The upgraded experimental setup Kolkhida designed to study interactions of polarized neutrons with polarized nuclei.

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Introduction

Nuclear neutron precession


\[ \omega = \frac{4\pi N\hbar I}{m_n} \frac{1}{2I+1} (f^+ - f^-)P_N, \]

The value of the effective magnetic field is:

\[ H_{ef} = \frac{\omega}{\gamma_n} P_N, \]
Introduction

Our plan is to study the nuclear precession of neutron spin in a wide range of neutron energies.

The projected studies on neutron nuclear precession will be performed in the neutron energy range from 0.062 eV to 2.3 eV.
Introduction

To carry out the experiment we need

- Polarized neutrons
- Polarized nuclei
- System for study of the process
The Kolkhida setup consists of the following components:

- polarized neutron spectrometer;
- polarized nuclear target;
- ferromagnetic neutron spin resonator;
- control systems of the setup.
Polarized neutron spectrometer

1 – primary collimator; 2 – Soller collimator; 3 – polarizer crystal; 4 – guiding field electromagnets; 5 – Mezei flipper; 6 – shim; 7 – cryostat; 8 – analyzer crystal; 9 – detector.
Control system

FL57STH76-1006B

OCD-SL00B-0016-C100-CRW

8SMC1-USBh
Energy spectrum of the primary neutron beam

The neutron flux in the specified energy range was $1.0 \times 10^6$ n/cm$^2$s.
The neutron diffraction

Bragg-Wolf condition

\[ 2d \sin \theta = n \cdot \lambda \]

- \( \lambda \) - is the neutron wavelength
- \( d \) - the interplanar distance
- \( \theta \) - the Bragg glancing angle
- \( n \) - the order of reflection

\( \theta = 6^\circ \)
The neutron diffraction
The neutron diffraction
# Parameters of the polarized neutron beam

<table>
<thead>
<tr>
<th>Angle $\theta$ (deg)</th>
<th>19</th>
<th>12</th>
<th>6</th>
<th>4</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wavelength $\lambda$ (Å)</td>
<td>1.15</td>
<td>0.74</td>
<td>0.37</td>
<td>0.25</td>
<td>0.19</td>
</tr>
<tr>
<td>Energy $E_n$ (eV)</td>
<td>0.062</td>
<td>0.15</td>
<td>0.60</td>
<td>1.3</td>
<td>2.3</td>
</tr>
<tr>
<td>Detector counting rate after the polarizer $n_1$ (s$^{-1}$)</td>
<td>800</td>
<td>270</td>
<td>65</td>
<td>33</td>
<td>22</td>
</tr>
<tr>
<td>Polarized beam intensity $I_1$ (n/s cm$^2$)</td>
<td>430</td>
<td>200</td>
<td>80</td>
<td>60</td>
<td>50</td>
</tr>
<tr>
<td>Detector counting rate after the analyzer $n_2$ (s$^{-1}$)</td>
<td>70</td>
<td>23</td>
<td>3.1</td>
<td>0.6</td>
<td>0.2</td>
</tr>
</tbody>
</table>
The neutron beam polarization

Measured with the use of

\[ p^2 = R' - 1 \]

\[ p^2 = \frac{AR - 1}{(2k - 1) AR + 1} \]

- The shim
- The method of two converters
- The flipper methods
Polarized nuclear target

$^3\text{He} - ^4\text{He}$ dilution cryostat diagram with a superconducting solenoid.
1 - main flange; 2 - vacuum housing; 3 - central $^3\text{He}$ pump-out pipe; 4 - nitrogen bath; 5 - nitrogen screen; 6 - helium bath; 7 - helium screen; 8 - helium bath to be evacuated; 9 - dilution stage helium screen; 10 - cryo-valve; 11 - superconducting solenoid; 12 - nitrogen trap of booster pump NVBM-2.5; 13 - oil filter; 14 - pump NVG-2; 15 - carbon trap; 16 - $^3\text{He}$ storage cylinder; 17 - $^3\text{He}$ - $^4\text{He}$ mixture storage cylinder; 18 - evaporation bath; 19 - heat exchangers; 20 - dilution bath.
We have also upgraded the polarized nuclear target:

- We have updated the cryostat service infrastructure by replacing old vacuum devices with modern ones.
- We have created a new, modern dilution bath for the cryostat.
- We have created a new cryostat component for neutron investigation of specimens in strong magnetic fields at room temperature (a “warm sluice”).
Ferromagnetic neutron spin resonator
Ferromagnetic neutron spin resonator
A warm sluice

Diagram of the ‘warm sluice’
1 – sluice; 2 – vacuum flange; 3 – nuclear target; 4 - superconducting solenoid; 
5 – cryostat’s baths; 6 - vacuum housing of cryostat; 7 - vacuum-valves;
Conclusion

We have completed the upgrade of the Kolkhida experimental setup. As a result of the modernization of the KOLKHIDA experimental setup we have upgraded the polarized neutron spectrometer control and monitoring system. We have completely updated fore-vacuum and high-vacuum pumps of the \(^3\)He-\(^4\)He dilution cryostat. The cryostat has been equipped with a detachable system designed to study specimens placed in strong magnetic field at room temperature. We have developed new software for the KOLKHIDA setup.
Thank you for your attention!