IXS2022

The 12th International Conference on Inelastic X-ray Scattering

Opening Remarks
Andrew Harrison, Diamond Light Source

Monday 22nd August 2022

diamond

IXS2022 – the long and winding road

- IXS International Conference series started in Krakow in 1992, covering Compton Scattering and non-resonant inelastic hard X-ray scattering, with soft X-ray resonant scattering introduced about 10 years ago and now the dominant subject
- Diamond originally bid to host the IXS conference in 2013 – and the first time for the UK - led by Ke-Jin Zhou
- Originally planned to be held in 2021, but due to the pandemic it was decided to postpone to 2022 to ensure in-person participation
- This week we welcome 120 delegates from 14 different countries
- Two thirds of the audience have travelled from Europe and further abroad to be here – thank you !

Auspicious timing: 75 years of synchrotron radiation

Radiation from Electrons in a Synchrotron

F. R. Elder, A. M. Gurewitsch, R. V. Langmuir,
and H. C. Pollock
*Research Laboratory, General Electric Company,
Schenectady, New York*
May 7, 1947

HIGH energy electrons which are subjected to large accelerations normal to their velocity should radiate electromagnetic energy.[1-4] The radiation from electrons in a betatron or synchrotron should be emitted in a narrow cone tangent to the electron orbit, and its spectrum should extend into the visible region. This radiation has now been observed visually in the General Electric 70-Mev synchrotron.[5] This machine has an electron orbit radius of 29.3 cm and a peak magnetic field of 8100 gausses. The radiation is seen as a small spot of brilliant white light by an observer looking into the vacuum tube tangent to the orbit and toward the approaching electrons. The light is quite bright when the x-ray output of the machine at 70 Mev is 50 roentgens per minute at one meter from the target and can still be observed in daylight at outputs as low as 0.1 roentgen.

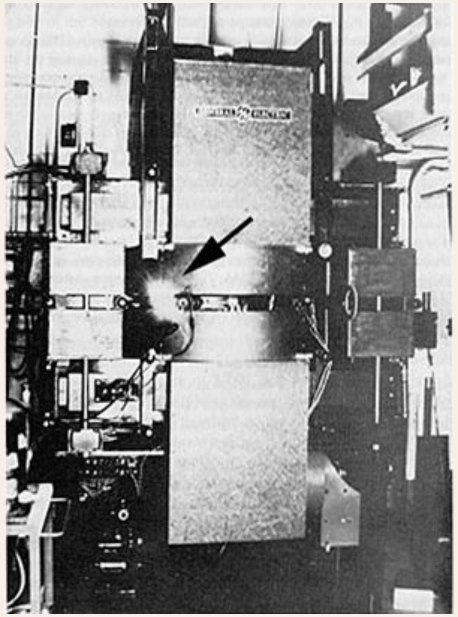
The synchrotron x-ray beam is obtained by turning off the r-f accelerating resonator and permitting subsequent changes in the field of the magnet to change the electron orbit radius so as to contract or expand the beam to suitable targets. If the electrons are contracted to a target at successively higher energies, the intensity of the light radiation is observed to increase rapidly with electron energy. If, however, the electrons are kept in the beam past the peak of the magnetic field and then expanded to a target, the intensity of the radiated light appears to be independent of the energy at which the electrons are removed from the beam. This is to be expected, for in a given machine the radiation is proportional to the fourth power of the electron energy. The light radiation is not observed if the beam is contracted before its energy is about 30 Mev. When the electron beam has been accelerated to the peak of the magnetic field and then decelerated to low energy, a rough measurement of the phase angle over which the light was visible gave a value of 90–100 degrees. The light was viewed through a slotted disk rotating at synchronous speed.

If the r-f resonator is turned off a short time before the peak of the magnetic field, the electron beam slowly contracts to a radius just larger than that of the interior target and then expands as the magnetic field decreases. In this case, the observer no longer sees a single point of light but a short line with extension in the plane of the orbit.

The light emitted from the beam is polarized with the electric vector parallel to the plane of the electron orbit. It disappears as the observer rotates a piece of Polaroid before the eye through ninety degrees. An investigation of the spectral distribution of the energy is in progress and will be reported.

This work has been supported by the Office of Naval Research under contract N5ori–178.

[1] D. Iwanenko and I. Pomeranchuk, Phys. Rev. **65**, 343 (1944).
[2] J. P. Blewett, Phys. Rev. **69**, 87 (1946).
[3] L. I. Schiff, Rev. Sci. Inst. **17**, 6 (1946).
[4] J. S. Schwinger, Phys. Rev. **70**, 798 (1946).
[5] H. C. Pollock *et al.*, Phys. Rev. **70**, 798 (1946).



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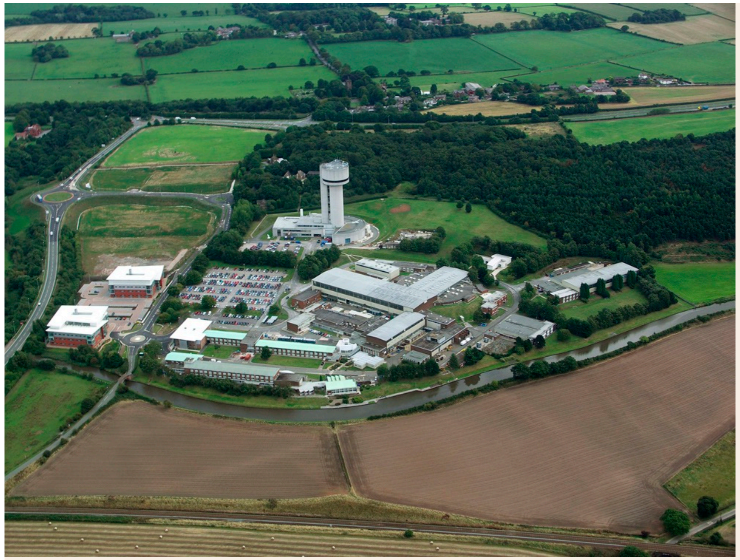

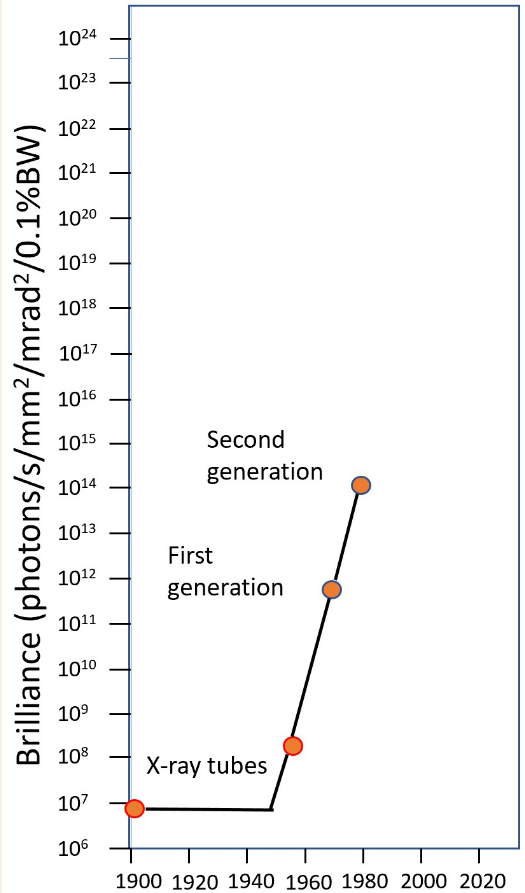

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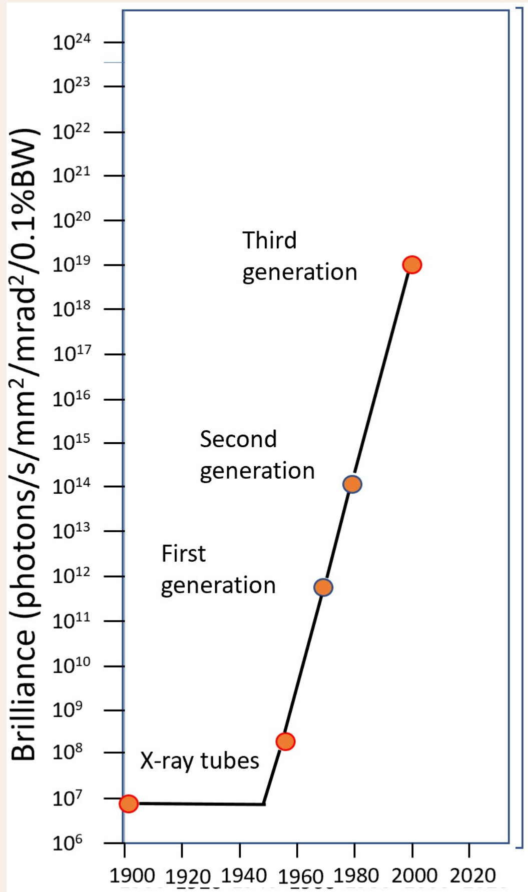

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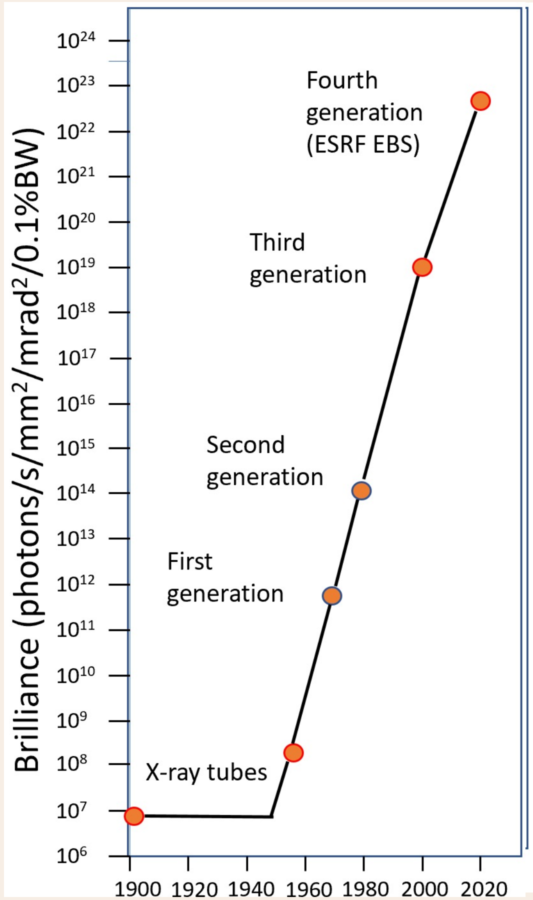

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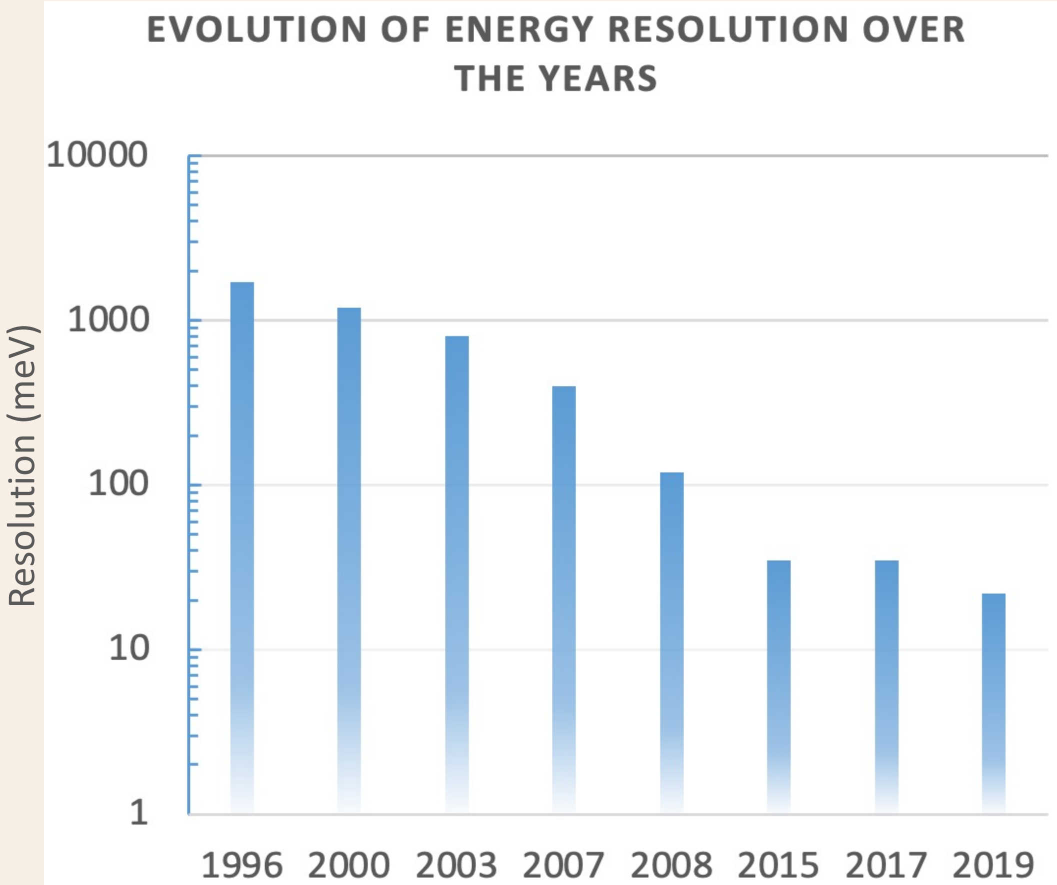
Impossible measurements….

"When a crystal is irradiated with X-rays, the processes of photoelectric absorption and fluorescence are no doubt accompanied by absorption and emission of phonons. The energy changes involved are however so large compared with phonon energies that information about phonon spectrum of the crystal cannot be obtained in this way. The same is true for Compton scattering."[1] W.Cochran, 1966.

Impossible measurements…become possible



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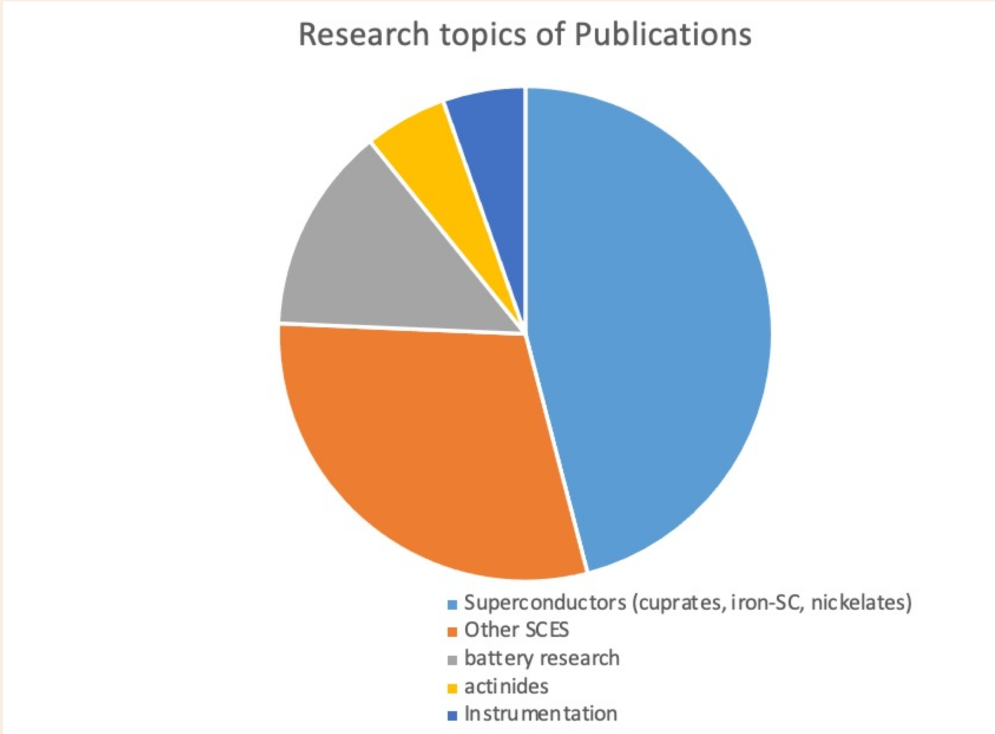
Broadening reach of science

- Quantum Materials I, II and III
- Functional Materials
- Energy and Catalytic Materials
- Time Domain Spectroscopy
- Novel Instruments and Methods
- Soft Extreme Conditions



Melting of charge order by quantum fluctuations in cuprates

nature physics

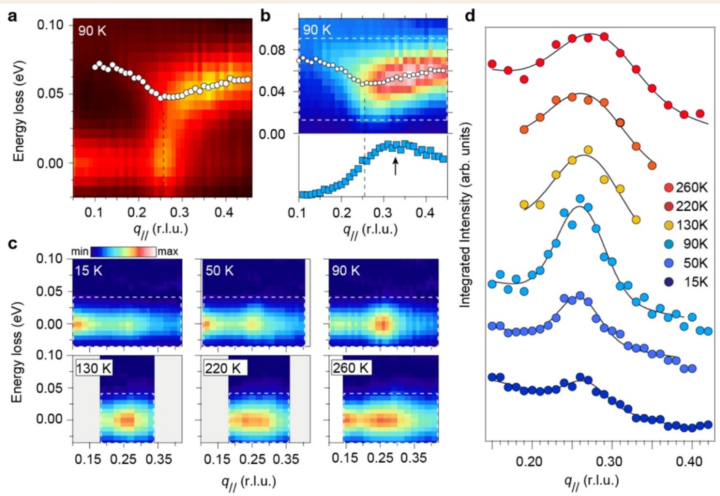
LETTERS

https://doi.org/10.1038/s41567-020-0993-7

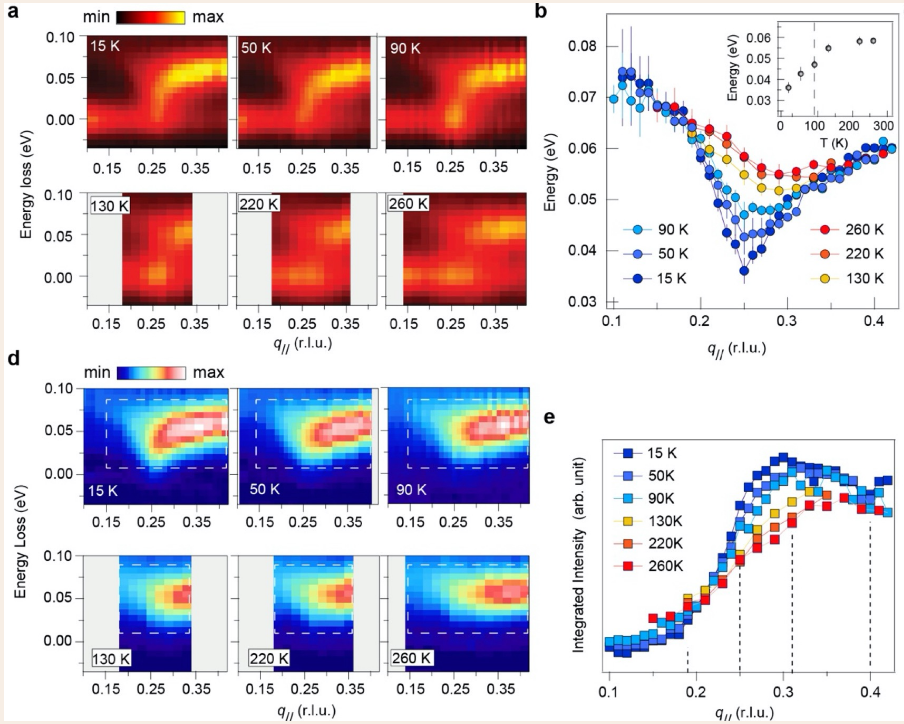
Check for updates

Spectroscopic fingerprint of charge order melting driven by quantum fluctuations in a cuprate

W. S. Lee[1], Ke-Jin Zhou[2], M. Hepting[1], J. Li[2], A. Nag[2], A. C. Walters[2], M. Garcia-Fernandez[2], H. C. Robarts[2], M. Hashimoto[3], H. Lu[4], B. Nosarzewski[4], D. Song[5], H. Eisaki[5], Z. X. Shen[1,6], B. Moritz[1], J. Zaanen[7] and T. P. Devereaux[1,6]



Quantum fluctuation associated with charge order in Bi2212 cuprate superconductors



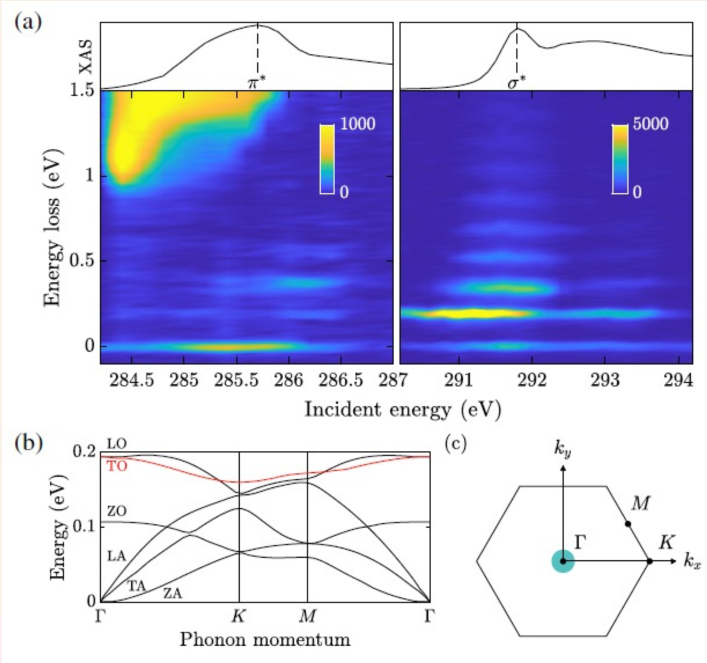
Electron-phonon interactions in graphite

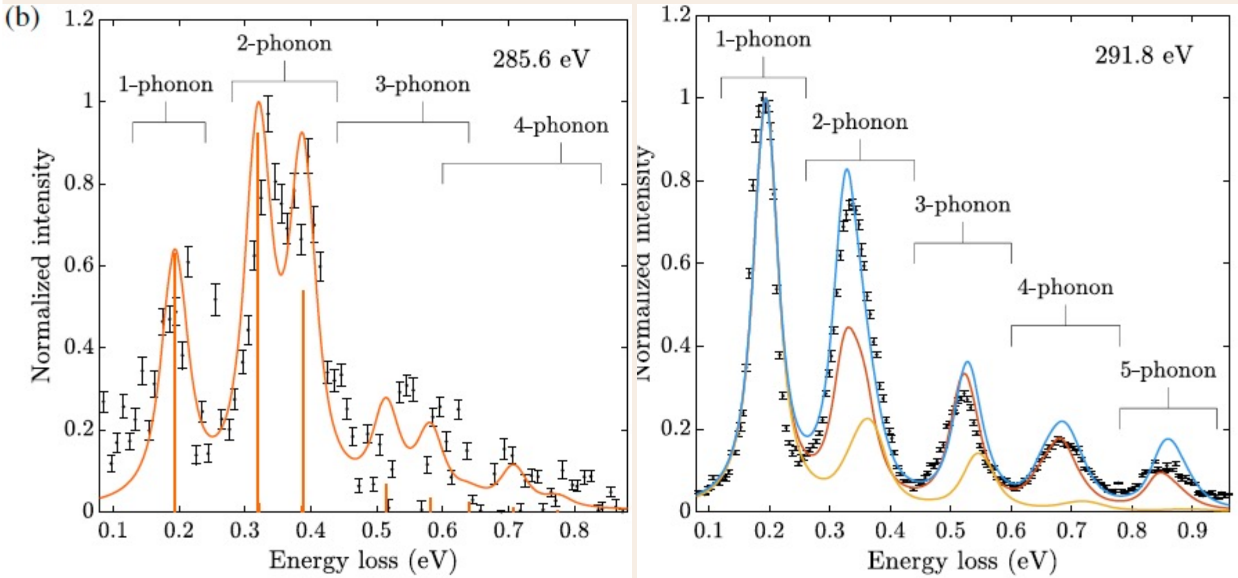
PHYSICAL REVIEW X **11**, 041052 (2021)

Probing Electron-Phonon Interactions Away from the Fermi Level with Resonant Inelastic X-Ray Scattering

C. D. Dashwood,[1,*,‡] A. Geondzhian,[2,3,‡] J. G. Vale,[1] A. C. Pakpour-Tabrizi,[4] C. A. Howard,[1] Q. Faure,[1] L. S. I. Veiga,[1] D. Meyers,[5,6] S. G. Chiuzbăian,[7,8] A. Nicolaou,[7] N. Jaouen,[7] R. B. Jackman,[4] A. Nag,[9] M. García-Fernández,[9] Ke-Jin Zhou,[9] A. C. Walters,[9] K. Gilmore,[5,10,11] D. F. McMorrow,[1] and M. P. M. Dean[5,†]

Energy tuned to probe phonon interactions with specific energy states: C σ and π





Performance of energy materials

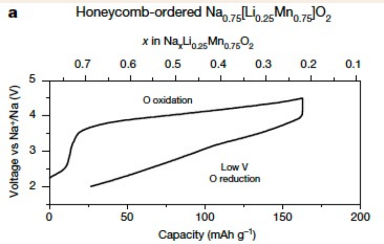
502 | Nature | Vol 577 | 23 January 2020

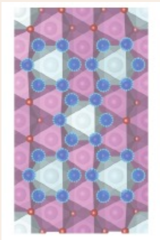
Superstructure control of first-cycle voltage hysteresis in oxygen-redox cathodes

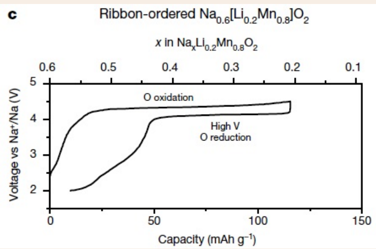
https://doi.org/10.1038/s41586-019-1854-3
Received: 12 February 2019
Accepted: 1 October 2019

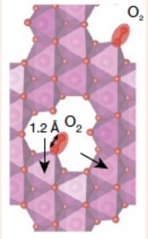
Robert A. House[1], Urmimala Maitra[1,8], Miguel A. Pérez-Osorio[1,8], Juan G. Lozano[1,2], Liyu Jin[1], James W. Somerville[1], Laurent C. Duda[3], Abhishek Nag[4], Andrew Walters[4], Ke-Jin Zhou[4], Matthew R. Roberts[1] & Peter G. Bruce[1,5,6,7]*

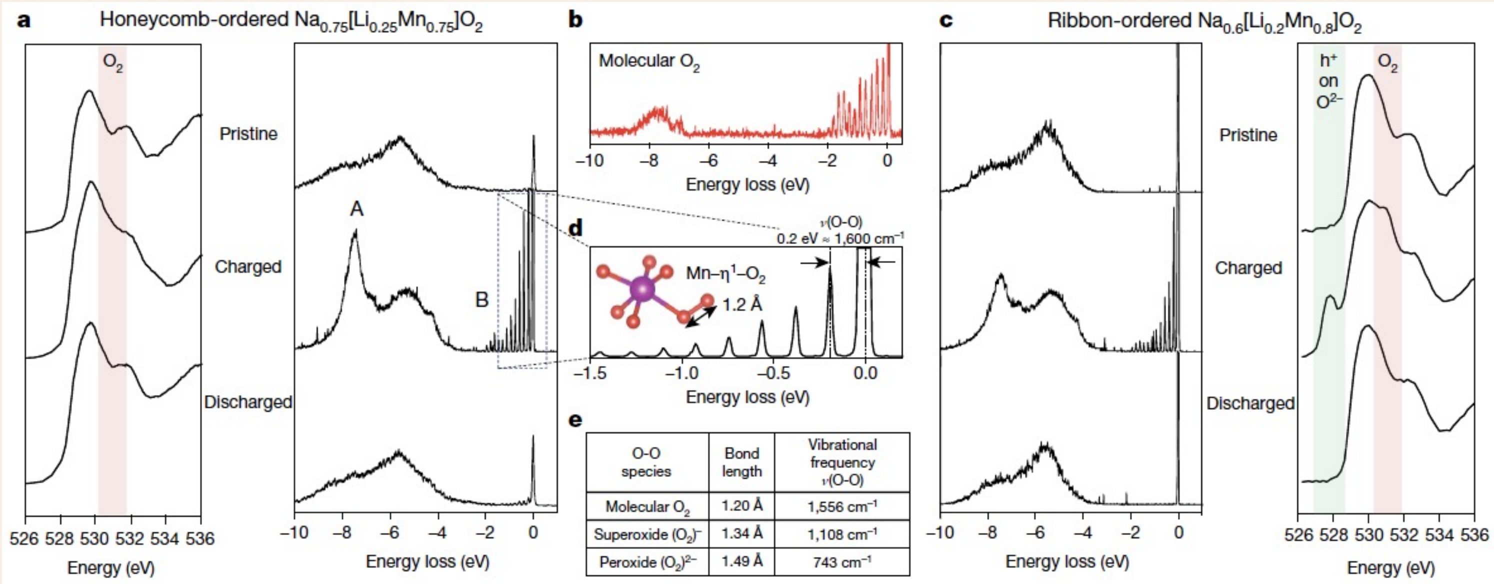
Oxygen-redox cathodes – Na^+-rich batteries and formation of molecular oxygen species











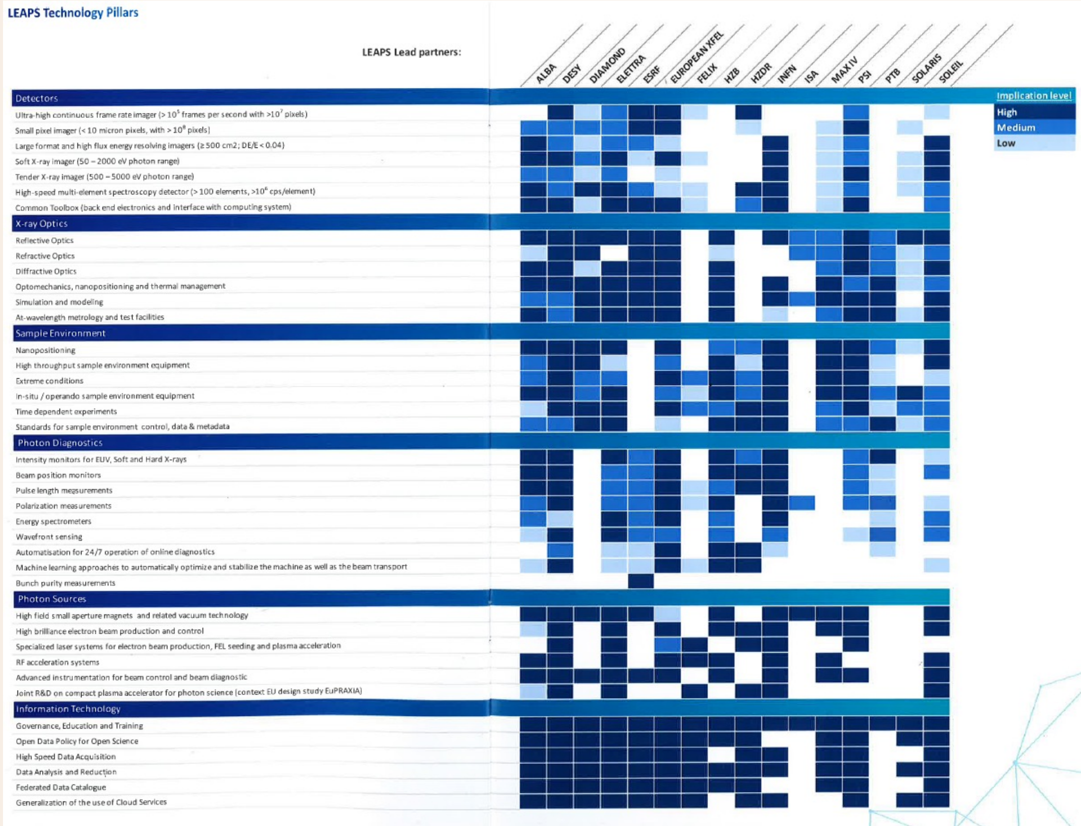
O-O species	Bond length	Vibrational frequency ν(O-O)
Molecular O_2	1.20 Å	1,556 cm^{-1}
Superoxide $(O_2)^-$	1.34 Å	1,108 cm^{-1}
Peroxide $(O_2)^{2-}$	1.49 Å	743 cm^{-1}

Challenges and opportunities

- Lower the energy resolution below 10 meV (at 1 KeV with reasonable photon flux) – requiring super high quality optics, yet more precise and stable engineering solutions and perhaps completely new optical concepts
- Extend availability of time-resolved RIXS, building on pioneers such Heisenberg RIXS at XFEL, Furka at SwissFEL, qRIXS at LCLS-II, RIXS at SHINE…
- Increased automation all the way from sample handling to data processing, particularly important for non-expert users
- Complementary theoretical modelling

Bringing techniques together

Strength in numbers



Thank you

- 9 plenary speakers
- 41 invited speakers
- 8 sponsors:
  - Brookhaven National Laboratory
  - Bestec
  - CINEL
  - DECTRIS
  - ExPaNDS
  - FMB Oxford
  - Lightsources.org
  - JTEC Corporation
- 14 contributing speakers
- 33 poster presenters
- 52 members that make up the:
  - Local Organising Committee
  - International Steering Committee
  - International Programme Committee
- IXS2019 hosts Brookhaven National Laboratory for their guidance and support throughout the planning

We hope you enjoy the conference!

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