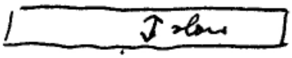
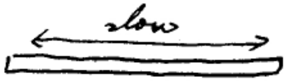
14. 4. 53

Microscopic examination of TMV ~~..~~ RNA (Pirie)

Supplied in thin strips, apparently cut from sheet,
<u>but</u> there is some orientation ∥ length of strip

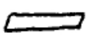
(1) 

¼ wave plate shows clearly (gives ~ complete extinction)

(2) edge-on, 

v. low birefringence

(quartz wedge used) extinction good
[conclusion about slow direction rather uncertain]

(3) end-on 
v. low birefringence
shows extinction, but less ~~..~~ good.
unable to distinguish slow direction
i.e. ⊥ plane of strip is fastest direction

Suggests ~~orientation of~~ long molecules lie in plane of strip, with tendency to align ∥ length of strip, but edge-on view shows length-wise orientation must be poor

(2) prob. wrong

29.9.53

In June, some of Bawden's TMV sol^n was concentrated by evaporating in neighbourhood of P_2O_5 on watch-glasses. Stored in 8mm dia. specimen tube. Birefringent — orange-yellow

29.9.53 this concentrated solution has formed some sediment, prob. ∴ dust. Strong gravity sedimentation, bottom of tube showing pink & green mottled colours, & ~~[illegible]~~ upper regions yellow – white – black

After shaking to mix, colour orange with v strong extinction direction // length of tube

30.9.53

Original Bawden sol^n put to concentrate on watch-glass over P_2O_5 (at night put over $Ca(NO_3)_2$)

5.30p.m.

Specimen B&F method, ~0.25mm thick, put to dry over ~~[illegible]~~ $Ca(NO_3)_2$. 1.10.53 10a.m., dry, cracked into brick-shaped pieces

Some of this, together with specimen dried in June & exposed to X-rays in Paris (grease washed off with ether) used for water-uptake measurements

wt of bottle + TMV	0·4413	
wt of bottle	0·4377	δ
1.10.53 11a.m. over 92% R.H.		
2.10.53 11a.m.	0·4413	
put over P_2O_5 — 6pm.	0·4409	
6.10.53 10a.m.	0·4410	

1.10.53 New specimen (B & F method) prepared using tapered glass rods instead of tilting slide

7 p.m. put over 92% RH (Na_2CO_3)

2.10.53. 10 ~~p.m.~~ a.m., specimen dry.

Less cracked & better oriented than previous prepⁿ

2.10.53

How nearly identical are TMV photographs (other than equator) at different humidities?

B & F. & ODW - photographs are v different in intensities (eg. 3rd layer line)

- is this : difference in virus or : diff. humidities?

In both spots appear too sharp for X tal diam. ~50 Å

ODW. says "very similar" diffraction pattern

9.10.53

Specimen prepared 1.10.53 on 80μ collimator in Philips camera

Extinction not v good. Specimen shows bright cracks which don't extinguish, bright edges which do, & blotchy background which mostly does. 

<u>Use of polythene film for holding specimen</u>

Polythene bag made by melting edges around spring clip. P_2O_5 sealed inside. Only v small leak in one corner. Bag containing P_2O_5 put under water

1.12.53

<u>Qualitative comparison of photos 15 (~dry) & 17 (wet)</u>

Most striking difference in 3rd layer-line

15 has ~~[illegible]~~  17 has 

+ more v. sharp reflections

Also ~~[illegible]~~ 1st layer-line, small ξ

<u>but</u> equatorials remarkably similar,

suggesting 1st water up-take is ~~[illegible]~~ intra-particular

Tendency for maxima to be more-or-less equally spaced in ξ

& to lie on curves  which are not row-lines!

B & F reproduction corresponds to 17 rather than 15

3rd layer-line maxima v. sharp. Some, perfectly resolved, are separated by distance corresp. ~ 150 Å^{-1} in ξ

∴ relate to particle > 150 Å

– or can structure factor of unit of diameter 150 Å have such sharp peaks?

<u>Intensities</u> Inner part stronger in 17, outer part in 15

7.12.53

A Photograph 23

Fade-out of sharp reflections after 8th layer-line

(∴ try tilted specimen)

except one diagonal reflection further out

To find approx. ~~[struck]~~ spacing, consider some meridional reflection on 15th layer-line (6.75 mm) gives $\frac{68}{15}$ A = 4.53 A

∴ for this reflection $2\sin\theta/\lambda = 0.221$ $\sin\theta = .1703$

$\theta = 9^\circ 49'$ $2\theta = 19^\circ 38'$

$\tan 2\theta = .357 = \frac{6.75}{2x}$ where x = specimen-film distance

$x = 9.45$ mm

for 16.7 mm, $\tan 2\theta = \frac{16.7}{2 \times 9.45} = .8845$ $2\theta = 41^\circ 30'$

$\theta = 20^\circ 45'$ $\sin\theta = .3543$

$d = \frac{\lambda}{2\sin\theta} = 2.17$ A

11.12.53

Equatorial spacings 15c

15c projection 6th layer-line, along meridian $\frac{120}{2}$ mm

other equatorial spacings 10.0, 13.6, 18.2, 27.0, 33.5, 36.4, 45.5, 48.5
70.5(?) 150.0(?

suppose layer-line spacing 68 A, 6th layer-line 11.33 A

$2\sin\theta/\lambda = .08825$ $\sin\theta = .0680$ $\theta = 3°54'$ $2\theta = 7°48'$

$\tan 2\theta = .1370 = \frac{120}{2x}$ where x = effective specimen-film distance

$x = 438$ mm

$\tan 2\theta$ for equatorial spacings	θ	d	
.0228	0° 39'	67.8	200
.0310	0° 53'	49.9	210
.0415	1° 11'	37.2	320
.0616	1° 46'	25.0	420
.0765	2° 11'	20.1	
.0831	2° 23'	18.5	
.1039	2° 58'	14.9	
.1108	3° 10'	14.0	
.1610	4° 34'	9.7	

2 4 c projection — 6th layer-line, along meridian $\frac{122}{2}$ mm

equatorial spacings 14·0, <u>19·0</u>, 24·3 (?) 27·5, <u>34·5</u>, 39·8, 46, 49, 52·5

Effective specimen - film distance = $\frac{122}{2 \times .1370}$ = 445 mm

tan 2θ	θ	d	d_{calc}	hkl
·0315	0° 54′	48·9	48·9	210
			43·0	300
·0427	1° 13′	36·2	37·3 35·8	220 310
			32·4	400
·0546	1° 34′	28·1	29·6 28·2	320 410
·0618	1° 46′	25·0	25·9 24·9	500 330
·0775	2° 13′	19·9	20·7 19·7	520 610
·0895	2° 33′	17·3		
·1034	2° 57′	14·9		
·1101	3° 9′	14·0		
·1180	3° 22′	13·1		

Apparent inter-particle distance = 4 × 37·3
= 149·2 (wet)

14 projection — 6th layer-line 123·5 mm — x = 451

equatorial spacings 18·7, 14·3, (12·4), 10·5, 9·6

tan 2θ	·0415,	·0317,	(·0275),	·0233,	·0213
θ	1° 11′	0° 54′	0° 47′	0° 40′	0° 36′
d	37·2	49·0	(56·4)	66·3	73·7
	220	210		[illegible]	[illegible]

15.12.53

28c Equator

6th layer-line 120·5 mm

∴ Effective specimen-film distance $= \frac{120.5}{2 \times .1370} = 440$ mm

Equatorial spacings (cm)	tan 2θ	θ	d	d calc for a=151A	hkl	Transform for uniform rod $J_1(x)/x$
a? ~~9.0~~ 10·3 7.4			66 ~~37~~ 92·2	65·6	200	+·0098
m 13·8			49·4	~~49·4~~ 43·6	210 300	+·0134 −·0145
S 18·2			37·5	37·7 36·3	220 310	−·0124 −·003
m 20·5			33·3 30·8	32·7 30·0	400 320	+·0134
vw 22·2						
?w 25·0			27·30	28·5	410	
m 26·2			26·05	26·15 25·2	500 330	
?w 28·0			24·38	24·7 23·45	420 510	
w 33·5			20·37 ~~20·75~~	21·8 21·5 20·9 19·9	600 430 520 610	
m 35·5	·0807	2°18′	19·23	18·9 18·7	440 {530 700}	
? 46·0						
m 48·3						
m 53·5						

Inter-particle distance, $\frac{4}{\sqrt{3}} \times 65.6 = 152$ A

Observed intensities are not consistent with hypothesis of uniform density rods, close-packed. For these, strongest reflection should be (300), which is ~~absent~~ weak. Central heavy core could correct this.

Suppose heavy core, diameter ~ $\frac{1}{4}$ that of main rod, then F is sum of $a J_1(x)/x + b J_1(y)/y$

where $y = x/4$.

– this gives +ve contribution to 300 ~~[illegible]~~ ~~without to 220 But~~ Also +ve to 200, 210, 220, ~~400~~, of decreasing importance

∴ can't explain absence of 300 + strong presence of 220

~~[illegible]~~ Suppose hollow cylinder of stronger density

– this gives contribution J_0

– require +ve to 300 & –ve to 220

∴ zero for x between 10.89 & 12.56, say 11.5

1st zero of $J_0(x)$ occurs for $x \sim 2.4$

$\therefore \frac{\text{radius of cylinder}}{\text{radius of rod}} = \frac{2.4}{11.5} = \frac{r}{75.5} = 0.209$

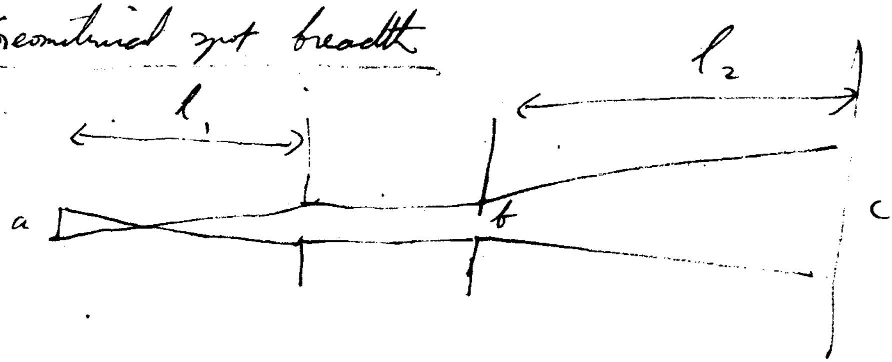
$r = 17$ A

This is radius of part occupied by RNA according to Watson!

∴ suggests phosphates on outside of RNA rod of radius 17 A! ?

(glass collimator).

<u>Geometrical spot breadth</u>



a : ~~other~~ size of focal spot (in perspective)

b : collimator bore

c : spot diameter

$$\frac{c}{b} = \frac{l_2 + \frac{b l_1}{a+b}}{b l_1 / a+b}$$

~~$c = b + \frac{l_2}{l_1}(a+b)$~~

$$c = b + \frac{l_2}{l_1}(a+b)$$

$$\text{resolving power} = \frac{l_2}{c} = \frac{l_1 l_2}{a l_2 + b(l_1 + l_2)}$$

$$= \frac{l_1 l_2}{l_2(a+b) + l_1 b}$$

For photos 24 . . . .

$b \simeq .055$ mm

$a \simeq .01$ mm (say)

then $c = .055 + .065 \frac{l_2}{l_1}$

for ~~l~~ $l_1 = l_2$, $c = 0.120$ mm

for $l_1 = 2l_2$ $c = 0.087$ mm

for $l_1 = 3l_2$ $c = 0.077$ mm