



# Neutron diffraction by a surface acoustic wave

G.V. Kulin, A.I. Frank, Yu.N. Khaydukov, D.V. Roschupkin, S. Vadilonga



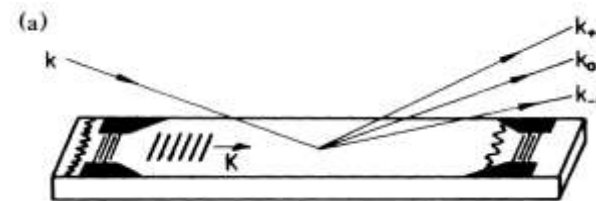
**I.M. Frank JINR Comm. R4-8851 (1975)** - possibility of inelastic process of neutron diffraction on surface (Rayleigh) waves in connection with the so-called UCN storage anomaly.

**UCN scattering for the case of waves at the surface of a fluid:**

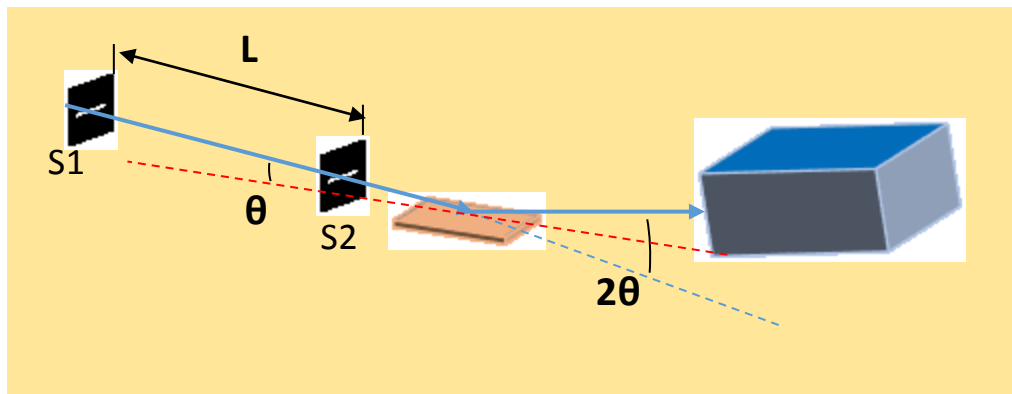
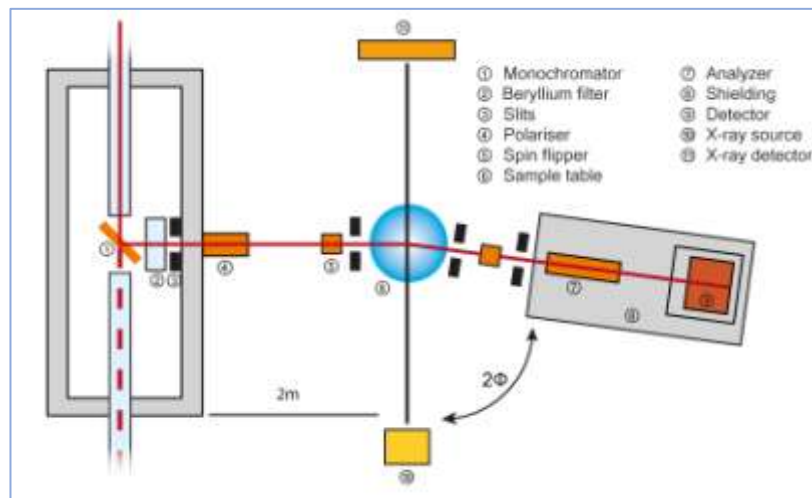
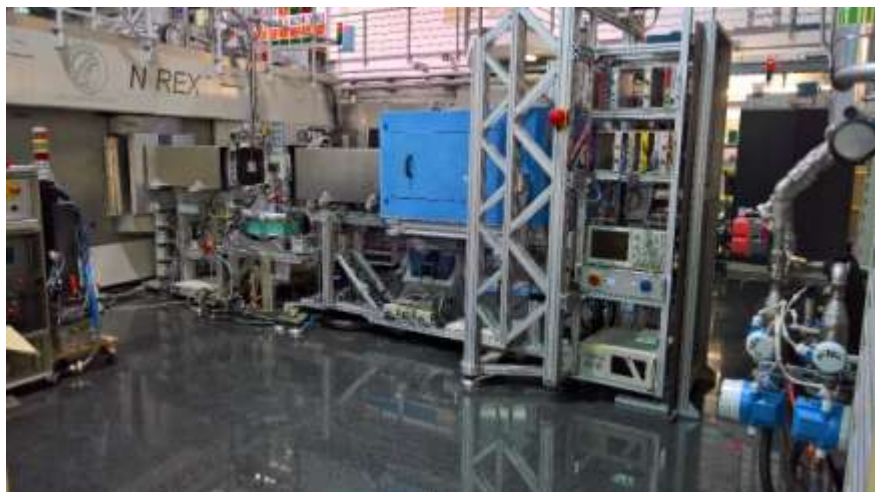
**Yu. N. Pokotilovski. Phys. Lett A, 255, (1999) 173**

**S. K. Lamoreaux and R. Golub, Phys. Rev. C 66, 044309 (2002)**

**W.A. Hamilton, A.G.Klein, G.I.Opat and P.A.Timmins. Phys. Rev. Lett. 58 (1987) 2770**



**A direct experiment (one-only) aimed at observing neutron diffraction on surface acoustic waves (SAW) excited on the surface of a quartz plate**



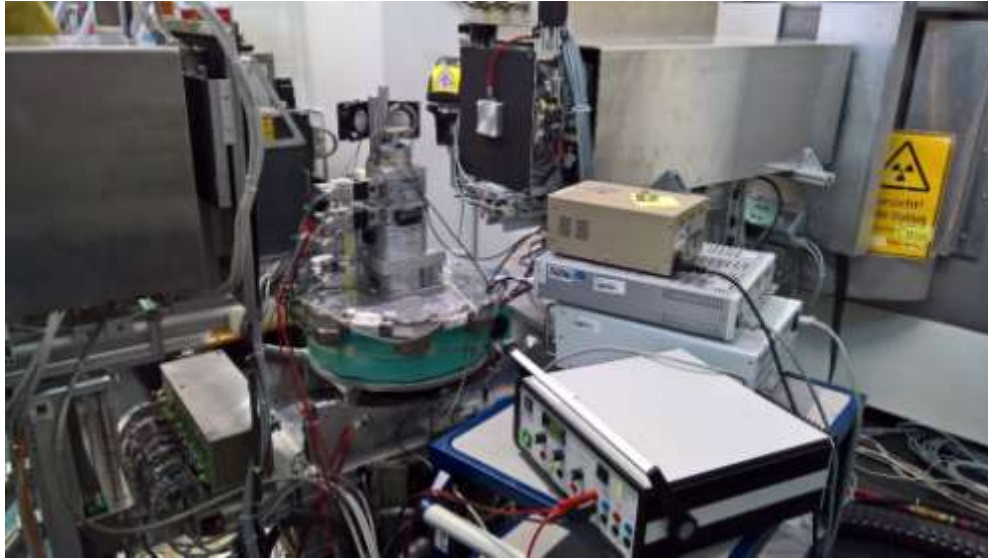
**Neutron wave length: 4.3 Å**

**Wavelength resolution: 1-2%**

**Angular divergence: 0.7 mrad**

**Sample: Single crystal Lithium Niobate (LiNbO<sub>3</sub>)**

# Single crystal Lithium Niobate ( $\text{LiNbO}_3$ )



**Size of Surface Wave Region:  $0.5 \times 6 \text{ cm}^2$**

**SAW velocity:  $3490 \text{ m/sec} > V_n = 920 \text{ m/sec} (4.3 \text{ \AA})$**

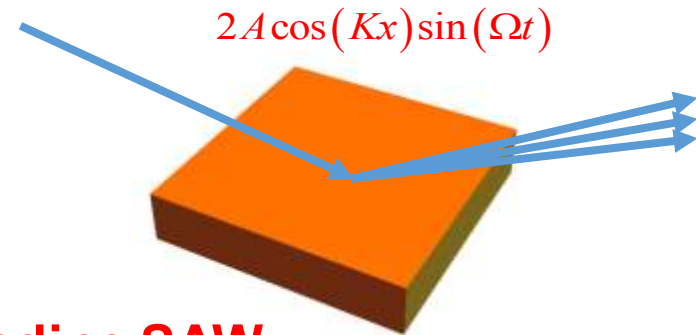
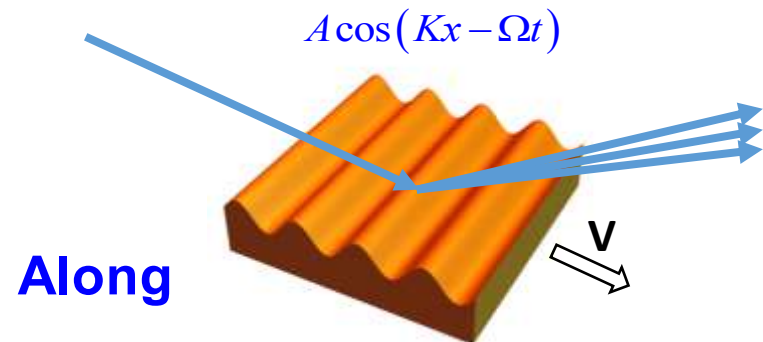
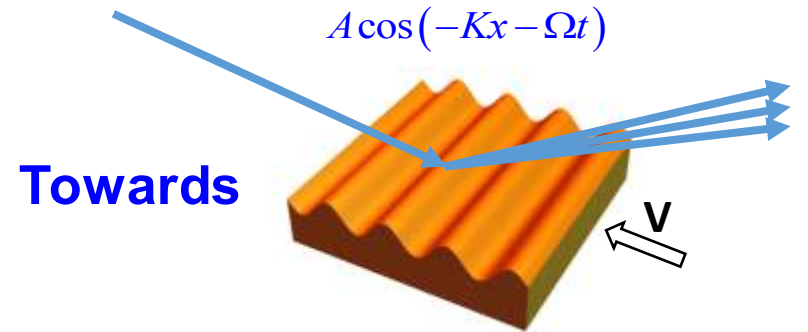
**SAW frequency:  $69 \text{ MHz}$**

**SAW amplitude:  $\sim 2 \text{ nm}$**

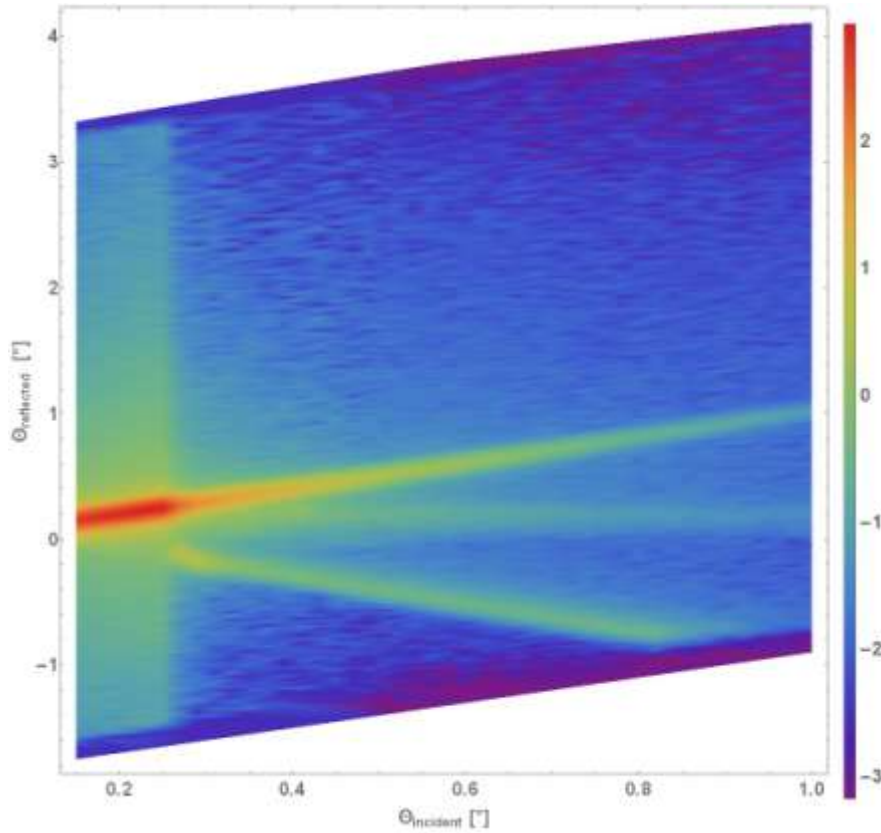
**SAW wavelength:  $\sim 50 \text{ mkm}$**



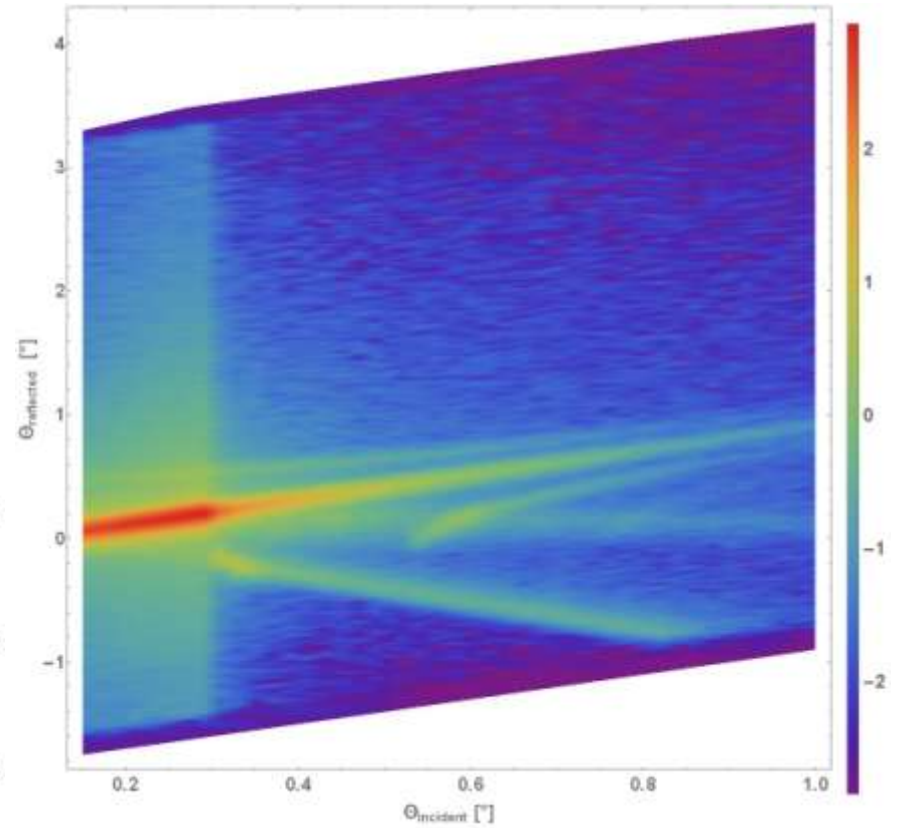
Two interdigital transducers were deposited



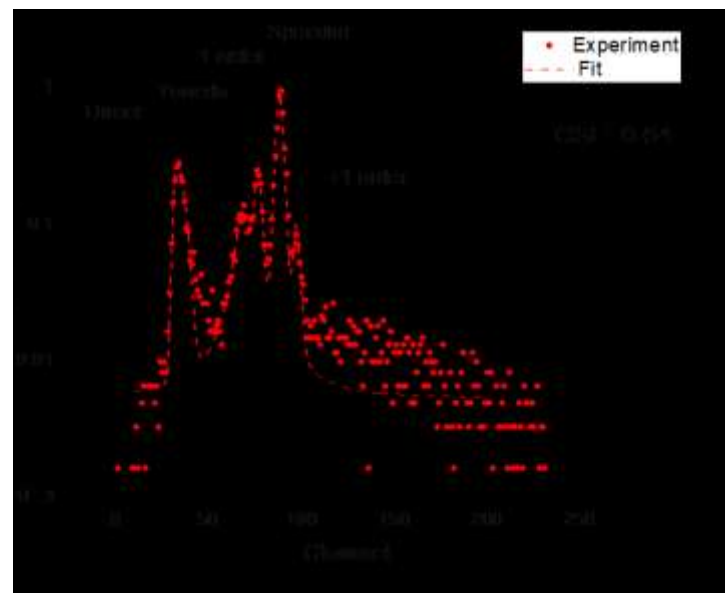
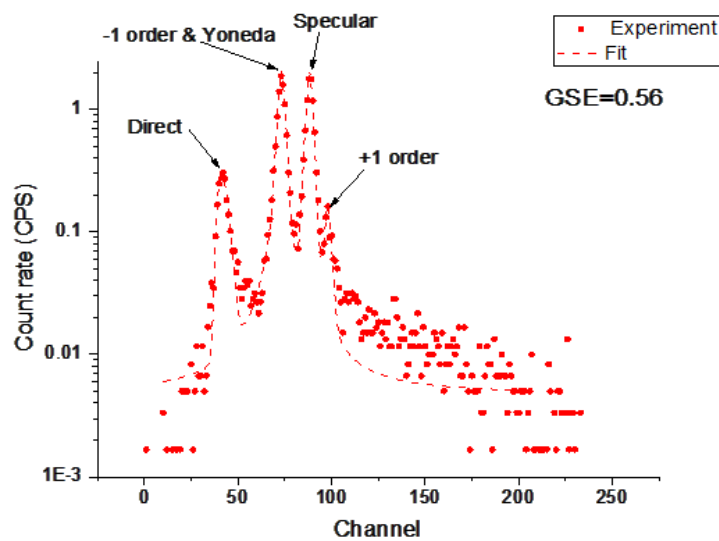
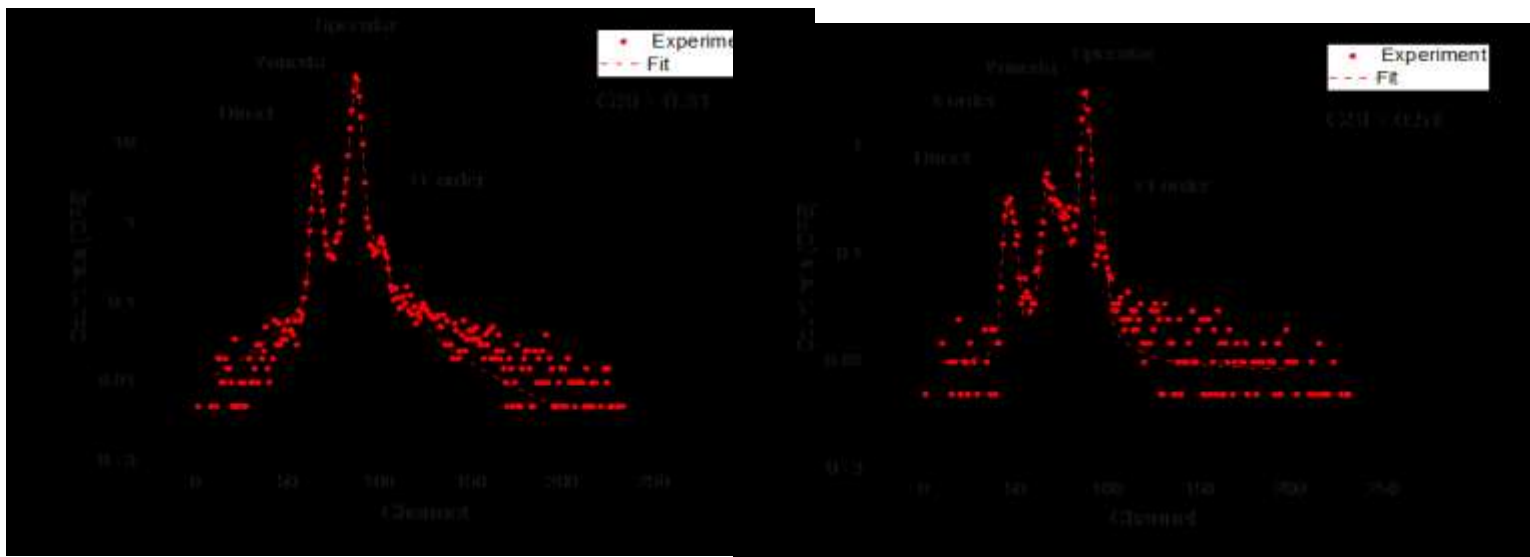
**Standing SAW**

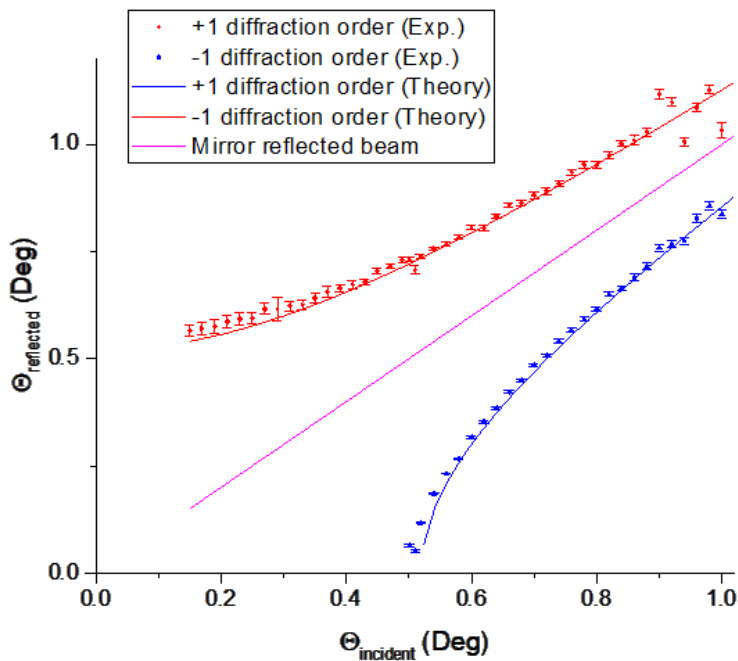


No SAW



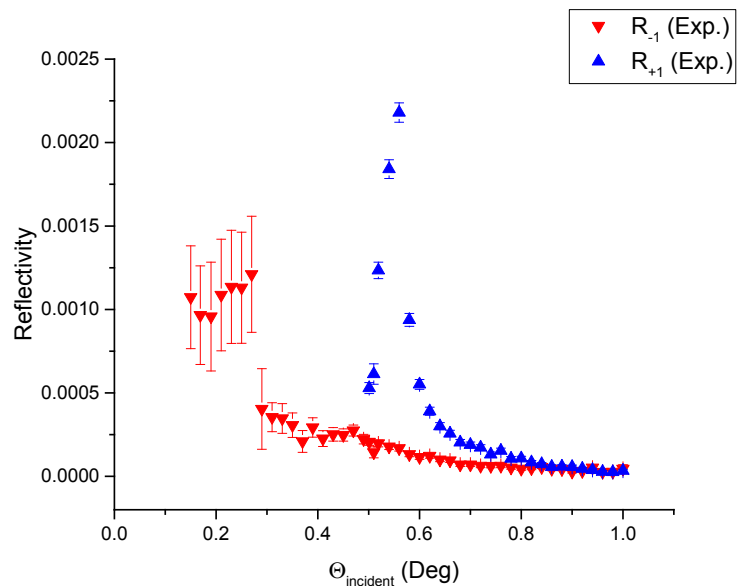
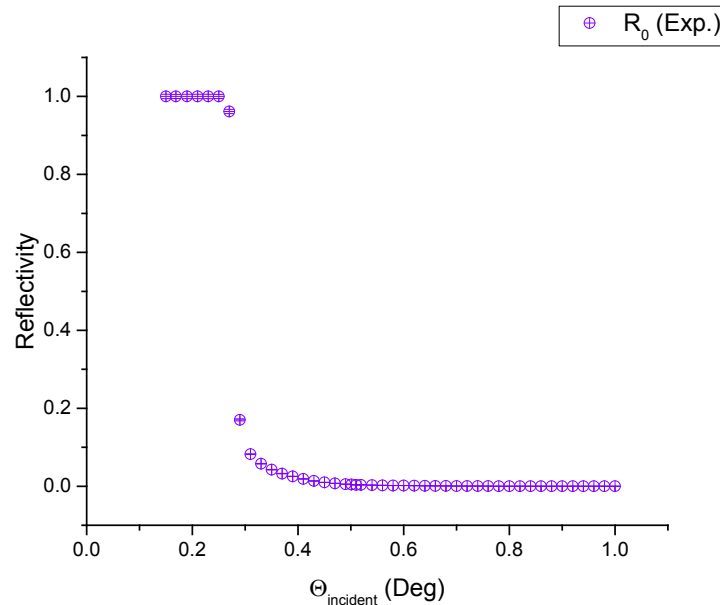
SAW travelling towards to neutrons



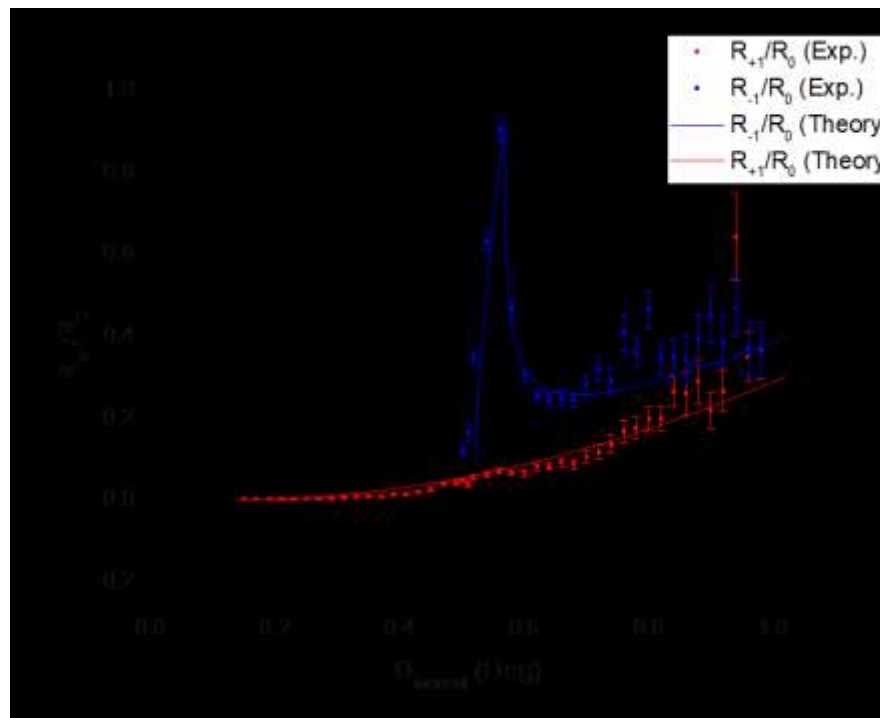
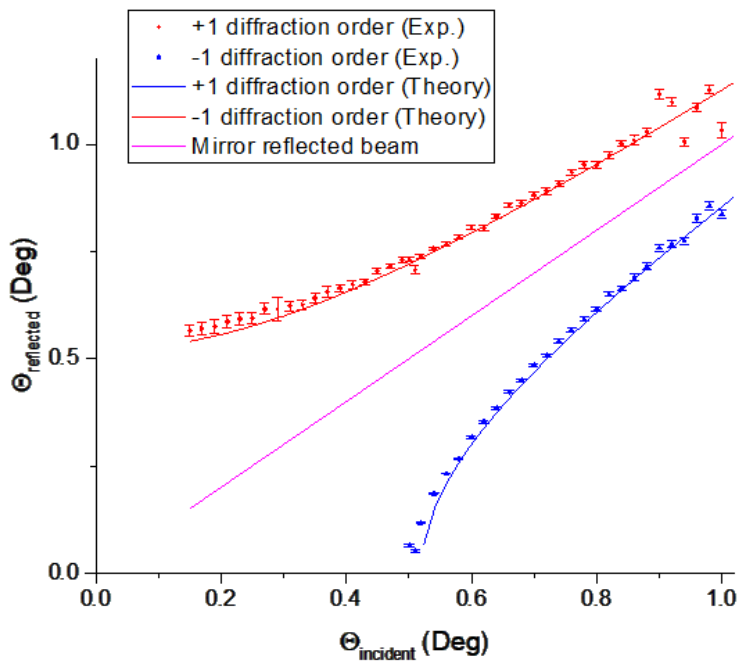


$s=-1$  SAW travelling towards to neutrons

$\Omega = 2\pi f$ ,  $f$  - SAW frequency



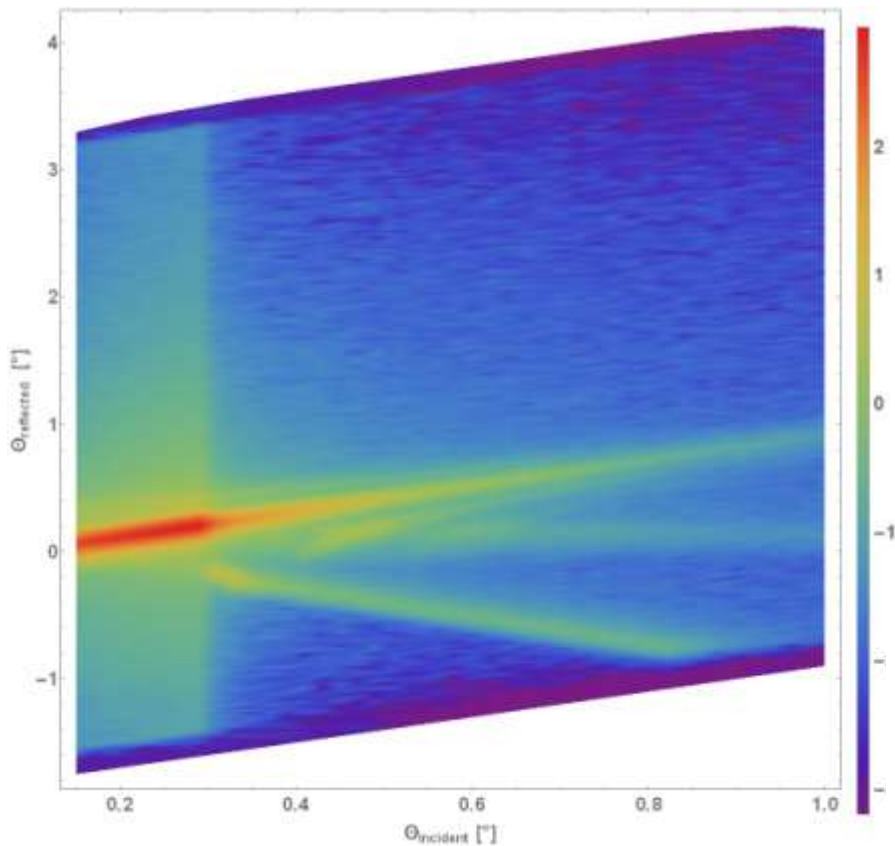




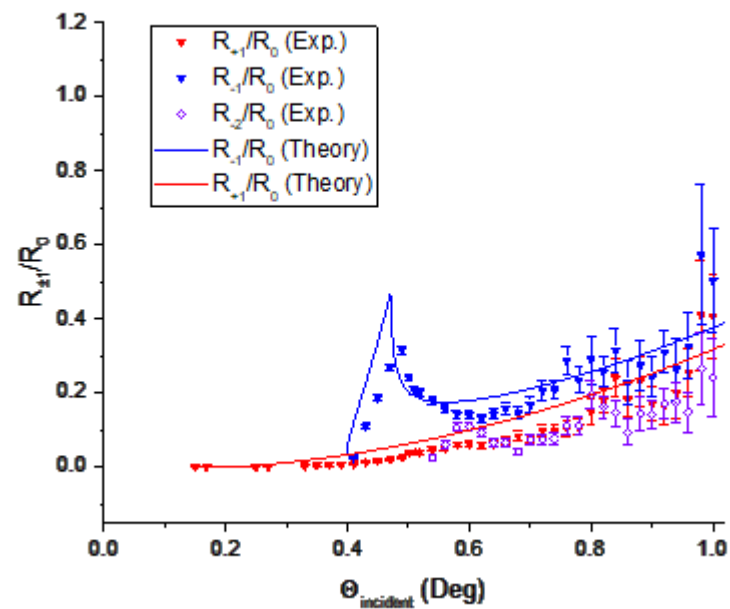
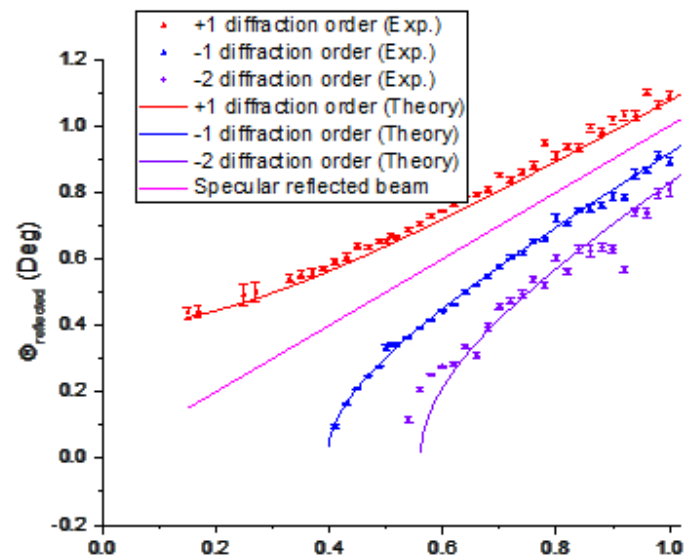
$s = -1$  **SAW travelling towards to neutrons**

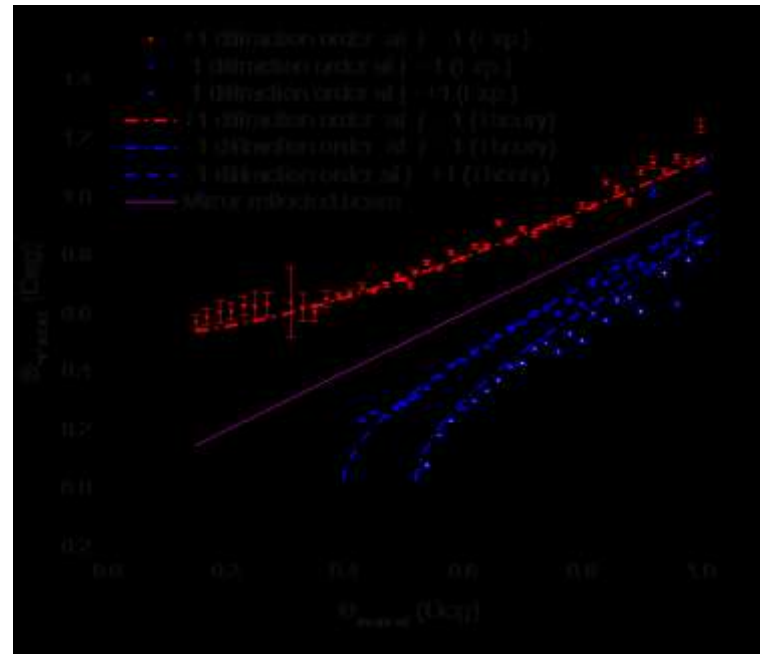
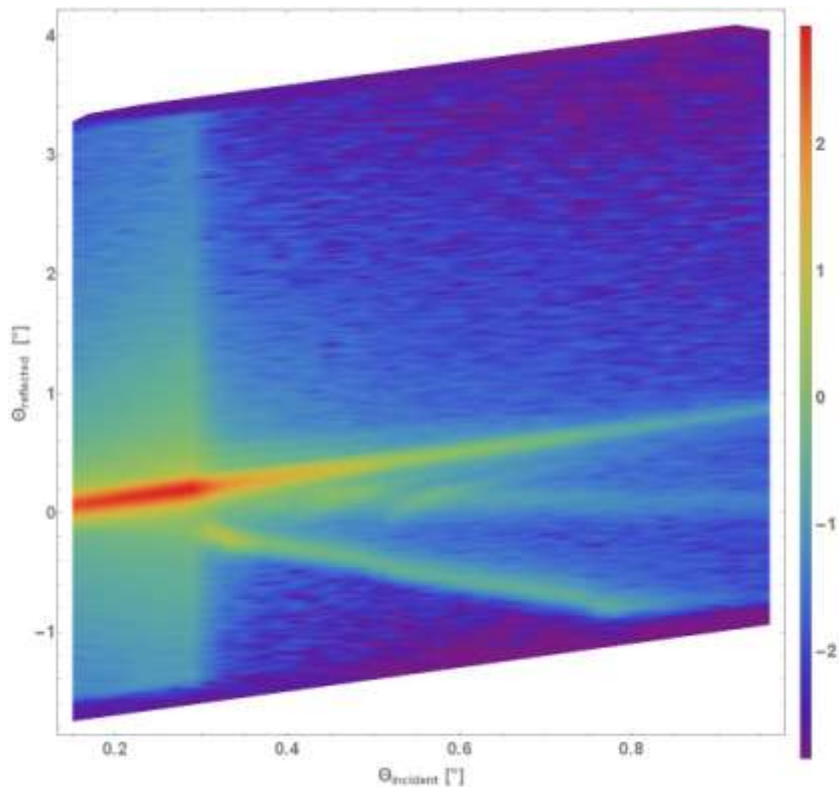
$\Omega = 2\pi f$ ,  $f$  - SAW frequency



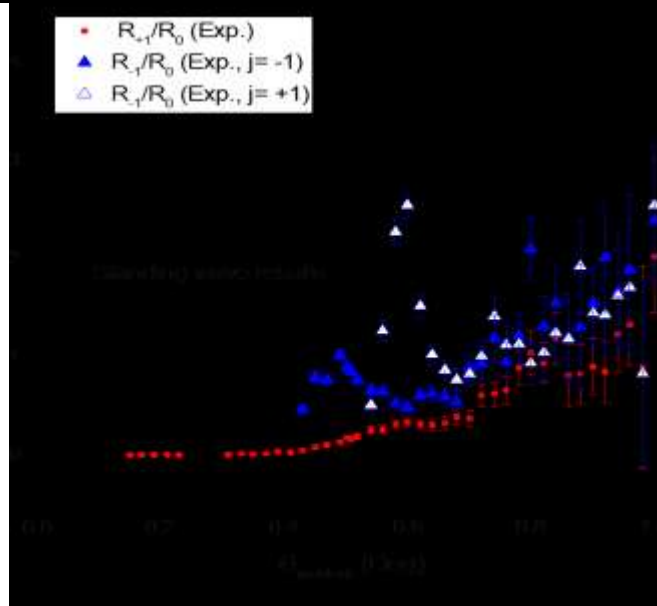


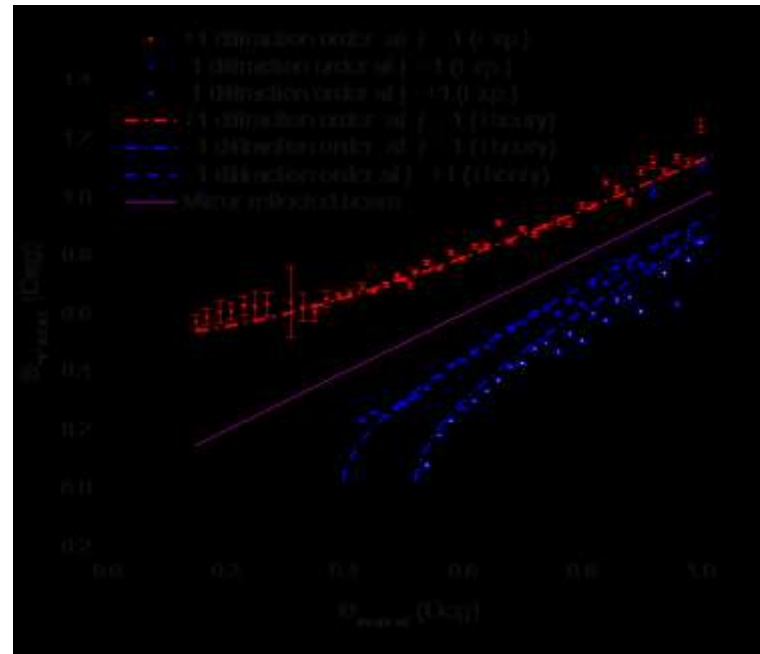
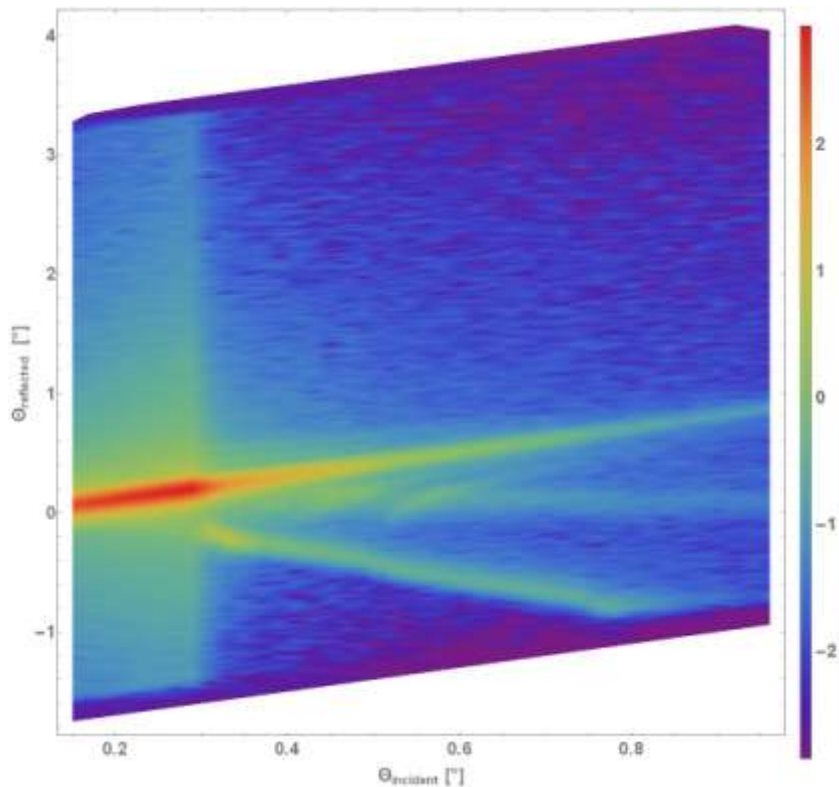
$s=-1$  SAW parallel to neutrons





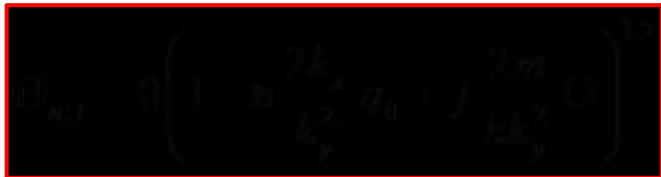
$$q_0 = \frac{2\pi}{\Lambda} = \frac{\Omega}{V}$$



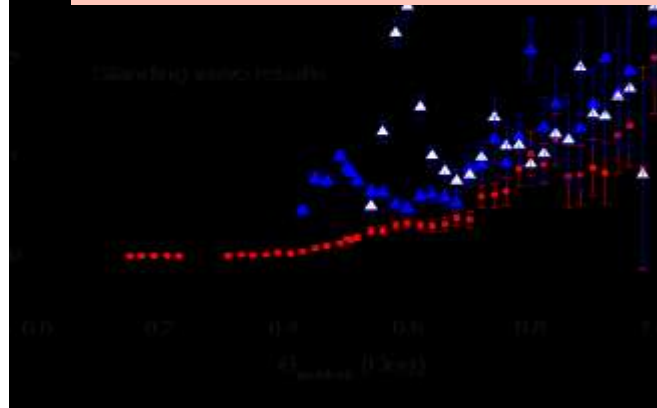


- $R_{-1}/R_0$  (Exp.)
- ▲  $R_{-1}/R_0$  (Exp.,  $j = -1$ )
- △  $R_{-1}/R_0$  (Exp.,  $j = +1$ )

**Theory is not finished yet**



$$q_0 = 2\pi/\Lambda = \Omega/V$$



## Matter moving with giant acceleration

$$W \approx \frac{\Delta F h}{m d} \approx W_{crit}$$

$b \approx 5 \times 10^{-13}$  cm – coherent scattering length  
 $d \approx 5 \times 10^{-8}$  cm – interatomic distance

A. I. Frank, *JETP Lett.*, 100, p. 613, 2014.

$$W_{crit} = 4 \times 10^5 \text{ m/sec}^2 - \text{UCN}$$

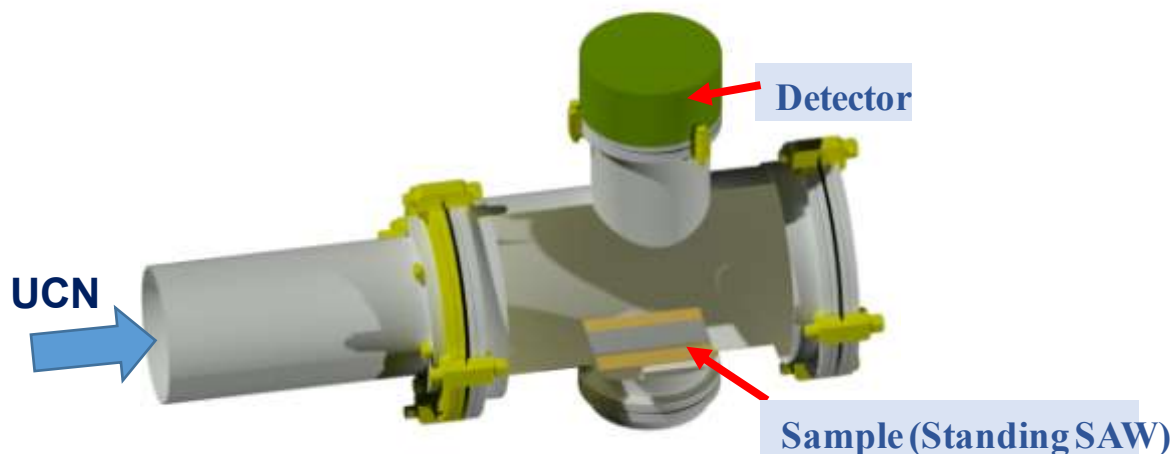
$$W_{crit} \approx 3.4 \times 10^{10} \text{ m/sec}^2 - 4.3 \text{ \AA} \text{ neutrons}$$

## Single crystal Lithium Niobate (LiNbO<sub>3</sub>):

SAW frequency: 69 MHz

SAW amplitude:  $\sim 2$  nm

$\approx$   $\text{m/sec}^2$  (Standing SAW),



- Experiment on diffraction of 4.3Å neutrons by a SAWs was performed.
  - Cases of SAWs travelling towards, along to direction of neutron wave propagation and case of standing SAW was realized.
  - The energy transfer to neutron was detected.  $\Delta E \approx 290$  neV.
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- Standing SAW can be suitable for the test of the concept of effective potential in case of giant acceleration.

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**Thank you for your  
attention!**

