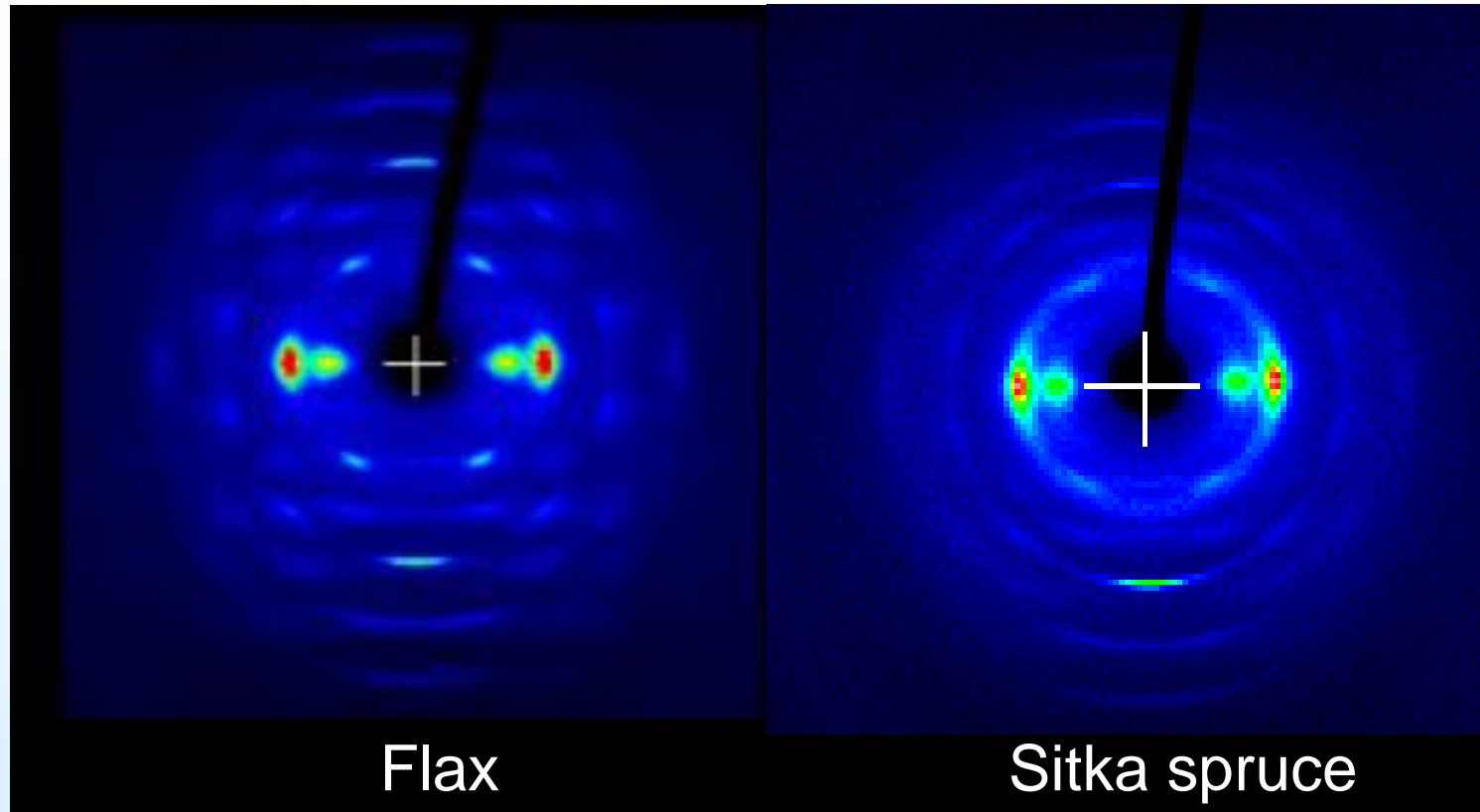
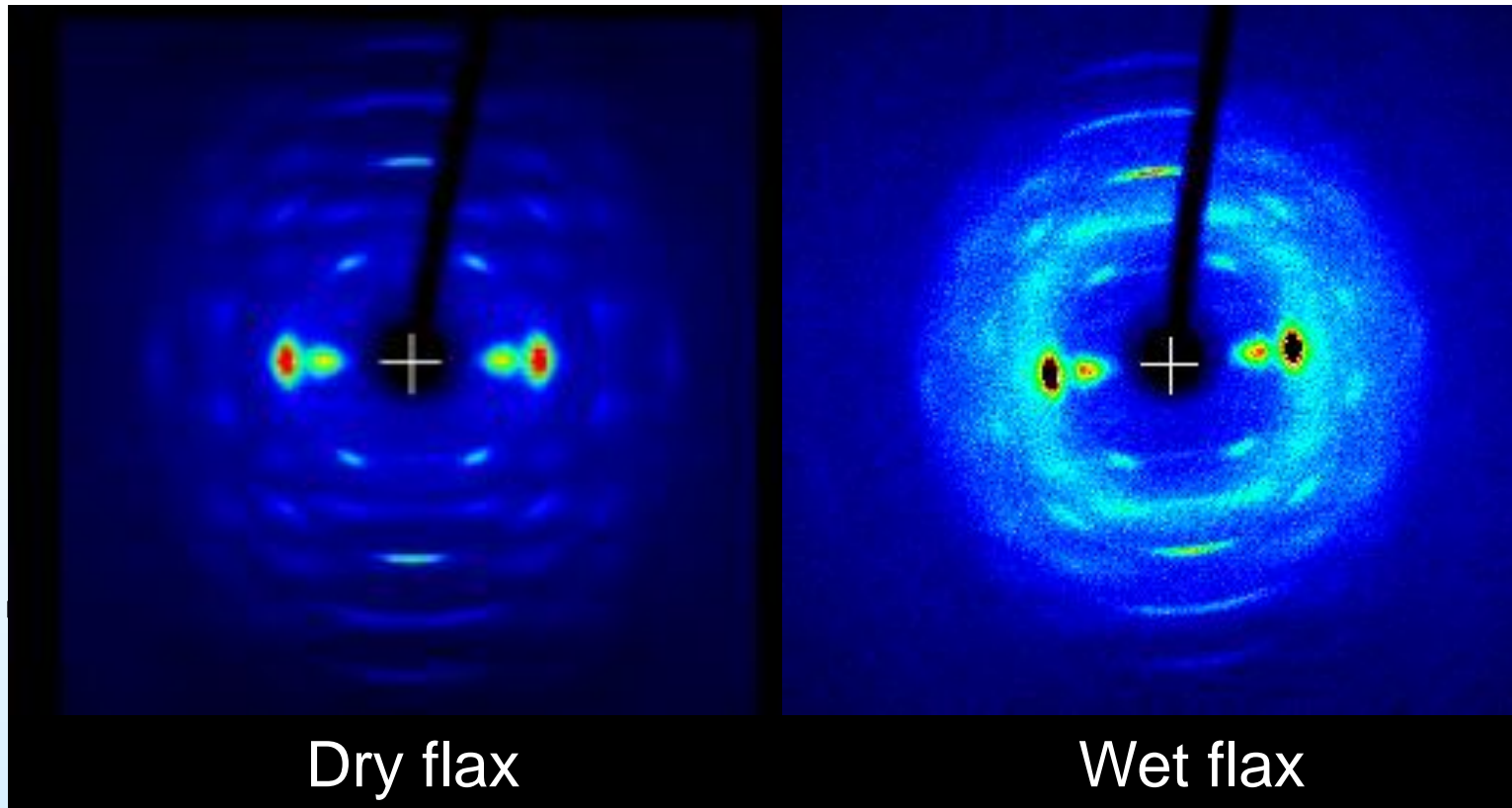


Hydration of the Nanoscale Structure of Sitka Spruce

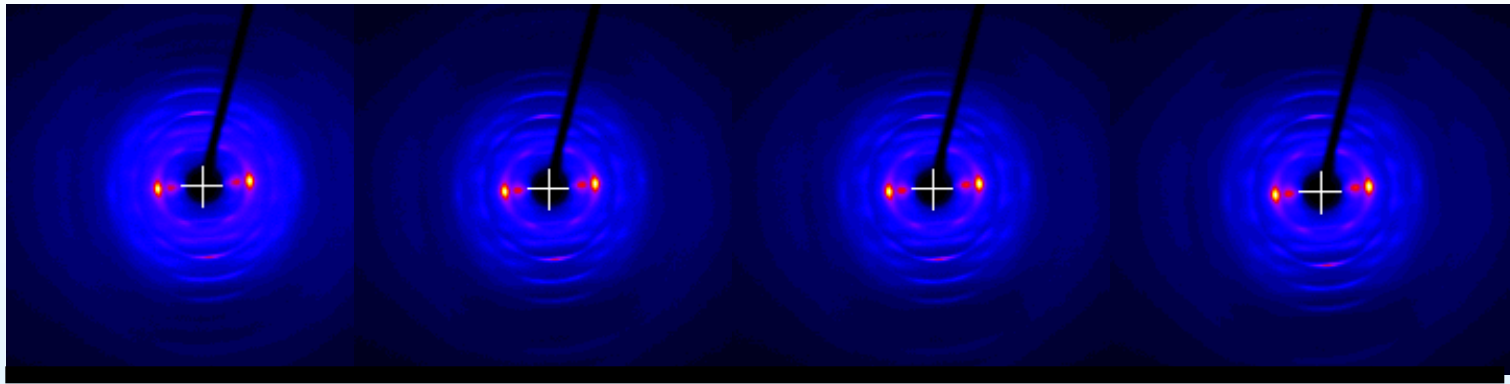
*Anwasha Fernandes, Lynne Thomas
and Michael Jarvis*



Fibre diffraction patterns from dry samples

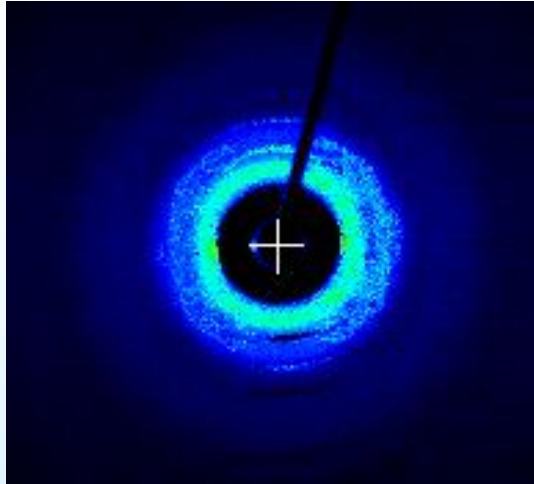


Hydrated fibres show quite intense annular scattering features attributable to water

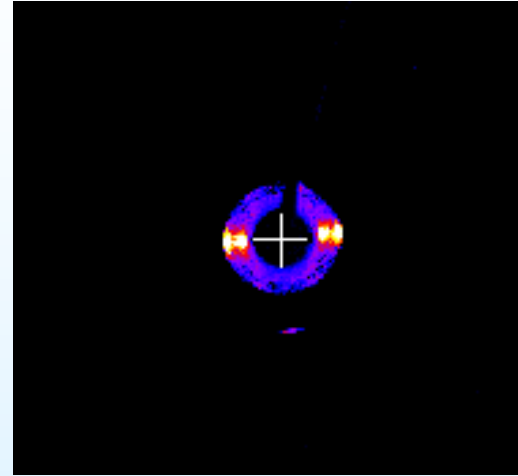


Wet spruce wood -----Dry

Hydrated fibres show quite intense annular scattering features attributable to water

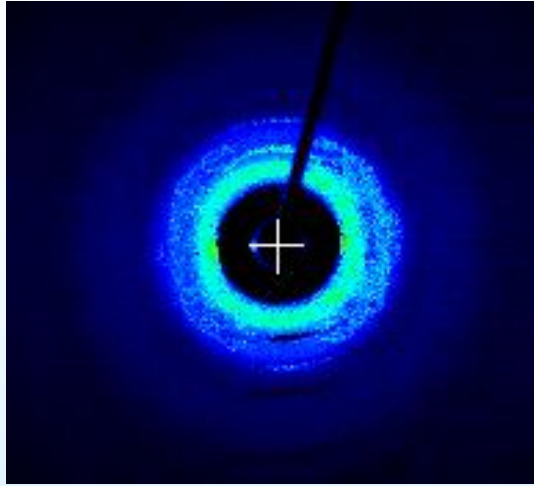


Wet-dry

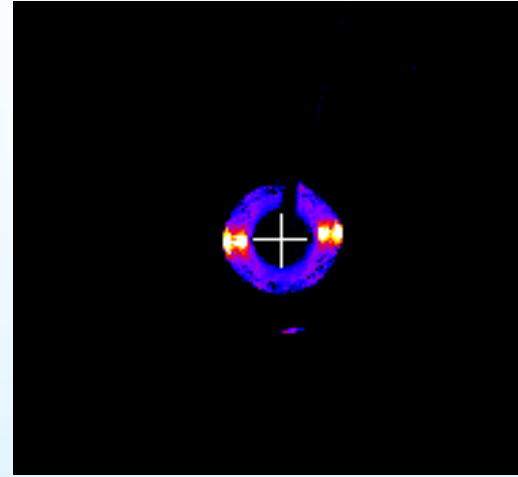


Dry-wet

(Wet-dry) subtraction images show characteristic features of scattering from water



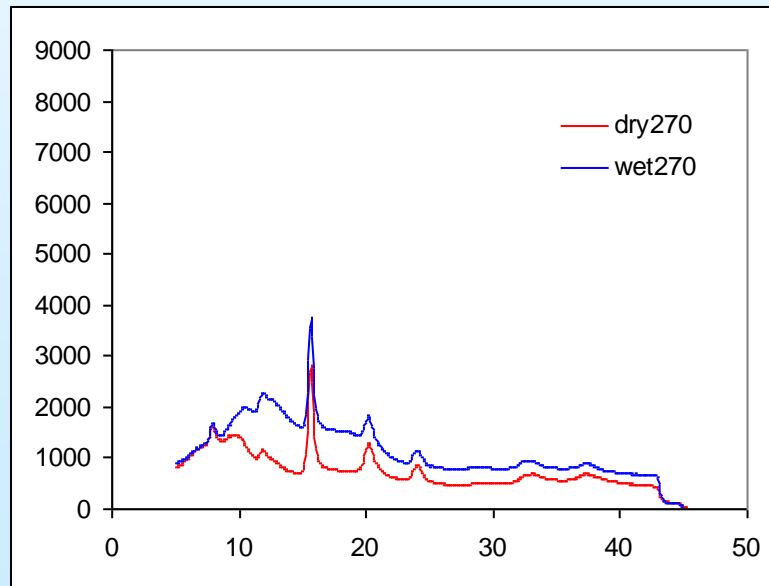
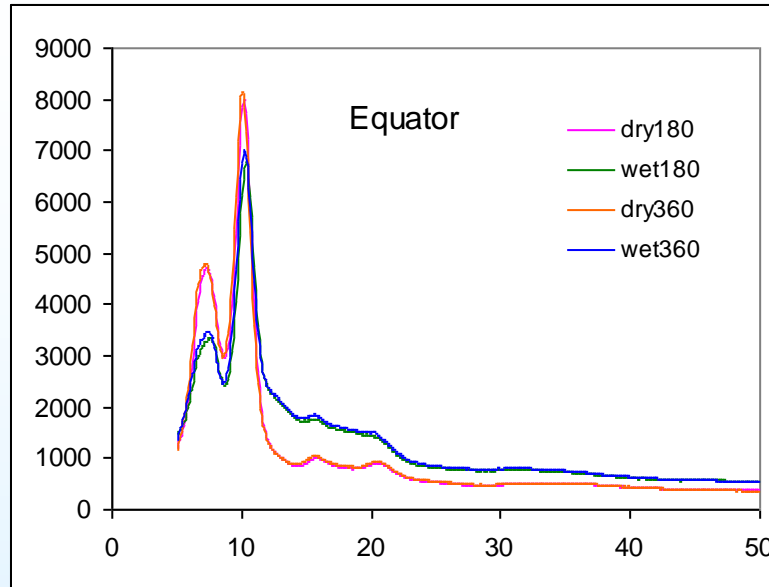
Wet-dry



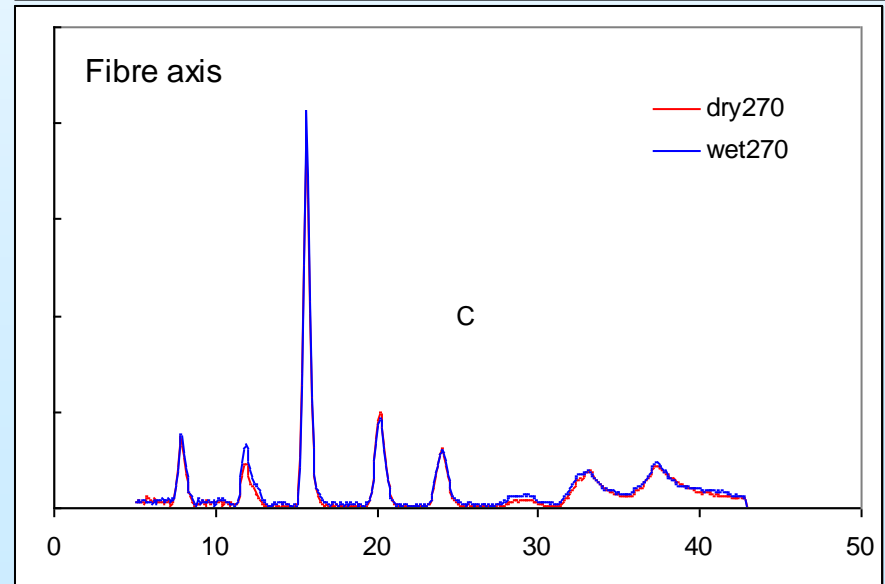
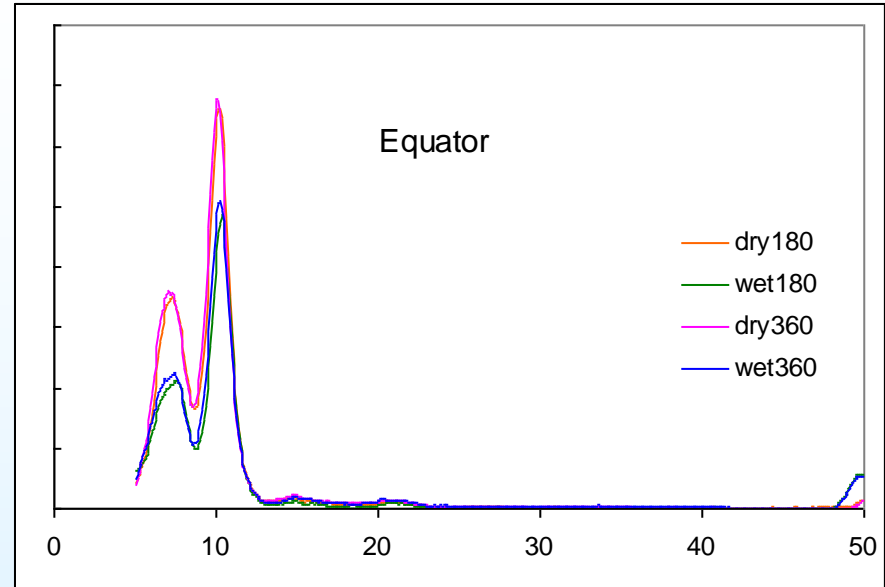
Dry-wet

(Dry-wet) subtraction images show extra intensity in equatorial and some other reflections from cellulose, plus low-intensity background from isotropic features at $d > 0.4$ nm (lignin plus any non-oriented hemicelluloses?)

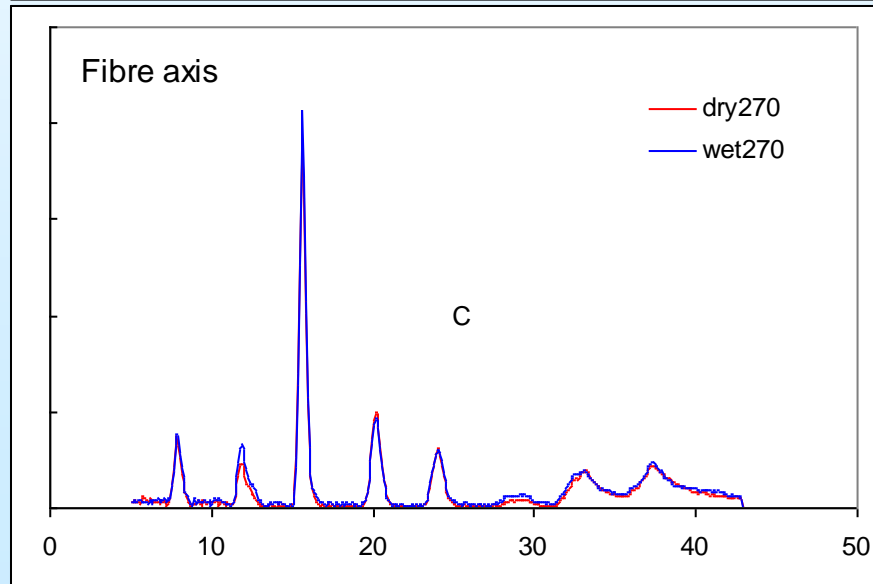
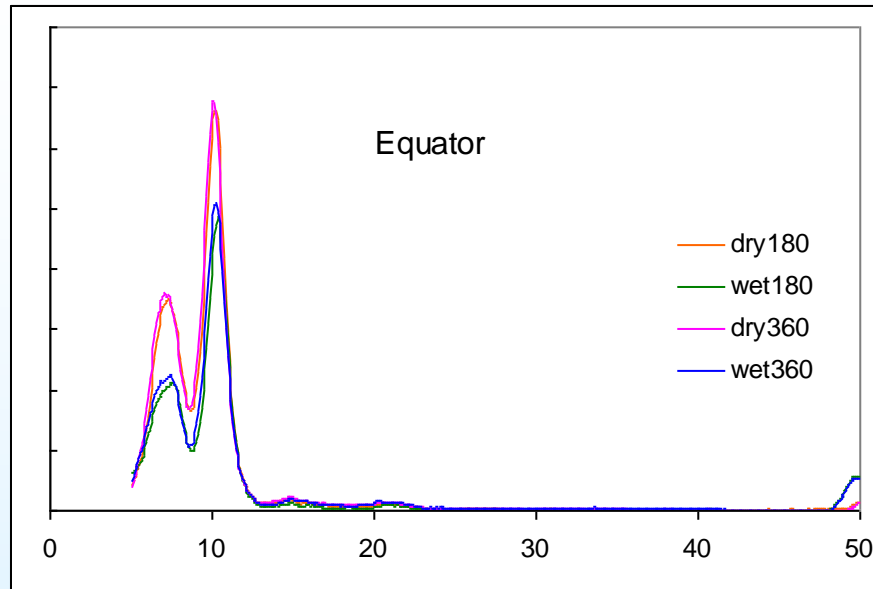
Scattering from water is readily visible in both equatorial and axial segments of the spruce diffraction pattern



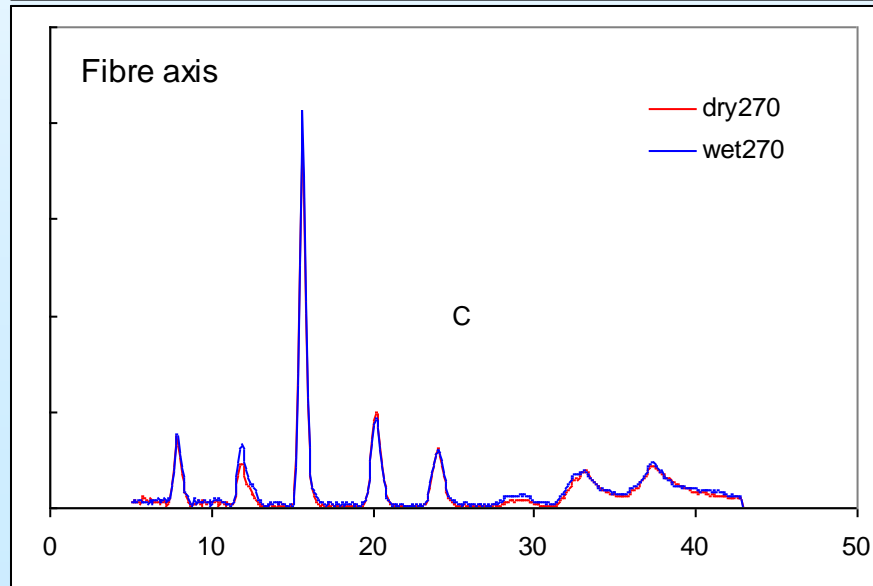
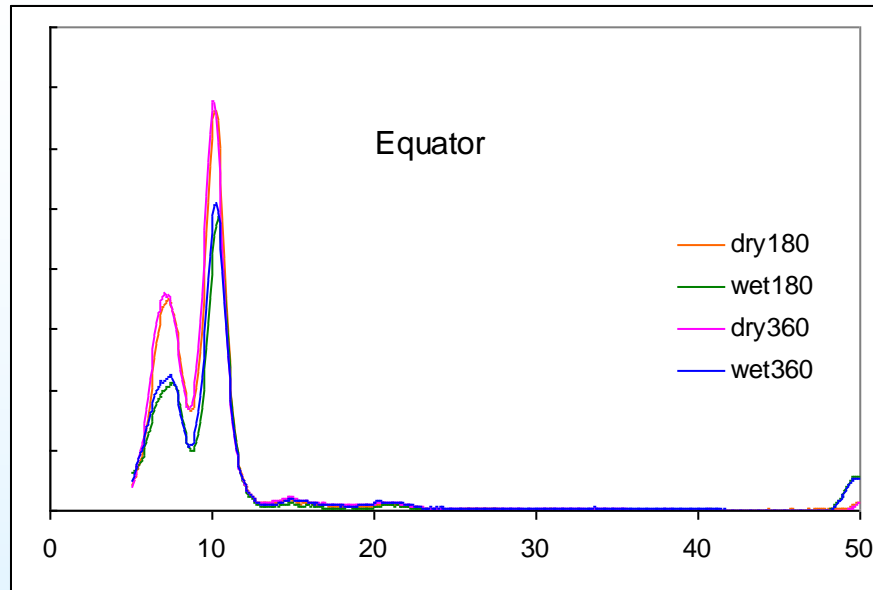
Water scattering contribution, together with differential isotropic scattering from lignin can be removed by subtracting a circularly symmetric background

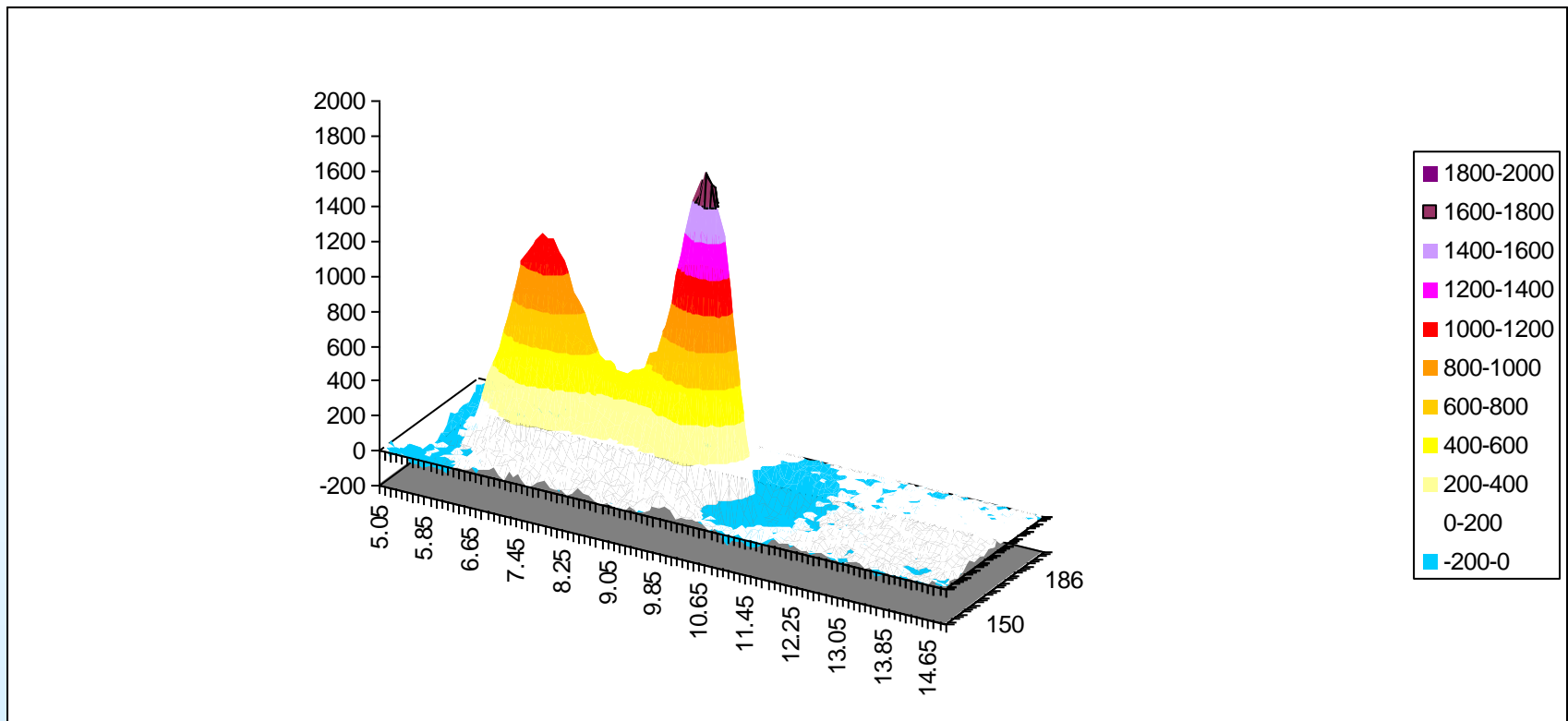


Dry and wet
diffraction
patterns are
then similar

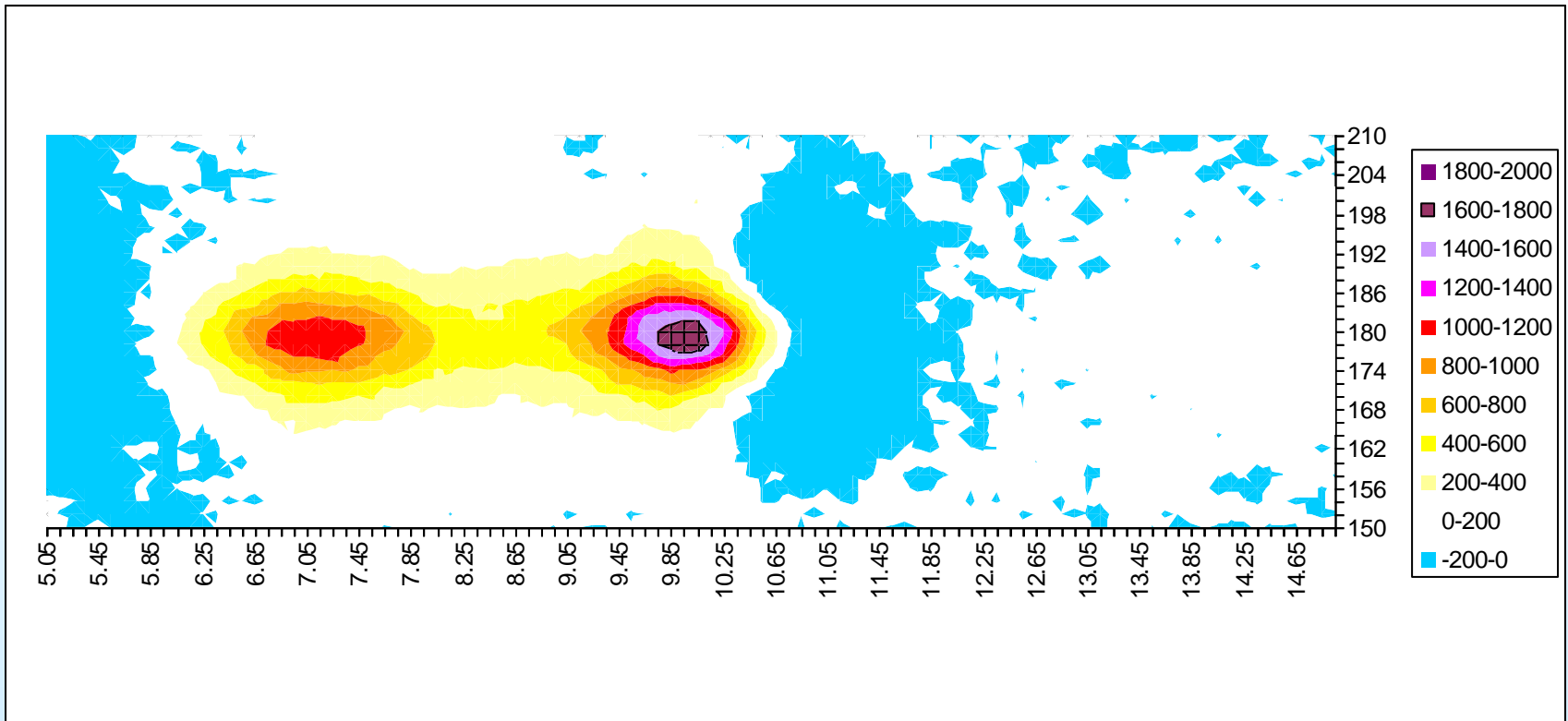


Dry and wet
diffraction
patterns are
then similar –
but not
identical





[Dry - wet] subtraction image shows general increase in scattering in equatorial region



[Dry – wet] subtraction image shows general increase in scattering in equatorial region

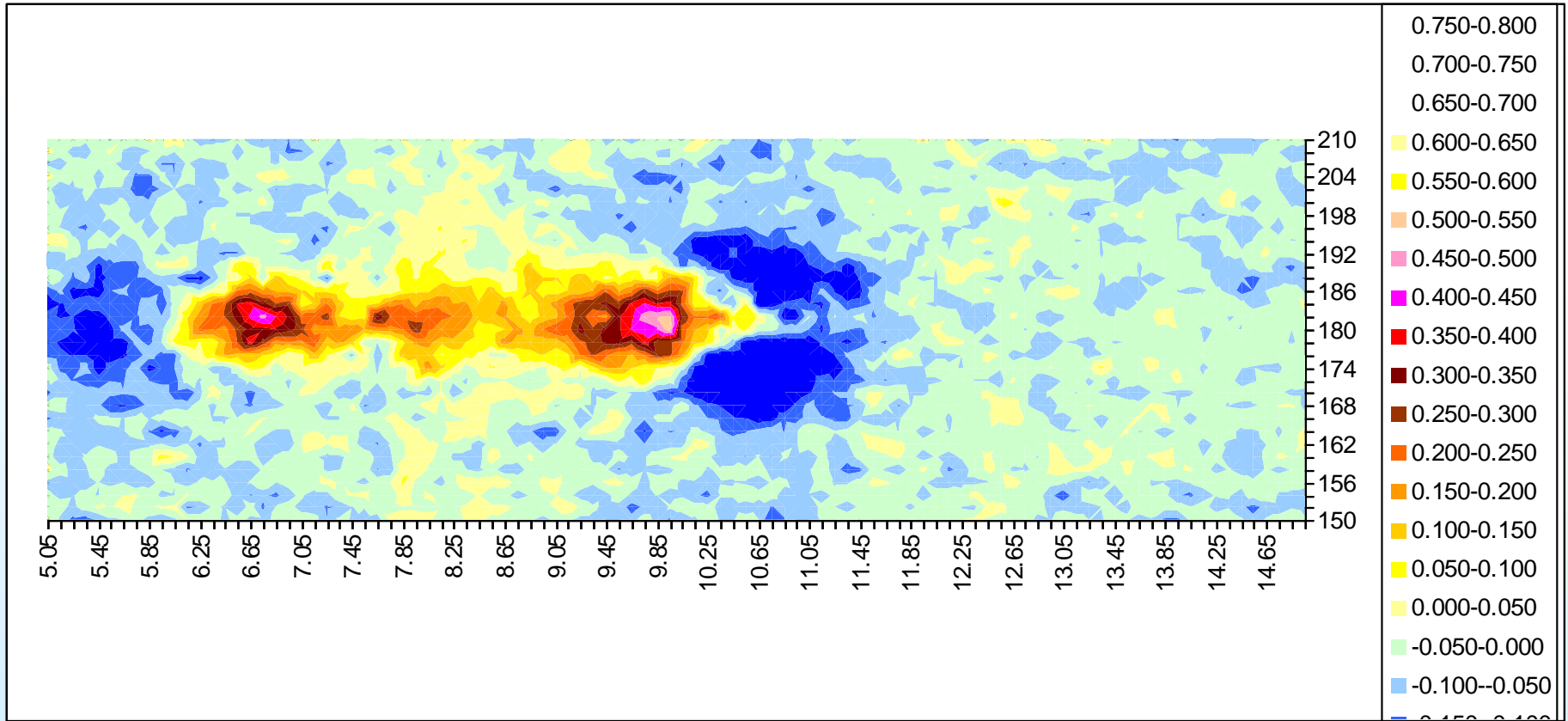
Effects of drying on equatorial scattering:

Increased overall intensity of 200, 1-10 and 110 peaks
(reduced thermal motion)

Slight increase in [200] d-spacing

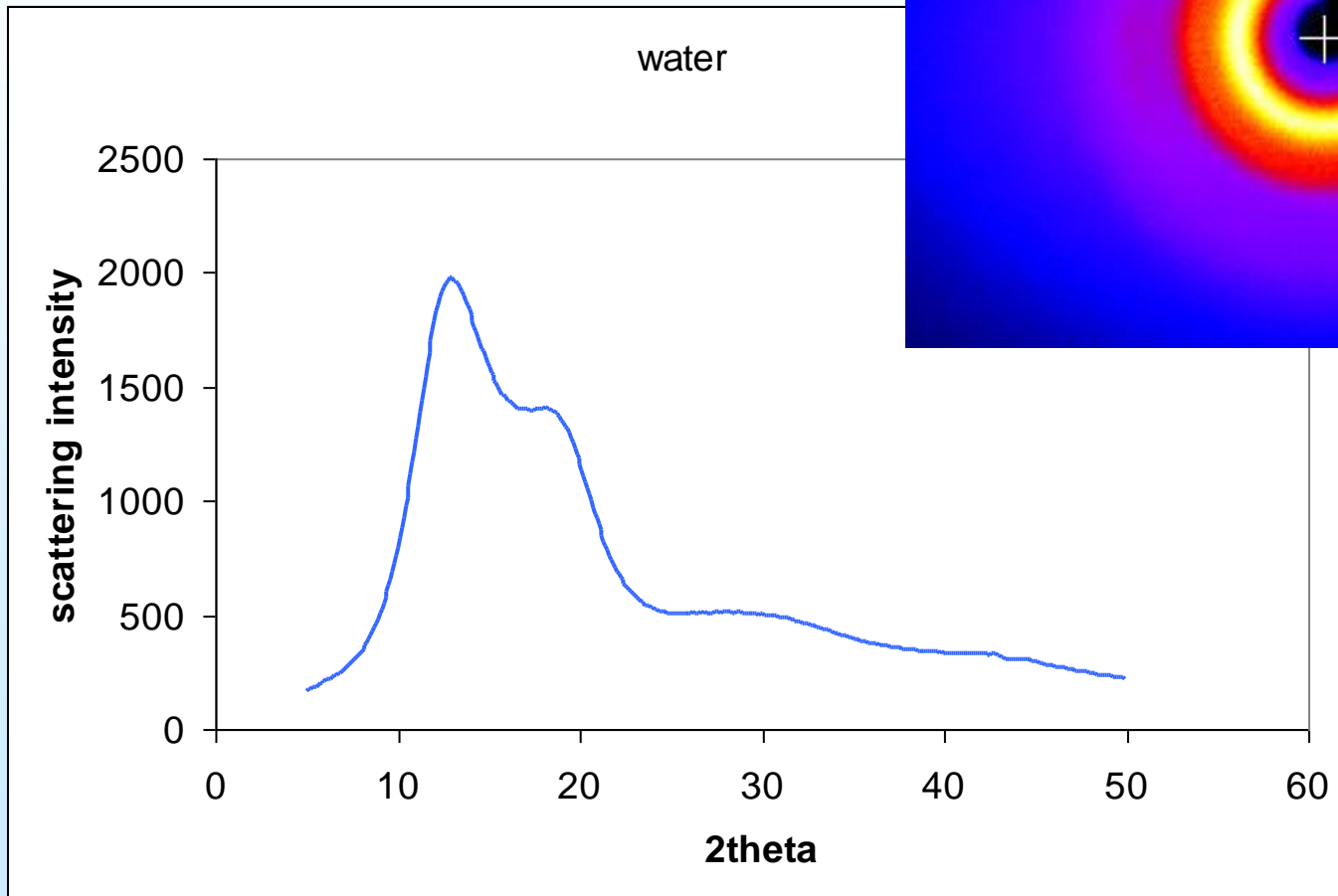
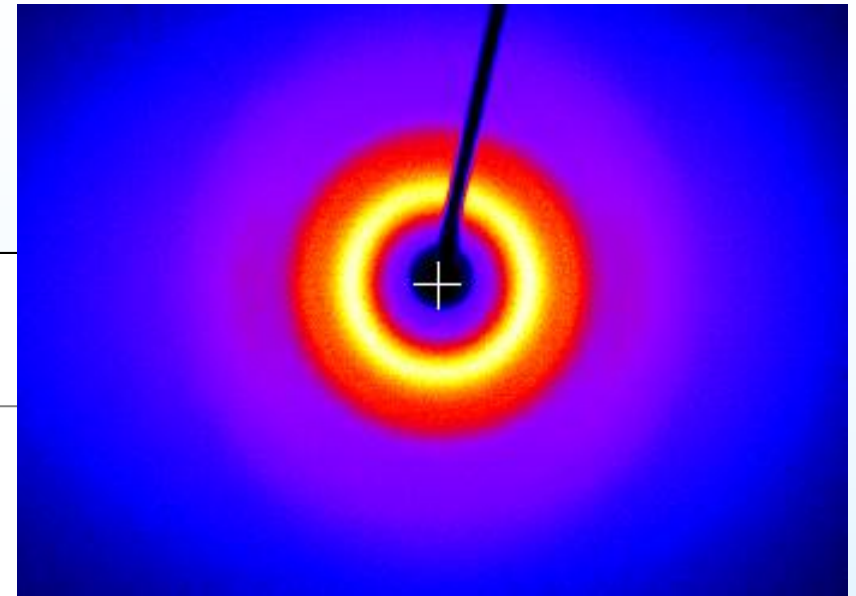
Closing up of 1-10 and 110 peaks (reduced monoclinic
angle)

Loss of a partially ordered component less oriented
than crystalline cellulose



Flax [dry – wet] subtraction image shows similar features. So partially ordered component lost on drying may be surface cellulose

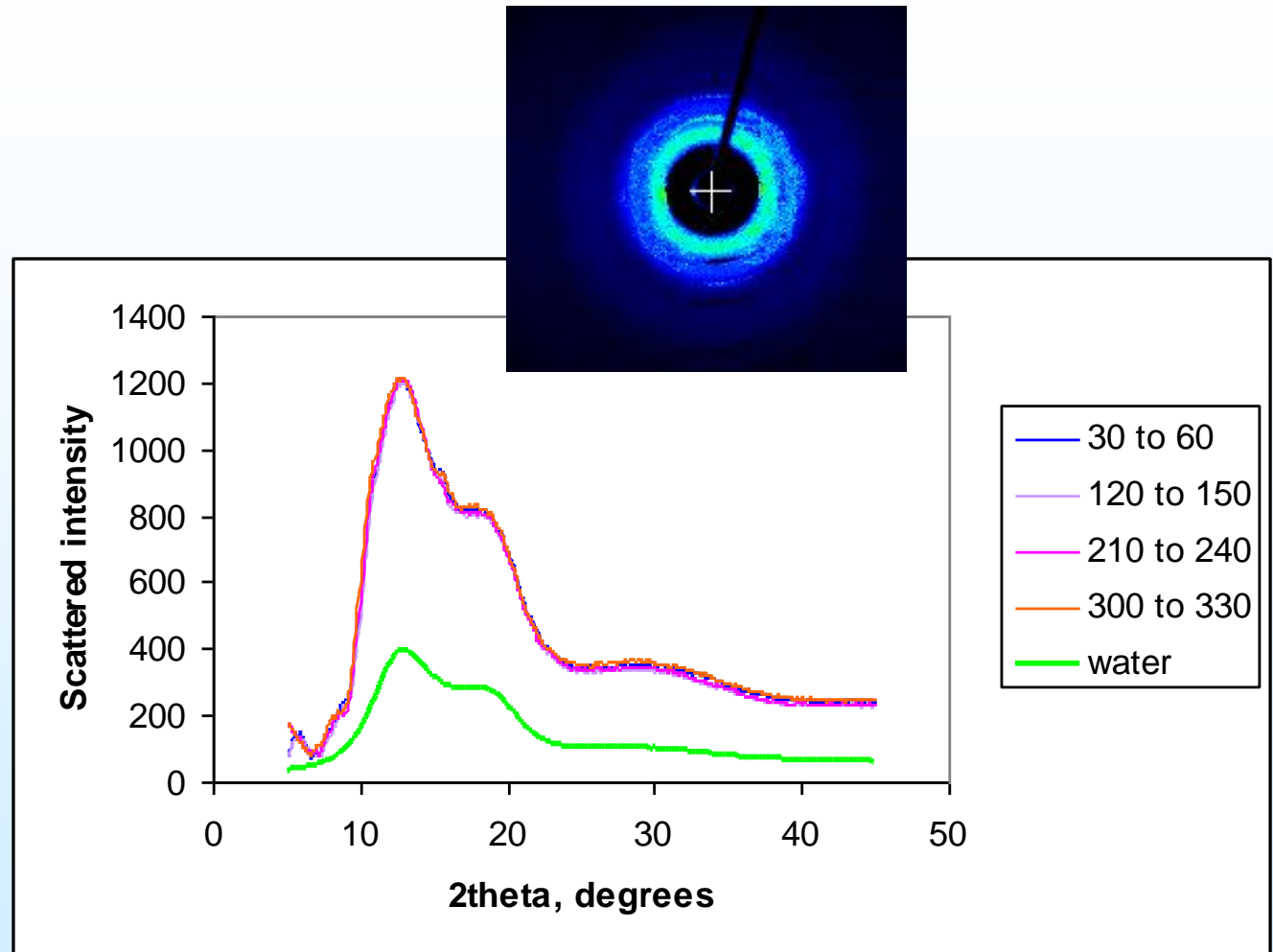
What does the water look like?



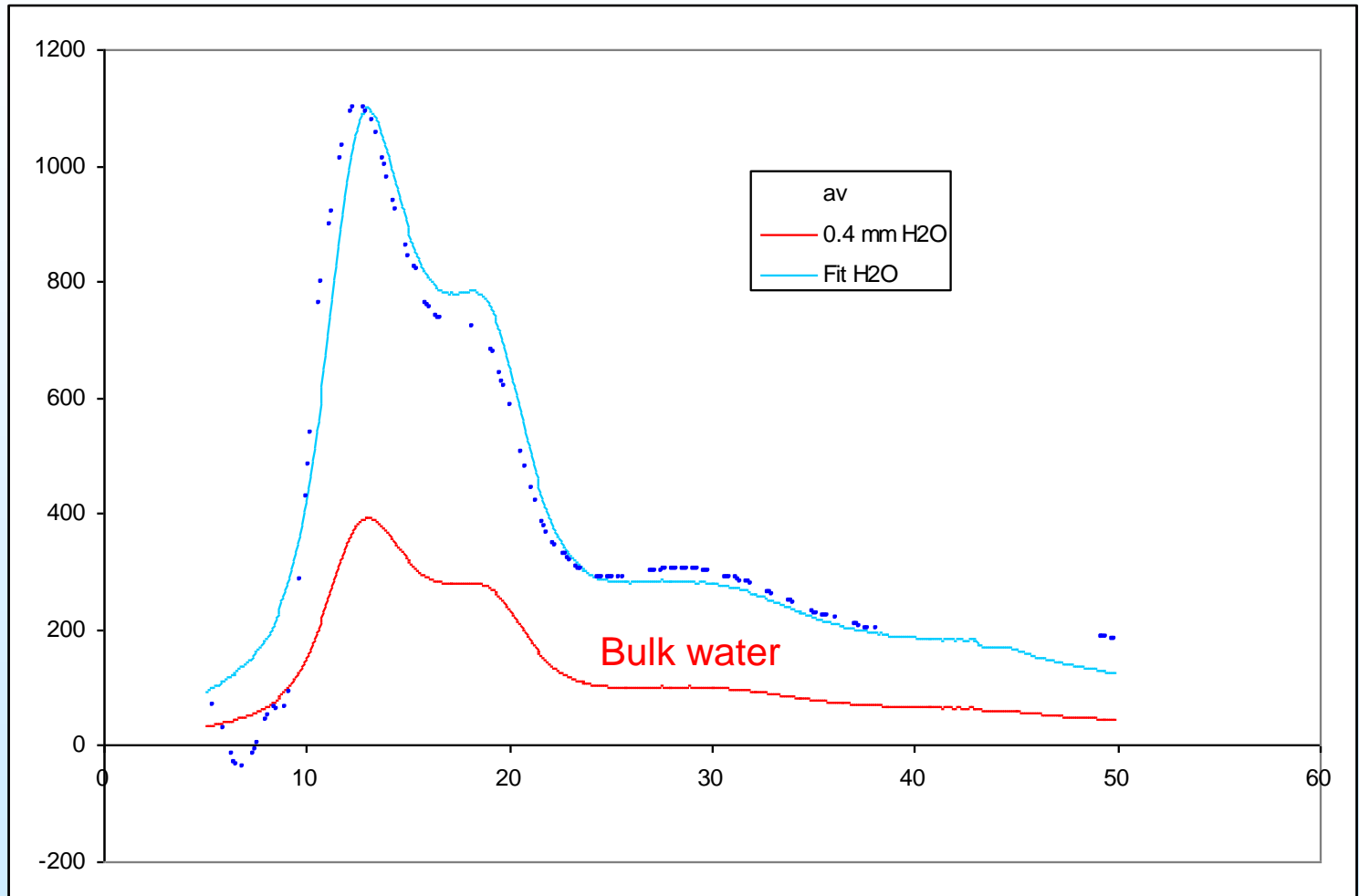
Bulk water

Radially
symmetric
scattering
profile –
(wet-dry)
spruce
wood.

Very like
liquid water
but greater
scattering
intensity

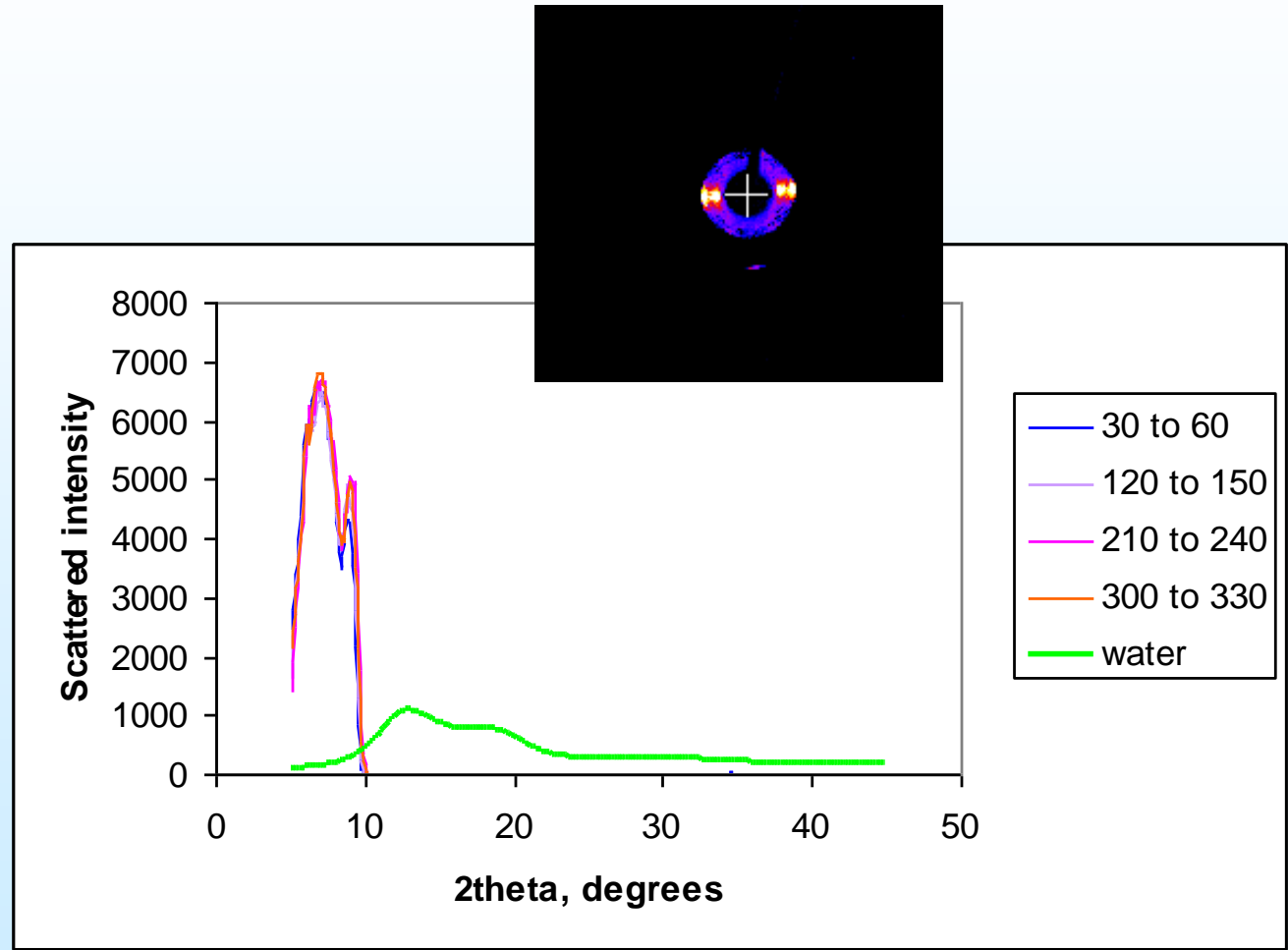


Similar data for celery collenchyma fibres



What do the isotropic polymers look like?

Radially
symmetric
scattering
profile –
(dry-wet)
spruce
wood -
Isotropic
wood
components
distinct from
crystalline
cellulose



Conclusions

Water, when present, contributes strongly to the diffraction patterns from wood

Wood polymers diffract more strongly when dry due to reduced thermal motion

Spruce microfibril structure is slightly altered on drying, with small changes in unit cell parameters and contraction of disordered, partially oriented components closer into the crystalline lattice

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