Matter-Wave BEC Magnetometer: A Breakthrough In Ultra-sensitive Magnetic Measurements
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Project objectives:
- to develop theoretical model of ultra-sensitive coherent dark-state magnetometer operating with EIT effect in alkali media.
- to investigate the ways to improving the maximal sensitivity using thermal alkali clouds and BEC media.
- to investigate the improvement in sensitivity of the magnetometer with different source of optical pulses in the interferometer
- to investigate the possibility of ferromagnetic detection from space.

Fig. 1 The optical EIT magnetometer

Fig. 2 Real and imaginary parts of susceptibility versus normalized detuning.

Ferromagnetic target detection
Objective of follow-on project is the developing the algorithms for ferromagnetic target detection from space. Tasks:
1) Adapt magnetic gradiometer algorithms for Earth orbit environment.
2) Develop simulation to test algorithms, including modes for the space-craft orbit, Earth’s magnetic field, target fields, and clutter.
3) Investigate the problem of submarine detection.
4) Test the algorithms against the model and develop realistic expectations for locating classes of targets from low-Earth orbit.

Benefits:
The EIT magnetometer is a very sensitive sensor of the magnetic field. The maximal sensitivity of the magnetometer is $10^{-12}$ Gauss for coherent light beam and $10^{-10}$ Gauss for the correlated beam.

For example, the magnetometer with sensitivity of $10^{-14}$ Gauss will detect a ferromagnetic target of 300 kg at the distance of 200 km.

Magnetometers with the sensitivities $<10^{-12}$ Gauss can be useful for the detection of ferromagnetic targets from space.

Fig. 3 BEC in the magnetic trap.