Supporting data for
"A low-frequency, high-amplitude, torsional oscillator for turbulence studies in quantum fluids"

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The data are tabulated in the file "DataForOscillatorPaper.xlsx". Relevant details of the data plotted in Figs. 3-5 of the paper are given below.

Figure 3
(a) First, we tabulate the velocities plotted in Fig. 3(a) of the paper. They were derived from our experimental measurements for a conventional oscillator, on resonance, at a radius of 15mm (centre of electrode) using the formula

$$v = \frac{\mu A \epsilon_o}{G_A V_{dc} C_2^2} \qquad \text{mm/s} \tag{1}$$

Where $\mu = V_x = mV_{rms}$ is the output voltage, $A = 10^{-4}$ m^2 is the area of the electrodes, $G_A = 10^6$ is the gain of the amplifier, V_{dc} is the DC voltage bias, $C_2 = 3.867$pF is detector capacitance and ϵ_o is the permittivity of free space. Other quantities recorded are the resonant frequency, signal voltage recorded on the lock-in amplifier, signal voltage of the laser vibrometer which is calibrated such that $1000\,\text{mV}_{rms} = 10\,\text{mm/s}$. These velocities were then divided by 15 and 8.5, respectively, to give the electrical and optical angular velocities.

(b),(c) The same methodology was used for the data in Figs. 3(b) and 3(c) from the new oscillator, but deriving the velocities by use of the formula

$$v = R\frac{\mu\eta}{G_A V_{dc} C_2 G_M} \times \sqrt{2} \times 1000 \qquad \text{mm/s} \tag{2}$$

where $R = 20$ mm is the radius for electrical measurement, $\mu = V_x$ in mV$_{rms}$ is the output voltage, $\eta = 0.105$ rad is the electrode overlap angle, $G_A = 10^6$ is the gain of the amplifier, V_{dc} is the DC bias voltage, and $C_2 = 12.455$pF for (b) and $C_2 = 16.148$pF for (c) are the detector capacitances. The $\sqrt{2}$ is for conversion to peak velocity, the multiplication by 1000 is to convert to mm/s, and $G_M = 0.82$ is a geometrical factor that takes account of the true capacitance. The radii for the laser spot for the optical measurements were 7.5 mm and 19.0 mm for (b) and (c), respectively, and the optical voltages are in mV$_{rms}$

Figure 4
Figures 4(a) and 4(b) are frequency sweeps with peak rim velocity tabulated from experimental data using equation (2), where $R = 20$ mm is the radius for the electrical measurement $\mu = V_x = V_{rms}$ and $V_{dc} = 200$ V for Fig. 4(a) and $V_{dc} = 600$ V for Fig. 4(b), with $C_2 = 11.1$ pF for Fig. 4(a) and $C_2 = 12.0$ pF for Fig. 4(b). The angular velocities are also tabulated as a comparison.

Figure 5
The figure shows amplitude sweeps with peak rim velocity vs. peak torque. They are tabulated from the raw experimental data, where $R = 20$ mm is the radius for electrical measurement $= V_x = \mu V_{rms}$ and $V_{dc} = 800$ V for Fig. 4 (black circles) at 100 mK and $V_{dc} = 800V$ for Fig. 4 (blue circles) at 4.2 K, with $C_2 = 12.651$ pF for (a) and $C_2 = 12.651$ pF for (b) The formula used to derive the torque was

$$\tau = \frac{C_1 G_M}{\eta} V_{dc} V_{ac} \times \sqrt{2} \qquad \text{Nm} \tag{3}$$

Where $V_{dc} = 800$ V is the DC voltage, V_{ac} (ac amplitude) $= \text{mV}_{\text{rms}}$ (which is multiplied by 5 as we are using a $\times 5$ voltage amplifier) is the drive voltage and $C_1 = 13.065$ pF for (a) and $C_1 = 13.065$ pF for (b) and $\eta = 0.105$ rad is the overlap angle. The $\sqrt{2}$ is for conversion to peak torque.