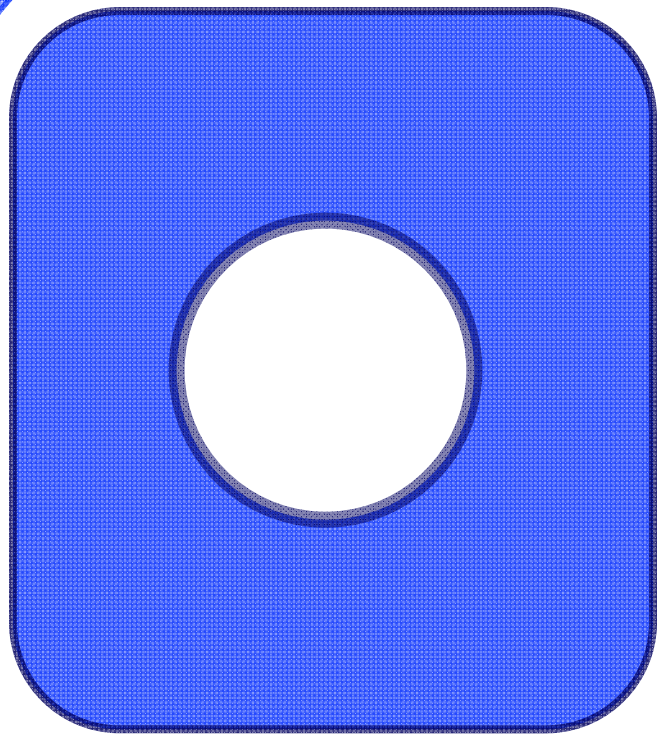

Spherical Heat Source in Superfluid Helium

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TREND 2008 FAIR

1. Superfluid Helium

Helium is superfluid below 2.2K

Superfluid transports no heat

Only recently have we been able to visualize superfluid motion

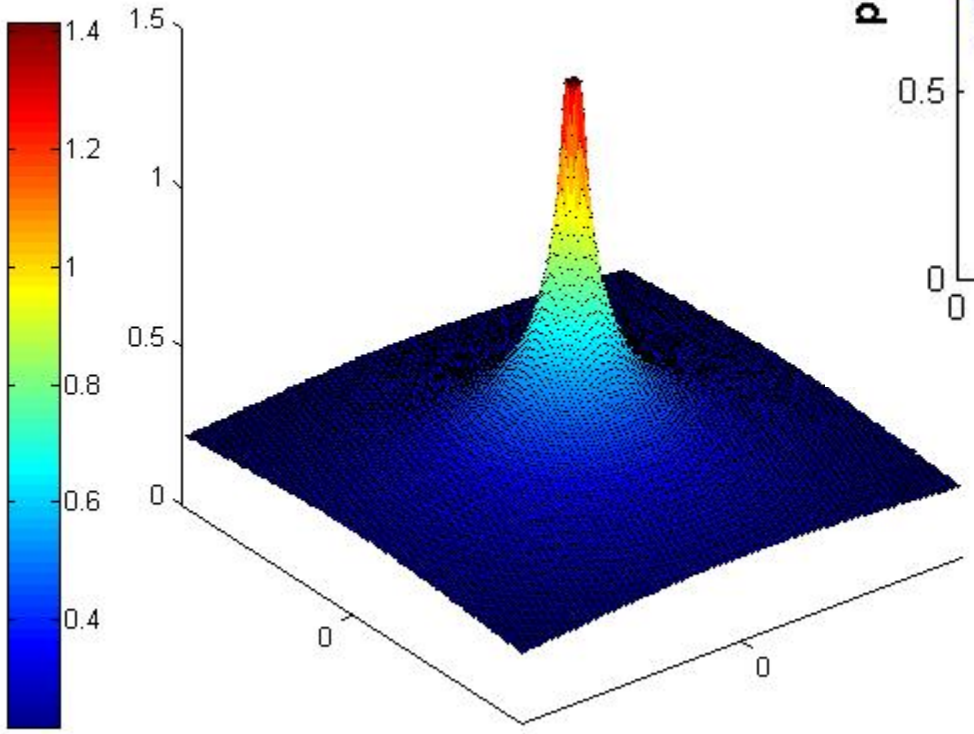
At absolute zero temperature, superfluid is described by the nonlinear Schrödinger equation:

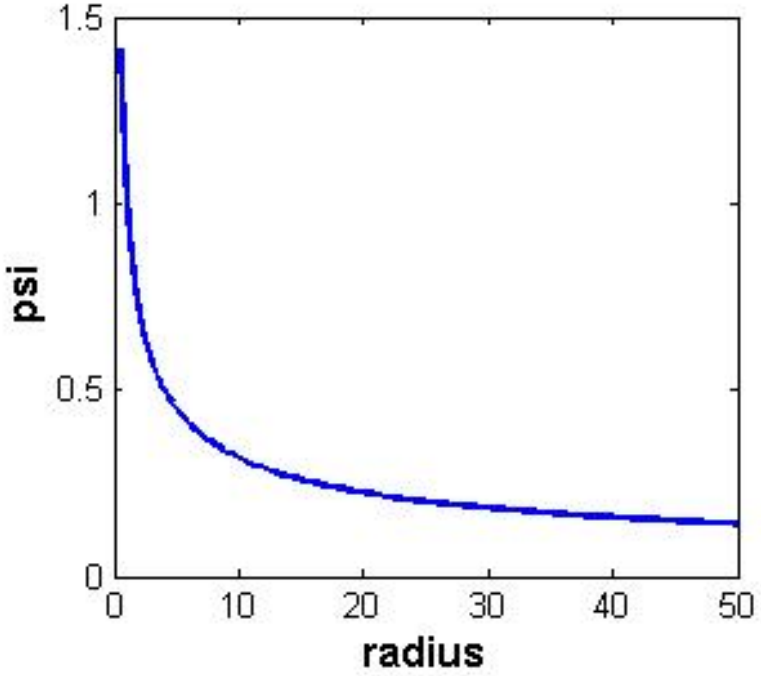
$$i\hbar\frac{\partial\psi}{\partial t} = \frac{-\hbar^2}{2m}\Delta\psi + g|\psi|^n\psi - \mu\psi$$

2. Analytic Solution

for the case n = 4 and μ = 0

$$\psi(r) = Ar^{-1/2}e^{ikln(r)}$$





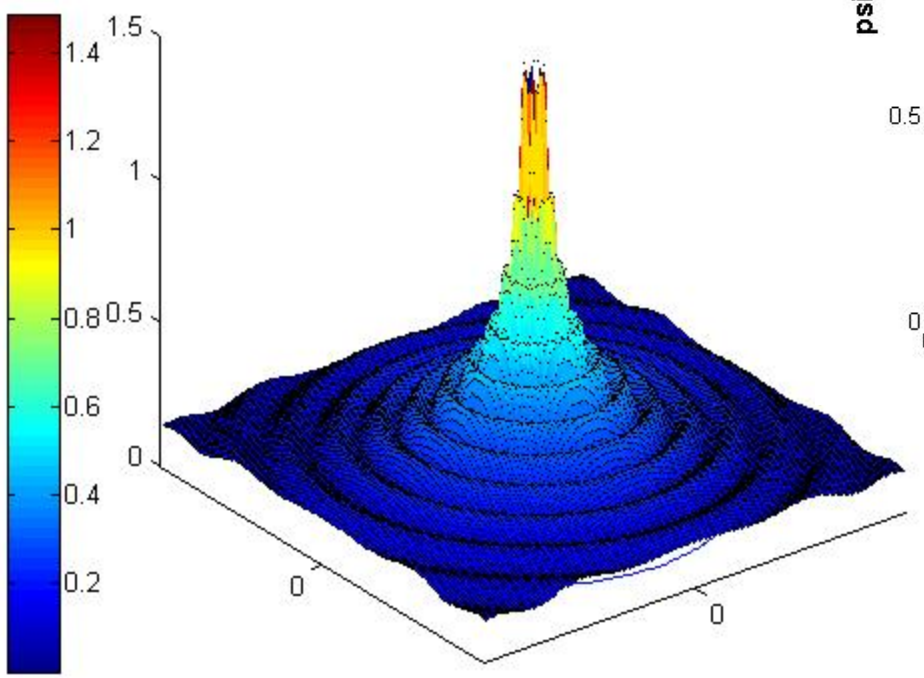
we find more general solutions through numerical integration

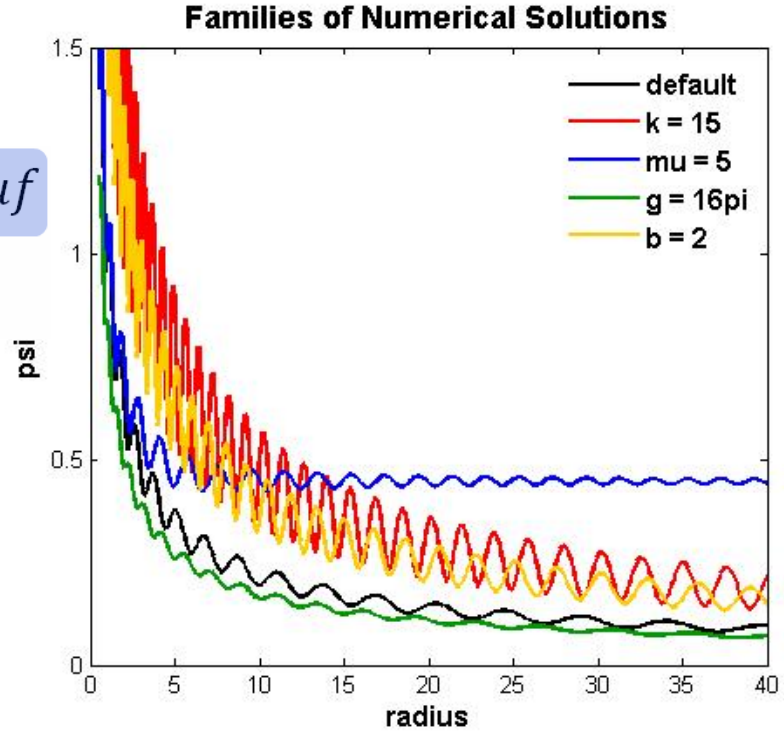
3. Numerical Integration

Runge-Kutta integration from small r = ε outwards

$$f' \equiv h \qquad h' = \frac{-2}{r}h + fu^2 - gf^n + \mu f$$

$$u' \equiv v \qquad v' = -2v\frac{h}{f} - 2\frac{v}{r}$$

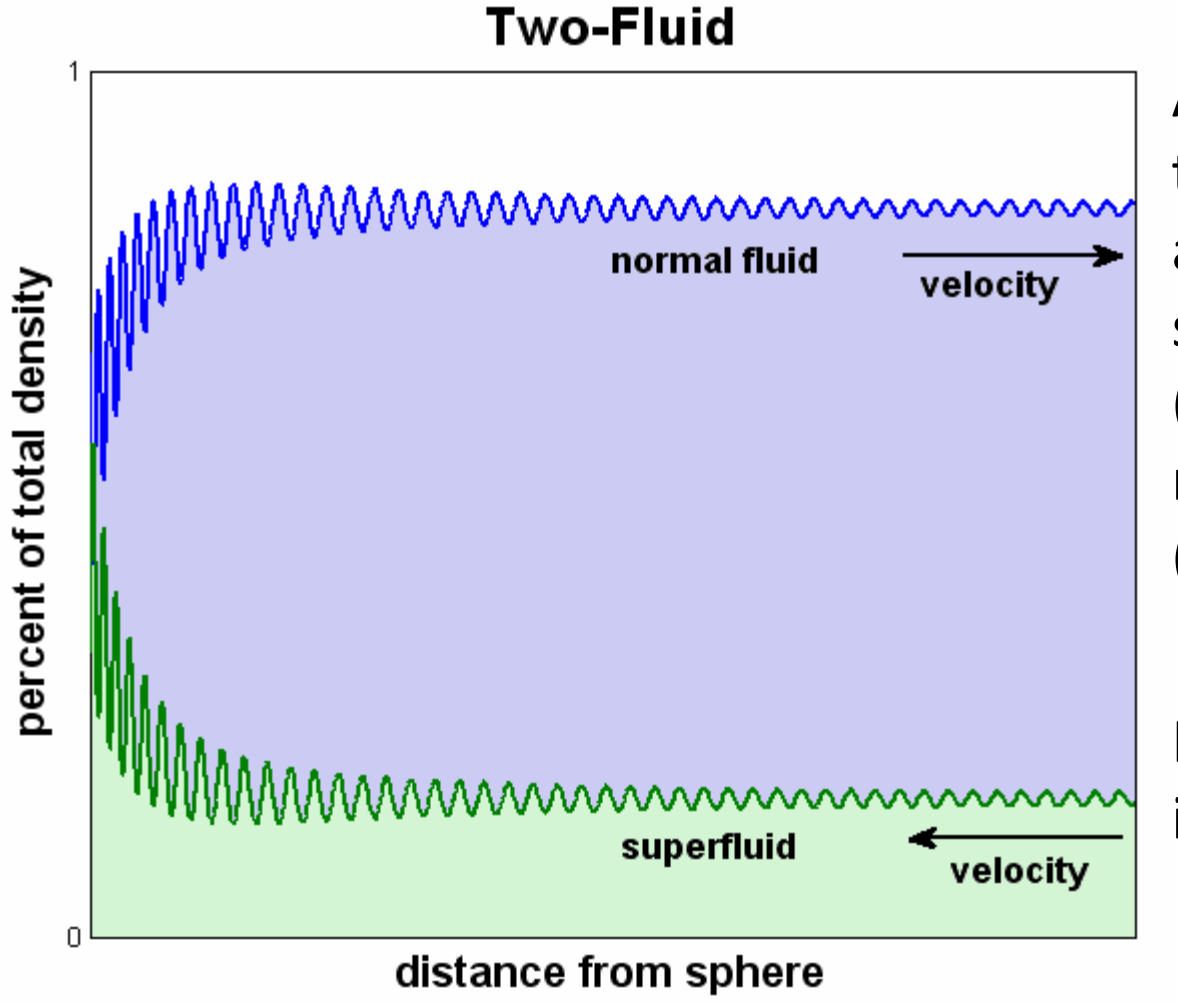




inherent oscillation

families of solutions for small changes in the initial conditions

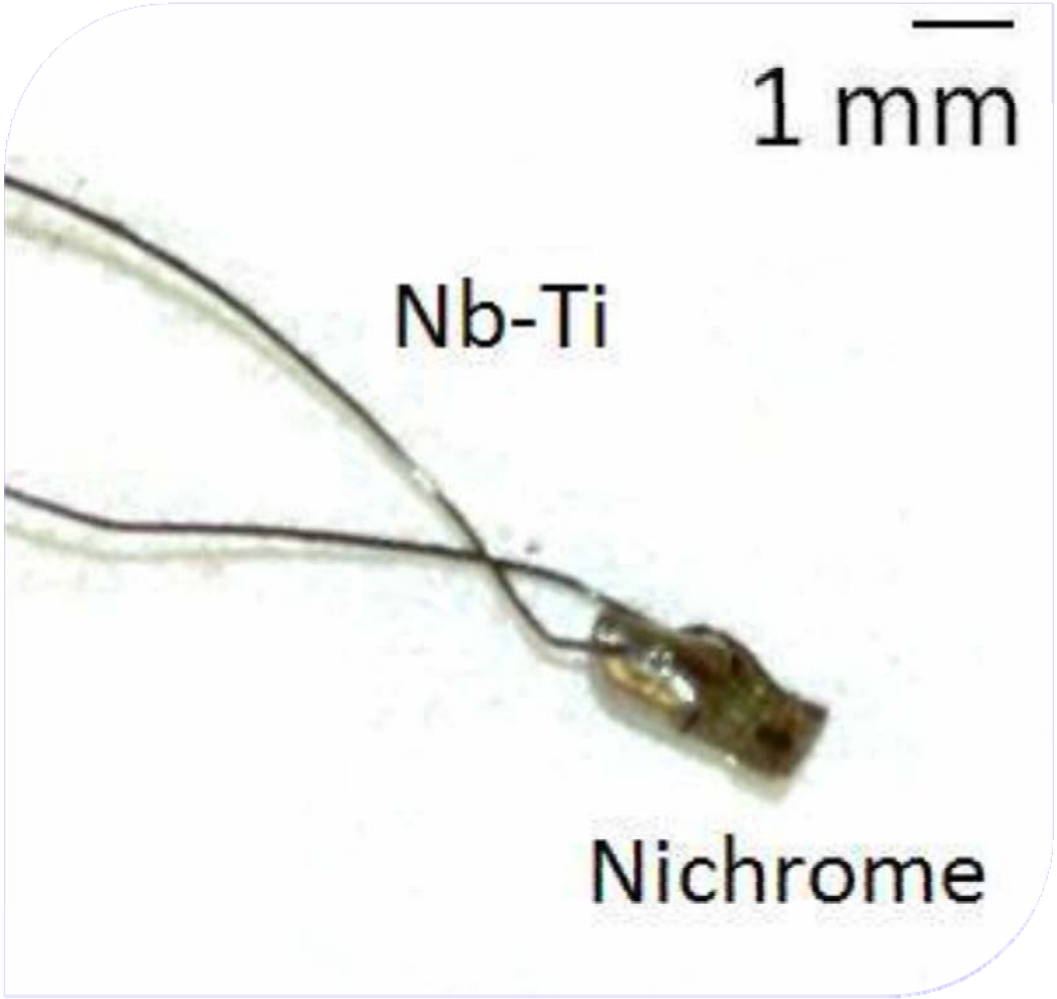
4. Two-Fluid Model

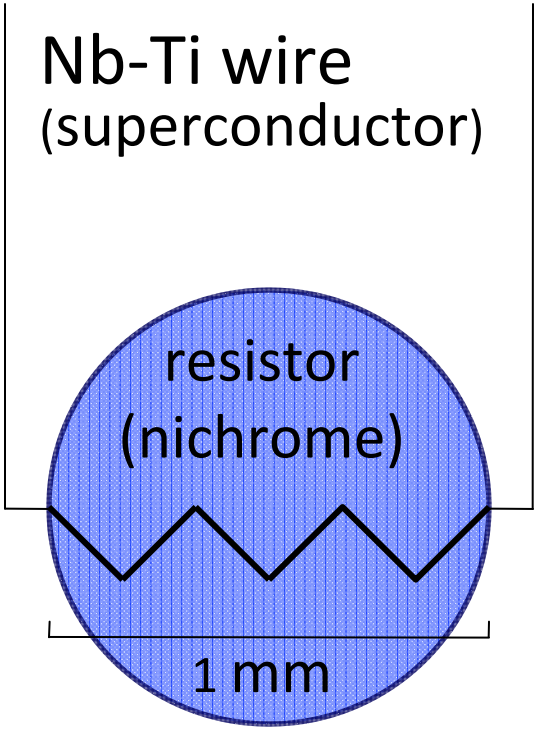


Above absolute zero temperature, helium acts as a mixture of superfluid (quantum) and normal fluid (classical)

Heat turns superfluid into normal fluid

5. Building the Sphere





the sphere is constructed and ready to test