi Burgiel ~~U of~~ U. Ill, Chicago

unifm polyhed. version of gyroid

Crivojic

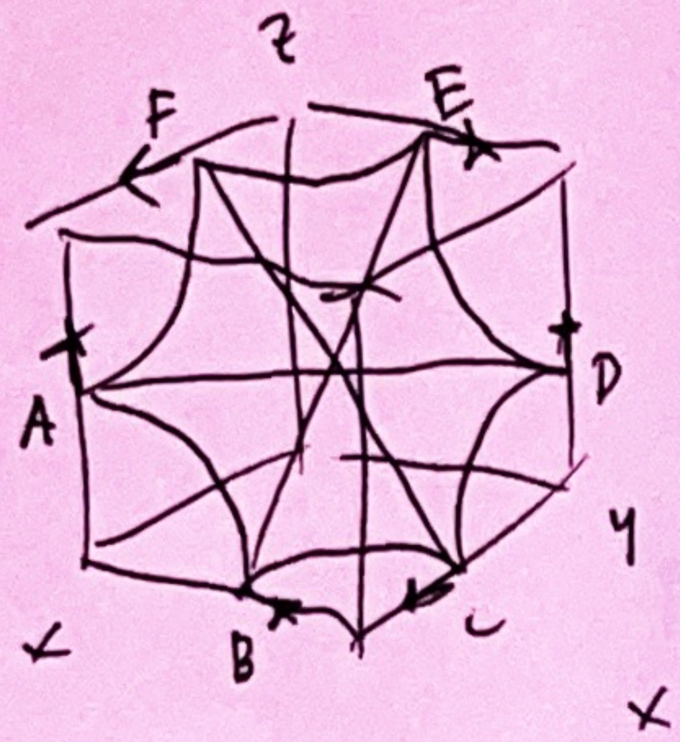
Cjivovic

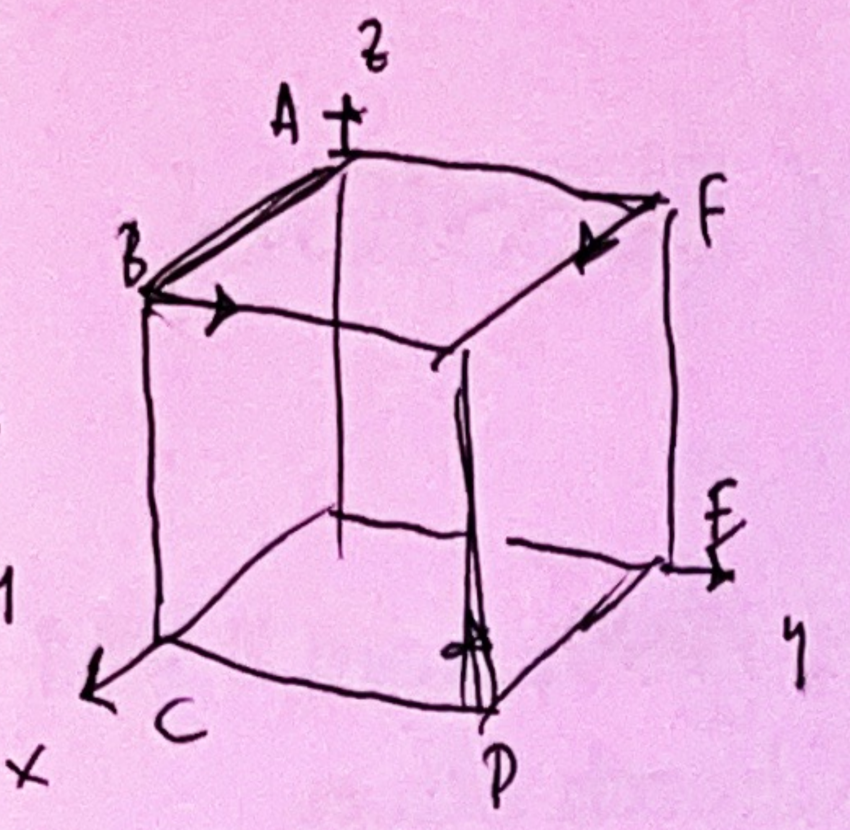


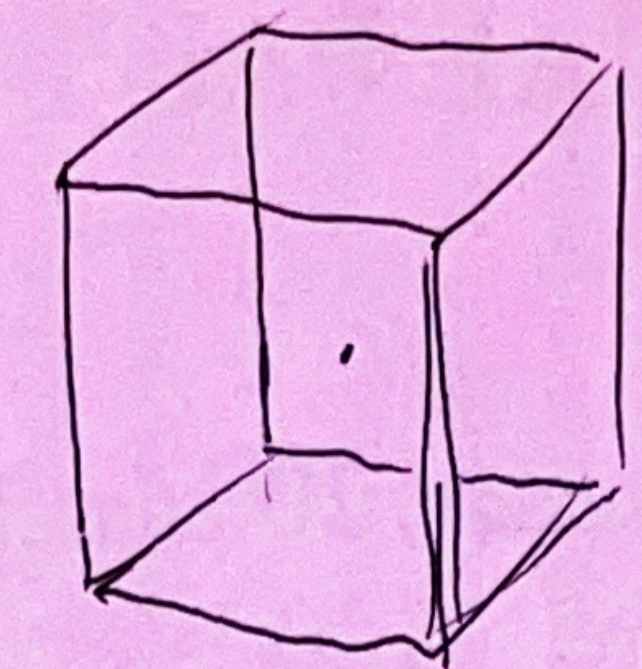
<u>Lund</u>   Sculptor 1968   <u>"L" the Laves surface</u>

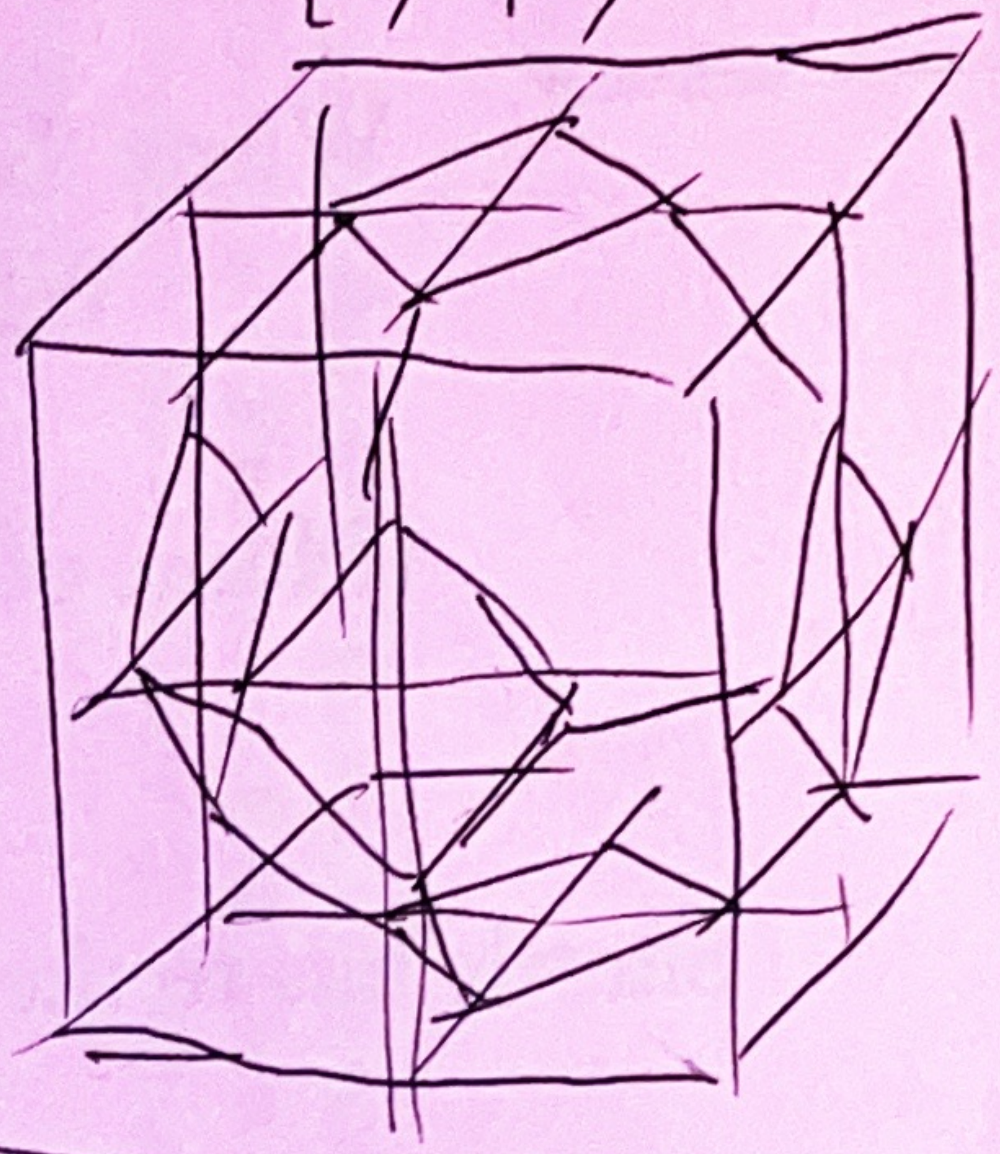
~~A few~~ <u>On Dec. 30 1969</u>, ~~the~~ NASA director came to ERC — told us all we had 6 months.
A few days later, Lee DuBridge, former pres. of CalTech, was quoted on front pg of NY Times about

$\{4, 6 \mid 4\}$
$\{6, 4 \mid 4\}$
$\{6, 6 \mid 3\}$





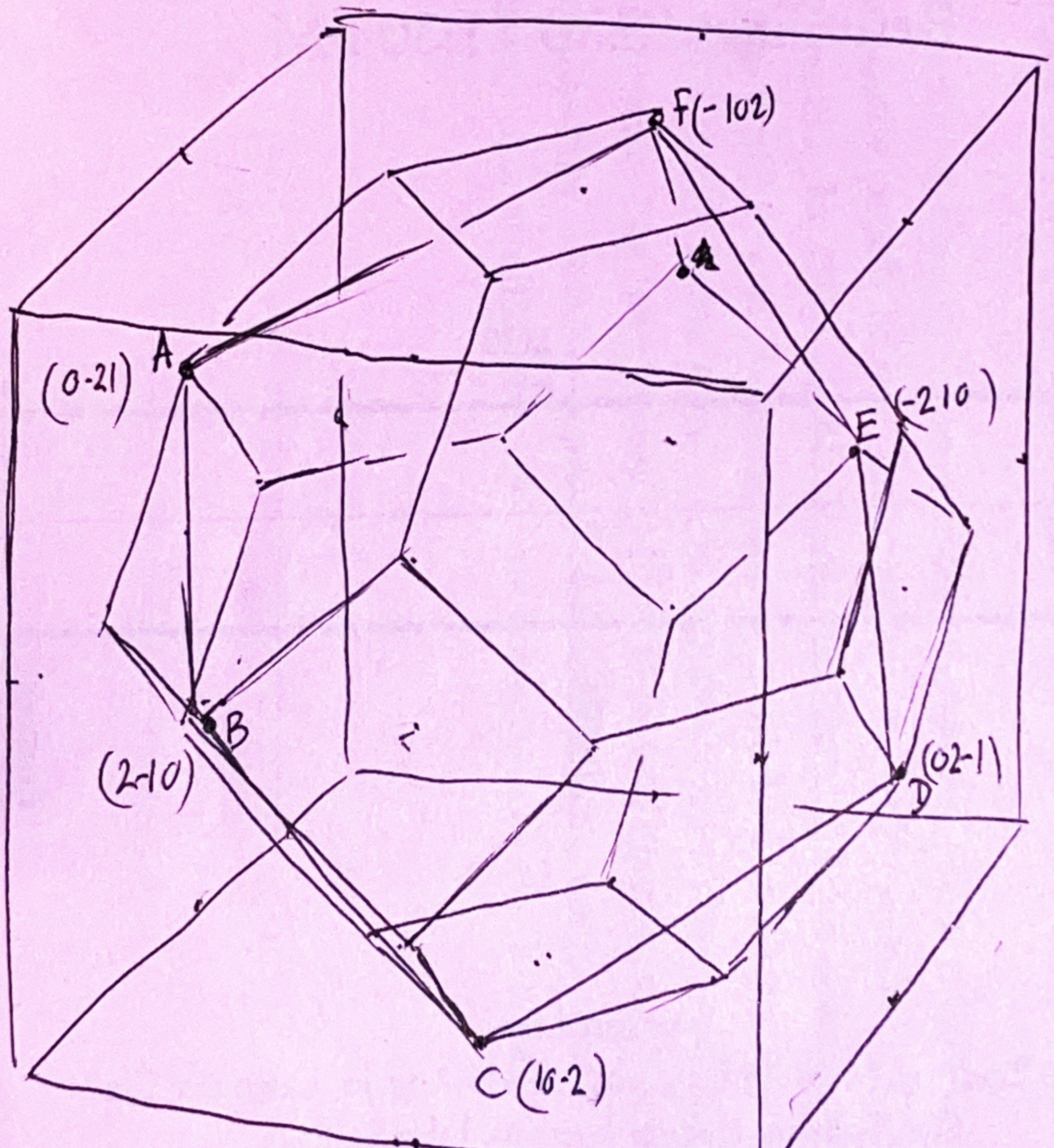


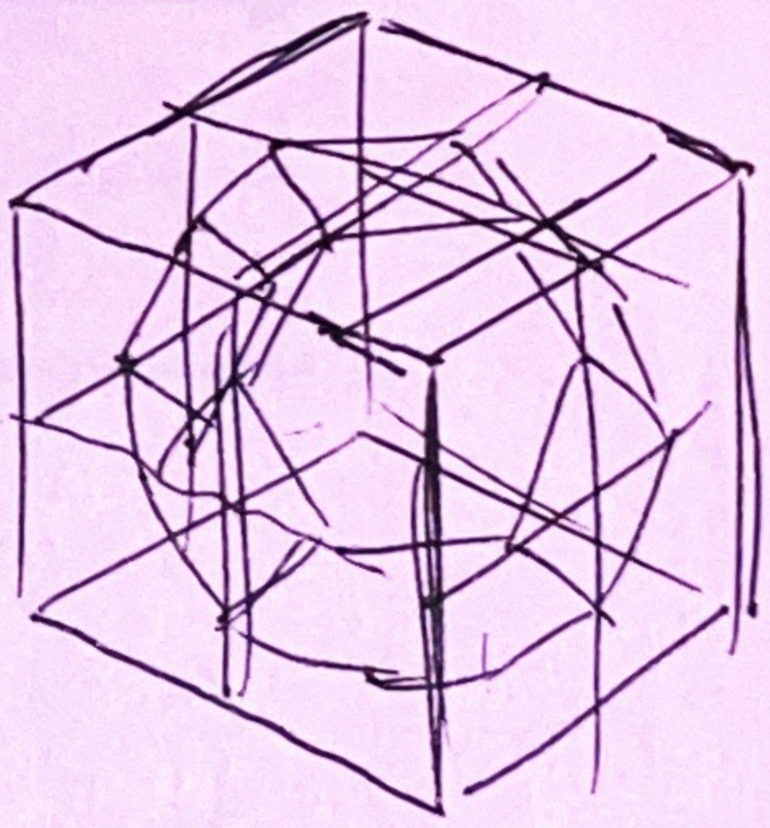


A	2 | 0 1	1 -1 0
B	2 | 1 0	1 0 -1
C	1 | 2 0	0 1 -1
D	0 | 2 1	-1 1 0
E	0 | 1 2	-1 0 1
F	1 | 0 2	0 -1 1

A	0 | 0 2	-1 -1 1
B	2 | 0 2	1 -1 1
C	2 | 0 0	1 -1 -1
D	2 | 2 0	1 1 -1
E	0 | 2 0	-1 1 -1
F	0 | 2 2	-1 1 1

A	2 0 3	0 -2 1
B	1 1 2	2 -1 0
C		1 0 -2
D		0 2 -1
E		-2 1 0
F		-1 0 2





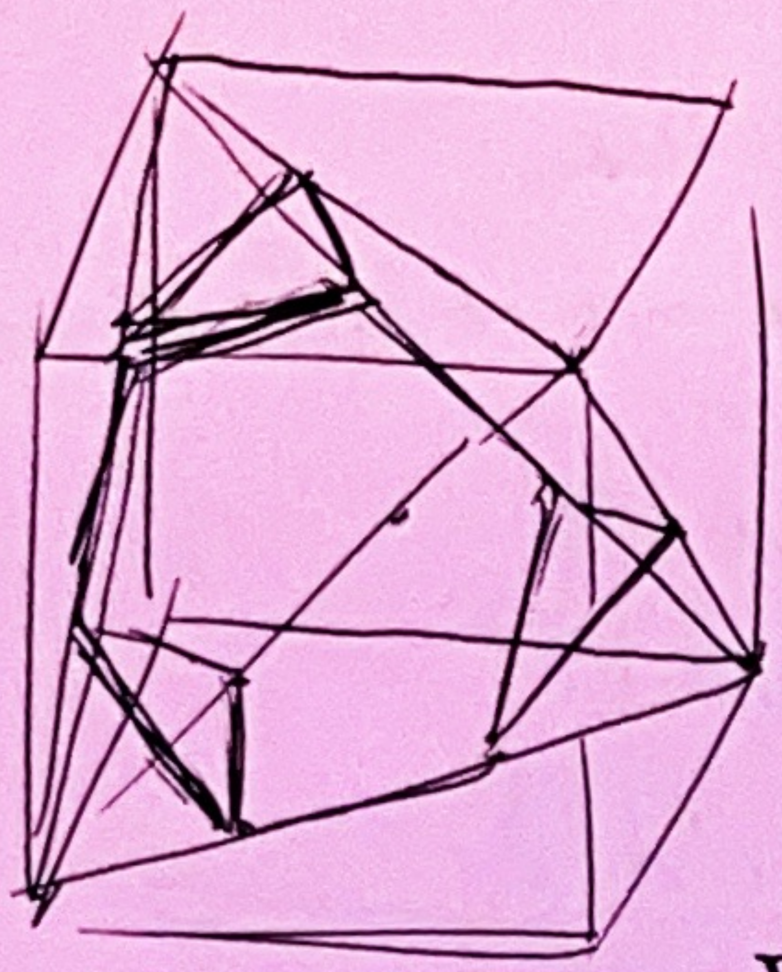
$\vec{AB} = (2\ 1\ {-1})$
$\vec{BC} = (-1\ 1\ {-2})$
$\vec{CD} = (-1\ 2\ 1)$
$\vec{DE} = (-2\ 1\ 1)$
$\vec{EF} = (1\ {-1}\ 2)$
$\vec{FA} = (1\ {-2}\ {-1})$

$\cancel{\theta =}\ (\vec{AB}) \cdot (-\vec{BC}) = (2\ 1\ {-1}) \cdot (1\ {-1}\ 2) = 2 + (-1) - 2 = -1$

$|\vec{AB}| = \sqrt{6} \qquad \therefore\ \theta = \cos^{-1}\left(-\frac{1}{6}\right)$

941-11-269 **Professor Bruce C. Berndt** (`berndt@math.uiuc.edu`), Department of Mathematics, University of Illinois, and **Professor Ken Ono** (`ono@math.psu.edu`), Department of Mathematics, Pennsylvania State University. *Ramanujan's Second Unpublished Manuscript on the Partition Function.*

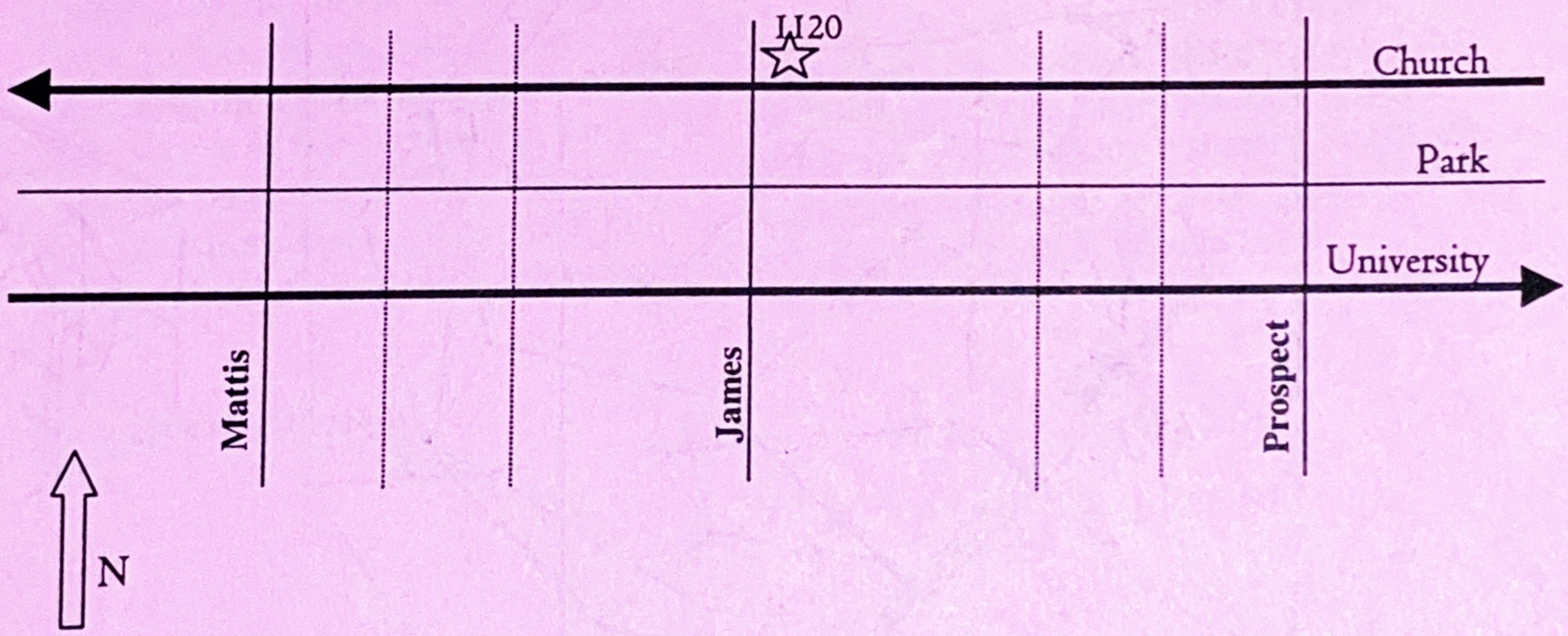
Shortly before he died, Ramanujan wrote a paper in two parts on the partition function $p(n)$ and the tau function $\tau(n)$. G. H. Hardy extracted a portion of Part I, giving Ramanujan's proofs of his congruences for $p(n)$ modulo 5, 7, and 11, and had it published posthumously under Ramanujan's name. In 1952, J. M. Rushforth published a paper providing further material, mostly on congruences for $\tau(n)$, from the first part of Ramanujan's unpublished manuscript. Further contents from Part I were discussed by R. A. Rankin in 1977. Both Parts I and II, in handwritten forms, were published with Ramanujan's lost notebook in 1988 by Narosa. No attention has been given to Part II in the literature. The purpose of our lecture is to describe Part II. In particular, the manuscript contains a proof of Ramanujan's congruences for $p(n)$ modulo any positive integral power of 5, and the beginnings of a similar proof for his congruences modulo any power of 7. (Received January 26, 1999)



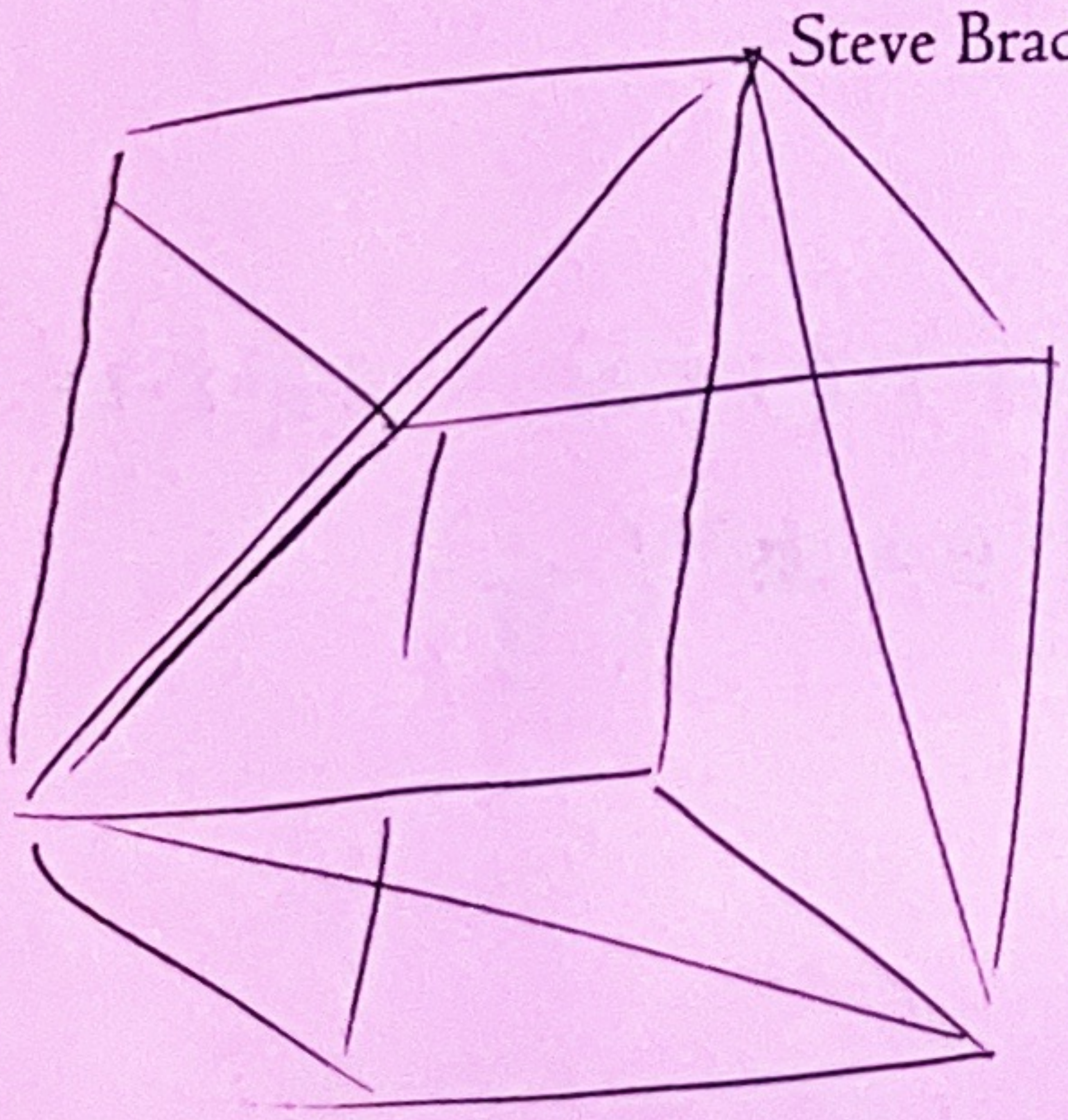
SPECIAL PARTY SESSION

When: Saturday, 20 March, 1999; from 8 PM
Where: 1120 West Church Street
Champaign, IL 61821
(Home of Steve Bradlow and Bridget Carragher)
tel: 359-8858

Shuttle bus to the party from the Illini Union: 7:45 to 8:45 PM
Returning: 10:30-11:30 PM



Sponsored by:
Steve Bradlow, Maarten Bergvelt, John D'Angelo, Lawrence Ein,
Sue Tolman, Eugene Lerman, John Sullivan



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