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Sketchnote summary of "50 years of neutron backscattering"

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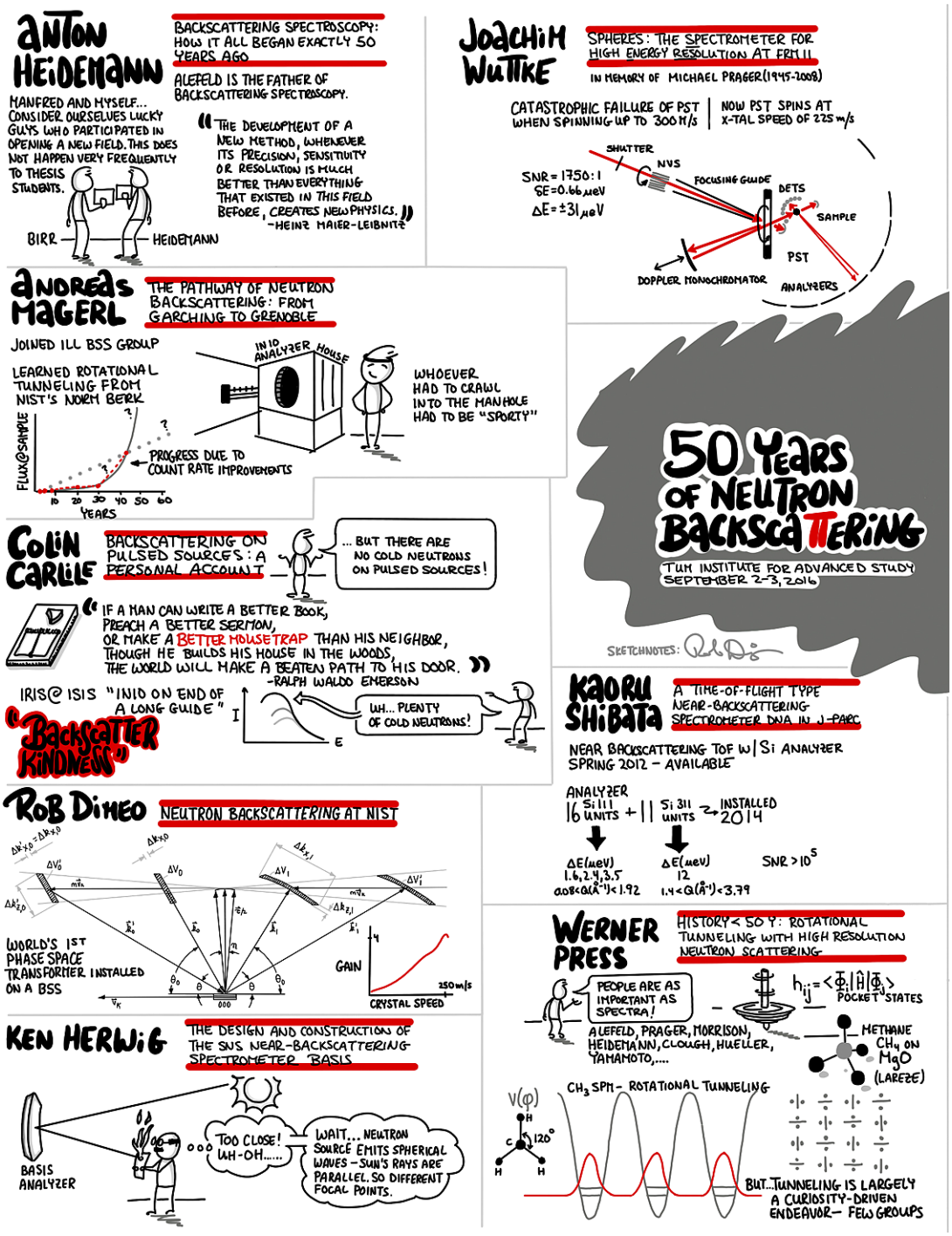
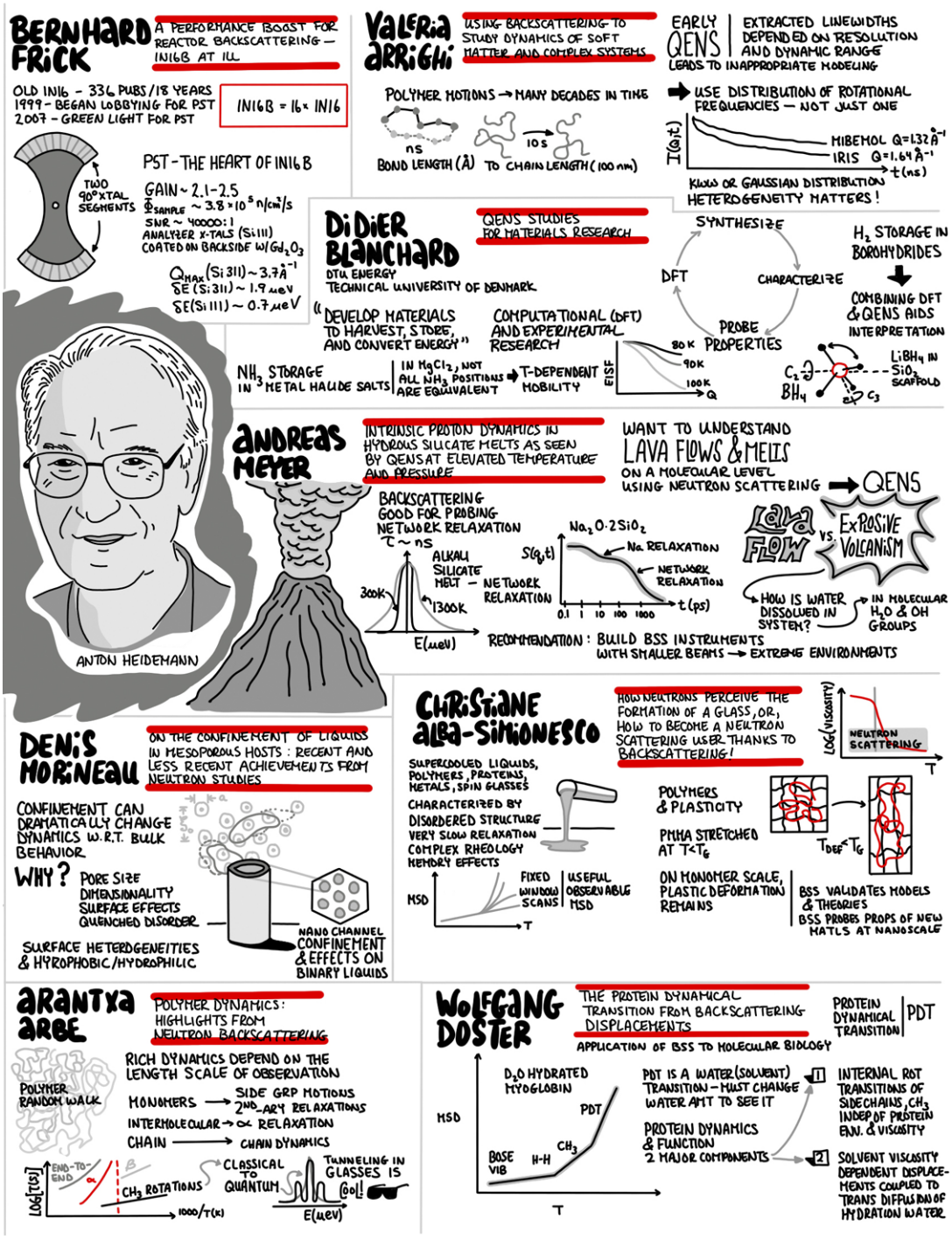
Abstract. A celebration to commemorate 50 years of neutron backscattering spectroscopy was held in Garching September 2–3, 2016. This event was marked with a series of exciting and informative presentations by practitioners of backscattering spectroscopy from around the world. This sketchnote summary presents highlights in visual form from the following topical sessions: *Historical Talks on Neutron Backscattering, Innovations in Backscattering, and Major Sciences Fields tackled with Backscattering*. This sketchnote is not meant to be a concise summary of the presentations but merely to include impressions, highlights, an important quote, something amusing and/or memorable, or anything that gives a small flavor of the presentation.

Keywords: Neutron scattering, neutron spectroscopy, backscattering, sketchnotes


ANTON HEIDEMANN
BACKSCATTERING SPECTROSCOPY: HOW IT ALL BEGAN EXACTLY 50 YEARS AGO
ALEFELD IS THE FATHER OF BACKSCATTERING SPECTROSCOPY.
MANFRED AND MYSELF... CONSIDER OURSELVES LUCKY GUYS WHO PARTICIPATED IN OPENING A NEW FIELD. THIS DOES NOT HAPPEN VERY FREQUENTLY TO THESIS STUDENTS.
"THE DEVELOPMENT OF A NEW METHOD, WHENEVER ITS PRECISION, SENSITIVITY OR RESOLUTION IS MUCH BETTER THAN EVERYTHING THAT EXISTED IN THIS FIELD BEFORE, CREATES NEW PHYSICS." -HEINZ MAIER-LEIBNITZ
BIRR
HEIDEMANN
JOACHIM WUTTKE
SPHERES: THE SPECTROMETER FOR HIGH ENERGY RESOLUTION AT FRM II
IN MEMORY OF MICHAEL PRAGER (1945-2008)
CATASTROPHIC FAILURE OF PST WHEN SPINNING UP TO 300 M/S
NOW PST SPINS AT X-TAL SPEED OF 225 m/s
SHUTTER
NVS
FOCUSING GUIDE
DETS
SAMPLE
PST
DOPPLER MONOCHROMATOR
ANALYZERS
SNR = 1750:1
δE = 0.66 μeV
ΔE = ±31 μeV
ANDREAS MAGERL
THE PATHWAY OF NEUTRON BACKSCATTERING: FROM GARCHING TO GRENOBLE
JOINED ILL BSS GROUP
LEARNED ROTATIONAL TUNNELING FROM NIST'S NORM BERK
FLUX@SAMPLE
YEARS
PROGRESS DUE TO COUNT RATE IMPROVEMENTS
IN10 ANALYZER HOUSE
WHOEVER HAD TO CRAWL INTO THE MANHOLE HAD TO BE "SPORTY"
50 YEARS OF NEUTRON BACKSCATTERING
TUM INSTITUTE FOR ADVANCED STUDY
SEPTEMBER 2-3, 2016
SKETCHNOTES:
COLIN CARLILE
BACKSCATTERING ON PULSED SOURCES: A PERSONAL ACCOUNT
... BUT THERE ARE NO COLD NEUTRONS ON PULSED SOURCES!
"IF A MAN CAN WRITE A BETTER BOOK, PREACH A BETTER SERMON, OR MAKE A BETTER MOUSETRAP THAN HIS NEIGHBOR, THOUGH HE BUILDS HIS HOUSE IN THE WOODS, THE WORLD WILL MAKE A BEATEN PATH TO HIS DOOR." -RALPH WALDO EMERSON
IRIS@ISIS "IN10 ON END OF A LONG GUIDE"
"BACKSCATTER KINDNESS"
I
E
UH... PLENTY OF COLD NEUTRONS!
KAORU SHIBATA
A TIME-OF-FLIGHT TYPE NEAR-BACKSCATTERING SPECTROMETER DNA IN J-PARC
NEAR BACKSCATTERING TOF W|Si ANALYZER SPRING 2012 - AVAILABLE
ANALYZER
16 Si111 UNITS + 11 Si 311 UNITS → INSTALLED 2014
ΔE(meV) 1.6, 2.4, 3.5
0.08<Q(Å⁻¹)<1.92
ΔE(meV) 12
1.4<Q(Å⁻¹)<3.79
SNR > 10⁵
ROB DIMEO
NEUTRON BACKSCATTERING AT NIST
WORLD'S 1ST PHASE SPACE TRANSFORMER INSTALLED ON A BSS
GAIN
250 m/s
CRYSTAL SPEED
WERNER PRESS
HISTORY < 50 Y: ROTATIONAL TUNNELING WITH HIGH RESOLUTION NEUTRON SCATTERING
PEOPLE ARE AS IMPORTANT AS SPECTRA!
ALEFELD, PRAGER, MORRISON, HEIDEMANN, CLOUGH, HUELLER, YAMAMOTO,....
$h_{ij} = \langle \Phi_i | \hat{H} | \Phi_j \rangle$
POCKET STATES
METHANE CH_4 ON MgO (LARGE)
CH_3 SPM - ROTATIONAL TUNNELING
V(φ)
120°
BUT... TUNNELING IS LARGELY A CURIOSITY-DRIVEN ENDEAVOR - FEW GROUPS
KEN HERWIG
THE DESIGN AND CONSTRUCTION OF THE SNS NEAR-BACKSCATTERING SPECTROMETER, BASIS
BASIS ANALYZER
TOO CLOSE! UH-OH.....
WAIT... NEUTRON SOURCE EMITS SPHERICAL WAVES - SUN'S RAYS ARE PARALLEL. SO DIFFERENT FOCAL POINTS.


BERNHARD FRICK
A PERFORMANCE BOOST FOR REACTOR BACKSCATTERING — IN16B AT ILL
OLD IN16 - 336 PUBS/18 YEARS
1999 - BEGAN LOBBYING FOR PST
2007 - GREEN LIGHT FOR PST
IN16B = 16× IN16
TWO 90° XTAL SEGMENTS
PST - THE HEART OF IN16B
GAIN ~ 2.1-2.5
Φ SAMPLE ~ 3.8×10^5 n/cm²/s
SNR ~ 40000:1
ANALYZER X-TALS (Si111) COATED ON BACKSIDE W/ Gd2O3
Q MAX (Si 311) ~ 3.7 Å^-1
δE (Si 311) ~ 1.9 μeV
δE (Si 111) ~ 0.7 μeV
ANTON HEIDEMANN
VALERIA ARRIGHI
USING BACKSCATTERING TO STUDY DYNAMICS OF SOFT MATTER AND COMPLEX SYSTEMS
POLYMER MOTIONS → MANY DECADES IN TIME
ns
10s
BOND LENGTH (Å)
TO CHAIN LENGTH (100 nm)
EARLY QENS | EXTRACTED LINEWIDTHS DEPENDED ON RESOLUTION AND DYNAMIC RANGE LEADS TO INAPPROPRIATE MODELING
USE DISTRIBUTION OF ROTATIONAL FREQUENCIES — NOT JUST ONE
I(Q,t)
MIBEMOL Q=1.32 Å^-1
IRIS Q=1.64 Å^-1
t (ns)
KWW OR GAUSSIAN DISTRIBUTION
HETEROGENEITY MATTERS!
DIDIER BLANCHARD
QENS STUDIES FOR MATERIALS RESEARCH
DTU ENERGY
TECHNICAL UNIVERSITY OF DENMARK
"DEVELOP MATERIALS TO HARVEST, STORE, AND CONVERT ENERGY"
COMPUTATIONAL (DFT) AND EXPERIMENTAL RESEARCH
SYNTHESIZE
CHARACTERIZE
PROBE PROPERTIES
DFT
H2 STORAGE IN BOROHYDRIDES
COMBINING DFT & QENS AIDS INTERPRETATION
NH3 STORAGE IN METAL HALIDE SALTS
IN MgCl2, NOT ALL NH3 POSITIONS ARE EQUIVALENT
T-DEPENDENT MOBILITY
80K
90K
100K
Q
EISF
C2
BH4
C3
LiBH4 IN SiO2 SCAFFOLD
ANDREAS MEYER
INTRINSIC PROTON DYNAMICS IN HYDROUS SILICATE MELTS AS SEEN BY QENS AT ELEVATED TEMPERATURE AND PRESSURE
WANT TO UNDERSTAND LAVA FLOWS & MELTS ON A MOLECULAR LEVEL USING NEUTRON SCATTERING → QENS
BACKSCATTERING GOOD FOR PROBING NETWORK RELAXATION
τ ~ ns
ALKALI SILICATE MELT — NETWORK RELAXATION
300K
1300K
E(meV)
Na2O·2SiO2
Na RELAXATION
NETWORK RELAXATION
S(Q,t)
0.1 1 10 100 1000
t (ps)
LAVA FLOW vs. EXPLOSIVE VOLCANISM
HOW IS WATER DISSOLVED IN SYSTEM?
IN MOLECULAR H2O & OH GROUPS
RECOMMENDATION: BUILD BSS INSTRUMENTS WITH SMALLER BEAMS → EXTREME ENVIRONMENTS
DENIS MORINEAU
ON THE CONFINEMENT OF LIQUIDS IN MESOPOROUS HOSTS: RECENT AND LESS RECENT ACHIEVEMENTS FROM NEUTRON STUDIES
CONFINEMENT CAN DRAMATICALLY CHANGE DYNAMICS W.R.T. BULK BEHAVIOR
WHY?
PORE SIZE
DIMENSIONALITY
SURFACE EFFECTS
QUENCHED DISORDER
SURFACE HETEROGENEITIES & HYDROPHOBIC/HYDROPHILIC
NANO CHANNEL CONFINEMENT & EFFECTS ON BINARY LIQUIDS
CHRISTIANE ALBA-SIMIONESCO
HOW NEUTRONS PERCEIVE THE FORMATION OF A GLASS, OR, HOW TO BECOME A NEUTRON SCATTERING USER THANKS TO BACKSCATTERING!
SUPERCOOLED LIQUIDS, POLYMERS, PROTEINS, METALS, SPIN GLASSES
CHARACTERIZED BY
DISORDERED STRUCTURE
VERY SLOW RELAXATION
COMPLEX RHEOLOGY
MEMORY EFFECTS
MSD
T
FIXED WINDOW SCANS | USEFUL OBSERVABLE MSD
LOG(VISCOSITY)
NEUTRON SCATTERING
T
POLYMERS & PLASTICITY
PMMA STRETCHED AT T<Tg
TDEF<TG
ON MONOMER SCALE, PLASTIC DEFORMATION REMAINS
BSS VALIDATES MODELS & THEORIES
BSS PROBES PROPS OF NEW MATLS AT NANOSCALE
ARANTXA ARBE
POLYMER DYNAMICS: HIGHLIGHTS FROM NEUTRON BACKSCATTERING
POLYMER RANDOM WALK
RICH DYNAMICS DEPEND ON THE LENGTH SCALE OF OBSERVATION
MONOMERS → SIDE GRP MOTIONS 2ND-ARY RELAXATIONS
INTERMOLECULAR → α RELAXATION
CHAIN → CHAIN DYNAMICS
LOG[τ(s)]
END-TO-END
α
β
CH3 ROTATIONS
CLASSICAL TO QUANTUM
TUNNELING IN GLASSES IS Cool!
1000/T(K)
E(meV)
WOLFGANG DOSTER
THE PROTEIN DYNAMICAL TRANSITION FROM BACKSCATTERING DISPLACEMENTS
APPLICATION OF BSS TO MOLECULAR BIOLOGY
PROTEIN DYNAMICAL TRANSITION | PDT
D2O HYDRATED MYOGLOBIN
MSD
PDT
CH3
BOSE VIB
H-H
T
PDT IS A WATER (SOLVENT) TRANSITION — MUST CHANGE WATER AMT TO SEE IT
PROTEIN DYNAMICS & FUNCTION 2 MAJOR COMPONENTS
1 INTERNAL ROT TRANSITIONS OF SIDECHAINS, CH3 INDEP OF PROTEIN ENV. & VISCOSITY
2 SOLVENT VISCOSITY DEPENDENT DISPLACEMENTS COUPLED TO TRANS DIFFUSION OF HYDRATION WATER