Institute Laue-Langevin

NEUTRONS FOR SOCIETY

Endurance
Setting the pace

50+ years of contacts and collaboration with JINR

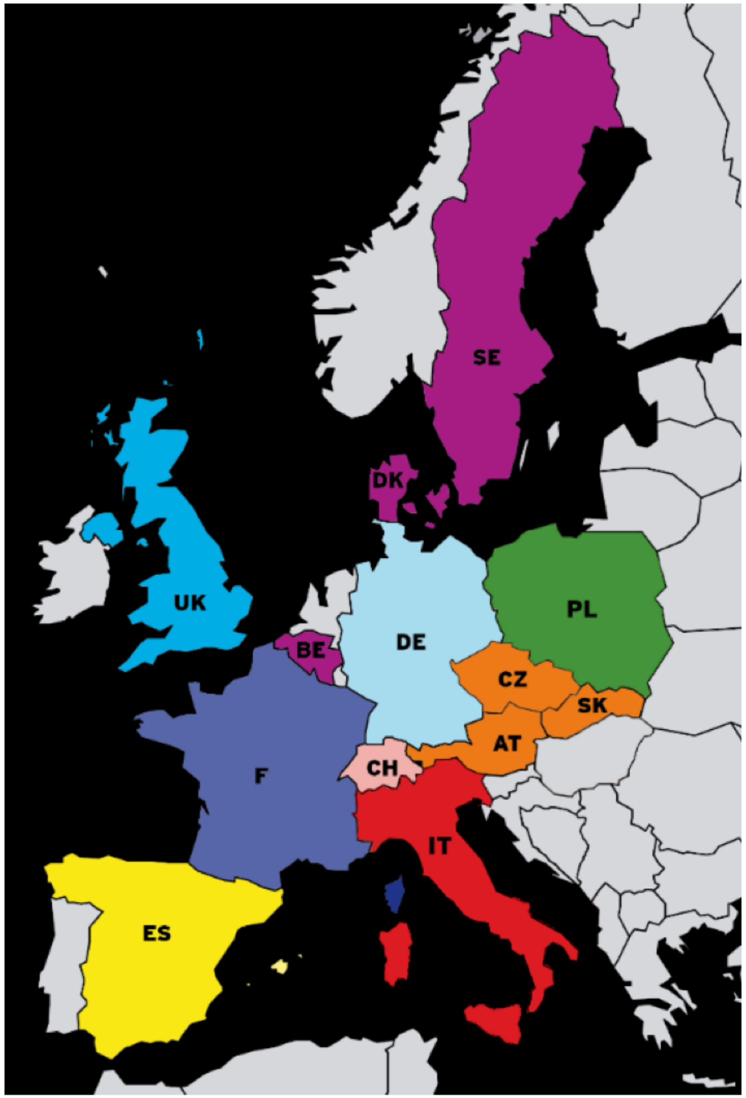
Jiří Kulda ILL Grenoble, France

ILL: 50th anniversary!

ILL member countries

NEUTRONS FOR SOCIETY

Endurance
Setting the pace



Germany : 25 %
UK : 25 %
France : 25 %

Spain
Italy
Switzerland
CENI (Central European Neutron Initiative, Austria, Czech Republic, Hungary, Slovakia)
Denmark
BELPOLSWENI (Belgian-Polish-Swedish Neutron Initiative)
India

scientific members: ≈ 25%

ILL scientific output

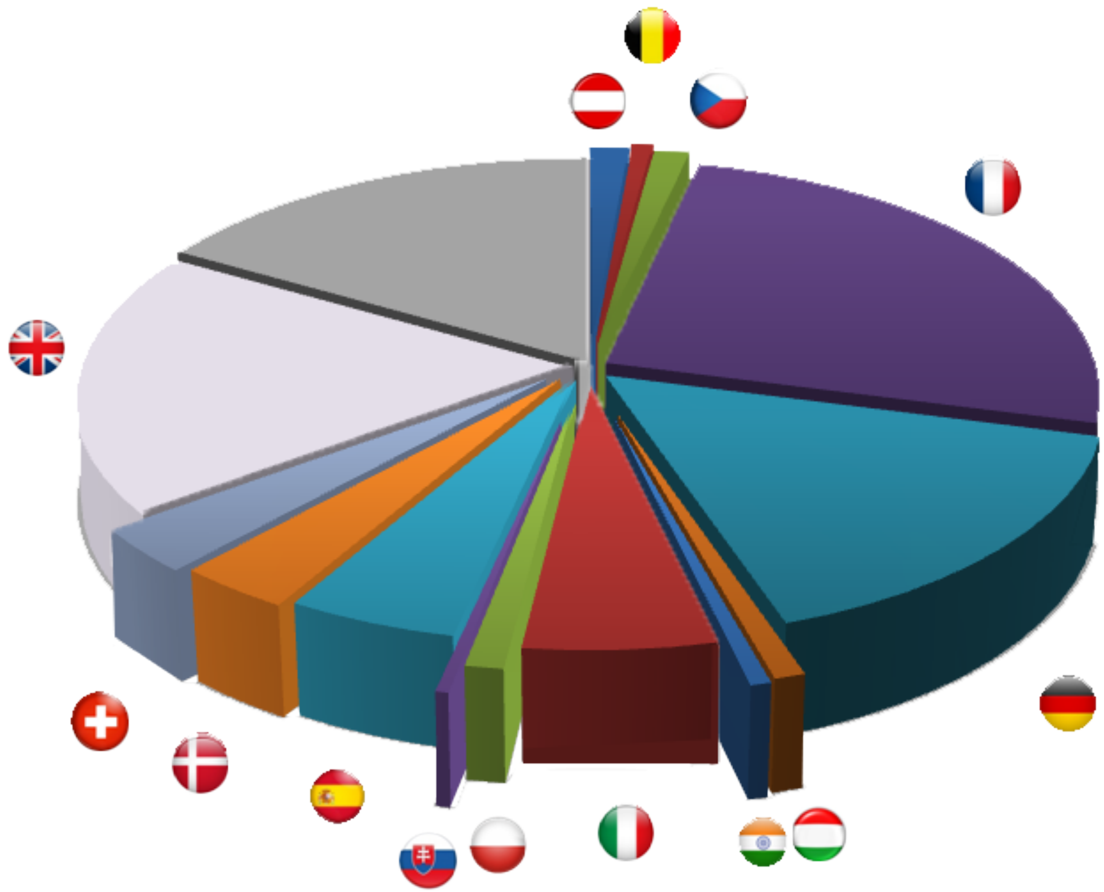
850 experiments/year

2000 users

38 countries

28 instruments + 8 CRG

650 publications/year



Neutron life-time

PHYSICAL REVIEW C **78**, 035505 (2008)

Neutron lifetime measurements using gravitationally trapped ultracold neutrons

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(Received 11 February 2008; published 23 September 2008)

Our experiment using gravitationally trapped ultracold neutrons (UCN) to measure the neutron lifetime is reviewed. Ultracold neutrons were trapped in a material bottle covered with perfluoropolyether. The neutron lifetime was deduced from comparison of UCN losses in the traps with different surface-to-volume ratios. The precise value of the neutron lifetime is of fundamental importance to particle physics and cosmology. In this experiment, the UCN storage time is brought closer to the neutron lifetime than in any experiments before: the probability of UCN losses from the trap was only 1% of that for neutron β decay. The neutron lifetime obtained, $878.5 \pm 0.7_{stat} \pm 0.3_{sys}$ s, is the most accurate experimental measurement to date.

$$\tau_n = 878.5 \pm 0.7_{stat} \pm 0.3_{sys} \text{ s}$$

NEUTRONS FOR SOCIETY

Quantum states in gravity

Endurance
Setting the pace

NATURE | VOL 415 | 17 JANUARY 2002 |

Quantum states of neutrons in the Earth's gravitational field

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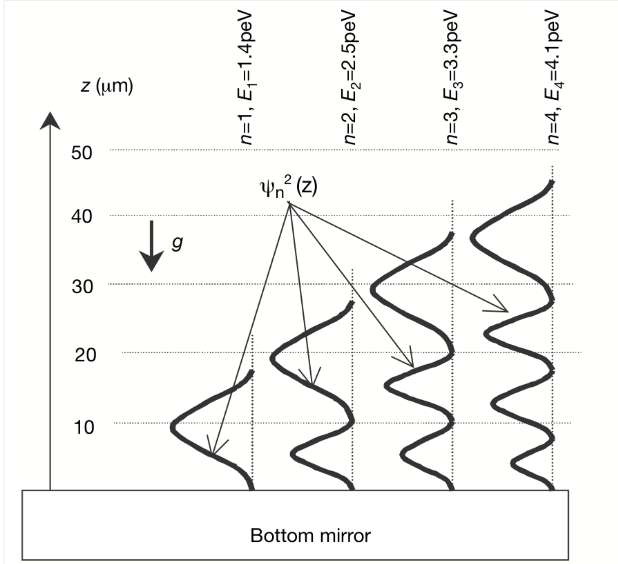
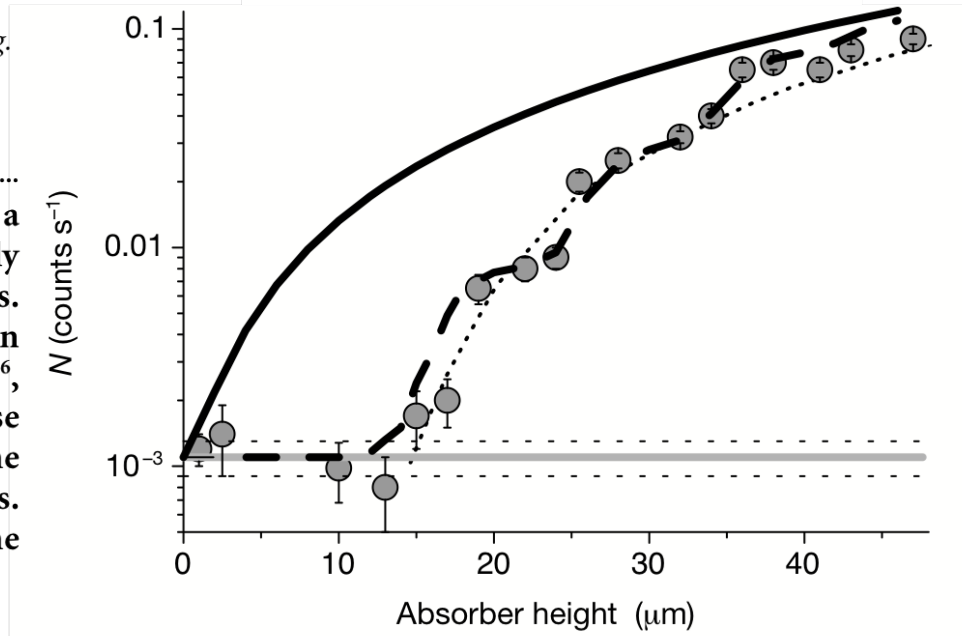
The discrete quantum properties of matter are manifest in a variety of phenomena. Any particle that is trapped in a sufficiently deep and wide potential well is settled in quantum bound states. For example, the existence of quantum states of electrons in an electromagnetic field is responsible for the structure of atoms[16], and quantum states of nucleons in a strong nuclear field give rise to the structure of atomic nuclei[17]. In an analogous way, the gravitational field should lead to the formation of quantum states. But the gravitational force is extremely weak compared to the

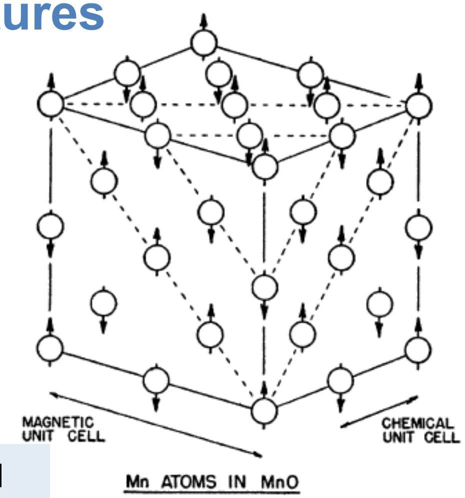


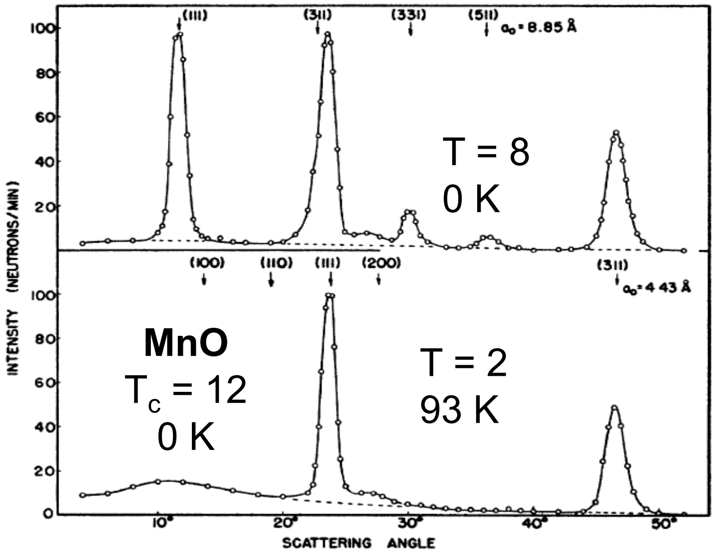


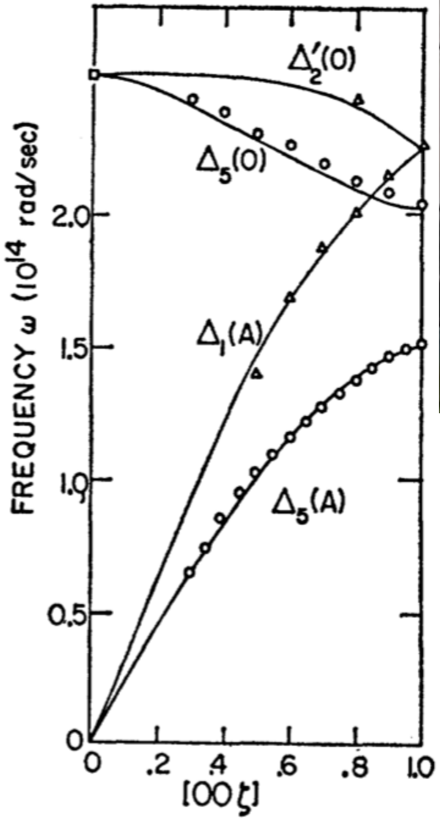
Neutron Nobel prize 1994

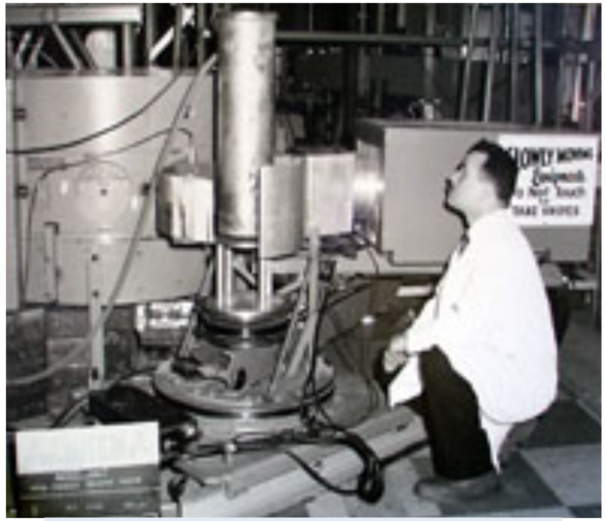
magnetic structures

Clive Shull, ORNL 1951









Bertram Brockhouse
Chalk River, 1957

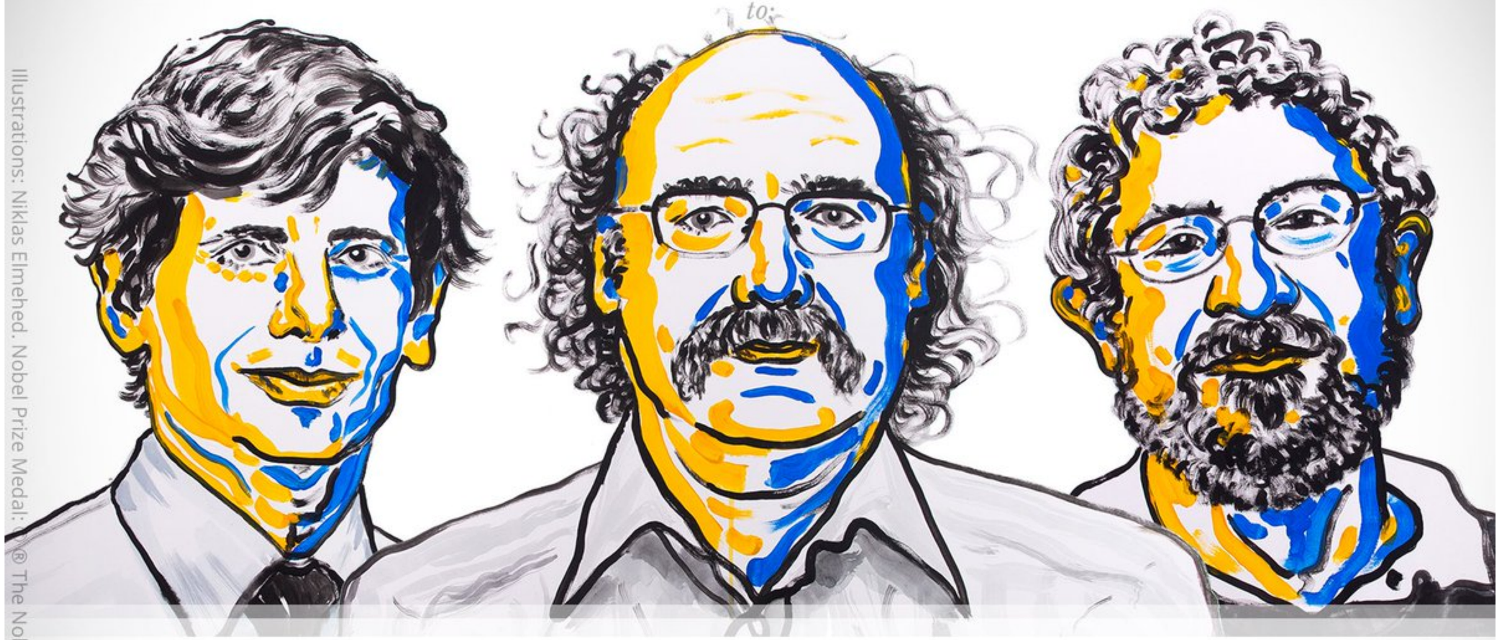
spectroscopy of excitations in solids

"For the greatest benefit to mankind"
Alfred Nobel

The Royal Swedish Academy of Sciences has decided to award the

2016 NOBEL PRIZE IN PHYSICS

to:



David J. Thouless
F. Duncan M. Haldane
J. Michael Kosterlitz

"for theoretical discoveries of topological phase transitions and topological phases of matter"

Nobelprize.org

Spectroscopy of condensed matter

I. Natkaniec et al., J. Phys. **C:** Solid St. Phys., 13 (1980) 4265-83

Phonon dispersion in d_8-naphthalene crystal at 6 K

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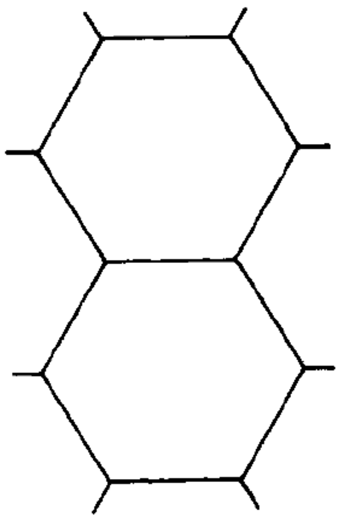
Received 10 December 1979

Abstract. The phonon dispersion curves for the 12 external and the four lowest internal modes in d_8-naphthalene ($C_{10}D_8$) have been determined at 6 K for the $[\xi, 0, 0]$, $[0, \xi, 0]$, $[0, 0, \xi]$, $[\frac{1}{2}, \xi, 0]$ and $[\xi, \xi, 0]$ directions by coherent inelastic neutron scattering. The results agree very well with optical data. Calculations performed in the harmonic approximation for the rigid-molecule model based on the atom '6-exp' potential were carried out beforehand to produce inelastic structure factors, which turned out to be very useful in the experimental work. This model predicts the qualitative behaviour of the dispersion curves surprisingly well, although some frequencies do differ by 20%. The experimental results show many mode-mixing and anticrossing effects. The present results should serve as a basis for improvements on the model.

Spectroscopy of condensed matter

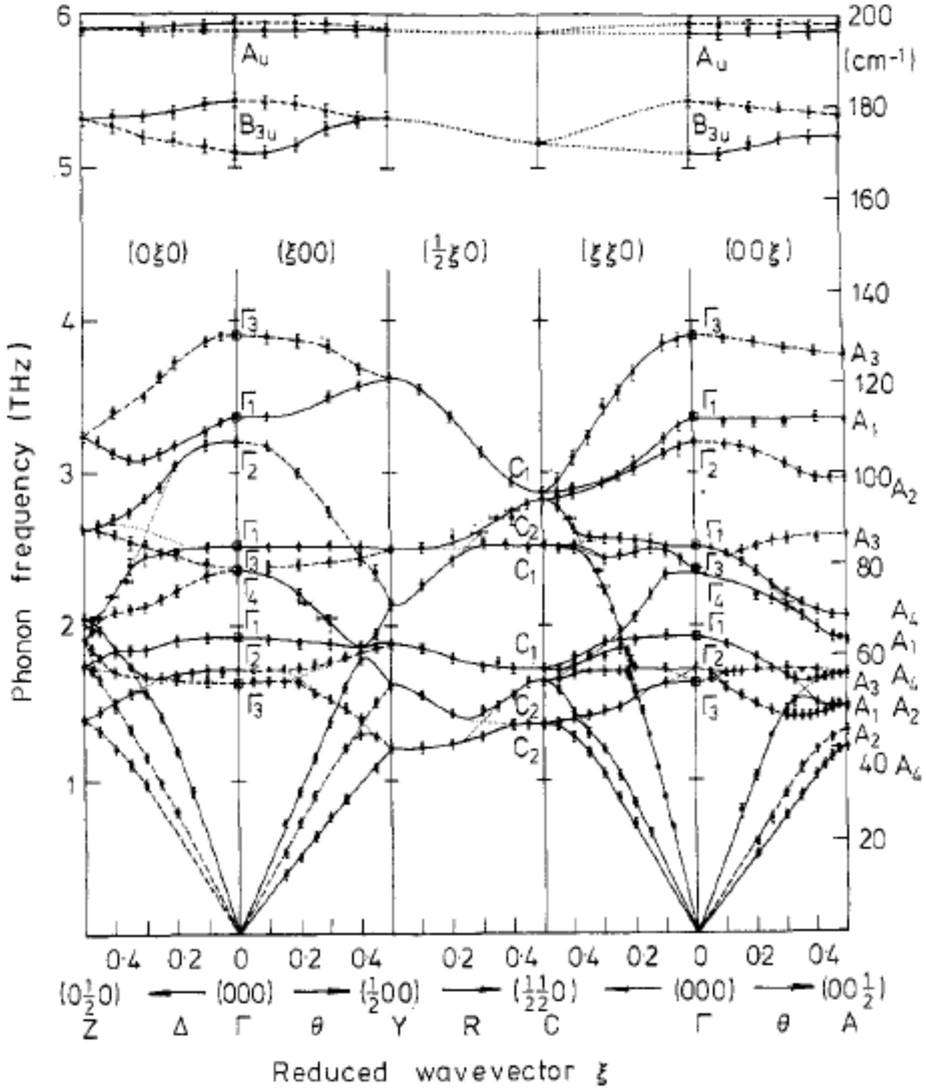
naphtalene



internal modes:
free state
mmm symmetry

external modes:
monoclinic $P2_1/a$
2 molecules/unit cel

"The sample was a single crystal of 99.7 at.%deuterated naphthalene, cylindrical in shape (21 mm diameter and 30 mm long). "



I. Natkaniec et al., J. Phys. **C:** Solid St. Phys., 13 (1980) 4265-83

To conclude:

ILL–JINR contacts

have a long and rich history

reaching beyond the traditional fields of fundamental physics with UCN

.... what about their future?