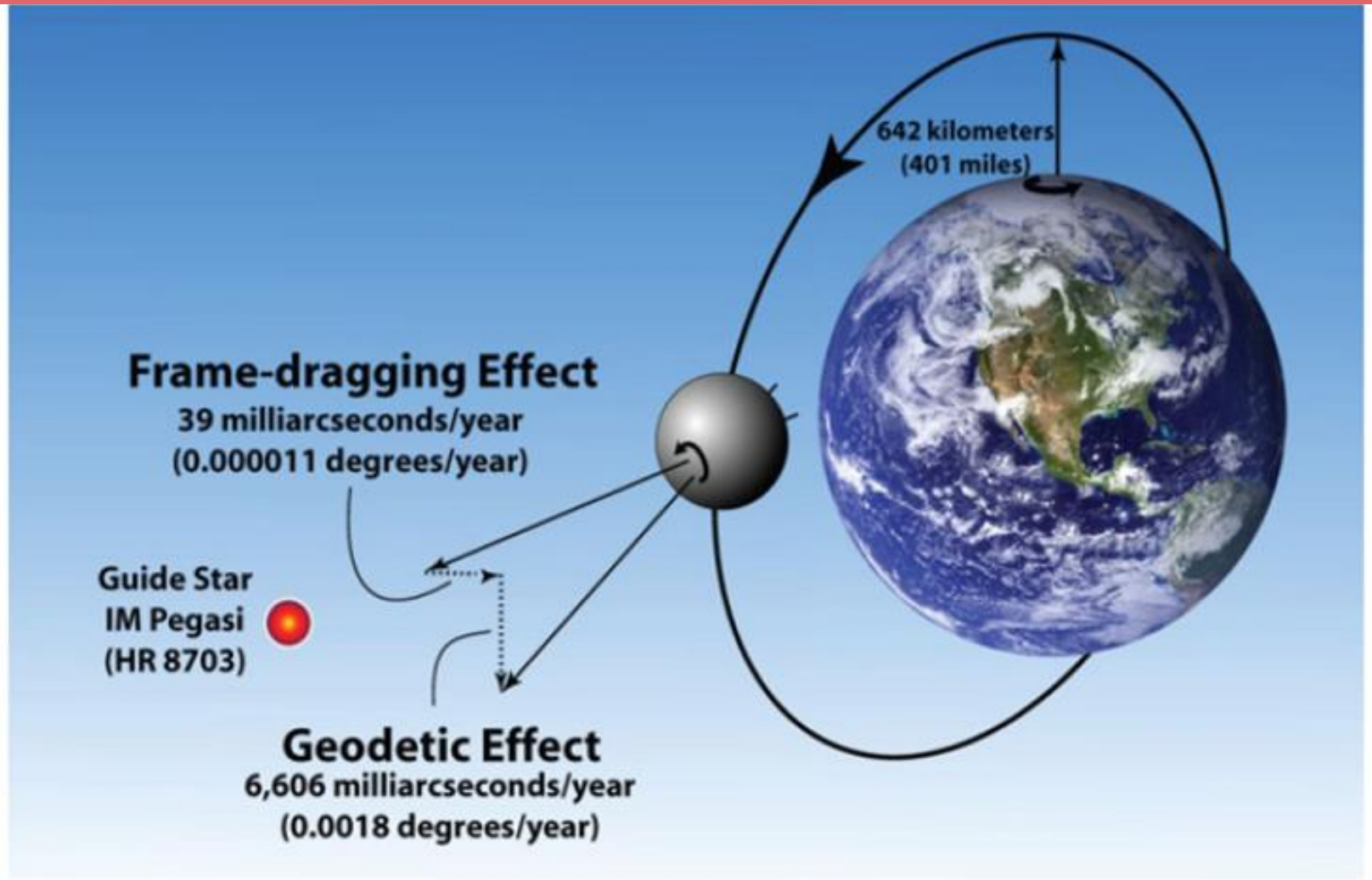
Make a magnet precess

Pavel Fadeev

Sydney

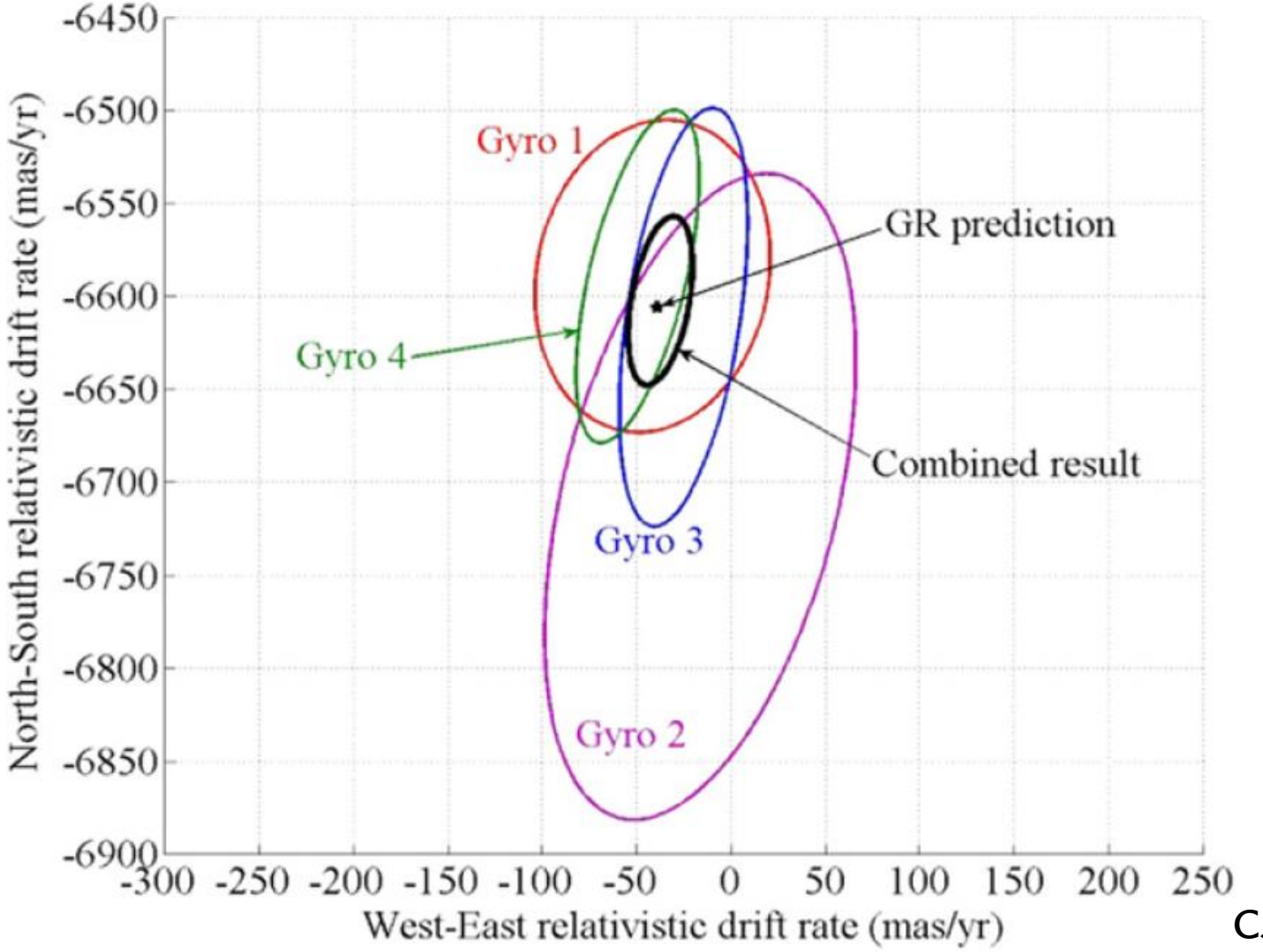
08.12.2022

Gravity Probe B measures GR effects



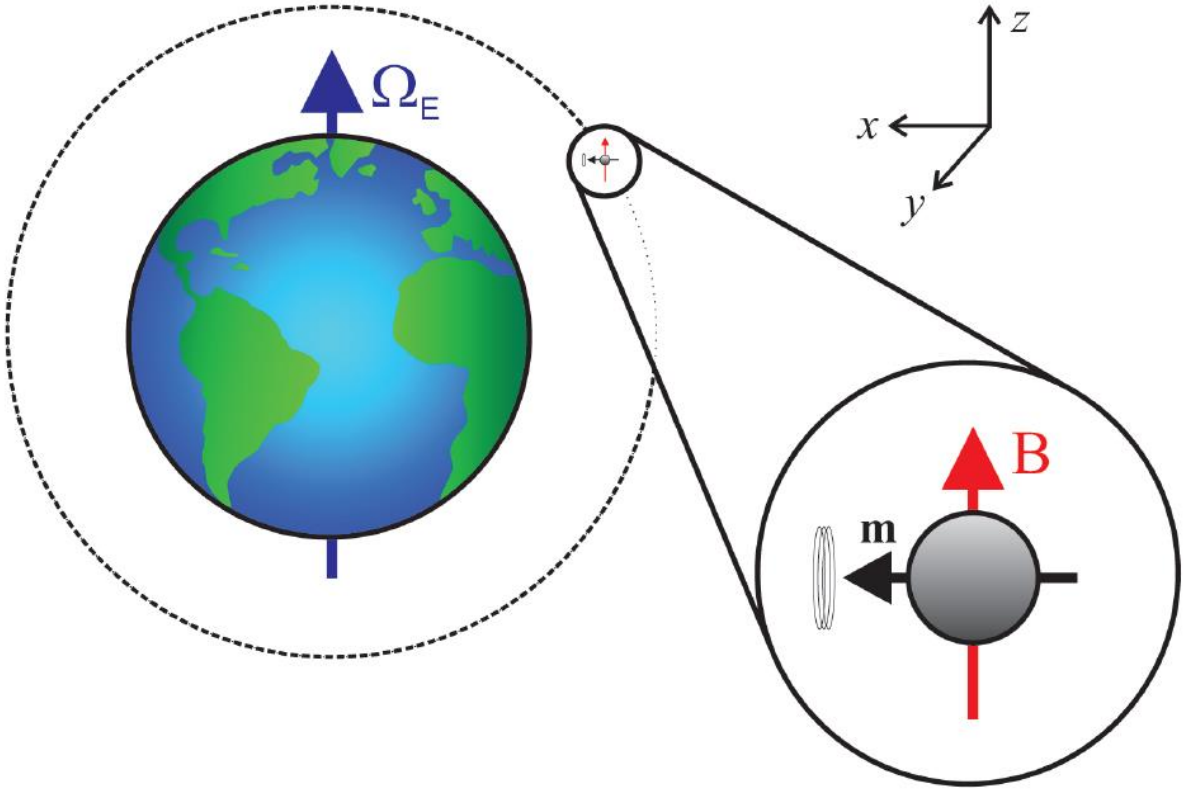
C.W. F. Everitt et. al., PRL **106**, 221101 (2011)

Gravity Probe B measures GR effects



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

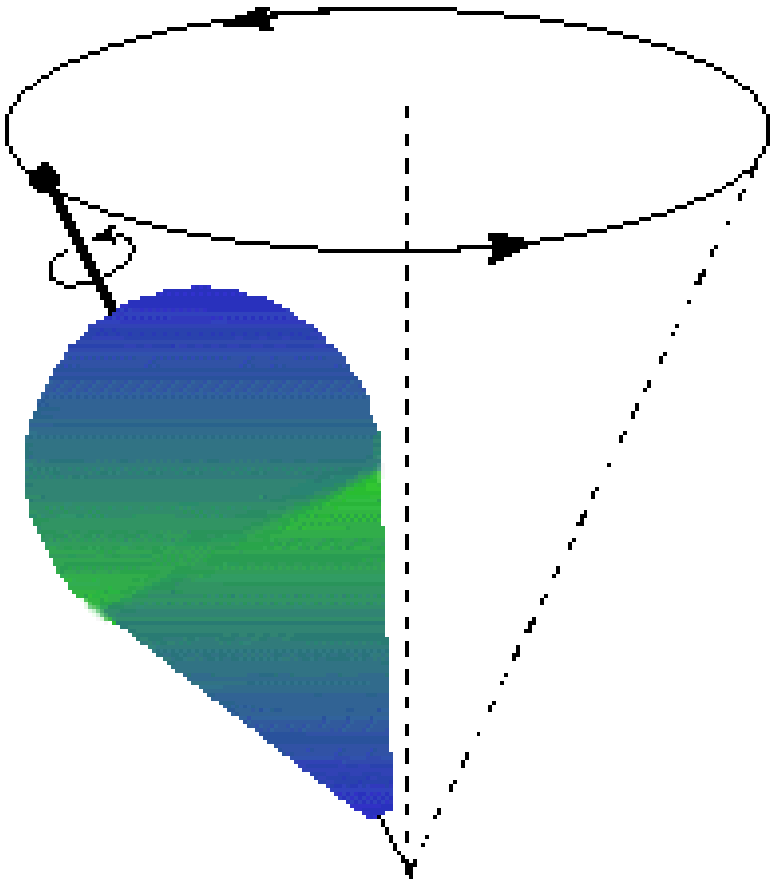
Gravity Probe Spin, a space mission



1 mm radius cobalt sphere in cryogenic vacuum, $B^* \approx 10^{-11}$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).

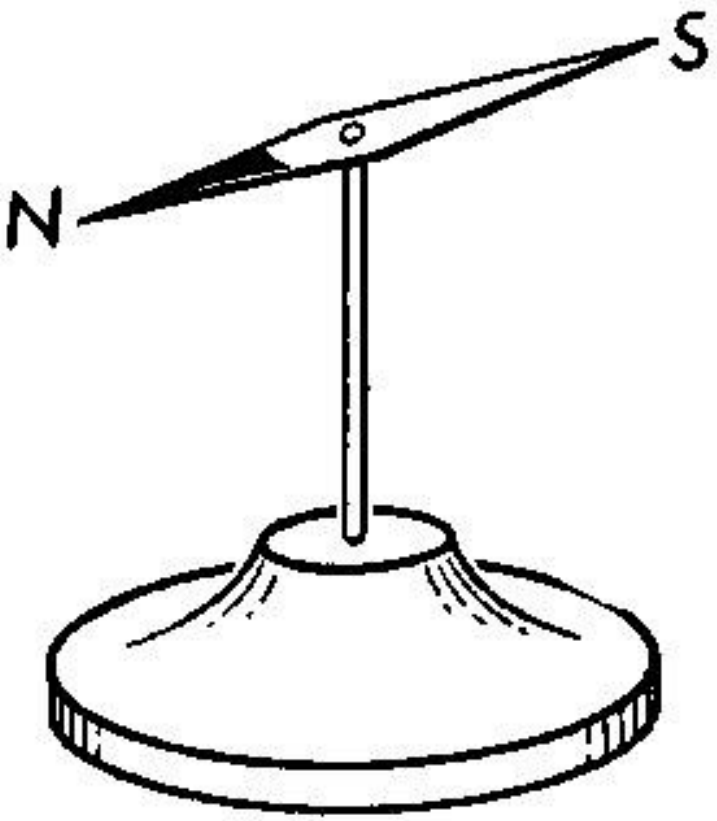
Two regimes of motion

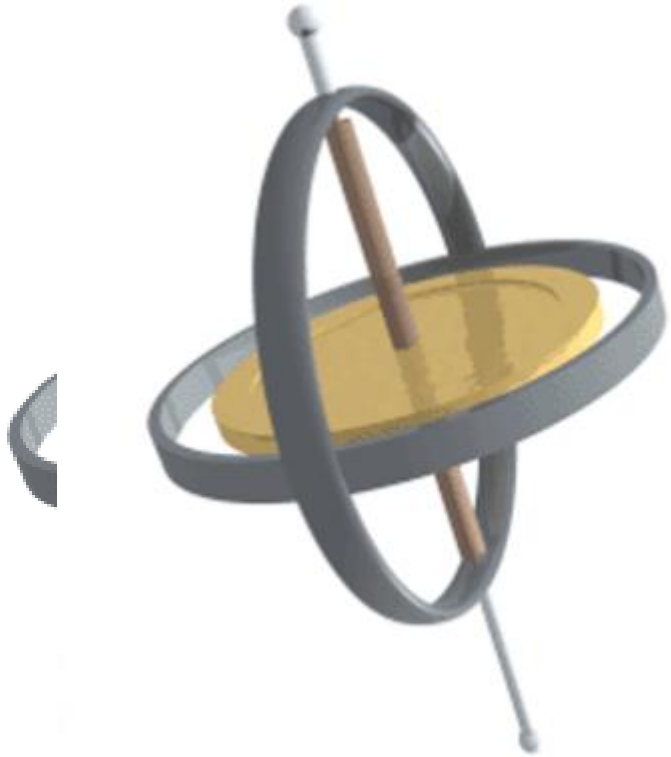


Precessing regime: $S \gg L$;

Tipping regime: $L \gg S$.

Ferromagnetic Gyroscope





✓ For precession to dominate

$$L \ll S$$

In other words

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

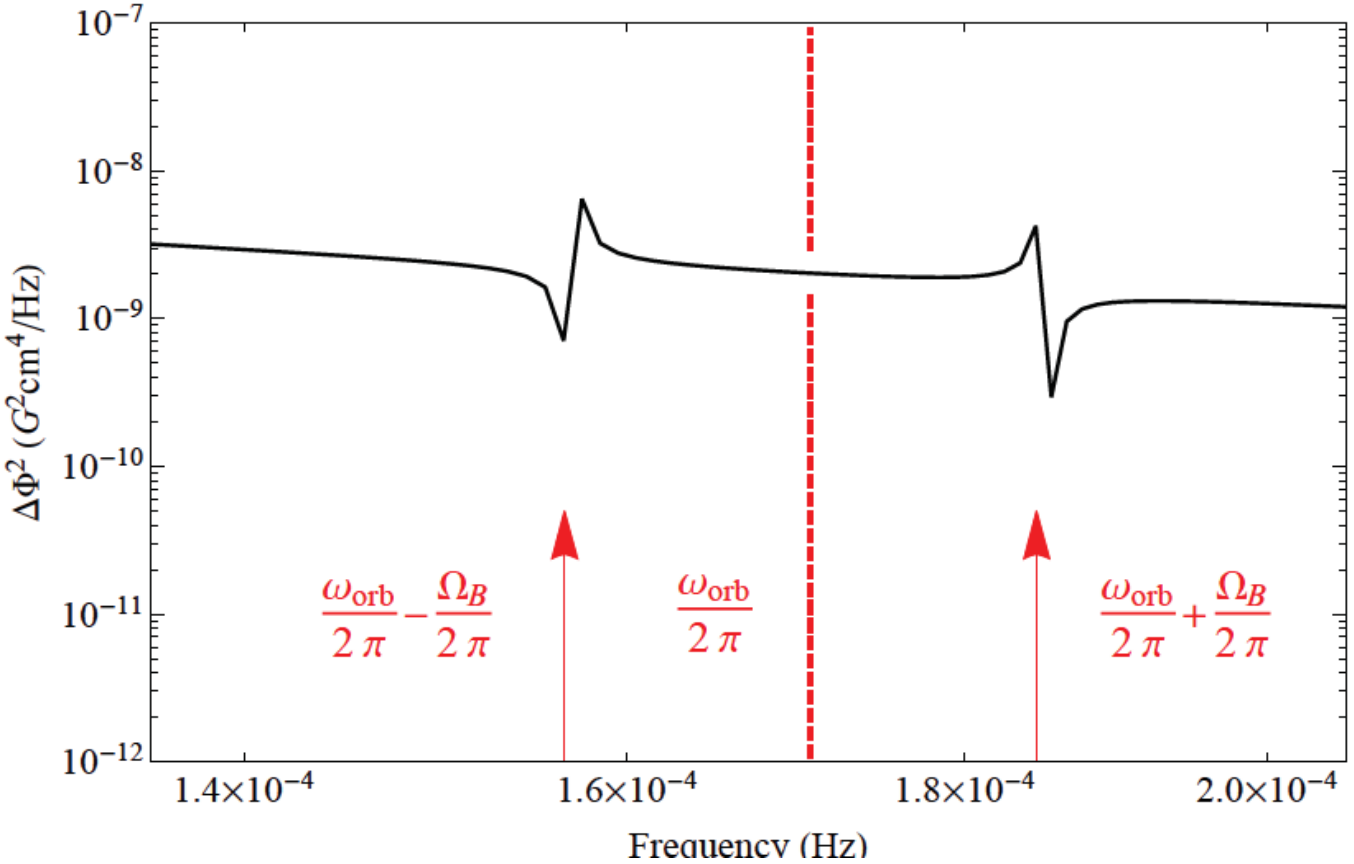
Threshold frequency

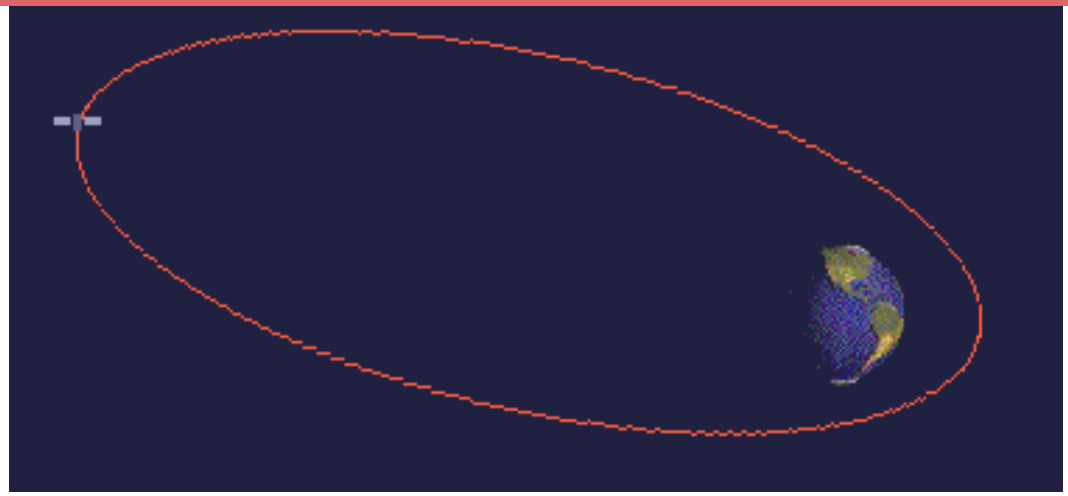
$$\Omega^* = \frac{N\hbar}{I}$$

Threshold magnetic field

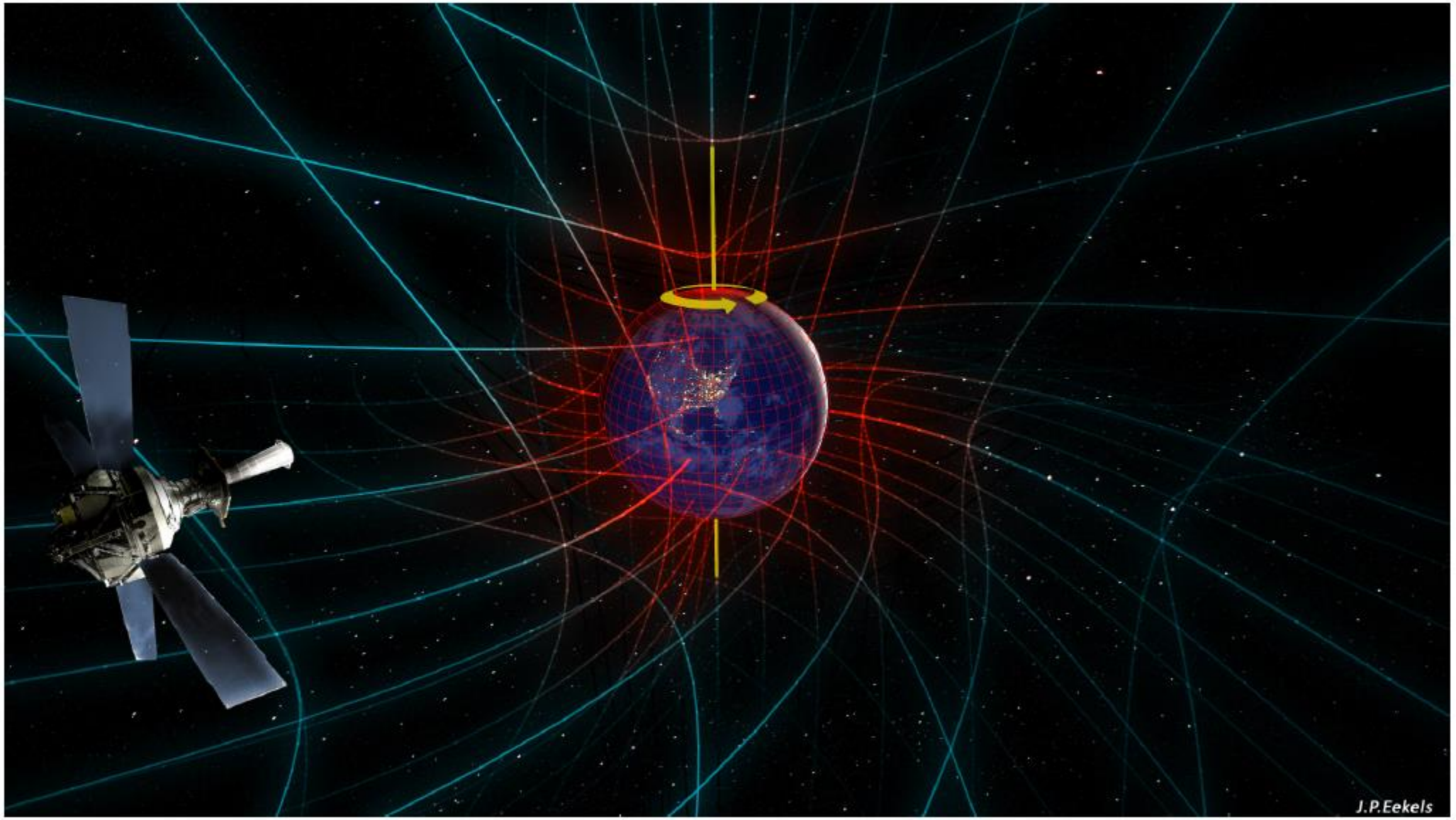
$$\mathrm{B}^* = \frac{\hbar\Omega^*}{g\,\mu_B}$$

Spectrum of a difference between two magnets

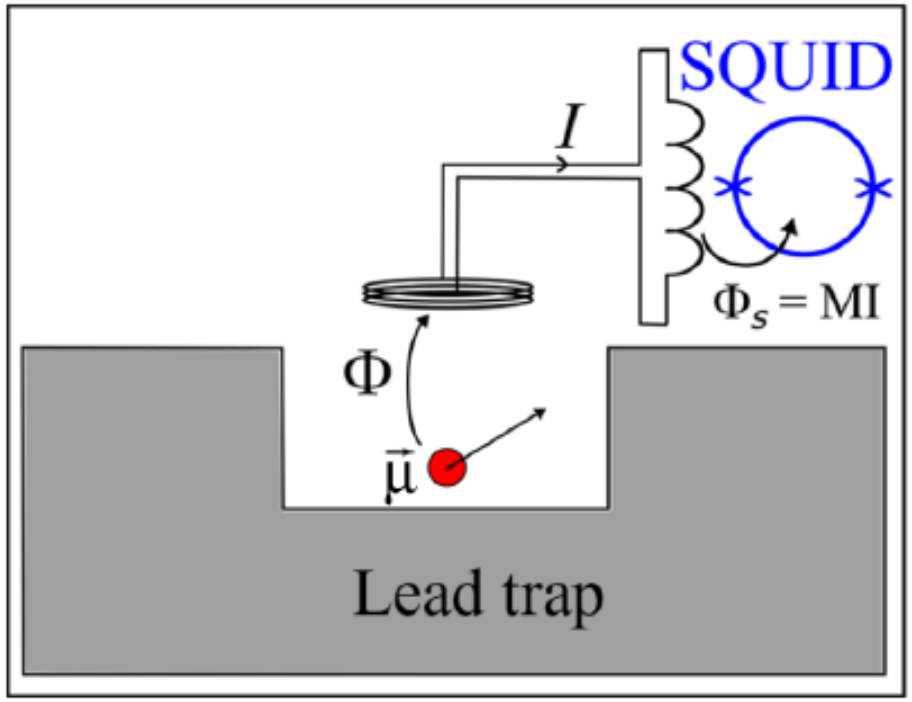


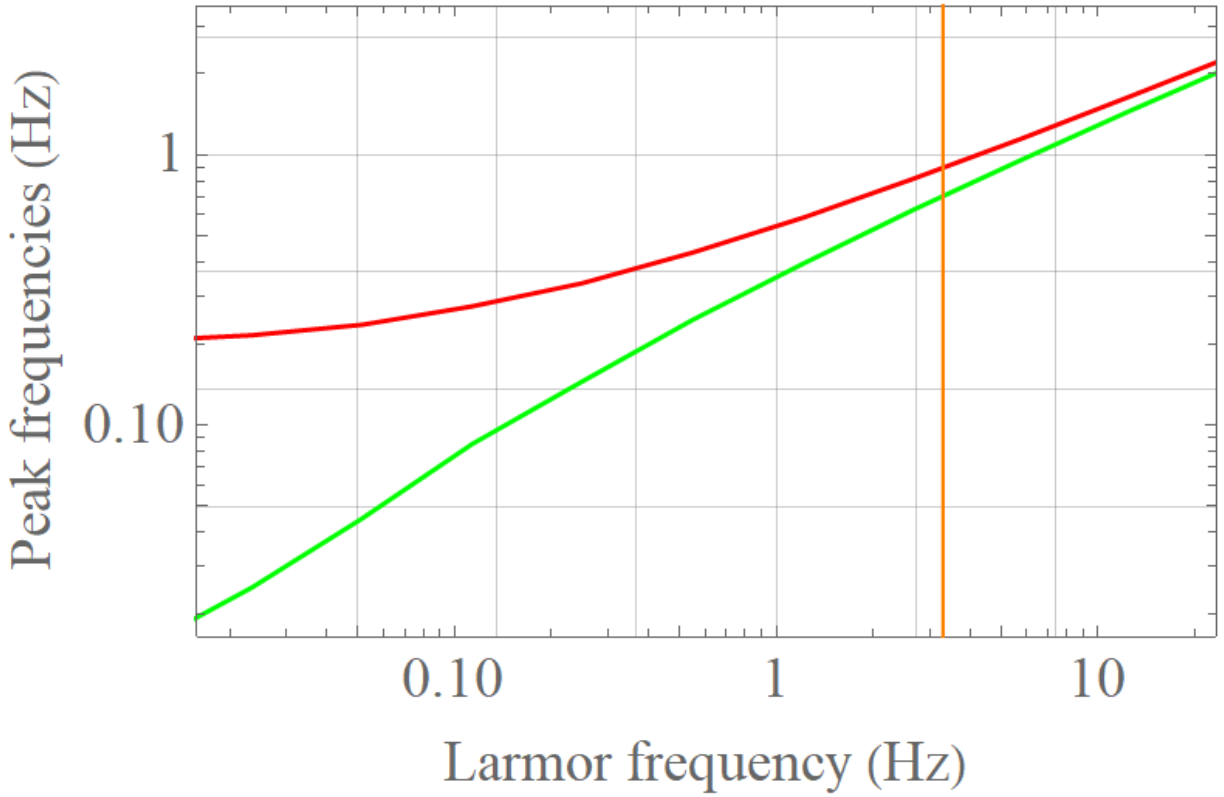


Ferromagnetic Gyroscope in freefall



Proof-of-principle device in the lab





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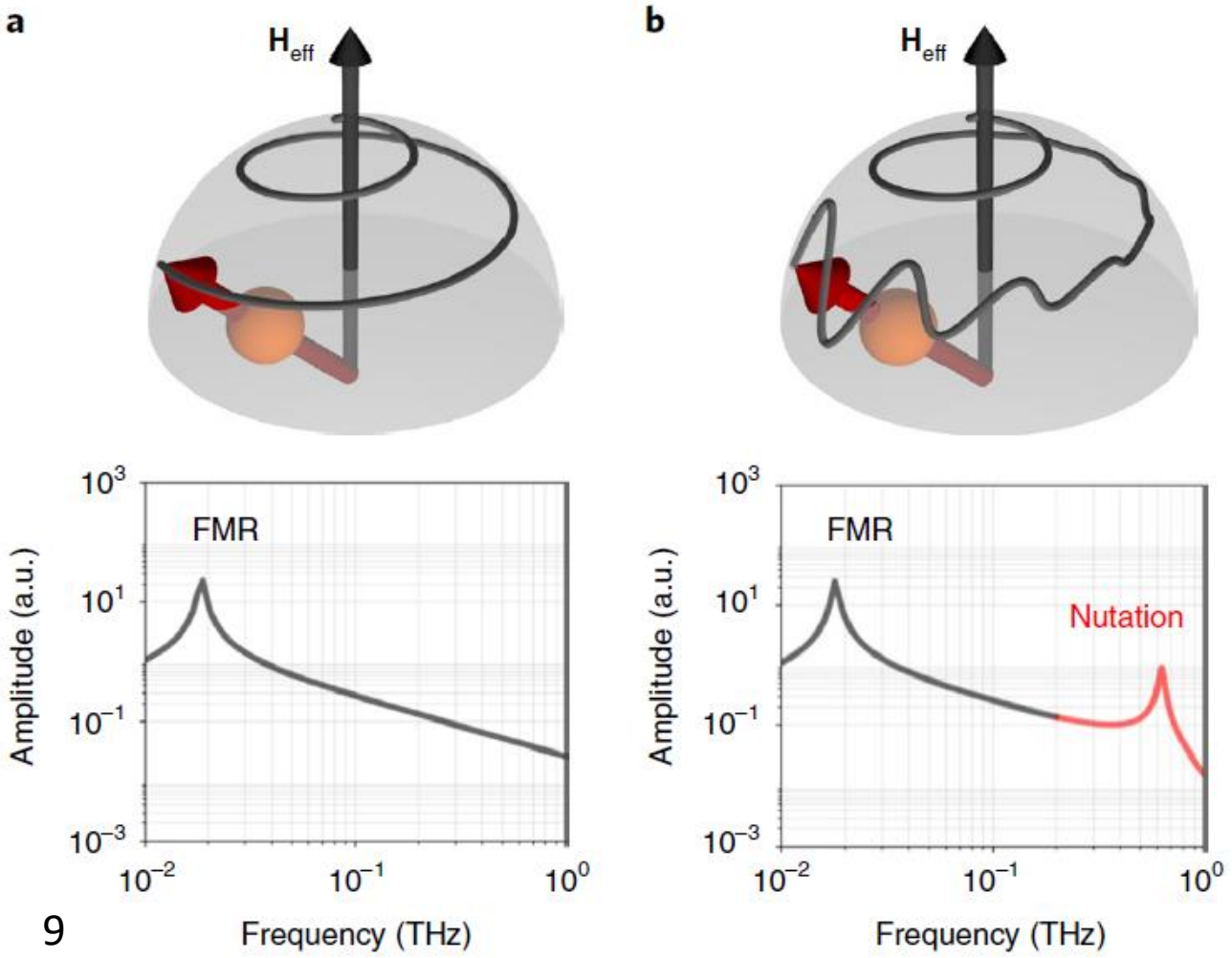
Inertial spin dynamics in ferromagnets

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



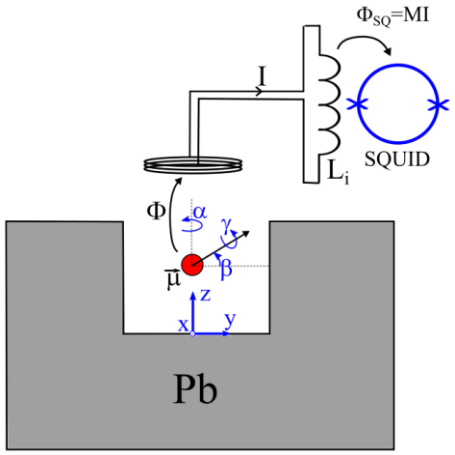
LeMaQuMe
Levitated Magnets for Quantum Metrology

QUANTERA

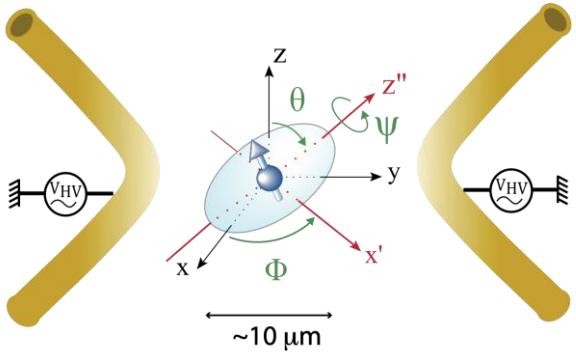
- Partners: CNR-IFN Trento (IT), CNRS Paris, (FR), JGU Mainz,
  LUH Hannover, Uni Ulm (DE), Uni Latvia (LV), Ben Gurion Uni (Israel)

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

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