

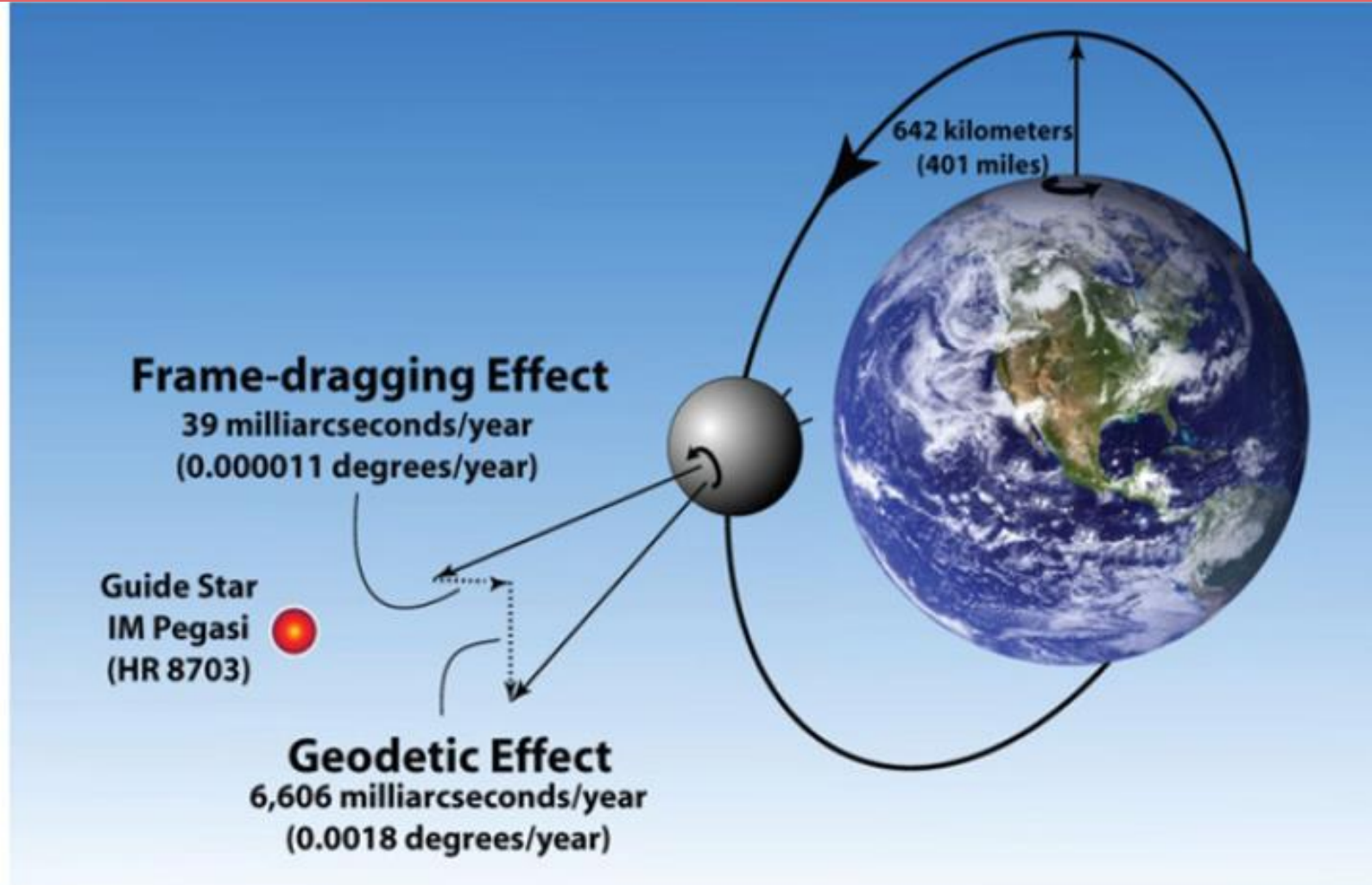
Make a magnet precess

Pavel Fadeev

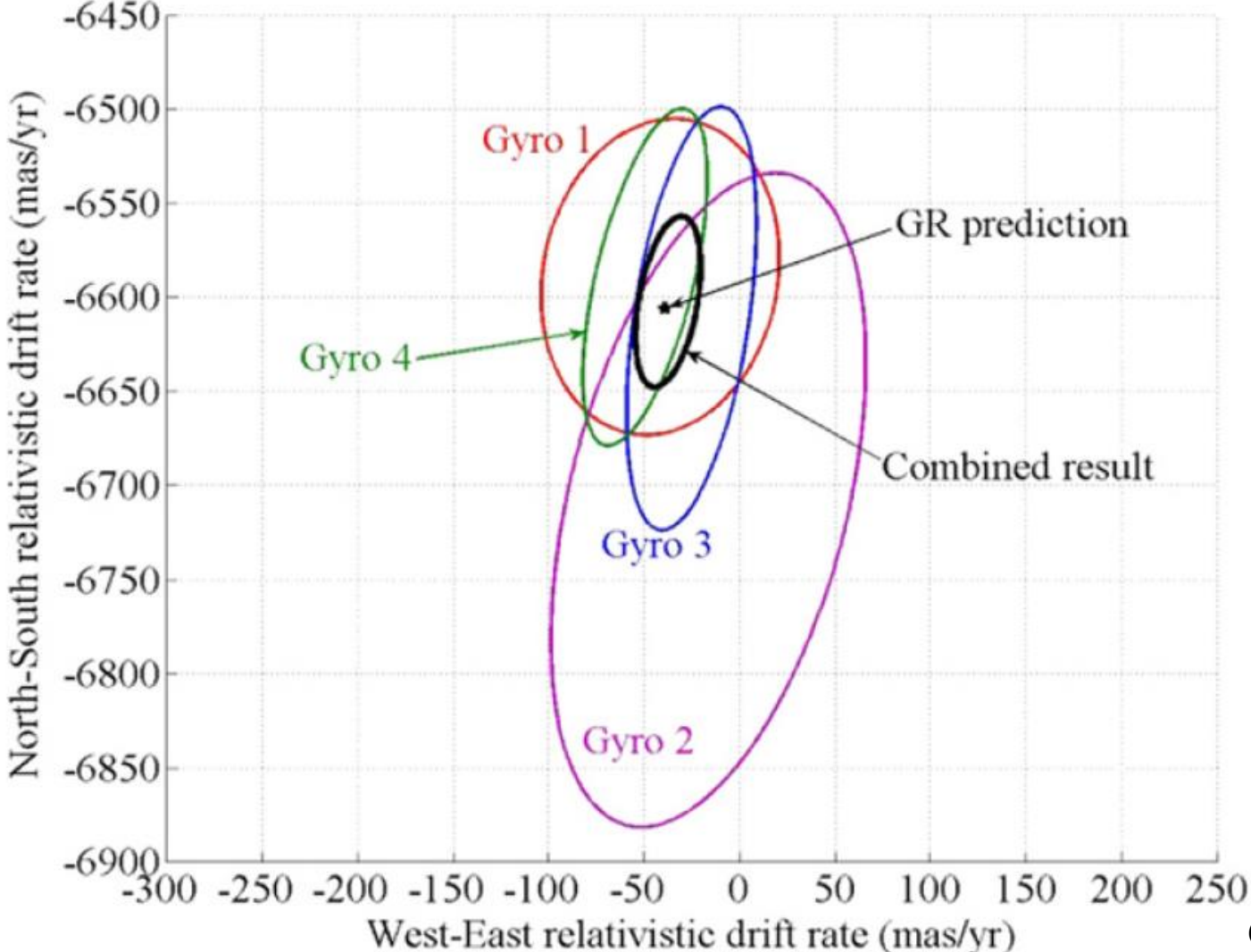
Sydney

08.12.2022

Gravity Probe B measures GR effects

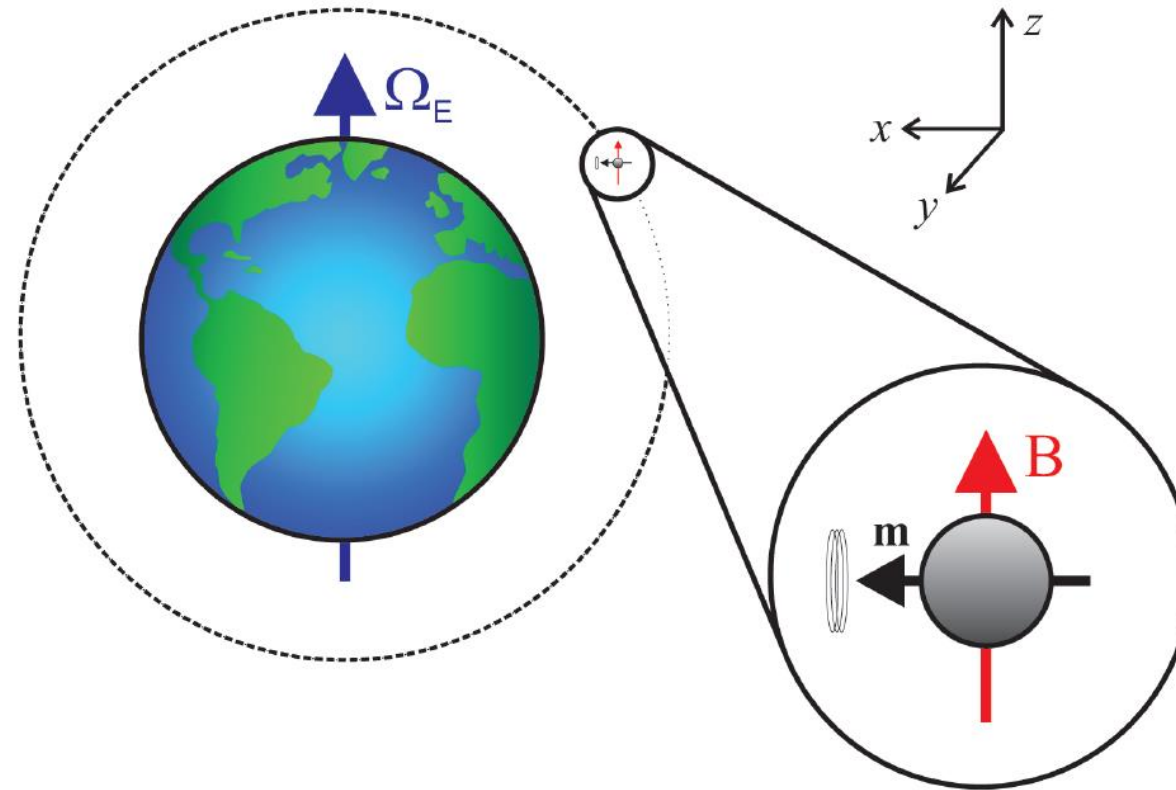


Gravity Probe B measures GR effects



C.W. F. Everitt et. al., PRL 106, 221101 (2011)

Gravity Probe Spin, a space mission



1 mm radius cobalt sphere in cryogenic vacuum, $B^* \approx 10^{-11} \text{G}$, $N = 10^{20}$ polarized spins

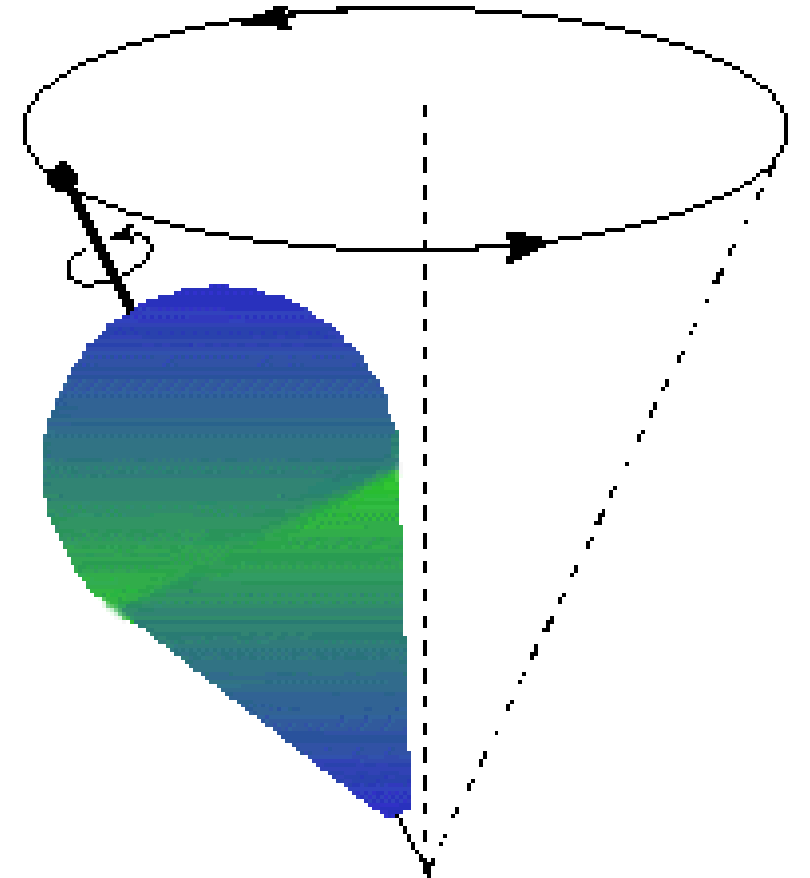
P. Fadeev, C. Timberlake, T. Wang, A. Vinante, Y. B. Band, D. Budker, A. O. Sushkov, H. Ulbricht, and D. F. Jackson Kimball, Quantum Sci. Technol. 6, 024006 (2021).

Two regimes of motion

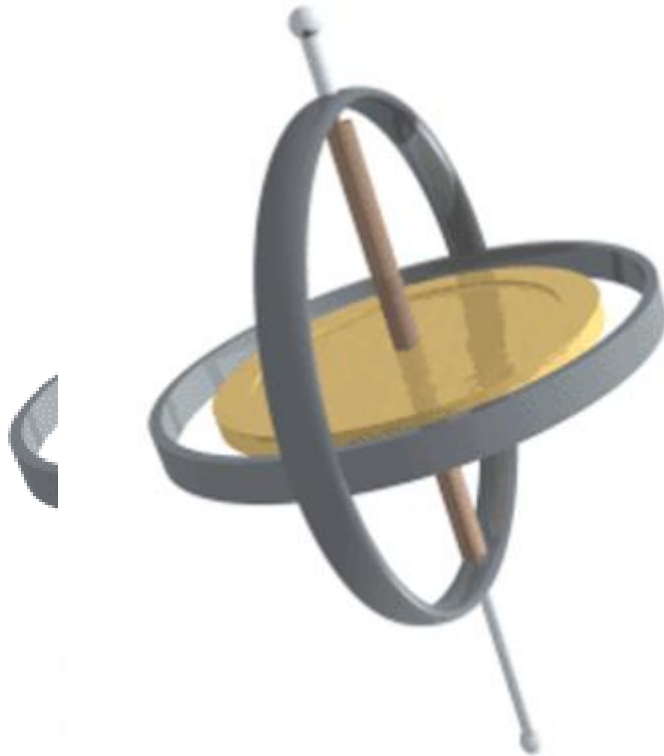
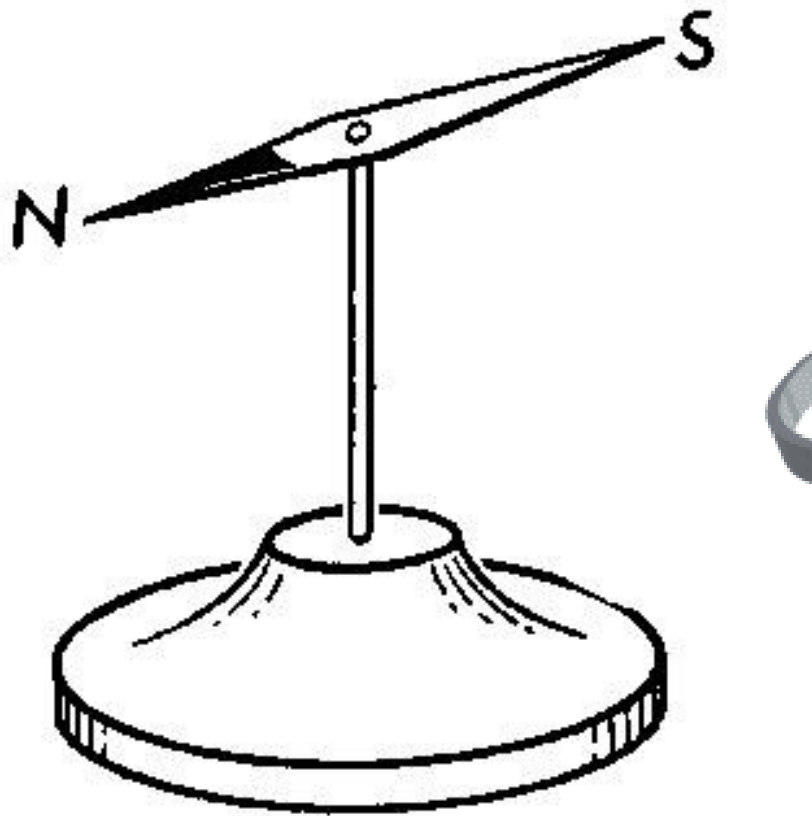


Precessing regime: $S \gg L$;

Tipping regime: $L \gg S$.



Ferromagnetic Gyroscope



✓ For precession to dominate

$$L \ll S$$

In other words

$$I \Omega \ll N \hbar$$

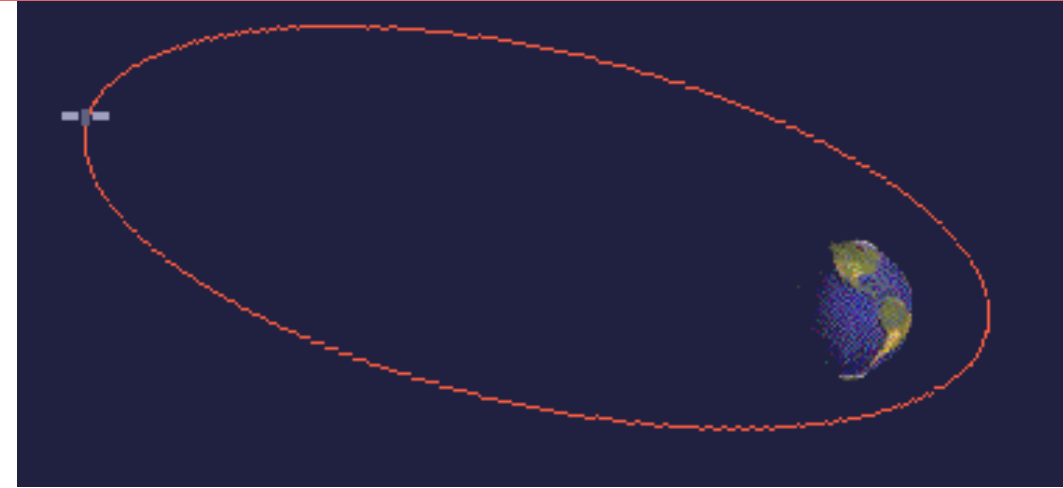
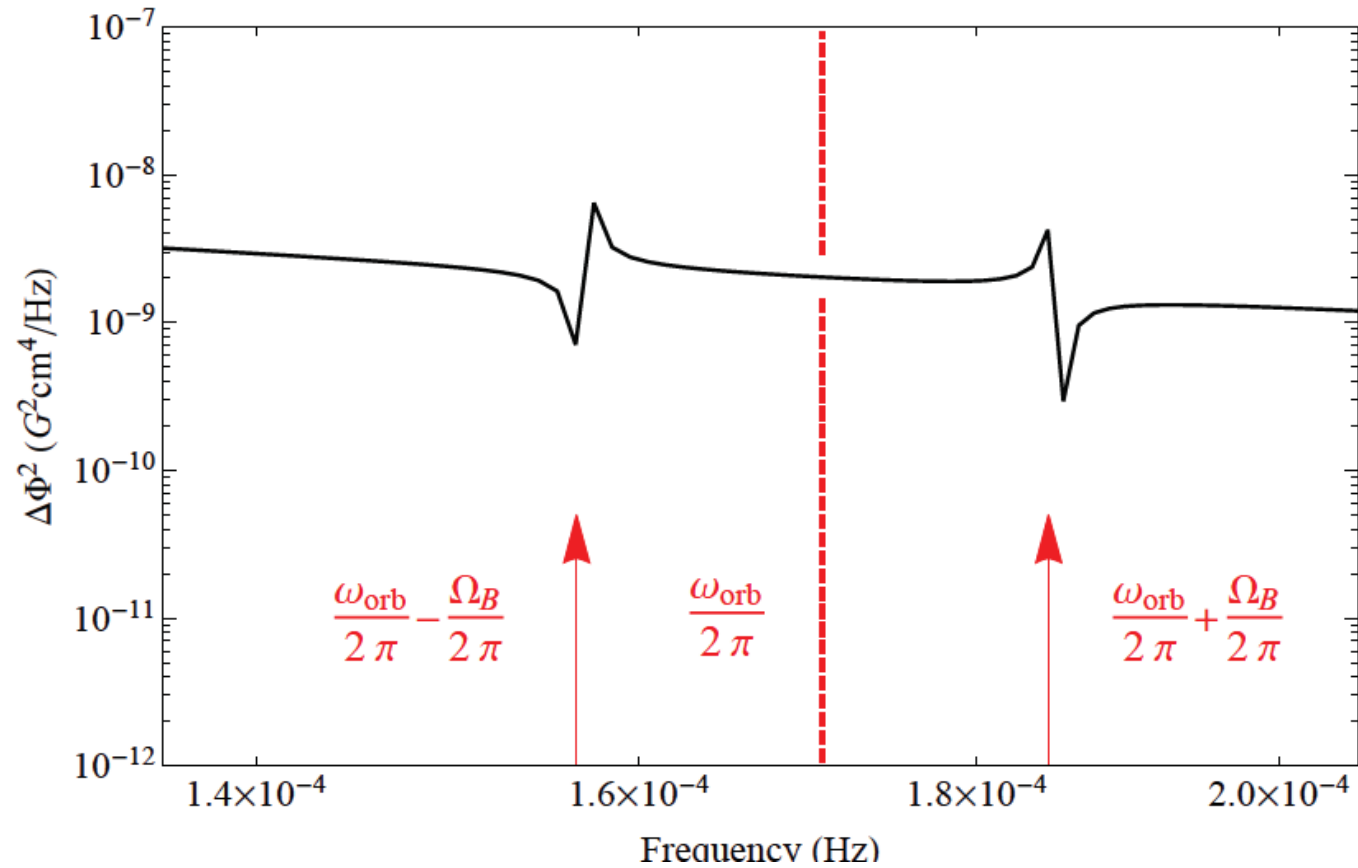
Threshold frequency

$$\Omega^* = \frac{N \hbar}{I}$$

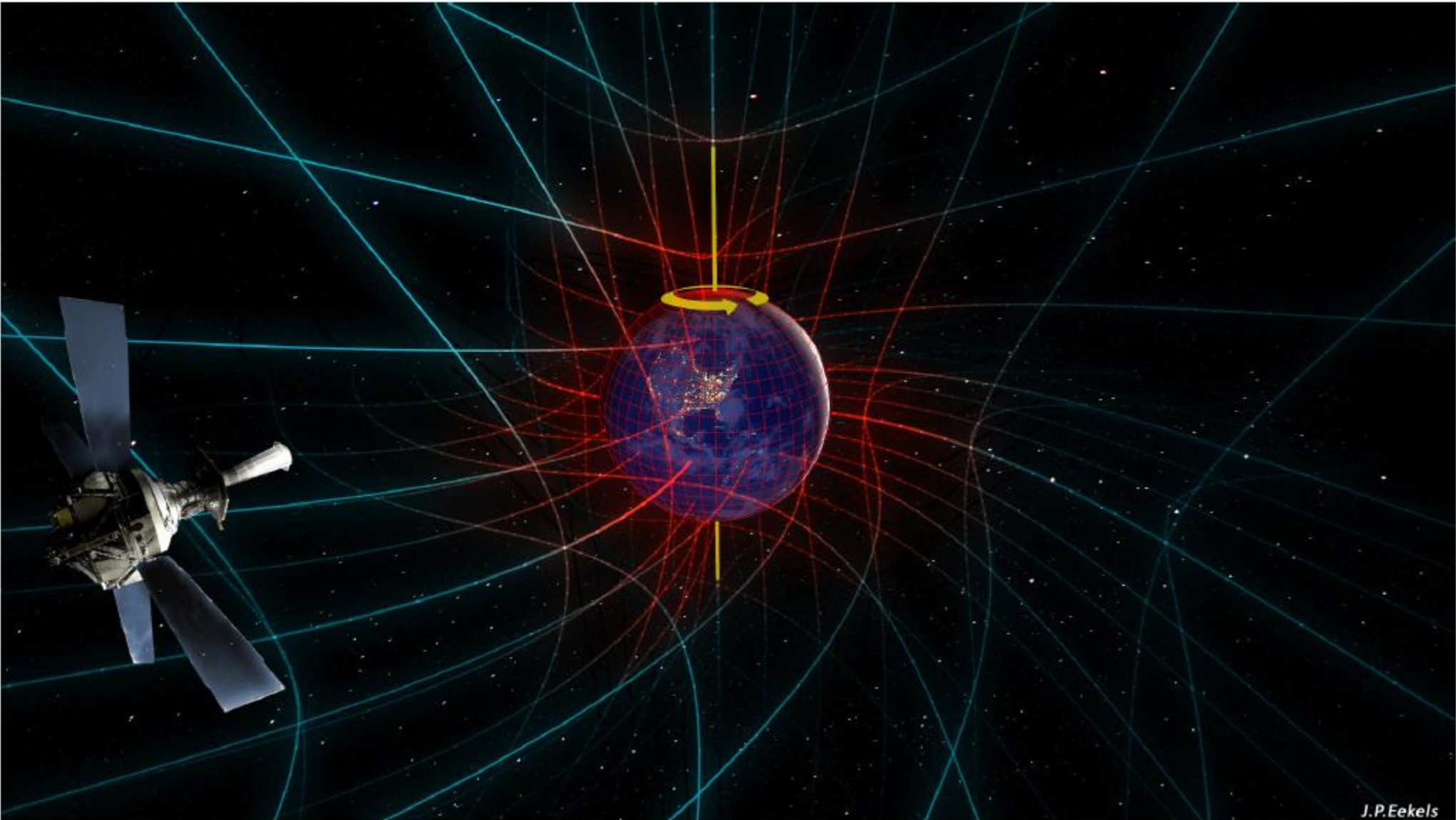
Threshold magnetic field

$$B^* = \frac{\hbar \Omega^*}{g \mu_B}$$

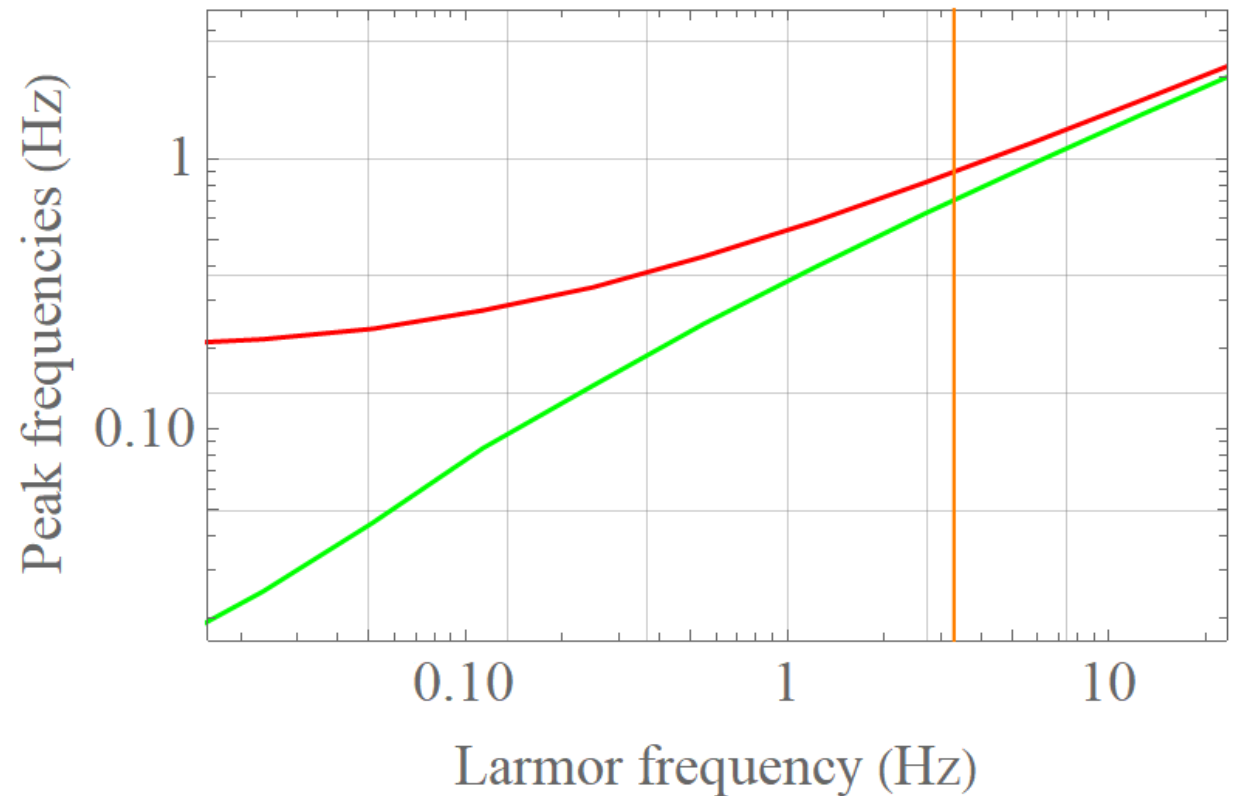
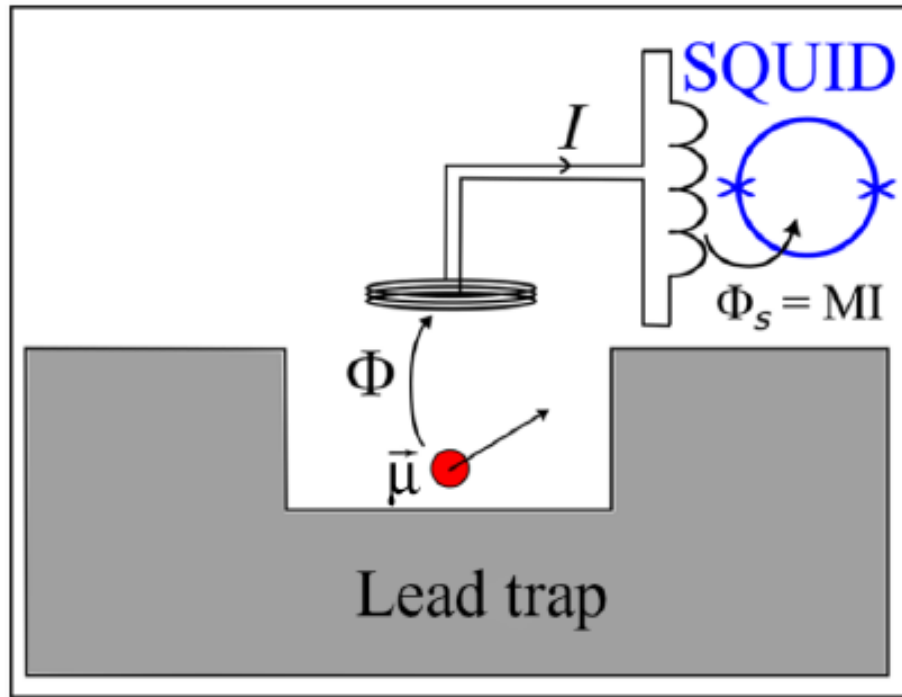
Spectrum of a difference between two magnets



Ferromagnetic Gyroscope in freefall



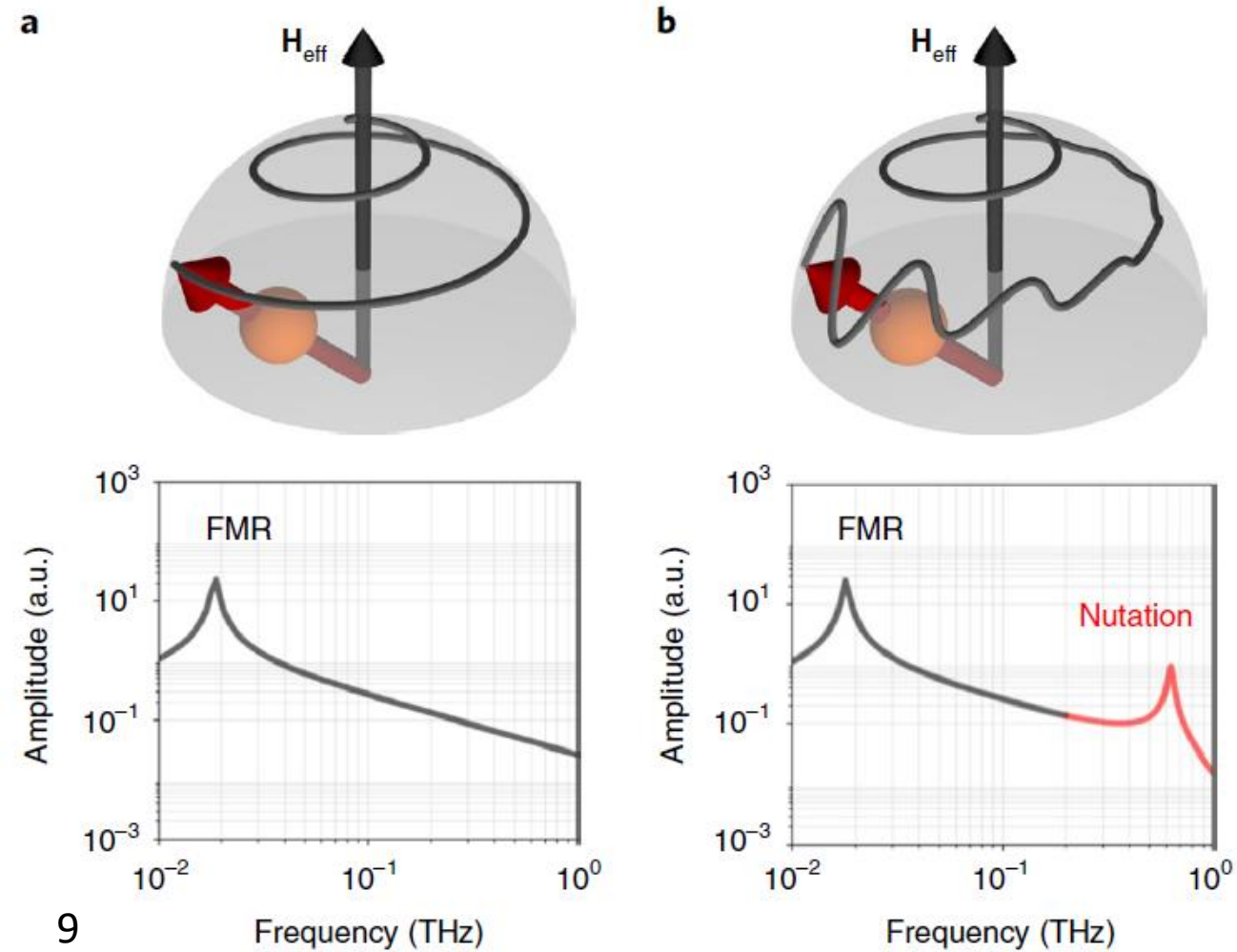
Proof-of-principle device in the lab



P. Fadeev, C. Timberlake, T. Wang, A. Vinante, Y. B. Band, D. Budker, A. O. Sushkov, H. Ulbricht, and D. F. Jackson Kimball, *Quantum Sci. Technol.* 6, 024006 (2021).

Inertial spin dynamics in ferromagnets

<https://doi.org/10.1038/s41567-020-01040-y>



LeMaQuMe

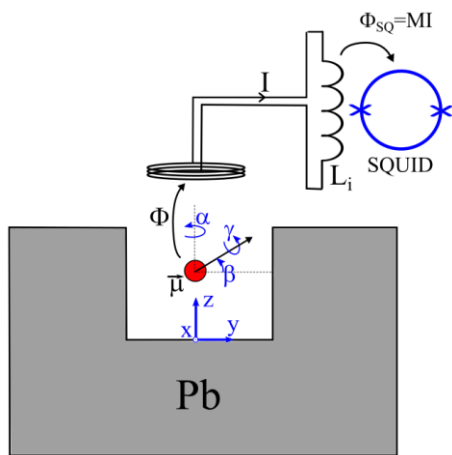
Levitated Magnets for Quantum Metrology



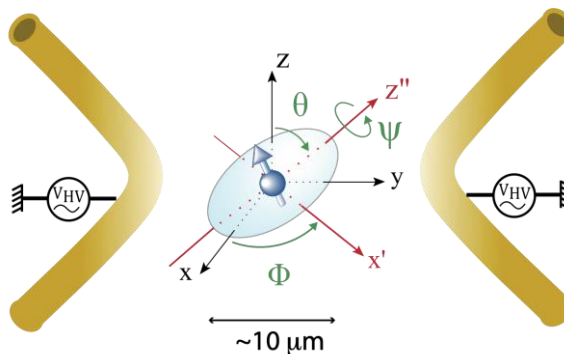
- Partners: CNR-IFN Trento (IT), CNRS Paris, (FR), JGU Mainz, LUH Hannover, Uni Ulm (DE), Uni Latvia (LV), Ben Gurion Uni (Israel)

External Partners: Southampton (UK), Boston, California East Bay (US)

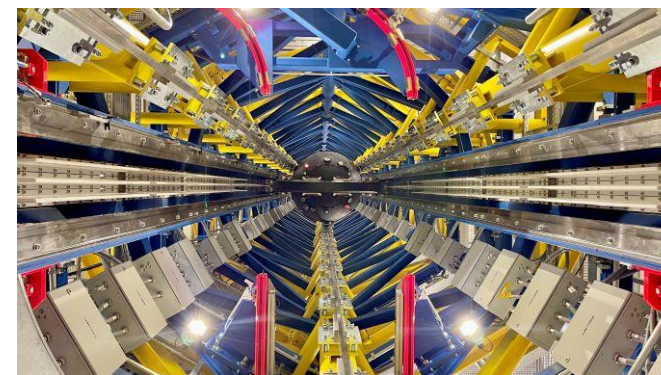
Three platforms for levitated micro/nanomagnets



SUPERCONDUCTING TRAPS



PAUL TRAPS & CIRCUIT TRAPS



FREE-FALL (EINSTEIN ELEVATOR)

Thank you

pavelfadeev1@gmail.com