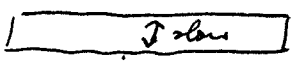
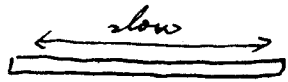
14. 4. 53

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

Supplied in thin strips, apparently cut from sheet,
but there is some orient" ∥ length of strip

(1) 


¼ wave plate shows clearly
(gives ~ complete extinction)

(2)
edge-on, 


~ low birefringence

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

(3)
end-on

~ low birefringence
shows extinction, but less ~~ff~~ good.
unable to distinguish slow direct"

i.e. ⊥ plane of strip is fastest direct"

Suggests ~~orient of~~ long molecules lie in plane of strip, with tendency to align ∥ length of strip, but edge-on view shows length-wise orient" 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. Birefringence — orange-yellow

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

After taking 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 $P_2O_5$ (or might put over $Ca(NO_3)_2$)

5.30 p.m.

Specimen B & F method, ~0.25mm thick, put to dry over $Ca(NO_3)_2$. 1.10.53 10 a.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 + EMV | 0·4413 |
| wt of bottle | 0·4377 δ |
| 1. 10.53 11a.m. over 92% RH | |
| 2. 10.53 11a.m. | 0·4413 |
| over $P_2O_5$ — 6p.m. | 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 ~~pm~~ a.m., specimen dry.

Less cracked & better oriented than previous prep.

2.10.53

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

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

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

In both spots appear too sharp for X tal diam. 150 A

TDW says "very similar" diffraction patterns

9. 10. 53

Specimen prepared 1.10.53 on 80μ collimator
in Phillips camera

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

Use of polythene film for holding specimen

Polythene bag made ~~out~~ 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

Qualitative comparison of photos 15 (~dry) & 17 (wet)

Most striking difference on 3rd layer-line

15 has [illegible] 17 has [illegible]

+ more v sharp reflections

Also 1st layer-line, small $\xi$

but equatorials remarkably similar,

suggesting 1st water up-take is intra-particular

Tendency for maxima to be more-or-less equally spaced in $\xi$

& to lie on curves ((. which are not zero-lines!

B L F reproduction corresponds to 17 rather than 15

3rd layer-line maxima v sharp. Some, perfectly resolved, are separated by distance corresp. ~ 140 $A^{-1}$ in $\xi$

∴ relate to particle > 150 A

- or can structure factor of unit of diameter 150 A have such sharp peaks?

Intensities Inner part stronger in 17, outer part in 15

7.12.53

A Photograph 23

Fade-out of sharp reflections after 18th layer-line
(∴ try tilted specimen)

except one diagonal reflection, further out

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

∴ 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

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

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

$x = 438$ mm

| tan 2θ 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 | |

24c projection — 6th layer-line, along meridian $\frac{122}{2}$ mm

equatorial spacings 14·0, 19·0, 24·3 (?) 27·5, 34·5, 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 |
| ·0427 | 1° 13′ | 36·2 | 35·8 (43·0, 37·3) | 310 (300, 220) |
| ·0546 | 1° 34′ | 28·1 | 28·2 (32·4, 29·6) | 410 (400, 320) |
| ·0618 | 1° 46′ | 25·0 | 24·9 (25·9) | 330 (500) |
| ·0775 | 2° 13′ | 19·9 | 19·7 (20·7) | 610 (520) |
| ·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 — n = 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 | | 200 | 110 |

15.12.53

## 28c Equator

6th layer-line 120·5 mm

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

| | Equatorial spacing (mm) | tan 2θ | θ | d | d calc for a = 151A | hkl | $J_1(x)/x$ |
|---|---|---|---|---|---|---|---|
| m? | ~~9.6~~ 7.4 10.3 | | | ~~66.3~~ 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 | 420 | |
| w | 33.5 | | | 20.37 ~~20.75~~ | 23.45 21.8 21.5 20.9 19.9 18.9 18.7 | 510 600 430 520 610 440 530 700 | |
| m | 35.5 | .0807 | 2°18′ | 19.23 | | | |
| ? | 46.0 | | | | | | |
| m | 48.3 | | | | | | |
| m | 53.5 | | | | | | |

Transform for uniform rods

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

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

Suppose heavy core, diameter $\sim \frac{1}{4}$ 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]~~ ~~contribution to 220~~ But also +ve to 200, 210, 220, ~~300~~, of decreasing importance

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

Suppose hollow cylinder of stronger density

– this gives contribution $J_0$

– requires +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 $x \sim 2.4$

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

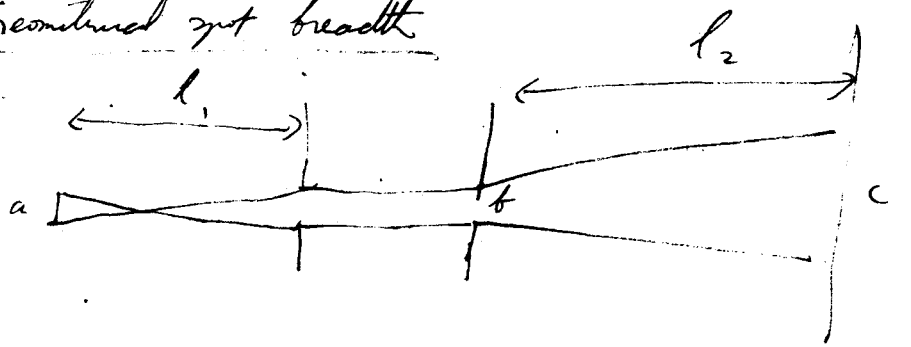
$$r = 17 \text{ A}$$

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

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

(grass collimator).

## Geometrical spot breadth




a : ~~[illegible]~~ size of focal spot (in perspective)

b : collimator bore

c : spot diameter

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

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

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

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 $l_1 = l_2$, $c = 0.120$ mm

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

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