Bridging Classical and Quantum Turbulence, Cargèse, Corsica
4th-14th July, 2023

Lancaster University

Flying Balls in Superfluid Helium

M. Arrayás[1], F. Bettsworth[2], C. C. E. Elmy[2], D. Field[2], R. P. Haley[2], R. Schanen[2], D. E. Smart[2], J. L. Trueba[1], C. Uriarte[1], V. V. Zavjalov[2] and D. E. Zmeev[2]

[1] *Área de Electromagnetismo, Universidad Rey Juan Carlos, Tulipán s/n, 28933, Móstoles, Madrid, Spain*
[2] *Department of Physics, Lancaster University, Lancaster, LA1 4YB, United Kingdom*

Lancaster University

Ultra Low Temperature

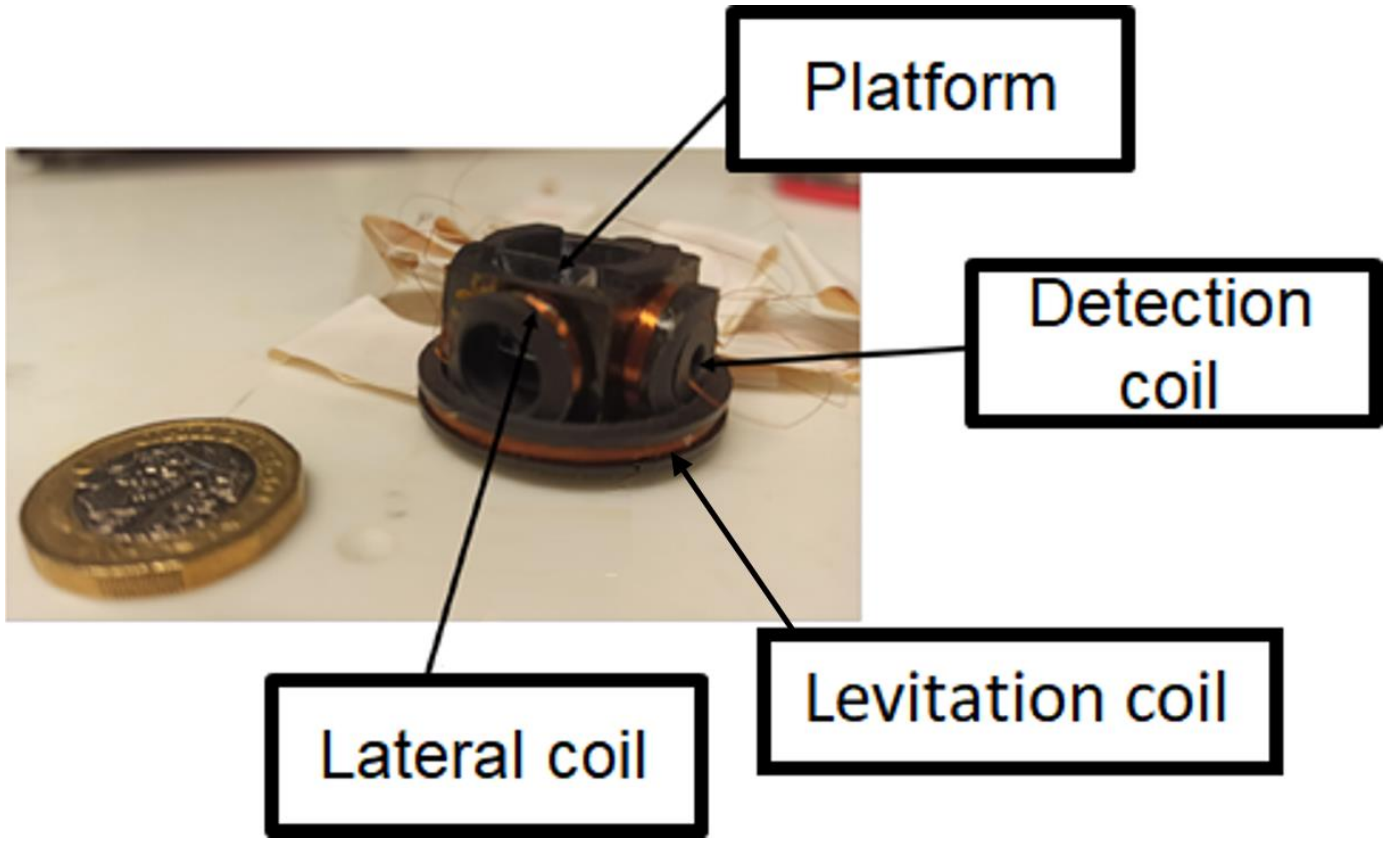
Universidad Rey Juan Carlos

UKRI Engineering and Physical Sciences Research Council

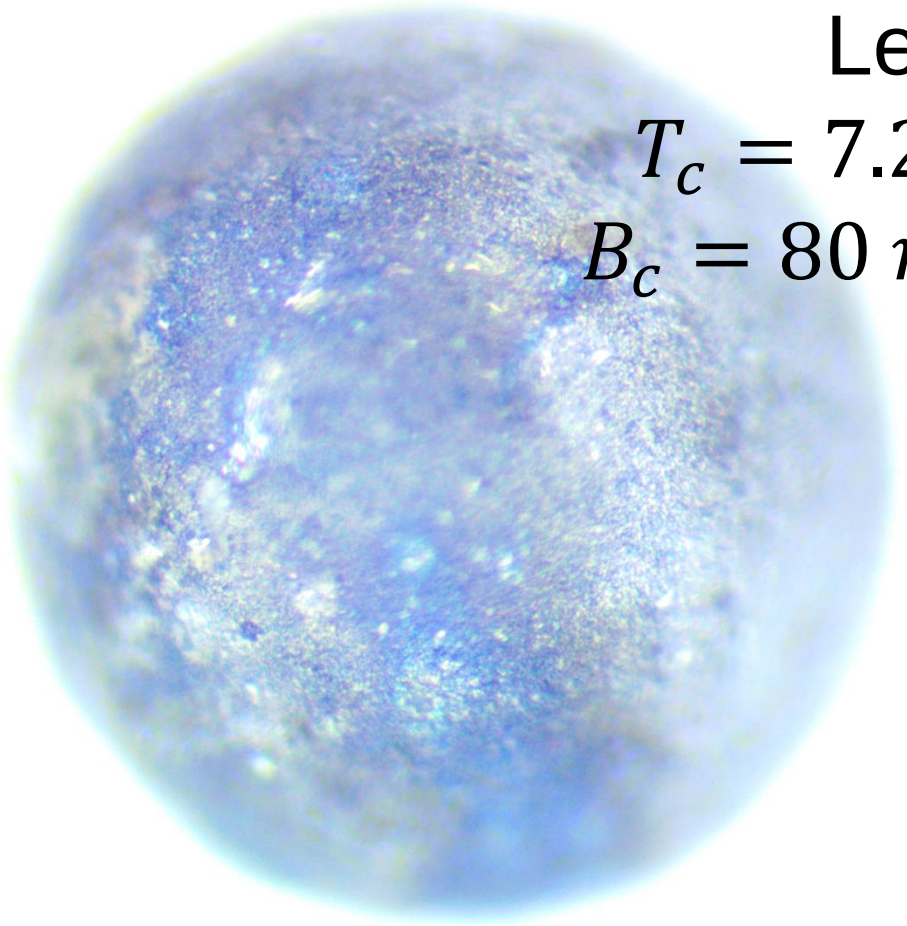
EMP

Context

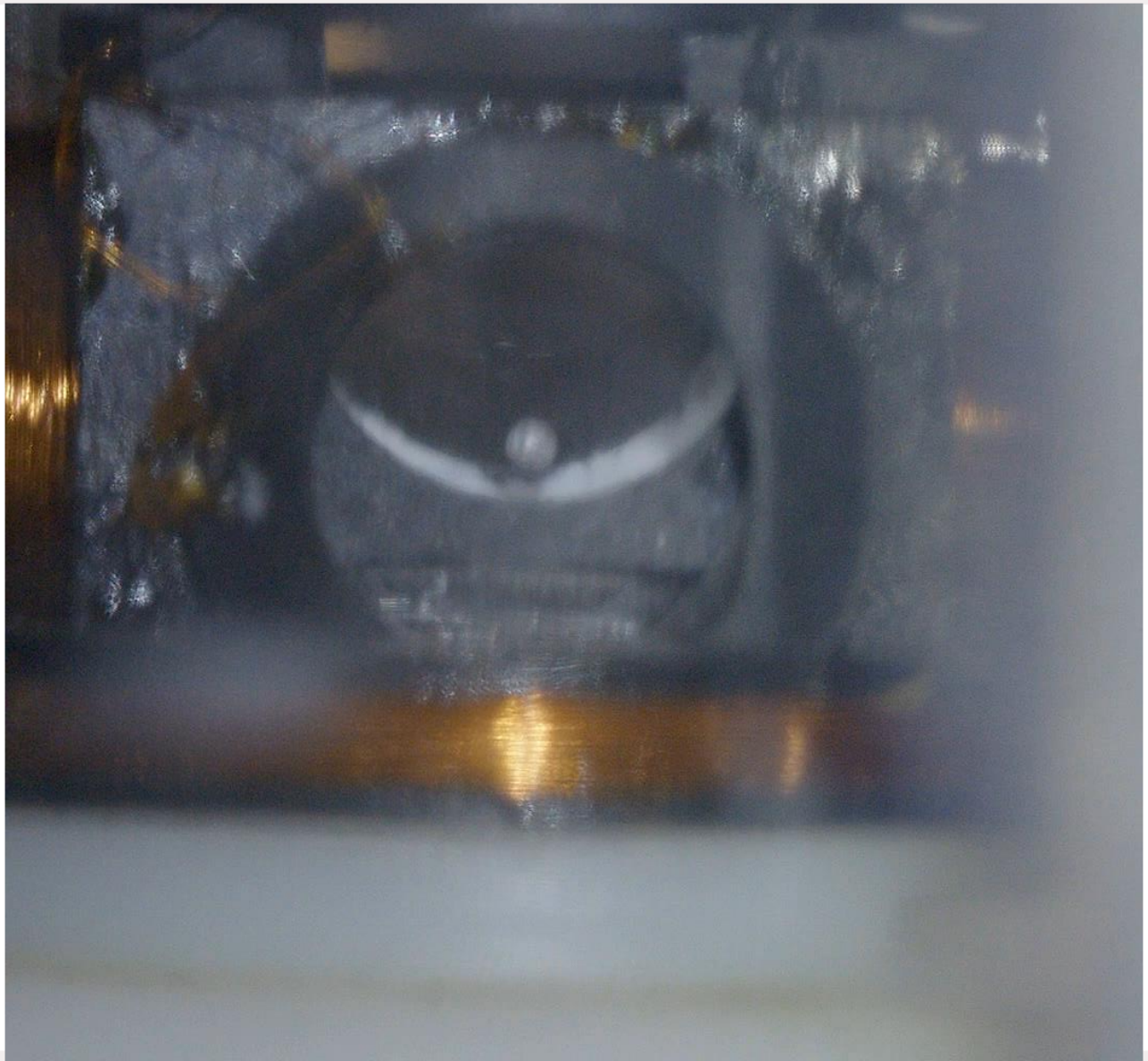
- Oscillating microspheres in helium-II (Schoepe, 1995-present)
- Oscillating Nb spheres in helium-II (Van Sciver, 2009)
- Microspheres levitated in an anharmonic potential (e.g. Wieczorek, 2023)
- Cryogenic wind tunnel (Sreenivasan and Donnelly, 2001)



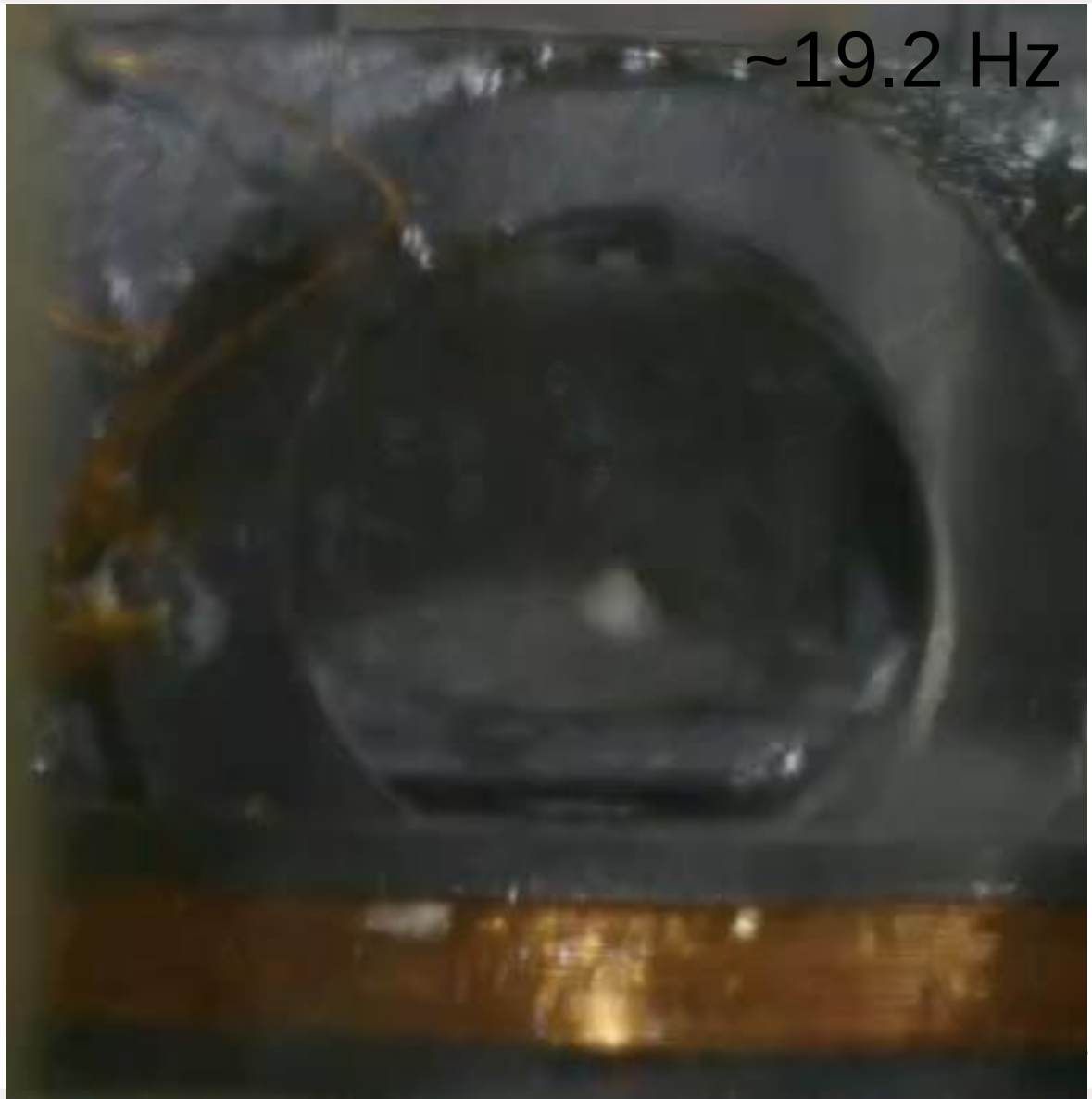
The Flying Balls



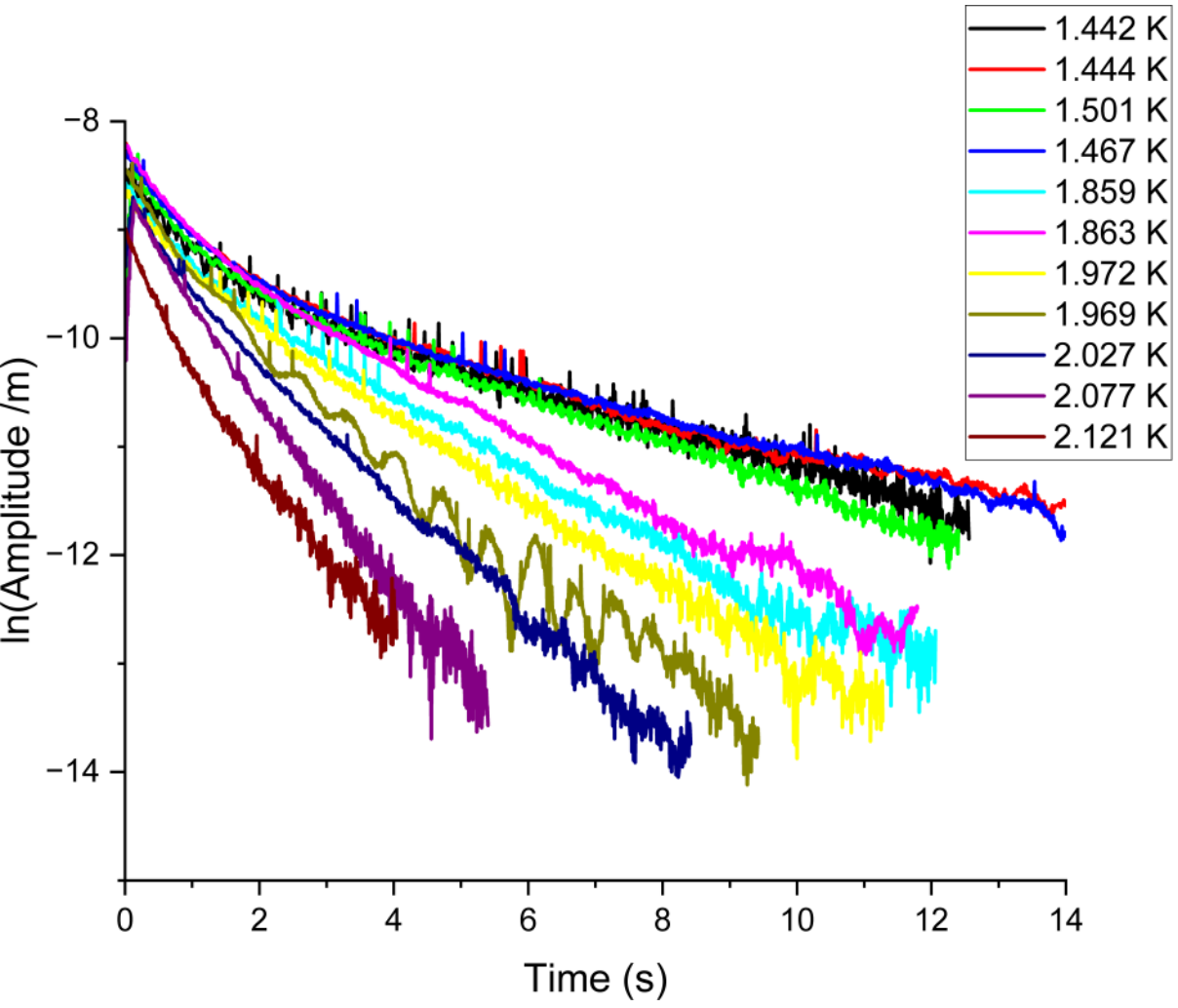
Uniform Linear Motion (In)

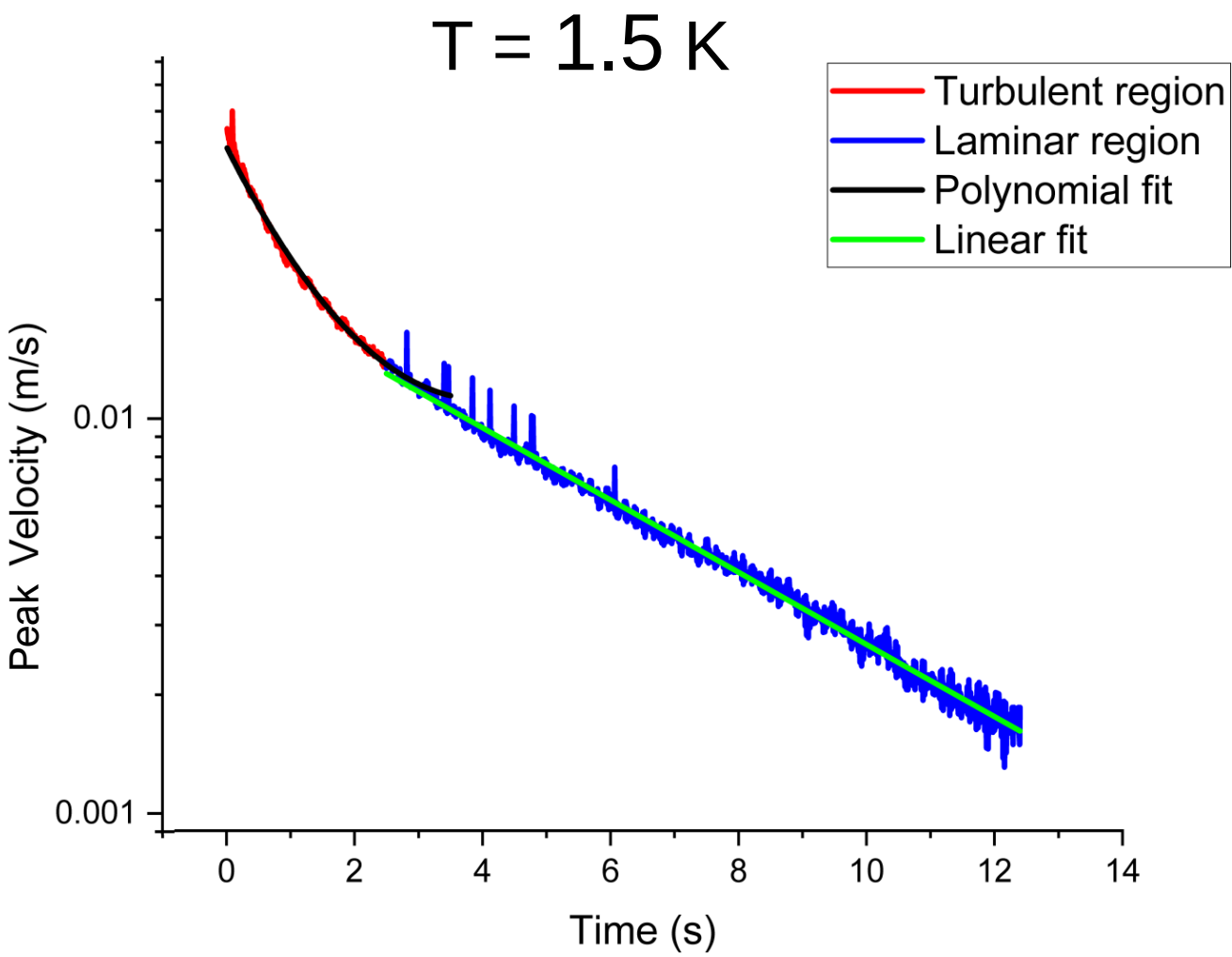


Damped Oscillatory Motion (In)

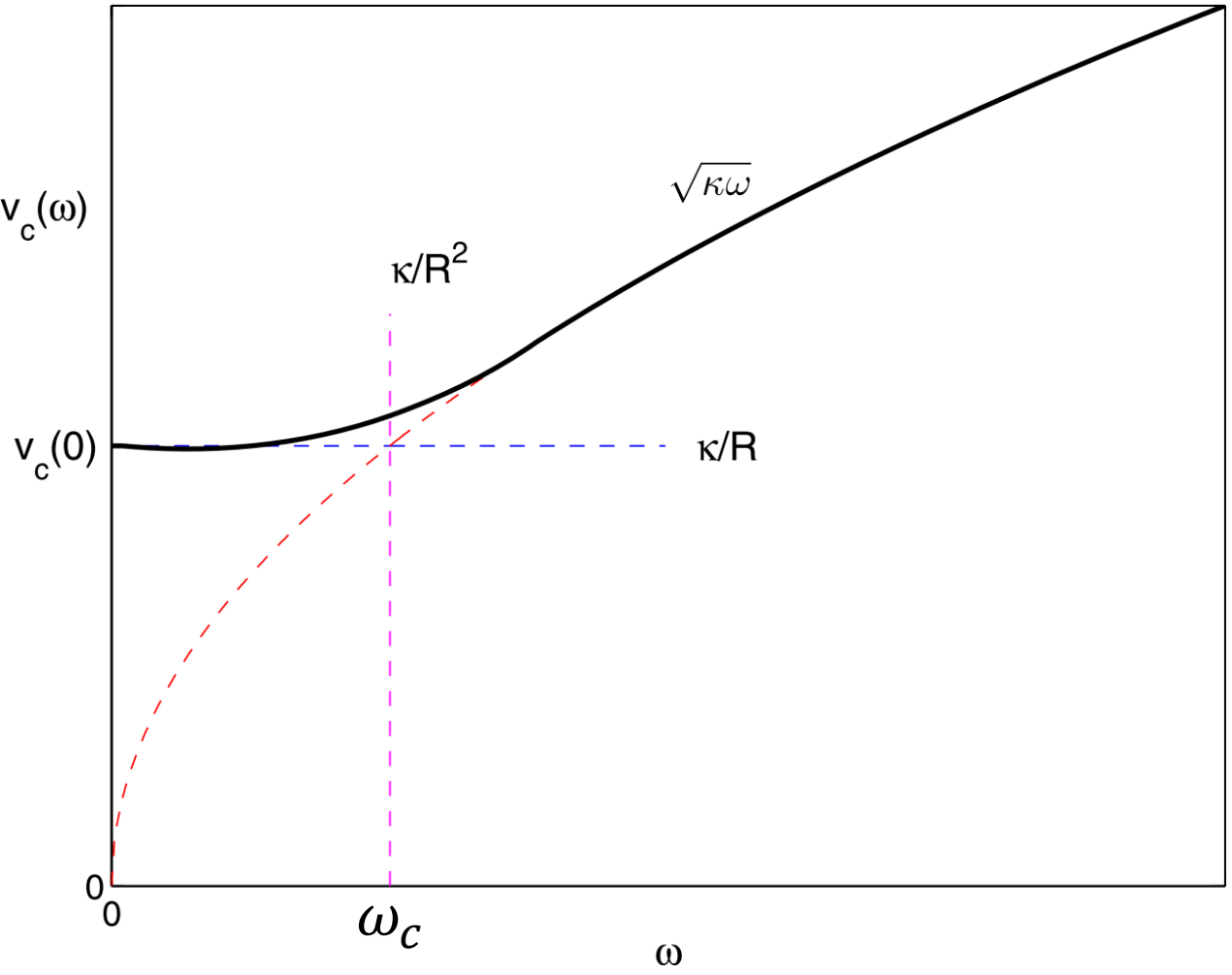


Vertical Oscillations: Results at 20 Hz





Critical Velocity vs Frequency



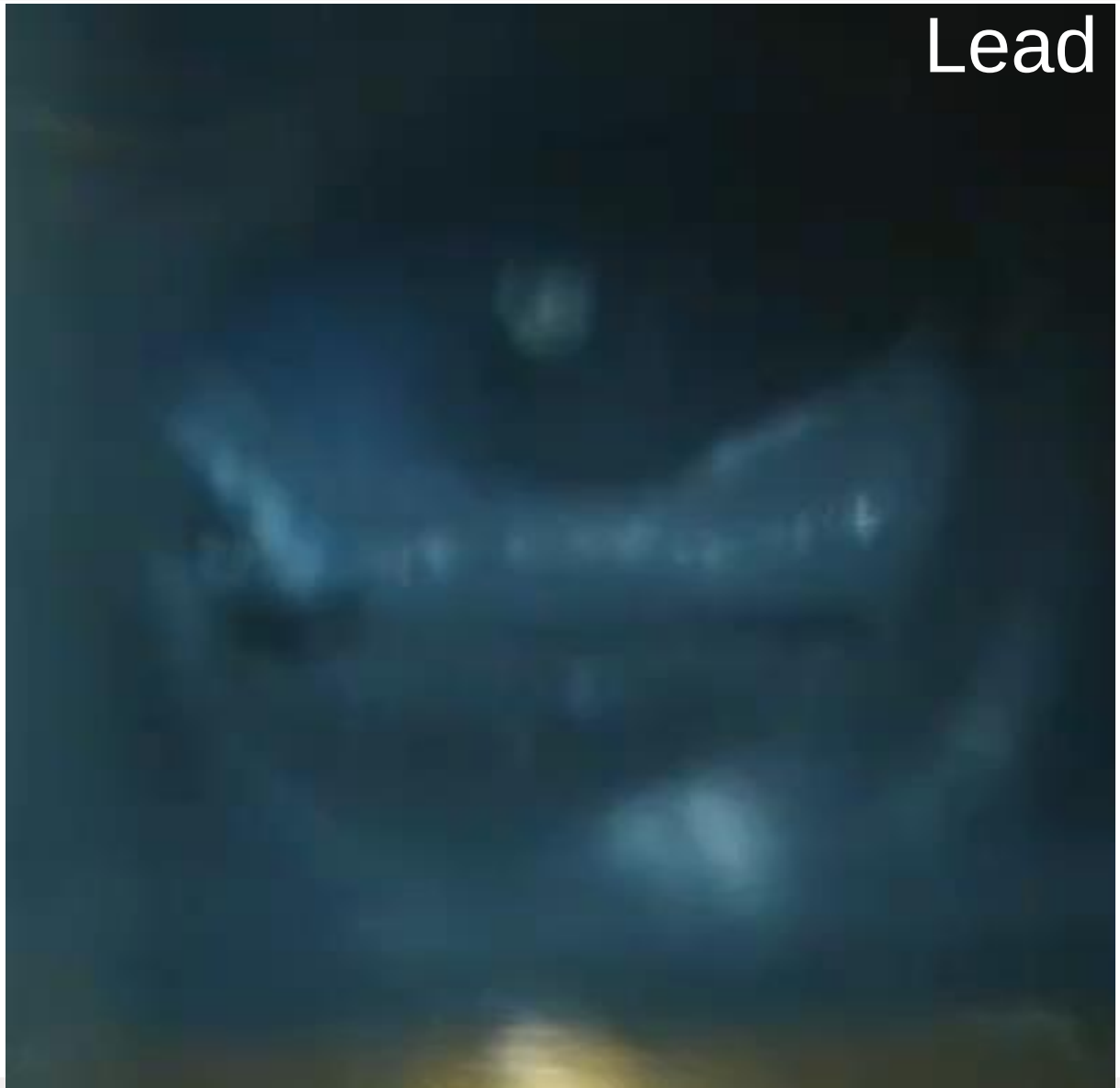
$$v_c(19.2\ Hz) \approx \sqrt{\frac{8\kappa\omega}{\beta}} = 11\ mm/s$$

$$\frac{\omega_c}{2\pi} \sim \frac{\kappa}{2\pi R^2} = 16\ mHz$$

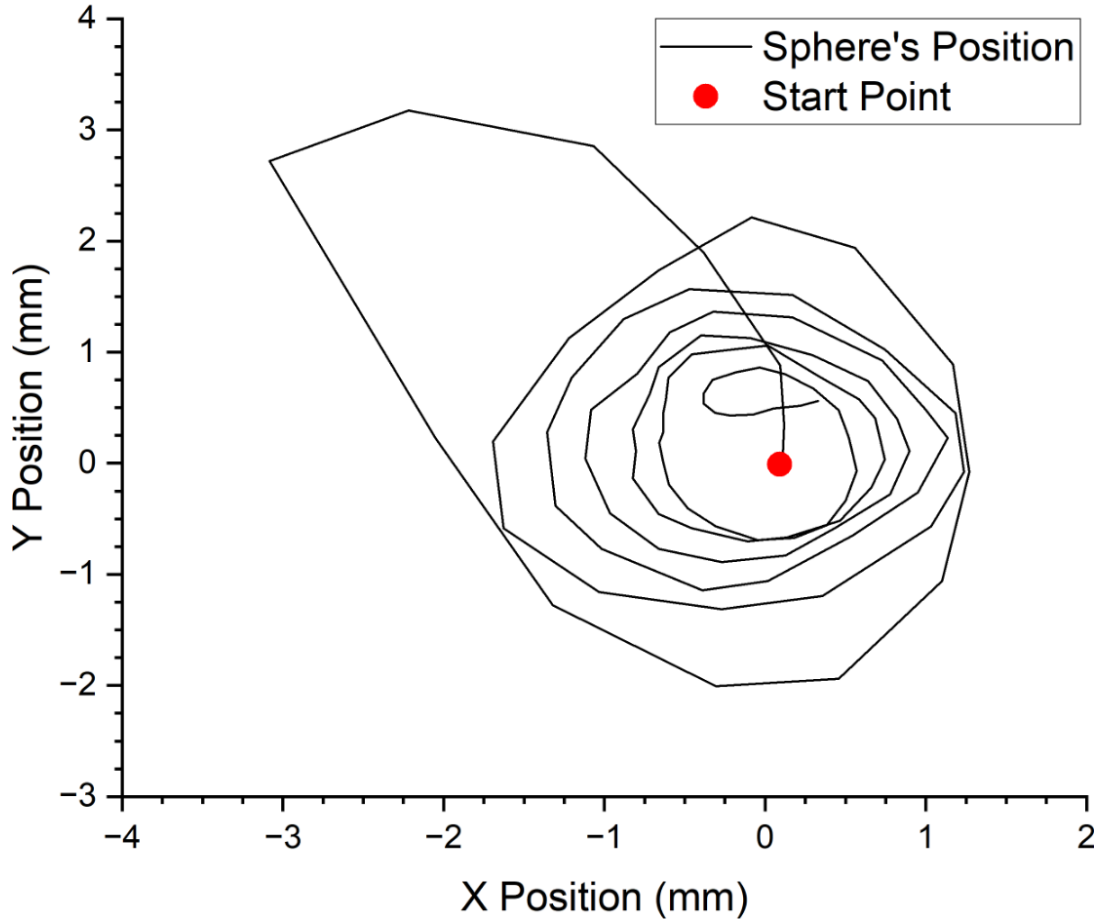
$$v_c(0) \sim \frac{\kappa}{R} = 0.1\ mm/s$$

Hänninen and Schoepe, *J. Low Temp Phys.* (2010)

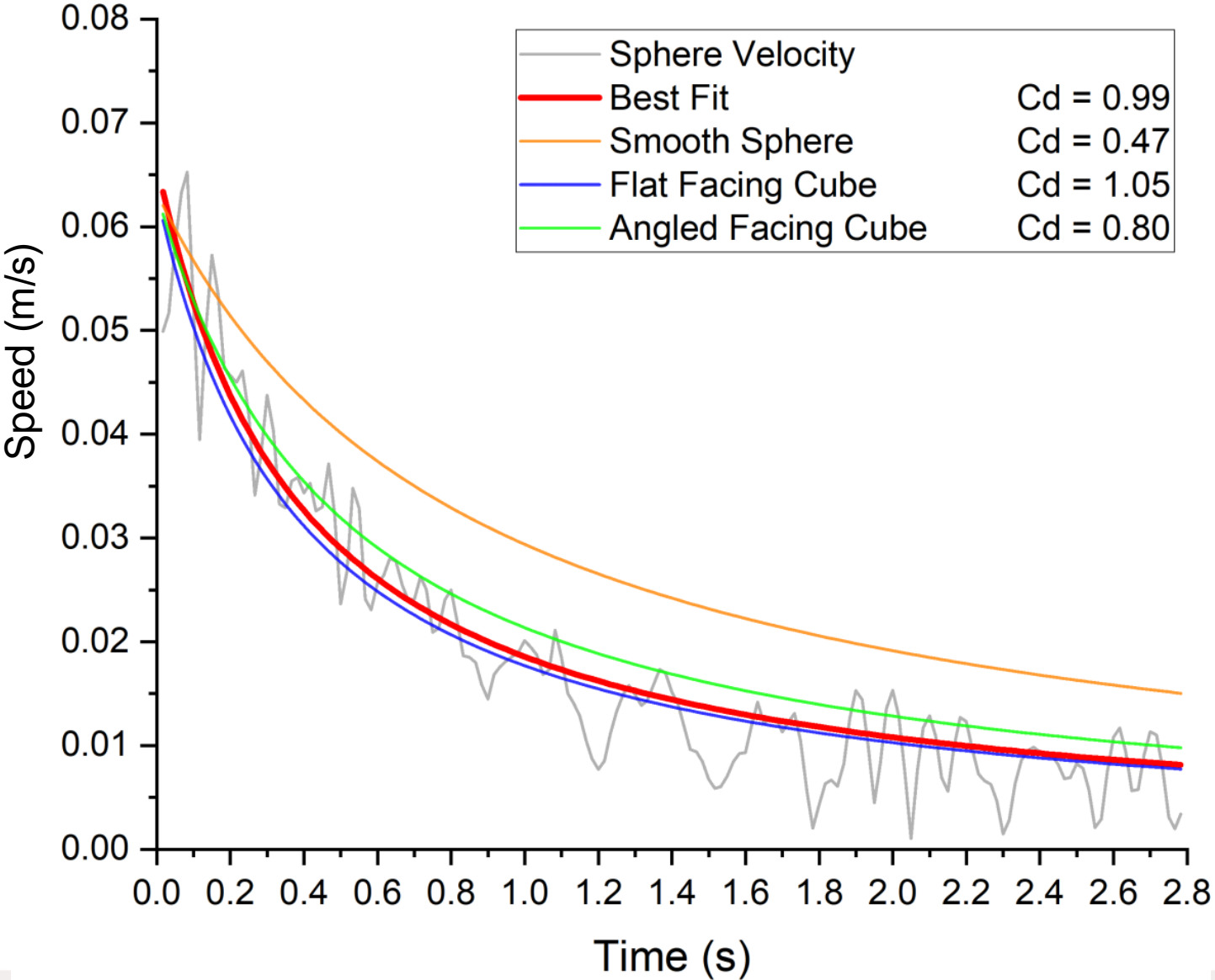
Circular Motion



Circular Motion: Results



Circular Motion: Results at 1.5 K

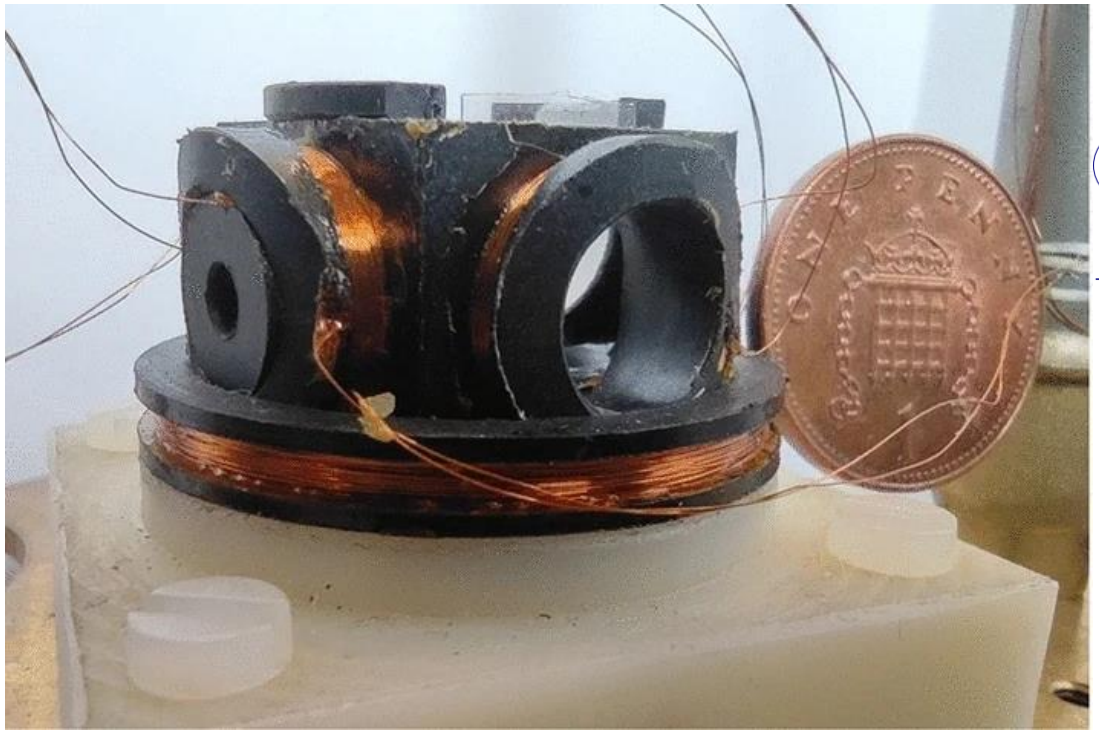


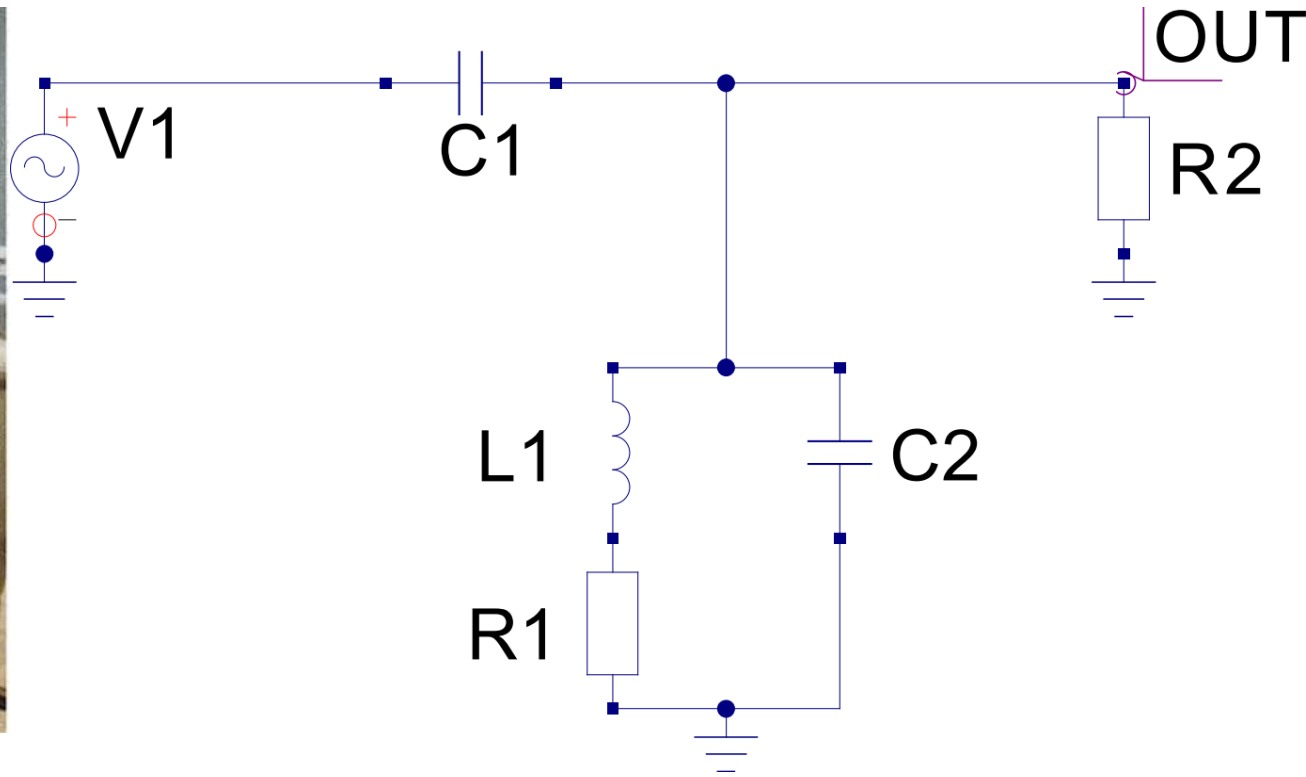
$$m\dot{v} = -\gamma v(t)^2$$

$$\gamma(T) = \frac{C_d \rho_s(T) \pi R^2}{2}$$

$$v_c(0) \sim \frac{\kappa}{R} = 0.1\ mm/s$$

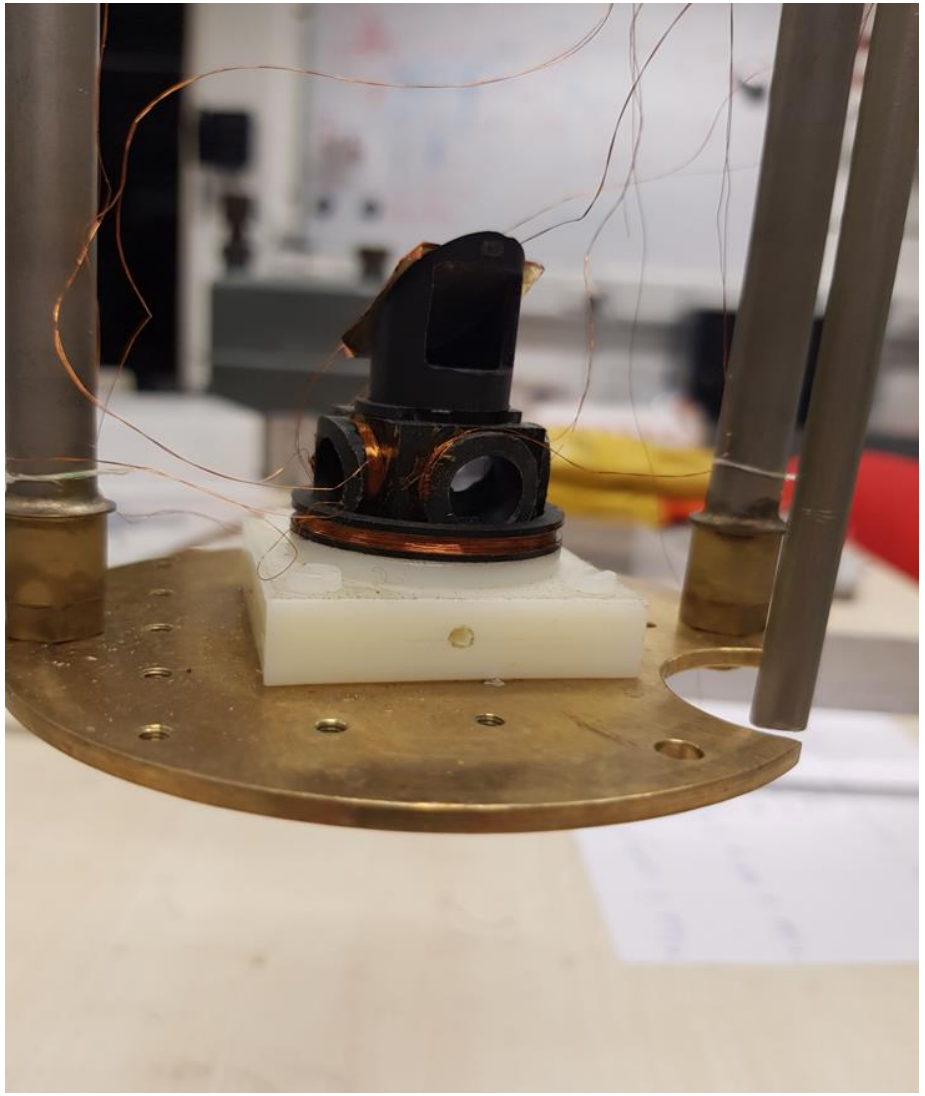
LC Detection System





Future Work

- Flying in cryogenic gas
- Aerofoils in superfluid
- Cryogenic wind tunnel
- LC detection system
- Repeat experiments using superfluid ^{3}He
- Lapping



Acknowledgements

- I wish to acknowledge the support of the Lancaster Ultra-low Temperature Group and our collaborators at Universidad Rey Juan Carlos.
- This work was supported by UK EPSRC (Grant No. EP/P024203/1 and EP/X004597/1), the EU H2020 European Microkelvin Platform (Grant Agreement 824109) and by Universidad Rey Juan Carlos, Programa Propio (Estrucura y dinámica de redes con interaciones de orden superior, M3038).

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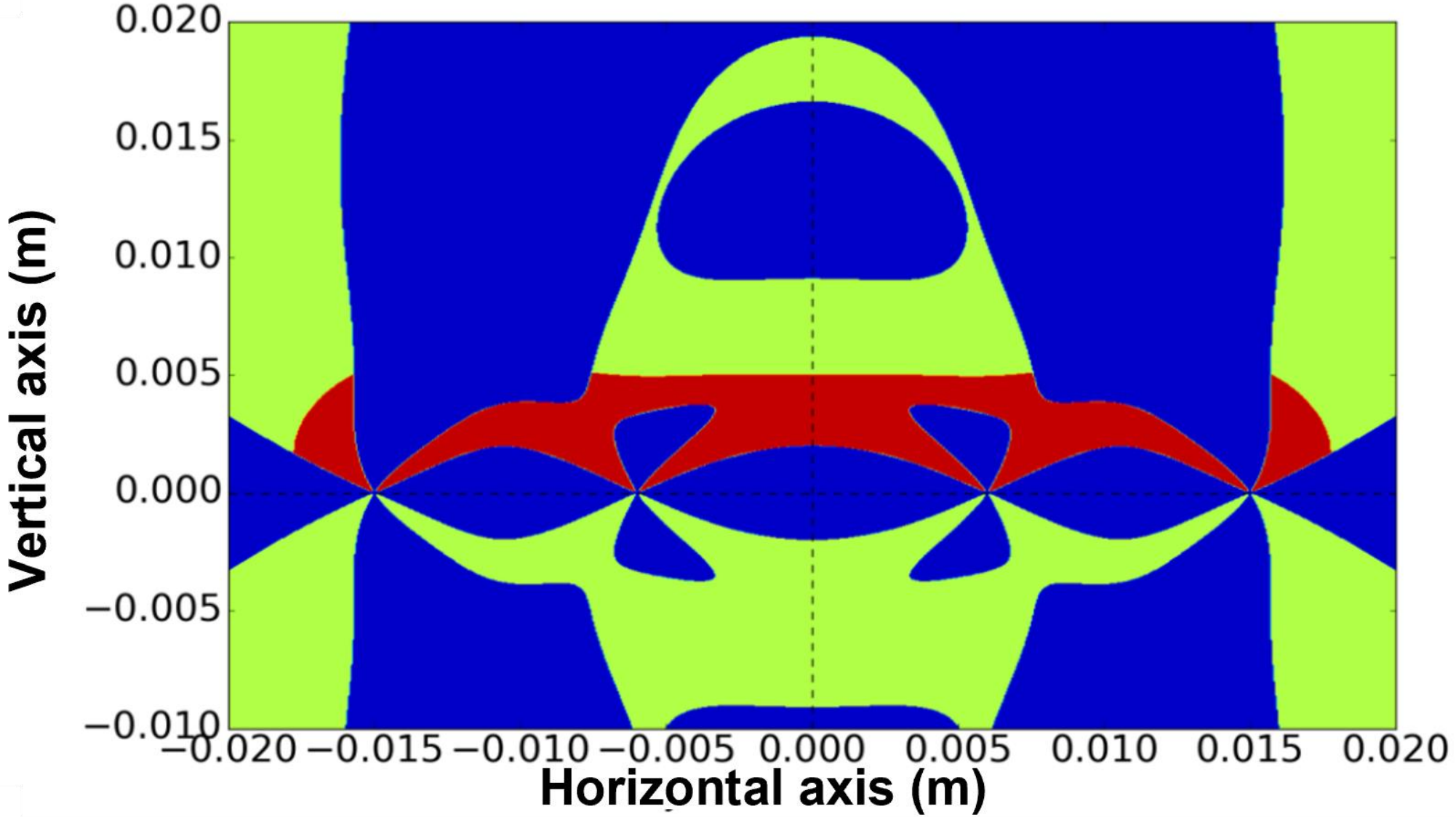
Appendix I: Stability



Appendix II: Circular Motion Currents