Experimental data for the article on *Topological nodal line in superfluid ^{3}He and the Anderson theorem*

This dataset includes experimental data analyzed and plotted in the article titled *Topological nodal line in superfluid ^{3}He and the Anderson theorem* published with DOI 10.1038/s41467-023-39977-2.

The article describes measurements of the nuclear magnetic resonance (NMR) spectra of superfluid ^{3}He confined between strands of nafen-243 nanomaterial. The nearly parallel solid strands are of 9 nm diameter and of 35 nm spacing, giving 94% open volume between the strands, which is filled by helium liquid. Strands provide strong scattering for Bogoliubov quasiparticles in the superfluid with inverse scattering time smaller than the superfluid energy gap of bulk ^{3}He. Unconventional *p*-wave superfluidity of ^{3}He is expected to be fully suppressed in these conditions. Nevertheless, the transition to the polar phase of superfluid ^{3}He with very little suppression of the critical temperature T_c compared to the critical temperature T_{cb} in bulk (unconfined) superfluid ^{3}He is found. Measurements of the frequency shift of the peak in the NMR spectrum compared to the Larmor value (which is the position of the peak in the normal liquid) as a function of temperature, reveal a cubic temperature dependence. This is characteristics of the presence of the nodal line in the energy spectrum of Bogoliubov quasiparticles in the polar phase. The parameters of the gap dependence on temperature are found to be close to the clean-limit expectations, despite the strong scattering. The results are explained via extension of the Anderson theorem, which protect static properties of conventional *s*-wave superconductors, to the unconventional *p*-wave polar phase of superfluid ^{3}He.

The NMR spectra are measured in the magnetic field of about 11 mT at a fixed rf pumping frequency 362924 Hz by sweeping the static field. The temperature is changed by sweeping the current I in the magnet of the nuclear demagnetization cooling stage. The experiment is equipped with the quartz tuning fork IQD LFXTAL04219Bulk of 32768 Hz nominal frequency immersed in the liquid helium. The temperature is determined from the thermal model including values of the current I, the fork resonance width and frequency shift in the NMR measurements into account. See the Methods section of the article for details.

The dataset includes following files:

Tc.csv: Critical temperature of the superfluid transition to the polar phase of ^{3}He confined in nafen-243 nanomaterial. First column – pressure P in bars, second column – ratio of the measured transition temperature T_c to the critical temperature T_{cb} in bulk (unconfined) superfluid ^{3}He. All recorded transitions are included separately. Figure 1d in the article shows temperatures averaged for each pressure as circles.

spectrum-normal.csv, spectrum-0.1bar-0.21Tc.csv, spectrum-7bar-0.21Tc.csv, spectrum-29.5bar-0.21Tc.csv: NMR spectra from Fig. 2a in the article. First column – frequency shift from the Larmor frequency in kHz. Second column – NMR absorption. The value is normalized so that the integral of the absorption is 1. Thus, absorption units are kHz^{-1}.

frequency-shift-*.csv: Measurements of the frequency shift versus temperature at pressures quoted in the file name. Each file includes a temperature sweep upward from the lowest temperature and then downward. At 23 and 29.5 bar two sweep pairs were performed and are presented separately (file names ending in -1 and -2). First column – time from the start of the sweep, seconds. Second column – temperature in units of T/T_c determined from the thermal model. Third column – frequency shift of the NMR spectrum from the Larmor frequency in kHz. All temperature sweeps at a given pressure are averaged for the plotting and analysis. The data are plotted in Figs. 2b and 3a in the article and in Supplementary Figs. 2 and 3.

fit-2parameters.csv: Results of the 2-parameter fit of the dependence of the frequency shift on temperature. These results are plotted on Figs. 3b and 4 in the article and in supplementary Fig. 3. Column 1: pressure, bar. Column 2: $a = - b_2/(2b_1)$. Column 3: error bar on a. Column 4: b_1 in kHz. Column 5: error bar on b_1. Column 6: $a' = - b'_2/(2b_1)$. Column 7: error bar on a'. Column 8: b'_3. Column 9: error bar on b'_3. The fit is performed to the data in the temperature range between $0.3T_c$ and $0.5T_c$. Error bars signify 1σ statistical uncertainty from the fit.

fit-3parameters-0-0.5.csv: Results of the 3-parameter fit of the dependence of the frequency shift on temperature performed to data at temperatures below $0.5T_c$. These results are plotted in Supplementary Fig. 2. Column 1: pressure, bar. Column 2: b_1 in kHz. Column 3: b_2. Column 4: b_3. Column 5: error bar on b_1. Column 6: error bar on b_2. Column 7: error bar on b_3. Error bars signify 1σ statistical uncertainty from the fit. Prefactor a in the temperature dependence of the gap can be found as $a = - b_2/(2b_1)$.

fit-3parameters-0.35-0.5.csv: The same data as in the file fit-3parameters-0-0.5.csv, but for the fit performed in the temperature range between $0.35T_c$ and $0.5T_c$.

strong-coupling-correction.csv: Ratio $[\Delta(T = 0, P)/T_c(P)]/[\Delta(T = 0, P = 0.1 \text{ bar})/T_c (P = 0.1 \text{ bar})]$ as a function of pressure P as determined from the zero-temperature frequency shift (given by column 4 in fit-2parameters.cvs). First column – pressure P in bars. Second column – the ratio. The dependence is plotted in Supplementary Fig. 4 as circles.

temprature-calibration-11bar-demag.csv: Example of the temperature calibration at pressure of 11 bar shown in Fig. 5a of the article. Column 1 – time from the beginning of the experiment in hours. Column 2 – demagnetization current I in amperes. Column 3 – temperature T^*, calculated from the demagnetization current, in units of T_{cb}. Column 4 – temperature of the sample T, calculated from the thermal model, in units of T_{cb}.

tempratature-calibration-11bar-fork.csv: Example of the temperature calibration at pressure of 11 bar shown in Fig. 5b of the article. Column 1 – time from the beginning of the experiment in hours. Column 2 – demagnetization current I in amperes. Column 3 – T/T_{cb}. Column 4 – fork resonance width. Column 5 – fork resonance frequency.

temprature-calibration-11bar-nmr.csv: Example of the temperature calibration at pressure of 11 bar shown in Fig. 5c of the article. Column 1 – time from the beginning of the experiment in hours. Column 2 – demagnetization current I in amperes. Column 3 – T/T_{cb}. Column 4 – frequency shift of the NMR absorption peak from the Larmor value in kHz.